

BANTAM LAKE FANWORT CONTROL PROJECT 2010



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Bantam Lake Protective Association

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Final Report

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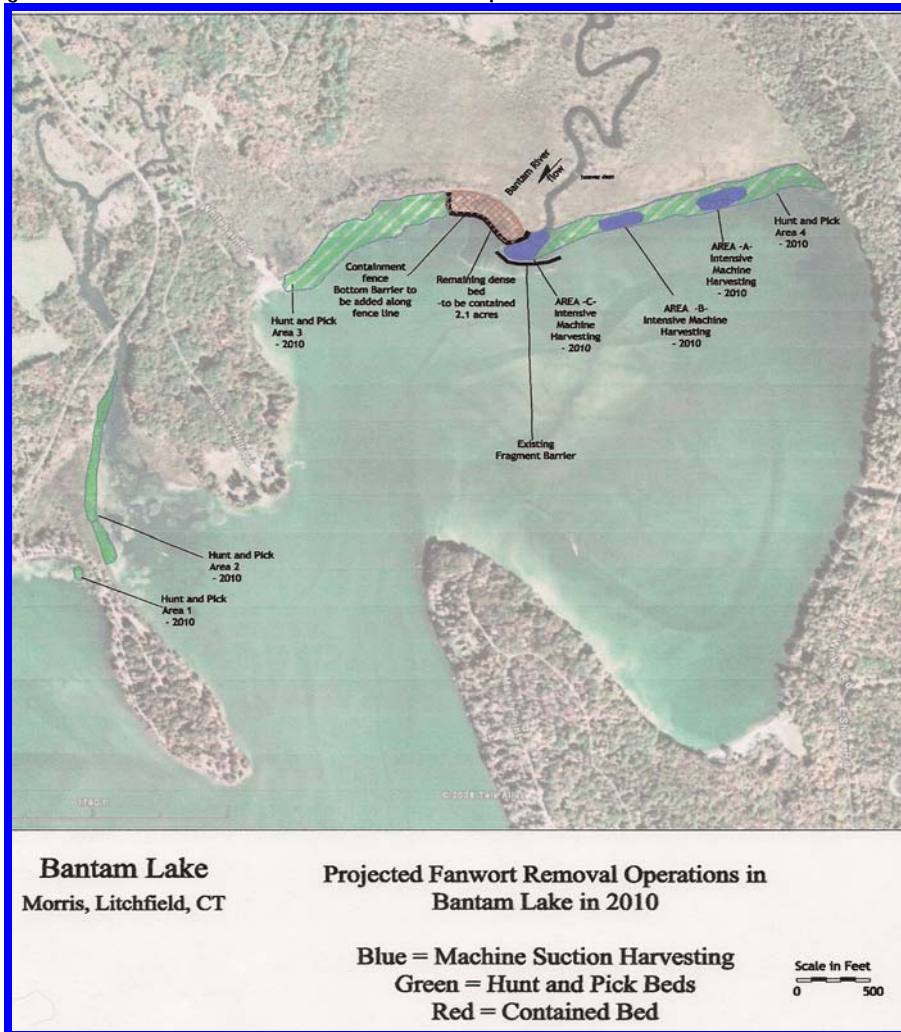
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Introduction

This final report summarizes the BANTAM LAKE FANWORT CONTROL PROJECT in 2010 to control the infestation of fanwort (*Cabomba caroliniana*) in Bantam Lake (Morris and Litchfield, Connecticut). Beginning in 2008, and continuing through 2009, Bantam Lake Protective Association (BLPA) funded suction harvesting to remove fanwort from the Bantam Lake. In 2010, the Connecticut Department of Environmental Protection funded the BANTAM LAKE FANWORT CONTROL PROJECT¹ (The Plan) to continue the fanwort removal effort at Bantam Lake. The Plan called for removal and containment of remaining fanwort beds in Bantam Lake (see following map). In addition, The Plan called for drafting a long-term fanwort management plan outlining steps needed to protect Bantam Lake from further infestation by fanwort and to develop methods to remove fanwort from heavily infested Bantam River. BLPA contributed additional funding allowing fanwort removal to continue beyond the scope called for in The Plan.

Existing fanwort beds in Bantam Lake and techniques to be used for removal / containment.



¹ Bantam Lake Fanwort Control Project Plan, approved by CT DEP on May 11, 2010

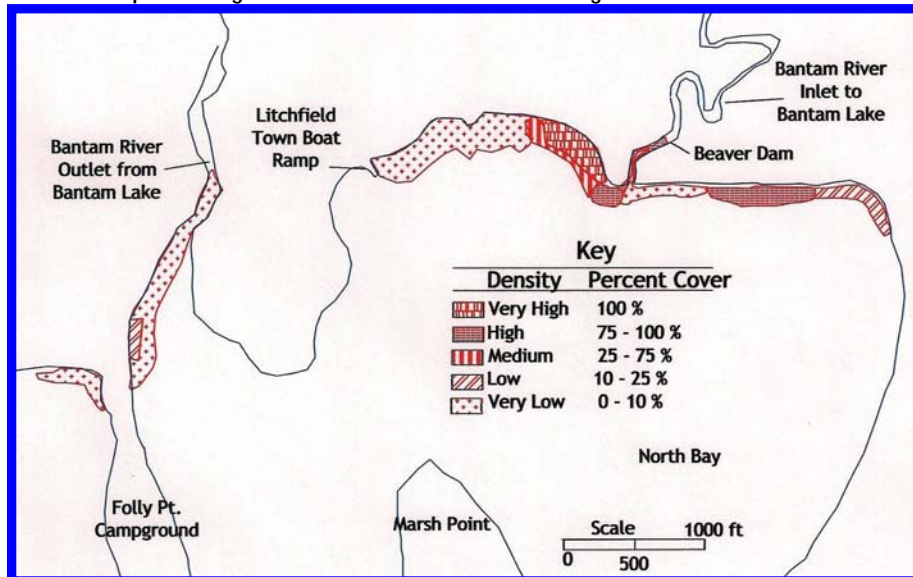
The four methods specified in The Plan to remove / contain fanwort in Bantam Lake during the 2010 season are as follows:

