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: 2016-C11

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 an application 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: 802-872-0629 | 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:

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

1. Preparer's Name:
2a. Mailing Address:
2b. Municipality: | 2c. State: | 2d. Zip:
3. Phone: | 4. Email:

D. Waterbody Information

1. Name of waterbody: Missisquoi River 2. Swanton and Highgate

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: 10/11/16

1b. Proposed end date (if known): 11/30/16

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

3. Pesticide(s) to be used[1]: 3-Trifluoromethyl, 4-Nitro
Trade Name: TFM-HP and TFM-BAR
EPA Registration #: 6704-45 and 6704-15
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 attachment 1
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. 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 YOUNG Digitally signed by BRADLEY YOUNG Date: 2016.04.12 14:28:09 -04'00' Date: 4/12/2016

G. 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: BRADLEY YOUNG Digitally signed by BRADLEY YOUNG Date: 2016.04.12 14:29:17 -04'00' Date: 4/12/2016

H. Application Fees

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, Main 2
Montpelier, VT 05620-3522

Direct all correspondence or questions to the Aquatic Nuisance Control Permit Program at:
ANR.Shoreland@vermont.gov
For additional information visit: www.watershedmanagement.vt.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)

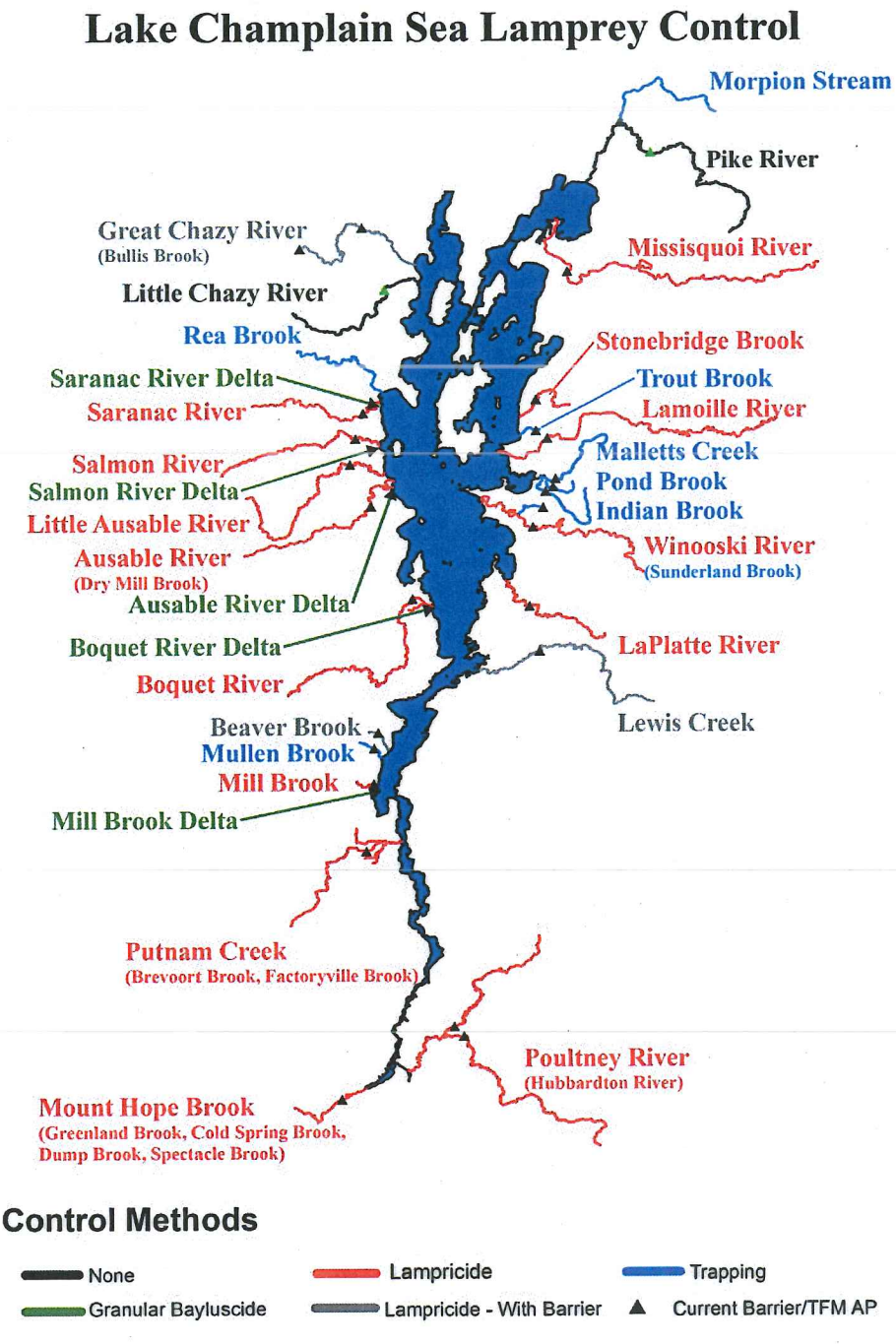
Attachment 1

Proposed Lampricide Treatment of the Missisquoi River in 2016 and 2020

Detailed Project Description
and
Information Supporting the Five Criteria for Aquatic Nuisance Control Permit Issuance

April 12th, 2016

Background and Rationale



The Lake Champlain Fish and Wildlife Management Cooperative (LCFWMC), made up of the Vermont Fish and Wildlife Department (VTFWD), New York State Department of Environmental Conservation (NYSDEC), and U. S. Fish and Wildlife Service (USFWS), initiated the long-term sea lamprey *(Petromyzon marinus)* control program in 2002. The Final Supplemental Environmental Impact Statement (FSEIS), *A long-term program of sea lamprey control in Lake Champlain*, details the program (purpose and need: pp. 3-10; history of the problem: pp. 27-31; summary of lampricide treatment methodologies: pp. 34-36). The long-term program was developed in response to significant improvements in salmonid survival, fishing quality, and economic impact resulting from the 1990-1997 experimental sea lamprey control program Fisheries Technical Committee (1999). There are currently 20 tributary systems included in the long-term program, with eight in Vermont, ten in New York, the Poultney/Hubbardton River system on the New York-Vermont border and the Pike River/Morpion Stream system in Quebec (Figure 1).

