Hardwick Lake
Today and Tomorrow

Northern Rivers Land Trust
2013

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Cover Photo by Farley Brown: Hardwick Lake

Photographic contributors: Farley Brown, Richard Perello

INTRODUCTION

In fall 2011 representatives of the Vermont Agency of Natural Resources, Department of Environmental Conservation with support of the Town of Hardwick sought funding for a re-evaluation of the Jackson Dam, Hardwick Lake and the Lamoille River in the Hardwick area. The last such evaluation was done as part on the Lamoille River Basin Water Quality Management Plan in 2009. At about the same time, the Northern Rivers Land Trust (NRLT) re-evaluated its mission as a resource for its seven community members on critical environmental issues and conservation opportunities within their boundaries. A specific goal of the revised mission is to research and provide public information on the status of important land and water areas of significant public interest in each of the member towns.

Given the importance of Hardwick Lake to the community as demonstrated by the strong public involvement in earlier proposals on the future of Jackson Dam and the lake, the NRLT trustees decided to conduct their first research study on the current status of the dam and lake and on its possible future. NRLT appointed a trustee committee to lead the study and they recruited students and faculty of Sterling College to conduct the necessary field research and provide guidance on research methodology. This report summarizes findings. Detailed results, especially of the preliminary ecological inventory of the lake and adjacent land, are available on the NRLT website.

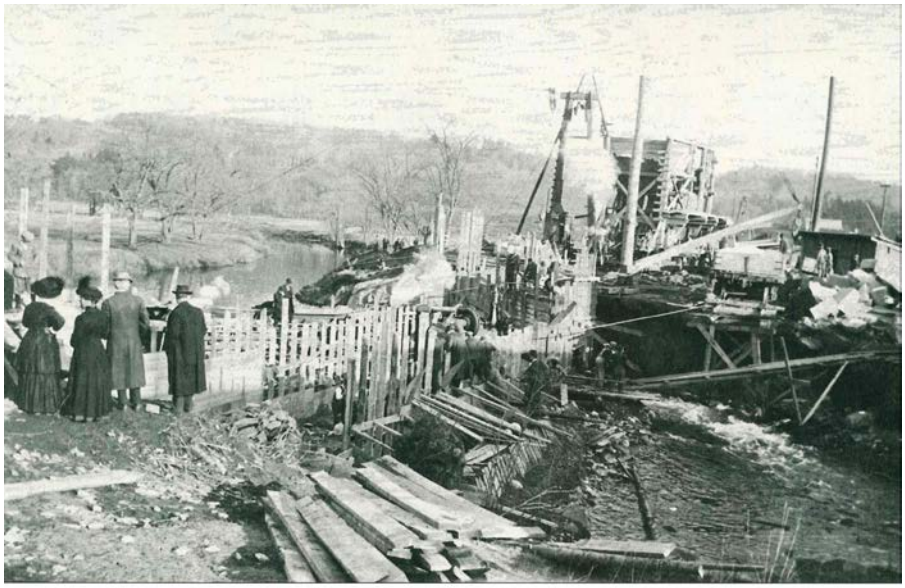
HARDWICK LAKE and JACKSON DAM

Jackson Dam, located near the intersection of route 14 and route 15, was completed in 1920. The dam is a gravity dam, meaning that the force of water pushing on the structure is outweighed by gravity pushing the mass of the dam down. Designed to withstand hard use and provide many years of service, the dam is made of concrete, with a foundation of rock and soil. During construction the perimeter of the lake was lined with gravel to uphold the banks and prevent erosion. The dam is about 523 feet long and 23 feet tall. Its normal surface area is 180 acres. The lake is formed by backing water up Alder Brook to the north and the Lamoille River. It drains an area of 122.1 square miles.

Although originally intended to generate electricity for the Hardwick granite industry it has never been used for that purpose. It has been used in the past to regulate stream flow below the dam to support the operation of the Hardwick Electric Department's hydroelectric generating facility at Pottersville Dam in Wolcott. Jackson Dam is operated and maintained by the Hardwick Electric Department under an agreement with the Town which owns the dam, the land under the lake and some surrounding land east of the lake.

Over recent years the operation of Jackson Dam has focused on controlling sediment release and controlling ice formation and flooding upstream. A large sediment release in 1999 from lowering the dam, bank erosion and influence of the dam on fish population composition in the river have caused the State concern for many years. In a 1988 report, the Water Quality Division of the Department of Environmental Conservation (DEC) reported on these problems and current operation of the dam. They reported the lake level

had been relatively stable until the mid1970's, but beginning about 1980 the outlet gate of the dam was opened and closed frequently resulting in regular variation of the lake level. Beginning in 1984 the lake level was lowered every winter and raised in the spring to help control ice accumulation and flooding in Hardwick. During winter the lake level was occasionally raised in an effort to 'float' accumulated ice and then lowered to move the ice downstream. This was done once or twice a year for periods of three days to two weeks. In 1994 the Army Corp of Engineers installed an ice control structure (ICS) consisting of four sloped granite blocks in the Lamoille River east of Hardwick. This was designed to restrain and break up ice jams that frequently caused flooding in the village, especially in the Wolcott Street area. Since installation of the ICS there have been no floods in the village. Accumulated ice along the river in the Wolcott Street area is excavated when necessary. Currently, the lake level is lowered every winter and remains stable until raised in spring.



Jackson Bridge Dam Under Construction
Hardwick, Vermont
(photograph circa 1912) ~1911
Courtesy of Hardwick Historical Society

In 2002 the Vermont Natural Resource Council and the Lamoille River Anglers Association proposed removal of Jackson Dam arguing that dam removal would "restore 4.4 miles of trout habitat, eliminate the extreme water level fluctuations associated with drawdowns, eliminate liability associated with the structural integrity of the dam and improve the Lamoille River's ability to transport sediment through the impounded reach." This proposal was defeated in a vote of Hardwick residents.

A review of the status of Jackson Dam and Hardwick Lake was conducted in 2008-09 as part of the Water Quality Management Plan for the Lamoille River Basin by ANR. These plans are reviewed and updated on a five year cycle. The 2009 plan repeats the 2004 plan DEC judgment that "removal of Jackson Dam as the best option available to both

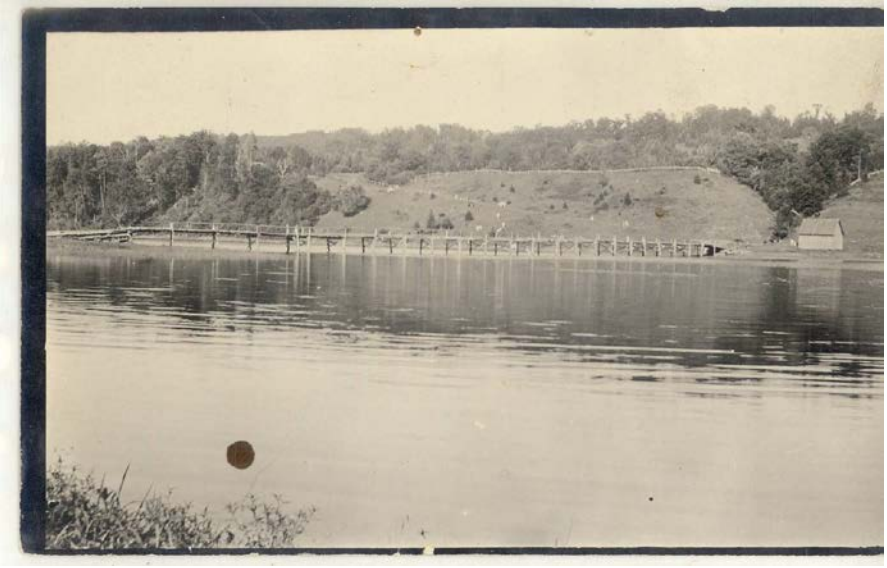
alleviate flooding and icing problems and achieve compliance with Water Quality Standards" without recommending further action. The report's summary assessment of the lake is that the annual draining of the lake "results in a highly unstable aquatic environment that prevents the establishment of a healthy aquatic community of plants, amphibians, aquatic insects and fish."

In summer 2010 the Facilities Engineering Division of DEC conducted a routine inspection of Jackson Dam and concluded, "The overall condition of the dam is poor due to the overall deteriorated condition of the concrete." No critical problems were found, but a number of areas requiring concrete repair were identified.