- 1) **Suction Harvesting** to remove three dense beds of fanwort,
 - 2.19 acres of dense fanwort was targeted for removal,
 - 4.85 acres of dense fanwort was removed,
 - 33 days of suction harvesting was performed between July 23 and September 29, 2010.
- 2) **Hunt & Pick** hand-pulling to remove remnants from all harvested areas,
 - 25 acres of plant beds were searched by Hunt and Pick crews,
 - 12 days of intensive Hunt & Pick were conducted on August 24 -27, 30, September 10, 13-17, and October 7, 8, 2010.
- 3) **Containment Fence** to contain the remaining very dense fanwort bed,
 - 666 feet of silt fence was installed along outer edge of dense bed,
 - Fence installed on July 14,
 - Removed October 8, 2010.
- 4) **Bottom Barrier (Aquascreen)** used experimentally to cover fanwort,
 - 2.5 rolls (1 roll = 7'x100') installed July 14, 2001,
 - 7.5 rolls installed in Bantam River August 11, 2010.
 - Bottom barrier was removed October 13 & 14, 2010.

Survey Results

Two surveys were conducted as part of The Plan to map the density and distribution of fanwort prior to any implementation or removal activities. The first, on May 15, 2010, established field delineation for the placement of the containment fence. The second, on June 1, 2010, was to map the density of existing fanwort beds for suction harvesting, and hunt and pick prioritization. The results of the June 1st survey are shown in the map below.

Distribution map showing locations of fanwort beds along the North Shore of Bantam Lake.



Fanwort Distribution

The map above shows distribution of fanwort in Bantam Lake organized into five different density categories. The categories are based on observed frequency of occurrence and growth characteristics of plants within each area. Frequency of occurrence, or density, is the number of plants within a unit area, while growth characteristics refer to size of the plants encountered. Typically, as the density of fanwort increased, more plants per unit area, the growth of the plants became more prolific, with each plant having more stems and longer shoots.

Very Low - fanwort is scarce in these areas with about 1% occurrence rate. Fanwort is difficult to find in the Very Low-density areas, requiring careful searching. Plants are widely scattered and occur as single short stems. Locally within this area, plant occurrence could increase to 10% but these areas were small and didn't affect the over density. Often these single plants were hidden within beds of native plants, sometimes occurring inside clumps of white water lily leaves.

Low - fanwort occurs more commonly with occurrence rates of 10 - 25%. Plants occur as both single stems and in small clumps of shorter plants. Clustered clumps can have density of 100% within small 8-10 foot areas.

Medium - fanwort is plentiful, with occurrence rate between 25 and 75%. Plants occur mostly as multi stem clumps with most areas consisting largely of fanwort. There are no single shoot individual plants. Several clumps had greater than 50 stems and shoot lengths of greater than 3 feet.

High - fanwort is very plentiful, occurring at greater than 75%. Plants consist of large multi-stem clumps. Most clumps merge leaving little open area for native plants. Shoot length was between 2 and 5 feet depending on water depth.

Very High - fanwort coverage is 100%. There is no open area available for native plants. All native plant growth is as secondary species growing within fanwort clumps. Plants within this area reached the surface and produced aerial flowers.

Very Low Density Beds

There are four areas where fanwort occurred at very low density, from west to east these are:

1. A small, 1.2 acre area on the west side of Folly Point- fanwort was discovered here in late 2008. Only a few plants have been found since that time. New plants continue to be found here each year.
2. About 4.3 acres on the west shore of Outlet Cove - fanwort was found here in the fall of 2007. A 0.5 acre bed of very dense fanwort was removed using suction harvesting in 2008. The remaining area was searched using Hunt and Pick in 2008. The area suction harvested in 2008 is marked as a low-density bed within the larger, very low-density bed.
3. Large bed of about 5.6 acres east of Litchfield Boat Ramp - fanwort occurs only sporadically in this area. Rate of occurrence increased toward the eastern end of the area.

- Small 1.2 acre area east of the mouth of Bantam River - The shoreline east of the Bantam River mouth is mostly clear of fanwort for about 500 feet. Fanwort in this area was removed with suction harvesting in 2009.

Low Density Beds

Two areas were designated as low density.

- A small 0.5 acre rectangle on the western shore of the Outlet Cove. This area was suction harvested in 2008. Three plants were observed in this area during the June 1, 2010 survey.
- A 1.6 acre area on far eastern shoreline of North Bay.

Medium Density Beds

One area was designated as medium density.

- A 1.1 acre area outside of the containment fence had medium density fanwort. There were also significant growths of Myriophyllum spicatum, Megalodonta beckii, Potamogeton amplifolius and P. zosteriformis. Fanwort although dense, was also patchy throughout the area. Meaning that there were large areas with no fanwort, where other aquatic plant species formed dense beds. Most notably was Megalodonta beckii that formed several very dense clumps with topped out shoots and aerial flower spikes.

High Density Beds

Two areas were designated as high density.

- A 1.0 acre area at the mouth of the Bantam River.
- A 1.9 acre bed 1000 feet east of the Bantam River on the north shore of North Bay.

