

2007 Water Chestnut Management Program: Lake Champlain and Inland Vermont Waters

FINAL REPORT

October 2008

A Report Prepared for the Lake Champlain Basin Program

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Table of Contents

Executive Summary	i
Introduction	1
Part I VTDEC Water Chestnut Management	4
Authorization.....	4
Budget.....	4
Equipment	5
Results.....	5
Conclusions.....	11
Part 2 TNC Water Chestnut Management Program	13
Objectives.....	13
Management Summary and Changes to Program, 2007	13
Volunteers	14
Methods.....	15
Results and Discussion.....	16
Conclusions.....	23
Acknowledgements.....	23
Part 3 Other Basin Water Chestnut Management Efforts	24

List of Figures

Figure 1-1. Summary of funds spent managing water chestnut in Lake Champlain and other Vermont watersbodies in 2007	1
Figure 2-1. Water chestnut rosettes removed by mechanical harvesting over time at eight Lake Champlain sites.....	7
Figure 2-2. Contracted crews handpulling water chestnut from Lake Champlain.....	8
Figure 2-3. Water chestnut rosettes removed by handpulling over time at eight Lake Champlain sites	9
Figure 2-4. Water chestnut rosettes removed by handpulling over time at eight other waterbody sites in Vermont	10
Figure 2-5. Annual water chestnut funding vs. northernmost mechanical harvest site	12
Figure 3-1. Water chestnut harvest trends at six sites in the Southern Lake Champlain Valley, 1998-2007.....	22
Figure 4-1. U.S. Fish & Wildlife Service staff and volunteers in Cranberry Pool.....	24

List of Tables

Table 1-1. Summary of funds spent on water chestnut management, 1982-2007	2
Table 1-2. Water chestnut indicators for 2007 management efforts.....	3
Table 2-1. Allocation of funds for VTDEC 2007 water chestnut management program.....	5
Table 3-1. Volunteer Hours and Water Chestnut Harvest Summary Data by Year.....	14
Table 3-2. Volunteer Statistics from Water Chestnut Handpulling, 1998-2007.....	15
Table 3-3. Water Chestnut Infestation Intensity Classification	16
Table 3-4. Pounds of Water Chestnut Harvested by Year per Site, 1998-2007	18
Table 3-5. Numbers of Rosettes and Area-based Harvest Statistics, 2005-2007	20

Appendices

Appendix 1. Water Chestnut Management Program Summary: 2007 Lake Champlain and associated tributaries.....	26
Appendix 2. Water Chestnut Management Program Summary: 2007 other waterbody sites	33
Appendix 3. Water Chestnut Management Program 2007 Site Maps	
Map 1. Northern Lake Champlain Sites: Missisquoi Bay.....	35
Map 2. Lake Champlain: Lower Broad Lake and South Lake; Dead Creek Sites and the Lemon Fair River.....	36
Map 3. Lake Champlain: South Lake Sites continued; Lake Bomoseen, Parsons Mill Pond, Coggman Pond, Brookside Pond, and Horton Pond.	37
Appendix 4. Water Chestnut Site Summary Statistics, 2007	38
Appendix 5. TNC Program Funding Sources, 2005 and 2007	40
Appendix 6. 2007 TNC Site Maps	
Map 1. Water Chestnut Handpulling Areas in South Bay, Lake Champlain, 2007.....	42
Map 2. Water Chestnut Handpulling Sites near Benson, Vermont, 2007	43
Map 3. Water Chestnut Handpulling Sites along the Lower Poultney River, Vermont and New York, 2007	44
Map 4. Water Chestnut Handpulling Sites in Orwell, Vermont and Ticonderoga, New York, 2007	45
Map 5. Water Chestnut Handpulling Site at Whitney Creek, Addison, Vermont 2007.....	46

Executive Summary

2007 Water Chestnut Management Program: Lake Champlain and Inland Vermont Waters

2007 marked the 10 years of a cooperative partnership between the Vermont Department of Environmental Conservation (VTDEC) and The Nature Conservancy (TNC) to manage water chestnut (*Trapa natans* L.), an invasive aquatic plant found in Lake Champlain, its associated tributaries, and other inland waterbodies in Vermont and New York. The goal of the partnership is to reduce populations of water chestnut and prevent its further spread. Prior to its formation in 1998, water chestnut was managed solely by VTDEC. As a direct result of the partnership, a significant reduction in large beds of water chestnut in Lake Champlain, in the marshes associated with the Poultney River and in other Vermont waters have been noted.

The majority of VTDEC water chestnut management is carried out under contract. Approximately 32% of VTDEC's 2007 water chestnut contract budget was spent on management at sites located on the New York side of Lake Champlain, from Port Henry south to Dresden.

TNC utilizes an all-volunteer workforce to handpull in ecologically significant wetland areas concentrated primarily near their Southern Lake Champlain Valley Preserve Office in West Haven, Vermont.

A combination of groups including VTDEC-hired contractors, VTDEC staff, TNC volunteers, U.S. Army Corps of Engineers interns, USF&W staff, and private citizens were involved in management efforts. In Lake Champlain, 67 sites were managed by mechanical harvesting, handpulling or a combination of both methods. Of these, 60 sites were handpulled only; 4 sites were mechanically harvested and handpulled and 3 sites were mechanically harvested only. An additional 20 other Vermont waterbody sites were managed by handpulling alone, including two new sites, and several small lakes and private ponds around the state.

Mechanical harvesters removed a total of 422 loads (802 tons wet weight) of water chestnut spoils from 7 mechanical harvesting sites between Benson and south four miles to Red Rock Bay (Vermont) in Lake Champlain. Red Rock Bay represents the furthest south that management has occurred in Lake Champlain since VTDEC initiated a pilot water chestnut control project in 1979 in that bay. Roughly 99% of 2007 mechanically harvested water chestnut spoils were composted on several farms in Benson, Vermont.

Handpulling hours by all involved groups totaled approximately 5,009, of which 3,246 were completed by VTDEC contracted handpullers and 1,249 were logged by TNC and its volunteers. The TNC hourly figure includes only actual on the water handpulling hours. TNC hourly rates portrayed in Part 2. of this report includes on shore training hours in their total of 1380 hours of handpulling. Contracted handpullers removed an estimated 20 tons of water chestnut and an estimated 5 tons were removed by TNC and its volunteers.

Only one new Lake Champlain water chestnut site was discovered in 2007. The site is located in Missisquoi Bay in Highgate, Vermont. Two new "other waterbody" sites were also discovered with water chestnut this year: Richville Pond in Orwell, Vermont, a run of the Lemon Fair River, and Bullis Pond in Franklin, Vermont, an 11-acre shallow impoundment of the Rock

River. All three sites were surveyed and handpulling activities followed.

Milestones for the 2007 water chestnut management partnership included: efforts advanced four miles south of Benson Landing for the first time in 27 years; 99% of the water chestnut plants collected thru the harvesting process were composted, up from only 19% in 2004; and rapid response actions occurred at all three newly confirmed infestation sites.

2007 Water Chestnut Management Program: Lake Champlain and Inland Vermont Waters

Final Report

Introduction

This report describes all aspects of 2007 water chestnut management activities conducted by the Vermont Department of Conservation (VTDEC) [Part 1] and The Nature Conservancy (TNC) [Part 2]. In addition to the VTDEC/TNC partnership, other groups are also involved in water chestnut management efforts in the Lake Champlain Basin. A discussion of these efforts is also provided in this report (see Part 3).

The Lake Champlain Basin Program, a partner and supporter of this program, identifies water chestnut control and spread prevention as a top priority in the Lake Champlain Basin. The highest priority action listed in the Nuisance Nonnative Aquatic Plants and Animals section of the Living Natural Resources Chapter of *Opportunities for Action* (April 2003) is *Prevent the Spread and Control the Population of Water Chestnut within Lake Champlain and Elsewhere in the Basin*. Water chestnut management can also be linked to goals and objectives set forth in other *Opportunities for Action* sections: Managing Fish and Wildlife; Protecting and Restoring Wetlands, Streams and Riparian Habitats; Managing Recreation Resources; Informing and Involving the Public; Monitoring and Measuring Success; and Economics in the Lake Champlain Basin.

VTDEC water chestnut management has occurred annually since 1982 and in partnership with TNC since 1998. Management goals are to significantly reduce the negative impacts of this aquatic invasive plant in Lake Champlain and other waters in Vermont, and to prevent further spread. All water chestnut control activities since 1982 have been of a non-chemical nature. Handpulling is employed to control sparse populations of water chestnut or populations inaccessible to mechanical harvesting equipment, while mechanical harvesting is used to control dense mats. VTDEC's program involves control in a north to south direction through handpulling and mechanical harvesting with the majority of the work conducted under contract. TNC utilizes an all-volunteer workforce to handpull in ecologically significant wetland areas concentrated primarily near their Southern Lake Champlain Valley Preserve Office in West Haven, Vermont.

Funds spent on water chestnut management efforts in Lake Champlain and other waters in Vermont in 2007 totaled \$605,248 (Figure 1-1). Funds spent on management since 1982, are estimated at \$7.4 million (see Table 1.1).

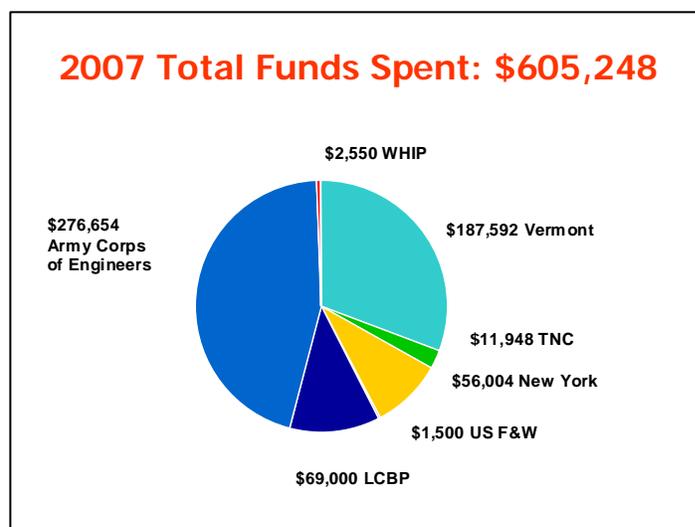


Figure 1-1. Summary of funds spent managing water chestnut in Lake Champlain and other Vermont waterbodies in 2007.

Table 1-1. Summary of funds spent on water chestnut management, 1982-2007.

Year	State		US ACOE	US F&W	USDA	US F&W	DU	LCBP		TNC	Total
	Vermont	New York						VTDEC	TNC		
1982	51,556		120,298								171,854
1983	40,700		95,000								135,700
1984	40,700		95,000								135,700
1985	73,000		170,000								243,000
1986	73,000		170,000								243,000
1987	73,000		170,000								243,000
1988	140,000		140,000								280,000
1989	110,000		110,000								220,000
1990	80,000		80,000								160,000
1991	16,667							50,000			66,667
1992		25,000						50,000			75,000
1993		16,667						50,000			66,667
1994	41,846		19,154					50,000			111,000
1995	21,727	7,000	12,060					50,000			90,787
1996	52,806	7,000	20,972					25,000			105,778
1997	136,000							36,000			172,000
1998	150,640		125,000					6,454	19,546		301,640
1999	141,000							160,504	23,040		324,544
2000	160,000	229,126	212,423	14,497				35,000	18,000		669,046
2001	160,000	112,464	157,000	45,503				33,000	14,000		521,967
2002	150,000	90,554	180,000				3,713	40,000	13,000		477,267
2003	133,854	42,147	220,846	11,000			6,287	50,000	13,000		477,134
2004	156,081		252,250	24,000		10,000	5,000	50,000	13,000		510,331
2005	186,919		188,000	13,215		10,000		50,000	13,000	11,917	473,051
2006	150,000	36,298	200,045	2,955	7,650	10,000		50,000	13,000	19,653	489,601
2007	187,592	56,004	276,654	1,500	2,550			56,000	13,000	11,948	605,248
Total	\$2,527,088	\$662,260	\$3,014,702	\$112,670	\$10,200	\$30,000	\$15,000	\$841,958	\$152,586	43,518	\$7,369,982

To support the goals of the Ecological Indicators Task Force, water chestnut indicators were developed and are presented in Table 1-2.

Table 1-2. Water chestnut indicators for 2007 management efforts.

Indicator	P S R	Suggested Measures	Values	Currently Collected?	Who Should Collect?	Spatial Resolution	Collection Frequency (minimum)	Reported Frequency (minimum)
Area Infested with Water Chestnut	P	Total number of infested acres	2,747	Y	VTDEC/NYDEC/TNC/QUEBEC		Annual	Annual
		Number of acres < 25% surface coverage	2,175	Y	VTDEC/NYDEC/TNC/QUEBEC		Annual	Annual
		Location of mechanical harvesting: miles north of Whitehall NY	8.5 miles	Y	VTDEC	South Lake	Annual	Annual
		Number of Lake Segments infested	5	Y	VTDEC	Lake Segment	Annual	Annual
Management Resources	R	Dollars spent on management	\$497,994	Y	VTDEC/LC Sea Grant/NYDEC/QUEBEC		Annual	Annual
Mechanical Management	R	Tons of water chestnut removed through mechanical harvesting	801.8 tons	Y	VTDEC/NYDEC/TNC		Annual	Annual
Hand Pulling Management	R	Tons of water chestnut removed through hand-pulling	25.14 tons	Y	VTDEC/TNC		Annual	Annual
		Number of hand-pulling hours in Lake Champlain and tributaries	4,046.5 hrs	Y	VTDEC/TNC		Annual	Annual

Part 1: VTDEC Water Chestnut Management

The majority of VTDEC water chestnut management is carried out under contract. Three contracts were awarded in 2007: mechanical harvesting, handpulling and composting. The field supervisor, often with other VTDEC staff, provide oversight of the contracts, obtain landowner permission for access and disposal, conduct surveys of existing and searches for new populations.

Authorization

Water chestnut mechanical harvesting activities in Vermont waters require an Aquatic Nuisance Control Permit. On June 8, 2005, Aquatic Nuisance Control Permit 2007-H01 was issued to VTDEC and allows mechanical harvesting and cutting activities in Lake Champlain from sites located in the towns of Ferrisburg, Panton, Addison, Bridport, Shoreham, Orwell, Benson, and West Haven. The permit was issued for 10 years. Handpulling activities do not require a permit in Vermont.

In New York, water chestnut control activities in Lake Champlain and associated waters, require a permit from the Adirondack Park Agency. Permit 2001-47, issued June 26, 2001 to the New York State Department of Environmental Conservation (NYSDEC) and VTDEC jointly, authorizes mechanical harvesting and handpulling of water chestnut from Lake Champlain in the towns of Dresden, Putnam, Ticonderoga, Crown Point, and Moriah. This permit expires in July 2011.

Budget

VTDEC had \$538,046 in available funds from state general funds, a USDA WHIP grant and the U.S. Army Corps of Engineers to implement 2007 water chestnut management. Contracts awarded by VTDEC in 2007 totaled \$276,204 for mechanical harvesting, \$125,000 for handpulling, and \$4,342 for water chestnut spoils composting. Approximately 32% of VTDEC's water chestnut contract budget was spent on management at sites located on the New York side of Lake Champlain, from Port Henry south to Dresden. Additional program costs included support of a field supervisor position and other administrative costs, and site improvements to one of the off-loading sites. Funds to support these costs came from LCBP, VTDEC, the U.S. Army Corps of Engineers and the U.S. Fish & Wildlife Service. Table 2-1 summarizes the distribution of 2007 funds with sources.