The fall 2011 effort of DEC to obtain funding for a thorough examination of the dam and its environs was unsuccessful. With the next five year review of the water quality plan due in 2014, the lack of current research on the dam and lake and the significance of Hardwick Lake as a major natural area in Hardwick, NRLT decided to undertake this exploratory assessment of the current 'aquatic environment' of the lake to provide up to date information to the community. This assessment is necessarily exploratory and incomplete since it is an entirely volunteer, limited, unfunded effort. The following sections present the methodology and results of the study.

HISTORICAL AND CURRENT LAND USE

Even before the installation of Jackson Dam, the land surrounding Alder Brook (now Hardwick Lake) was once productive agricultural land and both hillsides throughout the valley where actively sugared for many years. This area of Town was never highly populated but supported a district school and small local stores. In the spring of 2012, Sterling College students conducted a property deed research on several properties around the lake and found evidence of farming and maple sugar production in deeds from the 1800s. The property deed frequently included an accounting of the number of maple buckets and taps, and agricultural equipment and livestock sold with the property. While Hardwick history is documented through other resources such as the Beer's Map of 1875 and resources found in the Hardwick Historical Society, previous land use is also evident on the landscape as you walk the land and uncover stonewalls and old equipment throughout the forest, or explore the foundation of what was thought to once be the "Pest House".



Eastern shore of Hardwick Lake and possible “Pest House” 1900?
Courtesy of the Hardwick Historical Society

Current land use around the lake is predominately residential with limited businesses closer to the edge of town. The landscape is now forested and the Town gravel operation is the only natural resource extraction at this time. The eastern slope of Hardwick Lake is still a large tract of land, currently undeveloped and publically owned by the town of Hardwick, however it is currently being used and maintained by Hardwick Electric Department. The land parcel is 417 acres in total. The land to the west of Hardwick Lake consists primarily of private landowners. Many enjoy recreational opportunities on the east side of the lake with the establishment of the Hardwick Recreation Trail, and others enjoy canoeing and kayaking on the lake. The Hardwick Lake area is no longer a working landscape but more a residential and recreational landscape and its future is unknown.

Children in canoe on Hardwick Lake early 1900s Courtesy of the Hardwick Historical Society

NATURAL FEATURES OF HARDWICK LAKE AND SURROUNDING LANDSCAPE

During June 2012, a team of Sterling College students and Professor Farley Brown conducted a preliminary ecological survey of the flora and fauna around Hardwick. An aquatic bioassessment of two tributaries on the eastern shore was also conducted to better understand the health of the streams and the quality of the water entering Hardwick Lake. The survey also included a four hour "bioblitz" of the lake and shoreline by students and faculty as part of field ornithology and botany classes. Species lists from these studies are included in the appendix.


Columbine
Hardwick Lake

The biophysical regions of Vermont are often broken down into smaller units by climate, geography, topography, water resources, soils, natural plant communities and human history. Hardwick Lake has been categorized by Vermont ecologists as being in the Northern Piedmont bioregion[1]. This is a hilly region with many rivers, a cool climate, gentle topography, and rich soils derived from the calcareous bedrock (calcium rich) substrate. The region is defined by natural communities such as northern hardwood forest and hemlock and white cedar stands.

The ecological inventory of Hardwick Lake and its surrounding landscape includes looking at natural communities, which not only tell us the composition of a forest or wetlands, it also help us to understand historical land uses, as well as the current lay of the land. After natural communities have been delineated, it is necessary to identify the common species of plants and animals that make up these communities.

During four visits to the lake, various inventory techniques were used to determine the natural communities. We divided the lake and surrounding landscape into general natural communities such as cattail and emergent marshes, sedge meadows, tributaries, forested areas, and open water, and then inventoried those areas using several methods including field observations and stream assessment.


Sedge meadow along
Hardwick Lake shore

Plants and associated habitat for wildlife and birds can be used to determine a natural community. Since plants do not move, their steadiness allows us to easily pinpoint location and identification. On the other hand birds move across the landscape and can tell us a great deal in regards to natural communities -- species heard can inform us about the plants communities throughout the lake and surrounding landscape.

Identification of bird species was conducted by listening and by sight. In order to improve our chances of seeing all bird

[1] Sorenson and Thompson, Wetland, Woodland, Wildland: A Guide to Natural Communities of Vermont (2000)

species that occur on the lake, we focused on the center of the body of water, around the forest edge, and along two tributaries that feed into the lake. The habitat diversity along Hardwick Lake provided us with a variety of species. A slow paddle along the edge accounted for many of the bird sightings, such as Canada geese and common loon with their young, and shoreline species such as the belted kingfisher and osprey. Deeper into the forest we could hear a variety of neotropical migrant songbirds such as the wood thrush, as well as more endemic species such as ruffed grouse.

Similar to our bird inventory method, we paddled through open water, cattail and emergent marshes, and sedge meadows, and walked along the tributaries and associated forests, observing plant species along the way. The plants on the shoreline, the trees in the forest, and emergents in the lake can tell us a great deal about the past and present land use surrounding the lake. Overall plant communities included spring flora such as trillium, aster, columbine, and Canada mayflower; early succession forest species such as yellow birch, white ash, and cherry; conifer stands such as hemlock, red spruce and balsam fir. These plant communities, along with the wetland and shoreline plant associations, provide a diverse landscape.


Tracks along Hardwick Lake

Evidence of many different wildlife species were observed through tracks and scat. These mammals are indicator species of the health of the natural communities studied throughout Hardwick Lake, and reflect that the water edge and surrounding landscape provide sufficient habitat. Majority of tracks were seen in the mud associated where the tributaries meet the lake thus confirming the interrelationship of the habitat needs. Sterling College students and a Vermont Fish and Wildlife biologist walked a small portion of the town property along Hardwick Lake and determined that deer wintering area components (softwood cover, food source) are present on the landscape. This area is on the current Vermont Fish and Wildlife deer wintering area map. A winter tracking survey along with wildlife cameras would provide a deeper understanding of the animals present throughout the Hardwick Lake landscape. Several amphibian and reptile species were noted with great interest, especially because they are important indicator species of healthy habitat. (Salamanders alone provide great percentage of biomass and serve as a food source for many animals.) It is evident that there is a variety of wildlife throughout the landscape and that different habitat needs are available.


Stream on east bank of Hardwick Lake

Hardwick Lake has three main streams that run down the east side of the lake. Streams are frequently surveyed to better understand the biological, physical, and chemical conditions of water resources. Two of the streams were sampled for benthic macroinvertebrates - biological indicators of stream health - to determine if the current land use on the eastern side of the lake might be impacting water quality. The sampling included an assessment of stream geomorphology and vegetative cover. A high diversity of macroinvertebrates were found in both streams

along with stable banks and dense canopy cover, indicating that the streams entering Hardwick Lake are in good condition and not impinging the water quality of the lake.

Summary

Hardwick Lake and the immediate surrounding landscape are composed of a variety of natural features that provide diverse ecological systems. The wetlands, marshes, open water, lakeshore, streams, and intact softwood and hardwood forests on the eastern side of the lake, blend together to create a variety of habitats for many plants, birds, mammals, amphibians, and other fauna. Even though the landscape was once cleared for agricultural and forest purposes, the natural communities and associated wildlife are now thriving. Hardwick Lake and the surrounding land provide a link in the connectivity of natural landscape throughout the area.

While this ecological inventory is focused on Hardwick Lake and the surrounding shoreline, it is also critical to think beyond the boundaries. Hardwick Lake is part of Lamoille River watershed and the ecological relationships between the lake, Alder Brook and the Lamoille River are dynamic. Due to the artificial nature of Hardwick Lake, the Lamoille River is impacted upstream and downstream by the build up of sedimentation around the dam. Concerns about these impacts, including fish habitat degradation from warm water and sedimentation below Jackson Dam, were documented in the 2009 Lamoille River Basin Water Quality Management Plan by the Vermont Agency of Natural Resources. In order to protect the ecological health of the local watershed, these impacts must be monitored and addressed in the immediate future.