Very High Density Beds

One area was designated as very high density.

- a large 2 acre bed of dense fanwort directly west of the mouth of the Bantam River was completely infested with fanwort. This area was characterized by 100% cover of fanwort throughout. Most of the water surface had topped out flowering fanwort.

Summary

The sizes in acres of the areas of different fanwort density are summarized in the table below. The table below indicates that as of the beginning of the project approximately 20.2 acres of littoral zone of Bantam Lake had some growths of fanwort. About 6 acres or 30% had medium to very high-density growths.

Density	Pre-Harvest acres
Very Low	12.4
Low	1.8
Medium	1.1
High	2.9
Very High	2.0
Total	20.2

Ambient Vegetation

Several species of aquatic plants that occurred with fanwort are listed in the following table.

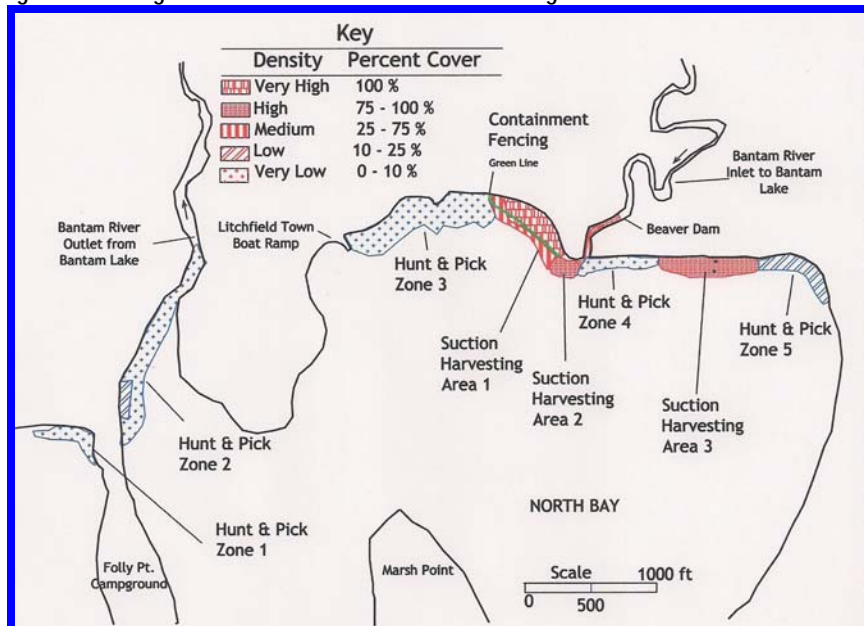
Megalodonta beckii	Eleocharis acicularis
Myriophyllum spicatum	Potamogeton robbinsii
Nuphar variegata	Potamogeton nodosus
Nymphaea odorata	Potamogeton zosteriformis
Vallisneria americana	Potamogeton praelongus
Elodea canadensis	Potamogeton gramineus
Elodea nutallii	Utricularia purpurea
Ceratophyllum demersum	Utricularia vulgaris
Marsilea quadrifolia	Pontederia cordata

The north shore vegetation consisted of emergent shrub wetland vegetation along the shoreline with pickerel-weed (*Pontederia cordata*) common to water depths of about 1 foot. Beds of white and yellow water lilies (*Nymphaea odorata*, *Nuphar variegata*), were mostly continuous along shoreline out to about 4 feet of water depth. Native species including Eurasian milfoil were common and abundant to about 6 feet of water depth. Large beds of pondweeds (*P. nodosus*, *amplifolius*, and *zosteriformis*), elodea, bladderwort (*U. purpurea*, and *vulgaris*) and coontail were common. In some areas, water marigold (*Megalodonta beckii*) formed very dense beds.

Fanwort Management Designations

Management activities were determined for each fanwort bed. Generally, all of the very low-density and low-density beds were targeted for Hunt and Pick removal. The medium and high-density beds were selected for Suction Harvesting. The very high-density bed was to be contained. The management actions for each bed are shown on the map below.

Management designations for each fanwort bed along the North Shore of Bantam Lake.



The removal / containment designations for each of the fanwort beds are summarized in the following table. The Hunt and Pick beds are referred to as Zones while the beds targeted with Suction Harvesting are call Areas.

Density	Name	Pre-Harvest acres	Management
Very Low	Zone 1	1.2	Hunt and Pick
	Zone 2	3.8	Hunt and Pick
	Zone 3	5.6	Hunt and Pick
	Zone 4	1.2	Hunt and Pick
Low	w/Zone 2	0.5	Hunt and Pick
	Zone 5	1.8	Hunt and Pick
Medium	Area 1	1.1	Suction Harvest
	Area 2	1.0	Suction Harvest
High	Area 3	1.9	Suction Harvest
		2.0	Containment
Very High			
Total		20.1	

