Environmental Assessment

Proposed Changes to the Long-Term Sea Lamprey Control Program on Lake Champlain

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i. Executive Summary

This Environmental Assessment (EA) addresses the proposed expansion of the long-term sea lamprey control program on Lake Champlain. It is written pursuant to National Environmental Policy Act (NEPA) requirements. Public comment was received orally at two public information meetings and in writing during the comment period- July 26, 2008 through August 26, 2008.

Sea lamprey control began on Lake Champlain in 1990 as an eight-year experimental program after completing an Environmental Impact Statement (EIS; NYSDEC et al. 1990). Following the experimental program, extensive evaluation of the program's impacts on sea lamprey populations, the salmonid fisheries, forage fish populations, and the local economy was conducted (Fisheries Technical Committee 1999). In 2001, a Supplemental Environmental Impact Statement (SEIS) was prepared outlining a long-term program of sea lamprey control for Lake Champlain (U.S. Fish and Wildlife Service et al. 2001). The long-term program included streams and control strategies not originally included in the experimental program. Implementation of the long-term program is ongoing.

Lampricide treatments have been conducted or are scheduled on 12 of the 13 tributaries where that is the primary control method recommended in the SEIS. The Pike River in Quebec is not scheduled for lampricide treatment because application of pesticides to flowing waters violates provincial statutes. Lampricide has been applied to two deltas where deep-water electrofishing surveys identified substantial populations.

Mechanical control, in the form of spawning run trapping and removal, has been implemented on seven small streams around the basin and new technologies for enhancing these trapping operations are under development or in the initial stages of implementation. One such place is Morpion Stream, a tributary of the Pike River, where a flow-through barrier and trapping facility is planned. Eliminating the Morpion Stream population will decrease the contribution of the Pike River system to the Lake Champlain sea lamprey population.

Despite the increased efforts to control sea lamprey, wounding rates on salmonids remain unacceptably high. For this reason, the Lake Champlain Fish and Wildlife Management Cooperative is proposing to expand the sea lamprey control program to include streams where sea lamprey populations have been discovered since the completion of the SEIS.

Three plausible alternatives are presented and discussed in this EA:

Alternative 1 - Expansion of the sea lamprey control program outlined in the SEIS.

This alternative increases the ongoing long-term sea lamprey control program by adding four Lake Champlain tributaries which have recently been identified as current or intermittent producers of parasitic sea lamprey. The streams proposed for inclusion are the Lamoille River, Otter Creek, and Pond Brook in Vermont and Mill Brook in New York. Recent surveys documented sea lamprey larvae in all four streams, and the results of comprehensive surveys indicate that the populations of Lamoille, Pond, and Mill, currently warrant control.

A comprehensive survey of Otter Creek in 2007, conducted after detection of three sea lamprey larvae in 2003, failed to collect additional larvae. All four streams were independently screened for technically feasible and environmentally and socially acceptable control techniques. Control strategies for each stream are outlined in section 3.1. Implementation of this alternative is expected to enhance fish populations, Lake Champlain's sport-fisheries, and the economic benefits associated with successful sea lamprey control.

Alternative 2 (Proposed Action) - Partial expansion of the sea lamprey control program outlined in the SEIS.

This alternative excludes Otter Creek from the streams identified in Alternative 1. The screening process and proposed control strategies remain the same for the three streams included in this alternative. Because of the dynamic nature of sea lamprey populations, it may be necessary to include Otter Creek in the long-term program at a later date. If inclusion of Otter Creek becomes necessary for the program to achieve success, additional environmental review will be necessary. Successful implementation of this alternative is expected to enhance fish populations, Lake Champlain's sport-fisheries, and the economic benefits associated with sea lamprey control beyond that of the current long-term program.

Alternative 3 (No Action) - Continue sea lamprey control program as outlined in the SEIS.

This alternative would limit sea lamprey control to its current scope as outlined in the SEIS at this time. Sea lamprey control would continue at *status quo* levels. There would be no additional benefit to fish populations, Lake Champlain's sport-fisheries, or the economy beyond those expected from the ongoing long-term sea lamprey control program. Wounding rates on salmonids may remain high and may continue to hamper efforts to restore these top predators to the offshore Lake Champlain fish community.

The SEIS provides a detailed description of the environmental setting of Lake Champlain emphasizing water quality and basin characteristics, known sea lamprey distributions, and the human environment. Inventories of state and federally-listed endangered and threatened species and their habitats, and certain non-listed species are provided in respect to ongoing sea lamprey control activities. Impacts to water, humans, wetlands, endangered and threatened species, plants, invertebrates, fish, amphibians, reptiles, birds, and mammals are discussed and mitigating measures are described. Unavoidable adverse impacts, beneficial impacts, irreversible and irretrievable commitments of resources and growth-inducing impacts of long-term sea lamprey control are also discussed.

This EA is a tiered document (40 CFR 1508.28 and 1502.20) which relies on the SEIS (U.S. Fish and Wildlife Service et al. 2001). Specific information relating to the Proposed Action included in this document is to be considered in addition to the information included in the SEIS. The SEIS and other supporting materials are available in electronic format through a link on the following website: http://www.fws.gov/r5lcfwro/lamprey.htm

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1. Purpose of Proposed Action

The purpose of this Environmental Assessment (EA) is to examine impacts associated with enhancing the sea lamprey control program and enabling the use of federally administered Sport Fish Restoration grant monies, other Federal funds, Federal equipment, and participation by Federal staff in implementation of sea lamprey control on selected tributaries. The purpose of the Proposed Action is to achieve and maintain greater reductions in Lake Champlain sea lamprey populations by including tributaries not covered in the Supplemental Environmental Impact Statement: *A Long-term Program of Sea Lamprey Control in Lake Champlain* (SEIS; U.S. Fish and Wildlife Service, et al. 2001). The experimental sea lamprey control program (1990-1998) provided important benefits to the Lake Champlain fishery, the area's economy and the basin's aquatic ecosystem (Lake Champlain Fisheries Technical Committee 1999, Marsden et al. 2003). For instance, anglers caught substantially more and larger lake trout and their fall catches of one-lake-year old landlocked Atlantic salmon from the Saranac River doubled during the experimental program. The experimental program also generated a favorable 3.48:1 economic benefit:cost ratio with benefits of approximately $29.4 million and costs of about $8.4 million (Gilbert 1999). Continuation of sea lamprey control following the completion of the SEIS has not achieved the benefits expected. Implementation of the Proposed Action would allow Federal and state agencies to control sea lamprey on tributaries where sea lamprey populations have expanded.

2. Need for Proposed Action

Wounding rates on salmonids have not decreased to levels deemed acceptable since implementation of the long-term sea lamprey control program. Currently, sea lamprey are controlled on 13 streams and deltas with the use of lampricides. Seven streams use traps that block migrating sea lamprey from suitable spawning habitat and remove them to prevent their redistribution. Two streams use permanent barriers that limit access to spawning grounds within the watershed. During the development of the long-term program of sea lamprey control, target wounding rates were set for lake trout, landlocked Atlantic salmon and walleye (Table 1). These targets were based on the success seen during the experimental sea lamprey control program, reasonable further reduction expected by implementing sea lamprey control on six tributaries not included in the experimental program, and wounding rates achieved through sea lamprey control in the Great Lakes.

Table 1. Sea lamprey wounding rates pre-sea lamprey control, post-eight-year experimental sea lamprey control, acceptable objectives for long-term sea lamprey control, and 2007 wounding rates on selected fish species. Wounds per 100 fish have been rounded to the nearest whole number.

Species	Mean number of lamprey wounds per 100 fish			
	Pre-control	Eight-year control	Acceptable Objective	Current
Lake trout [a]	55	38	25	46 [d]
Landlocked salmon [b]	51	22	15	71
Walleye [c]	13	4	2	5.5

[a] Pre-control (1982-92) and post-control (1993-97) data from mid-summer New York and Vermont Main Lake gill netting surveys for lake trout in the 533-633 mm (21.0-24.9 in.) length interval; current data from fall nearshore electrofishing surveys.

[b] Pre-control (1985-92) and post-control (1993-98) data from fall sampling of Main Lake spawning-phase salmon captured at the Willsboro Fishway in the 432-533 mm (17.0-21.0 in.) length interval; current data from fall nearshore and tributary electrofishing surveys, and salmon captured in the Winooski One fish passage facility.

