Bolton Lakes Watershed
An Update

Bolton, Vernon, Tolland & Coventry

Eastern Connecticut
Environmental Review Team Report

Eastern Connecticut
Resource Conservation & Development Area Inc.

Bolton Lakes Watershed Update

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Environmental Review Team Report
Prepared by the Eastern Connecticut Environmental Review Team
Of the
Eastern Connecticut Resource Conservation & Development Area, Inc.

For the
Conservation Commissions
Bolton, Vernon, Tolland & Coventry, Connecticut

April 2014

Report #631

Acknowledgments

This report is an outgrowth of a request from the Bolton, Vernon, Tolland and Coventry Conservation Commissions to the North Central Connecticut Conservation District (NCCD) and the Connecticut Environmental Review Team Subcommittee for their consideration and approval. The request was approved and the measure reviewed by the Eastern Connecticut Environmental Review Team (ERT).

The Eastern Connecticut Environmental Review Team Coordinator, Elaine Sych, would like to thank and gratefully acknowledge the following Team members whose professionalism and expertise were invaluable to the completion of this report.

The field review took place on Wednesday, September 26, 2012.

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I would also like to thank Rod Parlee, Bolton Conservation Commission, other Bolton town officials, Tom Oullette, Vernon Conservation Commission and several Bolton Lake residents for their cooperation and assistance during this environmental review.

Prior to the review days, each Team member received a summary of the proposed project with various maps. During the field review and after Team members received additional information in the form of reports and maps. Some Team members made separate or additional field visits to the sites. Following the reviews, reports from each Team member were submitted to the ERT coordinator for compilation and editing into this final report.

This report represents the Team's findings. It is not meant to compete with private consultants by providing site plans or detailed solutions to development problems. The Team does not recommend what final action should be taken on a proposed project - all final decisions rest with the towns. This report identifies the existing resource base and evaluates changes since the previous ERT report, and also suggests considerations that should be of concern to the towns. The results of this Team action are oriented toward the development of better environmental quality and the long term economics of land use.

The Eastern Connecticut RC&D Executive Council hopes you will find this report of value and assistance in developing a watershed management plan to protect the Bolton Lakes.

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Introduction

The Towns of Bolton, Vernon, Tolland and Coventry requested an update in 2012 to a 1978 Environmental Review Team report on Bolton Lakes. The 1978 report was requested by the Coventry Planning and Zoning Commission to produce a natural resource inventory and management suggestions for the Bolton Lakes Watershed. The update request was made by the Conservation commissions of Bolton, Vernon, Tolland and Coventry to address changes in the past 34 years to water quality and land use in the watershed.

The Bolton Lakes watershed area totals approximately 2,419 acres that fall within the four towns. The Bolton Lakes system includes Upper Bolton Lake and cedar swamp wetland in Vernon, Tolland and Coventry, Middle Bolton Lake in Vernon and Lower Bolton Lake in Vernon and Bolton.

Objectives

The towns are interested in information for watershed management and monitoring that can be incorporated into a regional watershed management plan as well as used for updating individual town plans of conservation and development. Information in this update covers topics and concerns that were indicated in the request application and from meetings with town representatives. A major change in the watershed area is the installation of sanitary sewers to properties around Lower and Middle Bolton Lakes and Route 44. Construction was begun in 2009 and it is anticipated to be completed July 2015. Lower Bolton Lake has been experiencing noticeable changes in water quality since 2010 with large amounts of Southern Naiad, an invasive aquatic plant, becoming a concern and in 2012 Lower Bolton Lake experienced a toxic blue-green algae bloom.

The ERT Process

Through the efforts of the Bolton, Vernon, Tolland and Coventry Conservation Commissions this environmental review and report was prepared for the Towns of Bolton, Vernon, Tolland and Coventry.

This report provides a natural resource inventory and a series of recommendations and guidelines which cover the topics requested by the towns. Team members were able to review maps, plans and supporting documentation provided by the towns.

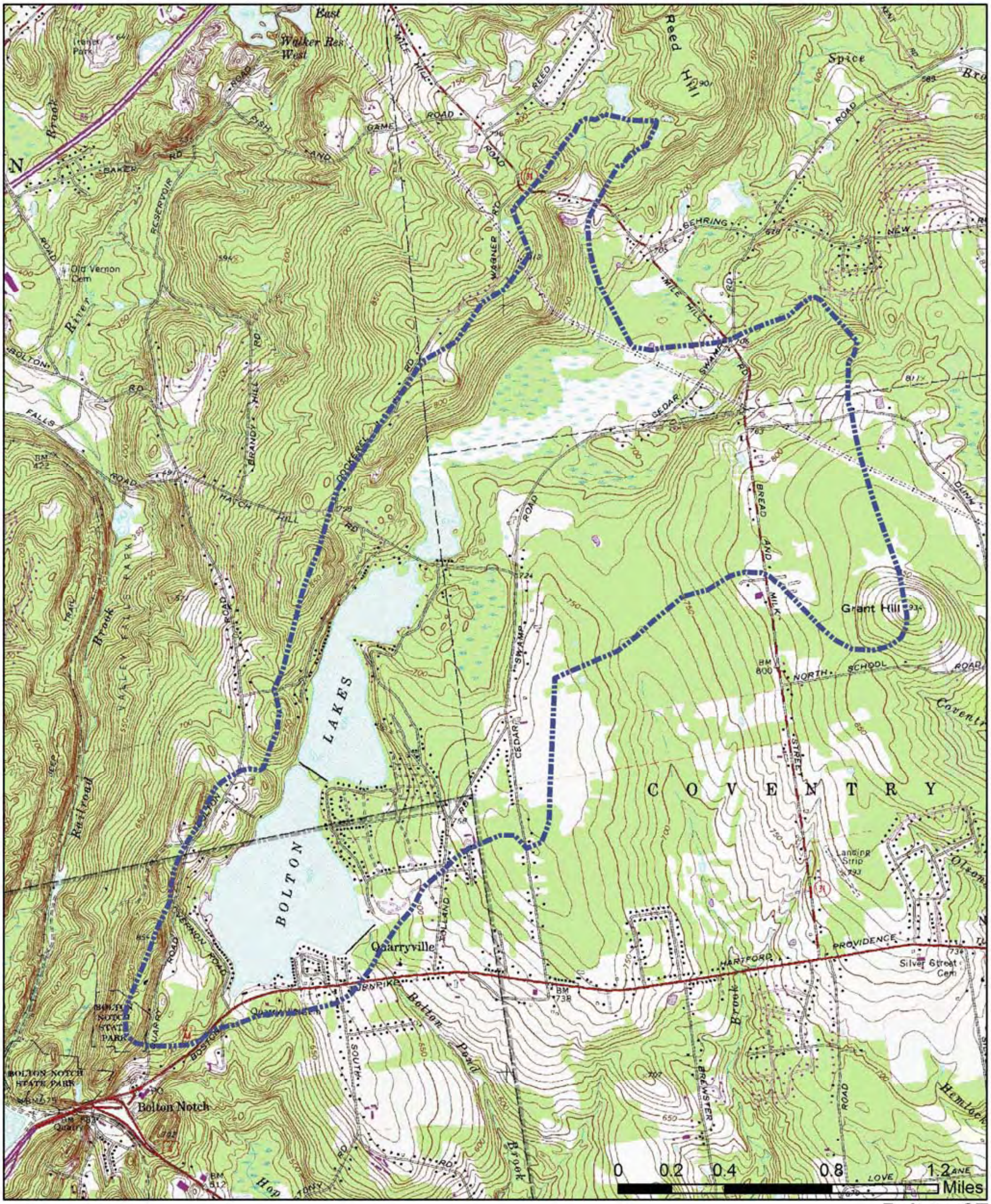
The review process consisted of four phases:

1. Inventory of the site’s natural resources;
2. Assessment of these resources;
3. Identification of resource areas and review of plans; and
4. Presentation of education, management and land use guidelines.

The data collection phase involved both literature and field research. The field review was conducted on Wednesday, September 26, 2012 Some Team members made separate and additional field visits on their own. The field review allowed Team members to verify information and to identify other resources.

Once Team members had assimilated an adequate data base, they were able to analyze and interpret their findings. Individual Team members then prepared and submitted their reports to the ERT coordinator for compilation into this final ERT report.

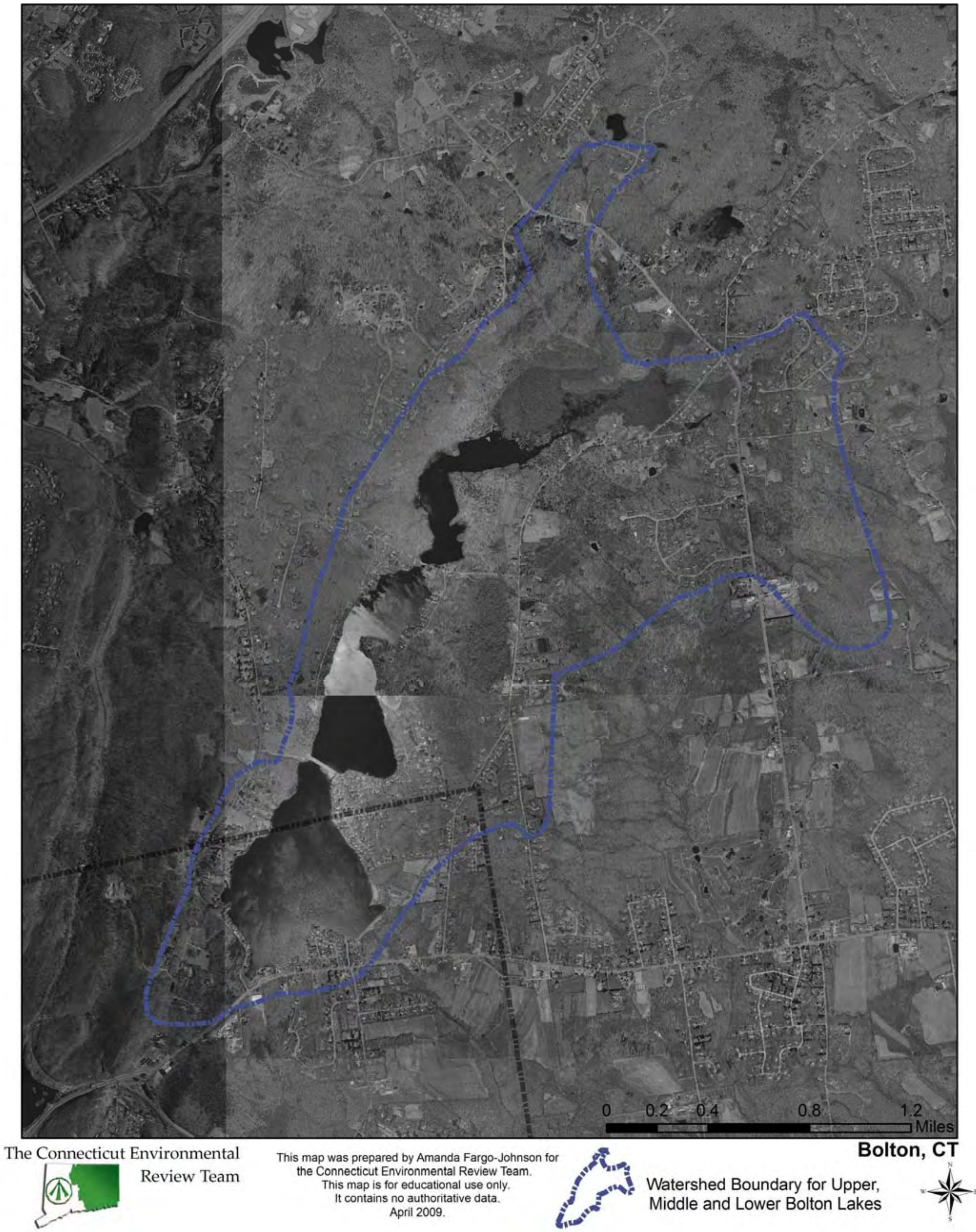
Bolton Lakes Watershed Update Site Map

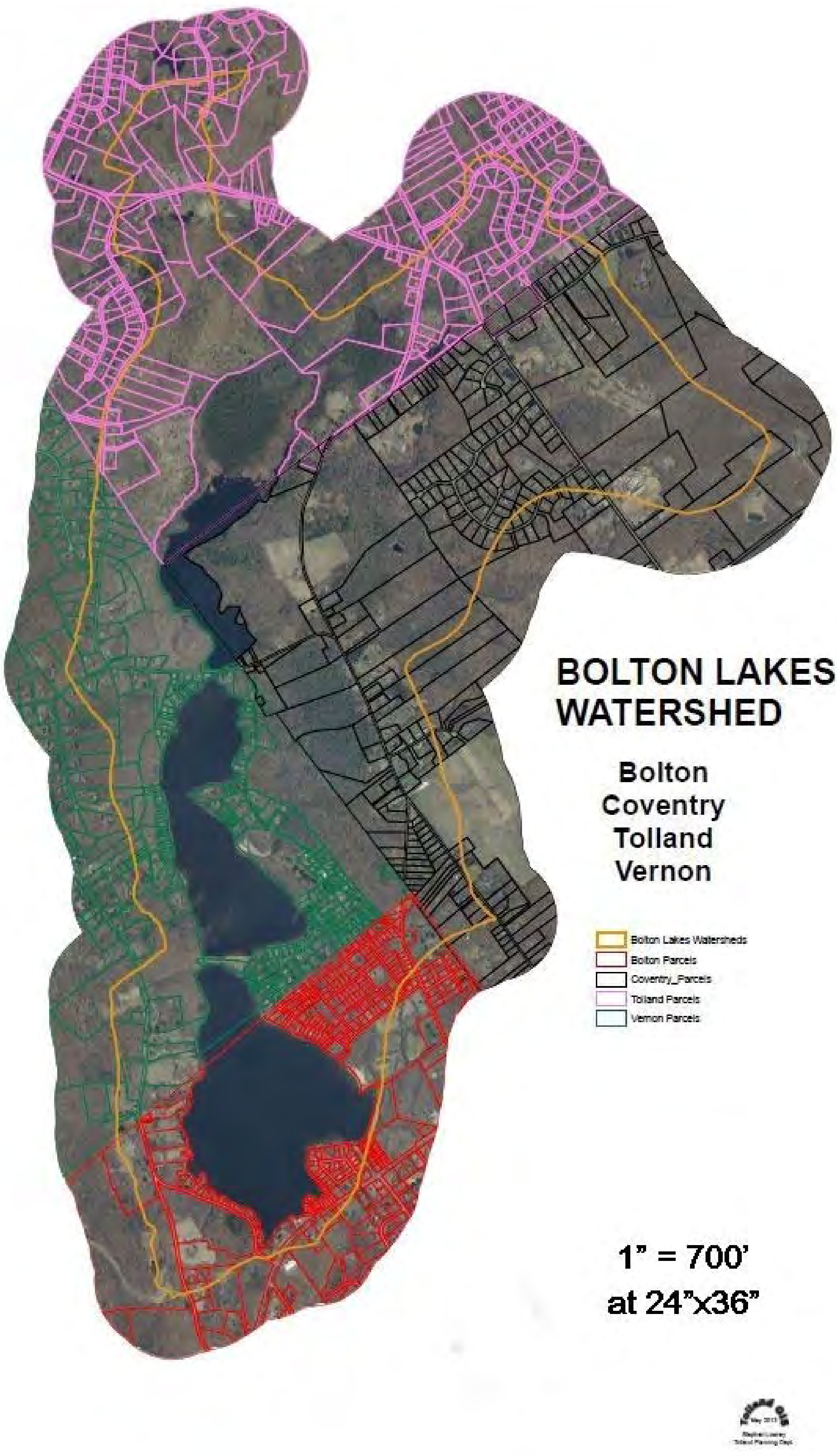


The Connecticut Environmental Review Team

This map was prepared by Amanda Fargo-Johnson for the Connecticut Environmental Review Team.
This map is for educational use only.
It contains no authoritative data.
April 2009.