Figure 1. Lake Champlain tributaries included in the sea lamprey control program.

Wounding Rates and Socio-economic Impacts

From the conclusion of the experimental program in 1997 to the initiation of the long-term program in 2002, the parasitic-phase sea lamprey population rebounded and lamprey wounding approached and exceeded pre-control levels. Current wounding rates (27) on Lake Champlain lake trout (*Salvelinus namaycush*) and landlocked Atlantic salmon (*Salmo salar*) (19) continue to remain just above targets established for the program (Table 1). The program's objectives, stated in the FSEIS, are a maximum of 15 and 25 wounds per 100 fish for salmon and lake trout respectively. The walleye (*Sander vitreum*) wounding rate monitoring program includes surveys that alternate by river and year in order to collect data that represent the wounding rate throughout the basin (Table 2). Consistent maintenance of a long-term program of sea lamprey treatments at regular intervals is necessary to achieve and sustain target wounding rates for salmon, lake trout, walleye, and other species affected by sea lamprey parasitism.

Poor fishing in the past led many anglers to seek fishing opportunities elsewhere and adversely affected the Lake Champlain charter fishing industry. In 1997, 13 Lake Champlain fishing charter businesses (based in Vermont and New York) participated in an economic study of fishing-related businesses (Gilbert 1998). This number is estimated to be less than half of the fishing charter businesses that operated at that time. Through the 2000's, about four to six fishing charter businesses remained with significant levels of operation on Lake Champlain. It has been estimated that $29.4 million (dollars in 1990 value) in annual economic benefits to businesses and residents of the Lake Champlain Basin may have been lost due to the impacts of the uncontrolled sea lamprey population (Gilbert 1999).

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).

While wounding rates are reaching all-time lows since the inception of the program, continued suppression of sea lamprey in Lake Champlain is necessary to sustain and enhance economic and environmental benefits. These benefits include improved fishing quality and related positive economic impacts, as well as enhancing restoration of native lake trout, landlocked Atlantic salmon, lake sturgeon (*Acipenser fulvescens*), and walleye populations in Lake Champlain. Reaching the LCFWMC goal of comprehensive control of all sea lamprey-producing sources in Lake Champlain will achieve and sustain these benefits in the long term (Fisheries Technical Committee 2009).

Table 1. Sea lamprey wounding rates (wounds per 100 fish) on lake trout and landlocked salmon through time. ML= Main Lake basin; IS-MB= Inland Sea-Malletts Bay. Sample sizes are in parentheses.

Species	Lake Trout[a]	Landlocked Salmon[b]		
Basin	**ML**	**Lakewide**	**ML**	**IS-MB**
Objective	**25**	**15**	**15**	**15**
Pre-control[c]	55 (1,854)	32 (646)	34 (115)	32 (531)
Experimental control[d]	38 (3,290)	31 (1,594)	27 (1,013)	39 (581)
1999	55 (318)	38 (106)	33 (76)	50 (30)
2000	61 (288)	26 (459)	25 (417)	40 (42)
2001	60 (166)	53 (209)	54 (163)	50 (46)
2002	72 (182)	56 (101)	38 (47)	72 (54)
2003	77 (203)	93 (134)	79 (66)	106 (68)
2004	62 (117)	53 (206)	47 (74)	57 (132)
2005	94 (64)	69 (159)	59 (118)	98 (41)
2006	99 (137)	70 (230)	71 (159)	69 (71)
2007	46 (26)	74 (205)	71 (180)	92 (25)
2008	31 (75)	38 (182)	35 (150)	50 (32)
2009	55 (88)	32 (513)	31 (414)	38 (99)
2010	40 (218)	15 (292)	15 (269)	22 (23)
2011	30 (168)	19 (621)	19 (543)	14 (78)
2012	40 (197)	21 (207)	21 (187)	26 (19)
2013	54 (332)	19 (331)	15 (259)	33 (72)
2014	30 (398)	15 (568)	13 (481)	29 (87)
2015	**27 (388)**	**19 (1,017)**	**18 (886)**	**25 (131)**

[a] Lake trout in the 533-633 mm (21-25 inches) length interval.
[b] Salmon in the 432-533 mm (17-21 inches) length interval.
[c] Pre-control included 1982-92 for lake trout and 1985-92 for salmon.
[d] Experimental control included 1993-98.

Table 2. Sea lamprey wounding rates on Lake Champlain walleye through time. Sample sizes are in parentheses ("ns" indicates not sampled).

Number of sea lamprey wounds per 100 walleyes[a]																	
Basin	**Objective**	**Pre-control**	**Experimental control**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Poultney & South Bay (South/Main Lake)	2	13 (831)	4 (451)	3 (122)	3 (80)	ns	0 (58)	ns	3.8 (52)	4 (50)	ns	ns	0 (489)	ns	ns	0 (326)	ns
Winooski (Main Lake)	2	ns	3 (664)	2 (110)	7 (174)	4 (265)	ns	11 (389)	6.4 (94)	ns	4.6 (173)	ns	ns	3.9 (362)	ns	ns	5.2 (346)
Lamoille (Mallet's Bay)	2	ns	4 (975)	16 (69)	ns	ns	9 (68)	ns	5.5 (105)	ns	ns	ns	5.0 (139)	ns	ns	2.7 (221)	ns
Missisquoi (Inland Sea)	2	ns	1 (877)	4 (789)	1 (140)	0 (78)	1 (267)	ns	3.8 (130)	3.3 (120)	ns	3.9 (208)	ns	ns	1.5 (133)	ns	ns

[a] Walleyes in the 534-634 mm (21.0-24.9 inches) length interval, collected in spring spawning population surveys. For walleye, pre-control included 1988-92, while eight-year control includes 1993-97. There are no pre-control data for the Winooski, Lamoille, and Missisquoi rivers.

