

Information Sheet on Ramsar Wetlands

(RIS) – 2009-2014 version

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Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.
2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 17, 4th edition).
3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

1. Name and address of the compiler of this form:

Ryan Crehan, USFWS, 11 Lincoln St, Essex Jct, VT 05452

2. Date this sheet was completed/updated:

December 12, 2013

3. Country: USA

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Designation date

Site Reference Number

4. Name of the Ramsar site:

The precise name of the designated site in one of the three official languages (English, French or Spanish) of the Convention. Alternative names, including in local language(s), should be given in parentheses after the precise name.

Missisquoi Delta and Bay Wetlands

5. Designation of new Ramsar site or update of existing site:

This RIS is for (tick one box only):

- a) Designation of a new Ramsar site ; or
b) Updated information on an existing Ramsar site

6. For RIS updates only, changes to the site since its designation or earlier update:

a) Site boundary and area

The Ramsar site boundary and site area are unchanged:

or

If the site boundary has changed:

- i) the boundary has been delineated more accurately ; or
ii) the boundary has been extended ; or
iii) the boundary has been restricted**

and/or

If the site area has changed:

- i) the area has been measured more accurately ; or
- ii) the area has been extended ; or
- iii) the area has been reduced**

** **Important note:** If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site:

Refer to Annex III of the *Explanatory Note and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

- i) a **hard copy** (required for inclusion of site in the Ramsar List): ;
- ii) an **electronic format** (e.g. a JPEG or ArcView image) ;
- iii) a **GIS file providing geo-referenced site boundary vectors and attribute tables** .

b) Describe briefly the type of boundary delineation applied:

e.g. the boundary is the same as an existing protected area (nature reserve, national park, etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

The boundary delineated is the boundary of the U.S. Fish and Wildlife Service Missisquoi National Wildlife Refuge (Federal owned land), the Maquam Wildlife Management Area, Carmans Marsh Wildlife Management Area, and the Rock River Wildlife Management Area (State owned conservation lands). The National Wildlife Refuge and Maquam Wildlife Management Area properties are abutting.

8. Geographical coordinates (latitude/longitude, in degrees and minutes):

Provide the coordinates of the approximate centre of the site and/or the limits of the site. If the site is composed of more than one separate area, provide coordinates for each of these areas.

44° 57' 18.58" N, 73° 10' 8.73" W

9. General location:

Include in which part of the country and which large administrative region(s) the site lies and the location of the nearest large town.

Extreme northwest corner of the state of Vermont, Northeast USA, adjacent to Lake Champlain, within towns of Swanton and Highgate, 0.1 mile to border with Quebec, Canada and less than 10 miles to State of New York, USA, approximately 35 miles NNE of Burlington, Vermont

10. Elevation: (in metres: average and/or maximum & minimum)

average – 30.4 meters

11. Area: (in hectares)
3,102 hectares

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Missisquoi River delta is the largest wetland complex in the Lake Champlain Basin. Lake Champlain was designated a resource of national significance in 1990 by The Lake Champlain Special Designation Act (Public Law 101-596). As it flows toward the lake, the Missisquoi River passes through the largest and perhaps highest quality silver maple floodplain forest in the State of Vermont as well as natural and managed marshes of wild rice, buttonbush, and tussock sedge that host thousands of waterfowl during migration. The part of the river in the Missisquoi Delta and Bay Wetlands (Ramsar site) harbors rare freshwater mussels, turtles, and fish. Its delta is a critical link for migratory birds along the Atlantic Flyway. These wetlands host the largest concentration of waterfowl in Vermont and approximately half of the waterfowl in the Champlain Valley during early October. The Missisquoi Delta and Bay Wetlands site includes Shad Island great blue heron rookery, the largest in Vermont. Also inside the Missisquoi Delta and Bay Wetland site is the Maquam Bog, a mixed shrub sedge bog which is one of the largest ombrotrophic bogs in New England. The Pitch Pine Woodland Bog is also found here and is the only example of this natural community type in Vermont.

13. Ramsar Criteria:

Tick the box under each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11). All Criteria which apply should be ticked.

1	•	2	•	3	•	4	•	5	•	6	•	7	•	8	•	9
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14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Criteria 1. The Missisquoi Delta and Bay Wetlands contain multiple natural wetland types that are unique to Vermont and the northeast United States. Within the Missisquoi Delta and Bay wetlands is the largest contiguous floodplain forest in Vermont (Sorenson et al., 1998). Within this area is Shad Island, measuring approximately 120 acres at the end of the delta, contains a mix of silver maple, swamp white oak, green ash, and cottonwood trees on an area that has been little altered by past land use practices. This Research Natural Area unit is home to the largest great blue heron rookery in Vermont, and provides extensive research opportunities for scientists concerned with herons, their habitat, and their interactions with double-crested cormorants. Also within the Missisquoi Delta and Bay wetlands is the Maquam Bog; this bog is also a Research Natural Area of the Missisquoi National Wildlife Refuge (refuge) and one of Vermont's largest bogs and within it is a mixed shrub sedge bog which is one of the largest ombrotrophic bogs in New England. The Pitch Pine Woodland Bog is also found here and is the only example of this natural community type in Vermont.

Criteria 2. The Missisquoi Delta and Bay Wetlands site supports many state listed threatened and endangered species. In the Maquam Bog there is a large population of the state threatened Virginia chain fern (*Woodwardia virginica*) as well as the state threatened few-seeded sedge (*Carex oligosperma*). The site is

home to seven rare species of freshwater mussels, six of which are state-listed as endangered and one is listed as threatened (VFWD 2013). The mussel species that are state endangered are: pink heelsplitter (*Potamilus alatus*) listed as Least Concern in the IUCN Red List, fragile papershell (*Leptodea fragilis*), cylindrical papershell (*Anodontooides ferussacianus*), pocketbook (*Lampsilis ovata*) listed as Near Threatened in the IUCN Red List, black sandshell (*Ligumia recta*) listed as Least Concern in the IUCN Red List, and fluted-shell (*Lasmigona costata*). The giant floater (*Pyganodon grandis*) is state threatened and listed as Least Concern in the IUCN Red List. The Missisquoi River delta is also home to the state threatened eastern spiny softshell turtle (*Apalone spinifera*) listed as Least Concern in the IUCN Red List and in CITES appendix 1. The site includes habitat for nesting, resting, feeding and one of only two hibernation locations in Vermont for this species. These wetlands are home to over 200 species of birds including Vermont's largest population of black terns (*Chlidonias niger*) listed as Least Concern in the IUCN Red List, another state endangered species, which nests on the Missisquoi National Wildlife Refuge. In recent years, the State's entire nesting population of black terns has been found on the refuge. The low marshes that flood each spring provide a suitable area for feeding, spawning and nursery grounds for many fish species including the State endangered lake sturgeon (*Acipenser fulvescens*) listed as Least Concern in the IUCN Red List and State threatened eastern sand darter (*Ammocrypta pellucida*) also listed as Least Concern in the IUCN Red List. These wetlands have supported nesting bald eagles (*Haliaeetus leucocephalus*) listed as Least Concern in the IUCN Red List in recent years, a state endangered species and provides foraging habitat for at least 8 adult and juvenile eagles during the year. Similarly, foraging habitat is provided for common terns (*Sterna hirundo*) listed as Least Concern in the IUCN Red List. The recently listed endangered little brown bat (*Myotis lucifugus*) listed as Least Concern in the IUCN Red List, is known to forage on these wetlands and northern long-eared bats (*Myotis septentrionalis*) listed as Least Concern in the IUCN Red List have been documented foraging on these wetlands in the past.