American Toad *(Bufo americanus)*
Hardwick Lake

THE COMMUNITY AND THE LAKE

To gather perspectives on the value of the lake and dam to the community, six local citizens who have been involved with lake issues and/or use the lake, two local officials, and three state agency personnel who have studied the lake were interviewed by a student intern from Sterling College for the NRLT in the fall of 2012. The purpose of these interviews was to assess the attitudes towards the future of the dam. Some of the themes that were mentioned include the wildlife that is present, the recreational value to the town, and the possible damage to the land from ice. During these interviews, it was evident that there was a core group of individuals who felt strongly about keeping Hardwick Lake and others who were more or less indifferent to its existence until it would require hefty funds to keep it. In addition to the interviews, we reviewed the public debate in 2002 on the proposal to remove Jackson Dam and we reviewed the Creative Communities Action Plan conducted in 2006 for the future development of Hardwick.

Public Debate 2002

In 2002, the Vermont Department of Conservation, working with the Vermont Natural Resources Council and the Lamoille River Anglers Association, approached the Hardwick Electric Department to explore the possibility of removing the dam and restoring Alder Brook. This quickly became a public issue resulting in presentation and discussion of studies and issues by State agencies, the Town, the Hardwick Historical Society, the Save the Lake Committee formed by local residents, and students at Hazen Union High School. The decision was ultimately left up to the residents with a vote of either yes, to restore Alder Brook or no, to keep the dam. When the vote took place in August of 2002, the residents of Hardwick decided to preserve the dam by a vote 403 to 159.

Creative Communities Program

In July 2006 the Vermont Council on Rural Development published its report and action plan on the pilot Creative Communities program in Hardwick[2]. This program brought together interested citizens and community organizations to discuss current conditions in Hardwick, select the issues of most importance to participating community members, and develop action plans on those issues. Following an organizing process, committee meetings, and information gathering throughout the community four projects were selected as most important to Hardwick's future, and action plans were developed at a community forum on May 20th. The four projects included,

- Spruce up downtown Hardwick
- Develop the future of the Town House
- Expand recreation in the Hardwick Lake area
- Create a business incubator and arts space

[2] Final Report and Action Plan, Hardwick Creative Communities Program, Vermont Council on Rural Development, July 2006.

The inclusion of Hardwick Lake in the four priority areas shows its importance to the citizens of Hardwick as a present and future recreation area and as an important landscape feature in the identity of Hardwick. The action plan for Hardwick Lake involves five steps:

- Research on dam conditions, assessment of natural resources in the lake area and on property ownership;
- Develop connections to existing walking, biking, and ski trail and develop new trails in the area;
- Improve lake access through existing roads and develop a boat access ramp on the west side of the lake;
- Develop signage to access the trails;
- Bring the community to the lake through walking tours, boating events, etc.

This report is a contribution to the first of these steps to improve recreation opportunities in the lake area.

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Interviews

During an interview with Ron and Norma Weisen, who are active members of the Hardwick Trails Committee, they said that initially they were hesitant to jump on the bandwagon to keep the dam when the issue arose in 2002; however after experiencing Hardwick Lake firsthand during that time, and seeing the abundant wildlife as well as the recreational value they realized how important it was to conserve the Lake and keep the dam. The Weisens still explore Hardwick Lake to this day and have been crucial to the development of a footpath that gives access to the lake from the network of trails behind Hazen Union High School. The increase in access to the lake has enriched the trails with the addition of Wayne's Way, which leads to the water. Their commitment to preserving Hardwick Lake was reinforced by their sightings of an active loon pair and the hundreds of birds that have stopped at the lake during their migration. A rare sighting of eagles has also been noted by many visitors to the lake.

Birds and other wildlife are a common sight on the lake; they are a key component in why the residents feel that the lake should be preserved. The loon pair that calls Hardwick Lake home is being monitored by local loon biologist, Eric Hanson, who was surprised at their presence on the lake because of the limited amount of space that Hardwick Lake provides. Sue Holmes, a resident of Hardwick and owner of the Kimball House, a bed and breakfast in town, spoke eloquently about the bats that fly along the water's edge at dusk and the beavers that slap their tails near her boat if she should get too close to their home. These and similar stories were the primary reasons why the

residents felt that the lake provided a special natural environment and resource in Hardwick.

In 2002, a study of the fish population in the lake was conducted by Hazen Union High School, and they found that the lake supported few fish species and the fish were small in size compared to other local lakes; therefore Hardwick Lake could not sustain the diet needed for the loons. However Lesa Cathcart, a homeowner on Hardwick Lake, said "They came in and drained the lake and killed all the fish, some were good sized trout and pickerel, and then they reported that there were no fish". She was referring to when they drained the lake during the summer time when the lake would not have been drained normally. Jon Jewett, the Town Manager, said that " there are a few pickerel and some small crawfish, but no one goes there to fish, so there can't be that healthy of a population of sizeable fish in the lake, the lack of depth and high water temperature make it difficult".[3] He has not personally been on the lake to fish but he is an avid fisherman and would know if others frequented the lake to fish and what quality of fishing is available there.

Eric Werner, the manager of Hardwick Electric and a fisherman, said that the water is too shallow and warm for large fish and the draining each year stunts the growth. Brian Fitzgerald and Jon Jewett also echoed this concern. Despite the reports that Hardwick Lake was a dead zone for life, the personal accounts have rebutted this argument and shown that the data may have been incomplete.

This raised the question, if there were a choice, would residents prefer that Hardwick Lake become year-round, versus the current situation where it is a lake during the summer and a stream during the winter? When asked this question, Ron & Norma Weisen, Sue Holmes and Lesa Cathcart said yes. They felt that it would be the best situation for the health of the ecosystem. Brian Fitzgerald, who works for the State of Vermont Watershed Division, reiterated that draining the lake stunted the ecosystem and would ultimately become a dead zone as the current population fails to survive the constant changing conditions.

Jon Jewett, Hardwick Town Manager and Eric Werner, Hardwick Electric Department were interviewed on the subject of current dam operation and the future of the dam. The lake continues to be lowered every fall and raised in the spring with the assumption this helps prevent ice backups. Jon Jewett said that once the Army Corps of Engineers put the granite blocks in, ice jams have not been an issue, but that one reason for lowering the lake might be keep the dam from being damaged during the winter due to ice and frost heaves. Eric Werner stated "there is an S-curve behind Lamoille Valley Ford that is the root of the problem, it jams up the ice and causes a lot of problems."[4] When questioned if the dam aid in ice jams, he replied "no, the S-curve is the problem; the ice never makes it to the dam". On the question of long term maintenance of the dam, Jon Jewett and Eric Werner stated that if the dam became inoperable and needed to be replaced that neither the town of Hardwick nor Hardwick Electric would pay to have it rebuilt.

[3] Jewett, Jon. personal interview. 13 Feb 2013.
[4] Werner, Eric. personal interview. 10 Feb 2013.

POSSIBLE FUTURES

There are many questions about the future of Hardwick Lake and the undeveloped public land around the lake, especially the land along the eastern slope of the lake. Answers to these questions all depend on the future status of Jackson Dam. For a clearer picture of the issues and opportunities that may arise, we consider three possibilities: the dam remains in its current operating status; the dam is removed; the dam is restored to full time operation maintaining the original lake level. Some change in the dam status in the future is likely. Currently the Hardwick Electric Department continues to maintain the dam under an agreement with the Town although the dam is no longer used for hydroelectric purposes. Recently the electric department has held preliminary discussions with other electric utilities on the possibility of merger or acquisition. Should such change occur or should the Department rescind its agreement with the Town, maintenance of the dam and its long-term future will become a Town responsibility.

It should be noted that two current improvements are making a significant contribution to the recreation value of the lake and adjacent land. The first of these is construction of a ramp providing hand-carry boat access to the lake and limited parking on State land along Route 14 on the west side of the lake. This will provide easy access for canoes, kayaks and small rowboats for boating and fishing. The Vermont Department of Fish and Wildlife is currently seeking funding for construction of the ramp. The second improvement is the opening of Wayne's Way, a trail that extends the Hardwick Trails behind Hazen School to the east bank of Hardwick Lake. This provides access to explore the bank, streams, and woods along the eastern slope. Also, support for wildlife on the lake is being provided by the Vermont Loon Recovery Project which places nesting rafts on the lake

The three scenarios presented below are necessarily speculative because our assessment of the ecosystem is exploratory and we cannot estimate long term costs and benefits of major changes in the dam, lake and river. In considering these possibilities, two perspectives should be kept in mind: the effect of major changes on the immediate area of the lake and on the Hardwick area, and the effect of major changes on the broader watershed and the Lamoille River ecosystem.