Sea Lamprey Population and Treatment History

Sea lamprey larval population assessments conducted by the USFWS Lake Champlain Fish and Wildlife Resources Office are used to select streams that warrant treatments. Sea lamprey annual reproduction in the Missisquoi gradually increased since the commencement of the sea lamprey control program. However, that trend stopped in 2015 as the most recent survey, after a thorough and successful treatment was conducted in 2012, showed a substantially reduced population confined to the uppermost surveyed sections (Figure 2). Many factors may contribute to this decline, but we believe that a large contributing factor is the overall reduced abundance of available spawning lamprey in the lake. This trend of reduced population size is being seen in many of our Lake Champlain tributaries now. Table 3 shows a summary of larval sea lamprey abundance estimates determined by USFWS QAS (Slade et al. 2003) surveys. The QAS method was discarded with respect to its estimation of population sizes in 2015. Instead, similar sampling protocols are used, but data are reported simply as number of animals caught per sampling transect (Figure 2.) and a reach or river density that reflects catch per unit effort. In our case, the density is the number of lamprey caught per meter of habitat sampled. Those data form the basis for the proposed 2016 treatment.

The Missisquoi River has been treated twice prior to this proposed 2016 treatment (Table 4). It was a late addition to the program because lamprey had not previously been detected there. The first treatment was less than successful because equipment and experience were both lacking. The second treatment was a success as we learned and adjusted to the variables we observed. The discharge for the Missisquoi River makes it our largest treatment as measured by amount of lampricide needed to treat it (Table 4.).

Table 3. Sea lamprey larval population estimates (young-of-year excluded) in Missisquoi River.

Year surveyed	Estimated No. Ammocoetes	Estimated No. Transformers	Year(s) of Lampricide Treatment
2002	8,020	1,337	2008, 2012,
2003	10,025	0	*proposed* 2016
2007	63,173	0	
2011	408,283	0	

Table 4. Missisquoi River lampricide treatment history. *1.84 pounds were in TFM-BAR formulation

Date	River miles	Discharge (cfs)	TFM used		Reference
			Formulation (gal)	Active Ingredient (pounds)	
11/07/2008	7.8	1,175	1,310	4,192	Chipman 2009a
10/26/2012	7.8	1,110	939*	2,987	Smith 2013

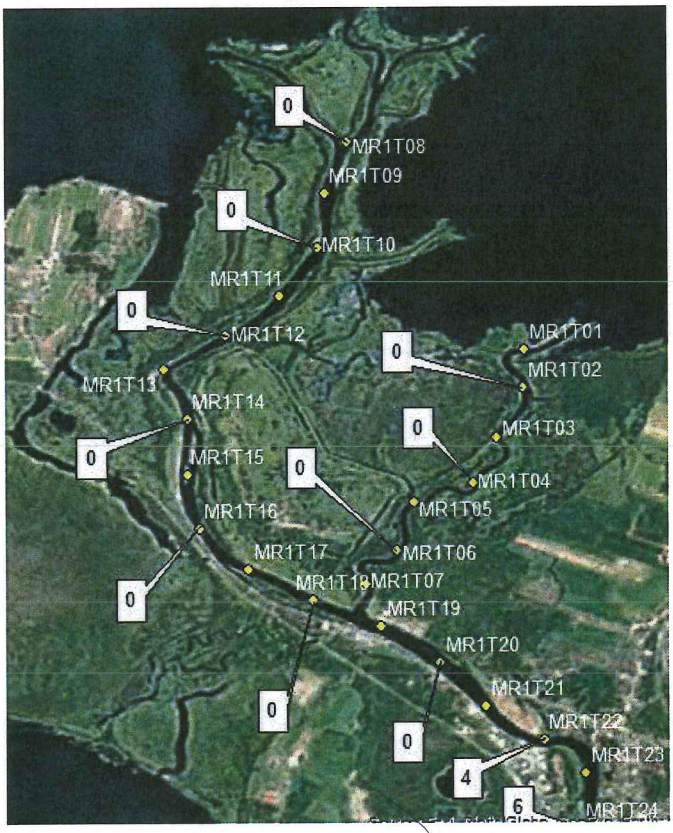


Figure 2. The twelve transects where lamprey were electrofished in 2015 and the associated catch. The overall catch per unit effort (density) or sea lamprey was 0.04 lamprey/m^2 for the entire river.

Five Statutory Criteria [10 V.S.A. § 1455 (d)] to be met for the issuance of a VT Aquatic Nuisance Control Permit

(1) There is no reasonable non-chemical alternative available. The USFWS uses an integrated pest management approach to determine appropriate long-term control strategies on a stream-specific basis (FSEIS pp. 41-47). A body of research has been developed on non-chemical sea lamprey control methods in the Great Lakes (Wagner et al. 2006, Sorensen and Hoye 2007, McLaughlin et al 2007, Bergstedt and Twohey 2007) and Lake Champlain (Alternatives Workgroup 2006). An entire issue of the Journal of Great Lakes Research was dedicated to current lamprey control and alternatives research (Jones et al. 2003) and a current list of research funded by the Great Lakes Fisheries Commission on non-chemical alternative control methods can be found at this website: http://www.glfc.org/research/scr.php#ac. Interest in the use of pheromone attractants as a potential non-chemical alternative has received considerable attention; however, pheromones related control methodologies have not yet progressed beyond the point of limited experimental usage (Johnson et al. 2015).

The *Status Report for the Lake Champlain Sea Lamprey Alternatives Workgroup* (USFWS 2006) summarizes nine studies conducted from 2002 through 2006 which 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.

Despite the completed and ongoing research on non-chemical controls 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.

A barrier in Quebec was put into use in 2014 which 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.

(2) There is acceptable risk to the non-target environment. The evidence presented in the FSEIS (pp. 104-170; 188-197; and 307-311) and the results of our 2 treatments of the Missisquoi River in 2008 and 2012 demonstrate the low impact that controlled applications of lampricides at the proposed concentration have on non-target species.