Criteria 3. The Missisquoi Delta and Bay Wetlands, due to its size, location and diversity of habitats are particularly important in maintaining the biological diversity of the region. The most notable habitats include an intact bird's foot delta and associated floodplain wetlands and the Maquam Bog, a large peatland that is a unique natural area. The Missisquoi Delta and Bay Wetlands site provides important habitat for numerous species which contribute to the overall biological diversity of Vermont. Since 2004, all breeding black terns in Vermont have nested on the refuge within the site (Renfrew 2013). The floodplain forest, scrub-shrub wetlands, swamps and emergent wetlands all provide important habitat for a diverse and abundant assemblage of plants and animals including amphibians, reptiles, fish, migratory birds, and mussels.

Criteria 4. The Missisquoi Delta and Bay Wetlands provide nesting habitat for rare species (including Vermont state threatened and endangered species), migration habitat for large numbers of waterfowl and spawning habitat for fish species. It is the only known breeding site for black terns in Vermont. The eastern spiny softshell turtle uses the refuge for feeding and loafing. The Missisquoi River delta is one of only two known areas of hibernation for this turtle species in Vermont. Multiple fish species utilize the site for spawning and feeding including northern pike (*Esox lucius*), pickerel (*Esox Niger*), and yellow perch (*Perca flavescens*). These populations are important food sources for waterfowl broods and marsh birds. The floodplain forest is important for breeding migratory songbirds of conservation concern including wood thrush (*Hylocichla mustelina*), veery (*Catharus fuscescens*), black-billed cuckoo (*Coccyzus erythrophthalmus*), Canada warbler (*Cardellina canadensis*), and rose-breasted grosbeak (*Phencticus ludovicianus*). Great blue herons (*Ardea herodias*) nest in the silver maples at the northern end of the delta on Shad and Metcalfe Islands. Wood duck (*Aix sponsa*), common goldeneye (*Bucephala clangula*), and hooded merganser (*Lophodytes cucullatus*) are three cavity nesters that breed in the floodplain forest. Black ducks (*Anas rubripes*) and mallards (*Anas platyrhynchos*) also nest in the Missisquoi Delta and Bay Wetlands. The refuge also supports populations of bobolink (*Dolichonyx oryzivorus*), eastern meadowlark (*Sturnella magna*), and Savannah sparrow (*Passerculus sandwichensis*) in managed grassland habitat. The Missisquoi Delta and Bay Wetlands site also provides habitat for numerous species of mammals as well.

Criteria 5. The Missisquoi Delta and Bay Wetlands are an important habitat for over 200 bird species and provides breeding habitat for numerous species of waterfowl, passerines, raptors, and wading birds. In

In addition, the wetlands are a critical link for migratory birds along the Atlantic Flyway. Fall populations of waterfowl on these wetlands often reach 20,000 birds (USFWS unpubl. data, USFWS 2007). These wetlands host the largest concentration of waterfowl in Vermont and approximately half of the waterfowl in the Champlain Valley during early October.

Criteria 7. The Missisquoi River and Missisquoi Bay provide habitat for numerous fish species, both common species and threatened or endangered species including the state endangered lake sturgeon (*Acipenser fulvescens*) and stonecat (*Noturus flavus*). The site provides one of the most important spawning areas for pike, pickerel, bass and other in Northern Lake Champlain. The low-lying marshes and shallow aquatic weed beds of the site, which flood during the spring snow melt and ice-out periods of April and May, serve as critical feeding, spawning, and nursery grounds for those species (Langdon et al 2006). Meadows and fields along the river, as well as the shallow, sloping, grassy dikes of Cranberry and Goose Bay Pools are also excellent habitats for numerous fish species, especially northern pike, pickerel, and yellow perch. Those populations are very important as food sources for marsh birds, osprey and bald eagles. The only confirmed native population of muskellunge (*Acipenser fulvescens*) in Vermont lived in a stretch of the Missisquoi River between the Swanton and Highgate dams but was wiped out by a chemical spill in the 1970s. The Vermont Fish and Wildlife Department is currently trying to reestablish a population in this stretch of river. There is a population of muskellunge in the lower Missisquoi River below the Swanton Dam, including the stretch through the Missisquoi Delta and Bay Wetlands site that is believed to have become established from fish released in the Great Chazy River on the New York side of Lake Champlain. The muskellunge is a species of high priority in the Vermont Wildlife Action Plan.

Criteria 8. The Missisquoi Delta and Bay Wetlands provide food sources and habitat for numerous fish species including those that otherwise reside in Lake Champlain or in the Missisquoi River. As a site that includes an extensive river delta and associated wetlands, there are numerous ecological interactions between the fish and birds (such as ospreys, and herons) of the wetland as well as between prey fish found in the wetland and the predator fish of the lake and river. The lower Missisquoi River is one of the few remaining spawning grounds for the state-listed endangered lake sturgeon (*Acipenser fulvescens*). Typical spawning sites are rocky and boulder-filled areas at the outside bend of rivers. Lake sturgeon eggs require clean river bottoms for survival. The state-listed threatened eastern sand darter (*Ammocrypta pellucida*) is another fish species in the lower Missisquoi River. The eastern sand darter is associated with 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 is quite sensitive to sedimentation and poor water quality. The lake sturgeon, eastern sand darter, and freshwater mussels are important indicators of water quality. The state-listed stonecat (*Noturus flavus*) is found in only two rivers in Vermont including the lower Missisquoi River (Langdon et al. 2006).

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region: Laurentian Mixed Forest Province, North-central lake-swamp-morainic plains, New England lowlands (212)

b) biogeographic regionalisation scheme (include reference citation): Bailey, Robert G. 1998. Ecoregions: The Ecosystem Geography of the Oceans and the Continents. Springer-Verlag. New York, New York. 192pp., 107 illus., 10 tables. ISBN 0-387-98305-8

16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

All of New England and northeastern New York were affected by the last continental glaciation, the Wisconsin, which peaked about 18,000 years ago. As the ice sheet began receding, its melt waters were blocked from draining northward by the ice, allowing historical Lake Vermont to form in the Champlain Valley. By 11,000 years ago, the glacier had receded beyond the St. Lawrence lowlands, allowing water from the Atlantic Ocean to reach the Champlain Valley. That marine embayment was called the Champlain Sea. As the glacier continued to regress northward, the weight of the ice sheet lifted, allowing the Earth's crust to rebound and lift the northern rim of the Champlain Valley above sea level, forming a barrier to the ocean. That initiated a gradual transition from a saltwater, to a brackish, to a freshwater aquatic environment that was complete by about 8,000 years ago (Chapman 1937). As the sea receded, thick deposits of clay, and in some places sand, remained to form some of the best farmland in eastern Canada and northeastern United States. Flying over northern Vermont today, one sees the Green and Taconic Mountains flatten and separate into the vast Champlain Valley, site of ancient seas. Immediately to the north, in Canada, the land broadens still farther into the valley of the St. Lawrence.