Maintaining Current Status

The critical questions about continuing current practice include is draining the lake in the fall essential for preventing ice jams and flooding in the winter and is the annual variation of lake level conducive to a healthy aquatic and land environment? As discussed above monitoring of floods since installation of the ice blocks shows that they have been very effective in flood and ice jam control. Occasional flooding in the Wolcott area continues, but as Eric Werner of HED stated "there is an S-curve behind Lamoille Valley Ford that is the root of the problem; it jams up the ice and causes a lot of problems."[5]

[5] Werner, Eric. personal interview. 10 Feb 2013.

The ever changing levels of the lake may be a more serious problem. As discussed above, previous studies of the lake suggest that present practice results in an unstable ecosystem with possible long-term damage. However, our exploratory inventory found healthy plant and animal life in the area. Since the lake is shallow, the water is warm and fish population is limited. Perhaps the major issue is how can the necessary maintenance and improvement of the dam and river channel be secured over time?

Removal of the Dam

If the dam is removed, Alder Brook would be restored and the Lamoille River would flow freely which could be beneficial for fish habitat as well as the overall health of the river. Without the building up of sediment behind the dam as well as the warming of the water, trout and other cold water fish populations might be restored over time and fishing could improve downstream on the Lamoille River. The restoration of Alder Brook would likely include formation of some pools that would support turtles and some other aquatic life now in the lake. Beaver and other shoreline creatures would likely remain. There would probably be a loss of habitat for waterfowl, including loons, ducks and geese, and the occasional shore birds that now visit the area. But with this loss there would be the development of a greater wetland complex which might provide habitat for additional avian species. Other wetland functions such as flood retention as well as stream bank stabilization could be additional benefits.

Aerial view of Hardwick Lake Spring 2001 (notice Alder Brook channel)
(Summer STARS Project Hardwick REACH Program 2001)

The problem of ice accumulation and river backup due to the S-curve would not be addressed. The major loss to the community would be a great reduction in recreational value.

Year-round Lake

Returning to a year-round lake would stabilize the ecology of the area and provide a significant increase in recreational value to the community. However, there would be some substantial costs. Repair of the concrete problems at the dam identified by the State should be completed prior to returning to a year-round lake. Dredging to remove accumulated silt in the river bed could improve fish habitat and improve boating. The cost of the dredging may be partly offset by sale of the accumulated silt. However, the lake would still be relatively shallow and warm and would not support a significant fish population. The cost of maintaining the dam and supporting the recreational development of the lake property would likely shift to the Town since Hardwick Electric Department would have no further operational interest in the dam. In addition, the ice accumulation at the S-curve behind Lamoille Valley Ford would have to be addressed.

Benefits and Costs

Potential benefits of each alternative: Removing the dam would improve river flow and could eventually improve fishing in the river. Creating a year-round lake would significantly improve recreational opportunities and the identity attachment of Hardwick with the lake. Maintaining current status generates limited benefits.

Potential costs of each alternative: Removing the dam would be a low cost option since public funds have been available for this purpose. Creating a year-round lake would be an expensive option for Hardwick since public funds have not been available for the initial costs for improving and maintaining the dam. Maintaining current status would be a relatively low cost, but an unpredictable option depending on cost of maintenance of the dam.

Whatever change eventually occurs, four actions appear important to pursue now:

- Addressing the S-curve ice accumulation
- Improving dam maintenance
- Monitoring the lake area and the surrounding Lamoille River for ecological impacts from sediment accumulation and warming waters
- Improving access to the recreational opportunities of the lake area

Hardwick Lake and the surrounding town property provide a variety of benefits for the citizens of Hardwick and visitors, as well as the wildlife and other natural features in the area. But there are significant costs associated with these benefits – financial and ecological costs. As options about current and future plans for Hardwick Lake develop, it is important that the community be informed and involved in these discussions. We hope this report is a contribution to that end.

ACKNOWLEDGEMENTS

First and foremost, NRLT is greatly indebted to Professor Farley Brown of Sterling College who is the principal author of this report. In addition she recruited, organized and supervised Sterling College students who conducted the field research on historical land use and the exploratory assessment of the lake environment. This project would not have been possible without her and the students' participation. We thank Alexis Drane, a Sterling College intern on the project, who conducted the interviews and helped write this report. We thank the students for their good work and Sterling College for its welcoming support of the project. We thank the State officials who helped guide the students' field work. We are grateful to the community citizens, the Hardwick Historical Society and the Town and State officials who gave freely of their time in interviews and interactions with students. The completion of the project and preparation of the report was made possible by a grant from the Northeast Kingdom Fund of the Vermont Community Foundation for which we thank them.

This report is available on the Northern Rivers Land Trust website: northernriverslandtrust.org

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ABOUT NORTHERN RIVERS LAND TRUST

Northern Rivers Land Trust (NRLT) , representing seven neighboring towns, is dedicated to protecting the natural, scenic, and working landscapes in the headwaters of the Winooski, Lamoille, and Black Rivers. Our objectives are:

- Protect and enhance natural resources and natural beauty;
- Safeguard our cultural heritage by preserving working farms and forests;
- Educate people about conservation;
- Provide stewardship for conserved properties;
- Preserve rural landscapes and communities for generations to come.

NRLT is a partnership of people working together to ensure that as Vermont changes rural land in our region is not lost to development. We help farm families conserve productive agricultural land for future generations, preserving not only our heritage but also our economic future. We protect forestland that supports a healthy wood products industry and sustains habitat critical for black bear, songbirds, deer, and other wildlife. We help to permanently protect irreplaceable fields, woods, and shoreline essential for recreation and scenic enjoyment.

Using legal tools called ‘conservation easements’ or ‘grants of development rights’ landowners voluntarily limit development while keeping the land open for forestry’ farming, and recreation. Conserved property remains in private ownership with the peace of mind that it is protected forever. The landowner decides whether to allow public access. Easement donations qualify as charitable contributions for federal and state income and estate taxes, but do not normally lower property taxes.

NRLT is a volunteer run non-profit, 501c3 membership organization and is dependent on contributions from members and others and foundation grants to support its work. Persons interested in NRLT may contact us by calling Susan Houston, chair at 802-586-2873 or a trustee in your community. More information about NRLT is at our web site www.northernriverslandtrust.org.

Trustees:

Susan Houston, chair, Craftsbury
Steve Young, vice-chair, Wolcott
Clive Gray, co-treasurer, Greensboro
Ann Ingerson, co-treasurer, Craftsbury
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Todd Hardie, Greensboro
George Hemmens, Hardwick
Chris Jacobs, Albany
Lisa Lammi, Woodbury
Steve Meyer, Hardwick
John Miller, Stannard

Appendix A – Interviews

Interviewees:
Jon Jewett is the current Hardwick Town Manager. Though he was not the Town Manager when the vote took place in 2002, he is well versed in the discussion about the dam and the lake, as well as the fluvial geomorphology of the Lamoille River.

Eric Werner is the manager of Hardwick Electric Department which maintains Jackson Dam. He is involved in the maintenance and evaluation of the dam.

Mike Wichwrowski is with the Vermont Department of Fish & Wildlife and is in charge of the new boat access plan that has been approved and will be located along Route 14, just north of the dam.

Susan Bulmer is the Parks Regional Manager for the Vermont Department of Forests, Parks & Recreation.

Brian Fitzgerald is the Streamflow Protection Coordinator for the state of Vermont. He was also a part of the Vermont Dam Removal Task Force that worked with the town to prepare the citizens for a town vote on the future of the dam.