Seven State-listed endangered or threatened mussel species (Black Sandshell, Fragile Papershell, Fluted-Shell, Pocketbook, Giant Floater, Pink Heelsplitter, Cylindrical Papershell) and four State-listed endangered or threatened fish species (Eastern Sand darters, Lake Sturgeon, Stonecat, and American Brook Lamprey) that are addressed in detail in the VT Endangered and Threatened Species Takings permit application for this proposed treatment which is currently under review by the Agency of Natural Resources and will not be readdressed in this permit application. Two non-listed species of concern

(silver lamprey and mudpuppy) in the Missisquoi River will be potentially adversely affected by the proposed treatment. Silver lamprey are effectively equal to sea lamprey in their susceptibility to the treatment, but Mudpuppies are more tolerant. A history of all observed mortalities following Missisquoi River lampricide treatments is shown in Table 5.

Table 5. History of observed non-target mortalities following lampricide treatments of the Missisquoi River.

	Missisquoi		
	2008	2012	
River Miles Treated	10.4*	10.4*	
River Miles Surveyed	10.4*	1.9	
% of Survey Area Accessible	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.

Silver Lamprey

Impacts of TFM on silver lamprey are discussed in pp. 136-140 of the FSEIS. Lampreys of the genus *Ichthyomyzon* (including silver lamprey *I. unicuspis* and northern brook lamprey *I. fossor*) are known to be slightly more resistant to TFM than is the sea lamprey, but substantial losses of silver lamprey larvae are unavoidable in TFM treatments. It has been suggested that reductions in larval sea lamprey abundance may benefit silver lamprey, since invading sea lamprey are highly adaptable and have a competitive advantage (Schuldt and Goold 1980). While not part of a study, USFWS survey data suggest that silver lamprey have proportionally increased in relative abundance to sea lamprey in both the Missisquoi and Poultney rivers following successive TFM treatments. In the Missisquoi River, the silver lamprey population has shown a gradual decline after 2 treatments as shown in Table 6. However, this is far from enough data to substantiate a trend given the number of variables involved. We have seen similar data in the AuSable River in NY where the numbers suddenly rebounded with no apparent explanation. The important message here is that the population is persisting, better than larval sea lamprey, and we are continuing to monitor their numbers.

Table 6. Missisquoi River Silver Lamprey population estimates

Year	River	Population Estimate	# (N)	M^2	Density
2007 (Pre)	Missisquoi	660,269	101	270	0.374
2008 Treatment					
2009 (Post)	Missisquoi	26,206	5	270	0.019
2011 (Pre)	Missisquoi	355,544	67	270	0.248
2012 Treatment					
2013 (Post)	Missisquoi	2,498	1	248.5	0.004
2015 (Pre)	Missisquoi	NA	32	225	0.142
Proposed 2016 Treatment					

Mudpuppy

Effects of lampricides on the mudpuppy and other amphibia are discussed in the FSEIS on pp.153-158. Boogaard et al. (2003) found adult mudpuppies to be moderately resistant to lampricides, with NOEC's of 1.6 (Table 7). Neuderfer et al. (2004) conducted a TFM toxicity test on mixed age (1-4 years) mudpuppies, and exposed young of year mudpuppies in tests to TFM. The resulting TFM NOEC for the mixed-age mudpuppies was 1.0 x MLC (LOEC = 1.3 x MLC). The young-of-year were slightly more sensitive, with a TFM NOEC of 0.8 x MLC, and an NOEC from the mixture of 0.6 x MLC: the LOEC for both TFM and the mixture was 0.9 x MLC.

Table 7. 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). NT=not tested.

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

Results from the toxicity studies described above indicate a trend of increasing resistance to lampricides with increasing mudpuppy age (Table 7), and this trend appears to be consistent with reported field observations. Breisch (1996, 2000a, 2000b) reported that larger proportions of juvenile than adult mortalities were observed in post-treatment assessments in the Great Chazy River and Ausable River. Lake Champlain tributaries treated with TFM at concentrations up to 1.5 times MLC. Weisser et al. (1994) reported that 100% of caged mudpuppies greater than 50 mm 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; they survived 1.3 and 1.6 x MLC (Chipman 2003). All of 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; these were generally 1.0 x MLC treatments with a small area exposed to 1.1 x MLC in 2004 and 1.3 x MLC in 2008 due to pH shifts (Chipman 2005 and 2009b). Seven mudpuppies were collected in the Poultney River after the 2007 TFM treatment at 1.2-1.3 x MLC (Durfey and Chipman 2008); five of these were juveniles ranging from 72 to 87 mm TL (VTDFW unpublished data).

Juveniles (25-200 mm TL) comprised 77% of over 500 dead mudpuppies collected after the 2009 Lamoille River treatment (1.1-1.2 x MLC); adults ranged up to 358 mm TL and those greater than 250 mm TL comprised 8% of the sample (VTDFW unpublished data). The Vermont Cooperative Fish and Wildlife Research Unit conducted a mudpuppy population study in the Lamoille River. A total of 80 mudpuppies were trapped and released from December 2008 through May 2009 (prior to the October 2009 Lamoille River treatment); and 75 of these were tagged. Following the treatment, with the objective to assess the population-scale impact from the treatment, the trapping effort was repeated in the winter of 2010 from December 2009
through May 2010. The winter 2010 collection effort resulted in 81 individual mudpuppies being collected. Ten of these mudpuppies were tagged recaptures from the previous effort conducted in the winter of 2009. The study did not detect a difference in the population estimate between the sampling efforts conducted before and after the TFM treatment. Only sex-ratio differences were detected between sampling efforts (Chellman and Parrish 2010). Some have claimed that a shift in sex ratios indicates an impact from TFM. However, the USFWS has surveyed all the mudpuppies following 2 recent treatments in the Great Chazy River in New York and the Poultney River and found no significant difference in sex ratio among the recovered mudpuppies following their treatments, each which had been treated 3 more

times than the Lamoille. If TFM were creating shifts in sex ratios in this species, that effect would be even more pronounced in the populations of these rivers.

In 2011, the Marquette Biological Station (USFWS) 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 times MLC to 1.5 times MLC (Fodale et al. 2012).