Table 2-1. Allocation of funds for VTDEC 2007 water chestnut management.

	USF&W ANS	USDA Whip	LCBP	VTDEC	US ACOE Corps	Total
Personnel, Fringe and Indirect (estimated): Field supervisor, full-time May through October 2007, part time the rest of the year			\$56,000	\$8,000		\$64,000
Contractual: Handpulling Mechanical harvesting Composting		\$3,300		\$125,000 \$24,250 \$4,342	\$248,654	\$125,000 \$276,204 \$4,342
Other: Administration Grant to TNC Site access improvement	\$1,500		\$13,000	\$26,000	\$28,000	\$54,000 \$13,000 \$1,500
Total	\$1,500	\$3,300	\$69,000	\$187,592	\$276,654	\$538,046

Equipment

Contracted mechanical control equipment used in 2007 included: 2 large mechanical harvesters each with 800 cubic foot storage capacity, a high-speed transport barge, a shore conveyor, and two dump trucks. The high speed transport barge was outfitted in 2007 with more powerful motors to increase transport speed. Contracted handpulling activities utilized ten kayaks, two boats and a motorized pontoon boat. VTDEC utilizes a variety of motorboats, canoes and kayaks for survey and search efforts, handpulling and contractor oversight.

Results

In Lake Champlain, 68 sites are known to support a population of water chestnut. Of these, 67 sites were managed with mechanical harvesting, handpulling or both methods: 60 sites were handpulled only, 4 sites were mechanically harvested only, and 3 sites were mechanically harvested and handpulled. The only site not managed in 2007 was the southern portion of the lake between Red Rock Bay, West Haven, Vermont and Whitehall, New York. Contracted management efforts concluded on August 21 as all available funds were expended. All 20 other water body sites in Vermont were managed, including two new sites discovered in 2007. Surveying was conducted to assess populations, direct contracted crews and search for new populations. A number of outreach activities were also implemented in 2007. A summary of these efforts follows.

Surveying

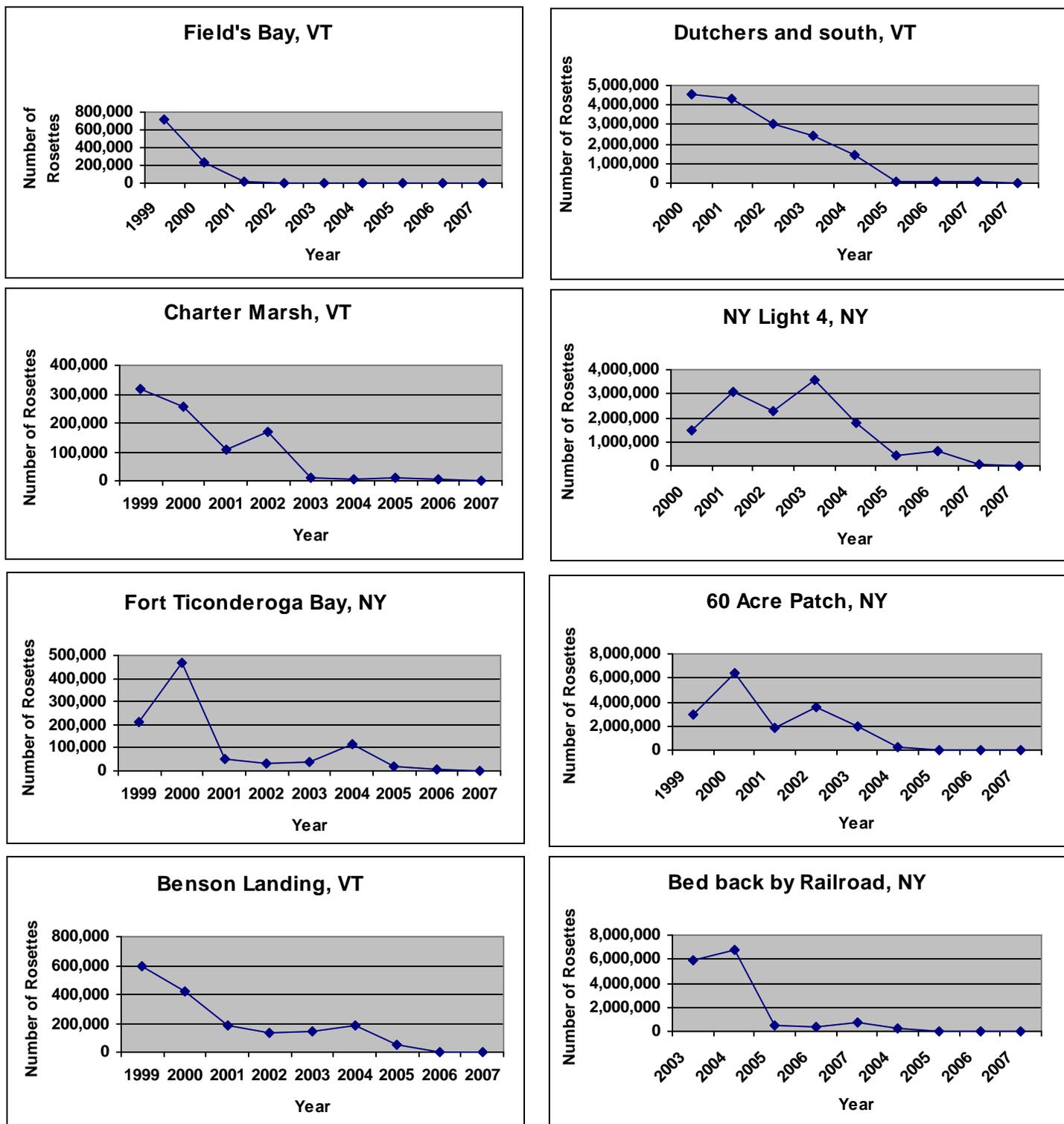
- VTDEC staff conducted 16 water chestnut surveys in 2007 between June and October: 6 surveys of water chestnut populations in Lake Champlain and 10 surveys of “other waterbodies.”

- The southern portion of Missisquoi Bay, Lake Champlain was surveyed extensively by VTDEC contracted airboat on August 16. Three water chestnut rosettes were discovered and removed from outside the mouth of Big Marsh Slough at the Missisquoi National Wildlife Refuge in Highgate, Vermont during the airboat survey. These annual airboat surveys have been conducted in Missisquoi Bay since 2002.
- The 600-acre wetland at the northern end of Lake Bomoseen, Castleton and Hubbardton, Vermont was surveyed for the third consecutive year by airboat on August 15. No water chestnut was found during the comprehensive survey.
- The two waters discovered with water chestnut in 2007, Bullis Pond and Richville Pond, were surveyed in early August.
- A comprehensive search of Star Lake in Mt Holly, Vermont was conducted following a report of water chestnut sightings by a VTDEC Vermont Invasive Patroller volunteer. No water chestnut was discovered.

Mechanical Harvesting

- The contract for 2007 mechanical harvesting was awarded to Aquatic Control Technology, Inc (ACT, Inc.) of Sutton, Massachusetts.
- Mechanical harvesting was only utilized in Lake Champlain.
- Mechanical harvesting in Lake Champlain began on July 9 in Benson, Vermont and concluded on August 21 in Dresden, New York.
- Two mechanical harvesting shifts, utilizing 8 to 10 people each, worked 5 days a week, 12 hour shifts from 7:00 a.m. to 7:00 p.m.
- A total of seven Lake Champlain sites were mechanically harvested. Figure 2-1 provides historical data for these seven sites and one additional site, Fields Bay, where only handpulling is now required.
- The northernmost mechanical harvesting site in Lake Champlain was reduced one mile from previous years. As of 2007, the northernmost mechanical harvesting site is the southern end of Dutchers Bay (site #38), Benson, Vermont.
- Mechanical harvesting occurred in Red Rock Bay (site #40), Benson, Vermont for the first time in 28 years.
- Total mechanical harvesting hours were 816.5, slightly lower than in the previous year (881 in 2006). Although funds available for mechanical harvesting were higher than in 2006, the decreased hours are attributed to increased distances to off-loading sites and contractor higher hourly rates.
- Approximately 5,908 cubic yards (an estimated 802 tons) of water chestnut spoils were removed in 422 harvester loads from 173 acres of the lake.
- Ninety-nine percent of mechanically harvested water chestnut was composted on two farms in Benson, Vermont. The remaining harvested material was utilized in a private garden also in Benson.

Figure 2-1. Water chestnut rosettes removed by mechanical harvesting over time at eight Lake Champlain sites.



Handpulling

- The 2007 contract for handpulling was awarded to Lakeside Sports of Fair Haven, Vermont.
- Contracted handpulling commenced in Lake Champlain on June 25 in the Ferrisburg, Vermont region and ended August 18, in Richville Pond Orwell, Vermont.
- Ten contracted handpullers each worked an average of 40 hours per week.
- At least 69 Lake Champlain and associated tributaries, and “other waterbody” sites were handpulled by contracted crews. These crews spent 3,245.5 hours removing approximately 20.24 tons of water chestnut.
- More than 1,000 acres along 125 shoreline miles of Lake Champlain in Vermont and New York were handpulled by contracted staff.
- For the first time in the 25-year history of VTDEC’s program, contracted crews removed water chestnut in areas up to 2.5 miles south of Benson Landing.
- Other groups, including VTDEC, TNC, LCBP, US Army Corps of Engineers, US Fish and Wildlife Service, Friends of the Missisquoi Refuge, and private citizens, provided additional handpulling, both in Lake Champlain and in other waters.
- Handpulling hours by all groups totaled 5,008.5.
- Figure 2-3 provides historical handpulling data for eight handpulling sites in Lake Champlain and Figure 2-4 provides historical handpulling data for eight “other waterbody” sites.
- Three new water chestnut sites, all in the Champlain Basin, were discovered in Vermont in 2007, one in Lake Champlain and two in other waterbodies. All new sites were managed by handpulling only.



Figure 2-2. Contracted crews handpulling water chestnut from Lake Champlain, Putnam, New York (NYSDEC)

Figure 2-3. Water chestnut rosettes removed by handpulling over time at eight Lake Champlain sites.