Removal / Containment Results

1 Control by Suction Harvest Machine

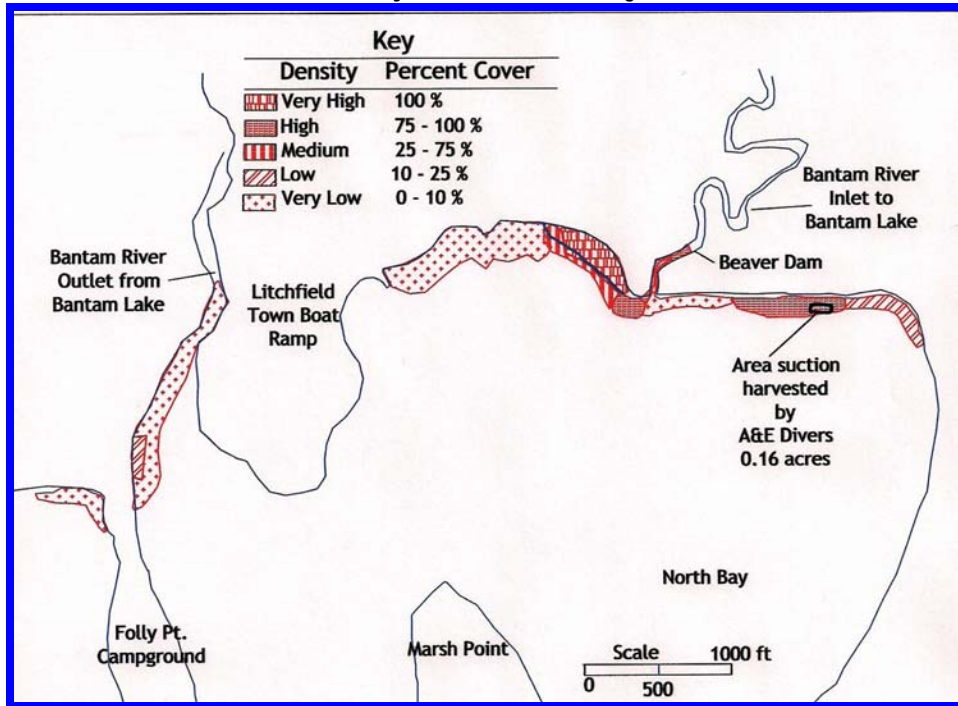
The goal was to remove fanwort using suction harvesting machines from three dense beds (Area 1, Area 2, and Area 3) occurring along the north shore of North Bay of Bantam Lake. The areas designated for suction harvesting are shown on the map on Page 7 and summarized here

A&E Commercial Diving Services

Suction harvesting of fanwort commenced on July 24 by A&E Commercial Diving Services (A&E Divers) working in the high-density fanwort bed labeled Area 3 on the map on Page 7. Fanwort coverage prior to harvesting was between 75 and 100% by surface area.

A&E Divers worked four days July 24, 25, and 31, August 1, 2010 performing 22 hours of removal and clearing fanwort in about 0.16 acres. During the four days, they removed 845 gallons of material, for a gross weight of between 3,000 and 3,300 pounds. About 20% of the material was fanwort, with remaining material consisting of water lilies, coontail, Eurasian milfoil, pondweeds, elodea, and bladderwort. Using 20% of the gross weight as an indicator of the fanwort net weight between 600 to 660 pounds of fanwort was removed. However, total weight due to fanwort was probably variable based on the clumping nature of the plant growth. The overall clearing rate was about 0.04 acres per day or 1 acre in 25 days.

Area A&E Divers Suction Harvested July 24, 25, and 31, August 1, 2010



The area was surveyed on August 3rd after A&E Divers was finished. Between 75 and 90% of the fanwort had been removed. There were small single stem and multi-stemmed plants remaining. Fanwort shoot length was between a few inches and 14 inches. Most of these single shoot plants were observed lying on the bottom, sometimes partially covered by silt suggesting that a small percentage of plants are buried during suction harvesting. The multi-stemmed plants occurred mostly entwined with emergent pickerelweed or at the base of water lilies.

The approximate coverage of fanwort within the area after A&E Divers completed harvesting was between 5 - 15 % by surface area, with a mean of about 7%.

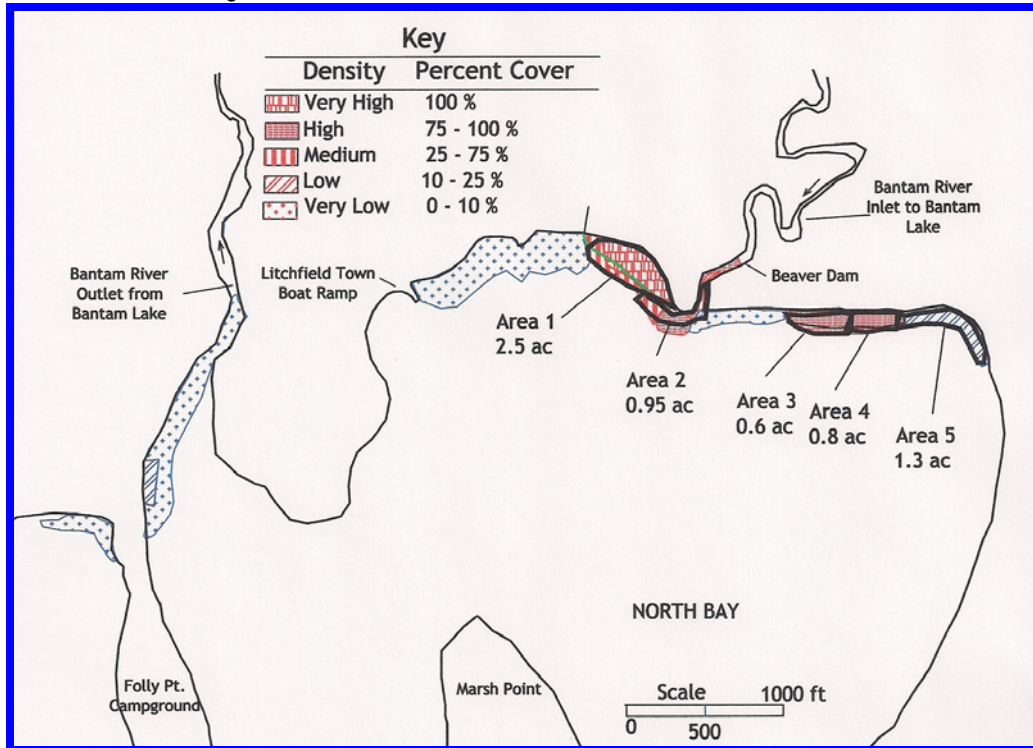
Water's Edge Restoration and Management (WERM)

WERM conducted 29 days of suction harvesting beginning on August 3, 2010 ending on September 29, 2010. WERM moved sequentially through each of the 5 Areas shown in the map below. Harvesting began in Area 3 and progressed eastward through Area 4 and 5 during August. WERM conducted suction harvesting at the mouth of Bantam River, Area 2, and in early September worked Area 1.