Based on the above findings, young-of-year and juvenile mudpuppy mortality is possible from application of TFM at or above the 9-hour MLC level for 12 hours. It should be noted that a 12-hour exposure at or above this level is the worst case. In practice, the target concentration at the application point is not maintained for a full 12 hours because the concentration increases to the target level gradually after the application begins, and concentrations in the TFM block tend to decrease as it travels downstream and attenuates. A 12-hour exposure from a 14-hour treatment would be expected for only a relatively short distance below the AP.

The above evidence and experience in treating rivers with lampricide shows that a proposed treatment concentration of 1.0 to 1.2 x MLC may cause mortality to young-of-year and yearling mudpuppies and other salamanders, 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 is discussed on pp. 101-104 in the FSEIS. In regard to public health, the U. S. Environmental Protection Agency (EPA) stated in its 1999 *Reregistration Eligibility Decision* that "Human risks from exposures of TFM and niclosamide do not exceed levels of concern for the currently registered uses." (FSEIS Appendix C). In 2004, EPA issued risk assessment guidance stating that TFM may be present in drinking water at levels up to 300 parts per billion (ppb) before there would be any potential concern about risk to human health (Lindsay 2004).

In addition to product label use restrictions, the USFWS will follow the mitigation procedures that further limit human exposure to TFM described in the FSEIS (pp. 178-188) and detailed in, Vermont prior notification, and water supply plan for lampricide applications (Smith 2016a), and Contingency plan for accidental spillage of lampricides during Lake Champlain sea lamprey control operations (Smith 2015). Water use advisories dictated by these procedures advise the public of the risk of exposure from household, agricultural, and recreational swimming uses, and recommend against water use or exposure until TFM levels fall below 35 ppb. All other recreational uses have an advisory level of 100 ppb. A water user survey will be sent to all landowners and leaseholders within the treatment advisory area whose properties are located along the shoreline of the affected area during the summer prior to treatment. The survey will identify surface water uses and potential water needs during the treatment (Smith 2016c). The USFWS will post public access points with a sign approved by Vermont DEC and provide a voluntary press release for local broadcast media to notify the public.

The USFWS is working with Vermont Department of Fish and Wildlife, the Lake Champlain Basin Program, and the Quebec Ministry of Environment to identify landowners along the shoreline of the Quebec advisory area who will be notified of the planned treatment and its implications. If desired, they will be provided with alternative water arrangements as is done for Vermont landowners under the treatment notification and water supply plan (Smith 2016a). Advisory signs (French and English) will be posted at public access areas within the advisory zones.

The Philipsburg-Bedford municipal water intake is located about 0.3 miles (0.5 km) outside the preliminary water use advisory zone and utilizes activated carbon filtration which removes TFM (if present) as well as other organic compounds from the water supply (Dawson et al. 1976). Water monitoring during the 2008 and 2012 Missisquoi treatment indicated that the carbon filter effectively removed TFM from the raw water to below the detection limit of the analysis equipment in most cases. However, anomalies were measured in the Philipsburg-Bedford finished water at their treatment plant. A trace amount (<2.5ppb) of TFM was detected on 4 days in 2012. With the carbon filtration precautions that were taken, this was not explainable. While we believe this concentration to be far below a level of concern, based on both the USEPA and the 10x more restrictive Vermont Department of Health advisement, we recognize and respect the desire of the Quebec provincial government to have all of the TFM removed. To facilitate further safety in 2016, we will be coordinating with the water treatment plant operator to increase the concentration of charcoal used this time. This further precaution should ensure no TFM is present inthe finished water.

(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 which incorporates 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 6 of the 13 Vermont streams inhabited by sea lamprey. 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 effectively control sea lamprey.

(5) Public Benefits. Substantial public benefits of sea lamprey control in Lake Champlain were demonstrated in the 8-year experimental program (Fisheries Technical Committee 1999). At the end of the experimental program, fishery benefits and angler satisfaction increased so dramatically that anglers planned to spend an estimated additional 1.2 million angler days annually fishing Lake Champlain, which generate an estimated 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.

Treatment Strategy and Methodology

Proposed Treatment Strategy

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 spread the applied lampricide evenly from bank to bank in order to avoid one bank receiving an excessive amount of chemical and the other bank not receiving enough to meet MLC requirements. Applying upstream of the dam will facilitate mixing where the uniform water depth and velocity at the head of the dam prevents overloading or underloading a portion of the uneven, natural river channel.*

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 MLC.*

3. *MLC will be determined by the results of an on-site toxicity test and diurnal stream pH and alkalinity analysis in the days prior to treatment. 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 on up to 4 small tributaries (SAP 1-4 on Figure 3) 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 3) 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.*

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.

Treatment Methodology

Treatment planning and execution will be similar to that of previous treatments. All applications of lampricides will be made in accordance with Endangered and Threatened Species Takings permit, companion to this one. 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). The MLC will be determined by the results of an on-site toxicity test 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 USFWS estimates that between 700 to 1,500 gallons of TFM-HP formulation may be applied to the Missisquoi River over a 12 to 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 3).

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 as for pH monitoring. 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 passes through each point, 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

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 3, Table 8. Water samples will be collected for analysis at intervals of 30 minutes at the most upstream sampling station below each application point (AP), as well as below supplemental application points where lampricide is applied with an adjustable rate pump. Lampricide concentrations will be monitored at least once every 2 hours at all other downstream sampling stations, by hand or by deployment of automatic water samplers, to assess concentrations and duration of the lampricide block passing each point. 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. Water samples may also be collected at other points on the stream to track progress of the block.

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 Stations M2 after lampricide application has ceased at the AP.