As the great continental ice sheets melted, they left behind river deltas and sand-gravel margins, creating a medium for the growth of a distinctive mosaic of plants found in few other places in northern New England. Before European settlement, the region was dominated by silver maple floodplain forest, red maple black-ash swamp, mesic oak hardwood forest, and sugar maple-beech-birch forest, depending on site-specific conditions. Pitch pine-scrub oak woodlands, emergent freshwater marshes, and large river systems were embedded in the region. Little of that natural vegetation remains in the St. Lawrence Plain, based partly on natural changes, but mostly because of large-scale, human-induced disturbance (Rosenberg 2000). These wetlands include some of the best remaining examples of those habitats.

The Missisquoi Delta and Bay Wetlands are located on the eastern shore of Lake Champlain in the Champlain Valley biophysical region of northwestern Vermont. That biophysical region extends beyond Vermont north and east to the St. Lawrence River and west into New York to the Great Lakes (excluding the Adirondacks). It is relatively warm, dry, and low in elevation compared to the surrounding landscape; local Vermonters call it the "banana belt." The mean summer temperature is 70°F; winter temperatures average 19°F. The annual precipitation in the Champlain Valley averages 28 inches close to the lake.

The Missisquoi Delta and Bay Wetlands also are located within the Bird Conservation Region (BCR) 13, the Lower Great Lakes, St. Lawrence Plain and, more specifically, in the St. Lawrence Plain physiographic area. Because of agriculture, that is now the largest and most important area for grassland birds in the Northeast. The small riparian and deciduous forest habitat that remains in the St. Lawrence Plain supports several high priority birds, most notably a large, expanding population of cerulean warbler (*Dendroica cerulea*). Early successional habitat is important habitat for American woodcock (*Scolopax minor*). The seasonal pattern of flooding in the Lake Champlain Valley, together with annual variations in the overall level of Lake Champlain, stimulate and maintain the diversity and the dynamic vitality of the lakeshore and floodplain vegetation. Although water levels generally change according to a fairly predictable seasonal pattern, variation in the level of Lake Champlain from year to year results in "low water" years and "high water" years. The distribution and density of emergent plants and the timing of their growth depend on that variation.

A peak lake level between 99 and 101 feet mean sea level (msl) is common in the spring, and high levels may remain until mid summer if spring or summer precipitation is above normal. The lake level usually recedes during the summer, and reaches its seasonal low of 94 to 95 feet msl between August and October.

The Missisquoi River Delta is considered unique and has been compared to the Mississippi River Delta. The similarities are in the arrangement and small number (three) of the distributaries (creeks that branch off from the main stem before reaching the lake), and the presence of only a narrow strip of delta on either side of the river for a long distance upstream from the point of branching. These long, narrow deltas found at the mouth of the Missisquoi and the Mississippi Rivers are known as "bird's foot deltas."

The geomorphology of the Missisquoi Delta is always changing. Precipitation (carrying and depositing sediments) in the Missisquoi River watershed and in Lake Champlain and wind (creating wave action) in the Lake Champlain Valley affect the deposition and erosion of sediments in the delta. The period of greatest sediment discharge, and therefore, of greatest delta-building activity is in April and May. Fillon (1970) compared the morphology of the 1970 delta to a depiction generated in 1857 (see Clews 2002). In that 100+ years, Shad Island had advanced more than one quarter of a mile out into the lake, the northwest corner of Hog Island and Martindale Point retreated, and Maquam Creek shifted from a navigable waterway to a smaller channel narrowed by sedimentation and natural building of levees. At various times in the past, Fillon (1970) concluded, based on evidence of former deltas in Maquam Bay and an abandoned channel along Maquam and Black Creeks that the Missisquoi River emptied into Maquam Bay. Fillon (1970) used aerial photos to identify relict channels and natural levees or terraces in the Missisquoi River Delta.

For the last 500 years or more, the main stem of the Missisquoi River has flowed north into Missisquoi Bay. Despite dam construction upstream, including one in Swanton that changed the flow rate and sediment loads, the delta continues to expand northward. The main channel is more stable now than during its long history; a result of the riprap along the river stretch that runs parallel to Route 78 and the 3 miles of dikes on the refuge (Clews 2002).

The hydrology of Maquam Bog, south of Route 78 and between the mainland and Hog Island, is also complex. The bog sits about 1 foot above the average lake level and, as a result, it is seasonally flooded, mostly from Charcoal Creek to the north. A natural terrace formed on the southern edge of the bog by wave-thrown sand from Maquam Bay. In the early 1900s, a railroad was built atop that terrace, creating an additional barrier to floodwaters from the bay. More study is needed to understand how far floodwaters penetrate the bog or how much groundwater contributes to the bog's hydrology (Clews 2002).

17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, and climate (including climate type).

Lake Champlain lies on a fault bounded between the Pre-Cambrian Adirondack Mountains of New York to the west and the Cambro-Ordovician Green Mountains of Vermont to the east. The bedrock on the eastern shore of Lake Champlain surrounding and under the Missisquoi River Delta consists of black shales of the Ordovician Iberville Formation. The bedrock of the eastern two-thirds of the Missisquoi River drainage is metamorphic consisting mainly of phyllites, schists, and graywackes. The western part of the drainage is sedimentary, mainly shales and dolomites (Fillon 1970). Due to the deep deposition of deltaic sediments, the bedrock of the lower Missisquoi River crops out in only a few areas, and thus, does not generally influence the distribution of plant and animal communities on these wetlands (Clews 2002). The Missisquoi Delta and Bay Wetlands site sits at the mouth (delta) of the 767,000-acre (310,400 hectare) Missisquoi River watershed that drains portions of Quebec and Vermont. Each spring, its waters submerge large portions of these wetlands. The 88-mile river flows through the refuge and then into Lake Champlain at Missisquoi Bay. The geography and water flow of Lake Champlain creates five easily identifiable segments with different physical characteristics and land uses in their respective sub-basins. Missisquoi Bay is in the northeastern corner with significant agriculture in the surrounding uplands. The bay is broad (5 to 10 miles across), shallow (maximum depth 15 feet), and warm. Some of the major management issues in the bay are seasonal blue-green algae blooms, high phosphorus levels, and a white perch invasion.

