Appendix A3

Fish SGCN Conservation Reports

Vermont's Wildlife Action Plan 2015

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S1
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Only two sub-populations of Northern Brook Lamprey are known to occur in Vermont, i.e. the Malletts Creek-Indian Brook watershed (Langdon 2014). On a range-wide scale no major threats are known, but the species is vulnerable to local extirpation through indiscriminant use of fish toxicants (COSEWIC 2007; NatureServe 2014). Li et al. (2014) investigated the status of native lamprey populations in the Great Lakes drainage basin where recent declines have been observed and attributed to habitat loss and degradation, anthropogenic stresses, and stream treatment with lampricides. They report that of six species historically found in Pennsylvania streams, current surveys confirmed the presence of four species and absence of two species, including Northern Brook Lamprey, in streams previously known to support them possibly indicating extirpation. The use of lampricides to control Sea Lamprey in the Lake Champlain basin probably represents the greatest threat to Vermont populations. As of yet neither population has been exposed to chemical treatment; however, the U. S. Fish and Wildlife Service recently made it known that it wishes to treat Malletts Creek (Langdon 2015). Northern Brook Lamprey is currently listed as endangered in Vermont, Pennsylvania, Ohio, Indiana and Illinois; and special concern in Minnesota, Ontario and Quebec. Recent research into the genetic relationship between Northern Brook Lamprey and Silver Lamprey seems to indicate that the two species may be ecotypes of one species (Docker et al. 2012), even though each is considered a distinct species in all taxonomic accounts (COSEWIC 2011) and that this convention should remain in place until such time that there is "strong evidence [that] rejects the hypothesis that parasitic and nonparasitic members of a paired species represents distinct species" (Renaud et al. 2009 cited in COSEWIC 2011). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

Northern Brook Lamprey occur in the Mississippi and Great Lakes drainages from western New York, Quebec, Ontario, Michigan and eastern Wisconsin; from the north shore of Lake Superior to northern Indiana and Ohio (Scott and Crossman 1973). Only one Northern Brook Lamprey population is known in Vermont. This population is limited to one watershed consisting of Indian Brook and Malletts Creek, both tributaries of Malletts Bay on Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley
Champlain Hills
Northern Green Mtns
Northern VT Piedmont
Northeastern Highlands
Southern VT Piedmont
Vermont Valley
Southern Green Mtns
Taconic Mtns

Distribution by Watershed:

Known Watersheds
Winooski River

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Clear streams and small to moderate sized rivers (Scott and Crossman 1973; Smith 1985; Langdon et al, 2006; Morman 1979). The non-parasitic Northern Brook Lamprey spends its entire life in streams. No known populations reside on Lake Champlain's deltas, unlike Sea Lamprey and American Brook Lamprey. It has a 4 to 6 year life span and spends most of it life buried in the substrate, where it grows to about 150mm, metamorphoses, and becomes sexually mature. Adults generally migrate upstream to spawn. Larval habitat includes lotic depositional and estuarine areas of streams with organic matter for feeding and fairly stable substrate in order to maintain burrow. Stream riffle areas with sand and pea gravel up to approximately 15 mm diameter are used for spawning (W. Bouffard, USFWS, personal communication). Spawning water depth is typically <450 mm deep (Scott and Crossman 1998).

Habitat Types:

Aquatic: Fluvial

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Culverts at road crossings may fragment habitat by creating barriers to upstream migration of spawning adult Northern Brook Lamprey. Sedimentation of stream bottoms reduces the quality of spawning habitat. The lower reaches of Malletts Creek and Indian Brook, which converge to form a large wetland complex, may reach the lethal temperature limit of 30.5 °C thereby limiting population distribution between as well beyond those streams.

Non-Habitat Threats:

Genetics

Competition

Pollution

Description of non-habitat threat(s): Due to the small population size, distance from other regional Northern Brook Lamprey populations, and absence of gene flow between populations, there is a potential for inbreeding depression to occur naturally within Vermont's population. No diagnostic characteristics exist for differentiating between Northern Brook and Silver lamprey accomocoetes. These two species were not readily distinguishable using mitochondrial sequence and mitochondrial restriction fragment length polymorphism analyses, raising the question whether they are different species or different ecomorphotypes. (Mandrak et al. 2004). This presents difficulties in understanding current distributions and population trends for Northern Brook Lamprey in the Lake Champlain basin. Competition for larval habitat with Sea Lamprey and Silver Lamprey could reduce survival and/or fitness of Northern Brook Lamprey larvae. Small population sizes and extremely limited geographic distribution increase the vulnerability of the population to a potential pollution event. The Lake Champlain Fish and Wildlife Management Cooperative is currently involved in a Sea Lamprey control program that includes the use of lampricides to

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

kill stream-resident Sea Lamprey larvae. These lampricides are toxic to all species of lamprey. Currently, Sea Lampreys are being controlled in streams with Northern Brook Lamprey through the use of traps, eliminating the need for lampricides. The repeated use of lampricides has been shown to adversely affect populations of Northern Brook Lamprey in Lake Superior tributaries (Li et al. 2014; Schuldt and Goold 1980).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Given difficulties in identifying Northern Brook Lamprey from other Ichthyomyzon spp. and apparent low population densities, efforts to survey other streams having suitable habitat to locate potential new populations and better define current distribution
Research	Threats and Their Significance	High	Threats and their significance are poorly understood for this species.
Research	Population Genetics	Medium	Genetic similarities between the disjunct Vermont population and other nearest populations within the region have not been investigated. Investigate gene flow within and between Northern Brook Lamprey populations in the Lake Champlain basin.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Current estimates are needed to ascertain status of known population.
Monitoring	Habitat Change	High	Habitat within species' limited distribution in state is not being monitored.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, USFWS, TNC, Echo Center, LCBP, LCI, watershed associations	
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Northern Brook Lamprey populations.	Number of existing populations of Northern Brook Lamprey protected and sustained.	LCFWMC, USFWS, VDEC	VFWD (DJ, SWG)
Research	Low	Assess, monitor and manage as appropriate the potential for Sea Lamprey competition with Northern Brook Lamprey for spawning and juvenile habitats.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Research	High	Current research indicates Northern Brook Lamprey and Silver Lamprey may be ecotypes of a single species. Both ecotypes should be conserved.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

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Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S2? **State Trend:** Stable
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

In Vermont, Silver Lamprey is widely distributed in Lake Champlain and its tributaries. The use of lampricides to control Sea Lamprey in the Lake Champlain basin probably represents the greatest threat to Vermont populations. Other threats to the species include construction of barriers that prevent access to spawning habitats, water pollution, habitat alteration, siltation, water level fluctuation and competition with introduced species (COSEWIC 2011). In conjunction with the program to control Sea Lamprey abundance in Lake Champlain the USFWS conducts quantitative assessment sampling (QAS) typically every four years to estimate Sea Lamprey and Silver Lamprey abundance in seven Vermont treatment rivers: Missisquoi River, Stonebridge Brook, Lamoille River, Winooski River, Lewis Creek, Poultney River, and Hubbardton River. Abundance trends based on QAS (raw data provided by Allaire 2015) indicate declining populations in the Winooski and Poultney rivers; and no discernible trends (decreasing or increasing) in the other streams where multiple treatments have been conducted. However, it needs to be pointed out that QAS estimates typically have very large confidence intervals (Allaire, USFWS, personal communication), so these results must be interpreted with caution. Recent research into the genetic relationship between Silver Lamprey and Northern Brook Lamprey seems to indicate that the two species may be ecotypes of one species (Docker et al. 2012), even though each is considered a distinct species in all taxonomic accounts (COSEWIC 2011) and that this convention should remain in place until such time that there is "strong evidence [that] rejects the hypothesis that parasitic and nonparasitic members of a paired species represents distinct species" (Renaud et al. 2009 cited in COSEWIC 2011). Selected as a Regional-SGCN by the 13 Northeastern states in 2014

Distribution

Silver Lamprey are restricted to eastern North America, from the St. Lawrence River as far down as Montmagny, Quebec, west through the Great Lakes, through the upper Mississippi Valley from Wisconsin, to eastern Manitoba; from Manitoba tributaries of Hudson Bay in the north to the Ohio River basin as far south as Kentucky (Scott and Crossman 1973). In Vermont, this species is at the eastern edge of its North American range. Vermont populations are limited to Lake Champlain and the lower reaches of several tributaries up to the fall line.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Mettawee River

Probable Watersheds
Otter Creek

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Lake Champlain
Lamoille River
Missisquoi River
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Generally occurs in large streams and lakes where host fish are present and can be parasitized. Larval habitat includes lotic depositional and estuarine areas of streams with organic matter for feeding and fairly stable substrate required to maintain burrows. Spawning occurs in riffle areas with sand and gravel up to approximately 30 mm diameter (W. Bouffard, U. S. Fish and Wildlife Service, personal communication). In Vermont, the silver lamprey spawns in the lower sections of several tributaries of Lake Champlain (Langdon et al. 2006).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Culverts and dams may constitute barriers to the upstream migration of spawning adults. Sedimentation of stream bottoms reduces the quality of spawning habitat.

Description of non-habitat threat(s): The Lake Champlain Fish and Wildlife Management Cooperative is currently involved in a Sea Lamprey control program that includes the use of lampricides to kill stream-resident larvae. These lampricides are toxic to all species of lamprey.

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Population monitoring to determine current status and changes.
Monitoring	Habitat Change	Medium	Habitat assessment and monitoring to assess habitat change and identify limiting factors.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, USFWS, TNC, Echo Center, LCBP, LCI, watershed associations	
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Silver Lamprey populations.	Number of existing populations of Silver Lamprey protected and sustained.	LCFWMC, USFWS, VDEC	VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners
Research	High	Current research indicates Northern Brook Lamprey and Silver Lamprey may be ecotypes of a single species. Both ecotypes should be conserved.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations, town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Invasive Species Control & Prevention	Low	Assess, monitor and manage as appropriate the potential for Sea Lamprey competition with Silver Lamprey for spawning and juvenile habitats.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

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Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Populations of American Brook Lamprey are currently known to occur in seven Vermont streams (Langdon 2014), all located in the Lake Champlain Valley biophysical region. NatureServe (2014) identifies no known major threats to the species at the range-wide scale. Nonetheless, all lamprey species are susceptible to mortality caused by the use of lampricides; as such, chemical control of Sea Lamprey in the Lake Champlain basin probably represents the greatest threat to the state's American Brook Lamprey populations. Two American Brook Lamprey populations that have been exposed to lampricides in Vermont are Trout Brook in Milton (treated in 1995) and Winooski River in Winooski (treated in 2004). Brook lamprey mortalities were confirmed to have occurred as a result of treatments in both streams (Chipman 2015). The coastal population in New Hampshire is listed as endangered and those in Massachusetts and Maryland are threatened. Threats to these populations are generally identified as sedimentation, water temperature increases, pollutants, extreme water level changes, and habitat fragmentation often associated with land development activities (MDNR; MDFW 2005; NHFGD 2005). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

American brook lamprey is restricted to east-central North America: on the eastern seaboard from southeastern New Hampshire south to Maryland; and in the St. Lawrence River and tributaries from Montmagny southwest through the Great Lakes, west to southeastern Minnesota, south into the Mississippi River drainage to Tennessee and Missouri (Scarola 1973; Scott and Crossman 1973). In Vermont, it is known to occur in the Missisquoi River and tributaries, Hungerford and Kelly brooks; Winooski River and its tributary, Sunderland Brook; Youngman Brook; and Trout Brook.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Missisquoi River
Winooski River

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Clear, cool streams and small rivers characterized by a large proportion of groundwater inflow (Scott and Crossman 1973; Smith 1985; Langdon et al, 2006; Morman 1979). The non-parasitic American Brook Lamprey spends its entire life in streams and infrequently migrates to lakes, except to reside on some Lake Champlain river deltas particularly in New York, i.e. Ausable and Salmon rivers (Langdon et al. 2006). It has a 4 to 6 year life span and spends most of it buried in the substrate, where it grows to about 200mm, metamorphoses, and becomes sexually mature. Adults generally migrate upstream to spawn. American Brook Lamprey spawn the earliest and initiate spawning in the coolest water (~7ºC) (Hardisty and Potter 1971) compared to other species of lamprey in the Lake Champlain Basin. Larval habitat consists of lotic depositional, estuarine, and lentic areas of streams, with organic matter for feeding and fairly stable substrate in order to maintain burrow. Spawning occurs in riffle areas with sand and pea gravel up to approximately 20 mm diameter (Manion and Hanson 1980; W. Bouffard, USFWS, personal communication). Adults require certain physical factors for successful spawning such as suitable substrate (pea gravel), water velocities (0.3-0.5 m/s), and temperatures (mean 14ºC, range 6.7-20.6ºC) (Manion and Hanson 1980; Hardisty and Potter 1971; Morman 1979).

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Culverts at road crossings and dams may fragment habitat by creating barriers to upstream spawning migration of adult brook lamprey. Sedimentation of stream bottoms reduces the quality of spawning habitat.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition for larval habitat with Sea Lamprey and Silver Lamprey may reduce survival and/or fitness of American Brook Lamprey larvae (Scott and Crossman 1998). The Lake Champlain Fish and Wildlife Management Cooperative is currently involved in a Sea Lamprey control program that includes the use of lampricides to kill stream-resident larvae. These lampricides are toxic to all species of lamprey. In most streams where American Brook Lamprey and Sea Lamprey co-occur, traps are used to remove adult Sea Lamprey before they spawn, eliminating the need to use lampricides. The repeated use of lampricides has been shown to adversely affect populations of American Brook Lamprey in Lake Superior tributaries (Schuldt and Goold 1980).

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Population monitoring to determine current status and changes.
Monitoring	Habitat Change	High	Habitat assessment and monitoring to assess habitat change and identify limiting factors.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Monitor known limiting factors to populations and their habitats.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations, town & regional planning & Cons Comms	Dam owners
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on American Brook Lamprey populations.	Number of existing populations of American Brook Lamprey protected and sustained.	LCFWMC, USFWS, VDEC	VFWD (DJ, SWG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations, town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, USFWS, TNC, Echo Center, LCBP, LCI, watershed associations	
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

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Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S4S5 **State Trend:** Stable
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

Historically, Sea Lamprey was abundant in the Connecticut River and tributaries as far upstream as the first barrier falls (Gephard and McMenemy 2004) and are thought to have been capable of ascending the river beyond Bellows Falls at river-mile 174 (Scarola 1987). Like other anadromous fishes (e.g., Atlantic Salmon and American Shad) the construction of the first barrier dam in 1798 near present day Turners Falls, Massachusetts obstructed lamprey passage; however, with the construction of fish ladders at Turners Falls, Vernon and Bellows Falls dams during the 1980s, lamprey was given access to spawning and nursery habitats in the Vermont-New Hampshire shared reaches of the Connecticut as well as in tributaries up to natural and artificial barriers.

The species is recognized as having an ecological role in the river's ecosystem (Weaver et al. 2016): Sea lamprey provide biological benefits by bringing marine-derived nutrients into freshwater systems and by exporting important nutrients out to sea. Sea lamprey eggs, emigrating transformers, and lamprey carcasses provide a valuable source of food for a variety of birds, fish, and mammals. During sea lamprey spawning activities, the loosened and clean substrate improve streambed structure, which benefits other species that utilize this habitat type for spawning, and refugia.

The sea lamprey has benefitted from fish passage facilities constructed for other anadromous fishes (USFWS 2010). The Connecticut River Atlantic Salmon Commission (CRASC) and its partners assume that the native distribution of Sea Lamprey closely followed that of Atlantic Salmon (Gephard and McMenemy 2004). The Connecticut River sea lamprey population appears to be relatively stable (USFWS 2010). For the last 20 years, lamprey counts at Vernon and Bellows Falls dams have averaged about 4,600 and 300 fish per year, respectively. Sea lamprey have been a focal species under the current FERC relicensing process at the three mainstem dams. It is anticipated that under the new license accessibility and improvements to spawning and rearing habitats will benefit sea lamprey in the Connecticut River . A CRASC Management Plan for Sea Lamprey is currently underway. Strategies outlined in the plan will guide management and conservation efforts in the region.

Distribution

Sea lamprey are common on both sides of the Atlantic Ocean; in the west, from southwestern Greenland and the Grand Banks, the Gulf of St. Lawrence, and as far up the St. Lawrence River and its tributaries as Sorel, Quebec, and south to northeastern Florida (Scott and Crossman 1973). Landlocked populations also exist, such as the one in Lake Champlain. Adult sea lamprey frequent the Connecticut River and many of its larger tributaries up to the first impassable barriers during the spawning season. Larval lamprey inhabit these waters wherever suitable habitat exist.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable

Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Middle Connecticut	Upper Connecticut-Mascoma
West	
Black-Ottauquechee	
White	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Anadromous populations of sea lamprey, as occurs in the Connecticut River basin, has a life cycle that depends on both marine and freshwater habitats. Adults migrate from the sea and ascend rivers and streams to spawn. Spawning occurs over substrate composed of a mixture of sand, gravel and rubble at water depth of 381-610 mm. Spawning activity starts when stream water temperature warms to 11.1-11.7 C and peaks at 14.4-15.6 C (Scott and Crossman 1973). Larvae take up residence by burrowing into rich organic stream bottoms and feed at the streambed surface by filtering out food organisms.