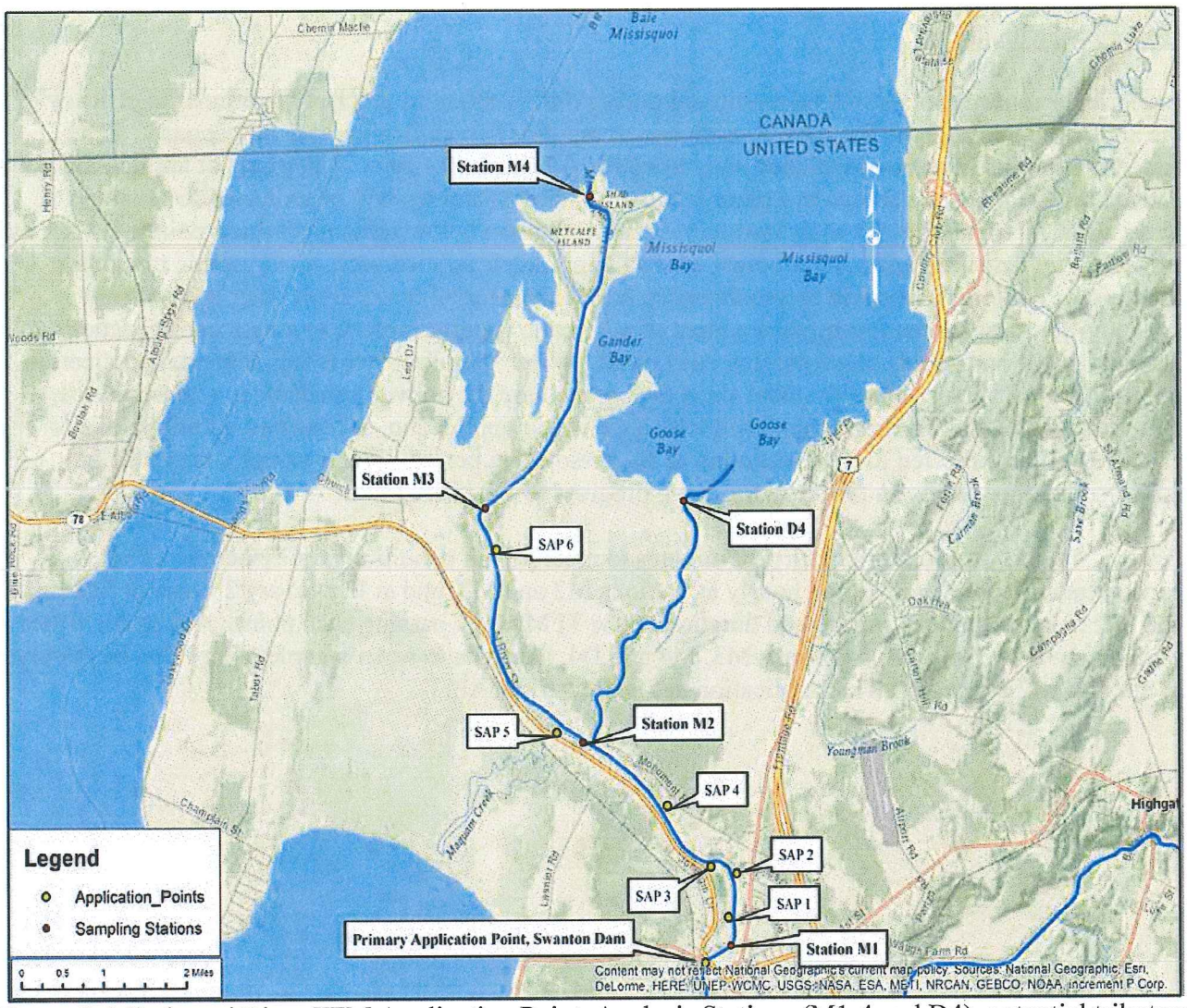


Figure 3. Missisquoi River TFM Application Point, Analysis Stations (M1-4 and D4), potential tributary mouth supplemental TFM application sites (SAP1-4), and potential backwater supplemental liquid TFM application sites (SAP 5-6).

Table 8. Description of the location of each application and analysis site on the Missisquoi River.

Description of analysis sites of 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

This strategy is designed to provide an effective sea lamprey control treatment, while providing a margin of safety for non-target species of concern in the Missisquoi River. The USFWS will coordinate with the Village of Swanton and Enel North America, Inc., 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.

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 3. 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 would 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.

Target/Non-target Species Mortality Monitoring

Post-treatment mortality assessment crews will walk 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 about 20 % of the treated reaches and are defined based on the locations of USFWS sea lamprey QAS 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 4.

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. 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.

This approach has been approved in previous permits issued for the treatments of the Winooski, Lamoille, Poultney, Hubbardton, and Missisquoi rivers, and Stone Bridge Brook. Results of non-target mortality surveys will be submitted to the VT DEC 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.