The following map shows the locations of WERM removal operations during the 2010 project.

- Area 1 - 2.5 acres = Suction Harvesting
- Area 2 - 0.95 acres = Suction Harvesting
- Area 3 - 0.6 acres = Suction Harvesting, with follow-up Hunt and Pick
- Area 4 - 0.8 acres = Suction Harvesting, with follow-up Hunt and Pick
- Area 5 - 1.3 acres = Hunt and Pick

WERM suction harvesting work areas



WERM Suction Harvesting Details

WERM fanwort removal by Area is shown in the follow table.

Area 1 was intensive suction harvesting at a high rate of fanwort removal due to the very high density of plant growth. Removing fanwort at a rate of 2.8 days / acre

Area 2 was intensive suction harvesting over 5 days removing 55 bags from the high-density fanwort beds around the mouth of the river. Material removed was mostly all fanwort. Fanwort removal was at a rate of 5.3 days / acre. The higher rate was due to increased density of the plant and the occurrence of few natives species, especially in the mouth of the river.

Area 3 was intensive suction harvesting that proved difficult because of the density of native vegetation and the degree of interspersion with robust emergents such as pickerel weed. WERM spent 9 days removing 82 bags of plant material of an estimated consistency of 50 - 75 % fanwort. The area or coverage, about 0.6 acres was cleared at a rate of 15 days / acre.

Area 4 was the area covered by A&E Divers earlier. The fanwort density was significantly less with only 16 bags of plants removed consisting of 80 - 100% fanwort. The higher consistency of fanwort was due to A&E Divers having cleared the majority of the native plants from the area so that fanwort was much more visible.

Area 5 was principally a Hunt and Pick area (Labeled Zone 5) while the machines were stationary at the eastern end of Area 4. Hunt & Pick has low bag / acre rates because of the scarcity of the plant abundance.

WERM suction harvesting details by Area

Area	Acres	Days	Hours		Bags
			Man	Machine	
1	2.0	7	212	118	119
2	0.95	5	136	76	55
3	0.6	9	254	122	82
4	0.8	2 (6)*	56	28	16
5	1.3	1	16	16	8

Area	Bags/acre	days/acre	Fanwort Fraction
1	60	3.5	95
2	58	5.3	85
3	137	15	60
4	20	7.5 *	80
5	6	0.8	100

* = The number of days and days / acre include 4 days by A&E Divers

Total area suction harvested by WERM in 2010 was 4.85 acres. Approximately 296 000 pounds of fanwort were removed. WERM used two suction harvesting machines running for 434 machine hours to complete this removal. There were 930 man-hours during the entire operation of which 800 hours were used during suction harvesting, and 130 for Hunt and Pick searching.

2 *Hunt and Pick Harvest Technique*

The goal was to remove isolated plants from areas that were harvested in 2008 and 2009, and to re-check areas that had been suction harvested during this project, 2010, to ensure that no stragglers remained.

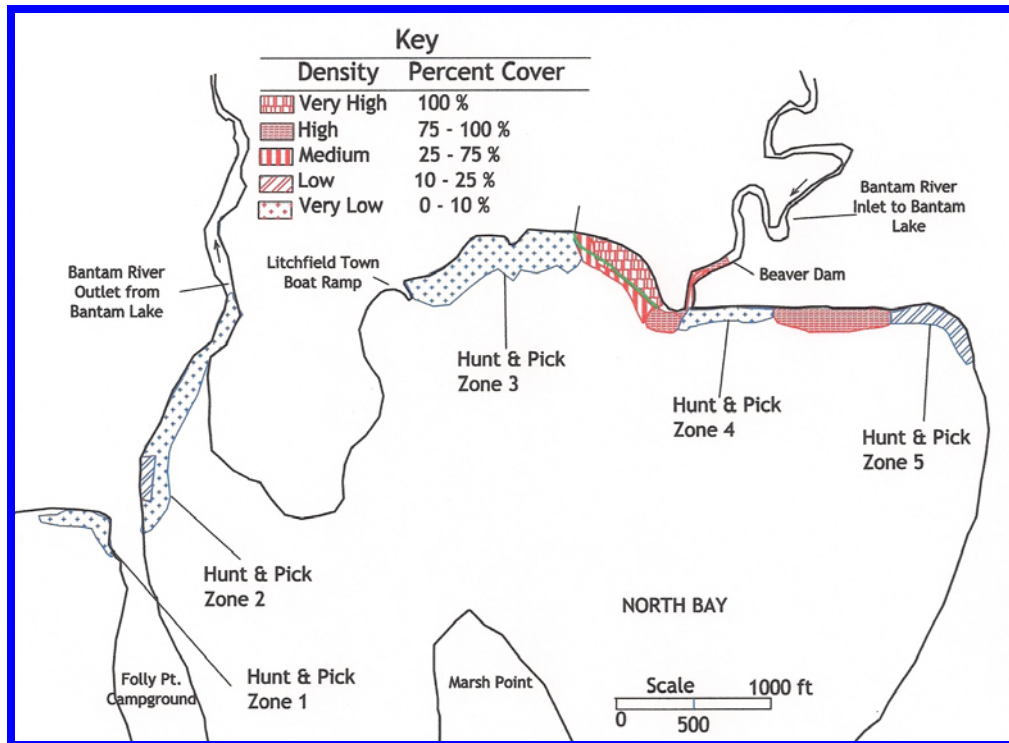
The hunt and pick operation started after all suction harvesting was completed. Hunt and Pick operations occurred between August 24 to August 27, 2010 and September 10 - September 17.