Bolton Lakes Watershed Update Aerial Map




BOLTON LAKES WATERSHED
Bolton
Coventry
Tolland
Vernon
Bolton Lakes Watersheds
Bolton Parcels
Coventry_Parcels
Tolland Parcels
Vernon Parcels
1" = 700'
at 24"x36"

Bolton Lake, Lower

Bolton, CT

Connecticut Department of Energy & Environmental Protection

This map shows lake depth. It is intended for general informational purposes only. Lake bathymetry contour lines may not align well with other features on the map. Please refer to the Boating or Angler's Guide for current boating regulations. Map date September 2011.

Lake acreage: 174.64

Lake depth (ft)

Trail

Dam

DEEP car top/carry-in launch

DEEP trailered launch

N

0 0.035 0.07 0.14 Miles

0 175 350 700 Feet

Bolton Lake, Middle

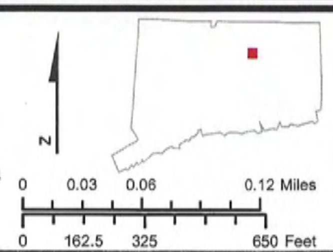
Vernon, CT

Connecticut Department of Energy & Environmental Protection

This map shows lake depth. It is intended for general informational purposes only. Lake bathymetry contour lines may not align well with other features on the map. Please refer to the Boating or Angler's Guide for current boating regulations. Map date September 2011.

Lake acreage: 121.41

- Lake depth (ft)
- Trail
- Dam
- DEEP car top/carry-in launch
- DEEP trailered launch



Bolton Lake, Upper

Vernon, CT

Connecticut Department of Energy & Environmental Protection

This map shows lake depth. It is intended for general informational purposes only. Lake bathymetry contour lines may not align well with other features on the map. Please refer to the Boating or Angler's Guide for current boating regulations. Map date September 2011.

Lake acreage: 50.33

Lake depth (ft)

Trail

Dam

DEEP car top/carry-in launch

DEEP trailered launch

N

0 0.02 0.04 0.08 Miles

0 100 200 400 Feet

Topography and Geology

The Bolton Lakes occupy a lowland created by glacial bedrock scour during the last Ice Age. Two earthen dams (dikes) impound water increasing the water depth in the basins. Nonetheless, the lakes are relatively shallow[1]; although the impoundment elevations of Lower and Middle Bolton Lakes are different, they both have a maximum depth of just greater than 18 feet; Upper Bolton Lake has a maximum depth of just over six (6) feet adjacent to the causeway that separates it from Middle Bolton Lake.

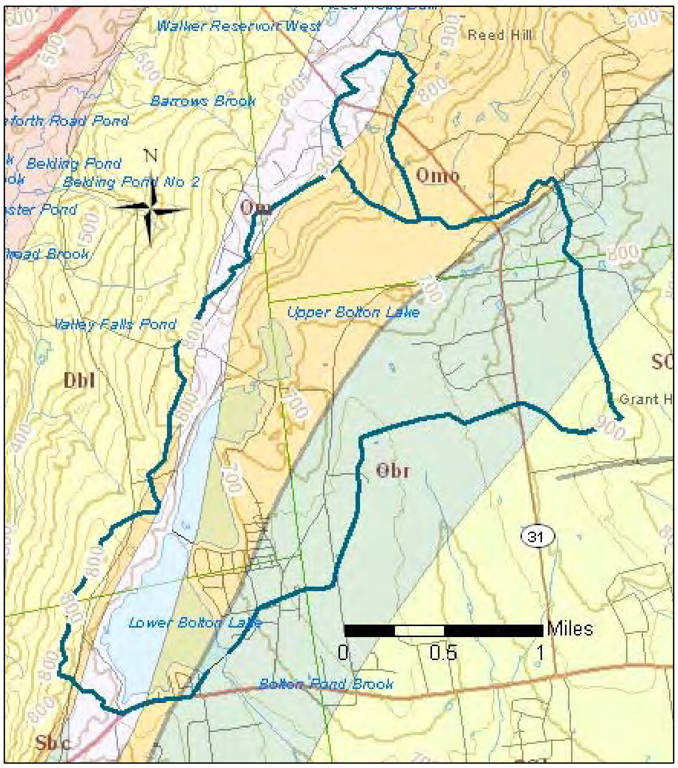


Figure 1. Geologic map showing the watershed (drainage basin) for the Bolton Lakes (marked by dark blue boundary) and the distribution of major rock units in the area. Obr (grayish-green) = Brimfield Schist, Omo (pale orangish-brown) = Monson Gneiss, Om (very pale pink) = Middletown Complex, Sbc (orange) = Clough Quartzite, and Dbl (yellow) = Littleton Schist. Rocks at the southeast corner of the map (Hebron Gneiss) and northwest corner (Glastonbury Gneiss) do not impact the lake drainage basin and are not discussed in this report.) The major fault (solid gray line) that separates the Brimfield rocks on the east from all the others to the west is the Bonemill Brook Fault which marks the boundary between Central Maine Terrane to the east and Bronson Hill Terrane to the west. Geologic map from Rodgers, 1985. Drainage boundary by author.

A drainage basin of several square miles feeds surface water into the lakes through several intermittent streams (Figure 2). Local observers of the lakes suggest, however, that the constant discharge of water (leaving the lakes) at the dam on Lower Bolton Lake requires additional recharge by subaqueous springs maintained by groundwater outflow, especially during

Figure 2. Intermittent stream with no flow at time of field review. The stream is located in a valley traversed by the access road to the middle lake dike. Other intermittent streams that were crossed during the field review likewise were not flowing, leading one to assume that there was no surface recharge to the lakes at the time. Yet outflow continued at the lower lake dam, suggesting groundwater recharge occurs through subaqueous springs.

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1. (http://www.ct.gov/dep/lib/dep/fishing/general_information/lakebathymetrymaps.pdf).

periods of low rainfall. The west side of the drainage basin follows a ridge that is held up by quartzite and schist on the south and by the Middletown Gneiss complex on the north (Figure 1). It is part of the drainage divide between the Connecticut River watershed to the west and the Thames River watershed to the east. The boundary of the watershed on the east follows hilltops underlain by a mantle of glacial till. Note that the northern-most sub-basin is separated from the rest of the watershed. It drains into a wetland that is crossed by a power line. Local property owners report that an access road constructed by the power company effectively diverts the flow of that sub-basin into a northerly draining system. That report was not field checked by this writer. The watershed of the lakes is diminished by several hundred acres if that is the case.

Topography

The upper two lakes are connected by culverts under a causeway and have an elevation of 674' above sea level. Lower Bolton Lake has an elevation of 667'. The high points in a drainage basin are always along the watershed boundaries (drainage divides). The highest point on the Bolton Lakes drainage divide is 934'on the east side at Grant Hill. The highest point along the western divide is about 920' near Dockerel Road. The total relief is 267 feet. Relief is most rugged along the western divide where there are moderate to steep slopes and local cliffs up to 15' in height. In contrast, the eastern side of the drainage basin has generally gentle slopes. The topography is largely due to the behavior of the local bedrock and its response to glacial erosion.

Bedrock Geology

(This discussion relies heavily on the work Wintsch et al, 2012, although specific reference is not usually made). Bedrock in the watershed is comprised of rocks from two different geologic terranes (see Skeehan, 2008, p. 32). The eastern third of the drainage basin is underlain by rocks of the Central Maine Terrane and the western two-thirds is underlain by rocks of the Bronson Hill Terrane. Terranes are bodies of rock with distinct geologic histories. Rocks of the Central Maine Terrane were initially formed as sedimentary and volcanic rocks on the ocean bottom in Ordovician time. They were metamorphosed and uplifted before those of the Bronson Hill Terrane. Bronson Hill Terrane rocks are sedimentary deposited in shallower, nearer shore ocean waters (compared to Central Maine Terrane rocks). They were metamorphosed and uplifted at a slightly younger time. Thus the two terranes have separate depositional and metamorphic histories. The two terranes today are separated by a major thrust fault, the Bone Mill Brook Fault. They were juxtaposed by plate tectonic processes during mountain building episodes 250 to 375 million years ago.

Rocks of the *Central Maine Terrane* do not crop out in the drainage basin of the Bolton lakes. Rocks of the Brimfield Schist, however, underlie approximately the eastern third of the watershed. The Brimfield Schist is composed of sulfidic schist and gneiss. It contains iron-sulfide minerals, pyrite and marcasite, that readily weather to a rusty color, releasing an acidic residue. The resulting processes tend to break down the rock and make it easy to erode. Although rocks of the Brimfield Schist were not seen in outcrops, a number of fragments of Brimfield were part of the dam on Lower Bolton Lake (Figure 3). Some contained sufficient sulfide minerals to cause the fragments to disintegrate to a sandy rubble.

Rocks of the *Bronson Hill Terrane*, Monson Gneiss, Middleton Complex, Clough Quartzite and Littleton Formation, crop out on the western side of the drainage basin. The oldest rock unit of this terrane is the Monson Gneiss, a light gray quartz-plagioclase gneiss. No outcrops of Monson Gneiss were found in the drainage basin, but it can be seen "just around the corner" on the north side of Rte. 44 between Quarry Road and Vernon Road. It is of Late Ordovician age. The overlying Middletown Complex is composed of several lithologies but is

Figure 3. Fragments of Brimfield Schist that are part of the dam for Lower Bolton Lake. They contain iron sulfide minerals that weather by dissolving and releasing iron oxide and sulfuric acid to the environment. Iron oxide is precipitated almost immediately in an oxidizing environment. Note on the right that what was originally a rock fragment is now rubble. Disc on key-chain in both images is 2 inches in diameter.

Figure 4. a. Amphibolite and amphibole gneiss at intersection of Dockerel Road and Rte. 31 at northern part of drainage basin. b. Detail of amphibolite in Figure 4a. Crystals of amphibole (black) are about 1 mm in length. White crystals are plagioclase feldspar. Tip if index finger at bottom for scale. c. and d.. Gray amphibole bearing gneiss at local 4-10' cliffs just south of access road to dike between Middle and Lower Bolton Lakes. These rocks have more plagioclase feldspar than amphibole. Foliations (layers) in d. are ½ -2" in thickness.

characterized by amphibole bearing gneisses (Figure 4a), including amphibolites (Figure 4b), and gray feldspathic gneisses (Figure 4c, d). They were initially igneous rocks, possibly volcanic, that were later metamorphosed. Rocks of the Middletown Complex crop out on east facing slopes along the western boundary of the watershed. There it forms steep slopes and craggy outcrops with scattered cliff faces of short lateral extent and 5 to 15' in height.

The Clough Quartzite (pronounced cluff) is composed of quartzite and quartz-mica schist (Figure 5). It unconformably overlies (was deposited on top of) the Middletown Gneiss. It forms discontinuous outcrops in the woods just west of Middle Bolton Lake southward. It grades upward from pure quartzite (Figure 5a) with increasing amounts of quartz-mica schist to mica schist. It formed as a sedimentary deposit of quartz sand in shoreline and gradually deepening near shore environments and became interbedded with off-shore mud layers. They were later metamorphosed to quartzite, quartz-mica schist and mica-schist. The schists contain variable amounts of garnet. The upper part of this rock unit is somewhat calcareous and has been subjected to local dissolution along fractures forming small caves (Figure 5b). Rocks below the calcareous zone tend to break easily into large slabs of quartzitic rock. These were extensively quarried in the 19th century for use as foundation and stoop stones. The old quarry scars may be seen along the west side of Quarry Road from just above to just below its intersection with Vernon Road (Figure 5c).


a


b


c

Figure 5. a. Clough Quartzite is a light gray quartzite that locally is garnet-bearing. It forms slabs of variable thickness between thin interlayers of mica schist. Quartzite is very resistant to weathering and the slabs form chemically stable building stones. b. Small cave in calcareous zone in upper part of Clough Quartzite. Cave opening appears top be sseveral feet in height. c. Remains of old quarry along west side of Quarry Road. Small black squarish area in middle of image is cave shown in Figure 5b. Note deep depression on right side of picture. Quarrying operations were limited by groundwater seepage and the fact that the sought-after layers are tilted into the earth toward Box Mountain. Keeping the quarries dry and stable became too expensive.

The Littleton Formation is not well exposed within the watershed. It underlies the ridge-top west of Lower Bolton Lake but mostly forms westward facing slopes outside the watershed to the north of the lower lake. It crops out in Bolton Notch. The Littleton is a gray mica schist with variable amounts of the minerals garnet and staurolite (Figure 6).

Figure 6. Littleton Formation consists of gray mica schist, some of which is garnitiferous. Mica grains are microscopic but give the rock a silvery sheen. Long and narrow black rectangular grains are staurolite.

Surficial Geology

Only three types of surficial deposits are found in the drainage basin: glacial till, stratified sand and gravel, and organic-righ swamp mud (Figure 7). Glacial till (pale green and gray on Figure 7a) consists of unsorted rock and soil debris eroded by the last Ice Age glacier and then deposited when the glacier melted. It forms a veneer of glacial soils, locally rocky, over the land surface that varies in thickness from zero (outcrops of ledge that are not

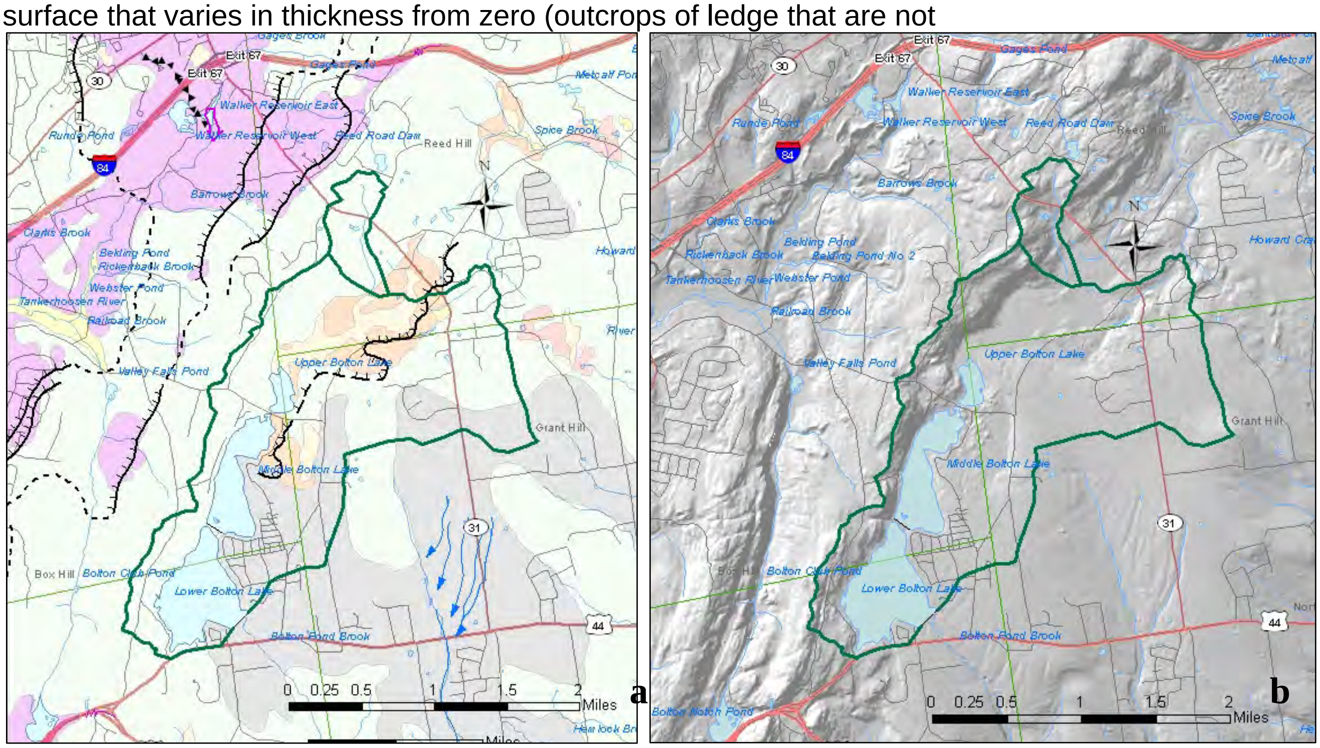

Figure 7. a. Quaternary geologic map showing distribution of glacial soils over the drainage basin and surrounding area. Area colored by pale green and pale gray are covered by glacial till of variable thickness. Gray area shows areas where till is greater than 15' thick. Pale orange areas show deposits of stratified sand and gravel. Pale yellow areas are covered with swamp deposits. Hatchured lines are interpreded position of the ice margin at various times in the glacial melt-back history. Blue arrows are inferred meltwater channels. Map from Stone *et al*., 2005. b. Interesting hillshaded relief map of drainage basin and surrounding area.

covered by soil) to greater than 15 feet. Local banks of sand and gravel (pale orange color in Figure 7a) were deposited by glacial meltwater streams along the valley deposits during the time of active melting of the glaciers. Finally, swamp deposits (pale yellow on Figure 7a) formed in the lowest portions of the valley floor.