The Missisquoi River watershed includes large areas of agriculture (dairy farming predominantly) including both row crops, hay and pasture in the lower elevation areas along with small towns. The

highest point in the watershed is Jay Peak (3,861 ft) and the steeper and higher elevation areas largely forested. Much of the watershed is underlain with glacial till with bedrock outcroppings. Other geological formations include marine sand, lacustrine deposits, and other fine sediment deposits toward the mouth of the river and in lower elevations. The climate of the basin is moderated by Lake Champlain near the river's mouth but otherwise the climate is typical for northern New England with cold, snowy winters and warm summers.

18. Hydrological values: Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

These wetlands include a variety of wetland types that due to their size, integrity, position on the landscape and diversity provide numerous functions and values. The principal functions and values the wetland provides are: wildlife habitat, floodflow alteration, nutrient removal, sediment/toxicant retention and uniqueness. The riparian wetlands and delta are a unique and expansive wetland system that is important in altering the floodflow into Lake Champlain while also removing nutrients and sediment that would otherwise be discharged into the lake. Missisquoi Bay faces challenges in maintaining water quality already due to the phosphorus load in its watershed and the refuge provides important water quality functions. These same wetlands also serve to retain floodwaters where nutrients can be retained or transformed. They moderate the floodflow and slowly release water back into the groundwater, river and lake (groundwater recharge). Through biological and physical pathways, sediment and associated nutrients are deposited into the refuge wetlands thereby removing them from the water column.

As previously noted, the Missisquoi Delta and Bay Wetlands site has unique habitat types in both the bird's foot delta and the bog, both of which are high quality. Another important function and value is fish and shellfish habitat. The wetland provides a broad array of production export values as well including wildlife food sources, fish and waterfowl production, a diversity of habitat, food sources for fish and other organisms important in food webs, as well as extensive flowering plants for pollinators.

The riparian and lacustrine wetlands of the Missisquoi Delta and Bay Wetlands site provide extensive sediment/shoreline stabilization on both the Missisquoi River and Lake Champlain where dense vegetation helps to retain sediment and prevent erosion. It should also be noted that while some areas of the wetland are closed to public access the Missisquoi River and much of the associated wetlands provide extensive recreation opportunities to hunters (particularly waterfowl), bird watchers, kayakers and motorized boaters, hikers, and fishermen.

19. Wetland Types

a) presence:

Circle or underline the applicable codes for the wetland types of the Ramsar "Classification System for Wetland Type" present in the Ramsar site. Descriptions of each wetland type code are provided in Annex I of the *Explanatory Notes & Guidelines*.

Marine/coastal: A • B • C • D • E • F • G • H • I • J • K • Zk(a)

Inland: L • M • N • O • P • Q • R • Sp • Ss • Tp • Ts • U • Va •
Vt • W • Xf • Xp • Y • Zg • Zk(b)

Human-made: 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • Zk(c)

b) dominance:

List the wetland types identified in a) above in order of their dominance (by area) in the Ramsar site, starting with the wetland type with the largest area.

Xf - 25%, W - 17%, Ts - 13%, U - 13%, O - 10%, Tp - 10%, L - 5%, M - 4%, Xp - 3%

20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

Floodplain forests: These wetlands contain the largest contiguous acreage of floodplain forest in Vermont (Sorenson 1998), with more than 1,000 acres along the lower Missisquoi River. In addition to silver maple, the floodplain forest contains eastern cottonwood, swamp white oak, green ash, and American elm, with a lush understory of sensitive fern. The forest is flooded each spring and is easily navigable by canoe for much of May. The wealth of bird species found in the floodplain forest is greater than anywhere else in these wetlands. Migratory songbirds use the floodplain forest for nesting, foraging, and as a stopover in spring and fall. As previously mentioned, the floodplain forest is important for breeding migratory songbirds of conservation concern including wood thrush, veery, black-billed cuckoo, Canada warbler, and rose-breasted grosbeak.

Emergent wetlands: sedge meadow, buttonbush swamp, wild rice marsh

These three communities are closely related and are found together throughout these wetlands. They are distinguished by three different dominant species: tussock grass, buttonbush, and wild rice, respectively. These three species are nearly ubiquitous across the permanently saturated wetlands of the Missisquoi Delta and form a productive matrix of wetland habitat on the refuge. These wetland communities are seasonally inundated as the lake level rises each spring, and are covered by five to 12 inches of standing water by early summer. The soils are generally shallow and composed of organic muck. These wetlands support nesting black terns, common moorhens, pied-billed grebes, American coot, bald eagle and osprey.

Emergent wetlands: deep broadleaf marsh

This community is found in shallow water and often forms dense mats of vegetation along the slower-moving portions of the river. The water level fluctuates with the seasons, but is on average six inches to three feet deep. Fish use these shallow waters to spawn and forage. Common plants include pickerelweed, broad-leaved arrowhead, and giant bur-reed. This natural community type is common in Vermont.

Emergent wetlands: deep bulrush marsh

These marshes are found along the outer margins of the delta in coarse sandy soils. They grow in one to four feet of water at the lake's edge where they are subject to lots of wave wind action. This plant community is dominated by soft and hard-stem bulrush, and does not support high plant diversity. Black terns perch on old tree trunks in the middle of the bulrush marsh and pied-billed grebes and common moorhens forage among the soft rushes. Bulrush marshes are common along the shore of Lake Champlain and smaller lakes and rivers across Vermont.

Red maple-green ash swamp

In addition to the dominant red maple and green ash, slippery elm, speckled alder, dogwood, and white birch are abundant. This swamp is stratified with a thick mid-story. Cinnamon and ostrich ferns carpet the forest floor in probably because of the more complex structure of this swamp, the Black Creek area supports all of the usual floodplain forest bird species, as well as several others species, such as the blue-gray gnatcatcher, that are found nowhere else on the site. Red maple-green ash swamps in Vermont are mostly along Lake Champlain typically in former bays of the lake and now separated by naturally formed sand or shale berms (Thompson and Sorenson 2000).

Maquam BogThe 900-acre Maquam Bog, one of Vermont's largest bogs, contains the state's largest populations of rhodora, as well as pitch pine, and Virginia chain fern, a state-threatened species. The center of the bog is about 100 feet above sea level, with an overall hummock-hollow relief of less than 8 inches. A natural gravel berm separates the bog from Maquam Bay to the south, Charcoal Creek, an old distributary of the Missisquoi River, defines the northern border, and the uplands of Hog Island form the

western border (Strimbeck 1988). Strimbeck (1988) identified three distinct vegetation zones in the bog: shrub-sedge, low shrub, and high shrub. Clews (2002) classified these as follows:

1. Mixed shrub sedge bog

This community forms the heart of Maquam Bog and is one of the largest examples of an ombrotrophic bog in New England. Peat mosses form a thick lumpy mat throughout this community, which is quite unstable in some places. Virginia chain fern and few-seeded sedge are found here and are both listed as state rare plant species. This area of the bog also provides potential nesting for short-eared owls and northern harriers, birds uncommon in the State of Vermont. Preservation of this community may require removal of the small trees and shrubs that are encroaching from the perimeter of the bog as well as maintenance of the current hydrological processes.