Habitat Types:

Aquatic: Lower CT River

Current Threats

Habitat Threats:

Energy Infrastructure and Development

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Excessive siltation degrades the quality of spawning habitat. Migration barriers (e.g., dams) fragment habitat and can prevent adults from gaining access to spawning areas. Unnatural flow regimes, erratic flow fluctuations, and inadequate base flows can cause behavioral changes in spawning activity, nest dewatering, nest scouring, and reduced survival and growth of rearing ammocoetes

Description of non-habitat threat(s):

Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Identify spawning congregations, spawning habitat, and man-made barriers to improve accessibility and quality of spawning and rearing habitats.
Research	Threats and Their Significance	Low	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Medium	Monitoring adult sea lamprey runs at Connecticut River fishways is critical to detecting any changes in population status and trends.
Monitoring	Habitat Change	Low	
Monitoring	Monitor Threats	Medium	Evaluate impacts of regulated flows during licensing and permitting processes

Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Support the development and implementation of a Connecticut River Atlantic Salmon Commission Management Plan for Sea Lamprey		CRASC, USFS, USFWS, VDEC, NRCS, ACE, CRJC,	USFWS, USFS,
Habitat Restoration	High	Protect and restore in-stream and riparian habitats via water quality, flow and temperature improvements; sediment reduction; riparian corridors.		CRASC, USFS, USFWS, VDEC, NRCS, ACE, CRJC, watershed associations, town planning and conservation commissions	
Habitat Restoration	High	Maintain and restore aquatic organism passage at barriers (e.g., dams, culverts) to provide access to critical habitats.		CRASC, USFWS, CRJC, VTRANS, hydropower companies	
Compatible Resource Use	High	Participate in existing regulatory processes (Act 250, FERC, stream alteration, etc.) to protect and restore sea lamprey critical spawning and rearing habitats.		VDEC, CRJC, RPCs, watershed associations, USFWS	

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Common Name: **Mottled Sculpin**
Scientific Name: **Cottus bairdi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S2 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

At present eight populations distributed among the same number of streams are known to occur in Vermont (Langdon 2014). All are in the Lake Champlain Valley biophysical region and are peripheral to the species' continental range. Very little is known of the biology, abundance of these populations, or population threats. On a range-wide scale no major threats are known (NatureServe 2014).

Distribution

The Mottled Sculpin has a wide but discontinuous distribution in North America with the more eastern range encompassing northern Quebec and Labrador, and the drainages of the Great Lakes, Hudson and James bays. Western populations are largely limited to the Columbia River drainage (Scott and Crossman 1973). In Vermont, seven populations of Mottled Sculpin have been identified, all in tributaries to northern Lake Champlain (Allen Brook, Colchester; Bartlett Brook, South Burlington; Englesbee Brook, Burlington; Lamoille River, Milton; Mill River, Georgia; Stonebridge Brook, Milton; Trout Brook, Milton. It is also suspected to inhabit shoreline areas of Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Mottled Sculpin occur in cool streams, small rivers and in lakes. It prefers a bottom of gravel or rubble, rarely being found over sand. In streams it is a riffle dweller. In lakes it inhabits rocky shorelines. Although most reports label Mottled Sculpin as a cold or cool water species, Vermont specimens have been recorded in warmer streams below the fall line (Langdon et al. 2006). Mottled Sculpin are found in areas with substrates composed of clean gravel and rubble/cobble. They are intolerant of habitat degradation (siltation and turbidity) and populations have been reduced in some parts of its range. Spawning takes place in cavities beneath rocks, ledges, or logs generally in May when water temperatures reach 10°C (Smith 1985; Trautman 1981).

Common Name: **Mottled Sculpin**
Scientific Name: **Cottus bairdi**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): Mottled Sculpin are intolerant of habitat degradation due to sedimentation, siltation and turbidity. This is believed to be one cause for the reduction or extirpation of populations in some parts of its range.

Non-Habitat Threats:

Unknown Non-Habitat Threats

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Very little is known about the distribution and abundance
Research	Threats and Their Significance	Medium	Evaluate and monitor the impacts of sedimentation and strategies to reduce sedimentation
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	Monitoring population status needed.
Monitoring	Habitat Change	Medium	Monitor known habitat to ascertain current status and future changes.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Monitor the impacts of sedimentation
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Mottled Sculpin**
Scientific Name: **Cottus bairdi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	Low	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Smith, C. L. 1985. Inland fishes of New York State. New York State Department of Environmental Conservation, Albany.

Trautman, M. B. 1981. The fishes of Ohio with illustrated keys. Revised edition. Ohio State University press, Columbus

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G3G4 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Lake Champlain and the lower reaches of four major tributaries (Winooski, Lamoille and Missisquoi rivers and Otter Creek, all directly accessible from the lake) are habitats for the only Lake Sturgeon population occurring in Vermont.

This population is on the eastern edge of its continental range. Prior to closure of the sturgeon fishery in 1967 commercial landings indicated a rapid decline in sturgeon abundance during the 1940s. In 1975 Lake Sturgeon was designated endangered in the state. Occasional encounters with Lake Sturgeon during VFWD fisheries assessments and incidental catches by anglers persist. Current data has found adult sturgeon ascend the Lamoille and Winooski rivers during the spring spawning season, and spawning has been confirmed by egg trap and drift net sampling done in those rivers as well as the Missisquoi River (MacKenzie 2014). Although sturgeon are known to occur in Otter Creek based on angler catch reports, spawning there has not yet been documented (MacKenzie 2015). Abundance, age class structure and distribution of sturgeon in the lake are unknown. Sturgeon ascending Missisquoi and Lamoille rivers to spawn are limited to suitable habitat located downstream of Swanton Dam and Peterson Dam, respectively, which likely have significantly reduced their historic range within these rivers.

Threats to sturgeon populations generally include overexploitation (including poaching), dams (direct and indirect effects), contaminants, habitat degradation, and introduced species (COSEWIC 2006). Because Lake Sturgeon is a slow growing, late maturing, intermittently spawning species, depleted populations, even when protected, may take many years to recover, if at all (COSEWIC 2006). The species is classified as threatened in New York State (NYSDEC 2005) as well as in the Great Lakes – Upper St. Lawrence unit of Canada (COSEWIC 2006). Selected as a Regional-SGCN by the 13 Northeastern states in 2014

Distribution

Lake Sturgeon has a wide distribution occurring from the St. Lawrence River to Hudson Bay, west to the Saskatchewan River in Alberta, south through Lake Champlain, the Mississippi River to the Tennessee River in Alabama and in northern Mississippi; from lakes Winnipeg and Manitoba south through eastern North and South Dakota, northeastern Nebraska and Kansas to eastern Missouri and Arkansas (Scott and Crossman 1973). In Vermont, it inhabits only Lake Champlain with small spawning runs recently documented to occur in the Missisquoi, Lamoille and Winooski rivers (C. MacKenzie, Vermont Fish and Wildlife Department, personal communication). The Vermont population is on the eastern edge of the species North American range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Distribution by Watershed:

Known Watersheds

Lake Champlain

Lamoille River

Missisquoi River

Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Lake sturgeon is a demersal species inhabiting lakes and large rivers, usually at 5-9 m depth, over mud, sand, and gravel (Page and Burr 1991). Sturgeon prefer spawning in fast, shallow water with rocky substrate (Harkness and Dymond 1961). Chiotti et al. (2008) located spawning sites in the Big Manistee River of Michigan at water depths in the range of 1.5 to 3 m and average water velocities in the range of 0.34 to 1.32 m/s. Lahaye et al. (1992) collected sturgeon eggs on spawning grounds in the Des Prairies and L'Assomption rivers (Quebec) at minimum and maximum water velocities of 0.02 and 1.39 m/s. Age-0 sturgeon prefer shallow (<2 m), riverine areas with substrate of coarse sand or pea-sized gravel, low current velocity (<0.60 m/s), and an absence of rooted vegetation (Kempinger 1996).

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Lake Sturgeon eggs require clean river bottoms for survival and the species has declined in areas where siltation has been high. Dams fragment habitat and create barriers to upstream migrating fish during the spawning season.

Non-Habitat Threats:

Genetics

Pollution

Reproductive Traits

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Harvest or Collection

Description of non-habitat threat(s): Sea Lamprey predation is believed to be the most significant threat to Lake Sturgeon in Lake Champlain, and mortality of sub-adult and adult sturgeon from lamprey predation is the most likely factor limiting recovery of the species in the lake (MacKenzie 2015). Lake Sturgeons are long-lived. Maturity is attained at 14-20 years, and thereafter reproduction occurs approximately every four years. These life history characteristics make Lake Sturgeon extremely vulnerable to harvest and other disturbances. Lake Sturgeon populations exhibit long recovery times because of delayed maturation and the number of years between spawning events. Low population size could lead to inbreeding depression. Over-harvest by sport and commercial fishermen prior to closure of the Vermont fishery in 1967 may have contributed to the decline of the species in Lake Champlain.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Little is known about the current distribution and abundance of Lake Sturgeon in Lake Champlain and spawning tributaries.
Research	Threats and Their Significance	High	
Research	Population Genetics	Medium	Genetic testing of tissue samples from Lake Sturgeon show s that the population is most closely related to that occurring in the St. Lawrence River. Genetic diversity appears to be relatively consistent among populations and heterozygosity is consistent with that observed for most other freshwater fish species. Even though the Lake Champlain population has declined significantly, genetic diversity within the population is not depressed nor is there signs of inbreeding at this time.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Estimates of lake population size and age structure are lacking.
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Legislation	Medium	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public.	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Species Restoration	High	Develop and implement a plan for restoring Lake Sturgeon to Lake Champlain and historic spawning tributaries.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, USFWS	SWG, DJ, USFWS

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Species Restoration	High	Reduce in Sea Lamprey wounding rates observed on Lake Sturgeon.	Sea Lamprey wounding rates.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC
Compliance & Enforcement	High	Protect Lake Sturgeon from directed and incidental harvest by anglers through law enforcement and enhanced public outreach.	Documented annual number of illegal harvest cases and number of fish harvested.	VFWD	VFWD

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Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G4 **Global Trend:** Unknown
State Rank: S2 **State Trend:** Declining
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Historically, American Eels were common in Vermont and found in watersheds lying east and west of the Green Mountains (Thompson 1853), but since colonial settlement of the state eels have been negatively affected by artificial barriers to their migrations (dams) and habitat loss and alteration (NatureServe 2014). Other identified threats to eel populations are hydro turbine mortality, oceanic conditions, overfishing, parasitism, predation and pollution (NatureServe 2014). MacMartin (1962) reported of his statewide survey of Vermont streams (1952-1960) that eels were found in only one tributary to the Connecticut River (i.e. the West River), where eels were encountered far upstream in the mainstem and in headwater streams. From the late 1980s through the 1990s eels were observed with some regularity in the lower West River (i.e. downstream of Ball Mountain Dam) and in certain tributary streams. However, since that time, eel sightings have become much less frequent in occurrence (K. Cox, Vermont Fish & Wildlife Department, personal communication).

Recent reports from fishermen, resource managers, and scientists indicate a further decline in American eel populations. Harvest pressure and habitat losses are listed as the primary causes of any possible historic and recent decline in abundance (Castonguay et al. 1994a and 1994b). In 2000, the Atlantic States Marine Fisheries Commission adopted an "Interstate Fishery Management Plan for American eel" to protect and restore the species. Management actions, conservation strategies and information needs outlined in ASMFC American Eel Fishery Management Plan guide regional efforts to improve eel abundances of all life stages within their native range including the Connecticut River and its tributaries.

The ASMFC (2012) reported "[a]ccording to the 2012 benchmark stock assessment, American Eel population is depleted in U.S. waters. The stock is at or near historically low levels due to a combination of overfishing, habitat loss, food web alterations, predation, turbine mortality, environmental changes, toxins and contaminants, and disease." In 2010 the U.S. Fish & Wildlife Service (USFWS) was petitioned to list American Eel as a threatened species (ASMFC 2014). In September 2015 USFWS announced its decision that listing "is not warranted at this time." The decision acknowledged that although local populations suffer losses from harvest mortality and hydroelectric projects, these stressors alone do not pose an overall threat to the species.

American eel was selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

The American Eel occurs from Greenland throughout much of eastern Canada, south through most of eastern United States to the Gulf coast, along the eastern seaboard of Mexico to the Yucatan Peninsula, the West Indies and Bermuda to the Gulf of Mexico, Panama and the West Indies and Bermuda (Scott and Crossman 1973). Spawning grounds are in the Sargasso Sea. In Vermont, eel historically was found through much of Vermont (Lake Champlain and Connecticut River drainages).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Not Probable

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

Northern Green Mtns	Not Probable	**Southern Green Mtns**	Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Probable		

Distribution by Watershed:

Known Watersheds
Upper Connecticut
White
Middle Connecticut
West
Black - Ottauquechee

Probable Watersheds
Waits
Upper Connecticut - Mascoma
Deerfield
Passumpsic

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

American Eel is a catadromous species and is reported to only spawn in the Sargasso Sea of the Atlantic Ocean. Larvae are carried by ocean currents to coastal areas where they transform into glass eels, then elvers and begin a long upstream migration to inland waters where they can live more than 20 years (as immature yellow eels) before returning to the sea to spawn (as silver eels). The only life stages occurring in Vermont is the immature yellow phase and at the beginning of their downstream migration the silver phase. Yellow-phase American Eels have occurred in both the Connecticut River and Lake Champlain drainages of Vermont, where they can live in a wide variety of habitats including ponds, lakes, rivers and streams. They often occupy areas where they can find cover (rocks, snags, weeds) during daylight hours.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Being a catadromous species, American Eels are subjected to a wide variety of challenges associated with extensive migrations and residency in both marine and freshwater environments. Obstructions, such as dams, can fragment habitat and limit access to valuable rearing habitats. Delays and mortality associated with hydro facilities during outmigration can limit spawning potential and reduce total production. Therefore, successful upstream and downstream fish passage at barriers is critical to maintaining a spawning stock biomass from the U.S. Atlantic coast (Lary and Busch, 1997). Studies by Knights (2003) and Wirth and Bernatchez (2003) suggest that climate change may be

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

affecting ocean temperatures and currents such that food and dispersal of eel larvae have been negatively impacted, thereby reducing survival and recruitment.

Non-Habitat Threats:

Pollution

Harvest or Collection

Description of non-habitat threat(s): Poor water quality can result in contaminants bio-accumulating in the reproductive tissue of eels, resulting in impairments to reproduction. Potential impacts from contaminants include mortality, changes in behavior, and decreases in fecundity (AMFC 2000). Artificial reproduction using mature eels to support the commercial industry is not yet feasible. Therefore, naturally reproduced glass eels and elvers have been harvested in coastal areas and tributaries of North America for many years to support an intensive aquaculture industry in eastern Asia (Moriarty and Dekker 1997). In recent years, glass eel and elver overharvest has given rise to serious concern as to the future viability of the eel industry (AMFC 2000).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Gain information on current distribution and abundance in tributaries, lakes and ponds or below potential barriers.
Research	Threats and Their Significance	High	1) Pollution and contaminants: analyze tissue samples for contaminants; monitor water quality in known rearing sites. 2) Passage: evaluate, and investigate technologies to improve, fish passage facilities for eels on the Connecticut River and tributaries; assess impacts of turbine mortality on out-migrating eels and investigate technologies to improve safe and timely downstream passage; and investigate congregations of eels below barriers to determine eel passage requirements.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitor populations and maintain an eel database.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to rearing habitats and ensure safe, timely and effective downstream passage of silver eels. Require eelways where warranted for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, TNC, watershed associations, town & regional planning & conservation commissions	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Invasive Species Control & Prevention	Low	Monitor health of American Eels populating the Connecticut River Basin. Enforce fish importation regulations and disease management protocols.	Enforcement of importation regulations.	VFWD, NHFGD, CRASC, USFWS	VFWD, NHFGD, CRASC, USFWS
Policy & Regulations	Low	Support and cooperate with the inter-agency program for the restoration of anadromous fishes to the Connecticut River basin (e.g., CRASC).		VFWD, NHFGD, CRASC, USFWS	VFWD, NHFGD, CRASC, USFWS

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

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Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G4 **Global Trend:** Unknown
State Rank: S2 **State Trend:** Increasing
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

American Eel was once an abundant species in the Lake Champlain drainage. As recently as the early 1980s, it was harvested commercially in Lake Champlain. For at least 150 years the Richelieu River, which flows out of Lake Champlain, supported a significant commercial eel fishery. Canadian fishery scientist estimated the average annual eel harvest between 1920 and 1980 was 35 metric tons; however, since 1981 landings decreased from 72.9 tons to only 4.7 tons (Dumont et al. 2004). Construction of large dams on rivers once ascended by eels have blocked juvenile fish access to critical rearing habitats. Dams used for hydropower generation have also been implicated in causing high levels of mortality as eels are subjected to turbine losses during their outmigration to sea. High commercial harvest of juvenile eels in coastal waters has further contributed to depressed U. S. stocks. Global climate change has also been identified as a potential limiting factor.

Recent reports from fishermen, resource managers, and scientists indicate a further decline in American eel. Harvest pressure and habitat losses are listed as the primary causes of any possible historic and recent decline in abundance (Castonguay et al. 1994a and 1994b). In 2000, the Atlantic States Marine Fisheries Commission adopted an "Interstate Fishery Management Plan for American eel" to protect and restore the species. Management actions, conservation strategies, and information needs outlined in ASMFC American Eel Fishery Management Plan, guide regional efforts to improve eel abundances of all life stages within their native range including the Champlain drainage.

In 2010 the U. S. Fish and Wildlife Service (USFWS) received a petition to list the American Eel as a threatened or endangered species under the Endangered Species Act. In September 2015, the USFWS announced its decision that listing is not warranted. The decision acknowledges that although local populations suffer losses from harvest mortality and hydroelectric projects, these stressors alone do not pose an overall threat to the species. In Lake Champlain abundances have recently increased due to management activities including elver stocking and the installation of eel passes on the Richelieu River, Quebec. However, without safe downstream passage facilities, it is not known to what extent these eels will contribute to the spawning population considering they have yet to make their spawning migration to sea.