[c] Pre-control (1988-1992), post-control (1993-1998), and current data from spring electrofishing surveys of Main Lake and South Lake tributaries in the 534-634 (21.0-25.0 in.) mm length interval.

[d] 2007 lake trout wounding rate based on small sample size (N=26). The intended sampling effort was reduced by treatment delays and adverse weather conditions throughout the collection period.

Sea lamprey populations in the Lake Champlain basin are dynamic. Some streams, which historically harbored populations of sea lamprey larvae, have not recolonized following lampricide treatments (e.g. Stone Bridge Brook), and populations have established in previously uninfested streams (e.g. Lamoille River). Blocking and trapping spawning adults has also temporarily eliminated sea lamprey populations from small streams (e.g. Sunderland Brook and Indian Brook; USFWS *unpublished data*). The Proposed Action is needed to address Lake Champlain tributaries where previously undetected or new sea lamprey populations have been identified since the long-term sea lamprey control program began.

Sea lamprey control in the Great Lakes has produced dramatic improvements in the fishery and major economic benefits to the area's economy. Lupi et al. (2003) estimated that sea lamprey control on the St. Mary's River would equate to a $2.6 to $4.7 million dollar benefit to Michigan's recreational angling economy by 2015. The Congressional Office of Technology Assessment (OTA 1993) estimated that terminating sea lamprey control on the Great Lakes would result in a $675 million annual cost for lost fishing opportunities and indirect economic impacts. Sturtevant and Cangelosi (2000) estimated that sea lamprey control produced a benefit of $2.1 to $4.3 billion per year.

Substantial economic benefits are also a factor in sea lamprey control on Lake Champlain. Estimated benefits and costs of the eight-year experimental sea lamprey control program indicated a favorable benefit:cost ratio of 3.48:1. Continuation of sea lamprey control on Lake Champlain has been estimated to generate up to an additional 1.2 million days of fishing and $42.2 million in fishing-related expenditures, as well as an estimated $59.3 million in additional water-based recreation expenditures each year (Gilbert 1999).

Sea lamprey control can also contribute to the restoration of biological and ecological functions and values in impacted systems. For example, in the 1990s the Great Lakes Fishery Commission declared success in rehabilitating lake trout populations in Lake Superior after more than 35 years of sea lamprey control and subsequently, stocking was halted in most Lake Superior waters in 1996 (Heinrich et al. 2003).

Implementing the Proposed Action would increase survival among salmonids and other fish species in the Lake Champlain system. This was indeed the case as a result of the eight-year experimental sea lamprey control program. For example, survival of age 3-4 lake trout improved 25 percent and pre- and post-treatment creel surveys revealed a 76 percent increase in estimated lake trout catch (Fisheries Technical Committee 1999).

More and larger salmonids would provide social benefits through improved fishing. Decreased lamprey attack rates would improve the health and appearance of fish. Improved tributary fisheries for landlocked Atlantic salmon would be a particularly unique and highly prized angling opportunity, while many nonanglers would have the opportunity to observe migrating salmonids at fishways and falls. Other water-based recreationists would experience fewer lamprey attachments to themselves and their equipment.

In addition to the above benefits, the Proposed Action responds to the specific objective of the long-term sea lamprey control program, as described in the SEIS:

> "Should new or previously undiscovered populations of sea lamprey be found, the stream will be subjected to sea lamprey control screening as described for the Proposed Action [in the SEIS]. Should inclusion into the sea lamprey control program be recommended, appropriate environmental review and permitting would be addressed prior to implementation of a control strategy."

Studies in the Great Lakes shows that a single sea lamprey-producing tributary, left untreated, can have a relatively large impact on the lake-wide population of sea lamprey (Wells 1980). For this reason, it is important that the sea lamprey control program on Lake Champlain has the flexibility to expand to control new or previously unidentified sources of sea lamprey.

3. Alternatives

3.1. Alternative 1 - Expansion of the sea lamprey control program outlined in the SEIS.

Expansion of the sea lamprey control program under this action would include four streams in Vermont and New York that have recently been identified as having sea lamprey populations which may warrant control. These streams have been screened through the process outlined in SEIS section V.A. and acceptable control techniques have been identified (see following stream specific sections). The control techniques follow the principles of integrated pest management, which is meant to balance economic, environmental, and social costs and benefits.

In the following sections, we analyze the potential control options based on technical feasibility, cost and impacts to non-target organisms, humans, and the environment. We have identified unique impacts of each control strategy on the streams proposed for inclusion. For a general discussion of impacts and proposed mitigation of various control options common to all streams, please refer to SEIS section VII.A.

3.1.1. Lamoille River

Sea lamprey habitat and population

The Lamoille River (Figure 1) flows into Malletts Bay on Lake Champlain. Sea lamprey have access to approximately 9.6 km (6.0 mi) of stream from the mouth upstream to the Peterson Dam in Milton, Vermont. Larval sea lamprey production was first documented in the Lamoille River in 2002. Quantitative assessment surveys conducted by the U.S. Fish and Wildlife Service (Service) in 2005 estimated a larval sea lamprey population of 38,719. All of the lamprey captured during the 2005 survey were larger, older ammocoetes. Logistic regression of length versus probability of transformation estimated that the majority of sea lamprey captured would have a high likelihood of transforming in the following year. Although no sea lamprey transformers were captured during the 2005 survey, the sizes and numbers of sea lamprey larvae indicate that the Lamoille River has the potential to produce significant numbers of parasites.

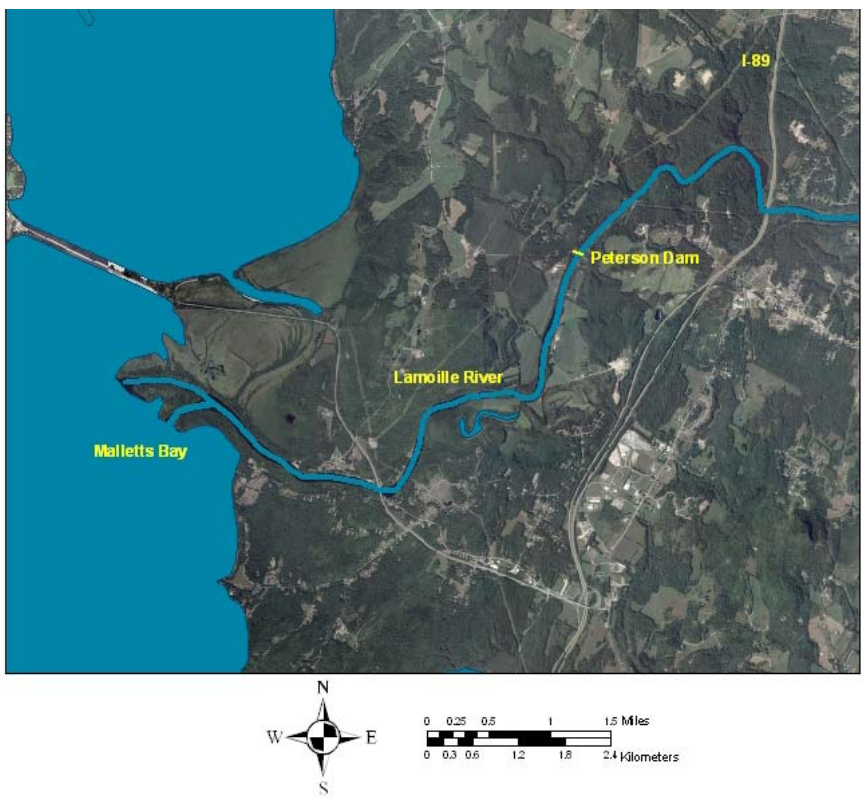

Figure 1. Lamoille River

Control options

TFM

- Technical considerations: TFM application is technically feasible on the Lamoille River. However, there are no locations below the dam in Milton where application sites could be located for maintenance of target lampricide concentrations. Water chemistry, plume, and wetland studies are needed to determine proper lampricide application procedures and to define water-use advisory zones prior to treatment.
- Non-target concerns: The Lamoille River is a known spawning location for lake sturgeon, a Vermont-listed threatened species. There is also a population of eastern sand darters (Endangered- Vermont). The Lamoille River also contains populations of six Vermont-listed mussel species (Endangered: pocketbook, fragile papershell, pink heelsplitter, and fluted shell; Threatened: giant floater and cylindrical papershell). Impacts to the lake sturgeon population and other TFM-sensitive species could be mitigated by applying TFM in accordance with the Service's "TOP:11.5A Interim Protocol for Conducting Treatments of Streams with Populations of Young-of-Year Lake Sturgeon (*Acipenser fluvescens*)" (Adair and Young 2004; see also SEIS section VII.A.2.g). By limiting the maximum concentration of lampricides, this protocol provides an additional margin of protection for other threatened and endangered species identified above.
- Human impacts: A TFM application would impact riparian landowners who draw water for domestic use from the river or surrounding affected lakeshore and any farms which use affected water for irrigation of crops or livestock. Water use advisories, notification of landowners, and provision of alternative water supplies for domestic and agricultural use will mitigate any adverse impacts.
- Habitat impacts: No unique impacts.
- Cost: The cost of lampricide for a TFM treatment would be $34,000 - $108,000 depending on discharge and water chemistry at time of treatment.