2. Dwarf shrub bog

This community type supports both plant and birds species commonly found further north or at higher elevations. Sheep laurel and leatherleaf are abundant, and the occasional song of a winter wren or white-throated sparrow can be heard here. Gray birch, tamarack and red maples form patches of taller forest, but the vegetation in this community is generally less than six feet tall. This community forms the matrix landscape around the patches of pitch pine woodland bog and is also a rare community in the state of Vermont.

3. Pitch pine woodland bog

This is the only example of this natural community type known to occur in Vermont and occurs in small patches among the mixed and dwarf shrub bog communities.

Alder swamp

This community type surrounds Maquam Bog and is an integral part of the bog ecosystem. In addition to speckled alder, other species include huckleberry, highbush blueberry, shrubby willows, dogwoods, and mountain holly are abundant in this swamp. Huge hummocks are formed by the thick rhizome masses of several fern and sphagnum moss species. The uneven terrain and thick brush make this community hard to navigate, effectively blocking entrance to Maquam Bog.

Rivershore grassland

Because of the similarity between river and lakeshore grasslands, and the ambiguous gradation between lake and river on the Missisquoi Delta, both communities are classified as rivershore grassland. These communities follow the length of the Missisquoi River and the lakeshore to either side. The shoreline is seasonally scoured by river and lake ice, then flooded during the spring thaw, and finally left high and dry by mid-June. These communities often form the transition zone between river mud shore and floodplain forest communities.

River mud shore

These transient communities exist on the slim margin of land that emerges as the Missisquoi River recedes in mid summer. They are often bordered by rivershore grassland and share many of the same species. Because of their proximity to the river (which is a source of both disturbance and seeds), these communities are prone to supporting invasive species such as purple loosestrife, flowering rush and common barnyard grass. Raccoon, muskrat, spotted sandpiper, and green frog are some of the native species that can be found here.

21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14, Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Section 14 provides information on all rare species identified on these wetlands. Due to the diversity and high quality of wetland types on the refuge, there are many niches for a diversity of species. In particular, the refuge contains excellent examples of a large bog and floodplain forest and bird's foot delta both of which provide unique habitat to a diversity of species.

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Section 14 provides an extensive overview of the noteworthy fauna found on these wetlands. Since these wetlands have extensive examples of important habitat, it is able to provide habitat for many species of fauna. These wetlands are also situated in a unique location, at the mouth of a large river and the shore of a major lake. While the Missisquoi Delta and Bay wetlands are located in the far northern portion of Vermont, the lake and elevation moderate the climate of the refuge allowing for a plethora of species to exist in one place such as the spiny soft-shell turtle and black tern, both of which have restricted ranges in Vermont.

As previously mentioned, these wetlands provide habitat for more than 200 species of birds, including thousands of migratory waterfowl during fall migrations, and is an important breeding area for waterfowl and other migratory birds. Fall populations of waterfowl often peak at 20,000. The largest great blue heron rookery on the Vermont side of Lake Champlain is located on Shad and Metcalfe Islands. In 2012 412 great blue heron nests were counted in this rookery. These wetlands also support breeding populations of numerous other species, such as rails, bitterns, common moorhens, pied-billed grebes, and numerous grassland, wetland and forest passerine species. In addition, wild turkeys are observed on the refuge, because of efforts by the Vermont Fish and Wildlife Department to establish flocks in Franklin County. The refuge also supports a diversity of native wildlife, including 35 species of mammals. Muskrat, beaver, and white-tailed deer are common.

23. Social and cultural values:

a) Describe if the site has any general social and/or cultural values e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values:

a) Describe if the site has any general social and/or cultural values e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values:

The exploration and exploitation of the Champlain Lowlands may have begun as early as 7500 B.C. Upstream on the Missisquoi River, on sandy beach deposits of the former Champlain Sea in Highgate, the Reagan Site was occupied by late Paleo-Indian times, 10,000 to 9,000 years ago. The site overlooked the Champlain Basin from an elevation of 500 feet (Thomas and Robinson 1979.) However, there are no known Paleo-Indian Period sites on the refuge. Although the Missisquoi Delta was exposed at that time, it still may have been too wet to be attractive for living (Thomas and Robinson 1979).

The Early Archaic Period (9,000 to 7,500 years ago) at Missisquoi coincides with a shift in environment to more closed forest cover (Corey et al. 2002:13). Both Early Archaic and Middle Archaic people seem to have used a wide variety of environments (Thomas and Robinson 1979). On the Missisquoi River in Swanton, upstream from the refuge, an Early Archaic site on a high terrace of the Missisquoi yielded corner-notched projectile points and a suite of stone tools dating to 8,100 years ago (Thomas and Robinson 1979). Two other Early Archaic sites have been dated in Highgate (Thomas and Robinson

1979), but no sites with Early Archaic tool kits or dating to that period have been found on the refuge. Delta buildup after the Early Archaic Period is likely to have buried any evidence of that period on the refuge (Hight and Wilson 1997). Small group size and low regional population during the Early and Middle Archaic may mean that their archaeological sites generally are smaller and easier to miss (Thomas and Robinson 1979).

Recent archaeological work just off the wetland site revealed a Middle Archaic Period archaeological site (Ellen R. Cowie, pers. Comm., 2005). It is likely that Middle Archaic people also used the wetlands. Elsewhere in New England, Middle Archaic people gathered at resource-rich sites to fish, work wood, and knap stone tools from stone obtained in the same drainage (Dincauze 1976).

According to Thomas and Robinson (1979) the Late Archaic Period (6,000 to 3,000 years ago) is widely represented in Vermont, although not many sites of that age are known in the Missisquoi River drainage. Late Archaic artifacts form a large percentage of surface collections in western Vermont. A large number of Late Archaic projectile points have a wide distribution in the Champlain Basin, and islands in the wet basin or wet environments in general attracted Late Archaic people in other parts of Vermont. The use of steatite bowls and the introduction of ceramic pots at the end of the period are significant. The Early Woodland Period (3,000 to 2,100 years ago) is represented by archaeological sites on the wetland as well as upstream. Some artifact continuity from the Late Archaic to the Early Woodland represents continuity of the basic subsistence and settlement patterns during those two periods. Hunting, fishing and gathering are not markedly different from the Archaic Period. Heightened burial ceremony and elaborate grave goods characterize that period in the Missisquoi Valley as well as other rivers in New England (Thomas and Robinson 1979). Early Woodland habitation sites have been identified on the refuge.

The Middle Woodland Period (2,100 to 1,000 years ago) (Corey et al. 2002) is marked by a continuation of hunting, fishing and gathering activity, and evidence of larger groups and perhaps more frequent visits to the same sites (Thomas and Robinson 1979). Nut and fish storage pits and perhaps corn horticulture existed by the end of this period. The presence of large heavily used Middle Woodland sites have been discovered in the lower Winooski, Lamoille and Missisquoi intervales before those rivers enter Lake Champlain (Thomas and Robinson 1979) and in the Connecticut River Valley in Vermont.