Distribution

The American eel occurs from Greenland throughout much of eastern Canada, south through most of eastern United States to the Gulf coast, along the eastern seaboard of Mexico to the Yucatan Peninsula, the West Indies and Bermuda to the Gulf of Mexico, Panama and the West Indies and Bermuda (Scott and Crossman 1973). Spawning grounds are in the Sargasso Sea. In Vermont, eels historically were found through much of Vermont (Lake Champlain and Connecticut River drainages).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Probable

Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Lake Champlain	Lamoille River
	Missisquoi River
	Otter Creek
	Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

American Eel is a catadromous species and is reported to only spawn in the Sargasso Sea of the Atlantic Ocean. Larvae are carried by ocean currents to coastal areas where they transform into glass eels, then elvers and begin a long upstream migration to inland waters where they can live more than 20 years (as immature yellow eels) before returning to the sea to spawn (as silver eels). The only life stages occurring in Vermont is the immature yellow phase and at the beginning of their downstream migration the silver phase. Yellow-phase American Eels have occurred in both the Connecticut River and Lake Champlain drainages of Vermont, where they can live in a wide variety of habitats including ponds, lakes, rivers and streams. They often occupy areas where they can find cover (rocks, snags, weeds) during daylight hours.

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Being a catadromous species, American Eel are subjected to a wide variety of challenges associated with extensive migrations and residency in both marine and freshwater environments. Obstructions, such as dams, can fragment habitat and limit access to valuable rearing habitats. Delays and mortality associated with hydro facilities during outmigration can limit spawning potential and reduce total production. Therefore, successful upstream and downstream fish passage at barriers is critical to maintaining a spawning stock biomass from the U.S. Atlantic coast (Lary and Busch, 1997).
Studies by Knights (2003) and Wirth and Bernatchez (2003) suggest that climate change may be affecting ocean temperatures and currents such that food and dispersal of eel larvae have been negatively impacted,

Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

thereby reducing survival and recruitment.

Non-Habitat Threats:

Pollution

Harvest or Collection

Description of non-habitat threat(s): Poor water quality can result in contaminants bio-accumulating in the reproductive tissue of eels, resulting in impairments to reproduction. Potential impacts from contaminants include mortality, changes in behavior, and decreases in fecundity (AMFC 2000).
For decades, eels from Lake Champlain have been harvested in Canada as they migrate out (silver eels) along the Richelieu and St. Lawrence rivers. In addition, eels were harvested for commercial sale in Vermont waters of Lake Champlain by electrofishing for a few years in the 1980s. The commercial harvest of eels in Lake Champlain was made illegal in 2002. Artificial reproduction using mature eels to support the commercial industry is not yet feasible. Therefore, naturally reproduced glass eels and elvers have been harvested in coastal areas and tributaries of North America for many years to support an intensive aquaculture industry in eastern Asia (Moriarty and Dekker 1997). In recent years, glass eel and elver harvest has given rise to serious concern as to the future viability of the eel industry (AMFC 2000).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Contribution of eels in northern regions to overall stock is unknown. Gain information on the current distribution and abundance in tributaries, lakes and ponds or below potential barriers.
Research	Threats and Their Significance	High	1) Pollution and contaminants: analyze tissue samples for contaminants; monitor water quality in known rearing sites 2) Passage: evaluate, and investigate technologies to improve, fish passage facilities for eels on Richelieu River and other known rearing waterbodies; assess impacts of turbine mortality on out-migrating eels and investigate technologies to improve safe and timely downstream passage; and investigate congregations of eels below barriers to determine eel passage requirements.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitor populations and maintain an eel database.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Improve flow regimes below hydroelectric generation and flood control projects.	Number of projects which operate under flow regimes that provide suitable habitat for American Eel.	VDEC, VFWD, USFWS, dam owners	Dam owners
Research	Low	Investigate the significance of recreational eel harvest in Lake Champlain and whether harvest protection measures are warranted.	Issue was reviewed with recommendations.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to rearing habitats and ensure safe, timely and effective downstream passage of silver eels. Require eelways where warranted for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored	Dam Owners, VDEC, VFWD, USFWS	Dam owners
Invasive Species Control & Prevention	Low	Monitor health of American Eels populating Lake Champlain Basin. Enforce fish importation regulations and disease management protocols.	Enforcement of importation regulations.	VFWD, USFWS, NYDEC	VFWD (SWG, DJ), USFWS
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI

Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: SU **State Trend:** Historic
Extirpated in VT? Yes **Regional SGCN?** Yes

Assessment Narrative:

Blueback Herring were once common in the Connecticut River mainstem as far upriver as the natural barrier (falls) at Bellows Falls, Vermont and North Walpole, New Hampshire, a distance of 174 river-miles from the river mouth on Long Island Sound. Construction of the first dam on the river in 1798 near present-day Turners Falls, Massachusetts extirpated the species from the upper river (Gephard and McMenemy 2004). With restoration of fish passage at Turners Falls (MA) and Vernon (VT) dams during the early 1980s Blueback Herring as well as other anadromous fishes once again have access to critical habitats in the upper river. During the first 10 years that the Vernon fish ladder was operated (1981-1990) an average of 35 Bluebacks were observed annually passing into the Vernon head pond which extends upriver nearly to Bellows Falls. In 1991 the Vernon Dam herring run peaked at 383 fish which was followed over the next nine years (1992-2000) with a downward trend (average annual passage count 22 fish). Since then, Blueback Herring have not been observed above Vernon Dam. A similar trend has occurred in the lower Connecticut River, represented by passage counts made at the Holyoke (MA) Dam fishlift, i.e. an increasing trend from the 1970s through mid-1980s followed decreasing numbers thereafter. Such declines have been noted in other U.S. river stocks ranging from Maine to Delaware. Stock assessments for Blueback Herring and Alewife, collectively reported as river herring, made by the Atlantic State Marine Fisheries Commission (ASMFC) concluded that 23 (including the Connecticut River) of the 52 stocks assessed are depleted relative to historic levels (ASMFC 2012). NatureServe (2013) lists Blueback Herring as vulnerable based on "drastic declines in abundance…in many areas in recent decades." Causes for stock declines are not fully understood at present; however, restoration of Blueback Herring to the VT-NH shared section of the Connecticut River is contingent on appropriate management actions implemented by coastal state fishery agencies and the federal government. Freshwater threats to Blueback Herring stocks include obstruction of migration routes by dams and other barriers, entrainment and impingement mortality, habitat degradation, overfishing, and predators e.g. striped bass (NatureServe 2013; Savoy and Crecco 2004). Selected as an Regional-SGCN by the 13 Northeastern states in 2014

Distribution

The Blueback Herring reaches its northern limit in Canadian waters and occurs along the eastern North American seaboard from Cape Breton, Nova Scotia south to northern Florida (Scott and Crossman 1973). Landlocked populations are also known to occur, including Lake Champlain. Anadromous Blueback Herring occur naturally in the Connecticut River basin, although their historic occurrence in the Vermont-New Hampshire shared section of the Connecticut River is reported to have been similar to that of American Shad. The upriver limit to their distribution extended to the natural barrier on the river between Bellows Falls, Vermont and North Walpole, New Hampshire. Although Blueback Herring are also found in Lake Champlain (since 1979), the species is not indigenous to that waterbody and is believed to have gained access to the lake by the Hudson Barge Canal connection to the Hudson River. The last year Blueback Herring 2 individuals) have been observed in Vernon fish ladder was 2000.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Probable Watersheds
Middle Connecticut

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Blueback Herring is an anadromous species spending portions of its life in both marine and freshwater environments. In freshwater, it migrates up rivers to spawn. Generally the upstream migration of Blueback Herring does not extend as far as for other clupeid species (e.g., Alewife); spawning may occur in both brackish and fresh waters (Scott and Crossman 1973). Spawning occurs in a diversity of habitats, including large rivers, small streams, ponds and large lakes over a range of substrates, such as gravel, sand, detritus, and submersed vegetation and other structures. Swift flowing waters are used as spawning sites. Blueback Herring spawn in rivers releasing their eggs into the water column whereupon the eggs settle and adhere to the substrate, including stones, gravel and sticks (Scott and Crossman 1973). Larval and juvenile Blueback Herring reside in the river during their first summer before out-migrating the following fall. Spawning success and survival of adults and juveniles are dependent on successful passage past manmade obstacles, such dams and hydroelectric generation plants.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Current Threats

Habitat Threats:

Habitat Fragmentation

Description of habitat threat(s): Spawning success and survival of adults and juveniles are limited by the existence and development of dams and hydroelectric generation plants which may impede access to spawning and nursery habitats, as well as cause mortality to out-migrating fish. River flow regimes as manipulated by hydroelectric poer generation activities can affect Blueback Herring habitat.

Non-Habitat Threats:

Predation or Herbivory

Description of non-habitat threat(s): Migrating adult and juvenile Blueback Herring are susceptable to predation, especially fish predators. Improvements in stock strength of Striped Bass and Bluefish are believed to have increased predatory pressure on migrating clupeid populations, including Blueback Herring and American Shad. Being an anadromous species, blueback herring are subjected to a wide variety of problems associated with extensive migrations and residency in both marine and freshwater environments. Out-migrating adult and juvenile herring may be exposed to turbine mortality at power dams

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

resulting in high losses.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	Medium	Turbine passage and mortality studies.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	Research is being conducted by other agencies to which Vermont is a cooperator.
Monitoring	Population Change	High	Monitor herring passage at Connecticut River fishpasses.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, USFWS, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to spawning and juvenile habitats and expedite outmigrants (post-spawned adults, juveniles) to sea. Operate and maintain existing fishways for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners
Natural Processes Restoration	High	Improve flow regimes below hydroelectric generation and flood control projects.	Number of projects which operate under flow regimes that provide suitable habitat for Blueback Herring.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, TNC, power companies, watershed associations, town & regional planning & Cons Comms	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, power companies, watershed associations, town & regional planning & conservation commissions
Species Restoration	High	Provide technical support to regional restoration plans and efforts as necessary.	CRASC River Herring Restoration Status & Plan in the Connecticut River Basin; ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, USFWS, NMFS, ASFMC, CRWC	CRASC, USFWS, NMFS, ASFMC, CRWC
Research	Medium	Striped Bass and other predator threats to American Shad stocks.	ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, NMFS, ASMFC	CRASC, NMFS, ASMFC
Policy & Regulations	Medium	Support and cooperate with the inter-agency program for the restoration of anadromous fishes to the Connecticut River basin (e.g., CRASC).	Implement Connecticut River Basin Management Plan for Blueback Herring. Percent of tasks implemented as prescribed in the plan.	VFWD, NHFGD, CRASC, USFWS, ASMFC	VFWD, NHFGD, CRASC, USFWS
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC	

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

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Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries research Board of Canada Bulletin 184, Ottawa.

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? No

Global Trend: Unknown
State Trend: Increasing
Regional SGCN? Yes

Assessment Narrative:

American Shad were once common in the Connecticut River mainstem as far upriver as the natural barrier at Bellows Falls, Vermont and North Walpole, New Hampshire, a distance of 174 river-miles from the river mouth on Long Island Sound. Construction of the first dam on the river in 1798 near present-day Turners Falls, Massachusetts extirpated the species from the upper river (Gephard and McMenemy 2004). With restoration of fish passage at Turners Falls (MA) and Vernon (VT) dams during the early 1980s shad as well as other anadromous fishes are once again provided access to critical habitats in the upper river. During the first eleven years that upstream fish passage was provided at Vernon Dam the number of adult shad passed above the dam followed an increasing trend from 97 shad counted in 1981 to 37,197 shad in 1991. Over the following 20 years the shad passage above the dam declined from 31,155 fish in 1992 to 290 in 2011. Since then annual shad passage counts at the dam have been in the range of 10,175 and 27,706 fish. Factors affecting shad abundance above Turners Falls Dam are complicated but illustrate the some of the threats that beset the species and challenge restoration of the species to the upper Connecticut River. Specifically, after 1990 commercial shad landings along the Atlantic seaboard and stock abundance in several rivers declined significantly. In the Connecticut River, 1.6 million shad were estimated to have returned to the river in 1992; by 1995 returns had declined to 304,500 fish (ASFMC 1999). Striped Bass predation on adult and juvenile shad has also been suggested (Savoy and Crecco 2004). It was also hypothesized that the thermal discharge from Vermont Yankee Nuclear Power into the Vernon headpond may have had negative effects on adult and juvenile shad migrations and survival. And lastly, structural and operational factors at both Turners Falls and Vernon fish ladders affecting fish passage were identified and corrected which appears to explain increased passage at Vernon observed in 2012-2014. Threats to American Shad habitats include the following: barriers to migration, water withdrawals, toxic and thermal wastewater discharge, channelization, dredging and instream construction, inappropriate land uses, atmospheric deposition, climate change, competition and predation by invasive and managed species, fisheries activities, and instream flow regulation (ASMFC 2010). Selected as an Regional-SGCN by the 13 Northeastern states in 2014

Distribution

American Shad inhabit waters along the Atlantic Coast from Newfoundland south to Florida; it has also been introduced to the Pacific Coast of North America (Scott and Crossman 1973). In Vermont, it is restricted to the Connecticut River from the Massachusetts state line upstream to at least Bellows Falls dam. Low numbers in some years are passed above Bellows Falls via the fish ladder there. The last year shad were observed in the ladder was 2005. Shad have also been observed in the lower West River.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Middle Connecticut	Black - Ottauquechee
West	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

As an anadromous fish, the American Shad divides its life between marine and freshwater environments. Adults ascend rivers and streams to spawn. Once the eggs hatch, larval and juvenile shad inhabit riverine habitats, including setbacks, through their first summer of life before out-migrating to the ocean in the fall. Maturity is attained at sea. Stier and Crance (1985) review the habitat requirements of American shad. Adults utilize well oxygenated (>=5 ppm), flowing water, although they do not appear to have specific preferences for spawning locations other than broad flats and shallow water. Spawning may occur over a variety of substrate types providing water velocity is sufficient enough to keep sedimentation minimal. Spawning generally occurs at water temperatures of 8-26°C with peak activity occurring within the range of 14-21°C. Temperatures for maximum egg hatch and survival is 15.5-26°C. Temperatures at or near 11°C are minimal for egg incubation, and temperatures in excess of 26.7°C are unsuitable. Juvenile shad are found at water temperatures of 10-31°C. Temperatures less than 10°C cannot be tolerated. Juvenile outmigration begins when the water temperature go below 15.5°C.

Current Threats

Habitat Threats:

Habitat Fragmentation

Description of habitat threat(s): Spawning success and survival of adults and juveniles are limited by the existence and development of dams and power generation plants which may impede access to spawning and nursery habitats, as well as impose artificial flow regimes associated which in turn alter and degrade habitat for shad. Fishway design deficiencies at ladders on the Connecticut River at Turners Falls, Massachusetts are being examined as likely causes for the significant reduction in shad run abundance into Vermont and New Hampshire. This exacerbates the habitat fragmentation problem.

Non-Habitat Threats:

Predation or Herbivory

Harvest or Collection

Description of non-habitat threat(s): Migrating adult and juvenile shad are susceptable to predation, particularly fish predators. Improvements in stock strength of striped bass and bluefish are believed to have increased predatory pressure on migrating clupeid populations, including shad. Being an anadromous species, shad are subjected to a wide variety of problems associated with extensive migrations and residency in both marine and freshwater environments. Excessive commercial harvest off the Atlantic seaboard and within the estuaries represents a problem for shad stocks. Out-migrating adult and juvenile shad may be exposed to turbine mortality at power dams resulting in high mortality.

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	High	Data are needed to design fish ladders for improved fish passage performance.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	High	Research is being conducted by other agencies to which Vermont is a cooperator.
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Natural Processes Restoration	High	Improve flow regimes below hydroelectric generation and flood control projects.	Number of projects which operate under flow regimes that provide suitable habitat for American Shad.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC	
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to spawning and juvenile habitats and expedite outmigrants (post-spawned adults, juveniles) to sea. Operate and maintain existing fishways for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, TNC, power companies, watershed associations, town & regional planning & conservation commissions	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, power companies, watershed associations, town & regional planning & conservation commissions
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Species Restoration	High	Provide technical support to regional restoration plans and efforts as necessary.	ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, USFWS, NMFS, ASFMC, CRWC	CRASC, USFWS, NMFS, ASFMC, CRWC
Research	Medium	Striped Bass & other predator threats to American Shad stocks.	ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, NMFS, ASMFC	CRASC, NMFS, ASMFC
Policy & Regulations	High	Support and cooperate with the inter-agency program for the restoration of anadromous fishes to the Connecticut River basin (e.g., CRASC).	Implement Connecticut River Basin Management Plan for Blueback Herring. Percent of tasks implemented as prescribed in the plan.	VFWD, NHFGD, CRASC, USFWS, ASMFC	VFWD, NHFGD, CRASC, USFWS

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

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Common Name: **Mooneye**
Scientific Name: **Hiodon tergisus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: SU **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

In Vermont, Mooneye is confined to Lake Champlain, where it is on the eastern edge of its continental range. Very little is known of its biology, distribution and habitat use, and past and present population abundance in the lake. On a range-wide scale no major threats are known (NatureServe 2014); however in New York, it is listed as threatened (NYSDEC 2014). The cause(s) for declines in New York populations are not as yet known, but increased siltation in part is suspected (NYSDEC 2014). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

Mooneye is a North American species with a range extending from James Bay, Ottawa River to the Lake Champlain and St Lawrence watershed, southwest of the Appalachian Mountains through western New York and Pennsylvania to Arkansas and Oklahoma, north through eastern Kansas to North Dakota, southeastern Saskatchewan and southern Manitoba (Scott and Crossman 1973). In Vermont, it is a peripheral species at the eastern most extent of its range and has been recorded only from Lake Champlain, including the southern part of the lake, and near the mouths of the Missisquoi and Lamoille rivers and Otter Creek.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Probable Watersheds
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Mooneyes are found in shallow areas of large lakes and deep pools of clear rivers where the bottom is relatively free of silt (Langdon et al. 2006). Although it is generally found in non-flowing waters, it may also occur in swift waters, such as below dams (Trautman 1957). Mooneyes have rarely been taken with collection gear at depths greater than 10.7 m (Scott and Crossman 1973). Mooneye is a warm water species, preferring water temperatures in the range of 27.5-29.0 C, and migrate up rivers to spawn when the water temperatures reach 19.4 C (Langdon et al. 2006).