TFM/Niclosamide

- Technical considerations: The large size of the Lamoille River makes it a candidate for a treatment using a TFM/Niclosamide combination (see SEIS section IV.A.2.). The treatment would be similar to a TFM treatment as described above, but would require an increase in application and analysis effort associated with the addition of Niclosamide. For details see SEIS section IV.A.2.
- Non-target concerns: Non-target concerns and associated mitigating measures are similar to those listed above for TFM. See also SEIS section VII.A.1 and VII.A.2. The application of TFM/Niclosamide mix does offer a wider margin of safety for some non-target species including lake sturgeon.
- Human impacts: Human impacts would be similar to those indicated with TFM treatments except that the duration of water-use advisories may be shorter than treatments using TFM alone, due to the overall reduction in chemical used.
- Habitat impacts: No unique impacts
- Cost: The cost of lampricides for a TFM/Niclosamide treatment would be $23,000 - $66,000 depending on discharge and water chemistry at time of treatment. The addition of Niclosamide results in a net savings by reducing the amount of TFM needed.

Bayluscide 3.2% granules

- Technical considerations: Application of Bayluscide 3.2% granules is appropriate in slow-moving rivers, estuaries or lake regions (deltas). If lamprey infestations within the river exist in specific areas within Lake Champlain backwater and they can be demarcated, it may be technically feasible to treat these specific areas with Bayluscide granules by boat. This method of control would reduce the amount of chemical used, avoid treatment of areas not inhabited by lamprey, and relieve some water-use impacts. It is not currently known whether sea lamprey inhabit the delta of the Lamoille River. Deep-water electrofishing surveys may be conducted to determine the presence of sea lamprey larvae. In the event that larvae are found on the delta in significant numbers, granular Bayluscide could be applied to the infested areas.
- Non-target concerns: Some mortality of the above listed mussel species along with other mollusks and fish would be expected (see SEIS section VII.A.1.f.). Targeting of localized lamprey infested areas, allowing portions of the delta to go untreated, would result in less non-target mortality. Other mitigation measures could include the removal of threatened and endangered mussels from targeted areas prior to lampricide application if feasible.
- Human impacts: No unique impacts.
- Habitat impacts: No unique impacts.
- Cost: The cost of a granular Bayluscide treatment would depend on the extent of area to be treated. The Lamoille River delta has an approximate area of 370 acres where sea lamprey populations may exist. Pre-treatment surveys would determine the area(s) of infestation and lampricide treatment. The cost of granular formulation of Bayluscide is approximately $1,600 per acre.

Barrier

- Technical considerations: The construction of a barrier (low-head, adjustable, or electrical) would be cost prohibitive and have major adverse impacts on fish movement in the Lamoille River.

Trapping

- Technical considerations: Because no trapping technology exists to adequately capture sea lamprey spawning in large streams, the Lamoille River is not suited for sea lamprey trapping to be used as a control measure.

<u>Lamoille River control strategy</u>

Technically feasible control strategies for the Lamoille River include the use of Lampricides in the form of TFM or TFM/Niclosamide mix for the main channel, and Bayluscide granules in the estuary and lentic areas. TFM/Niclosamide stream treatment would be more cost effective than a TFM stream treatment and have reduced negative impacts on the nontarget biota and riparian landowners. Effective stream treatments may limit the extent of colonization of the lentic areas by sea lamprey. The following sea lamprey control strategy is proposed:

1. *Treat the Lamoille River at river mile 6.0 (Peterson Dam) with TFM/Niclosamide mix or TFM every four years or as determined by routine assessment surveys. The treatment interval could be adjusted should assessment surveys indicate slow recolonization, early metamorphosis, or if shorter intervals would eliminate the need to treat the lentic areas with granular Bayluscide.*
2. *If deep-water electrofishing surveys identify lentic populations of sea lamprey larvae and impacts to listed mussel species can be adequately mitigated, treat the infested areas with granular Bayluscide.*

3.1.2. Pond Brook

Sea lamprey habitat and population

Pond Brook (Figure 2) is located in the town of Colchester, Vermont, and flows into Malletts Creek, a tributary of Malletts Bay. Malletts Creek was included in the SEIS and is currently controlled through migratory phase trapping and removal. Sea lamprey were first detected in Pond Brook in 2001 and have access to approximately 2.6 km (1.6 mi) from the confluence with Malletts Creek upstream to a set of falls below Middle Road, Colchester, Vermont. A quantitative assessment survey conducted by the Service in 2001 estimated a larval population of 1,113 sea lamprey larvae.

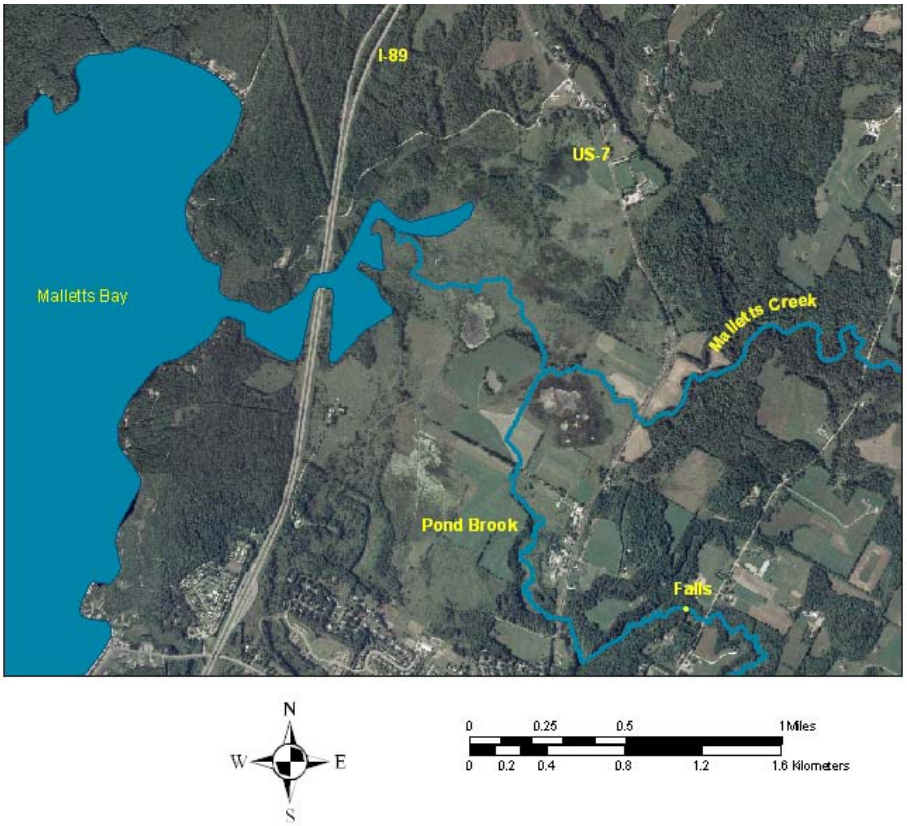

Figure 2. Pond Brook and Malletts Creek

Control options

TFM

- Technical considerations: TFM application is technically feasible on Pond Brook. There are adequate locations downstream of the falls suitable for maintenance applications of lampricide if necessary to maintain target concentrations. Water chemistry and plume studies will need to be conducted prior to conducting TFM treatments.
- Non-target concerns: There are no known populations of threatened or endangered species in Pond Brook. A TFM treatment in Pond Brook would expose a portion of the northern brook lamprey (Endangered-VT) population in Malletts Creek to low levels of lampricide downstream of the confluence of the two streams. Because the discharge of Mallets Creek is approximately four times the discharge of Pond Brook, the concentration of TFM in Malletts Creek resulting from an application in Pond Brook would be diluted to well below the lethal dose for lamprey and would not result in mortality of northern brook lamprey in Malletts Creek.
- Human Impacts: A TFM application would impact riparian landowners who draw water for domestic use from the river or surrounding affected lakeshore and any farms which use affected water for irrigation of crops or livestock. Water use advisories, notification of landowners, and provision of alternative water supplies for domestic and agricultural use would mitigate any adverse impacts.
- Habitat impacts: No unique impacts.
- Cost: The estimated cost of a TFM treatment for Pond Brook is $18,000 per treatment or $4,500 per year based on a four-year treatment schedule.