It is interesting to observe the shaded relief map of the area (Figure 7b). The contrast between the smooth surface on the southeastern side of the drainage basin and the rugged steep surface on the northwest side of the basin is striking. The smooth surface is largely controlled by the maner in which the Brimfield Schist weathers, producing rubble and “soft rock” that is easily scraped-off (like a bull-dozer) by the glacier. In contrast the Middletown, Clough and Littleton rocks resist weathering and are eroded by abrasion, ice wedging, and glacial plucking. Instead of easilly scraping the rocks away, the bull-dozing glacier rode up the back of the ridge held up the resistant rocks and tumbled over the ridge-top. There large broken fragments of the various formations were entrained into the flow of the glaciers and carried off to the southeast (direction of glacial flow in this area of Connecticut).

The ridge-top and steep east facing slopes are covered by very thin glacial soils. During the maximum phase of the last Ice Age, ice exerted extra pressure on the north and northwestward facing ground surfaces that it over-rode. Till was not deposited beneath the glacier in those locations. Also, during the waning phase of the last Ice Age, the glacial ice fractured as the ice travelled over the ridge top and plunged down the steep eastern slope. Summer melting produced water on the surface of the glaciers that naturally exploited these fractures and flowed in crevaces along the ground surface, eroding any till that may have been left there.

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"Many questions have been asked regarding the loss of water from the Bolton Lakes watershed to the Lydall Brook watershed as a result of the sewers. How much loss could be associated with the daily/weekly/monthly use of water for flushing, bathing, eating, etc? Could this massive loss of water exiting one watershed to another effect the groundwater levels around the Bolton lakes?"

The following section is an attempt to address these issues.

Most residential dwelling units in rural areas obtain their domestic water by drilling (or digging) a well into a local aquifer and pumping groundwater into their household. Most of the water that is drawn from the aquifer typically is used for washing and sanitation and as such, when its use has ended, the water goes down the drain and into a septic system, where it is renovated. Partially renovated septic water is discharged to a drain field where the renovation is completed and the renovated water soaks into the ground and recharges the groundwater system from which the domestic water was initially drawn.

The amount of water pumped from the aquifer varies from household to household. For the purposed of this discussion lets assume the average family used about 250 gallons of water per day; some households use more but many also use less (the writer's household of 2, for instance, uses between 60-100 gallons per day). Only a few gallons are consumed by drinking or cooking. Thus the amount of water pumped from the aquifer roughly equals the amount of water that is returned through the septic system and there is relatively little loss of water from the aquifer. When, however, the household gets connected to a sewer system, all the water pumped from the aquifer is lost to the local groundwater reservoir.

250 gallons per day = 91,250 gallons/year. If 400 households connect to the sewer system in the Bolton Lakes service district, a sizeable volume of water will be lost from the groundwater system. 400 houses drawing 91,250 gallons of water each year results in an annual loss of 36,500,000 gallons from the aquifer. To understand how big a loss this is to the lake system, we need to calculate how much water the lake system actually receives each year.

Using data from a 1979 feasibility report, the following are noted. Central Connecticut, where the Bolton Lakes are located, receives an average of about 45" of melted precipitation per year. Some of the precipitation evaporates and returns to the atmosphere and a large part is taken up plants and gets transpired back into the atmosphere. Evapotranspiration accounts for 23.1", about 51% of the total supply of rainwater and that goes back to the atmosphere. About 13.9", or31%, runs off the surface and into local intermittent and perennial streams that flow into the lakes, recharging the lake waters. 8" (18%) soaks through the surface soils and into the underlying aquifer and recharges the lake through subaqueous springs.

If the watershed for the lakes is 1845 acres (1 acre=43,560 ft^2=6,272,640 in^2), the amount of water falling on the watershed in an average year is 2.25 billion gallons of water: pptn (precipitation). Of that, groundwater recharge is only 18% of the annual precipitation, or 405,870,223 gallons, that soaks in to replenish the aquifer. Because the lakes are maintained by discharge of groundwater from subaqueous springs, diverting 35.6 million

Volume (in^3) = area (in^2) x precipitation (in.)
Area = 1845 acres x6,272,640 in^2/acre = 11,573,020,800 in^2.
Volume = 11,573,020,800 in^3 x 45" = 520,785,930,000 in^3.
Converting to gallons (1 gal = 231 in^3) yields
2,254,484,571 gallons.

gallons (just greater than 9%) by way of the sewer system may be significant. It seems likely that there will be local drawdowns of the water table where development is most concentrated. A trained hydrologist should be consulted if this is a concern.

Recharge for the lakes is not limited to groundwater. Total recharge for the lakes includes surface run-off through local streams, which although not continuous, is sizeable: almost 700 million gallons.

Reference

1979 ERT Report

A Watershed Perspective

A CT DEEP Watershed Manager participated in the fall 2012 ERT field tour of the Bolton Lakes watershed and provides the findings and recommendations below.   The Towns of Bolton, Coventry, Tolland and Vernon are encouraged to engage in further discussions and develop an action plan that can yield a desired regional management plan for this watershed.

Watershed Overview

- The connected system of Upper, Middle and Lower Bolton Lakes is located in eastern Connecticut within the bedrock geologic region of the Eastern Highlands. This lake system and watershed overlap the municipal boundaries of Bolton, Coventry, Tolland and Vernon.

- The local drainage basin, or watershed, that includes the chain of three Bolton Lakes is just over 5 square miles, or approximately 3,250 acres, in areal extent. (This figure refers to the DEEP Hydrography data layer called “Local drainage basin” that includes the three Bolton Lakes. That local natural drainage basin delineation includes Bolton Pond Brook.) Local lot and road network development, with associated stormwater conveyance systems, have undoubtedly modified the natural drainage basin boundaries. Local comments have been raised regarding some variability in boundaries for the northeast area of this watershed.

- This local watershed is considered a head water source for the larger Hop River sub-regional basin, which in turn is nested within the still larger Willimantic River regional basin and the even larger Thames River major basin. A drop of precipitation collecting within this watershed and discharging through surface and ground water flow paths in this drainage basin network in eastern Connecticut could eventually discharge to eastern Long Island Sound in New London and Groton. Precipitation falling just west of the adjacent Bolton Notch, or north of nearby Valley Falls, will follow flow paths leading to the Connecticut River major basin before discharging to the mid Long Island Sound region at Old Saybrook.

- The Bolton Lakes, along with lakes in Andover and Columbia along the Hop River watershed, were once used in part to supply water for power generation and process needs at the downstream Willimantic mills year round. Now these lakes are maintained for relatively stable water elevations, are primarily used for water-based recreational purposes, and support year-round residential populations.

Water is the great integrator – a meaningful phase often cited by water resource outreach programs, such as our local neighbors at the Connecticut NEMO (Nonpoint Education for Municipal Officials) program. Such a concept provides a strong foundation to this watershed chapter. Where watershed planning is pursued, it provides for a plan or blueprint of how to best protect and improve the water quality and its inter-related natural resources. The boundaries of a watershed often extend over political boundaries and into adjacent municipalities. That is why a comprehensive planning process that involves all affected municipalities located in the watershed is essential to successful watershed management. In this report, the towns of Bolton, Coventry, Tolland and Vernon are encouraged to participate in regional watershed planning for the Bolton Lakes watershed. Initial planning steps are essential in developing practical watershed management tools to protect and enhance the water quality and resources of the three Bolton Lakes. Equally important is the commitment by each town and other partners to identify and share responsibilities towards meeting a common goal of resource protection and wise uses of the Bolton Lakes. Effective partnerships can go a long way to prioritize watershed management actions, and to leverage available resources. Each of these elements has become more important during recent economically fragile times experienced by these towns and throughout the region.

Findings

Water Quality Classifications:

Lower, Middle and Upper Bolton Lakes each have an “A” water quality classification. Perennial flowing tributary streams entering these lakes have a presumed “A” surface water classification. Lower Bolton Lake discharges water to Bolton Lake Brook with an “A” surface water classification, and then to the Hop River, which is classified as “A” as well. Class A surface waters are waters that are designated for: habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture.

Ground waters are also classified across Connecticut. A review of the classification map for the Bolton Lakes watershed shows a nearly uniform Class “GA” ground water classification. There are two additional areas of public water wells that each have a Class “GAA” ground water classification. These are located in the Colonial Drive/Lynwood Drive area of Bolton and Vernon, and also off of Tolland Road and High Meadow Road area in Bolton. The designated uses of GA waters are: existing private and potential public or private supplies of water suitable for drinking without treatment; baseflow of hydraulically-connected surface water bodies. The CT DEEP presumes that ground water in such areas is, at a minimum, suitable for drinking or other domestic uses without treatment. The management goal is to protect these designated uses of the Bolton Lakes watershed.

Aquifer Protection Areas:

There is no designated Aquifer Protection Area (APA) within the Bolton Lakes watershed. Additional information about the Connecticut APA Program, including useful guidance to municipalities for aquifer protection not included in the current designation areas, can be found at the CT DEEP website (**1**).

Leachate and Wastewater Discharge Inventory:

There are no known wastewater discharges or leachate sources included in the CT DEEP databases for area included within or adjacent to the Bolton Lakes watershed.

Contamination or Potential Contamination Sites:

CT DEEP maintains a database of “Hazardous Waste Facilities” as defined in Section 22a-134f of the Connecticut General Statutes. A review of the listings within the Bolton Lakes watershed indicates two locations of underground storage tanks with documented leaks. These sites are in

Bolton on Keeney Drive (status is remediation started) and on Plymouth Lane (status is remediation pending). For more information about this statewide database, visit the CT DEEP website (**2**).

Water Quality Assessments:

The *2012 State of Connecticut Integrated Water Quality Report* (**3**) includes several waterbodies of interest within the Bolton Lakes and associated Hop River watersheds.

- Lower Bolton Lake (176.46 acres) is assessed as Full Support for the designated uses of Aquatic Life and also for Recreation.
- Middle Bolton Lake (117.2 acres) is assessed as Full Support for the designated uses of Aquatic Life and also for Recreation.
- Upper Bolton Lake (50.3 acres) is currently not an assessed waterbody.
- Bolton Lake Brook is currently not an assessed waterbody.
- The uppermost assessed segment of the Hop River (3.22 linear miles located in Bolton, Andover and Coventry and roughly parallel to Route 6) is assessed as Full Support for the designated use of Aquatic Life, and is assessed as Not Supporting for Recreation. As there are no designated beaches along the Hop River, the specific recreation impairment is for non-designated swimming and other water contact related activities (e.g. boating, fishing, aesthetic appreciation activities that do not require full body contact). The listed cause is elevated levels of *Escherichia coli*. The *E. coli* are potential harmful pathogens used as indicators for comparison with criteria contained within the Connecticut Water Quality Standards.
    - There is no current water monitoring data from the Lower Bolton Lakes outfall to Bolton Lake Brook (tributary to Hop River) to determine whether the Bolton Lakes and contributing watershed are a likely source of the *E. coli* bacteria. Potential sources of the indicator fecal bacteria in this watershed would include permitted and non-permitted stormwater, insufficient septic systems, agricultural activities, and nuisance wildlife/pets. However, this is not a comprehensive list. Further water monitoring and field investigation would confirm the listed sources as well as identify new sources. This Hop River segment was prioritized by CTDEEP for the development of a Total Maximum Daily Load (TMDL) in 2012. A TMDL analysis results in a pollution management budget that is protective of water quality standards for the river.
    - The Hop River segment was recently included in a detailed statewide analysis of a number of indicator bacteria-impaired waterbodies. The core TMDL document as well as the detailed Hop River appendix provide useful information for local planners and land use decision makers. The document can be found on the CT DEEP website (**4**). Identified management activities focus on the Town of Bolton

requirements necessary to comply with the Municipal Separate Storm Sewer System (MS4) General Permit.

- In addition to information obtained from the statewide water quality assessment and from the bacteria TMDL report, some in-lake surveys have been conducted. Recent Lower and Middle Bolton lake vegetation survey reporting is identified and commented on elsewhere in this ERT report. The Connecticut Agricultural Experiment Station (CAES) report is useful for some aspects of in-lake resource identification and assessment. The document by itself is not a watershed management tool. However, a watershed planning principle is to consider upland contributions of nutrient and altered hydrology as potentially aggravating factors to establishment or blooms of nuisance aquatic vegetation.

Land Cover Change:

The University of Connecticut CLEAR program (Center for Landuse Education and Research) provides a useful and rather unique data set of landscape changes of basic land cover across Connecticut since 1985. These data and the time scale closely matches one of the ERT requests to update the 1978 ERT Bolton Lakes watershed report for changes in the watershed. The multi-year land cover data has been derived from remotely-sensed satellite imagery and classified with computer programming and human expertise. Comparable information between the data sets allows land use planners and decision makers to observe how land cover categories through 12 categories have changed over the 21 year analysis period. Maps with interpretive narrative can be found on the CLEAR Changing Landscape Project website **(5**). A summary of the land cover changes that includes the Bolton Lakes watershed, nested within the larger Hop River sub-regional watershed, is well depicted in a map seen at this site as well (**6**). With this CLEAR data set, it is not simple to extract the land cover changes specific to the smaller Bolton Lakes watershed area. However, a visual review of the larger Hop River sub-regional watershed change detection map reveals that the communities of Coventry, Tolland and Vernon have each experienced class changes in multiple areas of this watershed, while much of Bolton's developed categories around Lower Bolton Lake existed prior to 1985. Relative to other watersheds within these four communities, broad scale land cover changes within the Bolton Lakes watershed do not appear to have occurred since the original 1978 ERT report, although the Team Forester found a significant change in forest cover comparing the 1978 ERT Report Land Use Map on page 22 and his 2012 Vegetation Cover/Land Use Map. (Please refer to the Forestry/Vegetation section this report.)

Water Pollution Issue:

Community pollution problems were documented in at least two wastewater management studies within the area surrounding Lower and Middle Bolton Lakes. The study area included approximately 245 single family homes. A combination of outdated septic systems that did not meet Connecticut Public Health Code, site limitations to make necessary repairs and water quality test results from a number of drinking wells and in the lakes led to recommendations of removing the wastewater from the area and providing treatment at a municipal wastewater treatment plant. The Bolton Lakes Sanitary Sewer Project was initiated and involved the establishment of the Bolton Lakes Regional Water Pollution Control Authority (BLRWPCA). As stated elsewhere in this report, due to a consent order issued by DEEP, the Bolton Lakes Regional Water Pollution Control Authority (the Authority) has undertaken a 5-phase Bolton

Lakes Sewer Project that includes installing a sewer line around most of Middle and Lower Bolton Lakes. Approximately 70% of the overall sewering project is located within Bolton, and approximately 30% is with Vernon town boundaries. All developed properties within the identified sewer service area are required to connect to the new sewer system. In mid 2013 the Authority requested DEEP to provide a temporary construction easement and a permanent sewer easement across the state-owned Bolton Lake Water Access off Hatch Hill Road in Vernon. DEEP Land Management and Constituent Affairs Division has provided an approval subject to several actions by the Authority that ensure short and long term protection of the water quality, aquatic and upland resources of the Bolton Lakes, as well as protection of adjacent private land. To protect the investment of federal funding used with the water access site, DEEP Boating Division will calculate an in kind compensation by the Authority to cover the partial loss of use of the water access facility.

Selected Land Use Regulations:

The towns of Bolton, Coventry, Tolland and Vernon have each recently revised their zoning and/or subdivision regulations and road drainage manuals in varying degrees with promotion of low impact development (LID) principles and practices.