Common Name: **Mooneye**
Scientific Name: **Hiodon tergisus**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Mooneye is not tolerant of silted habitats or turbidity (Scott and Crossman 1973).

Non-Habitat Threats:

Unknown Non-Habitat Threats

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Assess habitat requirements and use by mooneye in Lake Champlain.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Very little is known about the distribution and abundance of mooneye in Lake Champlain.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitoring population status needed.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Mooneye**
Scientific Name: **Hiodon tergisus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S4 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

In Vermont, Cisco is confined to Lake Champlain, and little is known of the population's biology, distribution and habitat use, and past and present abundance. It is not frequently encountered during fish population lake surveys and appears to be susceptible to competition from other fishes occupying similar trophic niches, e.g. invasive Alewives; possibly Sea Lamprey parasitism; and eutrophication of the lake (NatureServe 2014). All three threats are present in Lake Champlain. The species has experienced population declines in the Great Lakes (COSEWIC 2005; NatureServe 2014). The Vermont population appears to have been much more abundant back in the 1950s than it is today. Halnon (1963) described the fishery at that time as follows: "…occurs in large numbers and is taken by ice fishermen who seek this species. It was not uncommon to check fishermen with several hundred specimens during the intensive ice-fishing checks of the 1950's. Summer population studies regularly took the species in nearly all deep water gill net collections." Combined numbers of Cisco collected during rainbow smelt trawling at four locations in Lake Champlain from 1999 to 2013 indicate a declining trend over these years, although a peak did occur during 2002 to 2004 (data provided by N. Staats, U. S. Fish & Wildlife Service, personal communication).

Distribution

This species is the most widely distributed of the 14 species of the genus Coregonus occurring in North America. It is found from eastern Quebec to the Hudson Bay, through the Great Lakes system, Ontario, Manitoba, Saskatchewan and Alberta, north into the Northwest Territories, and in the Mackenzie River system north to Great Bear Lake (Scott and Crossman 1973). In Vermont, where it occurs on the eastern edge of its range, Cisco is restricted to Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

In Vermont, Cisco inhabit the cold, deep areas of Lake Champlain. It is an open-water, schooling species inhabiting cool mid-lake areas during the summer, shifting to shallower waters inshore from fall to spring. It cannot tolerate water temperatures of over 26.1°C. Cisco spawn in late fall, just prior to ice formation, at depths of about .9-3 m, over gravel to rubble bottom (Langdon et al. 2006).

Habitat Types:

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): The appearance of Alewife in Lake Champlain is of great concern due to to its potential impact through competition with other pelagic planktivores, such as Cisco. The species also require deep, cold water. If climate change has a significant impact on the thermal structure of Lake Champlain, this could affect the Cisco population.

Non-Habitat Threats:

Competition

Parasites

Loss of Prey Base

Description of non-habitat threat(s): Sea Lamprey have negatively impacted cisco in other bodies of water (Smith 1985, Bronte et al. 2003). As soft-scaled members of the salmon family, Cisco is susceptible to parasitism/predation by Sea Lamprey. Lamprey predation was identified as a contributing factor to the decline of Cisco in Lake Superior (Bronte et al. 2003), and 80% of Cisco in Oneida Lake, NY that died off during high summer temperatures had lamprey scars (Smith 1985). So far there are no direct reports of lamprey impacts on Cisco in Lake Champlain. Cisco is primarily pelagic (open-water) feeders on zooplankton, and therefore might compete with other species with similar feeding habits, such as smelt. The appearance of alewife in Lake Champlain could pose a problem to both of these native open-water planktivores.

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Develop population indices through forage base monitoring in Lake Champlain.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitats occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Research	Medium	Currently under VFWD fishing regulations Cisco is an unregulated activity. Whether or not harvest poses a threat to Cisco population(s) should be reviewed.	Review was conducted and recommendations were considered.	VFWD, UVM	VFWD (SWG, DJ), UVM
Research	Medium	Investigate whether predation on Cisco presents significant threat to the species.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP	
Research	Medium	Investigate whether Sea Lamprey parasitism is a significant threat to Cisco.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

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Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4?
Extirpated in VT? No

Global Trend: Unknown
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

In Vermont, Lake Whitefish is found only in Lake Champlain. Halnon (1963) expressed concern for the Lake Champlain population and pointed out observations that imply the species may have been experiencing problems as far back as the 1800s. In the later part of that century there were calls for a prohibition on commercial seining during the whitefish spawning season; it was not until 1913 that this fishery ended (Halnon 1963). Later in his 1963 review of Lake Champlain fisheries he stated the species is essentially untouched by fishermen. Historically, the Lake Whitefish fisheries were concentrated in the South Lake, Missisquoi Bay, and near St. Albans Bay (Halnon 1963, Marsden and Langdon 2012). 2012 was last year whitefish was harvested commercially in Vermont ; the fishery was closed the following year (Halnon 1963). In more recent years (1930s to late 1990s), Lake Whitefish have been encountered during biological surveys only incidentally (Herbst et al. 2011). Currently, little is known about the status of Lake Whitefish nor of the causes which may be affecting its population. Van Oosten and Deason (1939) studied the population in the 1930s but not much attention has been given to it since with the exception of recent studies undertaken by Dr. Marsden at the University of Vermont (see Herbst et al. 2011, Herbst et al. 2013, Marsden et al. 2014). Herbst et al. (2011) came to the conclusion that the population is stable and unexploited; however, they also concluded that (1) some local populations, namely those that existed off Larrabee's Point and in Missisquoi Bay, may have been extirpated due to past exploitation, (2) areas where they historically were found appear to be staging rather than spawning areas, and (3) spawning substrates have been degraded. Additionally, they hypothesize that past and current land use and riparian practices resulting in increased sediment loads and phosphorus to the lake may be responsible for degraded spawning habitat particularly affecting northern and southern regions of the lake. Similar impacts have been suspected of having contributed in Lake Whitefish population declines in Lake Michigan (NatureServe 1014) and Lake Simcoe (COSEWIC 2005). Other threats to Lake Whitefish in Lake Champlain are competition with exotic species (e.g. Alewife) and Sea Lamprey parasitism.

Distribution

Lake Whitefish is a widely distributed North American species. Its range includes virtually all of Canada and Alaska, the Great Lakes, the St. Lawrence River including northern New York, Vermont, New Hampshire and Maine (Scott and Crossman 1973). In Vermont, it is confined to Lake Champlain. However, in 1878 Lake Whitefish were introduced into five other Vermont lakes, such as Lake Dunmore in Addison County and Lake St. Catherine in Rutland County, but none of these introductions was successful (Langdon et al. 2006).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Lake Whitefish inhabit cold lakes which are deep and clear. Lake Whitefish spawn during November and December at water temperatures below 7.8 C; spawning occurs near the surface in water less than 7.6 m deep, and the adhesive eggs sink to the bottom onto a usually gravel or rubble and occasionally sand substrate (Langdon et al. 2006).

Habitat Types:

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Climate Change

Description of habitat threat(s): Lake Whitefish also require deep, cold water. If climate change has a significant impact on the thermal structure of Lake Champlain, this could affect the population of Lake Whitefish.

Non-Habitat Threats:

Competition

Parasites

Description of non-habitat threat(s): The appearance of alewife in Lake Champlain is of great concern due to their potential impact through competition with other pelagic planktivores, such as Lake Whitefish. Sea Lamprey has negatively impacted Lake Whitefish in Lake Superior (Bronte et al. 2003). As soft-scaled members of the salmon family, Lake Whitefish are susceptible to parasitism/predation by Sea Lamprey. Lamprey predation was identified as a contributing factor to the decline of Lake Whitefish in Lake Superior (Bronte et al. 2003), and whitefish populations rebounded after implementation of lamprey control.

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Develop population indices through forage base monitoring in Lake Champlain.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Medium	University of Vermont (E. Marsden) is currently engaged in a genetics study of sub-populations in Lake Champlain,.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Natural Processes Restoration	Medium	UVM is studying the effects of physical isolation/reduced connectivity on Lake Champlain bays and changed water movement, nutrient retention, and potential population sub-structuring of Lake Whitefish.	Completion of study and recommendations that may come from it.	VDEC, VFWD, USFWS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP	
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Research	Medium	Investigage whether Sea Lamprey parasitism is a significant threat to Lake Whitefish. Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM	
Research	Low	Currently under VFWD fishing regulations Lake Whitefish is an unregulated activity. Whether or not harvest poses a threat to Lake Whitefish population(s) should be reviewed. Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM	

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Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Declining
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Until recently Round Whitefish populations were reported from four lakes, all in northeastern Vermont and the St. Francis River drainage (Willoughby Lake, Lake Seymour, Holland Pond, Beaver Pond), and the upper Connecticut River. There is historic reference (Titcomb and Bailey 1896) to a whitefish species distinct from Lake Whitefish (Coregonus clupeaformis) in Lake Memphremagog, but it is ambiguous which coregonine species was intended; the persistence of Round Whitefish upstream in the watershed is evidence that Round Whitefish was indeed the so-called "shad" (i.e. whitefish) noted for Lake Memphremagog (Gerardi 2015). Sampling conducted by electrofishing, experimental gill nets and beach seines between 2006 and 2012 failed to collect whitefish in Seymour Lake, Holland Pond and Beaver Pond suggesting these populations may be extirpated (Kratzer 2011). Likewise, extensive sampling by McGill University staff and students at Lake Memphremagog in the early 1970s provided no documentation of Round Whitefish remaining in the lake (Nakashima and Leggett 1975; Gascon and Leggett 1977). Several possible causes of population elimination are Smallmouth Bass introduction and predation in Lake Seymour, competition with the resident White Sucker population in Beaver Pond, Chain Pickerel (Esox niger) predation and/or anoxia in the hypolimnion in Holland Pond (Kratzer 2011), along with major fish community changes in Lake Memphremagog brought about by introduction of many species not native to the lake (Gerardi 2015). As recently as 2011 sampling of the upper Connecticut River by New Hampshire Fish & Game Department captured Round Whitefish, which population is characterized as being abundant (Kratzer 2011). Historically, Round Whitefish were reported to be in Lake Champlain as early as 1894 (Evermann and Kendall 1902) but does not appear to have been encountered during the 1929 biological survey of the lake (Greeley 1930). Current reports of Round Whitefish in the lake appear to be lacking (Marsden 2014; Parrish 2014; Pientka 2014). Potential threats to the species have been identified by NatureServe (2014) to include habitat loss through either siltation of spawning streams or lake shores and decreased water quality resulting from poor forest management practices and land development; road, bridge and in-stream construction projects with negative effects on spawning habitat or obstruction of whitefish access to spawning habitat; piscicides; and exotic fish introductions. Round Whitefish is classified as an endangered species in New York in 1983. Historically, the species was found in over 80 lakes in the state but has now declined to populations numbering fewer than eight (NYSDEC 2015a). Possible reasons for the decline of the species in New York are predation by invading Smallmouth Bass and Yellow Perch, competition with Lake Whitefish, overfishing, loss of spawning habitat, siltation, and lake acidification (NYSDEC 2015b). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

In Vermont, Round Whitefish is found in lakes Seymour, Willoughby and in Beaver Pond in Holland. A historic record of "Lake Whitefish" in Holland Pond (located near Beaver Pond in Holland) is believed actually to have been a Round Whitefish.

Distribution by Biophysical Region:

Champlain Valley	Historic Record(s) Only	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds
St. Francois River
Upper Connecticut

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Round Whitefish is an inhabitant of cold, clear lakes and rivers. In rivers it occurs over rocky bottoms. In the Great Lakes it is commonly found inshore at depths of less than 36.6 m. It sometimes occurs in brackish waters. The Round Whitefish is a benthic insectivore, feeding on benthic invertebrates and occasionally fishes and fish eggs. Round Whitefish require gravel for spawning. Since eggs incubate overwinter with no parental care, a silt-free spawning substrate probably is essential for successful recruitment as for other salmonids.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): This species was once common to many of New York's Adirondack lakes. Recent surveys have shown its distribution there significantly reduced. The New York DEC has speculated on the possible causes: "predation by invading yellow perch on whitefish eggs and fry; predation by smallmouth bass; competition with lake whitefish; over fishing; loss of spawning sites; siltation; and lake acidification". Given the current and past locations in Vermont, only the following causes are possible for Vermont lakes: predation by Yellow Perch on whitefish eggs and fry (in lakes Seymour and Willoughby); predation by Smallmouth Bass (Lake Seymour only); loss of spawning sites and siltation (lakes Seymour and Willoughby). Beaver Pond is a small remote pond with no human structures along the shore and only seasonal human use within the watershed. With a low alkalinity (about 4mg/l) lake acidification, however, exists as a potential problem to that population. pH values for beaver Pond have been observed to drop well below 6.0 during spring runoff. Since this species is a benthic insectivore it relies entirely on invertebrates on the bottom as a food source. Loss or reduction of this food through sedimentation would limit its existence. Sedimentation may also limit egg survival by reducing oxygen exchange with surrounding water. Eggs incubate for months unguarded and unmaintained making a low sedimentation rate necessary for egg survival. Loss of spawning sites through siltation is also a threat. Climate change could result in the warming of the coldwater thermal regime that Round Whitefish require.

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Non-Habitat Threats:

Competition

Pollution

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Beaver Pond is a small remote pond with no human structures along the shore and only seasonal human use within the watershed. With a low alkalinity (about 4mg/l) lake acidification is a potential threat to that population. Acidification would first impact newly hatched eggs, since this stage is normally the most vulnerable to acidity. Multiple year class failures would result in reductions or possible extermination of the species. Predation on whitefish eggs and fry by Yellow Perch in lakes Seymour and Willoughby and by Smallmouth Bass in Lake Seymour is a threat to these populations. Lake Whitefish may be a competitor with Round Whitefish.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	
Research	Threats and Their Significance	High	Identify potential limiting factors.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications		Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, CRWC, TNC	
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, TNC, CRWC	
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, VFWD	VDEC (ANCG)
Policy & Regulations	High	Currently under VFWD fishing regulations Round Whitefish is an unregulated activity. Whether or not harvest poses a threat to Round Whitefish population(s) should be reviewed.	Review was conducted and recommendations were considered.	VFWD	VFWD (SWG, DJ)
Species Restoration	High	Develop and implement a plan for restoring Round Whitefish to additional waters that have the habitat and fish community makeup to sustain whitefish populations.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, USFWS	SWG, DJ, USFWS
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRWC, NRCS, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Research	High	Investigate whether predation on Round Whitefish presents significant threat to the species.	Review was conducted and recommendations were considered.	VFWD, UVM	VFWD (SWG, DJ), UVM

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S4 **State Trend:** Historic
Extirpated in VT? Yes **Regional SGCN?** Yes

Assessment Narrative:

Whether or not landlocked Atlantic Salmon were endemic to Vermont is not at all clear. Thompson (1853) described salmon spawning runs in the state as follows: "They came up the Connecticut river [sic] about the 25th of April, and proceeded to the highest branches. Shortly after they appeared [emphasis added] in lake [sic] Champlain and the large streams which fall into it." In that salmon are described as "appearing" in the lake seems to suggest that adult fish are not present year round but rather seasonally as is characteristic of anadromous salmon. Thompson (1842) mentions salmon as being in Lake Champlain but does not make any distinction between the population as being anadromous and/or landlocked ecotypes. However, the State of Vermont Fish Commissioners (VFC 1892) stated of landlocked salmon that it "is not known to be indigenous to any lakes in Vermont" and that "Atlantic salmon…entered Lake Champlain by way of the St. Lawrence and Richelieu rivers during their migratory period for the purpose of spawning…." As a consequence of the construction of dams and other obstructions anadromous salmon were prevented access to the lake, and subsequently landlocked salmon were introduced (VFC 1892). Greeley (1930) identified landlocked salmon in Lake Champlain as an introduced species. On the other hand, Behnke (2007) offers the opinion that landlocked salmon were native to Lake Champlain. Likewise, by all accounts, landlocked salmon were not indigenous to Lake Memphremagog but were introduced from Maine (Grand Lake, East Grand lake or Sebago strains) in the late 1800s (Gerardi 2015). As a result of stocking, landlocked salmon became naturalized in the Clyde River and established a vibrant fishery, based at least in part on natural reproduction until it collapsed during the 1940s as a result of expanded hydroelectric generation on the river (Gerardi 2015). Although not substantiated, anadromous Atlantic Salmon may have had access to Lake Memphremagog and its tributaries prior to European colonization and damming of the St. Francis River at Drummondville, Quebec (Gerardi 2015). Without regard to which ecotype was native to Lake Champlain and Lake Memphremagog threats to future restored populations are similar to both: dams and water pollution, stream acidification, sedimentation of spawning and holding habitats, and possible changes in water temperature have been attributed to declines of some populations; landlocked populations have also suffered from Northern Pike and/or Esox hybrid predation (NatureServe 2014). With the appearance of Alewife (Alosa pseudoharengus) in Lake Champlain salmon have become more reliant on this species as prey. This may result in thiamine deficiency and consequently lead to salmon reproductive failure otherwise known as early mortality syndrome of salmon fry (Chipman 2015).