TFM/Niclosamide

- Technical considerations: Pond Brook flows are too low to warrant the complex application of a TFM/niclosamide combination (see SEIS section IV.A.2.).

Bayluscide 3.2% granules

- Technical considerations: Application of Bayluscide 3.2% granules is not proposed for use in Pond Brook. This formulation is inappropriate for use in the riverine environment of Pond Brook.

Barrier

- Technical considerations: Suitable sites for a permanent barrier (lowhead, electrical, or adjustable crest) may exist downstream of available sea lamprey spawning habitat. Feasibility studies will be conducted to determine the impacts to landowners and potential barrier designs, should a barrier be needed in Pond Brook.
- Non-target concerns: There are no known threatened or endangered species in Pond Brook that would be affected by the construction of a barrier. Seasonal migrations of fish in Pond Brook are primarily limited to common species of cyprinids, catastomids, and centrarchids.
- Human impacts: No unique impacts.
- Habitat impacts: No unique impacts.
- Cost: The cost of constructing a barrier on Pond Brook largely depends on the design, and location of the barrier, as well as the possibility of purchasing land

easements for the construction site. A feasibility study would be needed prior to planning construction of a barrier and would include estimates of costs. For comparison, the cost for constructing a barrier on Youngman Brook (a similar sized stream) proposed in the SEIS was $173,989.

Trapping

- Technical considerations: Pond Brook is well suited for the use of seasonally installed barriers and traps to limit the number of spawners. Trapping operations may provide effective control of sea lamprey in Pond Brook. Assessment trapping on Pond Brook conducted by the Service since 2002 has shown that trapping operations can be successfully implemented in this stream.
- Non-target concerns: There are no known populations of threatened or endangered species that would be affected by the operation of a seasonal barrier and trap in Pond Brook. Malletts Creek (into which Pond Brook flows) does contain a population of northern brook lamprey (Endangered- Vermont). The presence of northern brook lamprey has not been documented in Pond Brook. Trapping operations have been implemented successfully on Malletts Creek since 2002 and have not had any adverse impact on the northern brook lamprey population in that stream. Northern brook lamprey are typically too small to be captured in the traps used to collect sea lamprey. Any northern brook lamprey captured would be released above the trap in Pond Brook.
- Human impacts: No unique impacts.
- Habitat impacts: No unique impacts.
- Cost: The estimated cost of equipment and personnel needed for trapping Pond Brook is $5,000 per year.

<u>Pond Brook control strategy</u>

Technically feasible control strategies for Pond Brook include the use of Lampricides in the form of TFM, the construction of a barrier, and seasonal blocking and trapping. The following sea lamprey control strategy is proposed:

1. *Initiate spawning-phase sea lamprey trapping for control purposes. A permanent site with improvements to the stream -bank and –bed may increase efficiency of trapping operations, if it is found that current methods are inadequate for control.*
2. *If trapping is insufficient for control, construct a barrier dam to block sea lamprey from available spawning habitat. Feasibility studies and appropriate permitting processes would need to be completed prior to construction.*
3. *If trapping is insufficient and a barrier is not feasible, then treat Pond Brook at river mile 1.6 with TFM every four years or as determined by routine assessment surveys. The treatment interval could be adjusted should assessment surveys indicate slow recolonization or early metamorphosis.*

3.1.3. Otter Creek

Sea lamprey habitat and population

Otter Creek (Figure 3) flows into the Main Lake Basin of Lake Champlain in Ferrisburgh, Vermont. Sea lamprey have access to approximately 12.5 km (7.8 miles) from the mouth up to a dam in Vergennes, Vermont. Spawning habitat is limited to a small area immediately below the falls where substrate size and water velocity are suitable for spawning sea lamprey. The majority of habitat below the dam consists of deep, slow moving water. Electrofishing surveys conducted in 2003 by the Service collected three sea lamprey larvae. A comprehensive quantitative assessment survey was conducted during the summer of 2007. No sea lamprey larvae were found during the survey. This indicates that the population in Otter Creek currently is either below the detection threshold of our survey techniques, or that Otter Creek only occasionally produces sea lamprey. Electrofishing surveys will be conducted in Otter Creek on four-year intervals, as part of the standard monitoring procedures for streams that do not contain known populations of sea lamprey. If future surveys indicate a substantial population of sea lamprey larvae, it may become necessary to control the population.