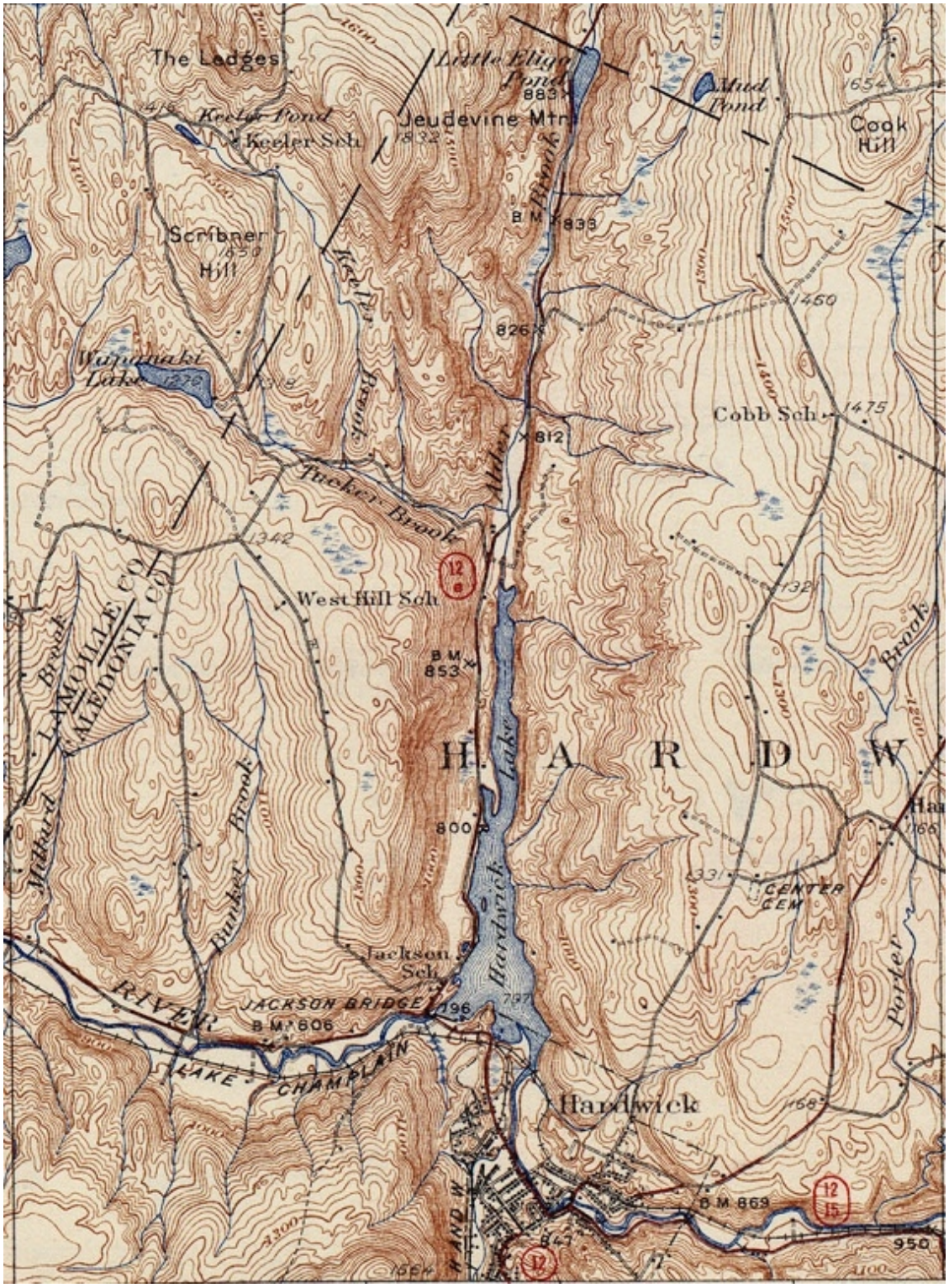
Ron & Norma Wiesen are Hardwick residents and they serve on the Hardwick Recreation committee and they are involved in the Hardwick Trails.

Sue Holmes is a Hardwick resident who runs a Bed & Breakfast and uses Hardwick Lake as a recreational area.

Lesa Cathcart is a Hardwick resident who lives on Hardwick Lake and uses it recreationally.