Distribution

Landlocked populations of Atlantic salmon occur principally in Newfoundland, Labrador and Quebec (Scott and Crossman 1973). Natural populations were also located in Maine and presumably in Vermont, i.e. lakes Champlain and Memphremagog. Scarola (1973) reports all landlocked salmon populations in New Hampshire are introduced. Landlocked populations have been stocked extensively to supplement natural populations, as well as to establish new fisheries. Even though salmon still occur in Lake Champlain, this is principally the result of a stocking program designed to restore a naturally reproducing population to the watershed, albeit there is little evidence of significant natural reproduction occurring there at this time. The Lake Memphremagog population does reproduce naturally with spawning occurring in the Clyde River.

Distribution by Biophysical Region:

Champlain Valley Historic Record(s) Only **Southern VT Piedmont** Not Probable

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Champlain Hills	Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
St. Francois River

Probable Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

The landlocked salmon is a fish of oligotrophic waters, i.e., deep, well oxygenated, relatively infertile lakes. As the spawning season sets in fish leave the depths of the lake to suitable spawning habitat located in shallow lake shore areas or to ascend tributary streams or use lake outlets (Scarola 1973). Habitat studies conducted in Lake Winnipesaukee, New Hampshire found salmon have a preference for depths below the thermocline during the summer period (12-21 m) (Scarola 1973). Water temperatures at this time of year are in the mid 10s (C). Salmon can survive water temperatures into the 21s for brief periods of time but such temperatures are usually avoided if cooler water is available. Longer exposure to these temperatures can cause the fish physiological stress. Temperatures into the 27s can be lethal. Spawning habitat preferences are similar to those for anadromous Atlantic Salmon.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Salmon require cool streams for spawning and juvenile rearing. Many of the historical salmon streams in Vermont have barriers that impede their access to these habitats (e.g., Missisquoi, Lamoille, Winooski, Clyde rivers and Otter Creek). Dams and other impassable barriers, such as culverts, also fragment habitats that are needed to access spawning and rearing habitats but also for seasonal movements (e.g., summer feeding, temperature refugia, overwintering habitats). Water quality degradation, such as in mean annual temperatures, have occurred due to losses in mature riparian canopies, impacts from land use practices, urban stormwater runoff, and water retention in impoundments. Stream habitats have been degraded and habitat complexity decreased from channelization and removal and reduced recruitment of large woody debris to rivers. Habitat degradation from a variety of stressors has

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

reduced the quality of spawning and juvenile rearing habitats in Vermont streams. The appearance of alewife in Lake Champlain is of great concern due to their potential impact through competition with other pelagic planktivores, such as landlocked Atlantic Salmon.

Non-Habitat Threats:

Genetics

Parasites

Competition

Description of non-habitat threat(s): The native stocks of landlocked salmon in Lake Champlain were extirpated by the mid 1800s. It is questionable whether past and current restoration efforts are using genetically appropriate strains for restoration given the habitat conditions present in the lake. Competition and displacement by introduced salmonids, such as rainbow trout, may impact juvenile rearing stages of salmon. Sea lamprey parasitism has been found to be a significant source of mortality affecting salmon restoration.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	High	Impacts of Alewife consumption on thiamine levels in salmon and reproduction. Medium priority: inter-specific non-native salmonid competition.
Research	Population Genetics	High	Evaluation of strains being stocked in Lake Champlain for restoration purposes.
Research	Taxonomy	Low	
Research	Other Research	High	Accelerate the development of Lake Champlain salmon strain(s) which are more appropriate to the environmental conditions of those waters.
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP, TU	VDEC (ANCG)
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, TU, dam owners	Dam owners
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners	Dam owners
Species Restoration	Medium	Evaluate strains of salmon to be used for species restoration with focus on identifying ones best adapted to the environments where restoration is to occur and have desirable survival and growth characteristics.	Assess strains.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP, TU	VDEC (ANCG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, TU, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Species Restoration	High	Implement salmon restoration plan in Lake Champlain.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, USFWS	SWG, DJ, USFWS

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, TU	
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations.	VFWD	VFWD (DJ)
Species Restoration	High	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations. Reduction of Sea lamprey wounding rates.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

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Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? No

Global Trend: Unknown
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

Brook Trout is the most widely distributed and abundant salmonid species indigenous to Vermont. Today, wild populations occur throughout the state wherever suitable habitat exists. Brook Trout is sensitive to pollution and habitat degradation. Deforestation, water development projects, pollution, habitat degradation, and competition and/or predation from introduced fishes have all taken a toll on wild populations throughout its range. Beginning around the mid-1800s and continuing up to present time Brook Trout have been cultured in hatcheries and stocked to provide fishable populations throughout the state. While the stocking of hatchery-reared trout is an important fisheries management tool, this practice poses several risks to wild trout populations including direct competition, displacement, genetic alteration and the introduction of diseases. Efforts to minimize potential negative interactions of hatchery and wild populations in Vermont have focused on wild trout management (no stocking) where robust populations exist, improved fish health protocols and development of triploid (sterile) Brook Trout to minimize potential genetic impacts. Wild Brook Trout populations are at risk from genetic interactions with stocked fish, as hatchery-reared trout only survive a few months after stocking to spawn with wild stocks. Although cases of reproductive isolation have been observed in conjunction with long-term stocking programs, introgression and hybridization between wild and hatchery stocks has been well documented for many salmonid species, including Brook, Brown and Rainbow trout (Kirn 2003). Genetic testing of five Brook Trout from geographically distinct Vermont watersheds was conducted in 2006. Results indicate that these populations are genetically diverse, highly differentiated and show no evidence of influence from past stocking practices (T. King, U. S. Geological Survey, personal communication). The existence of genetically distinct wild Brook Trout populations reinforces the need for a prudent approach to trout stocking (Kirn 2007). These results are consistent with other studies where wild Brook Trout have shownsinificant variation among populations, even within the same minor river drainage, and suggest that individual populations should be the primary ecological unit considered for conservation and management programs (Perkins et al. 1993, Jones et al. 1996).

hreats to Brook Trout populations include loss and degradation of habitats resulting from adjacent land use, channel alterations, artificial flow regimes, water pollution, habitat fragmentation by dams and other obstructions (e.g. culverts), reduction of riparian vegetation resulting in stream water temperature increases and loss of complex instream fish cover (e.g. large wood). Spawning habitat and trout egg and fry survival are negatively affected by sedimentation. Climate change is predicted to increase water temperatures at the expense of populations at state as well as continental range levels. Climatic warming will likely decrease thermally suitable summer habitat for lotic Brook Trout populations Meisner (1990). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

The Brook Trout is native to most of eastern Canada from Newfoundland to west of Hudson Bay; south in the Atlantic, Great lakes and Mississippi River basins to Minnesota and through the Appalachian Mountains to Georgia (Page and Burr 1991). It has been introduced widely outside of its natural range. In Vermont, the species is distributed throughout the state where suitable habitat is available and competing species are absent or low in abundance.

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Certain
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Certain
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds

West
Waits
Upper Connecticut-Mascoma
Black-Ottauquechee
Deerfield
Hudson-Hoosic
Lamoille River
Missisquoi River
Otter Creek
Passumpsic
St. Francois River
Upper Connecticut
White
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Brook Trout occur in headwater streams, small to medium rivers, and lakes and ponds where waters are clear, cool and well-oxygenated. Raleigh (1982) gives a comprehensive review of Brook Trout habitat requirements. Riverine Brook Trout habitat is characterized by being influenced by cold-springs, having silt-free rocky substrate in riffles and runs, well vegetated stream banks, abundant instream cover, and relatively stable stream flows, temperatures and stream banks. Lacustrine habitats are typically oligotrophic in character. The temperature range for Brook Trout is 0-24°C, with optimal temperatures for growth and survival in the range of 11-16°C. Warm water temperatures appears to be the single most critical factor influencing Brook Trout survival and production. Brook Trout normally require high dissolved oxygen concentrations, optimally near saturation or >= 7 mg/L at temperatures <=15°C and >= 9 mg/L at temperatures >= 15°C. Instream and riparian cover is recognized as an important component of Brook Trout habitat. Brook Trout tends to be more tolerant of low pH water than other salmonid species. Most spawning occurs in stream habitat, although Brook Trout may spawn directly in lakes and ponds where there are upwellings.

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Brook Trout habitat has been degraded by alterations of natural stream channel morphology and flow regimes; water pollution; fragmentation (e.g., dams and culverts); reduction of riparian vegetation resulting in stream water temperature increases and loss of instream cover (e.g., large woody debris) Spawning habitat and trout egg and fry survival are negatively affected by sedimentation. Climate change could potentially degrade temperature regimes required by Brook Trout throughout its distribution.

Non-Habitat Threats:

Genetics

Disease

Competition

Pollution

Predation or Herbivory

Description of non-habitat threat(s): Brook Trout compete poorly with introduced salmonids, such as Brown and Rainbow trout, as well as warmwater species (e.g., centrachids, percids and esocids). Additionally, these competitors may prey upon Brook Trout. Stocking of non-native brook trout strains on wild populations may result in inbreeding, loss of genetic characteristics necessary for species survival, and intra-specific competition. Stocking also puts heritage populations at risk of introducing disease causing pathogens, such as whirling disease.

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Identify currently non-stocked wild Brook Trout populations to inform planning and management
Research	Threats and Their Significance	High	1) Evaluate the impact of culverts and other artificial obstructions on brook trout passage and distribution. 2) Identify and evaluate stream barriers as fish passage barriers to critical habitat and/or their value in isolating wild populations.
Research	Population Genetics	Medium	Nothing is known about the genetic characteristics of Vermont's wild populations and the possible existance of heritage strains.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TU, TNC, EBTJV, Echo Center, LCBP, LCI, CRWC	VFWD, USFWS, VDEC, TU, TNC, Echo Center, LCBP, LCI, CRWC
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Monitor populations for high priority disease organsims. Enforcement of importation regulations.	VFWD, USFWS	VFWD (SWG, DJ)
Habitat Restoration		Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP, TU, EBTJV, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, TU, EBTJV, LCBP, CRWC	
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, EBTJV, TU, dam owners, watershed associations , town & regional planning & Cons Comms	VFWD (SWG), USFWS (AOPG), EBTJV, VTrans,

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Research	Medium	Take into consideration the strains of trout stocked into wild populations, including stocking avoidance where possible, and/or use of triploid fish.	Number of wild populations where management actions are being implemented.	VFWD, TU, private hatcheries	VFWD (SWG, DJ)
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, EBTJV, TU, dam owners	Dam owners
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, EBTJV, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S4 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Eighteen lakes in Vermont are currently being managed for Lake Trout fisheries. With a few exceptions more than half of these populations exhibit little to no natural reproduction and therefore stocking hatchery-reared fish is necessary to maintain fishing quality. Presently, eight lakes (up from six reported in the 2005 WAP), all located in the northeastern part of the state, have populations that exhibit significant natural reproduction: Big and Little Averill lakes, Averill; Maidstone Lake, Maidstone; Echo Lake, Charlestown; Caspian lake, Greensboro; Willoughby Lake, Westmore; Seymour Lake Morgan; Crystal Lake, Barton; two other populations, Eligo Lake in Greensboro-Craftsbury and Shadow Lake in Glover, also have been demonstrated support wild reproduction but currently considered too low to maintain Lake Trout fisheries without stocking (Gerardi 2015). Despite natural reproduction occurring in Willoughby and Seymore lakes, these populations are supplemented with stocked Lake Trout, although this contribution is minor in comparison to the total population at large, estimated to be in the range of 5 to 30% (Gerardi 2015). Maidstone Lake has populations representing two distinct morphs (i.e. common and lunge) (Baille et al. In press). Stocking cultured (hatchery-reared) fish has a long history in fisheries management as a tool to increase and sustain commercial and recreational fisheries that have become overfished, decimated by predation (e.g. Sea Lamprey) and/or have experienced habitat degradation and loss, and this is no less true of Lake Trout management (Page et al. 2004, Valiquette et al. 2014). Genetic implications of stocking cultured Lake Trout on top of wild stocks have been investigated and reported fairly extensively and have found that stocking can profoundly alter the genetic integrity of wild populations and possibly reduce genetic variability and environmental adaptation within individual populations (Valiquette et al. 2014). Historically, Lake Champlain supported a wild population, which subsequently became extirpated. A restoration program is in progress and although Lake Trout reproduction has been documented (Ellrott and Marsden 2004) a fully self- sustaining population without stocking has yet to be established. Restored naturally reproducing and self- sustaining Lake Trout populations within the species natural range warrant special conservation attention. Lake Trout populations are susceptible to habitat alteration or degradation including lake eutrophication, oxygen depletion in the hypolimnion, spawning shoal sedimentation, and lake level manipulation. Climate change is also a concern in that it may alter the temperature regimes of habitats adversely affecting wild Lake Trout populations as well as favoring other species (e.g. Smallmouth Bass) that may compete and/or prey upon trout. Year-class strengths of Lake Trout populations are projected to weaken, and that of Smallmouth Bass to strengthen as a consequence of water temperature increases during each species respective spawning season (Casselman 2002). Introduced species, such Alewife, are known to contribute to reproductive failure by disruption of thiamine metabolism in Lake Trout. Sea Lamprey parasitism on Lake Trout in the Great Lakes and Lake Champlain has been responsible for major population declines. And, as mentioned previously, wild populations may be put at risk genetically by stocking fish from long domesticated hatchery lineages or wild fish introduced from external populations.

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Distribution

The natural occurrence of lake trout is limited to North America. Its natural range closely aligns with the limits of the Pleistocene glaciation. In Vermont, the species has been stocked extensively throughout the state; however, with perhaps very few exceptions these populations are not self-sustainable and are completely dependent on continued stocking for the populations to exist. The few self-sustaining populations in Vermont are all located in the Northeast Kingdom: Big and Little Averill ponds, Averill; Maid stone Lake, Maidenstone; Echo Lake, Charleston; Caspian Lake, Greensboro; and Crystal Lake, Barton (Gerardi 2015). Natural reproduction has been documented in Lake Champlain, but that population is not at the present time sustainable without stocking.

Distribution by Biophysical Region:

Champlain Valley	Historic Record(s) Only	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Certain	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds

St. Francois River

Upper Connecticut

Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Lake Trout is a species of oligotrophic lakes. In the southern part of their range the species inhabits deep, cold lakes whereas at more northern latitudes they are also found in shallow and deep waters. This species is intolerant of waters with low oxygen content, and prefers cold water, seeking areas with temperatures below 16°C (Langdon et al. 2006). Lake Trout spawn over rocky shoals and along wave-swept shorelines. Spawning in riverine habitat is rare. Lake Trout can spawn in depths of water from .3-61 m over gravel that measures 3.8-10.2 cm in diameter, typically aggregating in the fall over clean substrate, with deep interstitial spaces (Langdon et al. 2006). Lake Trout prefer eating small crustaceans, insects, and fish. Young lake trout eat plankton, insects, and small aquatic invertebrates.

Habitat Types:

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): eutrophication, hypolimnion oxygen depletion, spawning shoal sedimentation, lake level manipulations. Introduced species, such as Alewives, are known to contribute to reproductive failure by disruption of thiamine metabolism in Lake Trout. Sea Lamprey predation in Lake Champlain on Lake Trout may be a significant factor in population declines there. Dams constructed at lake outlets raise lake levels that can erode shoreline soils, increasing sedimentation of spawning shoals and decreasing reproductive success. Water level fluctuations, associated with water storage for hydropower, may result in dewatered Lake Trout egg and embryos, also negatively impacting reproductive success.

Non-Habitat Threats:

Genetics

Parasites

Harvest or Collection

Description of non-habitat threat(s): Lake Maidstone contains a population of Lake Trout (a.k.a. locally as lunge) that is morphologically distinct from Lake Trout in all other Vermont lakes. It is possible that this population is genetically distinct and represents a unique population that is native to Vermont. Because it is unknown whether this population is genetically distinct, no strategies exist to protect this population. Lake trout are highly valued by anglers due to the large size that this species can attain. Overfishing could result in the loss of self-sustaining, native lake trout populations (Ellrott and Marsden 2004).

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	Low	
Research	Population Genetics	Low	Investigated: see Baille et al. In press. Deciphering hatchery stock influences on wild populations of Vermont Lake Trout Salvelinus namaycush. Transactions of the American Fisheries Society, Bethesda, Maryland.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TU, TNC, Echo Center, LCBP, LCI, CRWC	VFWD, USFWS, VDEC, TU, TNC, Echo Center, LCBP, LCI, CRWC
Invasive Species Control & Prevention		Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Invasive Species Control & Prevention		Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations.	VDEC, USFWS, LCBP	VDEC (ANCG)
Natural Processes Restoration		Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Habitat Restoration		Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, TU, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Research		Evaluate strains of Lake Trout to be used for species restoration with focus on identifying ones best adapted to the environments where restoration is to occur and have desirable survival and growth characteristics.	Assess strains.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Natural Processes Restoration		Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Invasive Species Control & Prevention		Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN. Reduction in Sea Lamprey wounding rates observed on Lake Sturgeon.	VFWD, VDEC, USFWS, TU	VDEC (ANCG)
Legislation		Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Compliance & Enforcement		Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Species Restoration	High	Implement Lake Trout restoration plans in Lake Champlain. Undertake appropriate management actions as needed to conserve and enhance populations in other lakes in Vermont.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, NYDEC, USFWS	SWG, DJ, USFWS
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations. Sea lamprey wounding rates.	VFWD, VDEC, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

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Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S4 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

Seven populations have been identified in Vermont (Langdon 2014). On a range-wide scale no major threats are known (NatureServe 2014); however, interspecies hybridization has been reported (Esox americanus X E. niger and E. americanus X E. lucius) which could pose a threat to populations where the Redfin Pickerel is the only resident esocid in the fish community and whether by intention or accident another esocid species might be introduced. Redfin Pickerel is listed as endangered in Maine (MDIFW 2013).