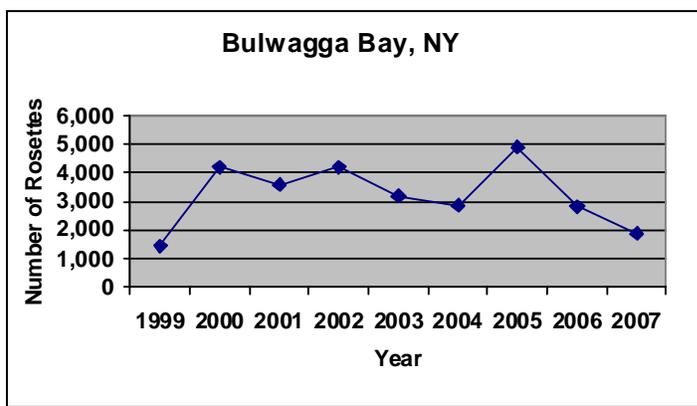
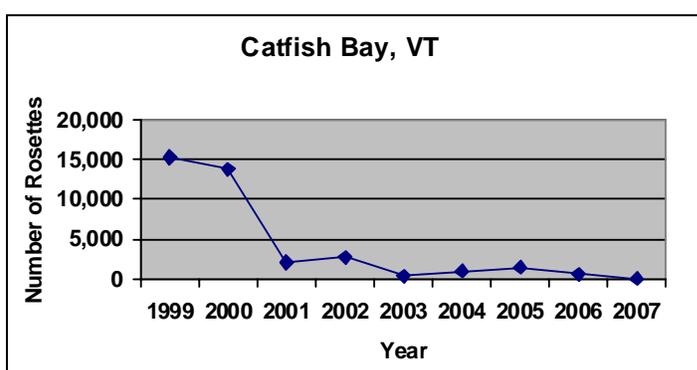
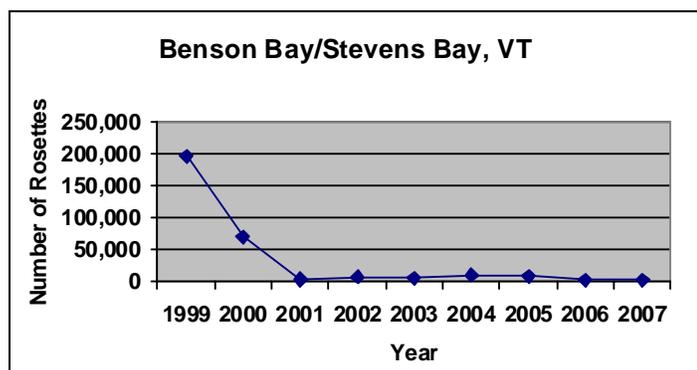
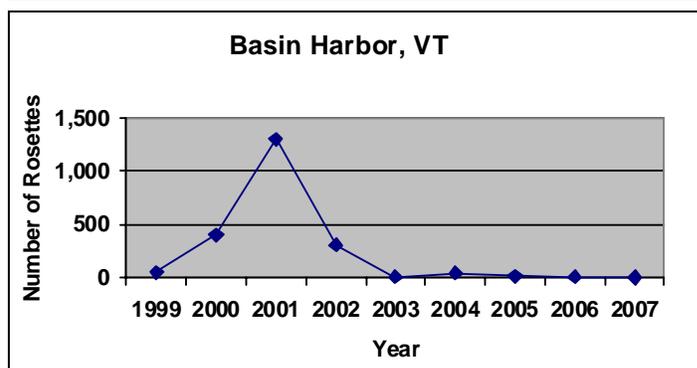
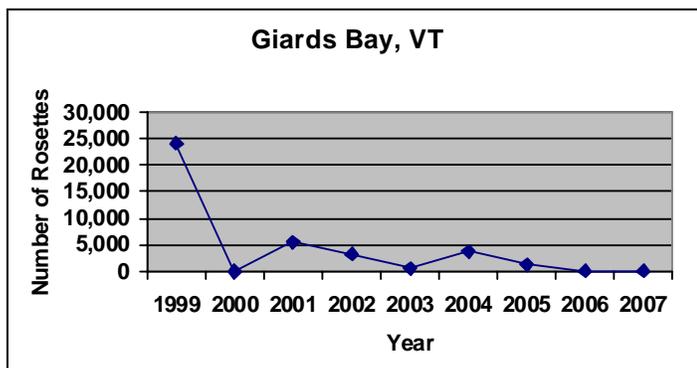
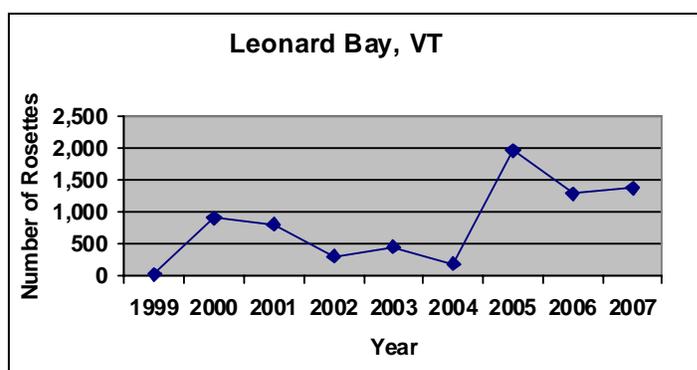
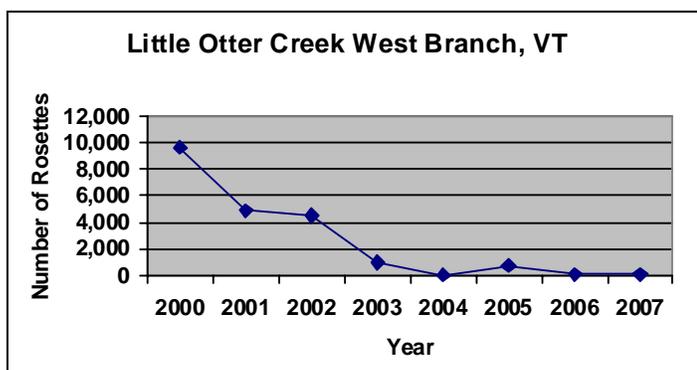
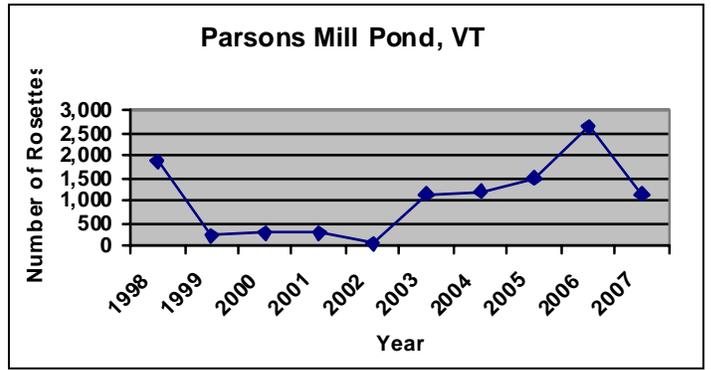
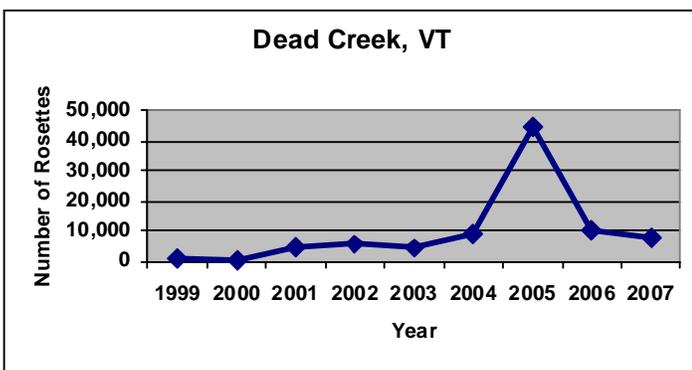
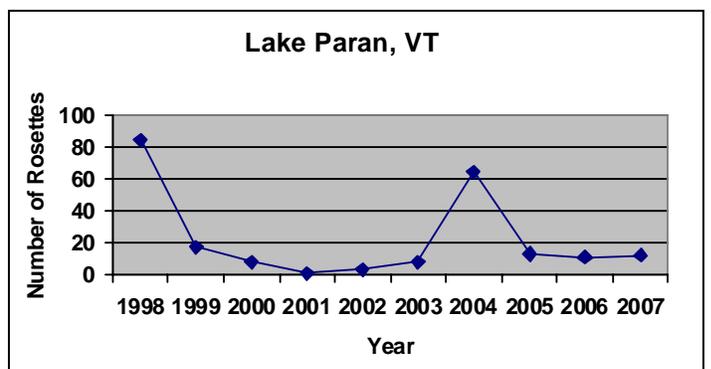
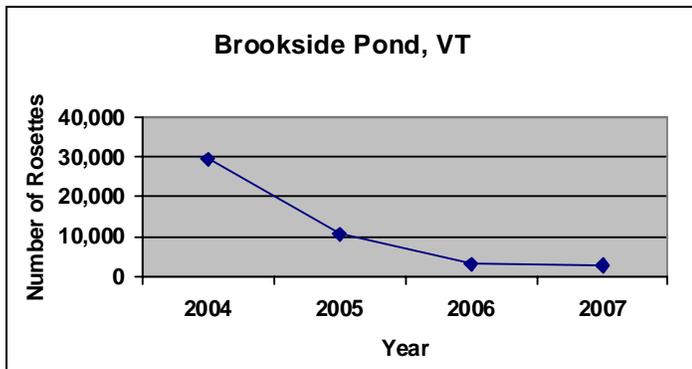
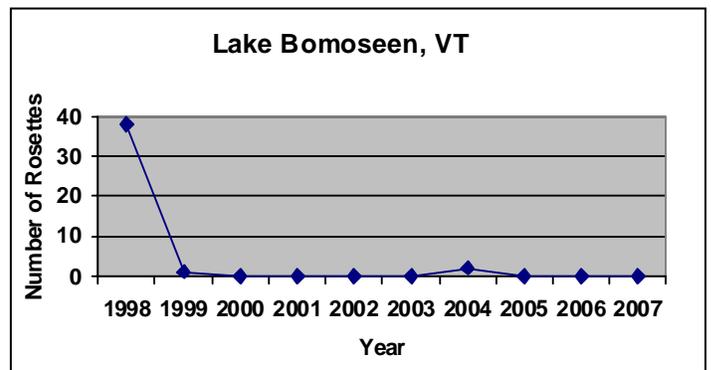
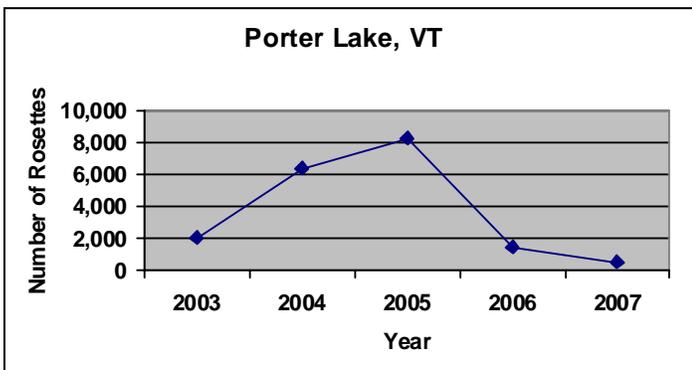
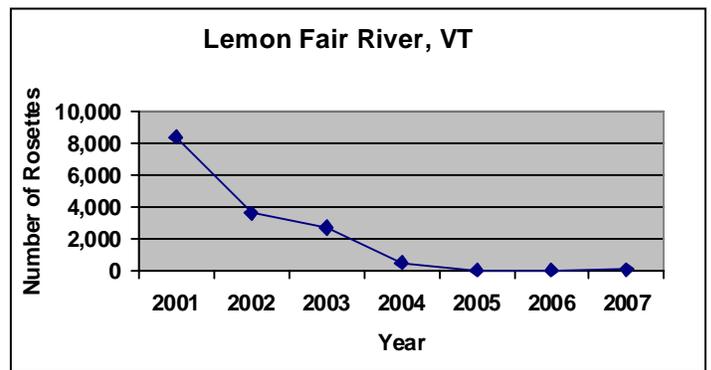
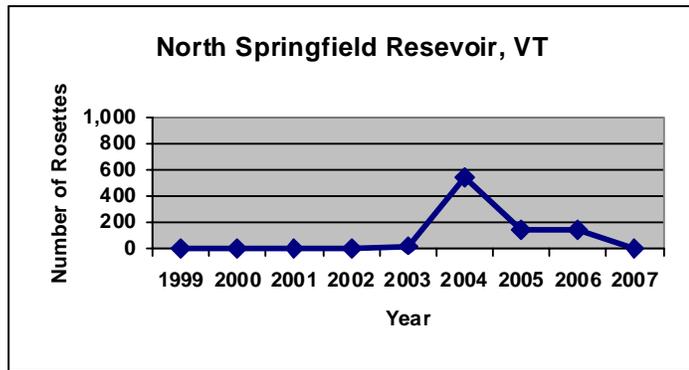


Figure 2-4. Water chestnut rosettes removed by handpulling over time at eight other waterbody sites in Vermont.



Education and Outreach Efforts

- Aquatic invasive species warning signs, with information about water chestnut and Vermont Transport Laws, were checked and repaired throughout the state at Vermont Department of Fish and Wildlife public accesses. Sixteen new signs were posted and 8 vandalized signs were repaired or replaced in the Lake Champlain Basin. Aquatic invasive species brochure boxes were installed at 23 accesses and 10 small water chestnut signs were also posted at accesses where infestations were known.
- VTDEC staff gave several presentations about water chestnut issues around the state.
- AIS Stickers were distributed in 2007. The sticker was developed to raise awareness of aquatic invasive species issues in Vermont, as well as to support the VTDEC Grant-in-Aid Program. The Grant-in-Aid Program provides funds to municipalities managing aquatic nuisance species, including water chestnut.

The estimated total weight of water chestnut removed from Lake Champlain and associated tributaries utilizing both management methods in 2007 was 816 tons wet weight. The estimated total weight of water chestnut removed from all other waterbody sites in Vermont was 12 tons wet weight. A breakdown of management techniques for all water chestnut sites in 2007 is provided in Appendix 1 and 2. The distribution of water chestnut in Lake Champlain is provided in Appendix 3. Some of the other waterbodies with water chestnut are also in Appendix 3.

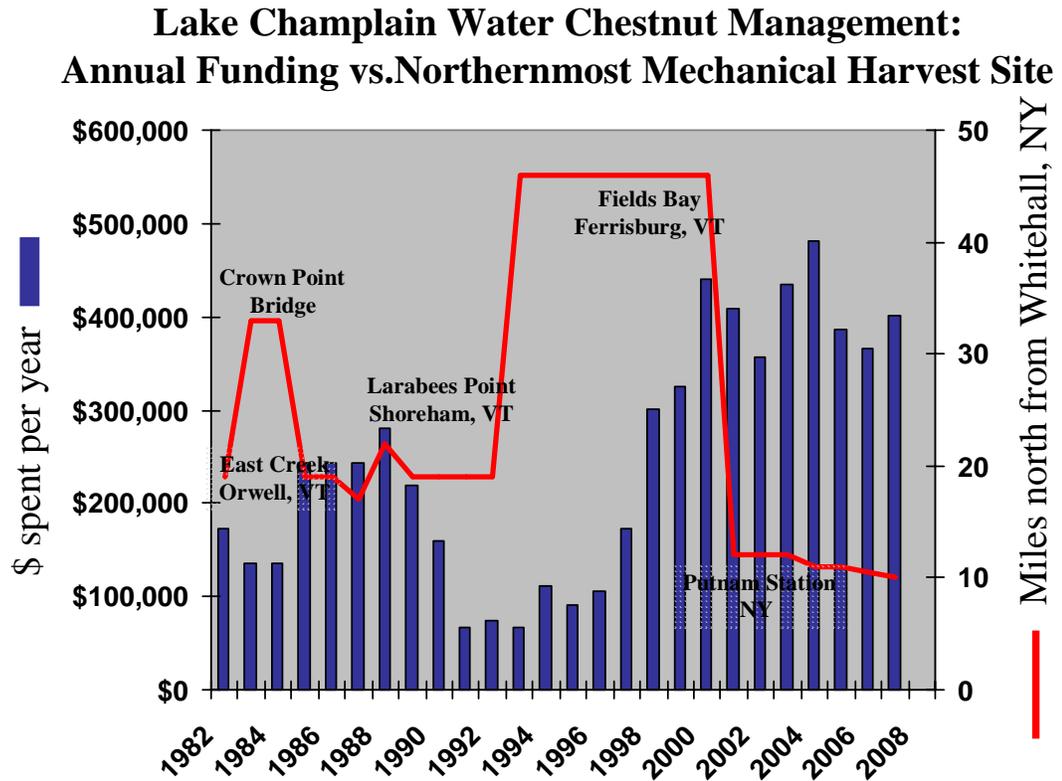
2007 program successes included: mechanical harvesting efforts advanced four miles south of Benson Landing for the first time in 27 years; 99% of the water chestnut plants collected thru the mechanical harvesting process were composted, up from only 19% in 2004; and rapid response actions occurred at all three newly confirmed infestation sites, including one site in Lake Champlain.

Conclusions

In 2007, continued declines of water chestnut densities at sites where management efforts have been consistent over at least the last five years were again observed. Successful ongoing long-term management of water chestnut is imperative due to the presence of viable water chestnut seeds in the sediment, the difficulty of finding all plants at each site, and the possibility of reintroduction. Figure 2-5 illustrates the importance of consistent management of water chestnut in Lake Champlain for successful control.

As the water chestnut population is pushed further south in Lake Champlain, suitable access for off-loading must be obtained to ensure program efficiency and the best use of already limited management funds. Unfortunately, all other known access sites along this stretch of the lake are primitive or un-navigable by the large harvesting equipment. In 2008, the possibility of access agreements with private landowners will be explored with the goal of securing a new off-load site for 2008 management efforts.

Figure 2-5. Annual water chestnut funding vs. northernmost mechanical harvest site in Lake Champlain, 1982-2007.



Part 2: TNC Water Chestnut Management

OBJECTIVES

The Nature Conservancy's mission is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. Towards this end, one of the goals of the Southern Lake Champlain Valley Program is to protect important natural communities from being degraded by non-native invasive species. Accordingly, TNC's motivation for organizing and conducting water chestnut control efforts is to abate the threats that water chestnut poses to our conservation targets in this landscape. The Conservancy has identified eight conservation targets in the Southern Lake Champlain Valley. Two targets: 1) wetland, floodplain, and riparian natural communities; and 2) the southern end of Lake Champlain, are adversely affected by water chestnut.

Water chestnut invades wetlands such as wild rice marshes, deep broadleaf marshes and deep bulrush marshes. It shades out submerged native vegetation such as wild celery (*Vallesneria americana*), waterweed (*Elodea canadensis*), pondweeds (*Potamogeton sp.*) common bladderwort (*Utricularia vulgaris*), water buttercup (*Ranunculus sp.*) and coontail (*Ceratophyllum demersum*). It also crowds out floating leaved plants such as lilies (*Nuphar*, *Nymphoides*, and *Nymphae sp.*), watershield (*Brasenia schreberi*), water smartweed (*Polygonum amphibium*), and burreed (*Sparganium spp.*). Floating mats of water chestnuts provide inferior habitat for sensitive fish species. Also, the rapid decay of plant matter can reduce dissolved oxygen in the water resulting in fish kills. In addition, water chestnut can affect hydrology because the dense biomass slows currents, and sedimentation is increased because the water chestnut masses trap silt and plant fiber. Finally, fibrous slow decaying native plants are replaced by the soft quick decaying material of the non-native water chestnut, and it is of limited food value to wildlife.

MANAGEMENT SUMMARY AND CHANGES TO PROGRAM IN 2007

In 2007, 39 workdays were completed including volunteer water chestnut workdays and 7 workdays without volunteers between June 20 and September 4, resulting in the harvesting of 9,771 pounds of water chestnut. Handpulling and scouting activities were conducted at 23 sites, and volunteers donated a total of 1,380 hours of labor to water chestnut management (Table 3-1). As in previous years, the focus was on sites considered ecologically significant: East Creek, Poultney River wetlands, and South Bay's southern end. In addition, inland sites were treated: Parson's Mill Pond, and Pelky's Swamp. No new sites were added in 2007; however, due to a surplus of volunteer handpulling capacity, two additional lesser-priority sites were worked. One of these was Cook Island, which is adjacent to the Champlain Barge Canal in Whitehall, New York. Left over rosettes (or regrowth) in portions of South Bay that remained after mechanical harvesters had removed thick mats of water chestnut were removed. Results from these areas are described in "South Bay harvester sites".