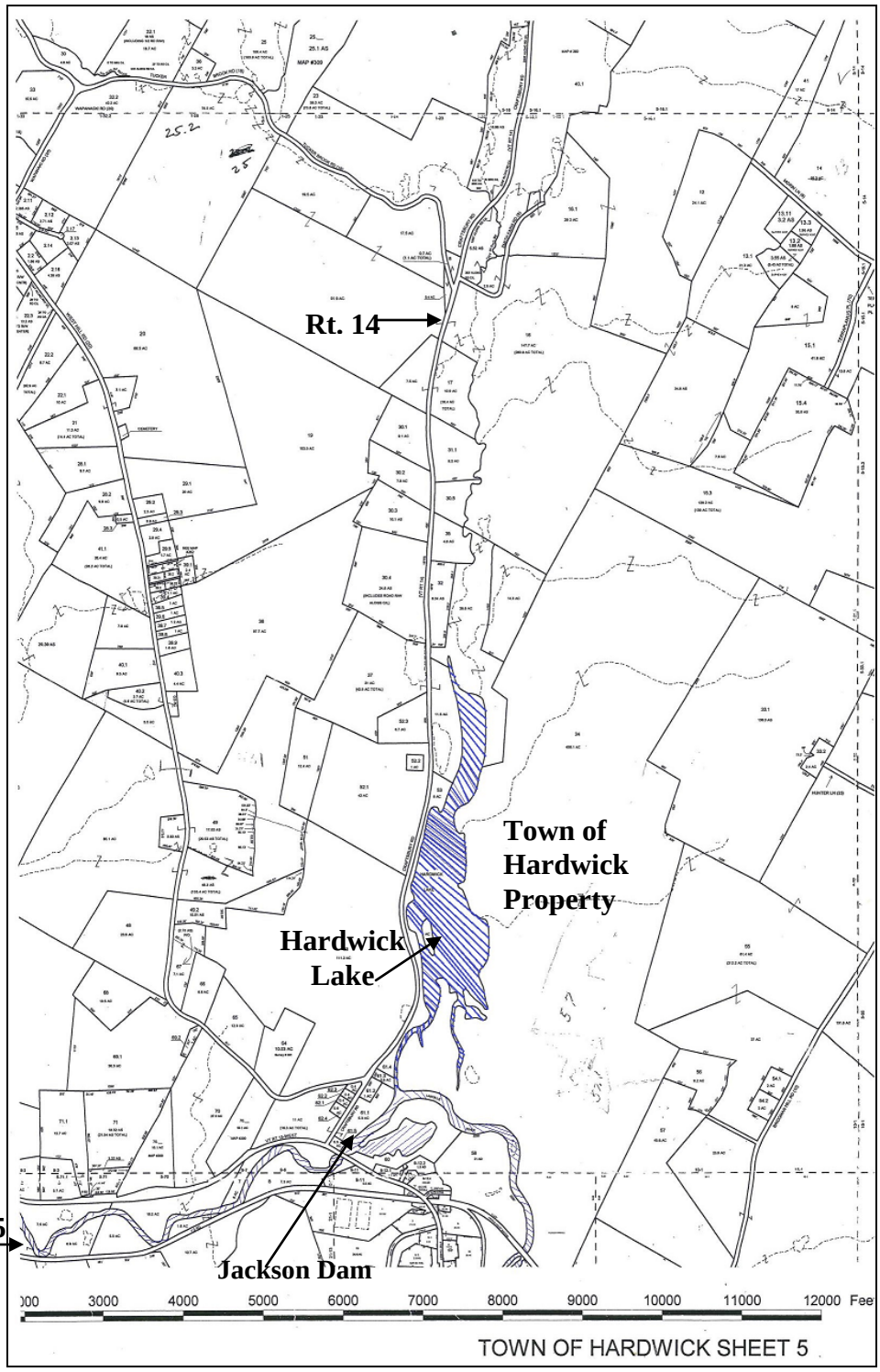
Appendix B – Hardwick Vermont Maps

Hardwick Topographic Map 1934



Appendix B – Hardwick, Vermont Maps

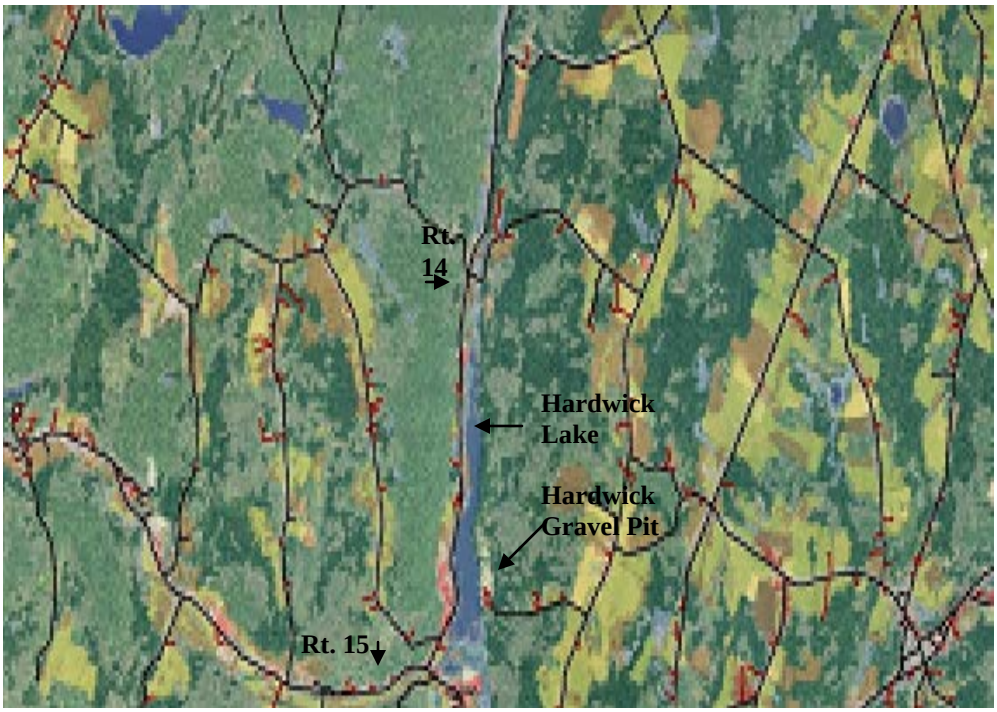
Hardwick Parcel Map 2012



Source: Hardwick Town Office

Appendix B – Hardwick Vermont Maps

Hardwick Land Cover and Land Use Map



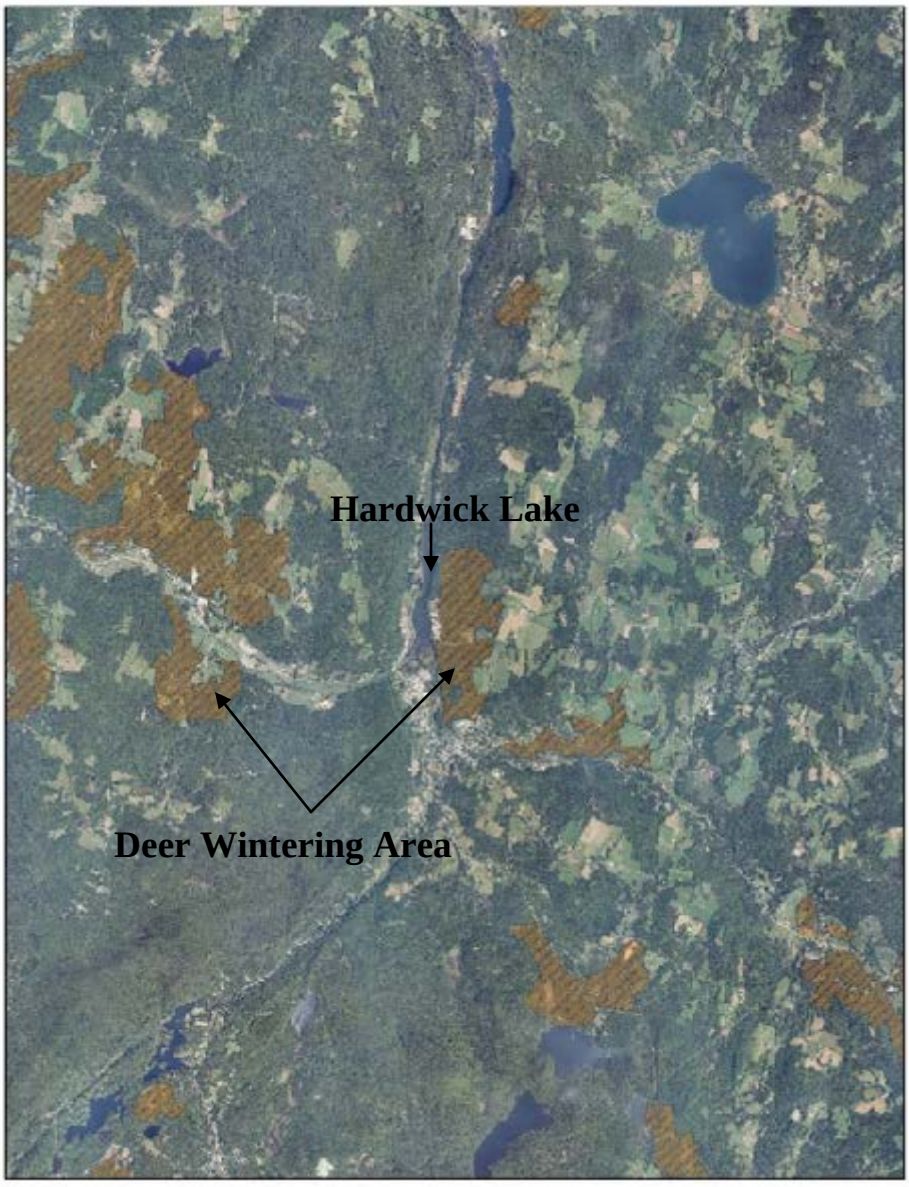
LEGEND

	Driveway
	Roads
	Open Water
	Developed Low Intensity
	Developed Medium Intensity
	Barren Rock (sand, Clay, Sand)
	Deciduous Forest
	Evergreen Forest
	Mixed Forest
	Shrub/ Scrub
	Grassland/ Herbaceous
	Pasture Hay
	Cultivated Crop
	Emergent Herbaceous Wetlands

Source: Sterling College GIS Lab and Vermont Center for Geographic Information

Appendix B – Hardwick Vermont Maps

Hardwick Deer Wintering Map
Vermont Department of Fish and Wildlife



Source: Sterling College GIS Lab and Vermont Center for Geographic Information

Appendix C – Species Lists

Hardwick Lake Plant Inventory

Sterling College- June 2012

Common Name	Scientific Name	Location	Notes
Balsam Fr	*Abies Balsamae*	NE Tributary	lower wooded area
Beech Tree	*Fagus*	NE Tributary	marsh lake shore
Bitter Nightshade	*Solanum dulcamara*	NE Tributary	Damp, Rich Woods
Bitterdock	*Rumex Obtusifolius*	NE Tributary	lower wooded area
Black Cherry	*Prunus Serotina*	NE Tributary	lower wooded area
Black Cherry	*Prunus Serotina*	SE Tributary	VAST trail above cellar hole
Blue Cohash	*Caulophyllum thalictroides*	NE Tributary	lower wooded area
Blue Cohosh	*Caulophyllum thalictroides*	NE Tributary	marsh lake shore
Blue Verain	*Verbena hastata*	SE Tributary	marsh lake shore
Braken Fern	*Pteridium*	SE Tributary	VAST trail above cellar hole
Broad Leaved Spirea	*Spiraea latifolia*	NE Tributary	
Broadleaf Spirea	*Spirea latifolia*	SE Tributary	Has coarse teeth
Broom Sedge	*Carex scoparia*	SE Tributary	marsh lake shore
Bulb-Bearing Water Hemlock	*Cicuta bulbifera*	SE Tributary	
Canada Mayflower	*Maianthemum canadense*	NE Tributary	lower wooded area
Canada Mayflower	*Maianthemum canadense*	SE Tributary	VAST trail above cellar hole
Cancer Root	*Conopholis Americana*	NE Tributary	lower wooded area
Cesel Leaved Bellwort	*Uvularia Sessileleaf*	SE Tributary	VAST trail above cellar hole
Christmas Fern	*Polystichum acrostichoides*	NE Tributary	marsh lake shore
Coltsfoot	*Tussilago farfarra*	SE Tributary	low, yellow flowers early spring
Common Arrowhead	*Sagittaria latifolia*	SE Tributary	marsh lake shore
Common Cattail	*Typha latifolia*	In the lake	in the lake, amongst other cattails
Common Cinquefoil	*Potentilla Simplex*	NE Tributary	lower wooded area
Common Dandelion	*Taraxacum*	NE Tributary	lower wooded area
Common Winter Cress	*Barbarea vulgrans*	SE Tributary	
Comon Plaintain	*Plantago Major*	SE Tributary	VAST trail above cellar hole
Doll's Eyes	*Actaea pachypoda*	NE Tributary	lower wooded area
Dwarf Enchanters Nightshade	*Circaea Lutetiana*	NE Tributary	lower wooded area