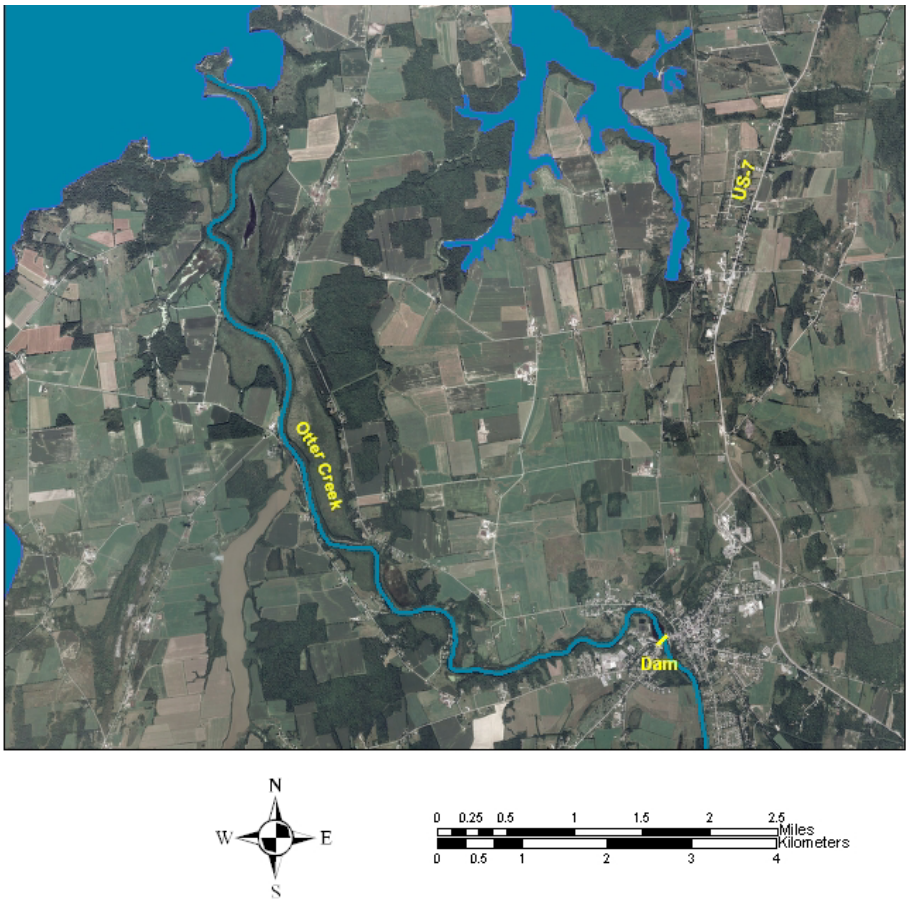

Figure 3. Otter Creek

Control options

TFM

- Technical considerations: A TFM treatment is technically feasible for Otter Creek. However, there are no suitable locations below the dam in Vergennes where maintenance applications could be placed to maintain target chemical concentrations. Water chemistry, plume, and wetland studies are needed to determine proper lampricide application procedures and to define water-use advisory zones prior to treatment.
- Non-target concerns: Lake sturgeon (Endangered- Vermont) have been found in Otter Creek. Suitable sturgeon spawning habitat exists below the dam in Vergennes, but spawning has not been documented. Otter Creek also contains populations of seven Vermont-listed mussel species (Endangered: black sandshell, pocketbook, fragile papershell, pink heelsplitter, and fluted shell; Threatened: giant floater and cylindrical papershell). Since the potential exists for lake sturgeon reproduction, potential impacts to the population could be mitigated by applying TFM in accordance with the Service's "TOP:011.5A Interim Protocol for Conducting Treatments of Streams with Populations of Young-of-Year Lake Sturgeon (*Acipenser fluvescens*)" (Adair and Young 2004; see also SEIS section VII.A.2.g). By limiting the maximum concentration of lampricides, this protocol provides an additional margin of protection for other threatened and endangered species identified above.
- Human impacts: A TFM application would impact riparian landowners who draw water for domestic use from the river or surrounding affected lakeshore and any farms which use affected water for irrigation of crops or livestock. Water use advisories, notification of landowners, and provision of alternative water supplies for domestic and agricultural use will mitigate any adverse impacts.
- Habitat impacts: No unique impacts.
- Cost: The cost of lampricide for a TFM treatment would be $27,000 – $84,000 depending on discharge and water chemistry at time of treatment.

TFM/Niclosamide

- Technical considerations: The large size of Otter Creek makes it a candidate for a treatment using a TFM/Niclosamide combination. The treatment would be similar to a TFM treatment as described above, but would require an increase in application and analysis effort associated with the addition of Niclosamide. For details see SEIS section IV.A.2.
- Nontarget concerns: Nontarget concerns and associated mitigating measures are similar to those listed above for TFM. See also SEIS section VII.A.1 and VII.A.2. The application of TFM/Niclosamide mix does offer a wider margin of safety for some nontarget species including lake sturgeon.
- Human impacts: Human impacts would be similar to those indicated with TFM treatments except that the duration of water-use advisories may be shorter than treatments using TFM alone, due to the overall reduction in chemical used.
- Habitat impacts: No unique impacts
- Cost: The cost of lampricide for a TFM/Niclosamide treatment would be $16,000 - $51,000 depending on discharge and water chemistry at time of treatment. The

addition of Niclosamide results in a net savings by reducing the amount of TFM needed.

Bayluscide 3.2% granules

- Technical considerations: Application of Bayluscide 3.2% granules is most appropriate in slow-moving rivers, estuaries or lake regions (deltas). If lamprey infestations within the river exist in specific areas within Lake Champlain backwater and they can be demarcated, it may be technically feasible to treat these specific areas with Bayluscide granules by boat. This method of control would reduce the amount of chemical used, avoid treatment of areas not inhabited by lamprey, and relieve some water-use impacts. It is not currently known whether sea lamprey inhabit the delta of Otter Creek. Deep-water electrofishing surveys may be conducted to determine the presence of sea lamprey larvae. In the event that larvae are found on the delta in significant numbers, granular Bayluscide could be applied to the infested areas.
- Non-target concerns: Some mortality of the above listed mussel species along with other mollusks and fish would be expected (see SEIS section VII.A.1.f.). Targeting of localized lamprey infested areas, allowing portions of the delta to go untreated, would result in less non-target mortality. Other mitigation measures could include the removal of threatened and endangered mussels from targeted areas prior to lampricide application if feasible.
- Human impacts: No unique impacts.
- Habitat impacts: No unique impacts.
- Cost: The cost of a granular Bayluscide treatment would depend on the extent of area to be treated. The Otter Creek delta has an approximate area of 280 acres where sea lamprey populations may exist. Pre-treatment surveys would determine the area(s) of infestation and lampricide application. The cost of granular formulation of Bayluscide is approximately $1,600 per acre.

Barrier

- Technical considerations: No new barriers are proposed for sea lamprey control on Otter Creek. The construction of a barrier (low-head, adjustable, or electrical) would be cost prohibitive and have major impacts on fish movement in Otter Creek.

Trapping

- Technical considerations: Because no trapping technology exists to adequately capture sea lamprey spawning in large streams, Otter Creek is not suited for sea lamprey trapping to be used as a control measure.

<u>Otter Creek control strategy</u>

Technically feasible control strategies for Otter Creek include the use of Lampricides in the form of TFM or TFM/Niclosamide mix for the main channel, and Bayluscide granules in the estuary and lentic areas. TFM/Niclosamide stream treatment would be more cost effective than a TFM stream treatment and have reduced negative impacts on the nontarget biota and riparian landowners. Effective stream treatments may limit the extent of colonization of the lentic areas by sea lamprey. There is currently not a population of sea lamprey in Otter Creek which warrants control, however if routine surveys indicate that a

substantial population is present then control measures would be implemented. The following sea lamprey control strategy is proposed:

1. *Monitor Otter Creek for presence of sea lamprey on a four-year schedule.*
2. *If comprehensive surveys determine that there is a sea lamprey population that warrants control, treat Otter Creek at river mile 7.8 (Vergennes Dam) with TFM/Niclosamide mix or TFM. Treatments would be repeated every four years or as determined necessary by routine assessment surveys. The treatment interval could be adjusted should assessment surveys indicate slow recolonization, early metamorphosis, or if shorter intervals would eliminate the need to treat the lentic areas with granular Bayluscide.*
3. *If deep-water electrofishing surveys identify lentic populations of sea lamprey larvae and impacts to listed mussel species can be adequately mitigated, treat the infested areas with granular Bayluscide.*

3.1.4. Mill Brook

<u>Sea lamprey habitat and population</u>

Mill Brook (Figure 4) flows into the Main Lake Basin of Lake Champlain in New York. Sea lamprey have access to approximately 0.6 km (0.4 miles) from the mouth upstream to a large waterfall near the Rt. 22 crossing. The majority of this section of the stream consists of suitable sea lamprey spawning habitat. A short stretch of suitable larval habitat exists in the lower portion of the stream. Mill Brook also has a small delta that provides additional larval habitat. Surveys conducted by the Service documented sea lamprey larvae from the lower portion of the stream and from the delta. Surveys conducted in 2007 estimated the population of stream-resident larvae to be approximately 13,468, and the delta population to be 2,883.