Hunt and Pick Zones 1 - 3 were searched between August 24 and August 27, 2010 by A&E Divers. Searches yielded:

- Zone 1 = 6 plants were found removed,
- Zone 2 = 1 bucket or about 20 pounds of fanwort,
- Zone 3 = 3 buckets or about 60 pounds of fanwort.

A&E Divers commented that additional plants remained along the eastern boundary of Zone 3 after they completed their contracted operation time.

Location of Hunt and Pick areas.



Hunt and Pick Zones 1 & 2 were searched by WERM between August 28 - 30, 2010. Searches yielded:

- Zone 1 = No plants
- Zone 2 = 3 plants removed
- Zone 3 = ¼ of a bag of plants removed or about 300 plants
- Zone 4 = 1 bags of plants removed
- Zone 5 = 24 bags of plants removed

3 Installation and Maintenance of Containment Barrier

Goal is to prevent spread of fanwort from the 2.0 acre very high-density bed fanwort immediately west of the inlet of the Bantam River see Map on page 3.

Containment fence, 666 feet long was installed along the outer edge of dense fanwort bed on July 14, 2010. Containment fence was removed on October 8, 2010.

The containment barrier had no affect on retaining fanwort. The plant was observed growing under the fence in a number of locations along its length, mostly toward the eastern end (closest to the mouth of the Bantam River). The barrier may have prevented human access into the dense fanwort beds contained within the bed but this was not noticed. Few anglers ventured close to the barrier due dense plant beds located outside of the barrier.

Fanwort was found to spread by stolons, or roots stocks that extend laterally as runners, away from the parent plant. Stolons were found with lengths of 10 - 15 feet and with 20 to 30, new plant shoots along its length. For this reason, the containment

barrier could not be used to retain fanwort within a confined area. It may have been possible to dig the barrier material into the sediment but that would have been very laborious because of the existing net of roots from other aquatic plants in the areas, specially the water lily rhizomes. The containment fence was removed on October 8, 2010

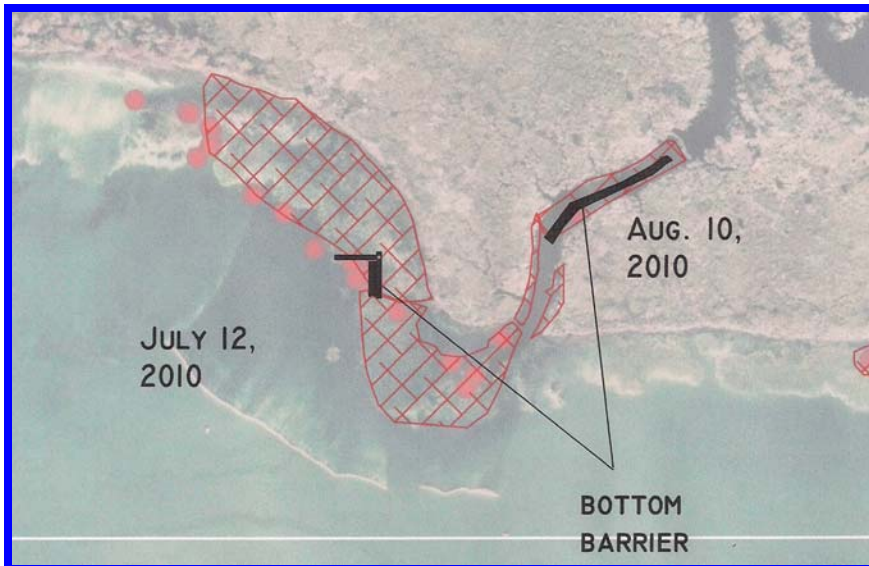
Location of containment fence as solid blue line 666 feet in length. Note the line in map below is shown wider than the actual fence for display purposes



4 Installation of Benthic Barriers

The goal was to experiment with Benthic Barriers as a method to control fanwort. Bottom Barrier (Aquascreen) was installed in two locations, 2.5 rolls were placed adjacent to the containment fence on July 14, 2010. The remaining 7.5 rolls were placed in the Bantam River on August 10, 2010.

Locations of Bottom Barrier Placement



Benthic barrier (Aquascreen) proved to be affective at killing plants it covered. In each area barrier was placed over dense beds of 100% fanwort plants. All fanwort under the material appeared dead. However, all Aquascreen removed from the lake was found to have new fanwort plants growing on top of the material (see following photograph). Aquascreen placed in the river was 60 - 90 % covered with new fanwort plants that rooted through the material. These plants were fragments that had been carried down river and settled on the Aquascreen.

Although Aquascreen could be used to kill existing plants, it will not work to keep areas fanwort free because fragments will settle and root though the material. It may be possible to use the Aquascreen in order to remove plants that grow during the season by allowing fragments to grow on the material and than remove the material at the end of the year.

All aquascreen was removed on October 14, 2010.