Low Impact Development is a development design strategy that aims to preserve or restore pre-development water quality and hydrology, primarily by infiltrating stormwater to the ground, and reducing effective impervious surfaces. If the strategy is successful, stream flows will be steadier through dry periods, with sustained groundwater discharges replenishing streams with cooler and cleaner flow. Resource planning areas of geology, water quality, biodiversity, recreation, cultural landscapes, and land use can all be considered within a local regulatory review. LID design strategies to improve stormwater management often include the following:

- ✓ Reduced road widths or elimination of sidewalks to reduce area of paved surfaces
- ✓ Elimination of curbs and gutters to encourage sheet flow across vegetated surfaces
- ✓ Impervious pavement surfaces which allow infiltration to the ground
- ✓ Depressed islands in cul-de-sacs that allow drainage to infiltrate into the ground
- ✓ Zero lot line and reduced front setbacks to allow preservation of green space behind buildings
- ✓ Shared driveways to reduce overall area of paved surfaces
- ✓ Vegetated swales alongside roadways to remove pollutants and encourage infiltration

The Town of Bolton incorporated LID standards into both zoning and subdivision regulations in 2012. (**7**) Where stormwater management plans are required for subdivisions, site plan approvals, and special permits in this town, certain standards must be met in key areas of design, construction and maintenance. Compliance with these standards is exempt for single family homes and/or accessory uses, or for farming or listed farming structures. The regulatory goals aim to reflect the goals identified in the *2004 Connecticut Stormwater Quality Manual*, as amended, and for the *Connecticut Erosion and Sediment Control Guidelines* (2002), as amended.

These Stormwater Management Standards intend to emulate the following goals included within

The 2004 Connecticut Stormwater Quality Manual, as amended:

1. *Preserve pre-development site hydrology (including runoff, infiltration, interception, evapotranspiration, groundwater recharge, and stream base flow) to the extent possible.*

2. *After construction has been completed and the site is permanently stabilized, reduce the average annual total suspended solids loadings in the post-development runoff by 80 percent. For high quality receiving waters and sites with the highest potential for significant pollutant loadings, reduce post-development pollutant loadings so that average annual post-development loadings do not exceed pre-development loadings (i.e., no net increase).*

3. *Preserve and protect wetlands, stream buffers, natural drainage systems, and other natural features that provide water quality and quantity benefits.*

4. *Manage runoff velocity and volume in a manner that maintains or improves the physical and biological character of existing drainage systems and prevents increases in downstream flooding/stream bank erosion.*

5. *Prevent pollutants from entering receiving waters and wetlands in amounts that exceed the systems' natural ability to assimilate the pollutants and provide the desired functions.*

6. *Seek multi-objective benefits (i.e., flood control, water quality, recreation, aesthetics, and habitat) from stormwater control measures.*

The Town of Tolland developed an LID design manual in 2008, which provides a legal framework for site development that incorporates LID strategies into land development (**8**). The manual provides development techniques to maintain the integrity of natural site features into the development process, which has the potential to reduce or even eliminate stormwater components of a conventional storm water management system. Several of the listed storm water goals are of particular interest to resource protection elements for the Bolton Lakes and their contributing watershed. This manual also provides good information on storm water management issues, as well as a useful overview of low impact development principles, practices and design considerations. It should be noted the Bolton Lakes/Hop River watershed is not identified as a major basin requiring particular care with stormwater discharges. This is likely due to its relatively small size and the largely rural development patterns to date. The manual does identify current conditions at a relatively low impervious cover percentage of approximately 3%-5%, with one residential neighborhood approaching 7.5%. It is important to note that Town staff and land use commissions have not had extensive opportunities to “test” the manual, due to the extended economic downturn in that community since the manual’s development.

The Town of Vernon adopted their LID storm water design manual in 2013. (**9**) The town has endorsed a policy to require LID to the maximum extent practicable for all projects that fall within current Town regulatory jurisdiction, with exemptions similar to those listed in the Town of Bolton regulations. The manual is intended to be used for guidance with site specific LID options, and in conjunction with the Connecticut Stormwater Quality Manual for other stormwater management needs. As with the Tolland manual, flexibility is a key attribute to fitting appropriate LID practices for the site-specific conditions and for meeting the standards set forth in the manual. Many examples of LID practices installed in the southern New England region are included in this manual.

The Town of Coventry approved zoning regulations in 2006 aimed to minimize adverse impacts from impervious surface coverage within the lake residential zone district, for further protection of its treasured Coventry Lake. (**10**) Within Section 4.04.06 Lot Coverage, the Lake Residential (LR) Zone provides for up to specified lot coverage if applicants demonstrate the capture and infiltration of impervious surface runoff calculated via a formula included within the regulation and associated lot coverage worksheet. Indeed, Town approval of such increases in lot coverage will be conditioned on the maintenance of the approved drainage or infiltration structures on that property. This information is placed on the land records as well. Commonly used infiltrating LID structures are chosen from a stormwater engineering design matrix. The Land Use Office maintains a tracking spreadsheet of permitted/waived stormwater practices and the Zoning Enforcement Officer does conduct follow up site visits and contacts with landowners. There are rain gardens (most numerous method to date), rain barrels, infiltrators, gravel trenches, crushed stone perimeters, cisterns and dry wells now in use across the lake zone district due to this regulation.

These documents are available in various forms in the respective town's websites or Town hall. These can be reviewed as a foundational tool for a set of regional forum presentations relative to land use planning and management strategies promoted throughout the Bolton Lakes watershed.

Planning principles for effective integration of LID practices in this watershed should consider:

Early on, emphasize conservation of important natural resources and also critical environmental areas. These areas provide natural processes that are commonly difficult to recreate or reengineer. Use existing natural site features, and then integrate with distributed or decentralized, small-scale controls.

Focus on source reduction of pollutants, often spread throughout a watershed, with site assessments and a community education and outreach campaign. Providing for less contamination entering rainfall and snowmelt runoff to start with usually offers the greatest efficiencies in protecting the receiving waterbodies. Remember learning Benjamin Franklin's adage of an ounce of prevention being worth a pound of cure?

The essence of LID as stormwater management measures revolves around the mimicking of natural drainage patterns, or hydrology, in residential and commercial (and even industrial) development settings. This is accomplished by reducing impacts to naturally vegetated areas and local topography, by minimizing and disconnecting impervious surfaces where practicable, and by slowing down, spreading out and soaking in the rainfall.

Think of rainfall as a resource, and not a nuisance to be collected, piped and conveyed "away".

Lake shoreline buffers can be designed and creatively installed to reduce rainfall and snowmelt runoff from upland areas. They will also perform double duty by stabilizing the dynamic shoreline as well as significantly reduce erosion; and they can be designed to provide an aesthetically appealing transition zone between the open lake and the built environment.

An important emphasis must be placed upon the long term operations and maintenance, reflected in growing literature of the importance of post-construction to maintain the effectiveness of chosen practices. The use of LID does not (necessarily) reduce maintenance requirements, but rather a different kind of maintenance.

While not currently demonstrated in the Bolton Lake communities, in some other communities there is a lack of governing will to widely implement LID policies and practices. This type of barrier to implementation raises the need for a continual education and training campaign to regularly reach town staff, consultants and land use decision makers who may change positions and/or duties over time.

(Note: The CTDEEP has recently posted the Proceedings from the Connecticut Green Infrastructure Symposium that was held in September 2013 which provides valuable information on overcoming barriers and creating opportunities to use green infrastructure and LID practices. http://www.ct.gov/deep/cwp/view.asp?A=2705&Q=533134&deepNav_GID=1654)

Homeowner and Municipal Practices:

Four practical and successful suggestions are offered here, though the limited list is not meant to dismiss numerous other practices that abound in relevant publications and outreach presentations.

- A strong focus should be place on turf lawns as a source of nutrient runoff from developed areas in this watershed. With so-called urban fertilizer management, a critical message is to promote regular soil testing BEFORE any fertilizer application. There are several avenues to obtain quality test results, including the University of Connecticut Soil Lab. Wherever the results come from, do follow the recommendations (which may very likely indicate little or no fertilization is necessary for optimal turf health and appearance).

- Consider alternatives to full turf lawns, including conservation landscapes that replace some turf with plants typically native to the area. Municipalities can provide high visibility demonstration areas at their town parks, playgrounds, conservation properties and roadside right of ways.

- Keep collected leaves, lawn clippings, yard debris and pet/livestock waste out of street drainage system, stream channels and wetlands.

- Protect your riparian areas - allow nature to do its thing! These streamside and lakeside areas are important ecological as well as environmental attributes. They provide for stream or lakeside shore stability. The surface and subsurface properties are often very productive in pollutant trapping and assimilation before they discharge into the waterway. They are somewhat specialized wildlife habitat corridors. They can provide for effective visual and sound buffering between natural(ized) water bodies and more intensive human development areas. Where human alterations have impacted their corridors in a particular watershed (e.g. turf lawn running down to water's edge, broadcast clearing of tall vegetation for unobstructed views or access, replacement of native plant species with those that often require more management and care), degraded water quality conditions and aquatic habitats often result.

Community Outreach:

There have been no recent watershed-wide forums held to date, though Bolton and Vernon Conservation Commissions held initial discussions with Coventry and Tolland Conservation Commissions and DEEP watershed and forestry program staff on post-ERT report opportunities in early 2014.

As stated earlier, the Bolton Lakes watershed is a contributing headwater to the Hop River sub-watershed, which is a significant tributary to the Willimantic River regional basin. The Willimantic River Alliance (WRA) is an established organization with primary focus on the Willimantic River main stem, and increasing interest with water quality and/or water resources development issues within tributaries including Roaring Brook (Willington) and Eagleville Brook (Mansfield). Over the last decade WRA has sponsored regional network meetings that included a forum for regional land trusts and one for water supply and management stakeholders. Along with established organizations such as Connecticut Federation of Lakes and perhaps North Central Conservation District, WRA could be approached co-facilitate a Bolton Lakes multi-meeting forum that can set the stage for a desired regional management plan.

Selected Approaches to Regional Water Resources Planning and Management:

Capital Region Council of Governments - Draft Plan of Conservation and Development. (**11**) Three of the four watershed towns are members of the same regional council of governments (COG), and the Town of Coventry is petitioning the State of Connecticut's Office of Policy and Management to officially join this same COG. This bodes well for a productive regional support platform to utilize COG staff, under direction and policy implementation support of the COG's governing body, to advance watershed planning and implementation within the multi-community Bolton Lakes watershed. More regional planning findings and discussion are provided elsewhere in this ERT report. With respect to watershed planning and management, the current draft regional plan of conservation and development, considered a vision statement of the broad greater Hartford area, provides numerous findings and policy recommendations. Many recommendations are supportive of natural resources conservation, watersheds and water quality, and enhanced land use decision making that support a healthy and vibrant Bolton Lakes watershed.

There is an established municipal land use evaluation (MLUE) process, more recently established in the 10-town Farmington River Valley and the 10-town Salmon River watershed that may be useful for the Bolton Lakes watershed communities. (**12 and 13**) The objectives include developing recommendations for revising municipal codes and management practices/policies that would be more protective of watershed health, and could specifically target a critical resource including one or more of the Bolton Lakes or the relatively unique Cedar Swamp. For instance, the Salmon River watershed MLUE targeted policies and practices that support the prioritized cold water fishery resources of that lower Connecticut River sub-watershed. Document links with local contact information are provided at the end of this report. The Farmington River Valley project included evaluation of current local regulations and ordinances, revisions of regulations to remove barriers to low impact development, and the hosting of workshops with guest speakers on relevant topics. Municipalities subcontracted expertise as needed by each town, with subject areas including Legal/Regulatory, Facilitation, Environmental science, Planning, and Engineering. A typical CT DEEP/Municipal Scope of Work included:

- Form local land use committee
- Contract with services as appropriate for town
- Review municipal regulations as specified when drafting a scope with DEEP (Focus on zoning, subdivision and wetlands)
- Draft regulatory revisions with municipal committee and consultant
- Present findings / vote to adopt regulatory revisions

Additional project work within some of scopes included:

- Town specific Engineering Standards

- LID and stormwater management design manual
- Ecological and Resource Assessment

Recent watershed planning projects through CT DEEP have focused primarily on water quality-impaired watersheds with known or suspected nonpoint source (NPS) contributions. The planning and resulting implementation actions are in support of requirements of the federal Clean Water Act. Section 319 of that act established a national program to control nonpoint source of water pollution. The DEEP –endorsed plans are typically structured to address nine elements identified by the U.S. Environmental Protection Agency. Approved watershed-based plans can then be used by a spectrum of identified parties to qualify for funding for specific implementation projects that aim to restore water quality conditions and meet Connecticut Water Quality Standards. A local coordinating committee is often established during this watershed planning process; that committee will assist its communities in developing specific strategies and follow up actions. Additional information that includes numerous plan examples is provided on the CT DEEP Watershed Management webpage. **(14)** Nearby watersheds recently benefiting from a broad watershed planning approach include the Hockanum River and the Tankerhoosen River.

A watershed-based planning project would be useful to address the myriad NPS pollution sources, pathways, activities and impacts to the receiving streams, wetland and the three Bolton Lakes. Other sections of this ERT report will discuss some of those pollutants that have negatively impacted lower Bolton Lake in recent years. Recent water monitoring data and analyses are suggesting that in-lake management approaches are impacting Lower Bolton Lake. Although a final monitoring report is pending by consultant George Knoecklein, it is likely that mention will be made of upper watershed contributions of excess nutrients. A watershed planning approach can provide valuable supplementary information to frame an effective management approach to declining water quality of the lakes. Such a process for the Bolton Lakes watershed should also tie in a healthy watershed approach to regional water resources management. Much of the watershed has low development impact and retains quality woodlands and wetland complexes and equally important connections for passage of water, wildlife and more. Assessing the good in the watershed will yield important community knowledge for all to share. Protecting healthy watersheds avoids future costs and benefits communities (**15**). Preventing water quality and other resource impairments in healthy watersheds protects valuable ecosystem services – filtered clean water, flood control recreation, enhance community quality of life. These natural services in turn provide economic benefits to our communities and prevent expensive “fix it” costs. Protecting the good in our watersheds is certainly less expensive that building new human engineered solutions and hardscapes (e.g. pipes, walls, culverts, treatment facilities). A key landowner and community asset - property values – are often enhanced by these services. Indeed, people value living near clean water. Studies across the country show that home values declined substantially with declines in water quality. Such a study was conducted in the town of Coventry to assess impacts on property values in proximity to Coventry Lake. Readers of this ERT report will have a better understanding of some elements that a relatively healthy Bolton Lakes watershed provides to the local economy. That can translate to strengthened land use decision making, both at the local governing level and also by individual landowners across this watershed. Locating development and new growth in areas that minimize negative impacts to the Bolton Lakes, and diverting inappropriate development from sensitive areas within the contributing watershed, can yield positive results for current lake and watershed residents and landowner now, as well as for generations to come.

Recommendations

- Fully assess the Bolton Lakes watershed boundaries, through a combination of local knowledge and "windshield surveys", coupled with expertise in geologic, hydrologic and mapping interpretation. Conventional maps likely used in each town are typically drawn on natural drainage basin delineations from U.S. Geological Survey topographic maps. With recent decades of development projects, expansion of road networks and associated hydrologic alterations in drainage in built up areas of the watershed, it is reasonable to expect the need for refining areas of the contributing watershed.

- Know where preserved land parcels are. Identify undeveloped (and underdeveloped) open space properties. It can be argued that preserved lands are THE most effective tool in maintaining high water quality and critical wildlife habitat in your communities. Assess their natural resources and limited development impact potential, and recognize their position with respect to existing protected open spaces. Each of the four watershed towns has recently engaged in open space and conservation planning, with some communities having lengthy and varied experiences worth sharing with their neighboring towns. Across Connecticut most municipalities, land trusts and other land protection organizations with active open space programs will refer to the statewide land protection plan. The reasons include reviewing local protection strategies for consistency with State goals and priorities for preserving 21% of Connecticut's land area by 2023. *The Green Plan: Guiding Land Acquisition and Protection in Connecticut 2007-2012* is currently being revised, with CT DEEP soliciting comments from land protection stakeholders and partners. (**16**)

- Utilize the Connecticut Environmental Conditions Online website to access and review protected open space maps for each watershed town (**17**). There are different levels of complexity that users can choose from, including a simple, uncluttered map viewer for early users. This regularly updated website has proven very useful to conservation and community land planners across the state, utilizing readily available statewide data and viewable at different scales and simple printing options.