Common Name	Scientific Name	Location	Notes
Dwarf Enchanters Nightshade	*Circaea Lutetiana*	NE Tributary	marsh lake shore
Eastern White Pine	*Pinus strobus*	NE Tributary	lower wooded area
False Hellbore	*Veratrum Viride*	NE Tributary	marsh lake shore
False Pimpernel	*Lindernia dubia*	SE Tributary	marsh lake shore
Forget Me Not	*Myosotis*	NE Tributary	marsh lake shore
Frost Grape	*Vitus vulpina*	NE Tributary	
Golden Rod	*Solidago*	NE Tributary	marsh lake shore
Golden Rod	*Solidago*	SE Tributary	VAST trail above cellar hole
Grey Birch	*Betula Populifolia*	SE Tributary	VAST trail above cellar hole
Hawthorn	*Crataegus*	NE Tributary	lower wooded area
Hedge Bindweed	*Convolvulus sepium*	NE Tributary	
Hemlock	*Tsuga*	SE Tributary	VAST trail above cellar hole
Herb Robert	*Geranium Robertianum*	NE Tributary	lower wooded area
Hog Peanut	*Amphicarpaea bracteata*	NE Tributary	lower wooded area
honey Suckle	*Lonicera*	SE Tributary	VAST trail above cellar hole
Hop Horn Beam	*Ostrya*	SE Tributary	VAST trail above cellar hole
Hornwort	*ceratophyllum demersum*	SE Tributary	80% confident
Horse Tail	*Equisetum*	SE Tributary	VAST trail above cellar hole
Intermediate Fern	*Dryopteris Intermedia*	NE Tributary	marsh lake shore
Interupted Fern	*Osmunda Claytoniana*	SE Tributary	VAST trail above cellar hole
Jewel Weed	*Impatien*	SE Tributary	VAST trail above cellar hole
Large Leaved Avens	*Geum Macrophyllum*	NE Tributary	lower wooded area
Marginal Fern	*Dryopteris Marginalis*	SE Tributary	VAST trail above cellar hole
Marsh Bedstraw	*Galium palustre*	SE Tributary	wet meadows and swamps
Marsh Skullcap	*Scutellaria epilobiifolia*	SE Tributary	Wet rich woods
Marsh St. Johnswort	*Hypericum virgininicum*	SE Tributary	marsh lake shore
Marsh St. Johnswort	*Hypericum virgininicum*	NE Tributary	marsh lake shore
Meadow Rue	*Thalictrum*	NE Tributary	
Meadow Rue	*Thalictrum*	NE Tributary	marsh lake shore
Mild Water Pepper	*Polygonella hydropiperoides*	SE Tributary	Wet rich woods
Milkweed	*Asclepias*	SE Tributary	VAST trail above cellar hole

Common Name	Scientific Name	Location	Notes
Moneywort	*Lysimachia nummularia*	NE Tributary	lower wooded area
Monkey Flower	*mimulus ringens*	NE Tributary	yellow tongue dead give away
Moose Maple	*Acer Spicatum*	SE Tributary	VAST trail above cellar hole
Narrow-leaved Cattail	*Typha angustifolia*	In the lake	in the lake, amongst other cattails
Nettle	*Urtica*	SE Tributary	VAST trail above cellar hole
Northern Honeysuckle	*Lonicera vullosa*	SE Tributary	
Pale St. Johnswort	*Hypericum ellipticum*	SE Tributary	marsh lake shore
Quaking Aspen	*Populus tremuloides*	NE Tributary	lower wooded area
Raspberry	*Rubus*	NE Tributary	marsh lake shore
Raspberry	*Rubus*	SE Tributary	VAST trail above cellar hole
Red Baneberry	*Actaea Rubra*	NE Tributary	lower wooded area
Red Clover	*Trifolium Pratense*	SE Tributary	VAST trail above cellar hole
Red Maple	*Acer rubrum*	NE Tributary	lower wooded area
Red Pine	*Pinus Resinosa*	NE Tributary	lower wooded area
Red Spruce	*Picea Rubens*	SE Tributary	VAST trail above cellar hole
Rough Bedstraw	*Galium asprellum*	NE Tributary	lower wooded area
Rough Cinquefoil	*Potentilla norvegica*	SE Tributary	
Rough Leaved Aster	*Aster radula*	NE Tributary	
Royal Fern	*Osmunda Regalis*	NE Tributary	marsh lake shore
Sensitive Fern	*Onoculea sensibilis*	SE Tributary	Damp, rich woods
Silver Maple	*Acer saccarinum*	NE Tributary	lower wooded area
Slender Toothwort	*Cardamine Angustata*	NE Tributary	lower wooded area
Small Sundrops	*Oenothera perennis*	SE Tributary	
Soft-stem Bulrush	*Scirpus validus*	SE Tributary	
Speckled Alder	*Alnus Incana*	NE Tributary	lower wooded area
Speedwell	*Veronica spp.*	SE Tributary	
Spike Rush	*Eleocharis aricularis*	SE Tributary	marsh lake shore
Spotted Joe Pye Weed	*Eupatorium maculatum*	SE Tributary	
Stinging Nettle	*Urtica Dioica*	NE Tributary	marsh lake shore
Strawberry	*Fragaria Vesca*	NE Tributary	marsh lake shore
Strawberry	*Fragaria Vesca*	SE Tributary	VAST trail above cellar hole
Sugar Maple	*Acer saccharum*	NE Tributary	lower wooded area
Sugar Maple	*Acer Saccharum*	SE Tributary	VAST trail above cellar hole
Swamp Bedstraw	*Galium Brevipes*	NE Tributary	lower wooded area
Swamp Milkweed	*Asclepias purpurascens*	SE Tributary	
Sweet Flag	*Acorus calamus*	SE Tributary	

Common Name	Scientific Name	Location	Notes
Sweet Vernal Grass	*Anthoxanthum odoratum*	SE Tributary	
Switch Grass	*Pancium Virgatum*	SE Tributary	
Tall Buttercup	*Ranunculus acris*	NE Tributary	lower wooded area
Tall Goldenrod	*Solidago altissima*	SE Tributary	3 veined w/2 veins nearly parallel
Trailing Arbutus	*Epigaea repens*	NE Tributary	lower wooded area
Trembling Aspen	*Populus tremuloides*	SE Tributary	VAST trail above cellar hole
Trillium	*Trillium*	NE Tributary	marsh lake shore
Trillium	*Trillium*	SE Tributary	VAST trail above cellar hole
True Forget Me Not	*Myosotis palustris*	SE Tributary	marsh lake shore
Twig Rush	*cladium mariscoides*	SE Tributary	
Virginia Creeper	*Parthenocissus quinquefolia*	SE Tributary	VAST trail above cellar hole
Water Smartweed	*Polygonum amphibium*	SE Tributary	emergent, pink spiked flowers
Weeping Willow	*Salix babylonia*	NE Tributary	
White Ash	*Fraxinus Americana*	NE Tributary	lower wooded area
White Avens	*Geum Canadense*	NE Tributary	lower wooded area
White Avens	*Geum Canadense*	NE Tributary	marsh lake shore
White Clover	*Trifolium Repens*	SE Tributary	VAST trail above cellar hole
White Pine	*Pinus Strobus*	SE Tributary	VAST trail above cellar hole
Wild Cucumber Vine	*Echinocystis lobata*	NE Tributary	lower wooded area
Wild Mint	*Mentha arvensis*	SE Tributary	
Wood Sorrel	*Oxalis*	SE Tributary	VAST trail above cellar hole
Wood Violet	*Viola Riviniana*	NE Tributary	lower wooded area
Yarrow	*Achillia Millefolium*	NE Tributary	lower wooded area
Yellow birch	*Betula alleghaniensis*	SE Tributary	VAST trail above cellar hole
Yellow Loosestrife	*Lysimachia terrestris*	NE Tributary	
Swamp Candle	*Carex flava*	SE Tributary	Marsh lake shore
Yellow Nutsedge	*Cyperus esculentus*	NE Tributary	lower wooded area
Yellow Sorrel	*Oxalis Stricta*	SE Tributary	