Table 3-1. Volunteer Hours and Water Chestnut Harvest Summary Data by Year

Year	Days	Volunteers	Hours	Sites	Pounds	Rosettes
1998	34	155	1,088	11	17,730	X
1999	33	282	1,554	11	154,620	X
2000	46	315	1,861.5	15	109,170	X
2001	45	259	1,463.5	20	87,435	X
2002	34	148	724.5	17	14,219	X
2003	34	238	941	17	30,225	X
2004	42	222	1,143	21	17,651	X
2005	45	292	1,225.5	29	16,412	187,568
2006	49	232	1,384	22	12,864	60,244
2007	49	307	1,380	23	9,771	47,956
Total			12,756		470,118	295,768

As in past years, workdays were scheduled in a manner that would minimize the probability of inadvertently dispersing zebra mussels to un-infested waters. All locations that are known to be infested with zebra mussels were handpulled first and zebra mussel free waters were surveyed last. Canoes were washed and sun-dried after each workday regardless of the schedule.

VOLUNTEERS

Volunteer involvement continued to be the mainstay of the program. Recruiting efforts continued in 2007 via newspaper, calendar announcements, bulk mailing to previous volunteers, flyer postings, and handouts. This year, 238 volunteers contributed 1,380 hours, more than was contributed in 2006 (Table 3-2). Compared to 2005, 2007 group hours exceeded work contributed by individuals, accounting for 78% of the volunteer hours. However, more individuals (54) volunteered in 2007 than in 2006.

Thirteen groups returned to pull water chestnut: Sangamon Camp, Camp Betsey Cox from Pittsford, VT, Camp E-Wen-Akee of Benson, VT, North Country Camps of Keesville, NY, Castleton VT 4-H Club, Green Mountain Peace Corps, Vermont Achievement Center of Rutland Vermont, Adirondack Wilderness Challenge (a youth correctional camp in Schyler Falls, NY), Fair Haven VT Grade School, the Zen Affiliate of Vermont, Castleton State College RA Orientation, an Americorps NCCC work crew, and the Vermont Youth Conservation Corps. Groups participating for the first time in 2007 included a Middlebury Freshman orientation group and a Castleton Community Adventures youth group. In addition to volunteer groups, the Lake Champlain Basin Program used one of our volunteer workdays as a staff outing, and interns from the New York City High School of Environmental Studies also contributed to water chestnut management efforts. In addition to the volunteer hours, TNC staff provided 580 hours of field labor.

METHODS

To manage water chestnut, crews searched for and handpulled water chestnut rosettes in targeted wetland sites throughout the growing season (June – August) via visual searches from canoes. Water chestnut is distinctive in appearance, and easily recognizable by supervised volunteers. The work objective for each site was to search for and handpull all existing water chestnut rosettes. At each site, harvested water chestnut plants were placed in Gardeners Supply bags and weighed with a spring scale.

Since water chestnut harvests were recorded as numbers of full bags in the initial years of this program (1998-2000), in order to compare harvest data between years, the harvest weight recorded during this period is estimated by multiplying the bags times by the approximate weight of a full bag (90 lbs).

Table 3-2. Volunteer Statistics from Water Chestnut Handpulling, 1998-2007

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Totals	Total number of volunteers	155	282	315	259	148	238	222	292	232	238
	<i>Total Volunteer hours</i>	1,088	1,554	1,862	1,464	725	870	1,143.5	1,225.5	1,334	1380
Group volunteers	Number of volunteers from groups	91	185	225	176	106	144	162	242	194	184
	<i>Hours from group</i>	529	772	974	766	341	380.5	663	1012.4	990	1083
Individual Volunteers	Number of Individuals	64	97	90	83	42	84	60	54	40	54
	<i>Hours from individuals</i>	559	782	888	698	384	490	480.5	210.19	344	297
	Number of returning volunteers	9	15	31	43	18	14	36	24	15	17
	Number of new volunteers	55	82	59	40	24	70	24	18	25	37

The number of rosettes harvested with the following methods were also estimated: a subset of harvested rosettes were counted and weighed, and total rosette harvest was estimated by extrapolating the rosette/lb ratio to the entire harvest weight. On a few days, staff estimated the number of rosettes from the total weight of all water chestnuts harvested by measuring the diameter of 15 – 25 rosettes per site, and using a mean diameter vs. rosettes/lb regression developed in 2006 ($\ln(\text{rosettes per lb}) = 3.9803603 - 0.939841 \ln(\text{mean diameter}; R^2=0.74)$). Both methods were used on three dates to compare methods. Rosette data used in this report was derived from the former method.

In order improve the ability to describe existing conditions and trends in water chestnut infestation, sites will continue to be characterized according to their infestation intensity.

Classification categories will be defined in terms of lbs of harvested water chestnut/acre, and will be done according to the following scheme:

Table 3-3. Water Chestnut Infestation Intensity Classification

Infestation Intensity	Lbs/Acre
Negligible	< 5
Low	5 – 150
Moderate	150 – 600
High	600 – 4,000
Mats	> 4,000

The upper limits of this classification were defined by looking at lbs/acre estimates from 2005 handpull harvests in the water chestnut mats in the Drowned Lands, which were 150,000 lbs/acre.

RESULTS AND DISCUSSION

Water chestnut harvest continues to exhibit an overall pattern of decline or stabilization at all sites that were visited in 2007. Overall, 19 sites are isolated enough from the influx of water chestnut propagules from other areas to be considered responsive to management efforts. Of these sites, 9 exhibited increases in harvest weights and 10 exhibited decreases compared to 2006 (Table 5). However, most of the differences between 2006 and 2007 were due to typical year-to-year harvest fluctuations. Major shifts in infestation intensity were not observed.

Overall, of all isolated sites not subject to influx of water chestnut seeds from other areas, six sites out of nine with low levels of infestation ($5 < x < 150$ lbs/acre) exhibited decreases of $>25\%$ pounds per acre compared to 2006. One site exhibited an increase of $>25\%$, and three sites increased $<25\%$.

The most noteworthy site-specific results in 2007 were at Whitney Creek, which yielded a substantially lower weight of water chestnut (93%) this season compared to 2006. Harvesting has been ongoing at Whitney Creek for eight years, and until 2006, it had been a remarkably productive water chestnut site. Also notable were results from Nichol’s Wetland, where harvests spiked in 2005 and 2006 without any apparent explanation. The 2007 harvest in Nichol’s Wetland returned to very low levels more comparable to harvests from 2001-2004. All management data for 2007 is included in Appendix 3-1 and 3-2 at the end of Part II, Maps of all the sites are included in Appendix 3-3. A summary of results from individual sites treated in 2007 follows:

Billing’s Marsh, West Haven, VT

After last year’s remarkable spike in water chestnut abundance in 2006 (Table 3-4), harvest weights at this site in 2007 (157 lbs) returned to levels more comparable with 2001-2005. One workday was held at this site in 2007. An effort was made to visit this site earlier in the season in 2007 in order to avoid the release of nuts that detach from mature plants while being handpulled during late-season workdays. Detached nuts from a late-season workday in 2005 may have contributed to the 2006 harvest spike. Infestation intensity at this site was low.

Brookside Pond, Orwell, VT

Two workdays were spent at this site in 2007, and 693 lbs of water chestnut (Table 3-4) were harvested. This is more than was collected in 2006 (412 lbs). This site was first treated by VTDEC contractor crews in 2004, and is a difficult site in which to work. Low water conditions that typify infested habitats in this impoundment make water chestnut plants virtually inaccessible by boat. Also, early season pulls (when water conditions are usually higher) are not effective here as the nuts from the plants are unable to be pulled out of the mucky substrate, resulting in second growth. This site is generally not workable with volunteers, due to the difficult conditions. Infestation intensity at this site was low.

Buoy 33 Wetlands, Dresden, NY

Water-chestnut in the wetlands just north of the South Bay railroad bridge on the NY side of Lake Champlain was pulled again in 2007. Overall, 527 lbs of water chestnut were pulled from this site in one workday (Table 3-4). This site featured a moderate infestation intensity in 2006, which decreased to low in 2007.

Coggman Pond, West Haven, VT

One workday was spent at this site in 2007, and a total of 39 lbs were harvested. This was somewhat higher than what was pulled in the previous two years, but still substantially lower than the 87 pounds pulled in 2004 and the 211 pounds that were collected in 2003. As in past years, water chestnut was concentrated near the access and at the tips of the pond's fingers. Overall infestation intensity was negligible.

East Creek, Orwell, VT

Seven workdays were spent at East Creek in 2007, which is two less than 2006, but more in line with pulling effort spent at this site in 2004 and 2005. As in past seasons, more water chestnut was found in reaches closest to Lake Champlain. The Conservancy has pulled water chestnut from East Creek since 1996 and there was a steady decline in the water chestnut population until 2002, after which harvests have varied annually (Table 3-5). In 2007, harvests decreased to 341 lbs from the spike observed in 2006 (2,315 lbs). This is the lowest harvest ever recorded in East Creek since records were first kept in 1998 (Figure 3-1). Accordingly, infestation intensity decreased at this site, from low in 2006 to negligible in 2007.

Finch Marsh, Whitehall, NY

This site yielded somewhat more water chestnut in 2007 (187lbs) compared to 2006 (124lbs). Water chestnut distribution was similar to past years – most was found near the beaver dam and by the Poultney River. Overall infestation intensity increased to just over the threshold between negligible and low between 2006 and 2007 (Table 3-5).

Finch Marsh Outlet, Whitehall, NY

Similar to 2006, no plants were found in the Poultney River at the outlet from Finch Marsh in 2007. In 2005, 16 pounds of water chestnut were found at this site. In 2004, after many years of absence, a large mat of water chestnut re-appeared at this site, from which 500 lbs were pulled.

Table 3-4. Pounds of Water Chestnut Harvested by Year per Site, 1998-2007

Site Name	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Billings Marsh	1170	1440	247.5	135	48	53	50	132	975	157
Brookside Pond	X	X	X	X	X	X	VTDEC	957	412	693
Buoy 33 wetlands	X	X	X	X	X	X	X	X	2006	527
Coggman Pond	VTDEC	450	135	VTDEC	320	211	87	18	26	39
Cook Island West	X	X	X	X	X	X	173	X	X	1839
East Creek	10170	2250	2250	652.5	2865	1034	996 ²	1281	2315	341
Finch Marsh	990	X	787.5	270	116	55	413	178	124	187
Finch Marsh Outlet	X	X	X	X	X	X	490	15	0	0
Hubbarton Ponds	X	X	X	X	X	X	X	0	X	X
Inman Pond	X	x	X	x	x	X	X	0	X	X
La Chute River Marshes	X	X	X	X	X	VTDEC	VTDEC	VTDEC	418	334
Nichols Wetland	X	X	X	22.5	46	75	31	203	280	18
Old Marsh Pond	0	X	X	X	0	X	X	0	X	X
Parson Mill Pond	292.5	67.5	90	135	18.5	635	365	400	697	181
Pelkey Swamp	24 plants	20 plants	2 plants	25 plants	0	0	2 plants	0	1 plant	15
Reed Marsh	1800	270	112.5	22.5	75	147	183	264	94	287
Rogers Marsh	2160	810	22.5	20 plants	3 plants	0	3 plants	6 plants	2 plants	26 plants
Root Pond	X	X	X	X	X	X	10 plants	X	10 plants	6 plants
S. Lake Champlain ³	720	X	X	X	540	259	1241	270	981	1042
Saslow Marsh	X	X	X	X	X	X	70	48	76	94
Schoolhouse Marsh	180	X	135	X	117	128	57	43	20	4
Schoolhouse Marsh North	X	X	X	X	X	587	83	51	43	70
South Bay	X	X	3240	8415 ⁴	363	492	173	30	43	91
South Bay/Timber Marsh	X	X	X		X	X	X	644	826	153
South Bay/Harvester sites										3120
South Fork	202.5	180	45	90	50	421	87	263	324	134
The Drowned Lands	X	X	X	X	6660	25479	13006	10359	X	X
Whitney Creek	VTDEC	2520	9405	4275	9270 ⁵	886	9282 ⁵	1333 ⁵	6998 ⁵	440

¹ 1998 – 2001 pounds are estimates made from number of bags filled: 1 full bag = 90lbs of water chestnut.

² Additional harvest conducted by VTDEC at the mouth of the creek.

³ From mouth of Poultney River to Buoy 33.

⁴ Includes Timber Marsh area of South Bay

⁵ Combined harvest from VTDEC and TNC

VTDEC – site treated by the Vermont Department of Environmental Conservation

X – Site not visited

La Chute River Marshes, Ticonderoga, NY

2007 was the second year that TNC volunteer workdays were held at this site, which had been pulled in years prior to 2006 by VTDEC contractor handpulling crews. Four workdays were needed to cover this site in 2007, and 334 lbs were harvested, which is less than in 2006 (418 lbs, Table 3-4). Overall, infestation intensity at this site was negligible. Because of the extensive area of emergent wetlands and open water at this site, it is difficult to search with volunteers.

Nichols Wetland, West Haven, VT

After two years of astonishingly high harvests, 2007 harvest weights declined to 18lbs, after spiking upward in 2006 and 2005 (280 lbs and 203lbs, respectively; Table 3-4). 2007 harvests were more in line with 2004, which produced only 31 pounds. Accordingly, infestation intensity decreased from low to negligible between 2006 and 2007.

Parson's Mill Pond, Benson, VT

Parson's Mill Pond was visited twice in 2007. Harvesting efforts yielded 181 lbs of chestnut from this site, substantially less than what was pulled in 2006 (697 lbs; Figure 3-1), and is the lowest harvest at this site since 2003. The effectiveness of searches at this site is easily compromised by an abundance of smartweed, which often obscures water chestnut from searchers. Infestation intensity continues to be low at this site (17.2 lbs/acre, Table 3-5).

Pelkey Swamp, Benson, VT

In 2007, 15 lbs were found at this site. This is by far the largest harvest ever recorded here. Harvests from previous years were typically <20 rosettes, while in 2007, 143 rosettes were pulled. This site is difficult to search due to shallow water and abundant emergent vegetation, and is most effectively searched during high water conditions early in the season. Water chestnut has never been abundant at this site since we commenced control efforts in 1998. Despite the increase in harvest, infestation intensity remains negligible.

Reed Marsh, West Haven, VT

In 2007, 287 lbs of water chestnut was harvested at this site (Table 3-4), which is three times greater than the 2006 harvest (94 lbs of water chestnut (Figure 3-1)), but is similar to the 2005 harvest (264lbs). Most of the water chestnut was found near shore in the southern most portion of the marsh and near a beaver dam. Other than this year's increased harvest, water chestnut pulled at this site has remained consistently low since the initial harvest of approximately 1800 lbs in 1998 (Table 4). Infestation intensity at this site remains low.

Roger's Marsh, West Haven, VT

Only 26 rosettes were found at this site in 2007, compared to two found in 2006. The reduction in water chestnut since 1998 at Roger's Marsh is more pronounced than any of our other sites (Figure 3-1). Approximately 2,160 lbs of water chestnut were pulled from this site in 1998 (Table 4). Infestation intensity at this site remains negligible.

Saslow Marsh, Whitehall, NY

Water chestnut harvests have been fairly consistent at this site since harvesting efforts began in 2004. In 2007, 94 lbs were collected, which is somewhat more than 2005 (46 lbs.) and 2006 (76 lbs). Infestation intensity at this site is low.