Current socio-economic values

The contribution of the Missisquoi Refuge and the Vermont Wildlife Management Areas (WMAs) to the local economy is multi-faceted. The refuge and WMAs contribute directly to the local economy through shared revenue payments. The Federal government does not pay property tax on refuge lands; instead it makes annual payments to respective municipalities based on a maximum of 0.75 percent of the fair market value of refuge lands as determined by an appraisal every five years. The Vermont WMAs contribute. The actual amount distributed each year varies based on Congressional appropriations, land acquisition, and the annual sale of refuge goods and products that contribute directly to the revenue sharing account. The latter includes proceeds from the sale of hay, timber products, etc.

The refuge also contributes indirectly to the local economy, yet provides valuable recreational opportunities for local residents and brings tourists and travelers into the area for the same reason. The refuge receives between 70,000 and 80,000 visitors a year. Public ownerships require little in the way of services from municipalities, yet provide valuable recreational opportunities for local residents. A 2001 national survey of hunting, fishing, and wildlife watching showed that 569,000 Vermont residents and nonresidents 16 years old and older fished, hunted, or watched wildlife in Vermont, and spent \$386 million on these activities. This included 171,000 anglers, 100,000 hunters, and 496,000 wildlife-watchers (USFWS & US Census Bureau 2003). Vermont ranked first in the nation in percentage of residents that actively observed wildlife (60 percent). At least 280,000 Vermont residents participated in wildlife-associated recreational activities; constituting nearly 50 percent of the state's resident population – the highest percentage in the nation. These statistics represent a significant contribution to Vermont's economy and highlight the strong connection Vermont residents and non-residents have to the land and wildlife (Kart et al. 2005).

Missisquoi Refuge is one of the premier spots in the State where these outdoor wildlife enthusiasts spend time and money. The refuge is popular for fishing, upland and big game hunting, and waterfowl hunting. The refuge is well known in Vermont as a premier waterfowl hunting venue. Each year, approximately 66 permits are sold to duck hunters at \$10 each. Waterfowl hunters contribute to the local economy through the purchase of gas, food, hunting-related equipment and clothing, boating gear, equipment repair services, and lodging. The WMAs also attract hunters and fishermen.

Approximately 100 permits to hunt big game and upland game are sold annually on the refuge. Most hunters pursue white tailed deer, but a few hunt for other species such as ruffed grouse, woodcock, or snipe. Although many hunters are local residents, approximately 20 percent reside outside Franklin County. These hunters contribute to local commerce through the purchase of gas, food, hunting-related equipment and clothing, and lodging. The Vermont WMAs included in the site area also open to hunting and contribute to the local economy in similar ways.

Trapping is a small factor in the local economic picture. Trapping is conducted on the refuge on a very limited basis; in any given year only two or three parties trap. Trapping is focused on those animals that are causing infrastructure or management problems relative to waterfowl management activities. Raccoons are trapped in an effort to reduce their predatory impact on colonial nesting birds such as great blue herons and black terns, as well as their impact on nesting waterfowl. Trappers are usually local people who purchase food, gas and other supplies as they conduct their work. The pelts are usually sold to large fur houses and their profits directly benefit the trappers.

Other economic uses of the refuge include commercial minnow collecting and haying. About one half dozen bait dealers buy special use permits from the refuge each year to access the river via Refuge land and collect minnows for sale as fish bait to ice fishermen. The sale of the minnows supports both the bait dealers and those who engage in the popular pastime of ice fishing.

In an effort to economically maintain about 200 acres of grassland as grassy herbaceous habitat for migratory birds and other animals, the refuge has cooperative farming agreements with about half a dozen local dairy farmers. The farmers pay the refuge a small amount to harvest hay from refuge land each year. Increasing numbers of birdwatchers, photographers, naturalists, and boaters are drawn to the refuge and WMAs. Recently the refuge was recognized as a premier stop on the Lake Champlain Birding Trail, likely leading to increased visitation, and, consequently, expenditure of funds in support of the local economy. In the next few years more canoeists are expected along the Northern Forest Canoe Trail, which courses from Maine to New York, passing through the wetlands on the Missisquoi River. Similarly we may see paddler use increase since the Lake Champlain Committee has identified a paddler's trail around the Missisquoi River Delta in their *Lake Champlain Paddler's Trail Guide 2006*. Increased visitation to the refuge is considered by many to be the cornerstone of the Swanton revitalization effort, as refuge users contribute to the local economy through consumption of goods and services, rental of equipment locally, and payment of fees for the use of shuttles and guide services. The refuge manager and other staff have also been involved in the Route 78 Improvement Project, aiding in the planning effort to improve the portion of Route 78 from the downtown Swanton bridge to the West Swanton bridge. Finally, the Missisquoi Refuge budget provides approximately \$400,000 per year to the local economy through staff salaries, expenditures for construction contracts on the refuge, and purchases from local businesses for operation and maintenance of the refuge.

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning?

If Yes, tick the box and describe this importance under one or more of the following categories:

- i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:
- ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:
- iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:
- iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

a) within the Ramsar site: Land within the Ramsar site is owned by the U.S. Federal Government and managed as a National Wildlife Refuge or the State of Vermont and managed as Wildlife Management Areas.

b) in the surrounding area:

The land surrounding the Ramsar site is in private ownership. There are some conservation easements on private lands within the vicinity of the site which maintain land in farm and woodland character, restricting development. There is one state wildlife management area (not included in this designation) approximately 5 miles to the west. There is a state park within 15 miles of the site and a bird sanctuary in Canada approximately 17 miles from the site. Lake Champlain is in the public domain.

25. Current land (including water) use:

a) within the Ramsar site: wildlife refuge and wildlife management area

b) in the surroundings/catchment: dairy farming, residential, tourism, limited industrial, low intensity commercial development, transportation infrastructure. The economy of Franklin County (where the wetlands are located) is based on a mix of agriculture, tourism and recreation, and industry. Many businesses near Lake Champlain cater to recreational interests and tourists. Campgrounds, fishing and other sporting goods and services, motels, and bed and breakfasts abound in the area. In addition, both Swanton and St. Albans have industrial parks that are slowly but steadily growing.

Farming is one of the largest land uses in the county. In 1997, 47 percent of the county, or 190,215 acres, was in farms. Franklin County is the largest dairy producer in Vermont and in New England. Dairy farms generated more than 75 percent of the total agricultural sales for the County. The total economic impact of the agricultural industry in Franklin County is estimated at more than \$210 million, providing more than 10 percent of all the jobs in the region (American Farmland Trust 2002).