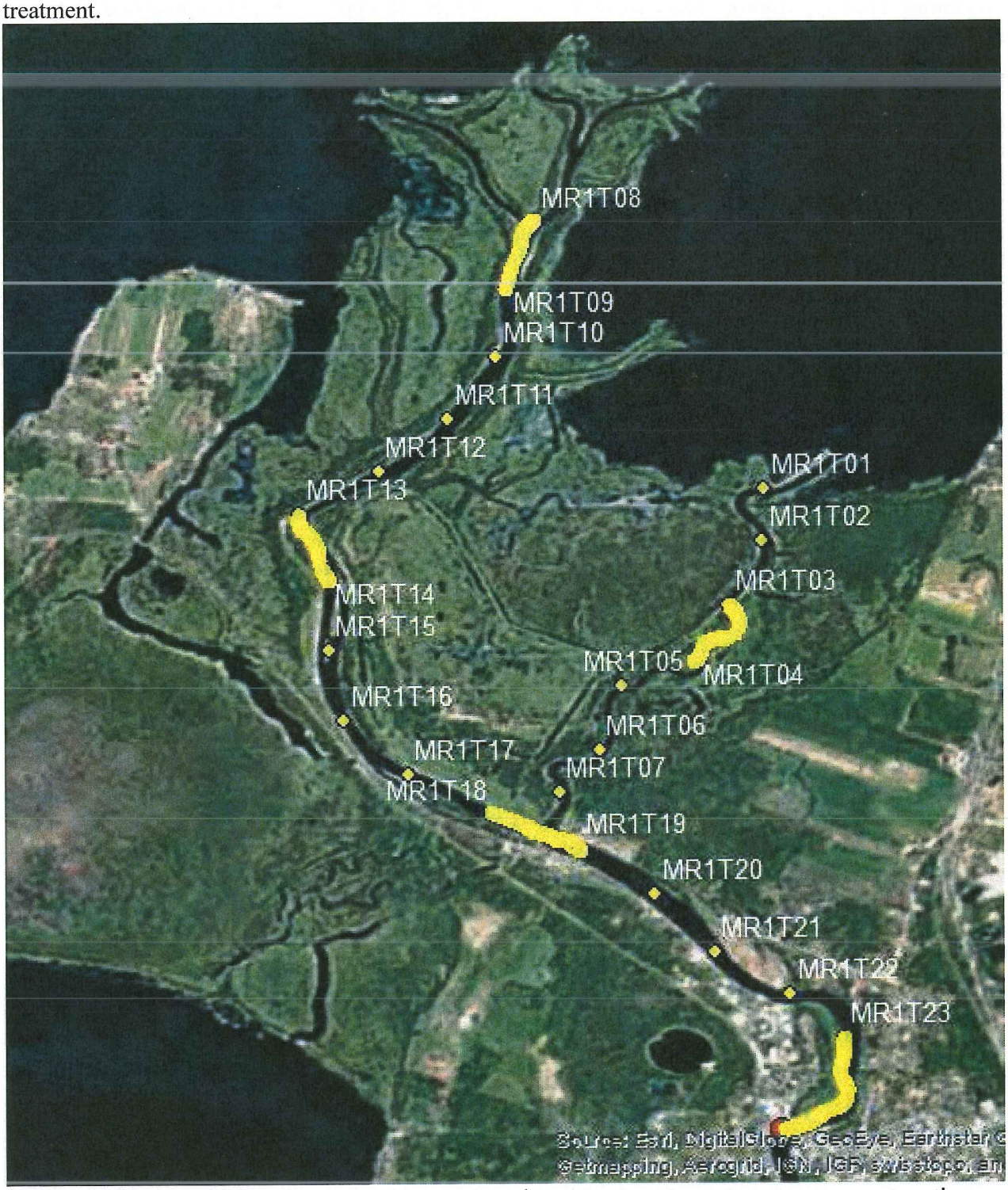


Figure 4. Missisquoi River, assessment transects and post-treatment non-target assessment sections

Conclusion

Considering the 5 Vermont statutory criteria discussed above, the USFWS has the opinion that a controlled application of TFM at a concentration of up to 1.2 X MLC will acceptably meet and fulfil the requirements necessary for obtaining an Aquatic Nuisance Control Permit for the proposed sea lamprey treatment of the Missisquoi River. Proposed permit conditions are presented in Attachment 2.

Permit cycle

At a meeting in Montpelier on February 24th, 2015 with Secretary Markowitz, Commissioner Porter, and other key individuals, the duration of the permits and the idea of lumping them was discussed. As a result, it was decided that the T&E permit should be made consistent in duration with the DEC's Aquatic Nuisance Control Permit which lasts 5 years. Therefore, we are asking for this ANC permit to remain consistent with the existing Poultney-Hubbardton rivers, Lewis Creek, and Winooski River ANC permits by becoming effective in the fall of 2016 and remain effective through the fall of 2021. This would allow the Missisquoi River to be treated twice on this one permit (2016 and 2020). If issues arise or need to be addressed, the permit can be reopened. This does not guarantee 2 treatments; instead it will allow a second treatment in 2020 assuming that nothing significant has changed during that time that would affect permit conditions. 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.

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Proposed Aquatic Nuisance Control Species Permit Specific Conditions for the 2016 and 2020 Missisquoi River TFM Treatments

Attachment 2

Proposed Permit Conditions

Part II. Pesticide Application Conditions

A. Pesticide Use Conditions

1. The Permittee is authorized to use TFM-HP Sea Lamprey Larvicide (EPA Reg. No. 6704-45), and TFM Bar (EPA Reg. No. 6704-86)

2. All TFM-HP, and TFM-Bar (lampricide) products shall be registered with the U.S. Environmental Protection Agency and the Vermont Agency of Agriculture, Food and Markets for use in Vermont at the time of the treatment, and shall be handled, applied, and disposed of in full conformance with all label requirements as well as all state and federal regulations in effect at the time of the treatment.

3. All Operators (pesticide applicators) shall be certified by the Vermont Agency of Agriculture, Food and Markets in Category Five – Aquatics.

B. Date, Location and Environmental Conditions

1. The Permittee is authorized two applications of lampricide under this permit; one between September 14 and December 1 of 2016 and one between Labor Day and December 1 of 2020. If the 2016 treatment must be postponed until 2017 or the 2020 treatment 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, not pushed back one year, to maintain the basin alignment strategy for conducting lampricide treatments.

2. The Permittee shall apply TFM only in the authorized areas of the Missisquoi River shown on Attachment 1, identified as follows:

a. The primary application location is less than 100 meters upstream of Swanton Dam (river mile 7.8).
b. Supplemental application in up to 4 tributaries of the Missisquoi watershed, downstream of the primary application point, using TFM-BAR for the purpose of negating the effects of incoming freshwater. TFM-Bar shall be placed no further than 100 meters upstream of a tributary's confluence with the 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.

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

4. The Permittee shall consult USGS stream gauge 04294000 for measure of stream flow. No treatment shall occur unless the flow of the Missisquoi River is less than 1500 cubic feet per second (CFS).

5. No treatment 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 permanent USGS gauging station located at Burlington, Vermont.

C. Pesticide Application Conditions

1. The Permittee shall apply the 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. Control Report 92-001.4 (Adair and Sullivan 2014); and,
b. *Contingency Plan for Accidental Spillage of Lampricides during Lake Champlain Sea Lamprey Control Operations* (Smith 2015).

2. 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.

3. The lampricide application rate at the Primary Application Point (M1) and any supplemental application points (SAP 1-6) shall not exceed 1.2 x MLC to sea lamprey.

4. The Permittee shall monitor TFM concentrations at the Primary Application Point (M1) and any supplemental application points (SAP 1-6) and adjust application rate to account for changes in pH, alkalinity, and discharge to ensure TFM concentration at those sites does not exceed 1.2 x MLC to sea lamprey.