Table 3-5. Numbers of Rosettes and Area-based Harvest Statistics, 2005-2007

Site	2005		2006		2007	
	Rosettes /acre	Lbs/acre	Rosettes /acre	Lbs/acre	Rosettes/ acre	Lbs/acre
Billings Marsh	26	8.1	297	59.8	66.4	9.6
Brookside Pond	801	76	245	32.7	193.9	55
Buoy 33 wetlands	X	X	2033	371.5	449.1	100.6
Coggman Pond	3	0.7	6	1	1.5	1.6
East Creek	74	8.2	87	14.9	11.3	2.2
Finch Marsh	76	6.1	25	4.1	1.9	6.2
La Chute River Marshes	X	X	31	3.4	12.7	2.1
Nichols Wetland	530	88.3	608	121.7	27.8	7.8
Parson's Mill Pond	38	10.2	67	17.7	29.2	4.6
Pelkey Swamp	0	0	0	0	3.1	0.3
Reed Marsh	51	16.1	20	5.7	63	17.5
Rogers Marsh	2	0.3	1	<1	7	1.4
Root Pond	X	X	1	0	0.3	<1
S. Lake Champlain	104	7.8	151	25.3	199.1	30.8
Saslow Marsh	28	9.4	57	14.9	73.7	18.4
Schoolhouse Marsh	38	3.6	2	0.4	0.4	0.1
Schoolhouse Marsh North	5	1.1	13	3.6	22.7	5.8
South Bay	8	0.3	4	0.4	53.4	0.8
South Bay/Timber Marsh	233	11.5	82	14.7	17.2	2.7
South Fork (E. Creek)	31	5.9	31	7.2	10.6	3
Whitney Creek	75	18.2	166	43.8	33.8	6

Schoolhouse Marsh, West Haven, VT

One workday was held at this site in 2007, and only 4 lbs of water chestnut were harvested, which is the lowest harvest ever recorded for this site since harvesting began in 1998. Infestation intensity at this site is negligible.

Schoolhouse Marsh North, West Haven, VT

2007 was the fifth year this site was harvested, and this year's water chestnut harvest of 70 lbs was greater than 2006. Despite this increase, the decreasing trend from the 2003 high of 581 lbs remains in place. The infestation intensity at this site is negligible.

Shaw Mountain Wetlands and Root Pond, Benson, VT

Six rosettes were found in Root Pond in 2007, which is similar to 2006 (10 rosettes). This site was not searched in 2005, and 10 rosettes were also found at this site in 2004. No water chestnut was found in adjacent wetlands near Shaw Mountain.

South Bay, Whitehall and Dresden, NY

Three workdays were held at this site, and resulted in a harvest of 91 lbs. This is greater than previous years. In 2006, 43 pounds were harvested and 30 pounds were collected in 2005. A few pockets of dense water chestnut were found deep within the extensive areas of emergent vegetation featured here. This illustrates how local hotspots might remain undetected for a year or two at such a site. Infestation intensity at this site remains negligible.

South Bay – Timber Marsh, Whitehall and Dresden, NY

In 2007, 153 pounds were harvested in the Timber Bay area during two workdays, which is less than in 2006 (826 lbs; Table 3-4). Water chestnut mats remain extensive in more northern parts of South Bay. Infestation intensity decreased from low to negligible from 2006 to 2007.

South Fork of East Creek, Orwell, VT

Three workdays resulted in the harvest of 134 pounds of water chestnut in 2006. This is a decrease in harvest compared to 2006 (324 lbs). Harvests at this site have exhibited substantial year-to-year variation, from 421 lbs (2003) to 45 lbs (2000). Despite the variable harvest trends, overall infestation intensity dropped from low to negligible between 2006 and 2007.

Southern Lake Champlain, West Haven, VT and Whitehall, NY

Three workdays were held at this site in 2007, and 1042 pounds of water chestnut were pulled. This is similar to the amount pulled in 2006 (981 lbs; Table 3-4). This site is subject to the deposit of seeds from plants dislodged from other areas of the lake, so varying harvest trends are not surprising, and infestation intensity is low.

Whitney Creek, Addison, VT

Two workdays were held at this site in 2007 by TNC. Only 440 lbs of water chestnut were collected, which is substantially less than previous years (6,998 lbs, in 2006 and 1,333 lbs in 2005), and is the lowest harvest weight on record for this site. Pulling conditions were remarkably different on this site than in previous years. The mats of floating algae that made canoeing through this wetland exceptionally difficult in years past, were absent in 2007. Consequently, there was an increase in the ease of water chestnut searches. Infestation intensity was low within the entire site, and as in past years, the majority of plants were concentrated near the outlet to Lake Champlain.

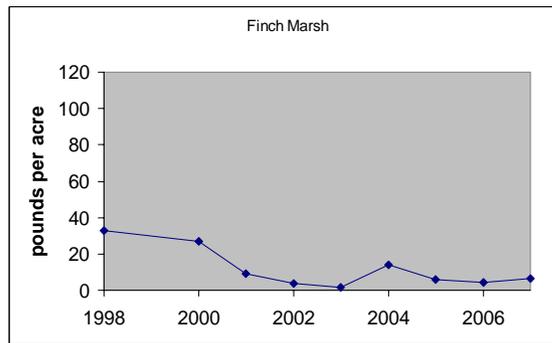
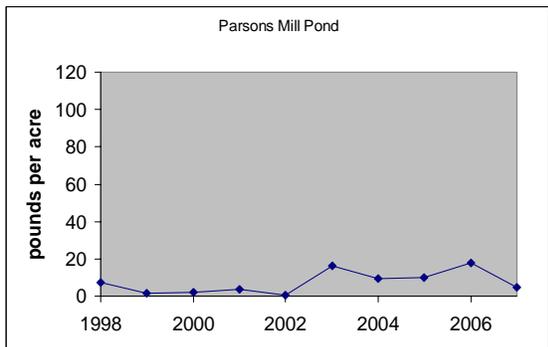
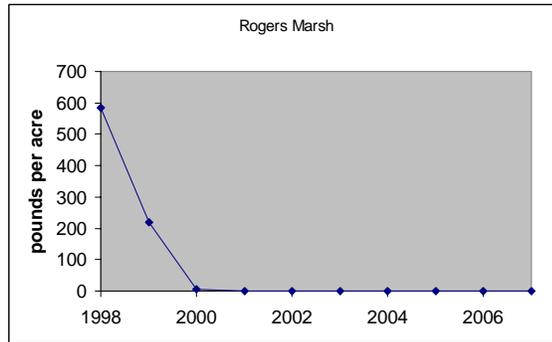
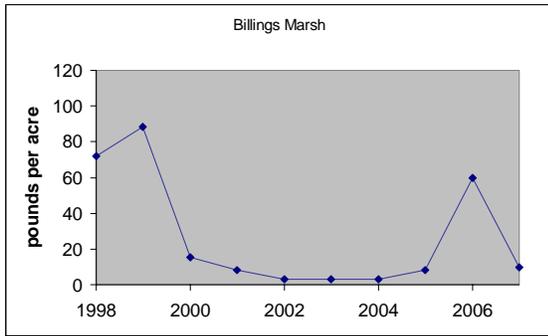
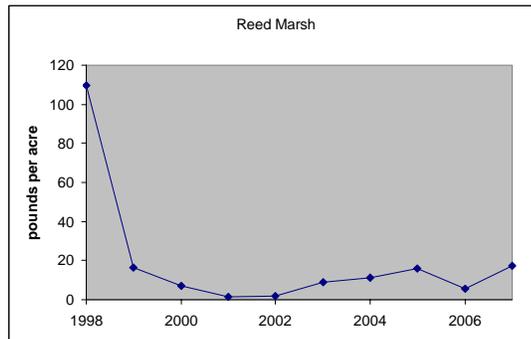
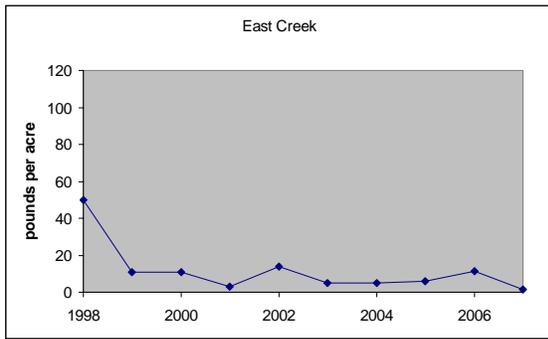
Cook Island, Whitehall, NY

Water chestnut was handpulled at this site towards the end of the season, in order to utilize available volunteer groups, after work at all other TNC sites had been completed. Working at this site, which is adjacent to the Champlain Barge Canal, is a low priority, and is only undertaken after our priority sites have been completed. Overall, 1839 lbs of water chestnut were pulled from this site.

South Bay/ Harvester sites

Extra volunteer capacity was utilized to handpull water chestnut in sites that had been treated with mechanical harvesters in South Bay. We will consider these sites a secondary priority in future years, and treat them according to the volunteer capacity that exists on any given year. Overall, 3120 lbs of water chestnut were pulled from these sites this year.

Figure 3-1. Water Chestnut Harvest Trends at Six Sites in the Southern Lake Champlain Valley, 1998-2007



CONCLUSIONS

After ten years of water chestnut control efforts, TNC's Water Chestnut Management Program continues to be successful at maintaining the diminished levels of water chestnut infestation that were achieved after the initial years of the program. Although some sites have exhibited puzzling variations in water chestnut harvests, in 2007, harvests at all of these sites have returned to the low levels that might be expected after multiple successive years of treatment.

Despite the observed decreases in harvests in 2007, it remains obvious that the prospect of complete eradication at any given site seems unlikely. Nevertheless, the overall effectiveness of handpulling of water chestnuts is remarkable – the data clearly indicate that handpulling efforts by volunteers have either reduced infestations or kept low-level infestation from becoming more severe at all treated sites. Moreover, TNC efforts cover a substantial proportion of the total area of infested habitat in Lake Champlain: volunteers' handpulled water chestnut in nearly 900 acres of infested habitat, which is approximately 35% of the entire infested habitat that exists in the basin.

This program's reliance on the effort of volunteers continues to be a successful formula for the control of water chestnut at a large set of ecologically significant sites in the Southern Lake Champlain Valley region. Since 1998, the recruitment and management of volunteers for TNC's Water Chestnut Management Program has proven to be both effective and cost-efficient. In 2007, 238 volunteers contributed 1380 hours volunteer time and removed almost 5 tons of water chestnuts. This is the equivalent of \$13,800 of donated labor, calculated at the going rate of compensation for contractor handpulling crews. Overall, since the establishment of this program, volunteers have donated 112,756 hours to handpull 223 tons of water chestnuts. The program also continues to be a valuable source of education/information on the water chestnut issue for volunteers and local residents.

ACKNOWLEDGEMENTS

Funds for this program were provided by the Lake Champlain Basin Program, the Waterwheel Foundation of VT, and the Wildlife Habitat Improvement Program (USDA, NRCS).

Part 3: Other Basin Water Chestnut Management Efforts

New York

In 2007, NYSDEC funds were available to operate New York State Canal Corps mechanical harvesting equipment for water chestnut removal in southern Lake Champlain. The Town of Dresden, New York oversaw the harvesting program with financial support (\$56,004) and help from NYSDEC staff. Four sites were harvested in the Dresden, New York and West Haven, Vermont region. A total of 805 loads of water chestnut spoils were removed from the sites or an estimated 6,600 cubic yards. Harvested material was disposed of in a gravel pit in Dresden.

Québec

In 2007, \$104,400 (Canadian dollars) was spent managing water chestnut in Québec. The Richelieu River, Pike River, South River, John Pond in Venise-en-Québec, and the Chateauguay River and vicinity were surveyed and targeted for control. Handpulling and the rake equipped boat (the Biocaptor) were heavily used during the season. Surprisingly, compared to 2006, water chestnut was much more abundant in the South River in 2007. Five colonies were controlled on the Richelieu River; however new sites were also identified, principally due to specimens drifting from South River. The populations of water chestnut in the Pike River dropped to one half. Only one rosette was found in the Chateauguay River.

Control efforts will continue in 2008, with the expectation of a sharper decline in water chestnut populations. A new infestation was detected in Ontario on the Ottawa River, just upstream of the Québec border. The Ontario Ministry of Natural Resources, in association with its Québec counterpart, is planning to instigate an eradication program there in 2008.

U.S. Fish & Wildlife Service

Missisquoi National Wildlife Refuge staff utilized crews from the Vermont Youth Conservation Corps (VYCC) for most of the Refuge water chestnut management in 2007. VYCC crews spent three weeks between July and August searching for and removing water chestnut. Approximately half as many rosettes were pulled in 2007 as had been found and handpulled in 2006. Although many areas of the refuge were searched in 2007, water chestnut plants were only found in sites previously identified, Cranberry Pool and in Big Marsh Slough. However, water levels were low in 2007 making searching difficult in some shallower areas of these marshes.



Figure 4-1. U.S. Fish & Wildlife Service staff and volunteers in Cranberry Pool (VT DEC)

LCBP Water Chestnut Workgroup

The LCBP Water Chestnut Workgroup formed in 2004 continued to bring strong guidance to water chestnut management in the Basin. Comprised of representatives from LCBP, TNC, VTDEC, NYSDEC, New York Sea Grant, New York State Canal Corporation and Missisquoi National Wildlife Refuge, the Workgroup developed management strategies and some members presented a Workgroup-developed slide show at a number of public forums in the Basin.

Appendix 1. Water Chestnut Management Program Summary: 2007 Lake Champlain and associated tributary sites.

Site Number and Name	Town	Control Implemented	Date Targeted	Number of HP or MH Hours	Estimated # of pounds removed	Estimated # of Harvester Loads or # of Rosettes Pulled
Vermont Sites						
MISSISQUOI BAY						
1.	Missisquoi Bay 45°00'33 N / 73°07'54 W	Highgate Springs	HP-DEC	8/16	1	0
2.	Long Marsh Channel, (Missisquoi National Wildlife Refuge) 44°59'34.38"N 73°09'20.88"W	Highgate Springs	USF&W	7/24, 8/16	5	0
3.	Outside Entrance to Big Marsh Slough NEW 44°58'32 N / 73°08'03 W	Highgate Springs	HP-DEC	8/16	.5	3
MAIN LAKE						
	McNeil Cove 44°18'03N / 73°17'47W	Charlotte	HP-DEC	6/25	1	0
4.	Converse Bay F&W Access & Bay South 44°17'19N / 73°16'01W	Charlotte	HP-DEC	6/25	2	0
OTTER CREEK						
5.	Town Farm Bay/Kimball Brook 44°16'60N / 73°16'01W	Charlotte	HP-DEC	6/25	2	0
6.	Little Otter Creek (West Branch) 44°13'28N / 73°01'38W	Ferrisburg	HP	6/25 North	7.5	.5
				6/25 West	7.5	.5
7.	Porter Bay 44°13'37N / 73°18'58N	Ferrisburgh	HP	6/25	10	.3
8.	Mouth of Otter Creek to Fort Cassin Access 44°13'31N / 73°19'27W	Ferrisburgh	HP	6/25	5	0
9.	Fields Bay 44°13'15N / 73°19'09W	Ferrisburgh	HP	6/25, 8/18	24	29.5
			HP-DEC	6/25, 7/31	4	0

* Key: HP = handpulling
 MH = mechanical harvesting
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 AUD = Otter Creek Audubon
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 L= Lakeside