- For more advanced planning needs that can integrate local maps and related geographic information NOT included in the statewide map layers available in the aforementioned CTECO, there is a geographic information system platform known as ArcGIS Online on the CTECO website, or you can visit the ESRI vendor site. (**18**) ArcGIS allows for sharing of interactive maps and users do not need either extensive GIS experience or an expensive GIS application and license on a computer. This could be a useful community planning and education tool. The aforementioned UConn CLEAR staff can provide technical assistance through an introductory workshop and references of local communities and project teams using this and the CTECO website tools.

- Develop a watershed scale open space mapping project that yields a watershed-framed, and not a town based, map. An advantage to this regional approach is to better depict where preserved lands are located in relationship to each other, but also in relationship to streams and wetland complexes and to each of the three Bolton Lakes. One suggestion is to depict protected lands with development restrictions in place with one color category, and depict other lands managed as open space but without permanent protection in a second category. The resulting map can be a powerful (and eye opening) outreach tool to community leaders, land use commissioners, land owners and other local citizens.

- A current discussion across Connecticut involves scrutinizing the levels of protection afforded certain state, local and privately held conservation lands. Protected open spaces and conservation lands may or may not provide for the desired functions and values necessary for long term protection for priority resources such as the Bolton Lakes. Advisory conservation commissions within the Bolton Lake watershed should consider conducting analyses on mapped open spaces and protected lands databases. For further information on the issues focusing on state conservation lands, review the Council on Environmental Quality's report, *Preserved But Maybe Not: The Impermanence of State Conservation Lands* (2014). (**19**) A Bolton Lakes watershed analysis may yield useful information for local land use decision makers and land managers. Furthermore, if shared more broadly the findings could prove beneficial to State agencies such as DEEP that have been working for years to develop an updated protected lands inventory, the Protected Open Space Mapping Project (POSM).

- A potential funding mechanism to support the above-mentioned local analyses is through the Connecticut Office of Policy and Management (OPM)'s Regional Performance Incentive Program. The stated goal is to encourage Connecticut towns to participate in projects that will produce measurable "economies of scale" that will benefit the municipalities, providing desired or required services and lowering the costs and tax burden related to providing those services. The Capital Region Council of Governments (CCROG) may be an effective applicant and administrator for such a shared services proposal amongst the Bolton Lakes communities. For more information visit the OPM website. (**20**) It is important to discuss this early with town chief elected officers for individual town priorities and interest in working regionally on this watershed planning task.

- The Town of Bolton recently received a Connecticut Small Town Economic Assistance (STEAP) grant award that can be used, in part, to address water quality issues identified for Lower Bolton Lake. If the timing still exists to define the final work plan prior to contract development, consideration should be given for expanding the water quality in-lake planning to include a watershed assessment for all three, interconnected Bolton Lakes.

- The towns of Bolton and Vernon should continue to work with CT DEEP to manage the water quality problems at Lower and Middle Bolton Lakes. In-lake and watershed data should be collected annually and analyzed by a consulting limnologist; this is important so that water quality changing conditions can be noted quickly and lake managers can respond appropriately.

- Following reviews of this overall ERT report, a renewed town-by-town effort should be taken and focused more specifically within this Bolton Lakes watershed. This would also involve inter-town dialogue amongst the Conservation Commissions, and promotion of a regional priority setting plan. The Capital Region Council of Governments, along with the Bolton Land Trust, Conserving Tolland, Joshua's Tract Conservation and Historic Trust, and Northern CT Land Trust would be valuable assets in such strategic conservation planning.

- The Town of Coventry recently established a Coventry Lake Awareness and Monitoring Committee within their Conservation Commission. Current projects include a survey of lake users and development of a lake management plan. The Committee has gained lake community support with promotion and activities during Coventry Lake Awareness Month (established by the Town Council resolution to occur each year in July). Such Committee activity support could be emulated amongst the Bolton Lakes communities to meet similar objectives.

- Properly implemented Erosion and Sediment Controls (E&SC), and associated education and outreach, are necessary throughout the Bolton Lakes watershed, and not just targeted along the perimeter and some buffered distance from the three lakes.

- Proper use and promotion of acceptable alternatives to turf lawns, garden fertilizers and pesticides should be encouraged and adopted on municipal and other public facilities as demonstrated practices for widespread community acceptance and use. The University of Connecticut's Office of Extension provides a wealth of resources to cover these practices. The Bolton Lake communities should take full advantage with the close proximity of a field office located at the Tolland County Agricultural Center (TAC) in Vernon.

- The TAC service agencies offer assistance with willing agricultural producers in developing comprehensive nutrient management planning, as well as a suite of technical and financial assistance to utilize best agricultural management practices. In addition to UConn Extension, this TAC includes the North Central Conservation District, whose staff has close working arrangements on numerous agricultural management projects with the federal USDA-Natural Resources Conservation Service.

- Promote the establishment of an illicit discharge, detection and elimination (IDDE) survey and program around the three Bolton Lakes and their contributing tributaries. This could involve a range of source and activities, from detection of residential washing machine or sink discharges, to road/yard catch basins. This is a particular issue raised by the regional Eastern Highlands Health District sanitarian, activities that are in violation of CT Public Health code. An effective IDDE survey and program has the potential to uncover pollutant sources, that left uncontrolled, could overwhelm and mask otherwise successful nonpoint source management activities.

- The Friends of Bolton Lakes organization could take on a valuable community role by conducting a lake shore vegetated buffer assessment. An accessible example is from the lower Connecticut River, conducted a few years ago by that area's regional planning agency. (**21**) Good examples of vegetated buffer guidance are provided through the

Candlewood Lake Authority, and also through the Bantam Lake Protective Association. In addition, the CT DEEP Lakes Management Program will soon have a new guidance document promoting the protection and use of natural shorelines.

- Build (and maintain) better buffers. Natural vegetated buffers along the lake shorelines and the few tributaries are a frontline of defense against surface water pollution. Trees, shrubs and grasses/forbs slow polluted runoff, including excess nutrients and pathogens such as *E. coli*, allowing plants and in some case amended soils to incorporate and break down contaminants before they reach the water. Buffers are among the most cost effective way to prevent water pollution to the lakes. The Friends of Bolton Lakes seem a likely group to spearhead a local effort. They should consider soliciting partnership support (e.g. planning, design/materials, labor) from local garden centers, the North Central Conservation District, and community civic and social organizations such as scout groups and garden clubs.

Selected Projects

One well-tested low impact development (LID) practice is proper siting and installation of shallow depression rain gardens, also known as bioretention areas. Beyond their effectiveness as decentralized, small-scale controls that typically have an aesthetic quality as well, rain gardens are good examples of LID controls that create a level of involvement with citizens and their community. Where many people don't typically think a lot about stormwater management, they can and often do interact with small scale gardening and landscaping. Educating local landowners about rain gardens can build awareness and sense of local control of their impacts on receiving waterbodies such as the Bolton Lakes. It's not an automatic sell – some bad examples have led to people calling them "yard divots" or "mosquito breeders". With science-based education and targeted training, an initial demonstration that is available for public viewing (a few have been installed locally) can lead to broader scale installations across the watershed. Some communities/regions have even benefited from promoting rain garden "competitions", in consultation with local land use and public works offices and with public health staff, and actively supported by conservation commissions or watershed/lake associations.

- Tankerhoosen River Watershed-based Plan – stormwater retrofit implementation project at Lake School in Vernon. This recent bioretention "rain garden" project was managed by the North Central Conservation District- a brief explanation is provided on the NCCD website. (**22**)

- A recent stormwater management demonstration project was designed and installed at Lake Hayward in East Haddam, through the support and assistance of the Lake Hayward Association, the CT River Coastal Conservation District, and the Eightmile River Wild and Scenic Coordinating Committee. (**23**)

- The Town of Coventry installed a stormwater detention basin to treat pollutants (including sediments, nutrients and pathogens) contained within the critical "first flush" of rainfall runoff from the municipal Patriots Park paved lot adjacent to Coventry Lake. Interested parties should contact the Town's Land Use Department to learn more about this project for possible replication around similar areas of the Bolton Lakes.

- Take a tour of the nearby University of Connecticut Storrs campus and its numerous stormwater management practices recently installed to reduce the negative impacts of impervious surfaces and resulting rainfall/snowmelt runoff on the receiving Eagleville Brook. The Natural Resources Conservation Academy at the University of Connecticut is an innovative, year-long program in conservation and land use planning for selected high school students across Connecticut. During the summer of 2013, the “LID team” within the Academy student body developed an interactive LID virtual tour of installed LID practices within the core UConn campus. Taking this virtual tour with any updated Internet web browser prior to visiting the sites firsthand will provide useful information. (**24**)

- Visit a suite of recently installed LID practices (including rain gardens, pervious pavement and a vegetated green roof) within the Hartford State Capitol Green Project, on the grounds of the Connecticut State Capital. View the descriptive before visiting the State Capital Grounds. Note there are no interpretive signs on site. **(25**)

Establish a regional conservation forum for the Bolton Lakes watershed.

- Several good examples are found across Connecticut, in support of healthy watersheds, such as Conservation Action Plans (CAPs) for the Natchaug River, Salmon River, Saugatuck River and Poquetanuck Cove watersheds. Stakeholders on a short list should include Friends of Bolton Lake organization and the Town of Bolton’s Lake Commissioner (currently is Kim Welch). The communities also should also look outward beyond the immediate lakes area. Suggested invitations would include the Bolton Land Trust, the Willimantic River Alliance, Capital Region Council of Governments, as well as Conservation Commissions from the Towns of Coventry and Tolland (Bolton and Vernon commission representatives were active in this ERT request).

Several recommendations are detailed in the aforementioned statewide Bacteria TMDL document and the specific Hop River appendix. In brief, the recommendations include:

- o Evaluating municipal education and outreach programs regarding animal waste.
- o Ensuring there are sufficient vegetated buffer areas on agricultural lands along the Hop River and its tributaries
- o Development of a system to monitor septic systems.
- o Identification of areas in the developed sections of the Hop River watershed to implement Best Management Practices (BMPs) to control stormwater runoff.
- o Expansion of monitoring of permitted sources. This includes modification of stormwater management plans to implement the TMDL.

These recommendations are appropriate to further pursue for the Bolton Lake watershed areas within Bolton as well as within Coventry, Tolland and Vernon.

During the Fall 2012 ERT watershed tour, a visit to the Town of Vernon's Camp Newhoca included the lake beach front bath house and parking lot facilities. It appeared that parking lot and building stormwater runoff was collected and conveyed through a catch basin and pipe collection system and sent as untreated discharge to Middle Bolton Lake. There may be subsurface storage and treatments built into this system, but access/inspection ports were not found during that visit. This municipally managed, high visibility facility could be a good candidate for a stormwater management review and retrofit project, and offer a useful demonstration to town staff and managers, and the broader Bolton Lakes community, of the benefits of enhanced stormwater management and source reduction and control prior to discharging into the lake.

It is beyond the scope of this ERT report, and certainly for this watershed chapter, to more fully address strategies that can be taken to enhance community planning and regulatory actions in the Bolton Lakes watershed. A recommended resource to pursue these topics comes from the Connecticut NEMO program, providing guidance on sustainable community practices that are demonstrated to yield protective water quality conditions. A subcommittee of participants from the recommended regional forum may want to review this document and invite NEMO staff to present in your communities. (**26**)

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Water Quality

This section of the ERT report will focus on present in-lake water conditions at Middle Bolton and Lower Bolton Lakes. The ERT report will address the relationship between the drainage basin and lake water quality in other sections of the report.

Lower Bolton Lake

As many area residents are aware, water quality conditions of Lower Bolton Lake have been noticeably changing since 2010. In 2010 nuisance levels of *Najas guadalupensis,* often referred to as Southern Naiad, became a concern for lake users and managers. (See picture at the end of this section.) In 2012 Lower Bolton Lake experienced an intense and prolonged blue-green algae bloom. The blue-green algae bloom in 2012 was the first bloom reported to DEEP as problematic at Lower Bolton Lake and indicated a potential departure away from the lake's previously acceptable water clarity conditions.

Since 2010 the aquatic plant Southern Naiad has inhibited recreation in Lower Bolton Lake by growing from the bottom, fragmenting, and floating into shallower areas and forming dense mats. Specimens of the plant were identified as Southern Naiad by University of Connecticut Professor Don Les who determined the plant's genetic fingerprint through DNA analysis. Southern Naiad is considered to be a native plant that spreads mostly by fragments settling in the sediments and rooting to form new plants. Fortunately the plant is not the non-native invasive *Najas minor* or a hybrid of the two.

In response to the Southern Naiad problem, the Town of Bolton hired consulting limnologist Dr. George Knoecklein of Northeast Aquatic Research (NEAR) to conduct vegetation surveys and collect and analyze water quality data at Lower Bolton Lake. In addition to gathering information on the Southern Naiad, NEAR also was hired to document whether or not Fanwort (*Cabomba caroliniana*) is present in Lower Bolton Lake. Fanwort is a non-native invasive plant that has been found in nearby water bodies but was not well documented in Lower Bolton Lake. In 2011 and 2012 Southern Naiad continued to be problematic at Lower Bolton Lake. (See November 26, 2012 and February 24, 2014 Powerpoint from NEAR for the most recent information:
http://www.bolton.govoffice.com/vertical/sites/%7B30EEBA3C-BE1C-42AE-911F-0E304A672785%7D/uploads/Lower_Bolton_Lake.pdf and
http://www.bolton.govoffice.com/vertical/sites/%7B30EEBA3C-BE1C-42AE-911F-0E304A672785%7D/uploads/Lower_Bolton_Lake_2014.pdf

In addition to the problems from Southern Naiad, in 2012 Lower Bolton Lake experienced a blue -green algae bloom, also known as cyanobacteria, from mid August into September. Although other lakes in Connecticut experience blue-green algae blooms of this magnitude, the 2012 blue -green algae bloom at Lower Bolton Lake was the first time this lake had a known bloom of this intensity. In response to the bloom, the Eastern Highland Health District (EHHD) issued a public health advisory and the Town of Bolton closed its swimming beach earlier than scheduled. The reason for the public health advisory was concern over potential releases of toxins from the blue-green algae bloom.

The growth of blue-green algae is closely related to phosphorus concentrations in a lake. As phosphorus increases, the likelihood of problematic blue -green algae blooms increases. In early July 2012 prior to the algae bloom, the phosphorus concentration in the surface water of

Lower Bolton Lake was recorded by NEAR to be 10 parts per billion (ppb). In August 2012 NEAR recorded a surface phosphorus concentration of 22 ppb. Although NEAR's data documents an increase in phosphorus concentration, the intensity of the algae bloom was greater than what would normally be expected at 22 ppb phosphorus.

In consultation with DEEP, the Town of Bolton increased the water quality monitoring services provided by NEAR so that phosphorus, nitrogen and algae monitoring would be more frequent. For 2013 the Town of Bolton had hired NEAR to develop a nutrient (phosphorus and nitrogen) budget and monitor Lower Bolton Lake at two stations monthly from March to November. NEAR will also collect nutrient data from the inlets and outlets of the lake and collect nutrient data during storm events. As part of this program, NEAR will conduct a review and investigation of the watershed. Additionally NEAR will be monitoring aquatic plant growth in Lower Bolton Lake. Through this nutrient data collection and analysis effort, we hope to identify sources of nutrient loading to Lower Bolton Lake and gain a better understanding of the growth patterns of Southern Naiad.

The Town of Bolton has also contracted with the applied lake management firm of Aquatic Control Technology (ACT). ACT has been hired to acquire permits and treat the Southern Naiad and potential blue -green algae blooms. The plan for 2013 was to perform a whole-lake treatment with the herbicide Fluridone to control Southern Naiad. Fluridone is also effective in controlling Fanwort. The initial treatment occurred in late April/early May after a pre-treatment survey by NEAR. At least one follow-up "booster" treatment will be conducted to maintain a target concentration and contact time. ACT also acquired a permit to treat Lower Bolton Lake with copper sulfate if needed in response to algae blooms. The treatment plan was developed in cooperation with the DEEP, Town of Bolton, and NEAR. To date, all work by NEAR and ACT has been funded by the Town of Bolton.