In 1987, Vermont enacted the Farmland Conservation Program to permanently protect land for agriculture. Vermont consistently invests more money per capita on farmland conservation than any other state in the U.S. By 2002, this program had helped protect 25,000 acres in Franklin County. Between 1982 and 1997, 15 percent of the farmland in Franklin County was lost to development; lower than the 20 percent statewide average (American Farmland Trust 2002). Many people who live near the refuge commute to jobs in the Burlington area. The relatively high cost and low availability of housing in the neighboring counties, especially Chittenden County that encompasses Burlington, is causing an increase in residential development pressure in Franklin County.

Farmers have sold the development rights to their farmlands to land trusts to provide cash for farm improvements, to buy more land, for retirement, and to ensure that the land will be there for their children to farm in the future. Of the 41,408 total acres in the Town of Swanton, about 13,000 acres, or

31 percent, are conserved. Federal and state wildlife refuges encompass about 7,000 acres of that total and the rest lies in the form of conservation easements on private lands. Twenty-seven privately owned dairy farms, representing roughly half the dairy farms in Swanton, are conserved. Swanton has the highest percentage of conserved land of any community in Vermont.

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

a) within the Ramsar site: Factors affecting the Missisquoi Delta and Bay Wetlands are largely driven by the greater watershed as activities within the refuge and WMAs are closely controlled. Pollutants, invasive species, and other concerns in Missisquoi Bay also affect the site. Work to combat these threats to the wetland's ecological integrity while managing its' important wildlife habitats is ongoing.

Nuisance, non-native aquatic invasive plants and animals are one of the biggest problems in the site and in the Lake Champlain Basin. Non-native organisms can displace native species, degrade wetlands and other natural communities, and reduce natural diversity and wildlife habitat values. Non-native plants out-compete native species for light, water, and nutrient resources. Invasive species can also limit recreational activities and substantially affect the economy by preventing or restricting access to infested areas by boaters, anglers, or swimmers.

The managers of these wetlands are concerned that, once invasive plants have become established, they are expensive and labor-intensive to eliminate; they are able to establish easily, reproduce prolifically, and disperse readily, making their eradication difficult. Preventing new invasions is extremely important for maintaining biological diversity and native plant populations. Examples of aquatic nuisance species include alewife, sea lamprey, zebra mussel, white perch, Eurasian water milfoil, purple loosestrife, phragmites, and water chestnut. Water milfoil and other invasive aquatic plants are of particular concern, because they are displacing natural beds of submerged aquatic vegetation (SAV). SAV beds are critical foraging habitat for the thousands of waterfowl that use the wetlands and the bay during migration.

b) in the surrounding area:

Historically, the lower Missisquoi River has been a spawning area lake sturgeon but habitat loss and degradation as a result of the construction of migration barriers (e.g., dams) has eliminated access to historic spawning areas as sedimentation alters spawning habitat and affects egg survival resulting in low population size and changes in the life history characteristics (e.g., the age of maturity is 14 to 20 years).

Currently, the surrounding area is also affected by the factors described in section 26.a. Another important factor is the degradation of water quality in the Missisquoi Bay and river from sedimentation and nutrient loading, which is a major concern expressed by many people and organizations in the region. The Lake Champlain Basin Program and the Missisquoi Bay Watershed Plan, among other initiatives, are documenting myriad water quality problems, and are also identifying and implementing solutions.

Three major tributary rivers—Missisquoi, Rock, and Pike—feed into Missisquoi Bay. The Rock River flows through Canada and the United States. The Pike River enters Missisquoi Bay in Canada. The bay receives the highest phosphorus load of any section of Lake Champlain. Discharge from wastewater treatment plants and runoff from nonpoint sources, including lawns, farms, and urban areas, carry phosphorus into the waterways. More than 90 percent of the phosphorus entering the bay is from nonpoint sources (Lake Champlain Steering Committee 2005).

Phosphorus is not harmful to humans; however, high phosphorus levels cause algal blooms that degrade water quality for aquatic life, affect recreational enjoyment and, if algal toxins are present, can irritate skin and cause internal damage to pets and humans. Nuisance algal blooms were first recognized as a problem in the mid-1990s when large blooms occurred in Missisquoi Bay. The toxin microcystin, produced during blue-green algae blooms, regularly exceeds recreational use guidelines in the bay from July to September (Lake Champlain Steering Committee 2005). Blooms in 2011 and 2012 caused widespread mussel and fish die-offs presumably from anoxic conditions resulting from algae decay. The managers of the Missisquoi Delta and Bay Wetlands are concerned about the impacts of the algal blooms on wildlife and wetlands habitats as well as recreational opportunities.

Additional water quality issues in Missisquoi Bay include the presence of mercury and pesticides and the spread of invasive species. Other water quality concerns on the site include increased sedimentation caused by upstream Missisquoi River watershed land uses that cause stream bank erosion or increased runoff. Extreme floods exacerbate that sedimentation. Throughout the year, but especially in the spring, the Missisquoi River carries loads of sediment into the site where the water spreads out through the floodplain, dropping the sediment into wetlands, fish spawning areas, and mussel beds.

In terms of fish, walleye come up from Lake Champlain into the lower Missisquoi as far as the Swanton dam. The State of Vermont Department of Health issued a fish consumption advisory for that 8-mile stretch due to mercury contamination from atmospheric deposition in the walleye. There are three permitted direct wastewater discharges, two indirect wastewater discharges, and at least seven permitted storm water discharges to the lower Missisquoi River and its tributaries. Along the length of the lower Missisquoi River, aquatic life and their habitats are stressed from high sediment loads, turbidity, nutrient enrichment, and temperature, and loss of riparian vegetation and stream bank erosion (VT DEC 2005b).

Much more needs to be done to maintain or restore water quality for fish and wildlife populations in the delta. Because those issues extend well beyond refuge boundaries, any improvements in water quality will require broad partnerships and coalitions.

27. Conservation measures taken:

a) List national and/or international category and legal status of protected areas, including boundary relationships with the Ramsar site:

In particular, if the site is partly or wholly a World Heritage Site and/or a UNESCO Biosphere Reserve, please give the names of the site under these designations.

The entire Ramsar site is located within a federal wildlife refuge or state wildlife management areas. In addition, 2 areas within the refuge have been designated Research Natural Areas (RNAs). RNAs are intended to represent the full array of North American ecosystems: biological communities, habitats and phenomena, and geological and hydrological formation and conditions. They are areas where natural processes are allowed to predominate with little or no human intervention.