Site Number and Name		Town	Control Implemented	Date Targeted	Number of HP or MH Hours	Estimated # of pounds removed	Estimated # of Harvester Loads or # of Rosettes Pulled
10.	Otter Creek Fort Cassin Access South to Dead Creek 44°12'23N / 73°19'16W	Ferrisburgh	HP	6/25	5	0	0
PORT HENRY							
11.	Basin Harbor 44°11'46N / 73°21'52W	Panton	HP	6/26, 7/31	1.5	0	0
SOUTH LAKE							
12.	Hospital Creek a. 44°02'32N/73°25'06W (L)	Addison	HP	6/27 L	10.5	.5	7
	b. 44°02'20N/73°24'40W			6/27	3	1	78
13.	Whitney Creek a. 44°01'40N / 73°24'05W (L)	Addison	HP	6/28, 7/27 L	11	2	172
	b. 44°02'50N / 73°24'40W			7/27	30	325	1,378
				HP-TNC	7/14, 8/11	70	440
14.	McCuen Slang VT 44°01'28N / 73°23'67W	Addison	HP	6/28	15	1	117
15.	Bridport Town Beach 43°59'55N / 73°24'04W	Bridport	HP	8/04	1	0	0
16.	Giards Bay 43°58'44N / 73°24'01W	Bridport	HP	6/28	15	1.5	143
17.	North of W. Bridport 43°57'34N / 73°24'21W	Bridport	HP	6/29	3	0	0
18.	Leonard Bay 43°56'16N / 73°24'00W	Bridport	HP	6/29, 7/02, 8/04	10.5	102.4	1,377
19.	Lapham Bay 43°55'33N / 73°23'37W	Shoreham	HP	7/02	20	17.6	336
20.	South of Lapham Bay 43°54'52N / 73°23'40W	Shoreham	HP	7/05	20	.5	56

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Site Number and Name	Town	Control Implemented	Date Targeted	Number of HP or MH Hours	Estimated # of pounds removed	Estimated # of Harvester Loads or # of Rosettes Pulled
21. North of Fivemile Point 43°54'32N / 73°23'40W	Shoreham	HP	7/05	10	0	0
22. Bays on Lake Street South of Five-Mile Point 43°54'06N / 73°22'35W	Shoreham	HP	7/05	10	.2	9
Stony Cove 43°54'15N / 73°22'56W	Shoreham					
23. Access by C. Farr Ranch 43°53'54N/73°22'30W	Shoreham	HP	7/03, 7/05	35	23.4	464
Watch Point 43°53'7N / 73°22'31W	Shoreham					
24. N of Larrabees Point 43°51'56N / 73°22'11W	Shoreham	HP	7/05, 7/06 7/09	55.5	177.3	3,664
25. Beadles Cove and South 43°51'1N / 73°22'15W	Shoreham	HP	7/06	10	1.5	174
26. East Creek a.43°51'50N / 73°22'37W (mouth)	Orwell	HP	7/09	36	12.2	239
b.43°49'38N/73°21'59W		HP-TNC	6/20, 6/28, 7/7-7/31, 8/1, 8/30	329.75	475	2,222
27. Shoreline between East Creek & Catfish Bay 43°49'52N / 73°23'06W	Orwell	HP	7/10	5.5	0	0
28. Catfish Bay 43°49'40N / 73°23'09W	Orwell	HP	7/10	5.5	.5	50
29. Buoy 39 Marina 43°49'21N / 73°23'25W	Orwell	HP	7/12	5	0	0
30. Dock at Curly Audette Farm 43°48'38N / 73°22'41W	Orwell	HP	7/12	15	.5	38
31. North shore Chipmans Point 43°48'7N / 73°22'32W	Orwell	HP	7/11	5	1	87
32. Shoreline between Chipmans Point and Benson Bay 43°47'07N / 73°21'10W	Orwell, Benson	HP	7/13, 7/16	99	157.4	3,492

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Site Number and Name		Town	Control Implemented	Date Targeted	Number of HP or MH Hours	Estimated # of pounds removed	Estimated # of Harvester Loads or # of Rosettes Pulled
33.	Benson Bay 43°45'50N / 73°20'41W	Benson	HP	7/12, 7/16	31.5	100.8	1,648
34.	Shoreline between Benson Bay & Stony Point 43°45'24N / 73°21'16W	Benson	HP	7/16	33	62	968
35.	Stony Point 43°44'37N / 73°21'57W	Benson	HP	8/01	5	.2	11
36.	Shoreline between Stony Point & Benson Landing 43°44'16N / 73°22'05W	Benson	HP	8/01	10	.3	27
37.	Benson Landing 43°43'45N / 73°22'03W	Benson	HP	8/03	9.5	175	1,280
38.	Dutchers and South 43°43'01N / 73°22'33W	Benson	MH	7/10-7/20	12	7,600	2
			HP	7/19, 7/20 7/23, 7/24 7/30	242	2,575.4	33,067
39.	Peters Bay 43°38'12N / 73°25'37W	Benson/ West Haven	MH	7/18-8/8	417	839,800	221
40.	Red Rock Bay and North 43°40'57 N / 73°25'37 W	West Haven	MH	8/9-8/14	128.5	239,400	63
41.	Poultney River and associated sites	West Haven	HP-TNC	6/26, 8/21, 9/4	124.25	1,042	3,040
	a. Mouth of the Poultney and region 43°34'08N/ 73°24'06W						
	b. Rogers Marsh 43°34'06N/73°23'52W						
	c. Shaw Mtn Wetlands 43°41'02N/73°21'23W						
	d. Reed Marsh 43°36'52N/73°22'42W						
e. Schoolhouse Marsh 43°35'33N/73°23'12W							
					Included in Root Pond search		
				8/16	12	287	1,033
				7/23, 8/9	10.5	74	292

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Site Number and Name		Town	Control Implemented	Date Targeted	Number of HP or MH Hours	Estimated # of pounds removed	Estimated # of Harvester Loads or # of Rosettes Pulled
	f. Billings Marsh 43°36'17N/73°22'39W	West Haven	HP-TNC	7/21	42	157	1,083
	g. Galick Road Wetlands 43°34'36N/73°24'48W			Included in 39.b. data not able to be singled out			
	h. Finch Marsh 43°34'36N/73°22'49W			6/21, 6/27 7/2, 8/28	22.25	187	1,150
	i. Nichols Wetland 43°37'03N/73°22'30W			8/15	1	18	64
New York Sites							
	j. Saslow Marsh 43°36'50N/73°22'26W	#Whitehall	HP-TNC	8/25	6	94	376
SOUTH LAKE							
42.	New York Light 14 and south 43°40'45 N / 73°24'43W	Dresden	MH	8/16-8/21	82.5	228,000	60
43.	Pulpit Point 43°42'45N / 73°23'43W	Putnam	MH	7/16, 7/17	50	110,200	29
44.	Bed Back by Railroad NY 43°42'45N / 73°23'26W	Putnam	MH	7/9-7/13	126.5	178,600	47
			HP	7/23, 7/24 7/25, 7/26 7/30, 8/13 8/14, 8/15 8/16, 8/17 8/20	689.50	10,094	66,183
45.	NY Light 4 43°42'48N / 73°23'09W	Putnam	MH	Several harvesting passes made in July en route to other sites			

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Site Number and Name		Town	Control Implemented	Date Targeted	Number of HP or MH Hours	Estimated # of pounds removed	Estimated # of Harvester Loads or # of Rosettes Pulled
			HP	7/31, 8/01 8/02, 8/03 8/10, 8/13 8/16	479	9,959	61,690
46.	60 Acre Patch 43°43'21N / 73°22'26W	Putnam	HP	7/18	77	1,549	25,803
47.	Sixmile Point and South 43°45'26N / 73°22'00W	Putnam	HP	7/16, 7/17 7/18	115.5	390	8,970
48.	South of Gourlie Point 43°46'45N / 73°21'50W	Ticonderoga	HP	7/12	20	36	502
49.	Gourlie Point Bay 43°47'38N / 73°22'25W	Ticonderoga	HP	7/12	5	0	0
50.	North of Gourlie Point 43°47'47N / 73°22'42W	Ticonderoga	HP	7/11	5	0	0
51.	Charter Marsh 43°48'16N / 73°23'5W	Ticonderoga	HP	7/11, 7/12	35	68.6	908
52.	North of Charter Marsh 43°48'33N / 73°23'11W	Ticonderoga	HP	7/11	15	12	198
53.	Fort Ticonderoga Bay & South 43°50'17N / 73°23'52W	Ticonderoga	HP	7/10, 7/11	85.5	112.8	1,614
54.	LaChute River 43°50'42.18N/73°24'08.82W	Ticonderoga	HP-TNC	7/11, 7/12 7/16, 8/27	124.75	334	2,057
55.	North of Fort Ticonderoga 43°51'29N / 73°23'20W	Ticonderoga	HP	7/06, 7/09 7/10	66.50	21	522
56.	North of Kirby Point 43°52'42N / 73°23'22W	Ticonderoga	HP	7/03	40	39.2	836
57.	South of IPCO 43°53'21N / 73°23'24W	Ticonderoga	HP	7/03	10	3	148

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Site Number and Name	Town	Control Implemented	Date Targeted	Number of HP or MH Hours	Estimated # of pounds removed	Estimated # of Harvester Loads or # of Rosettes Pulled
58. IPCO Bay 43°53'42N / 73°23'50W	Ticonderoga	HP	7/02, 7/03	28	22	551
59. Bay North of Five Mile Point Light 43°54'17N / 73°24'45W	Ticonderoga	HP	6/29, 7/02	77.5	298	6,148
60. North of Crown Point 43°57'15N / 73°24'49W	Crown Point	HP	6/29	15	1	63
61. Porters Marsh 43°58'13N / 73°24'58W	Crown Point	HP	6/29	15	1.5	83
62. Bay south of Burdick Crossing 43°59'4N / 73°25'14W	Crown Point	HP	7/02	2	0	0
63. Bay at Burdick Crossing 43°59'10N / 73°25'13W	Crown Point	HP	7/02	1	0	0
64. South of Lapstone Point 44°00'10N / 73°25'02W	Crown Point	HP	7/02	4	19.2	403
65. Shoreline between Lapstone Pt & Bay South of Crown Point Bridge 44°00'55N / 73°25'03W	Crown Point	HP	7/02	1	0	0
66. Bay south of Crown Point Bridge 44°01'30N / 73°25'06W	Crown Point	HP	6/27, 6/28	26	33.8	430
PORT HENRY						
67. Bulwagga Bay 44°00'17N / 73°26'51W	Crown Point, Moriah	HP	6/27, 6/28	72.5	139.2	1,866

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Appendix 2. Water Chestnut Management Program Summary: 2007 other waterbody sites.

Site Number and Name	Control Implemented*	Date Targeted	Hours	Estimated # of Pounds removed	Rosettes Removed	
Lakes and Ponds						
1.	Lake Bomoseen, VT 43°41'18N / 73°11'57W	HP-DEC	8/15	4	0	0
2.	Cogman Pond, VT 43°37'14N / 73°22'30W	HP-TNC	7/19	8	39	176
3.	Brookside Pond, VT 43°46'58N / 73°18'34W	HP-TNC	6/27,8/31	7.5	693	2,443
		HP	9/5	3.5	33	335
4.	Parsons Mill Pond, VT 43°42'20 N / 73°17'04W	HP-TNC	7/10, 8/22	59.25	181	1,149
5.	Lake Paran, VT 42°55'58N / 73°13'13W	HP-DEC	7/26	6	2	12
6.	Small pond, Benson, VT (Horton) 42°42'46N/73°15'20W	HP-owner	7/20, 10/23	3	4	43
7.	Small pond, North Bennington, VT (Allen) 42°53'46N / 73°15'20 W	HP-DEC	7/26	9	1	7
8.	Small pond, Bennington, VT (Glanzenberg) 42°53'28N / 73°15'9W	HP-owner	7/18, 8/10	3	.5	3
9.	Small pond at Benson Landing, VT 43°43'39N/ 73°21'57W	Checked by VTDEC and contract staff		1	0	0
10.	Root Pond, VT 43°40'46N / 73°20'59W	HP-TNC	7/30	2	1	6
11.	North Springfield Reservoir, VT 44°20'55 N / 72°30'20W	HP-CORPS	?	60?	.5	2
12.	Pelkeys Swamp, VT 43°42'33N/ 73°19'18W	HP-TNC	6/26	2.5	15	143
13.	Lily Pond, Lake St Catherine VT 43°29'32N / 73°12'23W	HP-DEC	7/10	2	15	202
		HP-ACT	8/23	1	.5	7
14.	Porter Lake, VT 44°12'38N / 73°19'09W	HP	6/25, 8/18	29	25	509

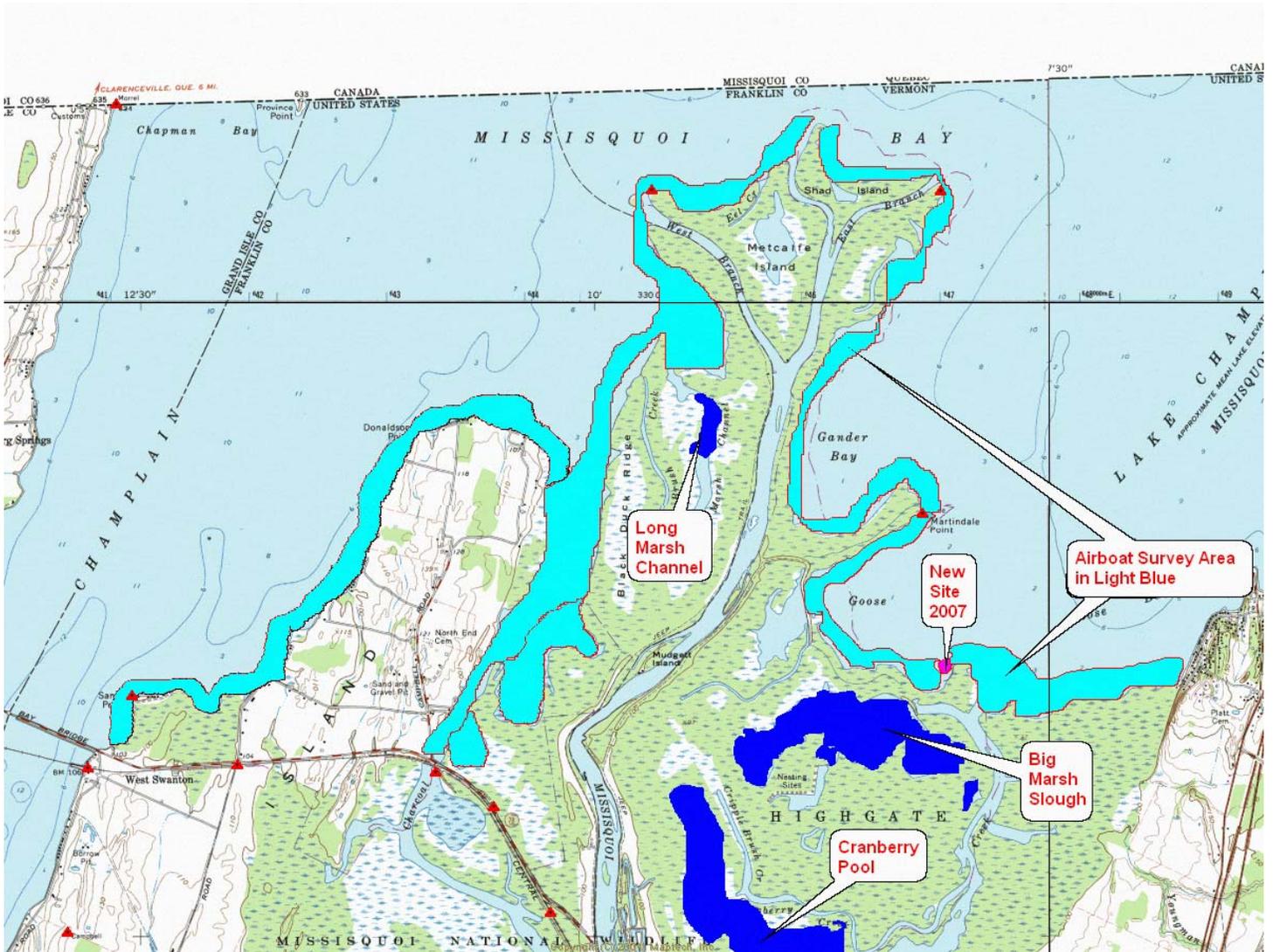
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Site Number and Name	Control Implemented*	Date Targeted	Hours	Estimated # of Pounds removed	Rosettes Removed
15. Bullis Pond, VT NEW 44°57'58N / 72°57'58W	HP DEC	8/2, 8/06*	40	600	2400
		8/07*, 9/7		* Pounds removed and rosettes removed included in contract totals from same dates	
	HP	8/06, 8/07 8/09	330	12,404	53,160
Rivers, Marshes, Wetlands, VT and New York					
16. Dead Creek, VT a. 44°11'01N / 73°18'53W b. 44°10'55N / 73°18'44W c. 44°09'11N / 73°19'14W d. Holcomb Slang 44°08'53N / 73°19'01W e. 44°07'53N / 73°19'42W f. 44°07'35N / 73°19'50W g. 44°05'12N / 73°20'50W	HP	6/26 North	30	25	660
		6/26 South	50	16	307
	h. Route 17 north and south	HP	7/21, 7/22 7/27, 8/18	79	834.3
17. Lemon Fair River, VT 43°59'27N / 73°15'00 W	HP	6/30	2.5	.5	54
18. Richville Pond NEW Lemon Fair River 43°51'33N / 73°15'26W	HP	6/23, 8/18	17.5	.4	23
Missisquoi National Wildlife Refuge Sites, Highgate, VT					
19. Cranberry Pool 44°57'16.59N 73°08'56.91"W	HP-DEC	7/25	12	Included in USF&W totals	
	USF&W	7/19, 7,23 7/24, 7/25 8/7	223.5	350	3,503
20. Big Marsh Slough 44°58'23"N 73°08'24"W	USF&W	7/26, 7/30 8/9	136	246	2,460