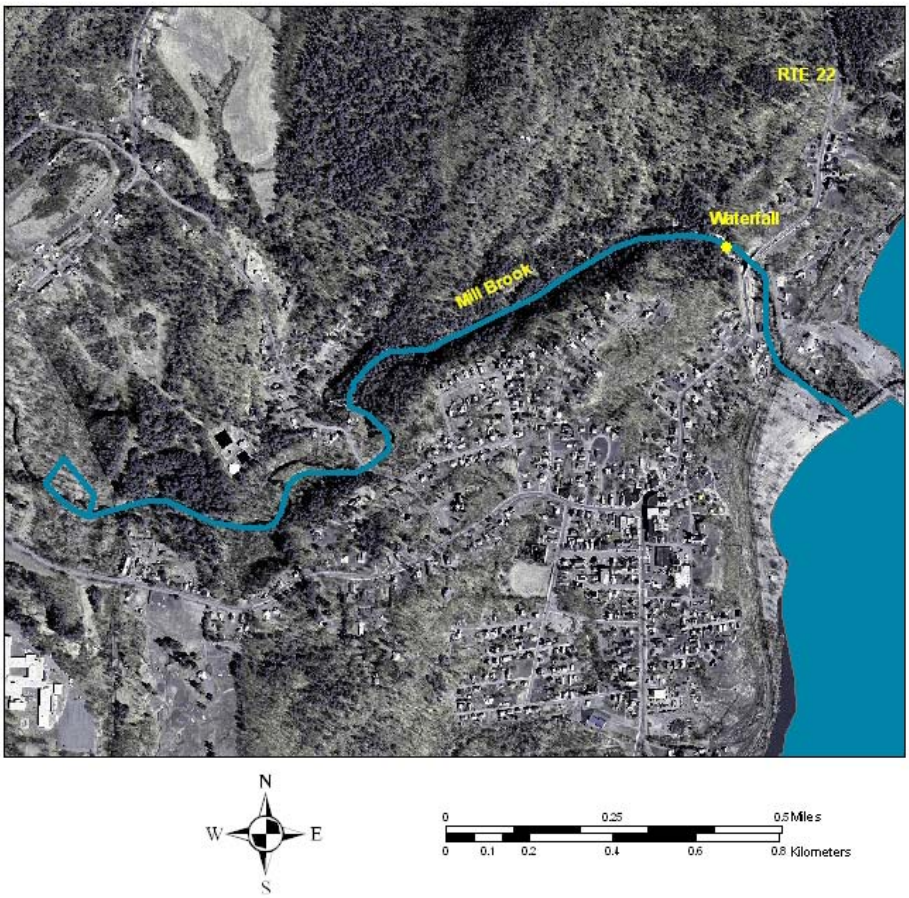

Figure 4. Mill Brook

<u>Control options</u>

TFM

- Technical considerations: A TFM treatment is technically feasible for Mill Brook. There is no need for maintenance applications of lampricide to maintain target concentrations due to the short stream reach and lack of other tributary inflows.
- Non-target concerns: There are no known populations of threatened or endangered species in Mill Brook. There would be no unique non-target effects from a TFM application.
- Human impacts: A TFM application would impact riparian landowners who draw water for domestic use from the river or surrounding affected lakeshore. There are no known farms in the area that use river water for irrigation of crops or livestock. Water use advisories, notification of landowners, and supplying of potable water for domestic use will mitigate any adverse impacts.
- Habitat impacts: No unique impacts.
- Cost: The cost of lampricide for a TFM treatment would be approximately $4,000 depending on discharge and water chemistry at time of treatment.

TFM/Niclosamide

- Technical considerations: Mill Brook flows are too low to warrant application of a TFM/niclosamide combination.

Bayluscide 3.2% granules

- Technical considerations: Bayluscide 3.2% granule application is appropriate for the Mill Brook delta. Deepwater electrofishing surveys have identified areas of infestation. Bayluscide granules can be applied by boat to infested areas of the Mill Brook delta to eliminate larvae.
- Non-target concerns: No threatened or endangered species are known to exist within the treatment area of the Mill Brook delta. Therefore, no special measures are necessary and typical treatment protocol will be followed. See SEIS section VII.A.1 for additional information regarding nontarget impacts and section VII.A.2. for standard mitigating measures.
- Human impacts: No unique impacts.
- Habitat impacts: No unique impacts.
- Cost: The Mill Brook delta has an approximate extent of 43 acres. Surveys conducted by the Service during the summers of 2006 and 2007 identified the sea lamprey infested area as a 10 acre area near the mouth. The cost of the granular formulation of Bayluscide to treat this area is approximately $16,000.

Barriers

- Technical considerations: There are no sites on Mill Brook where a low head or adjustable crest barrier can be constructed. The sea lamprey accessible stretch of stream is mostly under lake level influence during the spring. One option may be to use a new seasonal flow through barrier design that is currently under development for use on Morpion Stream in Quebec. This new design may eliminate the need to impound water and may prove effective in low-lying, near-shore areas. A feasibility and sighting study will be conducted to determine the impacts to landowners and potential barrier designs, should a barrier be considered for Mill Brook in the future.
- Non-target concerns: There are no known threatened or endangered species in Mill Brook that would be affected by the construction of a barrier. Seasonal migrations of fish in Mill Brook include rainbow trout, landlocked salmon and brown trout. The barrier design allows for removal of all gear that blocks fish passage during the majority of the year. The barrier would likely be in place and operated from early April through mid-June. Due to the timing of the sea lamprey spawning run, spring migrations of fish including rainbow trout may be affected. Fish passage would be incorporated for fish too large to fit through the bars of the barrier by using an integrated trap and sort facility.
- Human impacts: No unique impacts.
- Habitat impacts: No unique impacts.
- Cost: The cost of constructing a barrier on Mill Brook largely depends on the design and location of the barrier, as well as the possibility of purchasing land easements for the construction site. A feasibility study would be needed prior to planning construction of a barrier and would include estimates of costs. The cost of a similar barrier design on Morpion Stream in Quebec is estimated at $300,000.

Trapping

- Technical considerations: Mill Brook may not be well suited for the use of seasonally installed barriers and traps to limit the number of spawners. Assessment trapping on Mill Brook conducted by the Service in 2003 showed that trapping operations can be implemented in this stream; however, high flows encountered during 2003 rendered the trapping operations ineffective at blocking the entire spawning run. Trapping operations might be improved by the construction of a permanent trap or a platform to improve the efficiency of portable traps.
- Non-target concerns: There are no known threatened or endangered species in Mill Brook that would be affected by the installation of a seasonal barrier and trapping operations. See SEIS section VII.A.1 for additional information regarding non-target impacts and section VII.A.2.for mitigating measures.
- Human Impacts: No unique impacts.
- Habitat impacts: No unique impacts.
- Cost: The estimated cost of trapping Mill Brook is $5,000 per year using portable assessment traps. A permanent trapping site, including bank stabilization would have a one-time cost of approximately $5,000 for construction and approximately $5,000 to operate annually.

<u>Mill Brook control strategy</u>

Technically feasible control strategies for Mill Brook include the use of lampricides in the form of TFM for stream treatments and granular Bayluscide for delta treatments. The construction of a barrier and seasonal blocking and trapping may also be feasible. The following sea lamprey control strategy is proposed:

1. *Treat Mill Brook at river mile 0.4 with TFM every four years or as determined by routine assessment surveys. The treatment interval could be adjusted should assessment surveys indicate slow recolonization, early metamorphosis, or the relative success of experimental trapping efforts.*
2. *Treat infested lentic areas with granular Bayluscide every four years as determined by routine assessment surveys. The treatment interval could be adjusted should assessment surveys indicate slow recolonization or early metamorphosis.*
3. *Investigate experimental spawning-phase sea lamprey trapping for control purposes. A permanent site with improvements to the stream -bank and –bed may increase efficiency of trapping operations, if it is found that current methods are inadequate for control. Successful implementation of trapping for control may eliminate the need for future lampricide treatments.*

3.2. Alternative 2 (Proposed Action) - Partial expansion of the sea lamprey control program outlined in the SEIS.

Selection of Alternative 2, partial expansion of the control program, omits Otter Creek but would implement sea lamprey control activities on the other three streams identified in Alternative 1. There is not, at present, a sea lamprey population that warrants control in Otter Creek, however past surveys have confirmed the presence of sea lamprey and Otter Creek has the potential to harbor a large larval sea lamprey population and produce significant numbers of parasites. Under Alternative 2, if future surveys indicate that Otter Creek has a substantial sea lamprey population that needs to be controlled, additional environmental review will be initiated.

3.3. Alternative 3 (No Action) - Continue sea lamprey control program as outlined in the SEIS.

Selection of the 'No Action' alternative would limit sea lamprey control to the streams currently included in the long-term sea lamprey control program as outlined in the SEIS. Future changes to the program (e.g. inclusion of other streams and/or control techniques) may be considered following the appropriate environmental review in accordance with NEPA.

3.4. Alternatives considered but dismissed

During the development of the long-term sea lamprey control program, a number of alternatives were either considered but dismissed (SEIS section V.D.), or deemed unacceptable (SEIS section V.E.). The evaluation of the applicability and acceptability of those alternatives has not changed. The following alternatives were considered but dismissed during the development of a potentially expanded sea lamprey control program as outlined in the Proposed Action.

3.4.1. Abandon sea lamprey control

This alternative was deemed socially and ecologically unacceptable. Abandoning sea lamprey control while continuing salmonid restoration efforts does not address the problem of sea lamprey effects on salmonids or other fishes in Lake Champlain. Money spent raising fish for Lake Champlain would be wasted. The goal of the Proposed Action is to achieve greater benefits from the sea lamprey control program. Abandoning both sea lamprey control and salmonid stocking was addressed in SEIS section V.D.1. This alternative was dismissed because of the favorable economic assessment of the experimental program, because it would be socially unacceptable, and because this management action would result in increased wounding and subsequent mortality of non-salmonid fishes.