The Missisquoi Refuge has two RNAs: the Maquam Bog RNA and the Shad Island RNA. The Maquam Bog RNA, located southwest of State Route 78, was established in 1992. The 890-acre RNA is a large sphagnum bog with a diverse mix of plants. The Shad Island RNA was established in 1968. It is located at the extreme northern end of the refuge, and is the northernmost terminus of the Missisquoi River Delta.

b) If appropriate, list the IUCN (1994) protected areas category/ies which apply to the site (tick the box or boxes as appropriate):

Ia ; Ib ; II ; III ; IV ; V ; VI

c) Does an officially approved management plan exist; and is it being implemented?: Yes, The Missisquoi National Wildlife Refuge has an approved 15 year management plan. The management plan or Comprehensive Conservation Plan was finalized in 2007 and will be renewed in 2022. This plan is currently being implemented as is the policy with National Wildlife Refuges. The Vermont Fish and Wildlife Department has a completed Long Range Management Plan for the Maquam Wildlife Management Area approved in 2004 and has been implemented. Carman's Marsh and Rock River Wildlife Management Areas do not have approved management plans at this time. Although the USFWS and VTFWD have slightly different missions and guiding policies, land management principals such as wetland conservation and biological integrity of habitats are consistent.

d) Describe any other current management practices:

The focus of habitat management on the Missisquoi Refuge and the Vermont WMAs is to maintain and enhance habitat for migratory birds and other wildlife. Management activities include: prescribed burning, haying, cutting to maintain early successional habitat, manipulating water levels, trapping, and controlling invasive species.

The Lake Champlain Basin Program (LCBP) has funded phosphorus and other water quality monitoring since 1992. From 1990 to 2004, Missisquoi Bay consistently failed to meet the standards set by the State of Vermont. In 2002, Vermont and New York developed a plan to reduce phosphorus loads carried to the lake by its tributary rivers. Also in 2002, Vermont and Quebec signed an agreement to allocate responsibility for phosphorus reduction in the Missisquoi sub-basin: 60 percent for Vermont; 40 percent for Quebec (VT DEC 2005c).

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

The management of the Ramsar site is for the benefit of wildlife and will continue based on the management plan in place. The Missisquoi NWR Comprehensive Conservation Plan will be amended to include the designation as a Ramsar site. The VTFWD will similarly incorporate the Ramsar designation into their WMA Long Range Management Planning process. Both agencies management plans are consistent with the goals and objectives of Ramsar site management.

29. Current scientific research and facilities:

e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Research in the Missisquoi Delta and Bay Wetlands site has largely focused on the Missisquoi National Wildlife Refuge. The refuge has hosted numerous research projects including most recently, the Champlain Valley Carnivore Project in 2011 (through the University of Vermont) and a U.S. Department of Agriculture NRCS Sub-aqueous soils project. The refuge is also currently collaborating with U.S. Geological Survey and U.S. Fish and Wildlife Service Contaminants Program on a bass endocrine disrupter research project. The refuge conducts many biological surveys of wildlife each year, some in coordination with State of Vermont partners. Annual productivity surveys are conducted on the following species or species groups: Great blue heron, osprey, waterfowl and black tern. Surveys to assess habitat use and status of populations on the refuge include: breeding marsh and wading birds, breeding land birds, grassland nesting birds, breeding frogs and toads, migrating waterfowl, furbearers, purple loosestrife, and impoundment vegetation.

Each fall the refuge staff, in collaboration with the State of Vermont, bands ducks on the refuge. In 2012 800 ducks were banded. This effort supports the State's contribution to the Atlantic Flyway Council's banding program that helps guides waterfowl management decisions in the Flyway.

Vermont Audubon established a Monitoring Avian Productivity and Survivorship (MAPS) station in the marsh, shrubland and forest surrounding the Steven J. Young marsh in 2001. MAPS is a cooperative

effort among public agencies, private organizations, and bird banders in North America to provide long-term data on population and demographic parameters for more than 100 target landbird species at multiple spatial scales. The program uses standardized, constant-effort mist netting and banding during the breeding season. The MAPS methodology provides annual indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured; and annual estimates of adult survivorship, adult population size, proportion of resident individuals in the adult population, recruitment into the adult population, and population growth rate from mark-recapture data on adult birds. MAPS requires the standardized operation of a series of about 10 nets at permanent sites on one day during each of 6 to 10 consecutive 10-day periods between May and August. Standardization from year to year and continuation of the study for at least five consecutive years at each station are necessary to provide reliable productivity indices and survivorship estimates. Continuation of the study for 10 to 20 consecutive years at most stations will likely be necessary to obtain reliable trend information. One of the outcomes from the analysis of MAPS data by the Institute of Bird Populations is to identify those habitat characteristics associated with low productivity and those associated with higher productivity and in turn guide management that can lead to higher productivity (DeSante et al. 2005). Missisquoi Refuge has data for 2001-2004. As previously mentioned, the refuge contains two Research Natural Areas where research in these two rare ecological sites has been designated a priority.

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

e.g. visitors' centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

The refuge has a visitor center that has educational displays, a classroom and lab equipment, interpretative trails with information brochures, a boardwalk, two boat ramps, and staff that can assist and educate visitors. The refuge is frequented by area schools on field trips and also hosts a fishing derby for children, junior waterfowl training and a host of other special events. The refuge is also part of a regional canoe trail. The Rock River and Carmans Marsh Wildlife Management Areas have boat launches as well.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

The Missisquoi Delta and Bay Wetlands are popular among hunters, anglers, boaters, and wildlife watchers. Visitors who seek recreational experiences include local residents, U.S. and Canadian tourists, and others. The waters in and around the refuge receive a variety of boating traffic, including kayaks, canoes, anglers, speedboats, airboats, and personal watercraft; some conflicts arise between motorized and non-motorized watercraft. Boating supports the six priority public uses at Missisquoi Refuge by getting people out on the waters which surround the refuge. Hunting for waterfowl and big game is popular on the site. The refuge and WMAs are becoming increasingly popular for all recreational uses. These uses are only conducted in areas where they have been compatible with the purposes of the refuge and the WMAs. Limiting certain public uses ensures wildlife and habitat values are not compromised by public use activities.

The wildlife management areas include boat launches and areas open to hunting, fishing, trapping, and hiking. The refuge has 7.5 miles of interpretative trails and is accessible to people of all mobilities. It is also a scenic area with 4 season appeal for both nearby residents and tourists from distant places. The refuge is scenic and provides expansive views from public roads, trails and the water of multiple wetland types, open water and extensive wildlife habitat. Fall foliage is a particularly scenic time at the refuge.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept of Agriculture/Dept. of Environment, etc.

Vermont Agency of Natural Resources: 1 National Life Drive, Davis 2, Montpelier, VT 05620-3702

Patrick Berry, VTFWD Commissioner: (802)-828-1000
Patrick.Berry@state.vt.us

Vermont Agency of Natural Resources, Department of Environmental Conservation, Wetlands Section, 1 National Life Drive, Main 2, Montpelier, VT 05620-3702

Alan Quakenbush; Section Chief, State Wetlands: (802)-490-6179
Alan.Quakenbush@state.vt.us

U.S. Fish and Wildlife Service, Northeast Regional Office: 300 Westgate Center Drive, Hadley, MA 01035.

Wendi Weber, Northeast Regional Director: (413)-253-8300

Wendy_Weber@fws.gov

Scott Kahn, Assistant Regional Director: (413)-253-8550

Scott_Kahn@fws.gov

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Ken Sturm, Refuge Manager, Missisquoi NWR, 29 Tabor Road, Swanton, VT 05488
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34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see 15 above), list full reference citation for the scheme.

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