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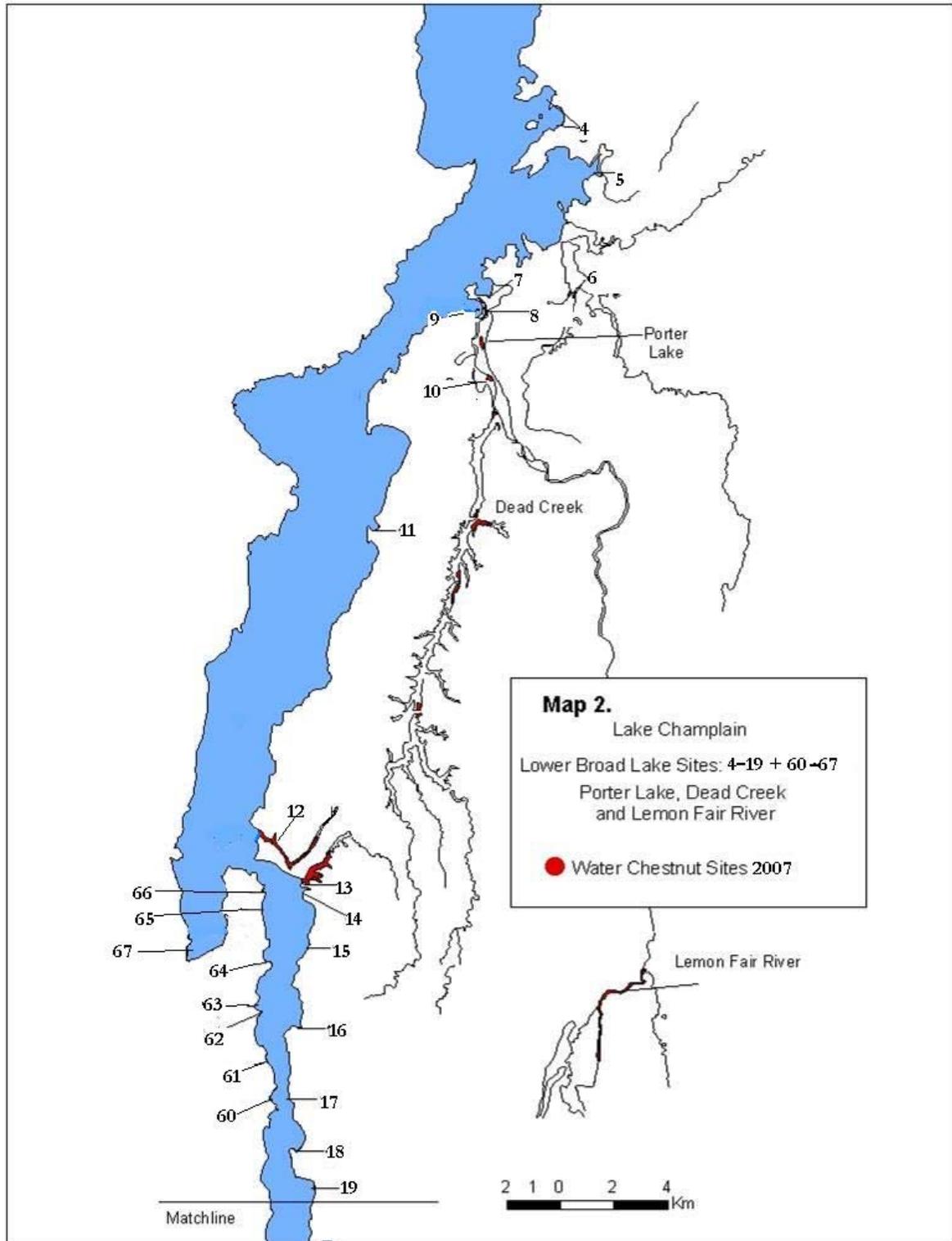
Appendix 3. 2007 water chestnut management program site maps.

Map 1. Northern Lake Champlain sites: Missisquoi Bay.

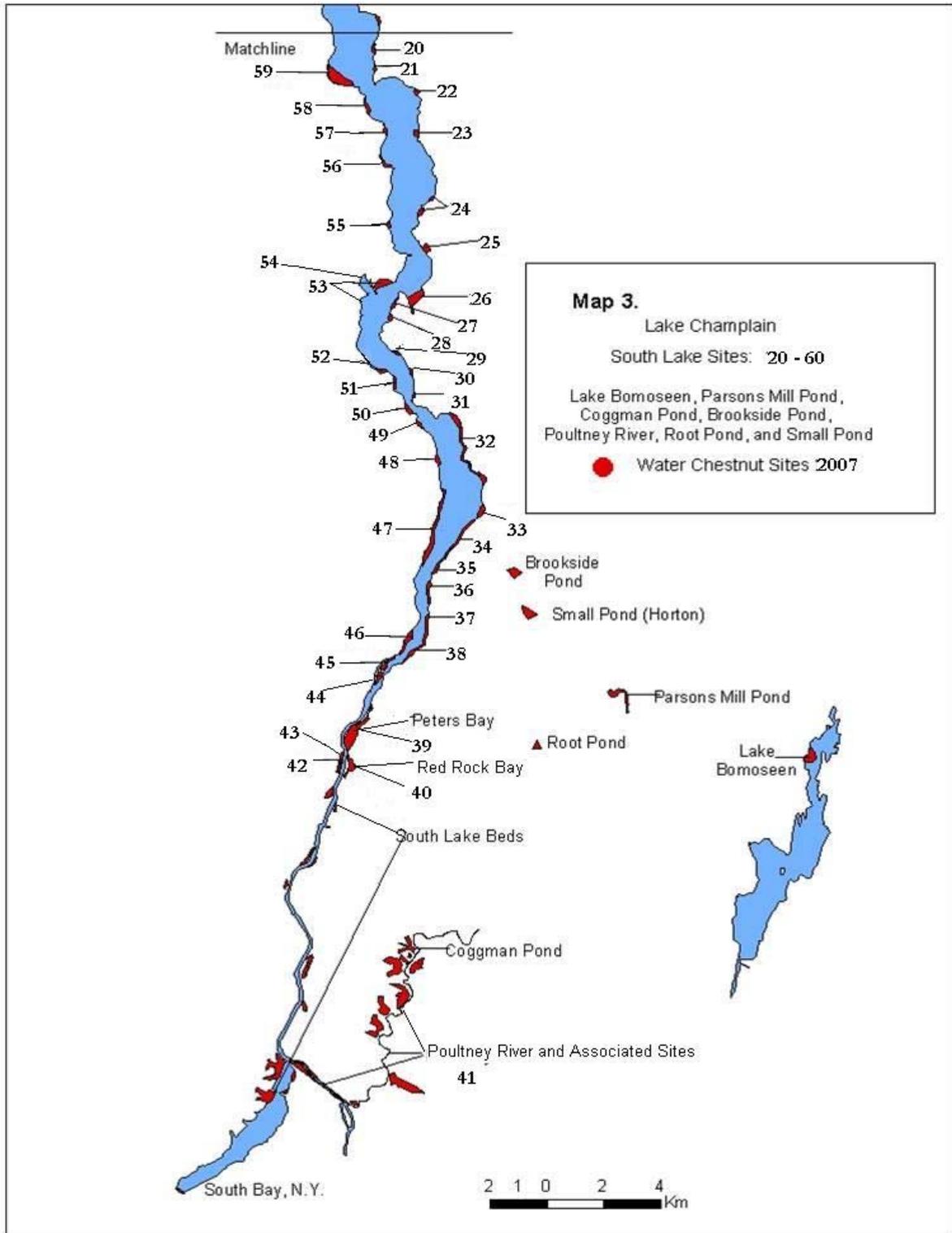


- pink = water chestnut site, 2007
- turquoise = airboat search area
- dark blue = previously known water chestnut sites

Map 2. Lake Champlain: Lower Broad Lake and South Lake, Porter Lake, Dead Creek sites and the Lemon Fair River.



Map 3. Lake Champlain: South Lake Sites continued, Lake Bomoseen, Parsons Mill Pond, Coggman Pond, Brookside Pond, Poultney River, Root Pond, and small pond in Benson.



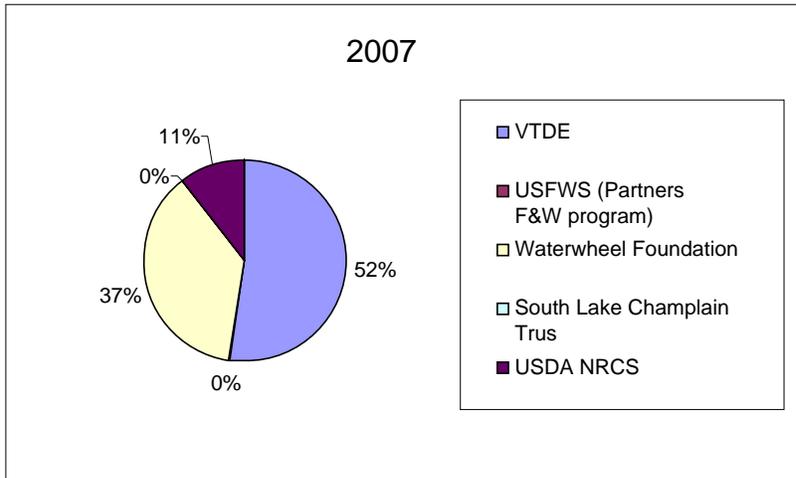
Appendix 4. Water Chestnut Site Summary Statistics, 2007.

Site	Date	Pulling hours	Volunteer hours	Pounds	Rosettes
Billings Marsh	7/21/2007	42	55	157	1083
Brookside Pond	6/27/2007	2	0	25	238
	8/31/2007	5.5	0	668	2205
Brookside Pond totals		7.5	0	693	2443
Buoy 33 wetlands	7/26/2007	29.75	13	527	3689
Coggman Pond	7/19/2007	8	6	39	176
Cook Island	8/3/2007	10	18	429	2360
	8/7/2007	24	27.5	186	1023
	8/8/2007	35	40.5	475	2613
	8/29/2007	33	31	749	2996
Cook Island totals		102	117	1839	8991
East Creek	6/28/2007	14.25	10	16	152
	7/7/2007	38.5	40.5	45	360
	7/17/2007	46.75	60	87	566
	7/30/2007	1.75	0	20	110
	7/31/2007	64.75	101	139	391
	8/1/2007	63.75	0	23	127
	8/30/2007	7	5.5	11	44
East Creek totals		236.75	217	341	1749
Finch Marsh	6/21/2007	8	5	26	247
	6/27/2007	2.25	0	30	285
	7/2/2007	3	0	26	208
	8/28/2007	9	6	105	420
Finch Marsh totals		22.25	11	187	1160
LaChute River	7/12/2007	22	13.5	130	939
	7/11/2007	19.25	21	68	544
	7/16/2007	52	60	12	78
	8/27/2007	31.5	27	124	496
LaChute River totals		124.75	121.5	334	2057
Nichol's Wetland	8/15/2007	1	0	18	64

Site	Date	Pulling hours	Volunteer hours	Pounds	Rosettes
Parson Mill Pond	7/10/2007	30	21	125	1000
	8/22/2007	29.25	39	56	149
Parson Mill Pond totals		59.25	60	181	1149
Pelky Swamp	6/25/2007	2.5	0	15	143
Reed Marsh	8/16/2007	12	8	287	1033
Roger's Marsh	6/26/2007	10	10	5	26
Root Pond	7/30/2007	2	0	1	6
S. Lake Champlain	6/26/2007	4	10	18	171
	8/21/2007	71.25	100.5	767	1841
	9/4/2007	49	66	257	1028
S. Lake Champlain totals		124.25	176.5	1042	3040
Saslow Marsh	8/25/2007	5.5	6	94	376
Schoolhouse Marsh	7/23/2007	6	5	4	15
	8/9/2007	2	2	0	3
Schoolhouse Marsh totals		8	7	4	18
Schoolhouse Marsh North	8/9/2007	2.5	3	70	274
South Bay	7/3/2007	22.5	16.5	20	160
	7/13/2007	38	54	25	240
	7/24/2007	37.5	40.5	46	189
South Bay totals		98	111	91	589
South Bay harvester sites	8/14/2007	35	48	451	2481
	8/17/2007	35	40.5	789	3156
	8/2/2007	90	119	1880	10340
South Bay harvester site total		160	207.5	3120	15977
South Fork (E. Creek)	6/20/2007	42	55	88	334
	7/18/2007	24	33	12	59
	8/20/2007	27	40	34	80
South Fork (E. Creek) totals		93	128	134	473
Timber Marsh	7/20/2007	28	36	153	967
Whitney Creek	7/14/2007	45.5	60	320	2080
	8/11/2007	24.5	27	120	395
Whitney Creek Totals		70	87	440	2475
Grand Total		1249	1380.5	9771	47956