3.4.2. Incremental expansion of the long-term sea lamprey control program

This alternative would allow fisheries managers to expand control efforts to only one or two of the sea lamprey producing streams identified in the Proposed Action. Sea lamprey do not home to their natal streams (Bergstedt and Seelye 1995) and are known to range throughout Lake Champlain (Howe et al. 2006). Therefore, this alternative was dismissed because a single untreated sea lamprey producing stream can have lake-wide effects (Wells 1980). Leaving one or more sea lamprey-producing streams untreated would impact the entire fishery and provide a continual source of adult lamprey which could then colonize or recolonize streams elsewhere in the Lake Champlain basin. Implementing a comprehensive sea lamprey control strategy is the only way to achieve current fishery restoration goals.

3.5. Control techniques under development

3.5.1. Use of pheromones to control sea lamprey populations

Research into new sea lamprey control techniques such as the use of sea lamprey pheromones is currently being conducted in the Great Lakes and in Lake Champlain. Research is currently focused on identifying optimal scenarios for implementation of pheromones as a control measure. While this research is promising, techniques are still in the initial phases of development and testing. Prior to implementation of pheromone mediated control, additional review and pesticide registration needs to take place. When and if pheromones become a feasible control technique, their use may reduce the sea lamprey control program's reliance on pesticides. Proper NEPA review will also be necessary before sea lamprey pheromones can be use for control on Lake Champlain.

4. Affected Environment

4.1. General Description

For a general description of the Lake Champlain Basin, please refer to SEIS section VI.A.

4.2. Lake Basins and Sea Lamprey-producing Tributaries

For a full description of all Lake Basins, including land use patterns, recreational activities, and water usage, please refer to SEIS section VI.B.

Both the Lamoille River and Pond Brook (via Malletts Creek) flow into the Mallets Bay Basin of Lake Champlain. These two watersheds represent the major tributaries to this Basin. The sea lamprey population in Malletts Creek is currently controlled using migratory phase trapping to remove adult sea lamprey prior to spawning. Mill Brook and Otter Creek flow directly into the Main Lake Basin of Lake Champlain.

4.3. Human Resources

For a description of human resources please refer to SEIS section IV.C.

4.4. Water Resources

For a description of water quality and water usage please refer to SEIS section IV.D.

4.5. Biological Resources

For a general description of the biological resources including wetlands, plants, invertebrates, fish, amphibians, reptiles, birds, and mammals, their protection status, and their potential for adverse impacts please refer to SEIS section VI.E. The following tables list the species of fish and mussels known to be present in the tributaries proposed for inclusion in the long-term sea lamprey control program.

Table 2. Fish species known to be present in reaches of tributaries accessible to sea lamprey. Scientific names can be found in SEIS section VI.E.9. (V=record from VTDFW; N=record from NYSDEC; U=record from USFWS)

Common Name	**Lamoille River**	**Pond Brook**	**Otter Creek**	**Mill Brook**
Silver lamprey	U		U	U
Sea lamprey	U	U	U	U
Lake sturgeon[a,c]	V		V	
Longnose gar	V		V	
Bowfin	V	U	V	
American eel				N
Mooneye[c]			V	
Rainbow trout	V		V	N
Landlocked Atlantic salmon	V		V	N
Brown trout	V		V	N
Brook trout				N
Lake trout	V		V	
Rainbow smelt			V	
Central mudminnow		V		
Northern pike	V	U	V	
Muskellunge			V	
Chain pickerel	V	V	V	
Carp	V	U	V	
Brassy minnow		U		
Eastern silvery minnow	V	V	V	
Golden shiner	V	V	V	
Emerald shiner	V	U	V	N
Common shiner		V		
Blacknose shiner		V		
Spottail shiner	V	U	V	U
Rosyface shiner	V			N
Spotfin shiner	V			
Mimic shiner	V		V	N
Bluntnose minnow	V	V	V	N

Table 2. continued

Common Name	**Lamoille River**	**Pond Brook**	**Otter Creek**	**Mill Brook**
Fathead minnow		U	V	
Blacknose dace		V	V	
Longnose dace		V	V	U
Creek chub	V	V		
Fallfish	V	U	V	
Quillback	V			
White sucker	V	V	V	N
Shorthead redhorse	V		V	
Yellow bullhead				N
Brown bullhead	V	V	V	U
Channel catfish	V			
Banded killifish	V			N
Brook stickleback		V		
White perch	V	U	V	
Rock bass	V	U	V	
Pumpkinseed	V	V	V	
Bluegill		U	V	
Smallmouth bass	V	V	V	
Largemouth bass	V	U	V	
Black crappie	V		V	
Eastern sand darter[b,c]	V			
Tesselated darter	V	V	V	N
Yellow perch	V	V	V	N
Logperch	V	U	V	N
Walleye	V		V	
Freshwater drum	V		V	
Mottled sculpin	V			U

[a] Endangered- Vermont; [b] Threatened- Vermont; [c] Threatened- New York

Table 3. Mussel species known to occur in the lamprey accessible portion of the Lamoille River and Otter Creek and their protected status in the state of Vermont. Scientific names can be found in SEIS section VI.E.9.

Common Name	Status	Drainage
Eastern elliptio	None	Lamoille, Otter
Eastern lamp mussel	None	Lamoille, Otter
Pocketbook mussel	Endangered- VT	Lamoille, Otter
Fluted shell	Endangered- VT	Lamoille, Otter
Creek heelsplitter	None	Lamoille, Otter
Giant floater	Threatened- VT	Lamoille, Otter
Fragile papershell	Endangered- VT	Lamoille, Otter
Pink heelsplitter	Endangered- VT	Lamoille, Otter
Triangle floater	None	Lamoille
Creeper (Squawfoot)	None	Lamoille, Otter
Eastern floater	None	Lamoille, Otter
Black sandshell	Endangered- VT	Otter
Cylindrical papershell	Threatened- VT	Lamoille

5. Environmental Consequences

5.1. Alternative 1 - Expansion of the sea lamprey control program outlined in the SEIS.

5.1.1. Adverse Impacts

For a discussion of adverse impacts to water, humans, wetlands, threatened and endangered species, plants, invertebrates, fish, amphibians, reptiles, birds, mammals, and user conflicts related to Alternative 1, please refer to SEIS section VII.A.1. Since the completion of the SEIS and the beginning of the long-term sea lamprey control program several toxicity tests have been conducted on various mussel species, mudpuppies, eastern sand darters, quillback, and sturgeon. The results of these studies are summarized in Tables 4-6. Adverse impacts resulting from the implementation of Alternative 1 would be similar to those encountered under the current sea lamprey control program. Only spatial differences exist as sea lamprey control activities are carried out in new locations. Water users in the vicinity of the Lamoille River, Otter Creek, and Mill Brook may experience water use advisories typical of lampricide treatments. Trapping operations in Pond Brook will not affect water quality or area residents. Impacts to wetlands resulting from lampricide treatments (SEIS section VII.A.1.c.) would be limited to wetlands lying within the zone of influence of Lake Champlain lake level (below 102 feet or 31.1 meters in elevation).