Blue-green algae can sometimes produce liver and nerve toxins, and skin irritants that can create conditions where contact recreation such as swimming, water skiing, and jet skiing are not advisable. Usually, the greater the intensity of the bloom the greater the concern that algal toxins will be released. Although many genera, such as *Anabaena*, can produce multiple toxins, the toxin microcystin is typically the only toxin analyzed when determining whether or not a blue-green algae bloom is producing toxins. At the time of the 2012 blue-green algae bloom at Lower Bolton Lake, the State of Connecticut did not have a guidance document for posting health advisories due to blue-green algae blooms. In lieu of a Connecticut guidance document, the EHHD was advised by the State of Connecticut Department of Public Health to use the guidance published by the Commonwealth of Massachusetts for posting blue-green algae bloom advisories. The Massachusetts guidance recommends closing public swimming areas at lakes experiencing blue-green algae blooms of 70,000 cells per milliliter or greater. Although blue green cell counts were above 70,000 cells per milliliter at Lower Bolton Lake in 2012, measurable levels of microcystin were not detected. Additional information on blue-green algae blooms may be found on the CTDEEP website:
http://ct.gov/deep/cwp/view.asp?a=2719&q=510024&deepNav_GID=1654.

As a result of the concerns generated about blue –green algae bloom toxins at Lower Bolton Lake in 2012, the DEEP, Bureau of Water Protection and Land Reuse, Planning and Standards Division began working with the State Department of Public Health and the EHHD to develop guidance on closing and reopening beaches due to blue-green algae blooms. This guidance was made available to local health officials in the Summer of 2013.
http://www.ct.gov/deep/lib/deep/water/water_quality_standards/guidance_lhd__bga_blooms_7_2013.pdf

Middle Bolton Lake

Middle Bolton Lake is a shallower Lake than Lower Bolton Lake and historically has had more rooted aquatic plant growth. In an effort to reduce rooted aquatic plant growth, the Town of Vernon has annually requested DEEP to conduct winter draw downs at Middle Bolton Lake. As owner of both the Middle Bolton Lake and Lower Bolton Lake dams, DEEP is responsible for repair and management of both dams. As owner of the dams, DEEP is also responsible for facilitating water draws downs.

Upon request from municipalities, DEEP may conduct winter draw downs of lakes and ponds where the State of Connecticut is the owner of the dam. Lake draw downs have been used as a management tool to help control the growth of nuisance aquatic plants by freezing the overwinter plants in the exposed sediments. Current DEEP policy for state-owned lakes dictates that draw downs should not occur prior to September 10th, and if maintained over the winter season, the water body should be returned to a prescribed water level by April 15th. Winter drawdown depth is dictated by policy, public sentiment, physical ability of the water control structure and the seasonal climatic conditions. Below is a table of winter drawdown depths for Middle Bolton Lake from 1989 to 2010 in feet.

Historical winter drawdown depths for **Middle Bolton Lake** from 1989 to 2010 in feet.	
Year	**Drawdown Depth (ft)**
1989-90	
1990-91	4.0
1991-92	2.0
1992-93	0.7
1993-94	1.0
1994-95	
1995-96	2.0
1996-97	2.0
1997-98	2.8
1998-99	3.0
1999-2000	2.9
2000-01	2.8
2001-02	2.8
2002-03	2.3
2003-04	2.5
2004-05	3.0
2005-06	2.8
2006-07	6.0
2007-08	6.0
2008-09	5.7

Between 2006 and 2009 DEEP collected data on seven lakes to assess impacts from continuous winter draw downs. One lake with no history of drawdown in the past 15 years was served as a control for the study. Two lakes that had no recent history of winter drawdown underwent annual 3-foot draw downs. An additional 3 lakes, including Middle Bolton Lake, underwent 6-foot winter draw downs. During the winters of study period (2006/2007, 2007/2008, and 2008/2009) Middle Bolton Lake was drawn down to approximately six feet rather than three feet as in the past. One of the hypotheses of the study was that Middle Bolton Lake would experience significant aquatic plant species composition change by becoming less diverse during the project years with a deeper draw down. Interestingly, aquatic plant species composition did not show signs of major shifts during the study period. Since Middle Bolton Lake had a history of winter draw downs, the aquatic plant species may have already adapted to draw downs impacts.

Spring and summer water quality data were collected the year before the deep draw downs began and throughout the draw down years. Water clarity was measured with a standard limnological secchi disk. Temperature and dissolved oxygen measurements were taken from surface to bottom at one meter intervals or less. Grab samples were collected at surface, mid depth, and bottom for analysis of total phosphorus and total nitrogen (ammonium, nitrite/nitrate, organic). Surface samples were analyzed for chlorophyll-*a*. Chlorophyll-*a* is a pigment in algae used as an index of algae biomass measured in ppb.

At Middle Bolton Lake the study found no significant differences observed in the geometric means for total nitrogen, total phosphorus, and secchi disk transparency from the year prior to the deep draw down to the deeper draw down years. Although not statistically significant, Middle Bolton Lake's mid depth total nitrogen concentration declined from 418 ppb in 2006 to 328 ppb in 2009. Near-bottom total nitrogen concentrations showed a stronger trend by declining from 807 ppb in 2006 to 324 ppb in 2009. However, a significant difference was observed in Middle Bolton Lake's chlorophyll-*a* concentration from 2006 to the 2007 and 2009 concentrations, with the observed chlorophyll-*a* geometric mean decreasing from 13.2 ppb in 2006 to 5.4 ppb in 2009. Below are the data from the draw down study for Middle Bolton Lake.

Middle Bolton Lake water quality data for the Lake Drawdown study for period 2007 to 2009.

Middle Bolton Lake		TN (ug L^{-1})			TP (ug L^{-1})			Chl-a (ug L^{-1})	Secchi (m)
		Surface	Mid	Bottom	Surface	Mid	Bottom		
	July-06	593	431	499	2	2	9	16.7	2.46
	July-06	396	378	607	16	19	39	21.9	1.97
	August-06	428	448	1050	15	28	50	11.8	2.09
	Sept-06	803	NT	1335	19	NT	18	13.2	2.44
	Geomean	**533A**	**418A**	**807A**	**10A**	**10A**	**24A**	**13.2A**	**2.2A**
	May-07	394	337	598	16	NT	34	2.9	2.5
	July -07	347	NT	526	13	NT	56	10.2	2.7
	August-07	284	NT	1009	12	NT	97	4.8	3.1
	Geomean	**339A**	**337A**	**682A**	**14A**	**----**	**57A**	**5.2B**	**2.7A**
	June-08	360	431	537	13	8	22	6.1	2.6
	July-08	335	343	304	10	22	16	6.7	2.7
	August-08	460	392	559	16	16	28	13.0	1.8
	Sept-08	461	411	429	19	8	18	11.6	1.7
	Geomean	**400A**	**393A**	**445A**	**14A**	**12A**	**21A**	**8.6AB**	**2.1A**
	June-09	332	345	353	13	14	13	7.7	2.4
	July-09	343	365	290	11	17	27	3.7	2.4
	August-09	292	279	333	11	NT	32	5.4	2.7
	Sept-09	NT	NT	NT	NT	NT	NT	**NT**	2.1
	Geomean	**322A**	**328A**	**324A**	**12A**	**15A**	**22A**	**5.4B**	**2.5A**

NT = not tested

*Concentrations followed by the same letter are not significantly different at $p = 0.05$.

At this time it is uncertain why Lower Bolton Lake has been experiencing signs of advanced eutrophication since 2010. One hypothesis discussed by DEEP staff is that nutrient rich water may have been released from the bottom of Middle Bolton Lake during the years when Middle Bolton Lake was lowered six feet. In support of this hypothesis is the analysis of the water quality data from the draw down study which shows decreasing nutrient and chlorophyll *a* trends in Middle Bolton Lake. Further supporting this hypothesis is the Middle Bolton Lake dam outlet structure that pulls water from ten feet below the surface when the water level is being manipulated. Deeper zones of a lake will have higher nutrient concentrations than surface water due to build up of organic materials and the resulting oxygen demand from the sediments.

Unfortunately the drawdown study was not designed to answer the question of how lowering Middle Bolton Lake could impact the water quality of Lower Bolton Lake. So there are limitations to the available data set to answer this question. In an attempt to gain a better understanding of this issue, NEAR’s 2013 monitoring program was designed to determine nutrient movement from Middle Bolton Lake to Lower Bolton Lake.

Moving forward it is important for the Town of Bolton, and the Town of Vernon to continue working with DEEP to manage water quality problems at both lakes. The changing conditions at Lower Bolton Lake indicate that more active involvement by residents as well as Town of Bolton officials and DEEP staff will be needed. A critical part of any program will be continuation of the monitoring programs developed in 2012. Ideally in-lake and watershed data would be collected annually so that changing conditions can be noticed immediately and managers can respond without delay. Monitoring data should be presented in an annual report. If possible, the monitoring report should be presented at a public meeting so that interested citizens have an opportunity to become more informed of the issues and ask questions.

Of particular concern is Fanwort in Lower Bolton Lake. Although only sprigs of this plant have been found floating in the lake to date, Fanwort can be a very aggressive non native plant. With the threat of Fanwort being present, it is strongly recommended that both lakes have annual vegetation surveys so that control efforts can be implemented before a spreading infestation of Fanwort becomes more difficult to manage. (See the following CTDEEP webpage and the CT Agricultural Experiment Station webpage for more information on invasive aquatics:
http://www.ct.gov/deep/cwp/view.asp?a=2702&q=474710&deepNav_GID=1620
http://www.ct.gov/caes/cwp/view.asp?a=2799&q=376972&caesNav=|

The water quality data will likely identify areas of high nutrient loading that may require capital projects to correct such as stormwater infrastructure improvements. To fund these capital projects, the Town of Vernon and Town of Bolton may need to set aside capital project monies and search for grants. If funds become available through the State of Connecticut, it is likely DEEP will be the agency that will administer these grants. As in the past three years, whether or not funds become available from the State of Connecticut, DEEP will continue to work with both Towns to address water quality conditions at Middle Bolton Lake and Lower Bolton Lake.

Southern Naiad

North Central Conservation District Review

Background

The initial request for the ERT was broad in scope, but generally expressed the desire to update the 1979 Bolton Lakes ERT to address changes in the watershed that have occurred since 1979, *and* to address potential changes that may result from the sewer project. A meeting with interested parties from the municipalities and participants was held in July 2012 at the Tolland County Agricultural Center to identify critical issues and address potential limitations of the ERT process that may affect expected outcomes of the report. By July, the issue of potentially toxic cyanobacteria blooms had begun to emerge and continued problems with the proliferation of Naiad was noted throughout the summer of 2012. A consensus seemed to emerge that the ERT would essentially be used as a planning tool to assist municipalities with prioritizing future activity and to identify critical strategies for continued lake management. It was generally acknowledged that additional data collection in terms of water quality was outside the scope of the ERT review and the municipalities were exploring different options for comprehensive water quality studies. George Knoecklein, a well-known Connecticut limnologist, has already conducted some water quality monitoring and analysis (see Water Quality section).

The 1979 ERT should be seen as the baseline document for this update, since it contains most of the basic resource information needed to assess general watershed characteristics. Although over 30 years have elapsed, there have not been significant changes in the overall *pattern* of development in the watershed. The lakes were described as eutrophic in 1979 (they are listed as “mesotrophic” in the DEEP’s current statewide water quality report) and most of the baseline conditions that were prevalent then are still present, with the notable addition of vascular plants (Naiads) in Lower Bolton Lake. Also, most of the recommendations in the 1979 report are still relevant and unless they directly relate to new information, will not be repeated here.

The other important reference for land use considerations is the Route 44/Bolton Strategic Plan, prepared by Fitzgerald and Halliday in 2008. This document covers a range of regional development issues, including concerns relating to the sewer project. The document includes recommendations for state-of-the art planning, zoning, and development techniques for both residential and commercial development. Generally, all recommended techniques include measures to protect natural resources and water quality.

District Review

The District’s standard review for development projects includes an assessment of wetlands, soils and erosion control, and stormwater. ERT members have not been assigned specific tasks, so it is unclear from our vantage what specific information will be included in the ERT report by others. The District is staffed with experienced environmental scientists with a range of capabilities and is available for additional assessment if specific issues are not addressed in the report. For instance, for this level of review, the District does not provide GIS mapping, but this service is available from the District for municipal projects. Further assessment and analysis could be accomplished with GIS. For a more comprehensive assessment of the watershed and water quality issues, the area town’s or concerned citizens may wish to initiate a Watershed Management Plan, which may more directly address some of the concerns outlined in the ERT request.

In-lake water quality monitoring and assessment is a long term project and NCCD supports hiring a professional limnologist. Long term continuity with a single entity is useful to identify long term trends and implement in-lake management techniques. Since Mr. Knoecklein has already been engaged and DEEP staff will address other management strategies, NCCD will not comment on in-lake water quality issues. Using available information, the following discussion focuses on basic resources (soils) and non-point source pollution in the watershed.

Soils

Appendix A is an updated soils report generated from the Natural Resource Conservation Service Web Soil Survey. Nearly all of the upland soils in the watershed consist of glacial till. Wetlands comprise less than 20% of the watershed. Wetland soils are listed below with the percentage of area within the "Area of Interest", which is the area of the watershed. As noted in the 1979 report, many of these till soils are poorly suited for on-site septic systems due to restrictive layers and high water tables.

Wetland Soils in Watershed by Percent

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
2	Ridgebury fine sandy loam	14.2	0.6%
3	Ridgebury, Leicester, and Whitman soils,extremely stony	197.9	7.7%
4	Leicester fine sandy loam	14.7	0.6%
13	Walpole sandy loam	101.3	4.0%
17	Timakwa and Natchaug soils	157.4	6.1%
		Total:	19%

The Soils Report includes two watershed-scale soil interpretations: one for general building suitability and one for general erosion hazard. A description of each interpretation from the report follows. The maps demonstrate that significant areas in the watershed are severely limited for development and contain highly erodible soils. Neither of these interpretations should be construed as prohibitive of development. They merely indicate that native soils have limitations that should be taken into consideration when development is proposed.

Building Site Development

"Building site development interpretations are designed to be used as tools for evaluating soil suitability and identifying soil limitations for various construction purposes. As part of the interpretation process, the rating applies to each soil in its described condition and does not consider present land use. Example interpretations can include corrosion of concrete and steel, shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping."

Erosion Hazard (Off-Road, Off-Trail)

"The ratings are both verbal and numerical. The hazard is described as "slight,""moderate," "severe," or "very severe." A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical."

Agriculture in the Watershed

The ERT request includes a request for information pertaining to “farming practices of potential concern, runoff concerns for Tolland and Coventry”. Based on personal knowledge and a review of several years of aerial photographs, agriculture in the watershed is generally limited to low intensity hobby-farming and hay production. There are no significant concentrations of livestock within the watershed that might contribute to non-point source agricultural pollution.

Non-point Source Pollution

Non-point source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into receiving waters like lakes, rivers, and wetlands (EPA, 2012). In most lakes, the main pollutants of concern are phosphorous, nitrogen, and bacteria, since these pollutants are associated with algal blooms, excessive plant growth, and beach closures, respectively. In the Bolton Lakes watershed, the most likely sources of nutrients are associated with residential development in close proximity to the lakes, including roads, driveways, and lawns.

Existing Conditions

It is worth noting that although the sewer project may result in additional development in the watershed, it is difficult to imagine a scenario in which any additional development has a greater negative impact on water quality in the Bolton Lakes than the continued use and maintenance of existing septic systems. The existing septic systems represent a significant load of nutrients discharging into the watershed. The insufficiency of native soils for waste treatment was noted in the 1978 ERT and frequent septic system failures are a common occurrence in the area (*personal communication, several town staff have made this observation*). It should also be recognized that the majority of the existing systems were constructed prior to the “modern era” of septic design standards. New development in the watershed will be reviewed for stormwater quality, as described below.

Numerous studies of non-point source pollution confirm that roads and other impervious surfaces, with their associated drainage collection systems, are the primary source of non-point source pollutants in developed areas. The District **recommends** an inventory of all stormwater discharges in the near-lakes area to identify all discharge points and begin the process of prioritizing discharges for stormwater retrofit (treatment) measures. This effort could be done by volunteers, with proper training. Or it could be done as part of a watershed planning effort. The District has completed a number of these “trackdown surveys” in the region and may be available for training or to conduct the field survey on a fee-for-service basis. (The field work and coordination involved with a trackdown survey is beyond the scope an ERT). Under existing programs, in order to be eligible for funding for stormwater retrofits from state or federal sources, a watershed plan must be prepared for the affected area.