Appendix 5. TNC Program Funding Sources, 2005-2007

Program Funding, 2007

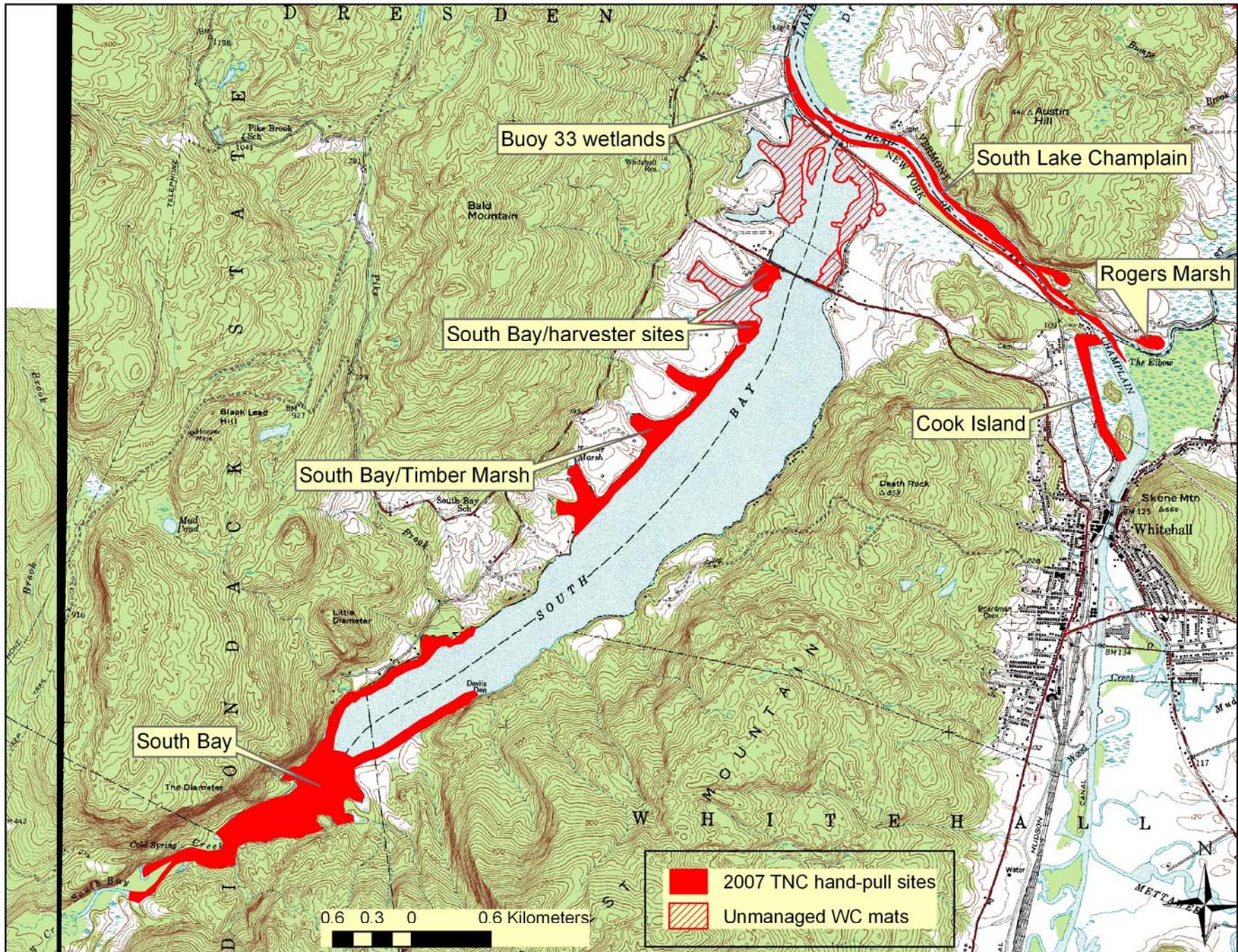


Funding Sources, 2005-2007

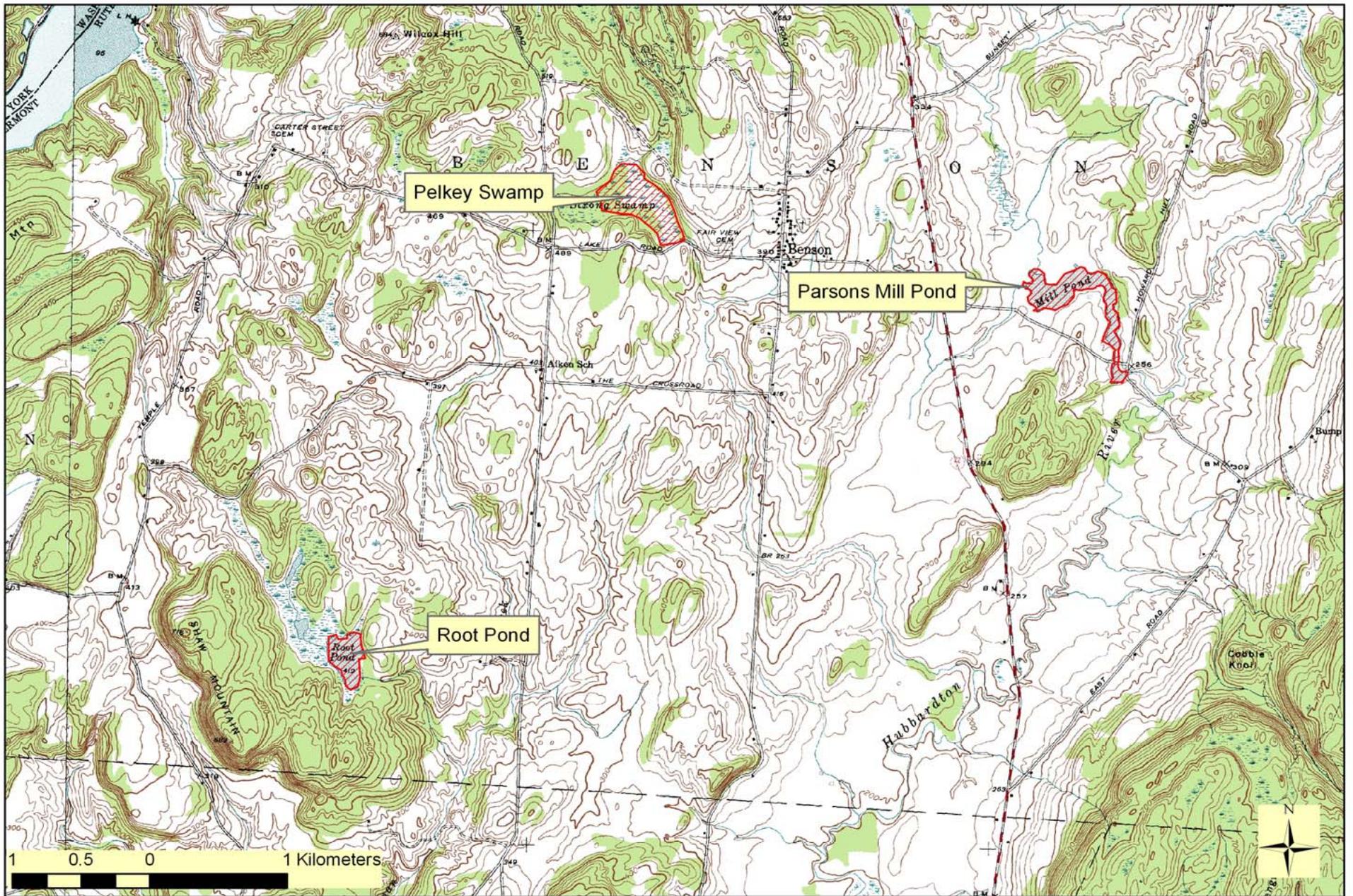
Year	VTDEC	USFWS (Partners for F&W program)	Waterwheel Foundation	South Lake Champlain Trust	USDA NRCS WHIP	Totals
2005	\$13,000.00	\$3,000.00	\$6,578.00	\$1,000.00	\$1,339.00	\$24,917.00
2006	\$13,000.00	\$2,000.00	\$15,000.00 ¹	\$0.00	\$2,653.00	\$32,653.00
2007	\$13,000.00	\$0.00	\$9,295.00	\$0.00	\$2,653.00	\$24,948.00

¹Funds were used to purchase a replacement truck for program use in 2006.

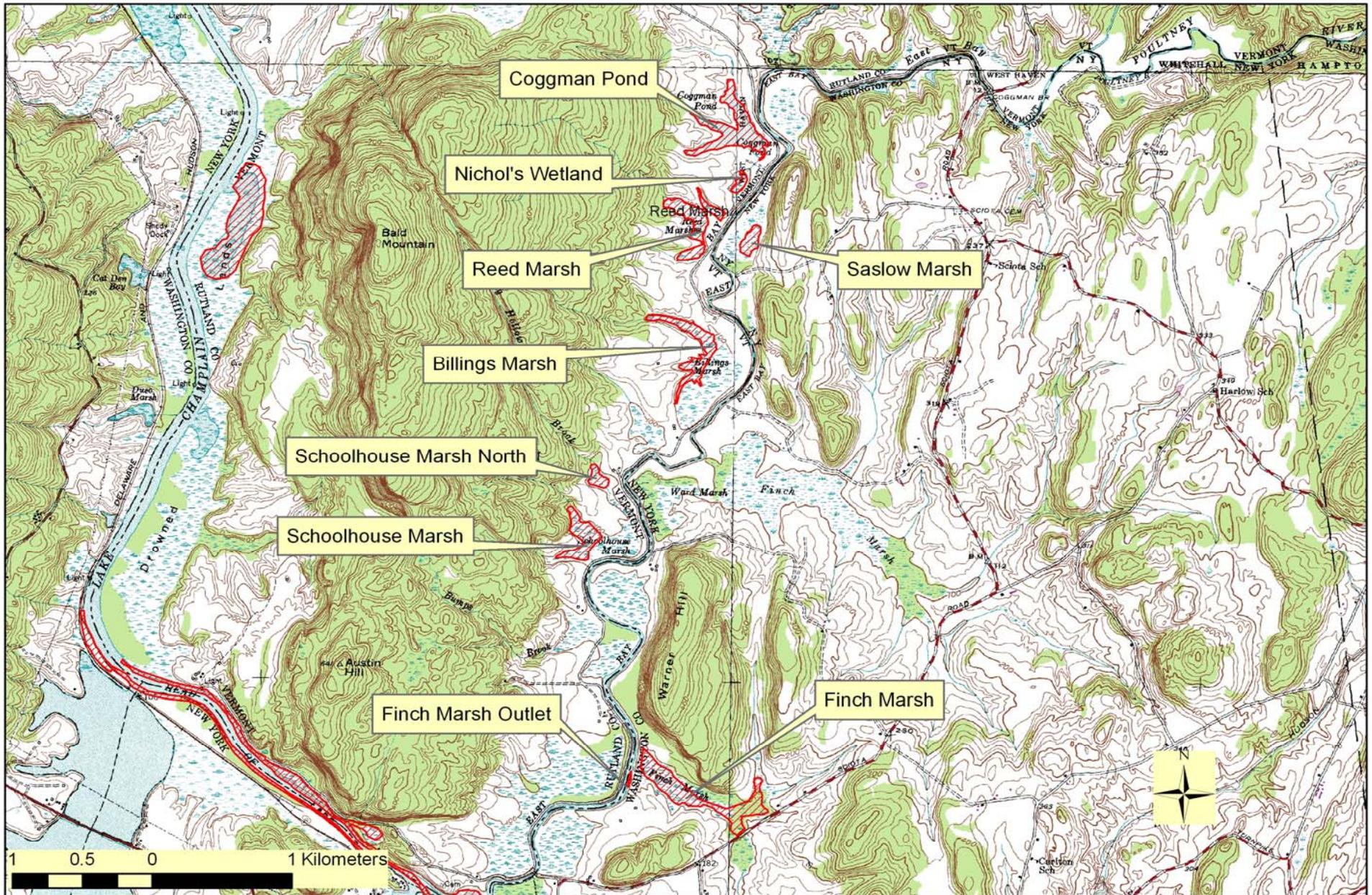
Appendix 6. 2007 TNC Site maps.



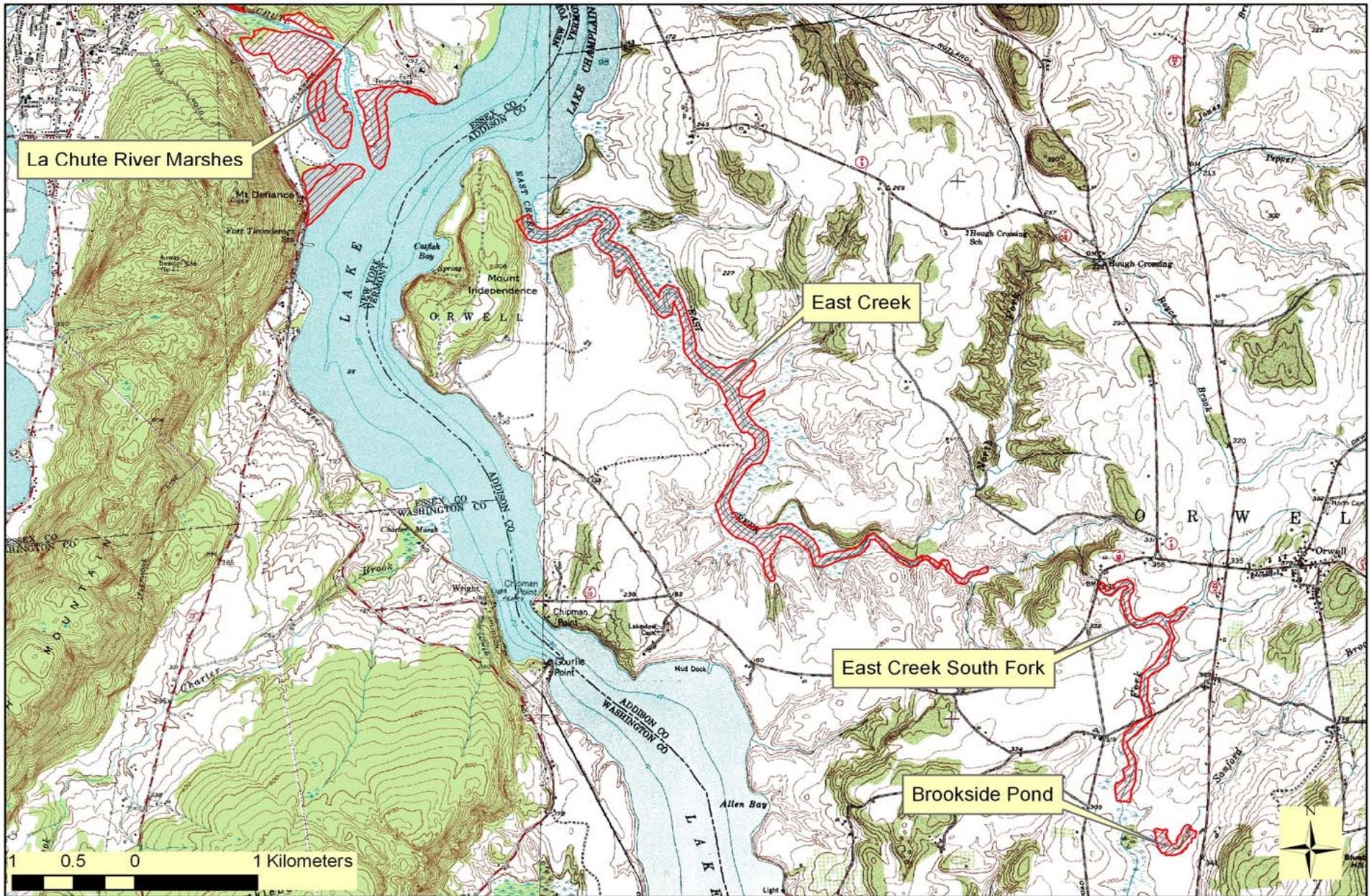
Map 1. Water Chestnut Handpulling in South Bay, Lake Champlain, 2007.



Map 2. Water Chestnut Handpulling Sites Near Benson, VT, 2007.



Map 3. Water Chestnut Handpulling Sites Along the Lower Poultney River, VT and NY, 2007.



Map 4. Water Chestnut Handpulling Sites in Orwell, VT and Ticonderoga, NY, 2007.



Map 5. Water Chestnut Handpulling Site at Whitney Creek, Addison, VT, 2007.