Fanwort roots growing through Aquascreen



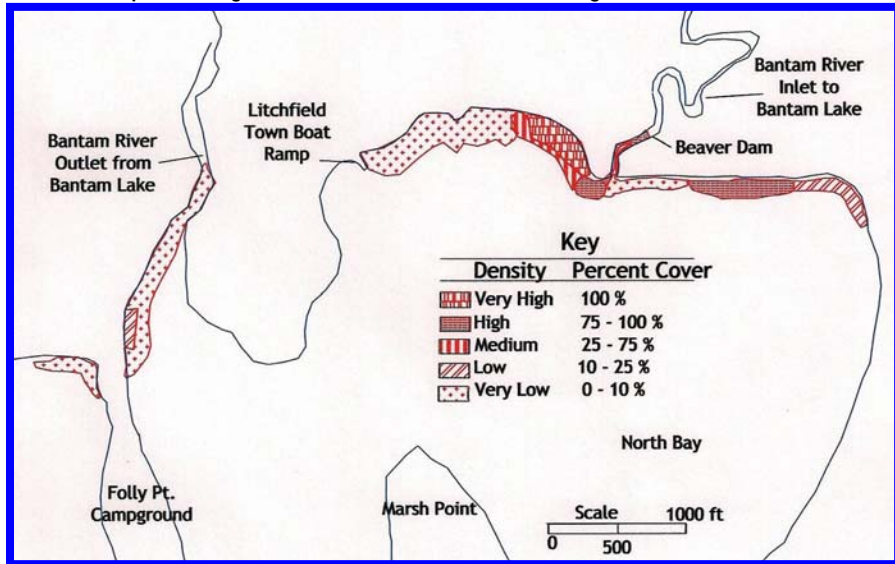
Conclusions

The 2010 BANTAM LAKE FANWORT CONTROL PROJECT employed three or four different methods, suction harvesting, hunt and pick harvesting, bottom barrier placement and containment fencing to control fanwort in Bantam Lake during the 2010 season. Of the four methods, suction harvesting, and hunt and pick operations proved successful while bottom barrier and containment fencing showed little or no success.

Changes in fanwort density due to the operation of this project are shown in the following two maps, and listed in the following table.

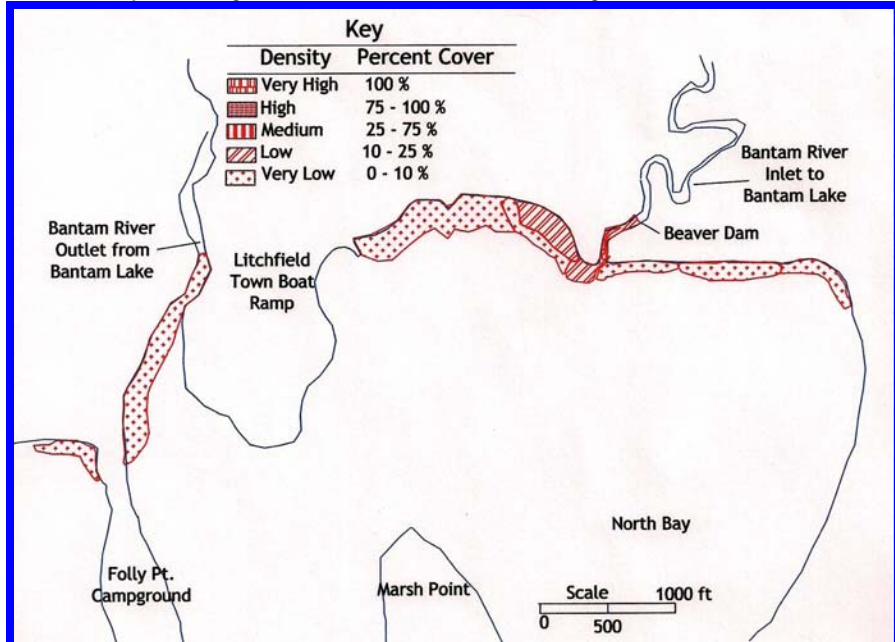
Pre-Harvest

Distribution map showing locations of fanwort beds along the North Shore of Bantam Lake.



Post Harvest

Distribution map showing locations of fanwort beds along the North Shore of Bantam Lake.



The change in density of the fanwort beds in Bantam Lake is given in the following table. All medium, high and very high beds were reduced to either low or very low density due to removal during this project. Although the low and very low-density beds were thoroughly searched, they cannot be considered fanwort free. The total area infested with fanwort remains the same at this time. Follow-up monitoring of the low and very low-density beds during subsequent seasons may provide results that allow certain areas to be declared fanwort free. However, as long as the Bantam River and Little Pond (approximately 2 river miles north of Bantam Lake) remain infested with fanwort new fragments will continually enter Bantam Lake potentially forming new beds.

Density	Pre-Harvest	Post-harvest
Very Low	12.4	15.3
Low	1.8	4.9
Medium	1.1	0
High	2.9	0
Very High	2	0