Distribution

The Redfin Pickerel (Esox americanus americanus) is the subspecies restricted to eastern United States; the Grass Pickerel (E. a. vermiculatus) is the western subspecies. Redfin Pickerel is a fish primarily associated with the eastern coastal plain. It is distributed from the St. Lawrence River (Lac St. Pierre) south through the Richelieu-Champlain-Hudson system into New York, east through southern Vermont and New Hampshire to Long Island and south along the coastal plain to Georgia (Scott and Crossman 1973). In Vermont, Redfin Pickerel appears to be limited to the Poultney-Castleton rivers drainage, South Fork of East Creek in Orwell, and Pond Brook in Monkton.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Redfin Pickerel occurs in weedy areas of lakes, ponds and slow rivers. The Redfin is often found in tea-colored, acidic waters with pH values as low as 4.3. The Redfin pickerel spawns during April and May when water temperatures reach 10°C (Langdon et al. 2006). Adults congregate to spawn and adhesive eggs are broadcast randomly in heavily vegetated, shallow areas along lakeshores or streambanks. Young Redfins first consume zooplankton, snails and crustaceans, switching to fish as they grow older. Adults feed on fish and crayfish, but may supplement these food items with small crustaceans and insects (Jenkins and Burkhead 1993). This species may play a significant role in fish community structure because of its preference to predate

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

on fish.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Loss or alteration (i.e. through flow alteration, dewatering, sedimentation) of vegetated, shallow areas along lakeshores or streambanks would pose a problem to the reproductive success of the species.

Non-Habitat Threats:

Genetics

Description of non-habitat threat(s): This species has a limited distribution in Vermont, located in three drainages. If any of these populations undergo a reduction in population size (i.e., population bottleneck), then it is possible that genetic variation will be lost, forfeiting the evolutionary potential of the species. Natural selection can only act in the presence of genetic variation, and, therefore, the higher the genetic variability in a population, the higher the likelihood for population persistence. If gene flow between the 3 populations is limited, then the genetic variability of each population could decrease over time. Also, Redfin Pickerel have been reported to hybridize with Northern Pike and Chain Pickerel (Jenkins and Burkhead 1993), which poses further genetic concerns. The introduction of Northern Pike or Chain Pickerel to waters populated by Redfin Pickerel poses the risk of hybridization, as well as introduce inter-specific predation and competition for habitat and forage. Decreased genetic variation in Redfin Pickerel would hinder the ability of the populations to adapt to changing conditions over time.

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Identify number of Redfin Pickerel populations in Vermont and those which are not co-habitants with other esocid species.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	The introduction of Northern Pike and Chain Pickerel to Redfin Pickerel waters limits the species by hybridization and should be monitored.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Invasive Species Control & Prevention	High	Identified populations which are not sympatric with other Esocid species should be managed to prevent to potential for interspecific competition and hybridization.	Number (percentage) of redfin pickerel waters remaining free of competing esocid species.	VDEC, VFWD, lake associations	VDEC (ANCG), VFWD (SWG, DJ)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners, lake associations	Dam owners, lake associations
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, VFWD, lake associations	VDEC (ANCG), VFWD (SWG, DJ)
Invasive Species Control & Prevention	High	Protect habitats currently supporting Redfin Pickerel populations from the introduction of other esocid species (e.g., Chain Pickerel, Northern Pike) which may compete for available habitat and/or potentially hybridize with Redfin Pickerel.	Number (percentage) of redfin pickerel waters remaining free of competing esocid species.	VDEC, VFWD, lake associations	VDEC (ANCG), VFWD (SWG, DJ)

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G3 **Global Trend:** Unknown
State Rank: S1? **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Seven populations are known to occur in Vermont (Langdon 2014), although two or more of these are outdated reports (Hospital Creek, 1935; Lake Memphremagog, 1975). Bridle shiners were captured in the Canadian portion of Lake Memphremagog in 1999 (COSEWIC 2013). The species was also collected in the Connecticut River in the vicinity of Hanover, New Hampshire in 2008 (Yoder et al. 2010). Scarola (1987) states that bridle shiner in New Hampshire only occurs in the Merrimack and Coastal drainages, therefore the origin of the species in the upper Connecticut River is unknown but is presumed to be native. The species was frequently encountered in the Richelieu River watershed between 1965 and 1970; in 1990 six were collected in Missisquoi Bay near its mouth but were not captured during sampling efforts done in 2003 and 2012 (COSEWIC 2013). Threats to populations have been identified as reduction or removal of aquatic vegetation and increased turbidity, including agricultural pollution, as well as predation from introduced fish species (NatureServe 2014). Bridle Shiner is also potentially at risk to climate change (COSEWIC 2013). While population status and specific threats acting on Vermont populations are unknown, until water quality issues identified for Lake Champlain including Missisquoi Bay (LCBP 2012) are corrected, efforts for the population to recover to a more secure status may not be possible. Bridle shiner is listed as endangered in New Hampshire and Pennsylvania; special concern in Massachusetts, Connecticut, Ontario and Quebec; and extirpated in Maryland. Selected as an Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

This North American species occurs in the Atlantic drainage from southern Maine to Virginia, west through Lake Champlain to New York and the Lake Ontario basin (Scott and Crossman 1973). In Vermont, bridle shiner are found in Lake Champlain, several other locations within that watershed, and has been reported to occur in Lake Memphremagog.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Historic Record(s) Only	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Probable Watersheds
Missisquoi River

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The Bridle Shiner is a species of quiet streams, lakes and ponds (Scott and Crossman 1973, Page and Burr 1991). Honeyfield and Ross (2004) describe its habitat as slow, warm backwater eddies of low gradient streams and ponds with dense vegetation and substrate of mud, sand or gravel. Spawning occurs in areas of calm water, at a depth of about two feet, and in openings within stands of dense emergent aquatic vegetation (Cornell web site). Holms et al. (1999) suggest Bridle Shiner require open water above aquatic plant stands to spawn. The species has a strong preference for clear water necessary for this daytime, sight-feeder to forage on prey organisms (Honeyfield and Ross 2004). It is tolerant of brackish water but is not acid tolerant (Holm et al. 1999).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Threats include stream channelization, erosion, point-source discharges, loss of riparian vegetation, and large-scale development all been identified aspractices that have have been identified as practices that have increased turbidity and altered Bridle Shiner habitat where the species have become extirpated (Sabo 2000). Sedimentation and siltation are suspected as being major factors for the decline of Bridle Shiner in the Delaware River Basin (Honeyfield and Ross 2004). They also suggest the species may be vulnerable to highway construction activities which alter bridle shiner habitat including streamflow regimes, channel structure, water quality, and aquatic plant abundance. Being a sight-feeder turbid water conditions interfere with bridle shiner feeding and suppresses the growth of aquatic vegetation on which the fish is dependent for feeding, reproduction and cover (Holm et al. 1999). They also identify the spread of Eurasian milfoil as a potential problem to the species. This plant can alter the composition of the plant community by replacing native vegetation and invading the entire water column thereby eliminating clear water areas above the plants that are necessary for spawning (Sabo 2000).

Non-Habitat Threats:

Genetics

Pollution

Predation or Herbivory

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Description of non-habitat threat(s): Scott and Crossman (1973) state Bridle Shiner are an important forage species for pickerel as well as other piscivorus fishes (e.g., Yellow Perch, Smallmouth Bass, crappie) where these species co-exist. In some New England lakes and ponds, where significant reduction or removal of submersed aquatic plant stands has occurred, fish predators (e.g., bass) have decimated bridle shiner populations (Sabo 2000). Honeyfield and Ross (2004) state, that within the species range populations appear to be highly fragmented and declining with separation distances between known populations exceeding 200 km. They suggest this may have resulted in genetic divergence among populations, although this has not been investigated. This species is sensitive to sedimentation and chemical runoff from agricultural lands (Ontario's Biodiversity website). The Bridle Shiner is not tolerant of acidic water making it vulnerable to atmospheric deposition (Holm et al. 1999).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Little quantitative data exists for Vermont populations; better distributional data is needed.
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitoring program is recommended to assess changes in species abundance and distribution.
Monitoring	Habitat Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

Seven populations are known to occur in Vermont (Langdon 2014). Very little is known of its biology, distribution and habitat use, and past and present abundance of these populations. On a range-wide scale no major threats are known (NatureServe 2014). Blackchin Shiner has all but disappeared from southern New York watersheds; possible threats identified include fluctuating water levels and habitat loss due to siltation; species also has a low tolerance to salt (NYNHP 2013).

Distribution

This North American species occurs only in the Great Lakes basin, the upper Mississippi River drainage, and downstream through the St. Lawrence River drainage into western Quebec (Scott and Crossman 1973). In Vermont, the species on the eastern edge of its distribution and if limited to a few locations within the Lake Champlain watershed.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Probable Watersheds
Lake Champlain
Metawee River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Trautman (1957) describes the Blackchin Shiner as a fish of glacial lakes and streams characterized by having very clear water, substrate of clean sand, gravel or organic debris, and the presence of dense beds of submersed vegetation. Scott and Crossman (1973) also note the species' preference for quiet pools in streams and weedy inshore areas of lakes. This shiner is also found in inlet and outlet streams of lakes (Becker 1983). Scott and Crossman (1973) state "clear, clean, weedy waters are essential for the survival of the blackchin shiner," but little information has been reported on spawning site preference and behavior. This species is an indicator of good water quality.

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Sedimentation

Invasion by Exotic Species

Description of habitat threat(s): The Blackchin Shiner is intolerant of silt. Trautman (1957) notes that it has disappeared from Ohio waters once they became turbid, silt covered the bottom, and the aquatic vegetation disappeared. The continuing expansion of the submersed exotic weed Eurasian milfoil in Vermont's lakes and ponds threatens Blackchin Shiner populations. Milfoil may displace native plant communities and alter the composition and fish habitat value of the aquatic plant community. Additionally the propensity for this invasive plant to establish dense beds impairing the use of some lakes for boating, swimming and fishing has resulted in the increased use of herbicides. Significant reduction in aquatic plant abundance could degrade habitat necessary for this species. One such herbicide in common use in Vermont is floridone (Sonar). The Michigan Environmental Science Board has concluded that this broad spectrum herbicide will not only control Eurasian milfoil but also significantly impact native aquatic plant species when applied at the labeled rate (Premo et al. 1999). Significant reduction in milfoil beds can subject Blackchin Shiner populations to increased predation pressure before native aquatic plants become reestablished restoring cover habitat for the shiner.

Non-Habitat Threats:

Predation or Herbivory

Description of non-habitat threat(s): The Blackchin Shiner does not appear to be particularly abundant in any of the waters it is known to occur in Vermont. Aggressive aquatic plant control activities in these waters could significantly reduce this important refuge habitat and subject the shiner populations to increased predation.

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	A greater understanding of the habitat requirements of this species is needed, especially the association with aquatic vegetation.
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Little quantitative data exists for Vermont populations; better distributional data is needed.
Research	Threats and Their Significance	High	Impacts of aquatic plant control (e.g., herbicide and mechanical treatments) on Blackchin Shiner habitat, biology, and aquatic community structure and function (e.g., species interactions, increased vulnerability to predation). Investigate and monitor these effects.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Habitat Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

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Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Six populations are known to occur in Vermont (Langdon 2014). Very little is known of its biology, distribution and habitat use, and past and present abundance of these populations. On a range-wide scale no major threats are known (NatureServe 2014). Blacknose Shiners require very clear water and moderate amounts of vegetation; the species quickly disappears from habitat that becomes turbid and substrate that is degraded by sedimentation (ODNR 2012).

Distribution

The Blacknose Shiner is a widely distributed species occurring from the Hudson Bay drainage to the New England states west to Iowa (Scott and Crossman 1973). In Vermont, it appear to be most frequently encountered in the Lake Champlain watershed, albeit there are a few occurrences from other locations within the state.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain
Missisquoi River
Winooski River

Probable Watersheds
Black-Ottauquechee

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Blacknose Shiner is a species of clear, shallow water habitats in glacial lakes and small streams (Scott and Crossman 1973). Most recorded occurrences in Vermont (11 out of 13 records) have come from riverine habitats (Langdon 2014). The species does not appear to have any particular preference for substrate type, although Trautman (1957) states it has been found in waters with bottoms comprised of sand, gravel, muck, peat or organic debris. The presence of submersed vegetation is an important component of Blacknose Shiner habitat (Page and Burr 1991, Trautman 1957). Backlund (1995) reports the fish requires cool well-oxygenated water. This species is intolerant of sedimentation and turbid water (Backlund 1995, Eddy and Underhill 1974, Trautman 1957). This species is an important indicator of pristine, high quality waters (Backlund 1995). The

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

biology and detailed habitat requirements of the Blacknose Shiner apparently have either been not thoroughly investigated or reported. Backlund (1995) states that the Blacknose Shiner is a host fish for the freshwater mussel cylindrical papershell Anodontoides ferussacianus, a state listed endangered species in Vermont.

Habitat Types:

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Sedimentation

Invasion by Exotic Species

Description of habitat threat(s): Backlund (1995) states the Blacknose Shiner is intolerant of turbid, polluted waters and that in South Dakota it has disappeared from may streams due to sedimentation, loss of aquatic vegetation and food, water temperature increases, and lowered dissolved oxygen. Aquatic plant control also poses a problem to Blacknose Shiner populations. In Minnesota the removal of aquatic vegetation along lake shorelines and increase sedimentation and turbidity levels have reduced this species (Eddy and Underhill 1974).

Non-Habitat Threats:

Pollution

Predation or Herbivory

Description of non-habitat threat(s): The Blacknose Shiner is reported to be intolerant of water pollution (Backlund 1995). Elimination of aquatic plant beds can expose this species to increased predation.

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	A greater understanding of the habitat requirements of this species is needed, especially the association with aquatic vegetation.
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Little quantitative data exists for Vermont populations; better distributional data is needed.
Research	Threats and Their Significance	High	Investigate and monitor the effects of aquatic vegetation control programs (e.g., Eurasian milfoil) on Blacknose Shiner populations.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Habitat Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

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Common Name: **Northern Pearl Dace**
Scientific Name: **Margariscus nachtriebi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S3 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

Bailey et al. (2004) and Page and Burr (2011) recently recognized Northern Pearl Dace (Margariscus nachtriebi) as a species, elevating it from the previous subspecies status M. margarita nachtriebi. Previously it was considered a subspecies of M. margarita, a species now referred to as the Allegheny Pearl Dace (M. margarita margarita). The latter species is a larger scaled form that ranges from southern New York and southwestern Vermont to Virginia (Bailey et al. 2004). Currently, Northern Pearl Dace are known from the Upper Rock and Pike river watersheds in northwestern Vermont (Franklin County near the Canadian border). Both watersheds drain to Missiquoi Bay in Lake Champlain. Allegheny Pearl Dace populations in Vermont (nine records) are distributed in Otter Creek, Poultney River and Batten Kill watersheds (Langdon et al. 2006).

Distribution

Upper Rock and Pike river watersheds in northwestern Vermont (Franklin County near the Canadian border). Both watersheds drain to Missiquoi Bay in Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Unknown	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Confident
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Probable Watersheds
Missisquoi River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Pools of cool, clear headwater streams, bogs, ponds and small lakes with silt, sand and gravel bottoms, close to aquatic vegetation; preferred water temperature is 16.2°C (Eakins 2015).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Common Name: **Northern Pearl Dace**
Scientific Name: **Margariscus nachtriebi**
Species Group: **Fish**

Current Threats

Description of habitat threat(s): While localized threats may exist, no major threats are identified for this species at the range-wide scale (NatureServe 2013).

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Determine current distribution of species in vermont.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Low	
Monitoring	Habitat Change	Low	
Monitoring	Monitor Threats	Medium	

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	Medium	Better deliniate Northern Pearl Dace distribution and abundance. Assess potential threats and develop management strategies as needed.	Number of streams, lakes and ponds identified as supporting Northern Pearl Dace populations.	VFWD, UVM	VFWD

Common Name: **Northern Pearl Dace**
Scientific Name: **Margariscus nachtriebi**
Species Group: **Fish**

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Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S2
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

In Vermont, Silver Redhorse is confined to Lake Champlain and the lower accessible reaches of larger tributary rivers to the lake, e.g. Missisquoi River, Winooski River, Otter Creek and Poultney River (Ferguson 2014). The population is on the eastern edge of its continental range. Little is known of its distribution and population status; however, based on anecdotal observations it is but appears to be less abundant than Shorthead Redhorse (M. macrolepidotum) but more abundant than Greater Redhorse (M. valenciennesi) (Ferguson 2014; Langdon 2014). Threats include poor water quality resulting from agricultural and urban pollution, artificial flow regimes, and habitat fragmentation (Cook et al. 2005). Eaton and Scheller (1996) identify Silver Redhorse as potentially at risk from climate change. NatureServe (2014) identifies no known major threats to the species at the range-wide scale, but acknowledges that localized threats may exist. In Vermont, little is known of this population or threats to it. Because populations are not being monitored, trends influenced by threats may not be detected.