5. The Permittee shall not apply TFM into the Missisquoi River for longer than 14 consecutive hours.

D. General Conditions

1. The Permittee shall notify the Aquatic Nuisance Control Program Coordinator, Misha Cetner, by phone 802-490-6199 or via email at misha.cetner@vermont.gov, at least five days in advance of the scheduled lampricide application taking place. In the event that any necessary treatment schedule changes are made within this 5-day period, the Permittee shall notify the Aquatic Nuisance Control Program as soon as possible to inform it of the schedule change and reasons for such change.

2. This permit may be modified or amended upon request by the Permittee or by the Department. Any modification under this condition shall be performed in accordance with the public notice requirements of the *Public Review and Comment Procedures for Aquatic Nuisance Control Permit Applications and General Permits,* dated January 30, 2003.

3. Prior to any treatment occurring with equipment (e.g. boat, trailer, vehicle, gear) that has been in or on any other waterbody, the Permittee shall comply with 10 V.S.A. §1454. All equipment shall be decontaminated in compliance with the *Draft Voluntary Guidelines to Prevent the Spread of Aquatic Invasive Species through Recreational Activities,* Aquatic Nuisance Species Task Force, November 2012. All Operators shall adhere to these guidelines.

4. Cause for permit suspension or revocation includes, but not limited to, the following:
   a. violation of any of the terms or conditions by the Permittee;
   b. failure to disclose relevant facts, new research, findings, or other information not previously made available by the Permittee;
   c. any misrepresentation of fact or the provision of false information by the Permittee;
   d. a determination that the risk to the non-target environment resulting from the activities authorized under this permit is unacceptable;

e. a determination that the risk to public health resulting from the activities authorized under this permit is more than negligible; and/or
f. a determination that there is an undue adverse effect upon the public good resulting from the activities authorized under this permit.

5. The Permittee shall obtain and conduct the treatment in accordance with an Endangered and Threatened Species Takings Permit from the Vermont Department of Fish and Wildlife.

Part III. Monitoring, Surveying & Reporting

A. Monitoring

1. 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 Attachment 1) where lampricide is applied with an adjustable rate pump.

2. The Permittee shall collect and analyze (for pH and Lampricide concentration) water samples every hour from the following stations (as indicated in Attachment 1) during treatment by hand or pH logger:
a. Station M2: Missisquoi Main stem-Dead Creek Fork (river mile 5.4);
b. Station M3: Macs Bend Access (river mile 3.0);

3. The Permittee shall collect and analyze (for pH and Lampricide concentration) water samples every 2-hours from the following stations (as indicated in Attachment 1) during treatment by hand or pH logger. Samples shall be analyzed for alkalinity at least at the time pH loggers are deployed and retrieved:
a. Station M4: Missisquoi Main stem middle mouth (river mile 0.0)
b. Station D4: Dead Creek Mouth (river mile 0.0)

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

5. The Permittee shall take samples at Station M1 at three locations in transect: at one-quarter, one-half and three-quarters across the Missisquoi River.
a. If 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 (one-half) location only.
b. If 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 three locations until subsequent measurements along this transect are within 0.1 MLC and at or below the 1.2 MLC target.

6. 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 2016)

B. Surveying

1. 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, transect-based Larval Assessment Sampling protocol within one year after treatment. The results of this survey shall be submitted to the Aquatic Nuisance Control Program within 6 months after completion of the survey.

2. The Permittee shall conduct post-treatment non-target mortality surveys in the 5 zones between the following Survey transects: 3-4, 8-9, 13-14, 18-19, and 23-AP. Transect locations and assessment sections are presented in Figure 4 of Attachment 1. This survey shall be conducted in accordance with and shall include the following information:

a. Each post-treatment non-target mortality surveys shall be conducted within 36 hours of the lampricide clearing each zone;
b. All visible bottom sections will be inspected and observations of non-target organism mortalities, except lampreys, shall be recorded;
c. At each survey Zone the first 30 lampreys (all species) encountered will be collected and brought back to the lab for identification.
d. Preliminary results shall be made available to the Aquatic Nuisance Control Program within 24 hours of completion; if preliminary results indicate a significant level of impact on non-target organisms, then a full reach survey may be requested at any time by the Aquatic Nuisance Control Program.
e. Final results of this survey shall be reported to the Aquatic Nuisance Control Program by May 1 of the year following the treatment.

C. Reporting

1. The Permittee shall submit a final report on the Missisquoi River TFM treatment to the Aquatic Nuisance Control Program by May 1st of the following year.

2. The final report shall include at a minimum:
a. the batch numbers and the quantity used of TFM-HP, and TFM Bar;
b. the results from the on-site toxicity test and MLC determination;
c. the treatment duration;
d. summary of water chemistry monitoring data;
e. summary of stream flow data;
f. all non-target, non-lamprey post-treatment mortality survey data; and,
g. a summary of treatment activities.
h. proportional representation of each lamprey species in post treatment collections

3. All required surveys and reports shall be submitted to:

Misha Cetner, Aquatic Nuisance Control Program Department of Environmental Conservation Watershed Management Division One National Life Drive, 2 Main Montpelier, VT 05620-3522

Or, preferably via email to Misha Cetner, at **misha.cetner@vermont.gov**.

Part IV. Public Use Advisories & Restriction Notifications

A. Use Advisories

1. The Permittee shall conduct all public use advisories in accordance with the approved *"Prior Notification Posting and Water Supply Plan for Lake Champlain."* (Smith 2016)

2. 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.

B. Restriction Notifications

1. The Permittee shall inform the public all surface water downstream of the primary application location should not be used for drinking, cooking, washing or other household purposes such as bathing, showering, and dish and clothes washing, as well as for swimming, irrigation or livestock watering until analytical results confirm that TFM residues are less than 35 ppb.

2. The Permittee shall inform the public that water within the use advisory area should not be used for fishing, hunting or and other water-based recreation activities until analytical results confirm that TFM residues are less than 100 parts ppb.

Part V. Compliance; Enforcement

The Permittee shall comply with all terms and conditions of this permit. Any permit noncompliance constitutes a violation of 10 V.S.A. Chapter 50, and is grounds for enforcement action; permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.