Under the State of Connecticut Small Municipal Separate Storm Sewers Systems (“MS4”) Program, which applies to all of the watershed towns, the municipalities must map their stormwater system, including discharge points. The Town of Bolton has completed some mapping of their system and it includes outfall pipes around lower Bolton Lake. The current map shows three outfalls. The last time NCCD inquired with the Town of Vernon, town-wide mapping was not completed, although some older, non-digitized maps were available. NCCD is not aware of the status of the other town's storm-water mapping. Even at their possible closest points, stormwater discharges from Tolland or Coventry are a distance away from the lakes. While they may be a source of pollutants, an inventory of near-lake discharges should be a greater priority.

New Development

Under the MS4 program, all of the watershed towns now regulate new stormwater discharges and have the ability to require advanced treatment methods. Tolland, Vernon, and Bolton all have some form of Low Impact Developments regulations for new development. These measures will significantly reduce the potential for significant pollutant loads associated with new development.

Other pollutant sources

Nutrient loads from established residential development are typically higher than for forested or other undisturbed landscapes. Sources include pet waste, excess fertilizer, and pollutants generated from vehicles. In relation to the Bolton Lakes, residential development is concentrated on the east side of the lakes, with generally sparser development on the west side. NCCD supports a non-regulatory, educationally-based approach to addressing water quality from residential sources. An organized and targeted education program focused on the approximately 360 households around the lake could be effective at reducing local pollution sources. Such an effort could be facilitated under the mandated municipal stormwater public education program, which is required under the MS4 program. Lake Associations often development their own local programs for homeowners. Educational materials are available from the EPA and many other sites. (EPA site – www.water.epa.gov/type/watersheds/index.cfm and another site that has excellent publications on water quality monitoring, health shoreland fact sheets, building and sustaining effective groups and protecting our lake guidebook examples is www.minnesotawaters.org/publications)

Under a new state law (**Public Act #12-155 An Act Concerning Phosphorous Reduction is State Waters**) effective January 1. 2013, fertilizing established lawns with fertilizers containing phosphorous (at prescribed levels) is prohibited unless the application is supported by a soil test. The statute also limits fertilizer application within 20 feet of watercourses and waterbodies. The provisions of the new statute could form the core of a targeted educational program.

Generally speaking, new aggressive regulatory approaches to address non-point source pollution from residential sources will be difficult to implement under current (political and economic) conditions. Regulatory approaches that approach *technical* aspects of development such as "Low Impact Development" and "Impervious Surface Regulations" are more likely to be successful than over-reaching regulatory approaches that affect individual residential property owners. All three watershed towns already have relatively new regulatory mechanisms to address stormwater under the MS4 stormwater program.

The District is available for additional assistance for stormwater tracking and development of a public education program for landowners.

Fisheries Resources

A. Upper Bolton Lake

Description (From Jacobs and O'Donnell 2002)

Upper Bolton Lake, in the Thames River Drainage Basin, is the smallest (50.3 acres) and most northern of the Bolton Lakes. ***Watershed*:** 1,293 acres of mostly wetland with some residential and agricultural development. The lake is fed from the north by a wetland and from surface runoff. It drains into Middle Bolton Lake through a culvert under Hatch Hill Rd. ***Shoreline*:** Most of the shoreline is undeveloped marshland. ***Depth*:** Max 7.5 ft., Mean 3.0 ft. ***Transparency*:** Visible to the bottom (3 ft.). ***Productivity*:** Not available. ***Bottom type*:** Organic muck. ***Stratification*:** Does not occur due to limited depth. ***Vegetation*:** Almost entirely covered by dense aquatic vegetation during the summer months.

An aquatic vegetation and basic water quality survey of Upper Bolton Lake was completed by the Connecticut Agricultural Experiment Station in July 2005, mapping and data which can be obtained at: http://www.ct.gov/caes/cwp/view.asp?a=2799&q=380560

Fish Community (From Jacobs and O'Donnell 2002)

The Inland Fisheries Division (IFD) has not sampled this waterbody as part of the statewide lake and pond survey. Fishing is reportedly fair for largemouth bass, chain pickerel, yellow perch, sunfish and bullheads. This is a Bass Management Lake with a 12 to 16 inch protected slot limit for largemouth and smallmouth bass. Daily creel limit is 6 bass; only two fish over 16 inches or greater in size can be harvested. Statewide regulations apply for all other species (*see current Connecticut Anglers Guide for details*). A significant fish kill occurred in Upper Bolton Lake in 2000 due to a winter drawdown of Middle Bolton Lake.

B. Middle Bolton Lake

Description: (From Jacobs and O'Donnell 2002)

Middle Bolton Lake is an artificial impoundment (121 acres in size) in the Thames River Drainage Basin that has an earthen and concrete dam. ***Watershed*:** 1,946 acres of mostly woods and wetland with moderate amounts of agricultural and residential development. The lake is fed by surface runoff and from the overflow of Upper Bolton Lake. The lake drains into Lower Bolton Lake via a spillway over the dam. ***Shoreline*:** Partially wooded and heavily developed with residences lining the entire shoreline. There are many docks, especially along the eastern shore. ***Depth*:** Max 20 ft., Mean 12 ft. ***Transparency*:** Fair; 8 ft. in late summer. ***Productivity*:** Moderate (mesotrophic-late mesotrophic). ***Bottom type*:** Sand, gravel, rubble and boulders covered by organic muck. ***Stratification*:** Partially stratifies; a temperature gradient forms at 13 ft. and dissolved oxygen declines to less than 1 ppm below this depth. ***Vegetation*:** Submerged vegetation is sparse to moderate in shallow water with variable leaf water milfoil being the dominant species.

An aquatic vegetation and basic water quality survey of Middle Bolton Lake was completed by the Connecticut Agricultural Experiment Station in July 2010, mapping and data which can be obtained at: http://www.ct.gov/caes/cwp/view.asp?a=2799&q=473082

Fish Community (From Jacobs and O'Donnell 2002)

Largemouth bass are abundant and stockpiled in smaller sizes (less than 12"), with larger fish being uncommon. Smallmouth bass and chain pickerel and black crappie are present at lower than average densities. Yellow perch are abundant up to 10", but larger fish are rare. Sunfish (mostly bluegill, some pumpkinseed, occasional green) densities are average for smaller fish and slightly above average for larger (7-8") ones. Forage fish include low densities of golden shiners and banded killifish. Table 1. depicts the representative fish community that can be found within Middle Bolton Lake based upon a sample collected on 10/13/2009. This is a Bass Management Lake with a 12 to 16 inch protected slot limit for largemouth and smallmouth bass. Daily creel limit is 6 bass; only two fish over 16 inches or greater in size can be harvested. Statewide regulations apply for all other species (*see current Connecticut Anglers Guide for details*). Fishing pressure is moderate to high on Middle Bolton Lake.

Table 1. Representative fish community within Middle Bolton Lake. Catch per effort (Number of fish/hr) for stock size and for quality size[1] (in parentheses) fish species captured by boat electrofishing on 10/13/2009. State average (CPE) also shown.

Species	Stock Size/ Quality Size (cm)	Catch Per Effort (CPE) Number of fish/hr Stock Size (Quality Size)	State Average (CPE) Number of fish/hr Stock Size (Quality Size)
GAMEFISH			
Largemouth bass	20(30)	39.8 (31.6)	57.9(29.4)
Chain pickerel	25(38)	10.2 (7.1)	20.6(6.3)
LARGER PANFISH			
Black crappie	13(20)	8.2 (7.1)	21.3(17.1)
Yellow perch	13(20)	28.6 (23.5)	102.1(48.2)
Yellow bullhead	15(23)	4.1 (3.1)	9.8(6.5)
SUNFISH			
Bluegill (BG)	8(15)	427.5 (297.1)	343.3(142.3)
Pumpkinseed (PS)	8(15)	38.3 (7.7)	59.3(23.5)
Green sunfish (GR)	8(15)	51.8 (21.1)	
PS x GR hybrid	8(15)	9.6 (1.9)	
GR x BG hybrid	8(15)	1.9 (1.9)	
NON-GAME SPECIES			
Golden shiner		58.24 ( )	20.9(6.7)
Banded killifish		2.09 ( )	

"Quality size" is a length in centimeters (cm) above which most anglers would consider fish desirable to catch.

C. Lower Bolton Lake

Description: (From Jacobs and O'Donnell 2002)

Lower Bolton Lake is a 175 acre natural lake within the Thames River Drainage Basin. Its water level was raised by an earthen dam with a concrete spillway that was rebuilt in 1994. ***Watershed*****:** 2,379 acres of mostly woods and wetland with moderate levels of residential and agricultural development dispersed throughout. The lake is fed by Middle Bolton Lake and surface runoff. It drains into Bolton Pond Brook to the southeast. ***Shoreline*****:** Heavily developed with residences. A town beach is located on the southeastern shore. ***Depth*****:** Max 20 ft., Mean 11 ft. ***Transparency*****:** Fair; 6 ft. in late summer. ***Productivity*****:** Moderate (mesotrophic). ***Bottom type*****:** Sand, gravel, coarse rubble and boulders in the shallows; mud and organic muck in the deeper areas. ***Stratification*****:** Partially stratifies in the summer with a temperature gradient beginning at 13 ft. Late summer oxygen levels decline to less than 1 ppm below this depth.

The most dominant aquatic plant in Lower Bolton Lake is southern naiad after being discovered within the lake in 2010. It has grown to nuisance levels and is thought to be an aggressive hybrid form of southern naiad. An aquatic vegetation and basic water quality survey of Lower Bolton Lake was completed by the Connecticut Agricultural Experiment Station in July/August 2011, mapping and data which can be obtained at: http://www.ct.gov/caes/cwp/view.asp?a=2799&Q=490410&PM=1

Fish Community (From Jacobs and O'Donnell 2002)

Lower Bolton Lake contains higher than average densities of largemouth bass to 14", but larger fish are scarce. Table 2. depicts the representative fish community that can be found within Lower Bolton Lake based upon a sample collected on 10/27/2008. Yellow perch and black crappie densities are average for all sizes with 10-11" fish being common. Densities of small sunfish (mostly bluegill, some pumpkinseed, occasional green and hybrids) are average with the abundance of larger fish (7-8") being above average. Major forage fish species are golden shiner (average densities) and banded killifish (very abundant). White suckers are also very common. Other gamefish species present at low densities are smallmouth bass and chain pickerel.

Lower Bolton Lake is one of 12 lakes/ponds throughout the State of Connecticut that have been stocked with channel catfish since 2007. Lower Bolton Lake has been designated as a put-and-grow channel catfish fishery in which yearling fish (23-30 cm in length) are annually stocked. Goals of the channel catfish introduction program are to: (1) diversify recreational fisheries in Connecticut, and (2) improve the quality of angling for other fish species since the introduction of a predatory fish such as channel catfish can improve growth rates/size structure of other sportfish by thinning out "stunted" populations of overabundant small fish.

Lower Bolton Lake is a Bass Management Lake with a 12 to 16 inch protected slot limit for largemouth and smallmouth bass. Daily creel limit is 6 bass; only two fish over 16 inches or greater in size can be harvested. Statewide regulations apply for all other species (*see current Connecticut Anglers Guide for details*). Fishing pressure is moderate in this lake.

Table 2. Representative fish community within Lower Bolton Lake. Catch per effort (Number of fish/hr) for stock size and for quality size[1](in parentheses) fish species captured by boat electrofishing on 10/27/2008. State average (CPE) also shown.

Species	Stock Size/ QualitySize(cm)	Catch Per Effort (CPE) Number of fish/hr Stock Size (Quality Size)	State Average (CPE) Number of fish/hr Stock Size (Quality Size)
GAMEFISH			
Largemouth bass	20(30)	30.1 (20.1)	57.9(29.4)
Smallmouth bass	20(30)	1.7 ( )	26.0(10.4
Chain pickerel	25(38)	6.7 (6.7)	20.6(6.3)
LARGER PANFISH			
Black crappie	13(20)	8.4 (8.4)	21.3(17.1)
Yellow perch	13(20)	195.5 (177.2)	102.1(48.2)
Yellow bullhead	15(23)	3.4 (8.4)	9.8(6.5)
Channel catfish	20(30)	3.3 (1.7)	
SUNFISH			
Bluegill (BG)	8(15)	249.0 (193.9)	343.3(142.3)
Pumpkinseed (PS)	8(15)	18.4 (6.7)	59.3(23.5)
Green sunfish (GR)	8(15)	55.2 (6.7)	
BG x PS hybrid	8(15)	6.7 (5.0)	
PS x GR hybrid	8(15)	5.0 (1.7)	
GR x BG hybrid	8(15)	1.7 (1.7)	
NON-GAME SPECIES			
Golden shiner		23.4 ( )	20.9(6.7)
Banded killifish		71.9 ( )	
White sucker		23.4 ( )	31.2(25.8)

"Quality size" is a length in centimeters (cm) above which most anglers would consider fish desirable to catch.

Comments/Recommendations

1. The determination of the overall health, status and condition of the Bolton Lakes Watershed would be best addressed through the development of a comprehensive watershed management plan. A watershed study and management plan can review local land use regulations, conduct detailed field assessments to document baseline watershed conditions, identify impacts and threats of future development in the watershed and recommend specific actions to protect and restore natural resources and water quality. A good local example is the adjacent Tankerhoosen River Watershed Management plan completed in 2009. A copy of this plan can be obtained at: http://www.ct.gov/dep/lib/dep/water/watershed_management/wm_plans/tankerhoosen/tankwp_final.pdf . CT DEEP guidance and potential funding sources for watershed management plans can be found at: http://www.ct.gov/dep/cwp/view.asp?a=2719&q=335504&depNav_GID=1654. Also refer to USEPA guidance in, Handbook for Developing Watershed Plans to Restore and

Protect Our Waters". Copy of the report can be found at:
http://water.epa.gov/polwaste/nps/handbook_index.cfm

2. Channel Catfish Introductions into Lower Bolton Lake. The issue of stocking a non-native fish species into Lower Bolton Lake was raised during the ERT informational meeting. While channel catfish are not native to Connecticut, this species is found in all major watersheds in Connecticut with a self-sustaining population found in the Connecticut River. Hartel et al. (2002) suggests that channel catfish were established in the Connecticut River in Massachusetts sometime between 1920 and 1960. While it is possible that these channel catfish moved downstream to Connecticut from Massachusetts, the exact source of the Connecticut River channel catfish population in Connecticut is unknown. Catches of large channel catfish have been reported to the DEEP from at least 21 lakes statewide as part of the Trophy Fish Program (Hagstrom et al. 2011). Channel catfish were found in four lakes during statewide lake electrofishing surveys. Most of these occurrences were probably the result of illegal transplanting by anglers. There is no indication that these transplants have resulted in any self-sustaining lake/pond channel catfish populations in Connecticut. Non-native fish species comprise up to 50% of the fish species already established within lakes that have been stocked with channel catfish, in fact, the numbers of individual fish that are introduced species tend to far outnumber the numbers of native fish (Hagstrom et al. 2011).

After the ERT informational meeting, the Friends of Bolton Lakes organization was formed and subsequently contacted the Inland Fisheries Division regarding the stocking of channel catfish as being a possible cause of the nuisance blue-green algal bloom that developed in Lower Bolton Lake in late summer 2012. A comprehensive DEEP response to that question was compiled by Justin Davis, A CTDEEP fisheries biologist August 2013. A copy may be found in the Appendix of this report. Some of the basic concerns are addressed below.

An Environmental Assessment (EA) was prepared and required by the U.S. Fish and Wildlife Service, prior to the initiation of catfish introductions (Hagstrom et al. 2011). The EA assessed potential effects of stocking channel catfish for aquatic wildlife (including endangered species), aquatic plants, water quality, terrestrial wildlife and recreational socio-economics. The draft EA was posted for public review in January 2007 and finalized in March 2007. The results of this process were the filing of a "Notice of No Significant Findings" due to lack of significant potential stocking impacts.