Distribution

A North American species which occurs east from the St. Lawrence River, south through central New York, southwest through the western half of the coastal states to northern Alabama, northwest through eastern Arkansas and Missouri, north through North Dakota, and into Saskatchewan and Alberta (Scott and Crossman 1973). In Vermont, the silver redhorse is on the eastern edge of its North American range and occurs only in Lake Champlain and up to the fall line in the Missisquoi and Poultney rivers.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain
Winooski River

Probable Watersheds
Lamoille River
Missisquoi River
Otter Creek

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Silver Redhorse is found in small to moderately-sized rivers and occasionally lakes. In rivers it prefers deep pools with some current (Meyer 1962). During their first year of life Silver Redhorses sometimes remain in small streams where they were hatched. This species avoids silty bottoms and may also be intolerant to general environmental degradation (Langdon et al. 2006). Adult Silver Redhorse perform annual migrations to spawn. Seasonal movement patterns may prove important for successful spawning. Silver Redhorse are early spawners and in their southern range breed from April through early May in water temperatures of 11-15°C. Spawning usually occurs in shallow riffles over gravel and cobble (Jenkins and Burkhead 1993). Silver Redhorse feed on insect larvae, microcrustaceans, mollusks, algae, detritus, crayfishes, and the fry of shiners (Jenkins and Burkhead 1993).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Flow alteration, temperature alteration, or decreased habitat diversity (i.e. loss of deep pool habitat) will most likely have negative effects for different life stages of Silver Redhorse. Fragmentation of Silver Redhorse habitat may disrupt the seasonal movement patterns of this species. For example, these movement patterns may prove critical for successful reproduction, and therefore the completion of the species life cycle. Disruption to the spawning efforts of this species poses a problem to population viability (i.e. weak year classes over time compound negative influences and population declines). If the quantity or quality of Silver Redhorse habitat is limited in a system, then interconnected river reaches will prove necessary for this species to find and occupy optimal or suitable habitat. Loss of riparian vegetation, general construction activity, road maintenance activities (ditching, sanding), bridge and culvert construction, agriculture, timber harvest, dam failure, rapid drawdown of dam impoundments, streambank erosion, and shifts in channel form or location are sources of sediment for Silver Redhorse habitat. Controlling sediment input into streams may be crucial to prevent detrimental effects to Silver Redhorse, because sedimentation decreases the quality and quantity of optimal habitat (i.e. spawning, feeding) for this species. Sedimentation eliminates interstitial spaces which could be critical for egg deposition and development and for production of benthic organisms, such as aquatic insects, a source of food for Silver Redhorse. Sedimentation has been shown to cause loss or reduction in fish populations, and disrupt the feeding and reproductive activities of fishes (Berkman and Rabeni, 1987).

Non-Habitat Threats:

Pollution

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Description of non-habitat threat(s): Water pollution may indirectly influence silver redhorse through negative impacts to its prey base. Depletion of food items will negatively affect species growth and survival.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Distribution, abundance and dynamics of Silver Redhorse populations in Vermont are poorly understood.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Sediment and pollution
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Research	Medium	Currently under VFWD fishing regulations Moxostoma species are "cull" fishes and as such their harvest and collection is essentially an unregulated activity. Whether or not Moxostoma are threatened by unrestricted harvest should be reviewed.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Scott, W. B., and E. J. Crossman. 1973. Fisheries Research Board of Canada Bulletin 184, Ottawa.

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S2 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

Shorthead Redhorse in Vermont is confined to Lake Champlain and the lower accessible reaches of larger tributary rivers to the lake (Langdon et al. 2006). It appears to be a widespread species within its Vermont range but based on anecdotal observations appears to be fairly abundant where found (Ferguson 2014; Langdon 2014). Threats include poor water quality resulting from agricultural and urban pollution, artificial flow regimes, and habitat fragmentation (Cook et al. 2005). NatureServe (2014) identifies no known major threats to the species at the range-wide scale, but acknowledges that localized threats may exist. In Vermont, little is known of this population or threats to it. Because populations are not being monitored, trends influenced by threats may not be detected.

Distribution

The Shorthead Redhorse is the most widely distributed of the redhorse species in North America. It occurs from the upper St. Lawrence River, south into the Lake Champlain drainage to the coast in New York, east of the Appalachian Mountains to South Carolina, west through Pennsylvania and Ohio, southwest into Indiana and Arkansas, the Tennessee River drainage in Alabama, west to Texas, northwest through eastern Colorado and Montana, north to central Alberta, east to southern Hudson Bay and the east shore of James Bay (Scott and Crossman 1973). In Vermont, the species is on the eastern edge of its North American range and is confined to Lake Champlain and several large tributaries up to the fall line.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Winooski River
Missisquoi River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

This species prefers the clear water of small to large rivers and sometimes lakes. Most individuals have been observed holding or feeding in deep pools. It is found over clean sand, gravel, and cobble substrate, and is tolerant of water temperatures up to 37°C. It requires a silt-free habitat and is thought to be susceptible to

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

many forms of water pollution (Langdon et al. 2006). It is common to find this species living in the same areas as other redhorse species. In Vermont, the Shorthead Redhorse is restricted to the larger tributaries of Lake Champlain (Langdon et al. 2006). The spawning period for Shorthead Redhorse occurs in spring from early April to early July, as influenced by local regional conditions (i.e. climate). Spawning water temperature is 11- 21°C. Spawning occurs in slow and moderate runs and pools over large gravel (Jenkins and Burkhead 1993). Shorthead Redhorse may perform spawning migrations to find optimal spawning habitat. Spawning groups of this species have been observed in streams where adults are normally not found except during breeding time (Jenkins and Burkhead 1993). Seasonal movement patterns may prove important for successful spawning.

Shorthead Redhorse is specialized to benthically feed on aquatic insects, small crustaceans, mollusks, algae, and detritus (Jenkins and Burkhead 1993). Highly silted or embedded substrate may preclude this species from consuming its preferred food items. Studies have shown that the principal, insect food items of redhorses are chironomids, ephemeropterans, and trichopterans (Meyer 1962)

Habitat Types:

Aquatic: Fluvial

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Flow alteration, temperature alteration, or decreased habitat diversity (i.e. loss of deep pool habitat) will most likely pose negative effects for different life stages of Shorthead Redhorse. For instance, shallow, channel margin habitats that are indicative of slower velocities are important for young redhorses. Anthropogenic flow alteration has been shown to alter and limit this habitat, affecting juvenile life stages (Scheidegger and Bain, 1995). Fragmentation of Shorthead Redhorse habitat may disrupt the seasonal movement patterns of this species. For example, these movement patterns may prove critical for successful reproduction, and therefore the completion of the species life cycle. Disruption to the spawning efforts of this species poses a problem to population viability (i.e. weak year classes over time compound negative influences and population declines). If the quantity or quality of Shorthead Redhorse habitat is limited in a system, then interconnected river reaches will prove necessary for this species to find and occupy optimal or suitable habitat. Loss of riparian vegetation, general construction activity, road maintenance activities (ditching, sanding), bridge and culvert construction, agriculture, timber harvest, dam failure, rapid drawdown of dam impoundments, streambank erosion, and shifts in channel form or location are sources of sediment for Shorthead Redhorse habitat. Controlling sediment input into streams may be crucial to prevent detrimental effects to Shorthead Redhorse, because sedimentation decreases the quality and quantity of optimal habitat (i.e. spawning, feeding) for this species. Sedimentation eliminates interstitial spaces which could be critical for egg deposition and development and for production of benthic organisms, such as aquatic insects, a source of food for shorthead redhorse. Sedimentation has been shown to cause loss or reduction in fish populations, and disrupt the feeding and reproductive activities of fishes (Berkman and Rabeni, 1987).

Non-Habitat Threats:

Pollution

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Description of non-habitat threat(s): Water pollution may indirectly influence Shorthead Redhorse through negative impacts to its prey base. Depletion of food items will negatively affect species growth and survival.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Distribution, abundance and dynamics of Shorthead Redhorse populations in Vermont are poorly understood.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Sedimentation and pollution
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Policy & Regulations	Medium	Currently under VFWD fishing regulations Moxostoma species are "cull" fishes and as such their harvest and collection is essentially an unregulated activity. Whether or not Moxostoma are threatened by unrestricted harvest should be reviewed.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

Based on current survey information, which is scant, Greater Redhorse appears to have the most restricted distribution of the three Moxostoma species occurring in Vermont, i.e. limited to northern Lake Champlain and the lower accessible reach of the Missisquoi River (Langdon et al. 2006). In 2009, it was documented to occur in Lake Memphremagog (Kratzer 2015). Whether Greater Redhorse has long been resident of the lake but has evaded detection until recently is no known. It is reported to be not difficult to find in the Missisquoi River during the spring season (Ferguson 2014). Threats include poor water quality resulting from agricultural and urban pollution, artificial flow regimes, and habitat fragmentation (Cook et al. 2005). However, in Vermont, little is known of this population or threats to it. Because populations are not being monitored, trends influenced by threats may not be detected.

Distribution

The Greater Redhorse is generally distributed in central and eastern North America primarily in the upper Mississippi and Great Lakes-St. Lawrence systems (Scott and Crossman 1979). This species has been recorded from northern Lake Champlain and the lower reach of the Missisquoi River (Langdon et al., 2006). In Vermont, the species is on the eastern edge of its North American range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Lake Champlain	Lamoille River
Missisquoi River	Otter Creek
St. Francois River	Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Greater Redhorse inhabits medium to large rivers, large lakes and impoundments. It prefers coarse substrate, such as gravel, cobble, and boulders in clean water. In rivers, this species is frequently found in moderate to swift current in run or riffle habitat and may also be found in large river pools. Generally, it is not found in silty areas and is believed to be intolerant of silt and turbidity (Jenkins and Burkhead 1993).

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Spawning occurs in spring or summer in high velocity riffle habitat over gravel or cobble substrate that is silt free. Spawning has been found to occur in moderate stream velocities (3.8-116.9 cm/s) and at shallow depths (10-100 cm) (Healy 2002). Greater redhorse may perform annual migrations upstream to spawn and downstream after spawning. In an Ontario river, this species was observed dispersing up to 15 km downstream from its spawning habitat (Healy 2002). This species demonstrates important seasonal movement patterns. Different life stages have specific habitat preferences. Age-0 fish were found in shallow (20 cm), slow velocity pools (21 cm/s). Juvenile fish (greater than age-0 but not sexually mature) were found in slightly deeper pools (60-149 cm) and higher velocities (37 cm/s) (Healy 2002). The Greater Redhorse is a specialized benthic feeder such that highly silted or embedded substrate may preclude this species from consuming its preferred food items.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Unknown Habitat Threats

Description of habitat threat(s): Flow alteration, temperature alteration, or low habitat diversity (i.e., loss of deep pool habitat, shallow riffles, or large woody debris due to human-induced change) will most likely pose negative effects for different life stages of greater redhorse. For instance, shallow channel margin habitats that are indicative of slower velocities are important for young redhorses. Flow alteration has been shown to alter and limit this habitat for juvenile life stages (Scheidegger and Bain 1995). Fragmentation of greater redhorse habitat may disrupt the seasonal movement patterns of this species. For example, these movement patterns may prove critical for successful reproduction, and therefore the completion of the species life cycle. Viability of Greater Redhorse populations most likely depends on optimal habitat availability (i.e., optimal or suitable depths, velocities, substrate, temperature, and flow regimes). Some evidence suggests that Greater Redhorse presence and abundance are correlated with longer contiguous river reaches (Healy 2002). If the quantity and quality of Greater Redhorse habitat is limited in a system, then interconnected river reaches will prove necessary for this species to find and occupy optimal or suitable habitat. Loss of riparian vegetation, general construction activities, road maintenance activities (ditching, sanding), bridge and culvert construction, agriculture, timber harvest, dam failure, rapid drawdown of dam impoundments, streambank erosion, and shifts in channel form or location are sources of sediment into Greater Redhorse habitat. Controlling sediment input into streams may be crucial to prevent detrimental effects to Greater Redhorse, because sedimentation decreases the quality and quantity of optimal habitat (i.e., spawning , feeding) for this species. Sedimentation eliminates interstitial spaces which could be critical for egg deposition and development and for production of benthic organisms, a primary food source for Greater Redhorse. Specialized benthic feeders, such as greater redhorse, represent a very ecologically vulnerable group to increased sedimentation, because they are unable to modify their feeding habits. Sedimentation has been shown to cause loss or reduction in fish populations, and disrupt the feeding and reproductive activities of fish (Berkman and Rabeni 1987). The Greater

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Redhorse seems to be rare over the majority of its range (Healy 2002). Determining the primary mechanism behind this trend is a challenge. Unknown habitat problems may exist.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): The reproductive strategy of the Greater Redhorse is a crucial aspect to its conservation. It becomes sexually mature at a late age, is highly fecund, and spawns seasonally. Disruption to the spawning efforts of this species poses a problem to population viability (i.e., week year classes over time compound negative influences and population declines). Water pollution may indirectly influence Greater Redhorse through negative impacts on its prey base. Depletion of food items will negatively affect species growth and survival.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Distribution, abundance and dynamics of Greater Redhorse populations in Vermont are poorly understood.
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Sediment and pollution
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Policy & Regulations	Medium	Currently under VFWD fishing regulations Moxostoma species are "cull" fishes and as such their harvest and collection is essentially an unregulated activity. Whether or not Moxostoma are threatened by unrestricted harvest should be reviewed.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

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Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184, Ottawa.

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Two populations are known to occur in Vermont: one in the Missisquoi River and the other in the LaPlatte River. In the Missisquoi River sub-populations occur immediately below Swanton Dam and the other from that dam upriver to the Highgate Falls Dam. In the LaPlatte River sub-populations occur down- and upstream of Shelburne Falls. The Vermont Cooperative Fish and Wildlife Research Unit at the University of Vermont is currently conducting research of populations in both rivers including estimating abundance, age structure, distribution and habitat use. The project is partially funded by a Vermont Fish and Wildlife Department State Wildlife Grant. On a wide-range scale no major threats are known; however, localized threats to populations may exist such as siltation, pollution and impoundment of habitat (NatureServe 2013). Low winter flows effects on overwinter survival are believed to be the most likely factor influencing stonecat abundance in the Milk River in Alberta (ASRD 2004). During the summer of 2012, stonecat stranding and mortality was observed immediately below Swanton Dam (Pientka 2014; Puchala 2014). The lack of adequate spillage over the dam to keep stonecat habitat under water as a consequence of unusually low base river flows and dam leakage are believed to have been the cause. Chemical control of parasitic Sea Lamprey also has the potential to cause non-target mortality. Large numbers of Stonecats are typically killed when the Great Chazy River in New York is treated with lampricides. Incidental mortality has also occurred in the lower Missisquoi River when lampricide has been applied to habitat holding stonecats. Recently, the U.S. Fish & Wildlife Service announced an interest in treating the LaPlatte River with lampricide to control Sea Lamprey ammocoetes numbers there (Langdon 2014).

Distribution

This is a North American species with a distribution described by Scott and Crossman (1973) as the St. Lawrence River and tributaries in Quebec, south in the Hudson, Allegheny and Mohawk systems in New York, west to the Appalachian Mountains, to western North Carolina and northern Alabama (Tennessee River), north through central Tennessee, west through northern Missouri, Kansas and northeastern Colorado, Wyoming to Alberta, east through North Dakota into Manitoba, southeast through the tip of Lake Superior to central Michigan, and into southern Ontario and Quebec (Scott and Crossman 1973). Only two populations of Stonecat are known to occur in Vermont. One population is located within a relatively short reach of the LaPlatte River immediately above and below the fall line; and the second is in Hungerford Brook, a tributary of the Missisquoi River. In Vermont, the species is on the eastern edge of its North American range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Known Watersheds
Lake Champlain
Missisquoi River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

The Stonecat prefers moderate currents of medium to large rocky-bottomed streams. It is absent, however, from high gradient streams with fast currents. It is also found in lakes near gravel shoals where the current is produced by wave action. The Stonecat appears to require a current to prosper, since it has been eliminated from streams where flows have been slowed by the construction of dams. It appears to be intolerant to siltation and general habitat degradation. The Stonecat is a state listed endangered species in Vermont with one known population in the state. This population is in a very short section of the river encompassing habitat immediately below and above the fall line. Population monitoring suggests the population has been declining due to unidentified causes. It appears from the literature and Vermont data from the LaPlatte River that this species requires moderate current and a low silt, coarse substrate. Stonecat prefer to use large cobble and boulders for hiding. The combination of habitat requirements of low silt, moderate current, and large substrate represent a somewhat restrictive combination within the Champlain Valley biophysical region.

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): It has been reported that this species is sensitive to siltation but the exact mechanism of impact is not known. It may be that siltation covers the developing eggs; however, this may not be a problem, since parents are cavity nesters, preparing the nest and providing care for the young. Or, siltation may embed coarse substrate materials eliminating cover habitat and nesting sites. Since in Vermont the stonecat is only found in the LaPlatte River and Hungerford Brook, a primary conservation consideration is the limiting of upstream land use activities that increase siltation in moderate gradient habitats.

Non-Habitat Threats:

Genetics

Loss of Prey Base

Description of non-habitat threat(s): Stonecat is a benthic insectivore, specializing in aquatic insects. Excess sedimentation can impact aquatic insects populations and reduce this species' food base. This species would have difficulty shifting to non-benthic foods. Because stonecat has one of the most restricted distributions of any other fish species in Vermont, reductions in population size causing a bottleneck which could possibly result in a loss of genetic variation forfeiting the evolutionary potential of the species. Natural selection can only act in the presence of genetic variation, and therefore, the higher the genetic

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

diversity in a population, the higher the likelihood for population persistence. If gene flow is limited to within one population of stonecat (estimated number probably much less than 100 individuals), the species is not prepared to adapt to environmental changes of time.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Comparative studies of habitat occupied by the more abundant New York populations to LaPlatte River habitat.
Research	Basic Life History	High	
Research	Distribution and Abundance	High	
Research	Threats and Their Significance	High	
Research	Population Genetics	Medium	Investigate genetic characteristics of the LaPlatte River Stonecat population and genetic similarity to populations in New York.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Stonecat populations.	Number of existing populations of Stonecat protected and sustained.	VFWD, USFWS	USFWS, VFWD
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Scarola (1973) reported Redbreast Sunfish to be in the New Hampshire portion of the Connecticut River watershed. More recently (2008), Yoder et al. (2010) during a fish assemblage assessment of the Connecticut River extending from Lake Francis in NH downriver to Turners Falls Dam in MA collected two Redbreast Sunfish from separate locations in the river situated between Bellows Falls and Wilder dams. NAI (2004) fish community monitoring conducted in the vicinity of Vermont Yankee Nuclear Power Station (Vernon, VT and Hinsdale, NH) captured a total of 14 Redbreast Sunfish from the Connecticut River during the years 1991-1999. Reports of the species occurring in Vermont "inland" waters, as far as known, appear to be limited to Lake Morey and Lake Fairlee. Extensive sampling in both waters over the past 25 years has not resulted in a confirmed observation of this species. This strongly suggests the species is uncommon in both the Connecticut River and likely extirpated from the two "inland" lakes where it was previously reported in Vermont.