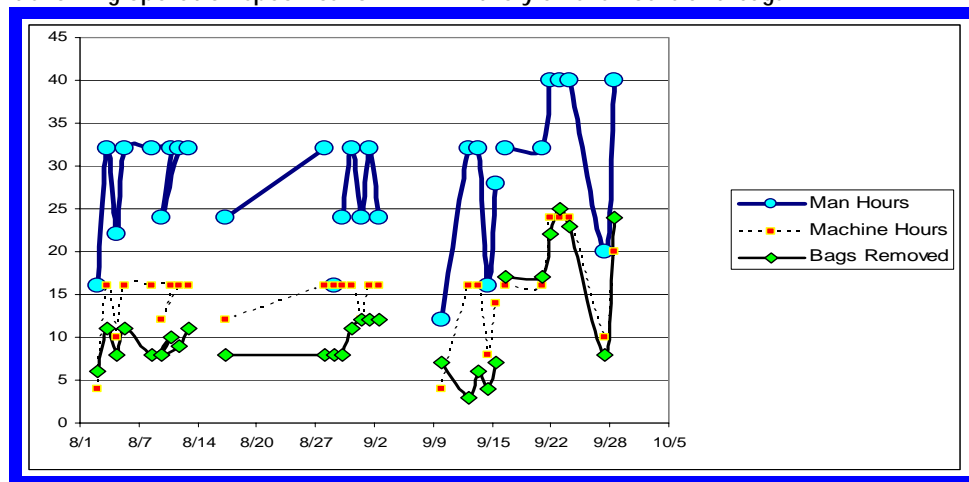
Approximately 4.85 acres of fanwort were cleared using combined suction harvesting, and hunt and pick methods removing an estimated 296,400 pounds of fanwort at a cost of nearly \$70,000. Although the actual daily removal costs varied due to plant density and degree of ambient vegetation, the overall removal cost per acre using this method was \$14,300/acre.

The details of each of the four methods used in The Plan are given below.

Suction Harvesting

Approximately 4.85 acres of fanwort cleared using suction harvested in 2010 taking 27 days at an overall removal rate of about 0.18 acres / day. At this rate, the suction harvesting operation cleared about 1 acre in 5.5 days. However, the actual rate varied between a low of 15 days / acre to a high of 3.5 days / acre. The likely reason for the variation is the condition of plant beds prior to removal and the degree of interspersed fanwort with natives, especially the floating leaved and emergent species. These values are not precise because beginning in early September several hours per day were used to clean up prior harvested areas.

Chart showing operation specifics for WERM - the y axis is hours and bags



Hunt and Pick

The hunt and pick operation became a critical aspect of this removal process. Once the fanwort was found to spread rapidly by root runners removing all plants became vital. Searching for individual plants that were either missed during the suction harvesting this year or had sprouted in areas worked during the last two years.

Containment Fence

The containment fence did not stop the spread of fanwort via stolons as these plants extended root runners under the fence.

Bottom Barrier

Bottom Barrier was affective at killing plants it covered but it proved to be an excellent rooting surface for fanwort fragments. The large number of newly rooted fragments on the aquascreen below the beaver dam in the Bantam River indicates the severity of fragmentation of fanwort growing in the river.

Long Range Management Plan

A long-range plan to control the spread of fanwort in Bantam Lake will need to include management of the plant in the Bantam River and Little Pond,

Fanwort has rapidly increased in coverage over the last 4 years going from coverage of about 0.9 acres in 2004, to 6.2 acres in 2008. The high use of the Bantam River by canoe and kayakers causes fragmentation of fanwort. It is now impossible to transverse more than 100 feet of the river in either direction of the launch site before encountering dense topped out bank-to-bank beds of fanwort. In order to paddle through these areas large numbers of fragments are generated as shown by the colonization of fanwort on top of the bottom barrier installed in the Bantam River. Between August 10 and October 15, 2010, about 2 months, the 7 rolls of aquascreen placed below the beaver dam (see the map shown on page 8 for the location of the beaver dam and the aquascreen), were mostly covered with new growing fanwort. A method is needed that will allow the removal of fanwort from the river but also prevent re-infestation of any cleared areas.

The 6.2 acres of fanwort currently infesting the Bantam River will cost approximately \$ 86,000 to remove using suction harvesting. Actual removal cost may be lower due to the high density and low ambient vegetation within many of the river beds. However, these savings will likely be offset by higher transportation costs because of the lack of off-loading sites within the river. The 14 acre Little Pond, located about 2 miles upstream from Bantam Lake had about 12 acres of dense fanwort when last surveyed in 2009. Removing fanwort in Little Pond using suction harvesting at these rates will likely cost about \$168,000. However, Little Pond also has extremely dense beds of water lilies, water shield, and smartweed, which will slow the removal process.

A long-range plan should include the following tasks:

1 - Hunt and Pick the entire 20.2 acres of know infested littoral zone of Bantam Lake. All areas where fanwort has been known to occur require annual inspections with both search professionals and Hunt and Pick crews. Surveys of fanwort beds should start no earlier than June 1st.

2 - Any area(s) of high-density fanwort observed in Bantam Lake during the Hunt and Pick should be mapped for suction harvesting.

3 - Begin removing fanwort from the Bantam River.

Fanwort beds in the river should be mapped by density as presented in this report. Once the areas of each density are known costs estimates for removal by suction harvesting can be determined in sufficient detail to go to bid.

Determine what type of equipment will be needed to suction harvest fanwort from the river. A pontoon boat may not be suitable to take up the river due to the several beaver dams, as well as local and state regulations.

Determine where harvested material will be off-loaded. Only a few sites present the necessary access to the river to be feasible for off loading bags of fanwort. These use and feasibility of these sites needs to be verified. Once locations of off-loading sites are known the transportation costs can be refined.

Identify how removal efforts in the river will not affect use by canoe and kayaks. Bantam River is a heavily used recreation resource during the summer months. Many people canoe and kayak between the lake and Little Pond. Removal

4 - Eventually including Little Pond or starting from Little Pond. The fanwort in Little Pond represents a larger challenge than either Bantam Lake or Bantam River. Little Pond has abundant ambient vegetation that will slow the removal process, and access may be more difficult.

5 - Continue the search for the original source of fanwort to the system. If fanwort came from the infestation of Timber Pond several miles upstream of Bantam Lake this site needs to be cleared of the plant. However, other sources may exist because efforts to find fanwort between Little Pond and Timber Pond have yielded no plants. Ruling out other sources should not be done until all likely sites have been searched.