Table 4. Summary of toxicity test results for TFM and TFM-1%Niclosamide tests conducted on several species of mussels. 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		TFM-1%Nic.		Source
	NOEC	LOEC	NOEC	LOEC	
Cylindrical papershell	2.6	3.2	NT	NT	NYSDEC and VTDFW 2007
	2.3	2.9	NT	NT	
Fluted shell	1.6	2.0	NT	NT	NYSDEC and VTDFW 2001
	1.6	2.0	NT	NT	
Pocketbook	1.6	2.0	NT	NT	NYSDEC and VTDFW 2007
	≥2.0	>2.0	NT	NT	
Fragile papershell	1.5	1.8	1.5	1.9	Boogaard et al. 2004
Giant floater	1.6	2.0	1.6	2.0	Boogaard et al. 2004
Pink heelspliter	≥1.9	>1.9	2.0	2.4	Boogaard et al. 2004
Eastern floater (adult)	1.6	1.9	NT	NT	Waller et al. 2003
	1.6	2.0	NT	NT	
	1.9	2.4	NT	NT	
Eastern elliptio (adult)	≥1.9	>1.9	≥2.4	>2.4	Waller et al. 2003
	2.0	2.5	1.9	2.4	
	≥2.4	>2.4	≥1.9	>1.9	
Eastern elliptio (juvenile)	1.6	1.9	≥2.4	>2.4	Waller et al. 2003
	≥2.5	>2.5	≥2.4	>2.4	
	≥2.4	>2.4	NT	NT	

Table 5. Summary of toxicity test results for TFM and TFM-1%Niclosamide tests conducted on two species of fish and 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		TFM-1%Nic.		Source
	NOEC	LOEC	NOEC	LOEC	
Quillback (young of year)[a]	≥1.9	>1.9	1.9	2.4	Neuderfer 2004
			2.1	2.7	
Eastern sand darter	1.4[b]	1.8[b]	1.6	1.8	NYSDEC unpublished data
Mudpuppy (adult)[c]	1.6	2.0	1.5	1.8	Boogaard et al. 2003
	1.6	1.9	1.5	1.8	
Mudpuppy (juvenile)[c]	1.0	1.2	0.8	1.0	Boogard et al. 2003
	1.0	1.2	1.3	1.6	
Mudpuppy (mixed ages)	1.0	1.3	NT	NT	Neuderfer et al. draft report
Mudpuppy (young of year)	0.8	0.9	0.6	0.9	Neuderfer et al. draft report

[a] TFM-1%Nic. results for quillback found in NYSDEC 2005.

[b] TFM results for eastern sand darters found in Neuderfer 2000 and reported in SEIS section VII.

[c] LOEC values for mudpuppy juveniles and adults from M. Boogaard personal communication.

Table 6. Summary of toxicity test results for TFM and TFM-1%Niclosamide tests conducted on several stages of lake sturgeon. No observed effect concentrations (NOEC) and lowest observed effect concentrations (LOEC) expressed as factors of sea lamprey minimum lethal concentration (MLC). NOEC values calculated from Boogaard et al. 2003, LOEC values from M. Boogaard, personal communication.

Size Range (mm)	Test trial	TFM		TFM-1%Nic.	
		NOEC	LOEC	NOEC	LOEC
100-110 (n=10)	1	1.0	1.2	1.2	1.6
	2	1.0	1.2	1.2	1.5
	3	1.0	1.2	1.2	1.5
150-170 (n=10)	1	1.0	1.2	1.0	1.2
	2	1.0	1.2	1.0	1.3
	3	1.0	1.3	1.0	1.3
200-225 (n=5)	1	1.3	1.6	1.2	1.5
	2	1.2	1.5	1.3	1.6
	3	1.0	1.3	1.2	1.5
1+ year class (n=5)	1	1.5	1.9	1.2	1.5
	2	1.6	2.0	1.2	1.6
	3	1.3	1.5	1.3	1.6

5.1.2. Mitigating Measures

For a discussion of mitigating measures related to water, humans, wetlands, threatened and endangered species, plants, invertebrates, fish, amphibians, reptiles, birds, mammals, and user conflicts related to the long-term sea lamprey control program, please refer to SEIS section VII.A.2. No additional mitigating measures are required for the implementation of Alternative 1.

5.1.3. Unavoidable Adverse Impacts

For a discussion of unavoidable adverse impacts related to the long-term sea lamprey control program, please refer to SEIS section VII.A.3. Implementation of Alternative 1 would cause no additional adverse impacts above and beyond those identified in the SEIS.

5.1.4. Beneficial Impacts

For a discussion of beneficial impacts related to the long-term sea lamprey control program, please refer to SEIS section VII.A.4. Implementation of Alternative 1 would further enhance the beneficial impacts identified in the SEIS.

5.1.5. Irreversible and Irretrievable Commitments of Resources

For a discussion of irreversible and irretrievable commitments of resources related to the long-term sea lamprey control program, please refer to SEIS section VII.A.5. Implementation of Alternative 1 would cause no greater commitments of irreversible or irretrievable resources above and beyond those identified in the SEIS.

5.1.6. Growth Inducing Impacts

For a discussion of growth inducing impacts including types of growth, characterization of the Lake Champlain fisheries, ancillary growth, competition for growth, and infrastructure capacity related to the long-term sea lamprey control program, please refer to SEIS section VII.A.6. Implementation of Alternative 1 could potentially increase the growth related to Lake Champlain's fisheries.

5.2. Alternative 2 (Proposed Action) - Partial expansion of the sea lamprey control program outlined in the SEIS.

Adverse impacts associated with Alternative 2 (the Proposed Action) are the same as those expected from the implementation of the Alternative 1, except that there would be no impacts to water users, or the biota of Otter Creek. It is assumed that the beneficial impacts would be less than those attainable by implementing the Alternative 1, should Otter Creek become infested with sea lamprey and begin to produce significant numbers of parasites. An additional negative impact of the Proposed Action would be the need to spend time and funds on the necessary environmental review should Otter Creek need future inclusion in the sea lamprey control program.

5.3. Alternative 3 (No Action) - Continue sea lamprey control program as outlined in the SEIS.

5.3.1. Adverse Impacts

Under Alternative 3 there would be no adverse impacts to water quality, humans, or the flora and fauna of the streams identified in the Proposed Action. Adverse impacts to fish populations, sport fisheries, non-fishing related lake activities on Lake Champlain and derived economic benefits may result from the failure to successfully control sea lamprey. Sales of fishing licenses, fishing tackle, live bait, and services associated with the angling public may suffer declines under Alternative 3.

5.3.2. Mitigating Measures

Adverse impacts identified under Alternative 3 could be partially mitigated by fisheries managers through a redirection of effort away from the salmonid fishery.

5.3.3. Unavoidable Adverse Impacts

Adverse impacts to fish populations, sport fisheries, non-fishing related lake activities on Lake Champlain and derived economic benefits may result from the failure to successfully control sea lamprey. Sales of fishing licenses, fishing tackle, live bait, and services associated with the angling public may suffer declines under Alternative 3.

5.3.4. Beneficial Impacts

Beneficial impacts associated with the implementation of Alternative 3 would include the lack of additional temporary water use advisories associated with lampricide treatments, no additional risks to aquatic organisms, and no agency funds directed toward sea lamprey control on the tributaries identified in the Proposed Action.

5.3.5. Irreversible and Irretrievable Commitments of Resources

Under alternative 3 there would be no additional commitments of resources.

5.3.6. Growth Inducing Impacts

There would be no additional growth inducing impacts above and beyond those identified in the SEIS.

5.4. Cumulative Impacts

SEIS section VII.D. describes the cumulative impacts of the long-term sea lamprey control program on Lake Champlain's fisheries, fish community dynamics, mussel species, and the region's social and economic structure. The addition into the program of the additional streams discussed herein does not pose new cumulative impacts beyond those addressed in the SEIS.

The inclusion of these streams would increase the total amount of lampricides applied within the Lake Champlain basin. However, the additional treatments will not have a cumulative impact of accumulating lampricides in the environment. Both TFM and Niclosamide are readily detoxified by biotic and abiotic processes and do not accumulate in the environment (Hubert 2003; Dawson 2003).

Since the start of the long-term sea lamprey control program two species of exotic fish have been discovered in Lake Champlain. Tench (*Tinca tinca*) were first discovered in the northern portion of Lake Champlain in 2002. The introduction of tench to Lake Champlain resulted from escaped fish from an unauthorized aquaculture operation in Quebec. Alewife (*Alosa pseudoharengus*) were first documented in Lake Champlain in 2003. The introduction of alewife most likely was the result of a bait-bucket introduction. Of these two species, the alewife has the greatest potential to affect the Lake Champlain fish community. Alewife are known to produce thiamine deficiencies in certain salmonids when they constitute the major forage base. Lake trout and Atlantic

salmon populations suffer from “early mortality syndrome” (EMS) resulting from the thiamine deficiency. The added factor of EMS has the potential to adversely affect salmonid restoration efforts on Lake Champlain. High sea lamprey parasitism rates combined with the symptoms of EMS have the potential to push the lake trout and Atlantic salmon populations beyond our ability to restore.

6. Literature Cited

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