NatureServe (2014) states there are no known threats to the species; however, dams and pollution have caused local declines. COSEWIC (2008) reports there is little information in the literature which addresses limiting factors affecting Redbreast Sunfish, although the species appears adaptable to a wide range of environmental conditions. COSEWIC (2008) identifies the shoreline development including seasonal and year-round homes, forestry and agricultural activities, and stream alterations to be the most obvious threat to the species in New Brunswick, although waterbody-specific assessments conducted in that province failed to demonstrate correlations between shore development and water quality parameters to Redbreast Sunfish abundance. Selected as a Regional-SGCN by the 13 Northeastern states in 2014

Distribution

The Redbreast Sunfish occurs along the Atlantic Slope from New Brunswick to Florida. It is also found in Gulf Coast drainages in Georgia and Florida, north into Kentucky and Arkansas. In Vermont , Redbreast Sunfish are found in the Connecticut River and lakes Morey and Fairlee (Orange County) and the Black River (Windsor County). Historically, the species has been recorded from New York waters within the Lake Champlain drainage (e.g., Lake George and its outlet, the Mettawee River and Little Chazy River) (Greeley 1930); however, no records, past or present, are known from Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Middle Connecticut

Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

West
Upper Connecticut-Mascoma
Black-Ottauquechee

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

This species inhabits the shores of lakes and ponds, and pools of clear streams with little current, but unlike other Vermont sunfishes it is more of a stream-adapted species. Aho et al. (1986) report cover, current velocity, and variables correlated with velocity (e.g., gradient, riffle/pool ratios) to be major factors determining the distribution and abundance of Redbreast Sunfish in riverine systems. Both juveniles and adults are usually found in shallow water near cover, although fish may occupy deeper habitats under warmwater summer conditions and during winter. Important cover include fallen trees, stumps and aquatic vegetation.

These hard structures appear to be important habitat components for spawning site selection. Additionally, hard structures have been attributed to being the substrate producing more than 60% of the food organisms consumed by sunfish species, including Redbreast Sunfish. Scarola (1973) states Redbreast Sunfish can be found over gravelly bottoms with or without vegetation; however, unlike the Pumpkinseed, it does not rely as much on there being aquatic vegetation present. Aho et al. (1986) quantify variables critical to habitat suitability models in both lotic and lentic environments for Redbreast Sunfish. Water temperatures regarded as suitable for growth and survival of adult and juvenile fish are assumed to be in the range of 15-35°C; for spawning and incubation the optimal range is assumed to be 21.1-27.2°C. Nests are generally constructed at depths less than 1.5 m. Water velocities at nest sites are less than 0.06 m/s with an average of 0.02 m/s. Based on available information for other sunfish species, 25-70% hard structure cover is estimated to be most productive for Redbreast Sunfish. This species appears to require a mixture of coarse sand and gravel substrate at spawning sites to be successful.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Abundance of hard structures for cover are critical components of Redbreast Sunfish habitat. Removal of such cover or inadequate structure being recruited into lakes and streams (e.g., from forested riparian areas) may negatively affect the suitability of habitat for this species. It may be sensitive to acidity (i.e., long term pH values <4.0), but is tolerant of high temperatures (<35°C) (Aho et al. 1987). Rapid reductions in water level of more than 0.9 m during the spawning season may adversely affect embryo development and survival (Aho et al. 1987).

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Aho (1987) identify several potential threats to this species. Low

Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

to moderate turbidity levels are suitable to this species; however, excessive levels may impact fish growth and abundance. Pesticide contamination of waters supporting Redbreast Sunfish has been a suspected cause for the observed decline of some populations.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	1) Determine its distribution in Vermont waters. It may be present in more streams of suitable habitat in the Connecticut Valley than is presently known. 2) The spatial extent of its presence in the Connecticut River and its larger tributaries should also
Research	Threats and Their Significance	Low	Evaluate and monitor pesticide levels in known populations of Redbreast Sunfish.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	Monitor known populations.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, CRWC, TNC	
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, CRWC, TNC	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, CRWC, TNC, lake associations , dam owners	Lake associations, dam owners
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

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Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G3 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

The number of populations known to occur in Vermont stands at four located in the Missisquoi, Lamoille, Winooski and Poultney rivers (Grandmaison et al. 2004; Langdon 2014), or five if the Winooski River is considered to have two populations separated by the natural fall line (present day Winooski One dam). Vermont populations are disjunct from the species' main distribution which encompasses the Midwestern states. Although populations in the Vermont are presumed to be stable, systematic and temporal assessments have not been conducted to quantify abundance trends. However, there is general agreement that the abundance of the species is declining throughout much of its continental range (Kuehne and Barbour 1983 cited in Grandmaison et al. 2004). Various sources summarized by Grandmaison et al. (2004) speculate that Vermont populations at present appear to be abundant enough to be viable; however, historical data and current monitoring activities are inadequate or lacking from which confident abundance trends can be derived and such conclusions are at best speculative. Grandmaison et al. (2004) present a summary of potential threats to Eastern Sand Darters in nine states within the species range. The most cited threats to the species are habitat destruction or degradation resulting from impoundment, channelization, channel dredging and siltation. Threats identified for Vermont populations are sedimentation resulting from bank erosion and storm water discharges; water quality degradation from livestock manure runoff, and chemicals and other catastrophic spills. The potential for sedimentation to impair critical habitat necessary for Eastern Sand Darters is a persistent problem within its Vermont range given most of the populations lie within drainages with high agricultural and land development activity. Sea Lamprey control measures employing lampricides (e.g. TFM) have also been a concern in Vermont. Bioassay testing on sand darters has determined the maximum no-effect concentration is 1.3 to 1.4 times the minimum lethal concentration of TFM needed to control Sea Lamprey. The range of Eastern Sand Darter encompasses nine states and two Canadian provinces. Of these, it is a species of special concern in two (Indiana, Ohio), threatened in five (Illinois, Michigan, New York, Vermont, Canada) and endangered in one (Pennsylvania) (Grandmaison et al. 2004). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

Eastern Sand Darters range from the St. Lawrence River drainage, southern Quebec, Vermont and New York; through the Great Lakes and Ohio River basins from western New York to eastern Illinois; and south to Kentucky (Page and Burr 1991). In Vermont, populations are known to occur below the fall line in the Missisquoi, Lamoille, Winooski, and Poultney rivers. There is one recent occurrence of the species being collected from above the fall line on the Winooski River. One individual has also been collected in Lake Champlain at the mouth of the Lamoille River in Malletts Bay. During Lake Sturgeon larval drift sampling downstream of Swanton Dam sand darters have been captured which occurred during a Missisquoi River high flow event (MacKenzie 2015). It is believed that the darters originated from above the dam but were transported downstream by the high water as there is little to no sand darter habitat downstream of the dam. In Vermont, this species is on the eastern edge of its range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds

Lake Champlain

Lamoille River

Missisquoi River

Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Eastern Sand Darter shows a strong preference for sandy areas of rivers and streams with slow to moderate currents, where it spends most of its time burrowed into the sand with only its eyes or head protruding. It has also been reported from sandy shoals in Lake Erie, but has not been reported in Lake Champlain, except for one individual at the mouth of the Lamoille River in Malletts Bay. The Eastern Sand Darter requires medium to fine sand, so water velocity and sedimentation are important factors in habitat suitability. Habitat use and preference studies indicate that the fish use areas with a large percentage of sand particles 0.23 to 1 mm in size. It is quite sensitive to sedimentation and poor water quality.

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): The range of the Eastern Sand Darter is believed to be shrinking due to the loss of clean sand habitat caused by increased siltation from soil erosion and agricultural activities. Hydroelectric power generation should be regulated to maintain suitable flows and habitat.

Description of non-habitat threat(s): Chemical lampricides (TFM and TFM/Niclosamide) are used extensively in the Lake Champlain watershed for the control of Sea Lamprey ammocoetes reducing adult lamprey parasitism rates on other fish species inhabiting the lake, such as Lake trout, Landlocked Atlantic Salmon, Walleye, Lake Sturgeon and whitefish. Non-target impacts on other fishes, including state threatened Eastern Sand darter, have been and continue to be a concern. TFM toxicity tests conducted on adult sand darters show it to be one of the more TFM-resistant darter species (LCFWMC 2001). Nonetheless concerns remain regarding long-term lampricide effects on sand darters at the population level. To date annual assessments of darter populations in treatment streams have not been designed or carried out to demonstrate that darter abundance is being maintained at no-effect levels.

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determination of optimal microhabitat requirements (e.g., depth, velocity and substrate).
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Increase sampling efforts in rivers with known populations, including sampling beyond known areas of occurrence.
Research	Threats and Their Significance	High	Effects of limiting factors (e.g., hydro-generation) on habitat, and possible long term effects of lampricide treatment on populations.
Research	Population Genetics	Medium	How closely are Vermont populations linked genetically to one another and to other populations located outside of the state.
Research	Taxonomy	Low	
Research	Other Research	Low	Diet studies.
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Eastern Sand Darter populations.	Number of existing populations of Eastern Sand Darter protected and sustained.	VFWD, USFWS	USFWS, VFWD
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)

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Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Four populations are currently known in Vermont. These are located in the Winooski, LaPlatte and Poultney rivers. Little, if anything, is known of the size, structure, and trends of these populations. Channel Darter has very specific habitat requirements and as such populations tend to restricted is size and distribution (COSEWIC 2002). NatureServe (2014) ranks the overall threat to populations to be high with reductions of Channel Darter populations occurring throughout its continental range. Threats to populations include habitat loss and degradation due to siltation, pollution, flow modification, and impoundments; fragmented populations have a reduced likelihood of recovering (COSEWIC 2002; NatureServe 2014). Potential causes of declines in Lake Erie include eutrophication, shoreline modifications from development, and invasive Round Goby (NatureServe 2014). Population declines and extirpation of some populations have been reported from Lake Erie, Ohio, Michigan, Ontario and Quebec (NatureServe 2014). Selected as an Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

This is a wide ranging species but is highly localized in the St. Lawrence, Great Lakes and Mississippi River drainages from southern Quebec and Vermont, south to northern Louisiana; along the Gulf Slope in Mobile, Pascagoula and Pearl River drainages (Page and Burr 1991). In Vermont, the species is on the eastern edge of its range with populations known to occur below the fall line in the Winooski, LaPlatte and Poultney rivers. There is a historic record from Lake Champlain on the New York side (Greeley 1930); however, no occurrences have been made within the Vermont portion of the lake.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Channel Darter is a bottom dweller of gravelly or sandy shoals of warm lakes and rivers. In rivers, it is found in areas with coarse sand and gravel substrate. These areas have low to moderate current, but enough

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

water velocity to prevent silt deposition. Channel Darters are found in areas with substrates composed of gravel and sand. Preferred habitat is low in sediments and turbidity. Some studies of spawning in rivers and aquaria indicate that Channel Darters require swift currents (0.03-0.04 m/sec) presumably with gravel substrate.

Habitat Types:

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): Channel darters are limited by the loss of clean gravel substrate resulting from increased siltation and turbidity from soil erosion and agricultural activities. Alteration of river flow regimes from hydroelectric power generation may also degrade habitat quality.

Description of non-habitat threat(s): Chemical lampricides (TFM and TFM/Niclosamide) are used extensively in the Lake Champlain watershed for the control of Sea Lamprey ammocoetes reducing adult lamprey parasitism rates on other fish species inhabiting the lake, such as Lake trout, Landlocked Atlantic Salmon, Walleye, Lake Sturgeon and whitefish. Non-target impacts on other fishes, including state endangered Channel Darter, have been and continue to be a concern. TFM toxicity tests conducted on adult Channel Darters show it to be moderately sensitive to TFM (LCFWMC 2001). Concerns remain regarding long-term lampricide effects on Channel Darters at the population level. To date annual assessments of darter populations in treatment streams have not been designed or carried out to demonstrate that darter abundance is being maintained at no-effect levels.

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Increase sampling efforts in rivers with known populations, including sampling beyond known areas of occurrence.
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Monitor impacts of sea lamprey control in the Lake Champlain watershed on channel darter populations.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Channel Darter populations.	Number of existing populations of Channel Darter protected and sustained.	VFWD, USFWS	USFWS, VFWD
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

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Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S4S5 **State Trend:** Declining
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Lake Champlain supports the only Sauger population in Vermont, where the species is on the eastern edge of its continental range. In Lake Champlain, historically they were more abundant in the southern than northern portion of the lake (Halnon 1963). Once described as common in Lake Champlain (Anderson 1978), Saugers have been rarely seen during the last 20 years (MacKenzie 2014) and has apparently declined to the point that it eluded detection by New York and Vermont fisheries biologists from 1994 (Nettles et al. 2005) until 2010 (NYDEC 2013). The species was once widely distributed in New York but is now extirpated from much of its historic range with exception of Lake Champlain. Sauger has declined in abundance and distribution across its range (Rawson and Scholl 1978; Hesse 1994; Pegg et al. 1997). Threats to the species include angler harvest, channelization, water flow fluctuations, migration barriers, loss of spawning and rearing habitat, and environmental degradation (Rawson and Scholl 1978; Hesse 1994; Pegg et al. 1997). Selected as an Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

The distribution of sauger in North America is from the St. Lawrence-Lake Champlain system south, west of the Appalachian Mountains to Tennessee River in Alabama, southwest to northern Louisiana, northwest through eastern Oklahoma to central Montana and central Alberta east below James Bay to Quebec (Scott and Crossman 1998). The distribution of Sauger in Vermont is limited to Lake Champlain, where it may have been more numerous in the southern portion of the lake. Anderson (1978) reported Sauger to be present in all sections of the lake except for the Main Lake.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Many of the general habitat requirements are similar between Sauger and walleye; however, Sauger habitat preferences are for large, shallow sections of lakes which are turbid with colloidal clay suspension, as well as

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

large, turbid, slow flowing rivers (Anderson 1978; Scott and Crossman 1978). Scott and Crossman (1978) considered Sauger "less adaptable" than walleye because of these preferences. Walleye and Sauger may utilize the same shoals or gravel to rubble in large turbid lakes for spawning (Scott and Crossman 1978). Preferred spawning habitats are shallow shoreline and shoals of lakes and riffles in rivers, including areas immediately below dams providing there is rocky substrate and good water circulation from wave action and river currents (McMahon et al. 1984). Sauger have been found to be highly selective for spawning sites and in some parts of their range have been shown to be reliant on access to a few discrete areas in large tributaries (Nelson 1968; Gardner and Steward 1987; Penkal 1992; Jaeger 2004). Sauger fry must reach their initial feeding grounds within 3-5 days before yolk-sac absorption or they will perish from lack of food (McMahon et al. 1984).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Sauger are considered to be the most migratory percid and are heavily dependent dependent throughout their life history on unimpeded access to a wide diversity of physical habitats (Collette 1977; Jaeger 2004). The historic spawning grounds of Sauger in Lake Champlain are not well known. Undoubtedly, dams have decreased their accessibility to many of the historical spawning grounds in the basin. For example, recent Lake Sturgeon and Walleye habitat assessments conducted on the Missisquoi River indicate most of the quality spawning habitat occurs above Swanton Dam (Madeline Lyttle, U. S. Fish and Wildlife Service, personal communication). Sauger also appear to be sensitive to changes in water quality. Sauger may be more dominant than Walleye under very turbid water conditions where they co- occur; however, dominance may shift with changing water quality (Scott and Crossman 1998). Improvements in Lake Champlain water quality may explain the perceived reduction in Sauger abundance, but this needs to be investigated.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): The Sauger population was once abundant in portions of Lake Champlain and were captured in considerable numbers as recently as the 1980s. Recent surveys of the South Bay, where Sauger was formerly abundant, failed to produce even in a single capture. Predation by native species, such as Smallmouth Bass (Johnson and Hale 1977) have been found to influence recruitment of walleye, a close relative to Sauger, in natural systems (as referenced in Quist et al. 2003). Others have speculated that native piscivorous predators, such Northern Pike, Smallmouth Bass, Lake Trout, Burbot and Atlantic Salmon, can be a major source of mortality for age-0 Walleye in Lake Champlain (Frater 2002). We would expect these interactions to be as important, if not more so, for Sauger. For example, the introduction of Black Crappie in Black Lake (New York) was believed to have caused successive Walleye year-class failures (Schiavone 1983). While Black Crappies are believed to be native to Lake Champlain, its cogener the White Crappie is not. It too has been found to be a significant walleye fry predator in some

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

systems (Quist et al. 2003). White crappies are known to occur in large numbers in areas where Sauger were historically abundant, e.g. South Bay (David Nettles, U. S. Fish and Wildlife Service, personal communication). Another exotic in Lake Champlain, the White Perch, has been found to be an important predator of Walleye eggs (Roseman et al. 1996; Schaeffer and Margraf 1987). White Perch have become or are becoming one of the most dominant species in the fish assemblage in some areas of the lake, e.g. Missisquoi Bay (Pierre Bilodeau, Quebec Parks and Wildlife, personnel communication).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Determine the current population status of Sauger in Lake Champlain (Vermont and New York sections), and identify critical spawning and juvenile habitats.
Research	Threats and Their Significance	High	1) Determine the effect of recent invasions of non-indigenous species (e.g., White Crappie, White Perch, Zebra Mussel) on Sauger in Lake Champlain. 2) Determine the effect, if any, changing water quality may have on the Sauger population.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications		Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	High	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	Change in habitat quantify and quality	USFWS, NRCS, DEC, VT Rivers Conservanc y	ANR, DEC, NRCS, FSA

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

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