Appendix C – Species Lists

Macroinvertebrate Species List

Sterling College- June 2012

Common Name	Order	Family	Southeast Tributary	Northeast Tributary	Comments
Aquatic Earthworms	Lumbricina		X		Very Tolerant
Snails	Gastropoda	Pulmonata		X	Somewhat Tolerant
Giant Stoneflies	Plecoptera	Pteronarcyidae			Very Sensitive
Common Stoneflies	Plecoptera	Perlidae			Very Sensitive
Rolledwinged Stoneflies	Plecoptera	Leuctridae	X	X*	Very Sensitive
Flathead Mayflies	Ephemeroptera	Heptageniidae	X*	X*	Somewhat Sensitive
Strongcase Maker Caddisflies	Trichoptera	Odontoceridae		X	Very Sensitive
Saddlecase Maker Caddisflies	Trichoptera	Glossosomatidae		X	Very Sensitive
Northern Case Maker Caddisflies	Trichoptera	Limnephilidae			Mainly Facultative
Freeliving Caddisflies	Trichoptera	Rhyacophilidae		X	Very Sensitive
Black Fly Larvae	Diptera	Simuliidae		X*	Primarily Facultative
Clubtail Dragonfly Larvae	Odonata	Anisoptera		X	Somewhat to Very Sensitive
Non-Biting Midge	Diptera	Chironomidae	X		Mostly Facultative

X*= Present and Abundant

X= Present

Appendix C – Species List

Birds potentially found around Hardwick Lake
(Adapted from the Hardwick Trails Bird List)

Common Loon - maniacal, quavering laughter (Tremelo-call)
Canada Goose – loud, resonant and musical honk, flock chorus gentle, mellow, slow-paced
Great Blue Heron - loud, harsh, guttural croak (an ugly noise for such a beautiful bird!)
Wood Duck – thin, squeaky whistles; Female: "ooEEK ooEEK" Male: "sweoooo, kip kip kip"
Mallard – familiar loud quacking, also deep, reedy laughing
Turkey Vulture - a soft, quiet chuckling
Bald Eagle – rather weak, flat, chirping whistles; immature calls harsher, more shrill
Broad-winged Hawk - a high-pitched, shrill "pweeeeeee" or "sigeeeee"
Red-tailed Hawk – an asthmatic squeal "keeeer-r-r" slurring downward
Wild Turkey - chirps, putts and yelps from hen, gobbles from the gobbler (of course!)
Ruffed Grouse - wings drumming like distant motor starting slowly, then increasing tempo
Mourning Dove - a low, mournful "cooo-AAH coo coo coo"
Ruby-throated Hummingbird - high squeaky notes, twittering sounds, buzzing wings
Yellow-bellied Sapsucker - drumming starts fast, then slows. A nasal 'fleeerrrr"
Downy Woodpecker - a rapid, descending whinny of notes; a flat "pick" note
Hairy Woodpecker - a sharp "peek" note; a kingfisher-like rattle
Northern Flicker - "WICka-WICka-WICka-wicka"
Pileated Woodpecker - 10-15 low pitched "cuk-cuk"s; also 6-8 high pitched, faster "kek-kek"s; or during breeding season "awoick-awoick"s
Olive-sided Flycatcher - a whistled "quick, three beers" middle note high, last sliding
Least Flycatcher – Emphatic, dry "CHEbek" or "cheBIK" repeated rapidly
Great Crested Flycatcher - a whistled, upward rising "wheeeep"
Eastern Wood Pewee - a whistled "pee-a-wee pee-aaah"
Eastern Phoebe - an enunciated "fee-BE fee-BE" (2nd note higher)
Blue-headed Vireo - 3 note phrases, slower, more melodic than red-eyed (see below)
Red-eyed Vireo - 3 note phrases distinctly separated "here I am, way up here" ad naseum
Blue Jay - harsh, slurring "jay jay jay"; a musical "queedle queedle"; multiple other calls
American Crow - a loud "caw caw caw"
Raven - a short, low, clipped "KROK"; a low, deep, throaty 'grro"; a deep, bell-like "KRONG"
Tree Swallow - clear, sweet whistles: "twit-weet twit-weet liliweet twit-weet"
Black-capped Chickadee - "chick-a-dee-dee-dee" also a whistled "fee bee"
Tufted Titmouse - a clear, whistled chant "peter peter peter"
Red-breasted Nuthatch - a nasal "yank yank yank" (higher pitched than white)
White-breasted Nuthatch - a nasal "whut whut whut whut" or "whi whi whi whi whi"
Brown Creeper - a thin, sibilant "see-see-sideeda-seedeo"
Winter Wren - a series of high tinkling trills and buzzes, a very long and complex song
Ruby-crowned Kinglet - 4 high notes then series of lower whistled notes on different pitches (surprisingly loud for such a small bird, very musical)
Veery - a flute like descending spiral "wheeeuurr wheeurr wheeur wheeur"
Hermit Thrush - ethereal, flute like: "seeeeee freedila fridla-fridla"
Wood Thrush - flute like, "e-olay" usually part of song
American Robin - series of 2-3 notes phrases with only a short pause in between

(Birds of Hardwick Lake cont.)

Gray Catbird - distinctive, mewing quality of low, hoarse notes with chips and squeaks
European Starling - a mushy, gurgling, hissing chatter with high, sliding whistles
Cedar Waxwing - a thin, high pitched, lisping hiss
Nashville Warbler - a slow, simple 2-part trill "seeta seeta seeta seeta pli pli pli pli"
Mourning Warbler – short, rhythmic "churee churee churee turi turi"
Northern Parula Warbler - an insect-like, rising buzz, with a final "tzzip"
Chestnut-sided Warbler - clear and musical with an emphatic ending "witew witew witew WEEchew", "pleased pleased pleased to MEETcha" or "see see see miss BEEcher"
Magnolia Warbler - short, musical, rather weak "sweeter sweeter SWEETEST"
Canada Warbler – a staccato burst, irregularly arranged "Chip, chuppety swee-ditchety"
Black-throated Blue Warbler - a husky, low, musical buzz "zheew zheew zheeeee"
Yellow-rumped Warbler - soft, warbled "sidl sidl sidl sidl sidl seedle seedle seedle seedle"
Black-throated Green Warbler - "zee zee zee zoo zee" or " zher zher zher zoo zee"
Blackburnian Warbler - sharp, dry song with extremely high and thin ending "tsi tsi tsi tsi tsi ti ti ti ti ti seeeeeee"
Pine Warbler - a rapid trill of simple, unslurred notes (similar to Chipping Sparrow)
Bay-breasted Warbler - high, thin, musical "se-seew se-seew se-seew"
Blackpoll Warbler - series of rapid notes on the same pitch "sisisisisiSISISISISIsisisisisis"
Black-and-white Warbler - "weesee weesee weesee weesee"
American Redstart - "tseet tseet tseet tseeow"
Ovenbird - "TEAcher TEAcher TEAcher TEAcher"
Common Yellow-throat - "WITCHity WITCHity WITCHity"
Louisanna Waterthrush – song musical, clear and sweet. 3-4 high whistles then a series of descending chips and chirps
Scarlet Tanager - like a robin with a sore throat, has a distinct buzziness or burr to the call
Chipping Sparrow - series of rapid notes on the same pitch, a rattle or trill
Song Sparrow - 3-4 notes on the same pitch, then a melodious series
Swamp Sparrow – a loose trill,similar to chipping, but slower, sweeter, longer
White-throated Sparrow - "Oooh Canada Canada Canada" or variously "Sam Peabody Peabody Peabody"
Eastern Towhee – "Drink your teeeee" (last syllable higher, wavering)
Cardinal – high, clear, sharp whistles "woit woit woit chew chew chew chew chew"
Rose-breasted Grosbeak - a robin on steroids, no pauses between phrases
Common Grackle - harsh, metallic hiss "kh-sheee" or "khr-reezzh". Call "krrrjk"
Brown-headed Cowbird – low, gurgling notes followed by thin, slurred whistles
Red-winged Blackbird – liquid introductory notes followed by gurgling "kon-ka-reeeee"
Purple Finch - slightly hoarse, warbled "plidi tididi preete plidi tititi preeer"
Baltimore Oriole - rich, clear, whistled notes "pidoo tewdi tewdi yewdi tew tidew"
Pine Siskin - rapid, run-on jumble of low, husky notes. Calls harsher than Goldfinch
American Goldfinch - long, canary-like warble, very musical "toWEE toWEE toWEEto tweer tweer tweer ti ti ti ti". Call a thin, wiry "toweeeowee" or "tweeeee"
Evening Grosbeak - finch-like, low rattle or buzz "thirrr", "chirp", "cleer" or "clee-ip"