Relative to the effects of channel catfish introductions and water quality, a review of peer-reviewed literature determined that there are no known negative changes in water quality due to channel catfish stockings, furthermore there is a potential to actually help improve water quality through cascading trophic interactions on the food chain (Carpenter et al. 1985). The trophic interaction is explained by the following. Fish eating, top food chain predators such as channel catfish will prey upon much smaller fish species that primarily consume zooplankton. Since zooplankton eat phytoplankton (those microscopic algae that can increase in number and result in nuisance algae blooms), the increase in zooplankton production through the reduction in small fish abundance may result in the actual reduction of unicellular algal densities. Some water companies in Connecticut (e.g. Aquarion and South Central Regional Water Company) have encouraged stocking of predators in water supply reservoirs (walleye in Saugatuck Reservoir and Lake Saltonstall, channel catfish in Maltby Ponds #2 and #3) since these introductions can improve water quality through top-down control of zooplanktivorous fish (B. Jacobs, personal communication). Since the channel catfish stocking program was initiated in 2007, there have been no known reports of nuisance algal blooms in any of the other 11 lakes that received fish.

3. Water level control of Upper Bolton Lake. Water from Upper Bolton Lake is conveyed through an undersized round concrete culvert underneath Hatch Hill Road flowing downgradient into Middle Bolton Lake. In essence, Hatch Hill Road serves as a berm and water control for the lake. There have been instances in the past when winter drawdowns within Middle Bolton Lake have caused water levels in Upper Bolton Lake to excessively drop, sometimes resulting in fishkills due to dissolved oxygen depletion. It is recommended that the existing culvert be replaced with a more functional water control device that can effectively manage water levels in Upper Bolton Lake, especially when Middle Bolton Lake is lowered.

4. Winter drawdown practices within Middle and Lower Bolton Lakes. Property owners along these lakes have requested annual lowering of water levels (typically 3 ft.) to help facilitate the control of aquatic vegetation. The Middle Bolton Lake aquatic plant community was surveyed as part of a DEEP Interdisciplinary Lake Drawdown Study to measure the effects of drawdown on aquatic plants. Preliminary analysis of the Middle Bolton Study results showed no significant differences in aquatic plant species composition and percent coverage over the study years. Thus, given the lack of conclusive information that drawdowns control nuisance levels of aquatic plants, it is recommended to minimize the depth of drawdowns within the Bolton Lakes in the future to 1-1.5 ft. which should afford sufficient ice damage protection to docks and other man-made shoreline infrastructure.

Literature Cited

Carpenter, S. R., J. F. Kitchell and J. R. Hodgson. 1985. Cascading trophic interactions and lake productivity. Bioscience 35:634-639.

Hagstrom, N.T., J.P. Davis, G. Leonard and C.P. McDowell. 2011. Development of Channel Catfish Fisheries in Connecticut Waters. Connecticut Department of Environmental Protection, Bureau of Natural Resources, Inland Fisheries Division. Federal Aid to Sportfish Restoration F-57-R-29 Segment Report.

Hartel, K. E., D. B. Halliwell, and A. E. Launer. 2002. Inland Fishes of Massachusetts. Massachusetts Audubon Society. Lincoln. 328 pp.

Jacobs, R.P. and E. B. O’Donnell, 2002. A Fisheries Guide to Lakes and Ponds of Connecticut. Connecticut Department of Environmental Protection. Fisheries Division. Bulletin 35.

Forestry /Vegetation

Changes in Vegetation Cover Types

Since the 1978 environmental review there have been significant changes in the land use within the watershed. There are only slight differences in cover type mapping and acreage estimation methods used between 1978 and present day. These differences would not affect the percentage change of the various cover types. See the attached 2012 Vegetation Cover Map.

Forest cover within the watershed decreased from 49% to 31%, a loss of 18% since 1978. This is the greatest loss of any of the cover types. Agricultural land decreased by 1% to the present 4%. Wetlands decreased to 11%, a loss of 2%.

Residential acreage increased from 18% to 39% of the watershed, up 21% since 1978. This increased acreage accounts for the loss from the forest, agricultural, and wetland cover types.

The percentage of the total watershed acreage in water and municipal parks remained unchanged, 13% and 2% respectively.

With this loss of forest cover in the watershed, there is a loss of the ecological and environmental benefits gained from trees and wooded land. Increased storm water runoff, lower water quality, increased water treatment costs, eroding soils and loss of wildlife habitat are consequences of the loss of forest cover. Efforts should be made to restore as much forest cover to the watershed as possible.

Landowners should be encouraged to consult with certified forest practitioners when contemplating commercial forest practices in the watershed. A listing of the Forest Practitioners certified to practice in Connecticut and additional information is available on the CT DEEP website. To protect water quality and ecological benefits when conducting forestry operations within the Bolton Lakes watershed follow the published Best Management Practices (BMP's). The 2012 Connecticut Field Guide - "Best Management Practices for water quality while harvesting forest products" is available on the DEEP website: www.ct.gov/deep/Environmental Protection/natural resources/forestry.

Forestry activities within this watershed may require a permit from the appropriate Town. Landowners should contact the Town Inland Wetlands agency during the planning stages of any project involving forestry activities.

Atlantic White Cedar Swamps

The Atlantic white cedar, an uncommon tree species in Connecticut, occurs in two locations within the watershed. Approximately 6% of the Bolton Lakes watershed is Atlantic white cedar stands. This forest type has been identified as one of the thirteen most imperiled ecosystems in Connecticut.

Atlantic white cedars grow at elevations ranging from sea level to 1,500 feet, and can occur shoreward of lakes, river or stream channels, or estuaries; on river flood plains; in isolated basins; or on slopes. They grow primarily on organic soils (peat or muck) which are usually saturated by water for long periods of the growing season. This groundwater of these swamps is often highly acidic. Cedar forests may be composed exclusively of stands with even-aged, close ranked cedars, or of uneven-aged mixed stands. In mixed stands, red maple and black gum are the most common associates. Common shrubs are highbush blueberry and sweet pepperbush.

Atlantic white cedars grow extremely slow and are adapted to a wide range of water depths. However, rapid, prolonged change in water depth stresses or kills mature trees, and kills seedlings and young trees.

There is typically little natural Atlantic white cedar regeneration within this cover type and it is in danger of being replaced by hardwoods and Eastern hemlock throughout its range. Regeneration of these stands typically occurs following windstorm events and low intensity fires. This cedar is not as tolerant of shade as red maple, black gum and other hardwoods which are the climax species in forested swamps. Atlantic white cedar is not sufficiently shade tolerant to grow through dense shrub thickets or hardwood canopies.

Deer browse is also an issue. Atlantic white cedar is preferentially browse during the winter leaving its primary competitors; red maple, black gum and sweet pepperbush untouched.

Fertilizers, detergents, pesticides and other chemicals can reduce water quality and have lasting effects on the quality of the natural community. Changes in soil/water acidity and nutrient levels likely favor the associated hardwoods, especially red maple. Increased growth and dominance of the hardwoods will shade the cedars causing mortality.

Land use changes in upland areas adjacent to the Atlantic white cedar swamps can adversely impact the height of the water table, water flow rates, and stream flooding characteristics, all factors which are critical to the structure and function of the cedar swamps.

Management Considerations for Atlantic White Cedar

Management of Atlantic white cedar swamps includes maintaining water levels, flow, and quality; and restricting access. Human induced alterations in water levels should be avoided. Beaver activity should be monitored and steps taken to mitigate changing water levels if needed.

Wherever possible, establish and maintain a natural wetland buffer to reduce storm-water, pollution, and nutrient run-off while capturing sediment before it reaches the wetland. Slope steepness, erodibility of soils and surrounding land use must be taken into account when planning these buffers. The table of recommended widths of filter strips in the 2012 Connecticut BMP Field guide might be used as basis to establish the widths of the wetland buffers. Restrict access to the extent possible as trampling by humans flattens the hummock - hollow terrain, wears permanent paths into the peat mats, and kills plants.

Prevent the spread of non-native invasive plants into the cedar stands and associated wetlands through appropriate direct management and by minimizing potential dispersal sites such as residential areas. Education of the public in recognition, monitoring and management of the non-native invasive plant species will be necessary.

On site research is needed to determine the actual condition of these two Atlantic white cedar swamps. Following this research, detailed management recommendations may be developed for each of these swamps.

Interesting further reading on Atlantic White Cedar -

The Ecology of Atlantic White Cedar Wetlands: A Community Profile (1989)
http://www.nwrc.usgs.gov/techrpt/85-7-21.pdf

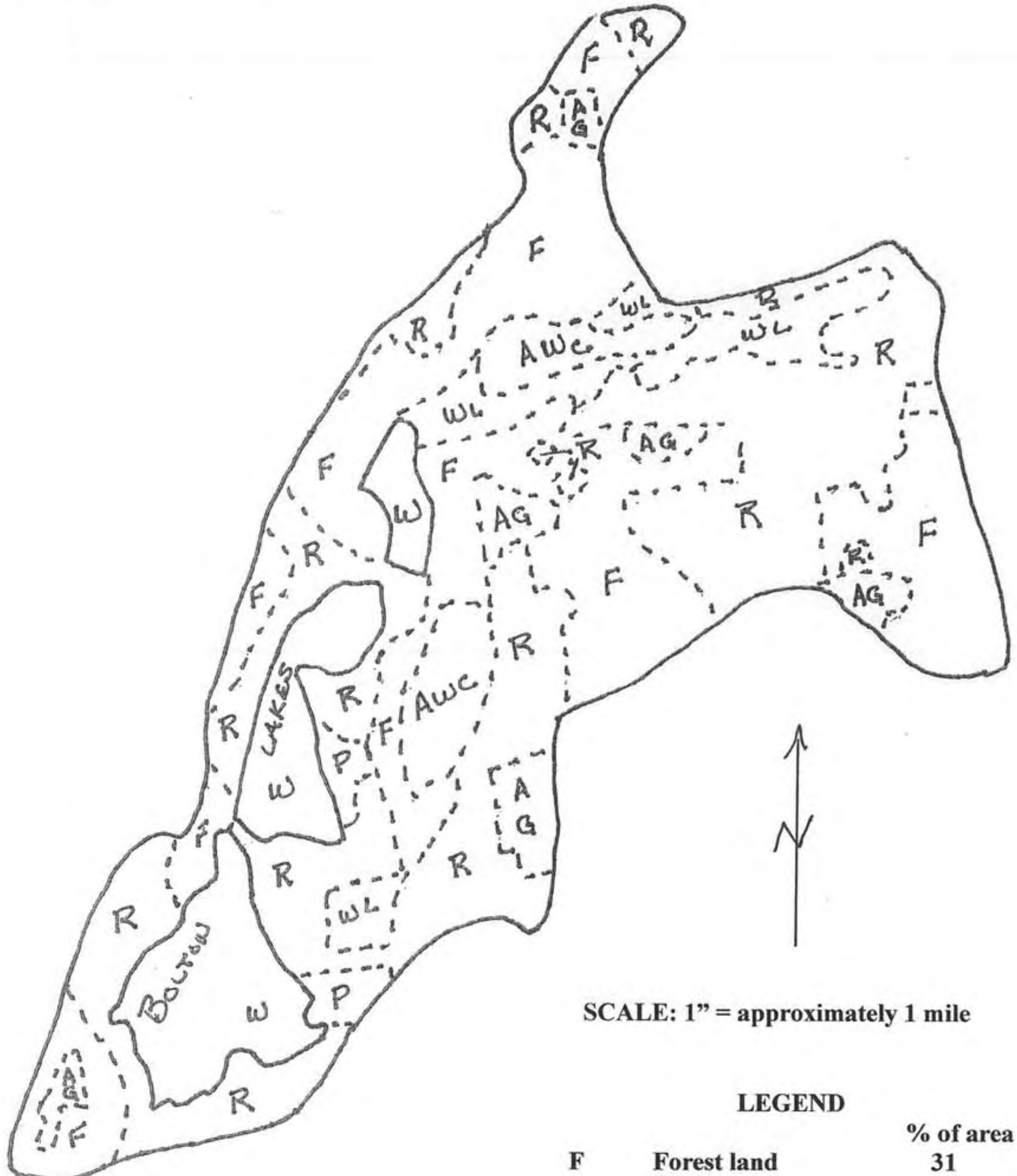
Atlantic White Cedar by Dave Schroeder
http://www.ecfla.org/articles/awc.htm

Methods of Ecosytem Analysis – Atlantic White Cedar Swamp -2002, Yale School of Forestry and Environmental Studies
http://classes.yale.edu/fes_tgs3/fes519/Cedar_Swamp/home.html

Why Protect Atlantic Cedar Swamps by E.A. Zimmerman
http://www.ourbetternature.org/atwhcedar.htm

The White Cedar Web Pages – An alphabetically indexed list of reference materials related to Atlantic white cedar
www.loki.stockton.edu/~wcedars/references.htm

BOLTON LAKES WATERSHED UPDATE
VEGETATION COVER/LAND USE MAP



SCALE: 1" = approximately 1 mile

LEGEND

		% of area
F	Forest land	31
R	Residential	39
W	Water bodies	13
WL	Wetlands	11
AG	Agricultural	4
P	Municipal parks	2

AWC Atlantic white cedar swamps
(included in WL % total)

Wildlife Resources

Background

The Bolton, Vernon, Tolland and Coventry Conservation Commissions requested an environmental review of the Bolton Lakes watershed, in order to update the 1978 ERT report and address the changes that have occurred in the watershed over the last 34 years. The primary concern is water quality issues in the lakes.

Bolton Lakes Watershed

The entire Bolton Lakes watershed is approximately 1,945 acres. The Bolton Lakes System consists of Lower Bolton Lake (~176 acres), Middle Bolton Lake (~117 acres) and Upper Bolton Lake (~23.5 acres). There is an Atlantic White Cedar Swamp (~190 acres) adjacent to Upper Bolton Lake.

While primarily concerned with water quality issues, the ERT requesters also raised increasing development as an issue that the ERT report should address. Development around the lakes has changed and will continue to change the composition of species using the habitat around the lakes. There are many wetland-dependent species, including invertebrates, reptiles, amphibians, birds, and mammals that are unable to tolerate development that changes shoreline habitat to suburban landscape. Habitat components, emergent vegetation for example, are often lost when near-shore habitat is developed, resulting in the loss of a required resource for many invertebrates, amphibians, dabbler ducks such as wood ducks and mallards, shorebirds such as herons, and semi-aquatic mammals. While some species may decline, there are others that are well-adapted to suburban habitats and have likely increased, including Canada geese, raccoons, and skunks. These species can cause damage to homes and yards, and are often considered nuisance species. Local officials are familiar with this, as they have already had to deal with problems resulting from residents feeding Canada geese.

Of particular importance is the 190-acre Atlantic White Cedar Swamp located at the northern end of Upper Bolton Lake. This habitat type is typically dominated by Atlantic white cedar, and can also include highbush blueberry, rosebay rhododendron, swamp azalea, red maple, and yellow birch. Atlantic White Cedar Swamps are considered one of the 13 most imperiled ecosystems in Connecticut (Metzler and Wagner, 1998). Most are in poor condition with poor cedar reproduction and are threatened by development (both directly and through hydrologic changes caused by development) and non-native invasive plants and wildlife. This habitat type is important for species such as green heron, chestnut-sided warbler, and spotted turtle.

Protecting the Atlantic White Cedar Swamp as well as other undeveloped areas around the lakes is the most important step in retaining existing wildlife habitat. There are, however, steps that can be taken to improve the remaining existing habitat in the already-developed areas. One step is to retain native emergent vegetation along the edge of the lakes, which provides cover and foraging habitat for both invertebrates and amphibians, while removing nonnative invasive emergent vegetation, which can outcompete and displace native vegetation while not providing good foraging opportunities. Encouraging homeowners to allow native vegetation to remain rather than replacing it with grass can help promote wildlife habitat in otherwise depleted areas. Another step is to retain any downed logs, providing basking opportunities for turtles, cover for fish and invertebrates, and resting spots for wetland birds. Finally, treating nonnative invasive vegetation in upland areas in addition to within the lakes will also improve existing habitat. Many wetland-dependent species are also dependent on adjacent upland habitat, so retaining the quality of this habitat is as critical as for the wetland habitat. For example, species such as wood duck require nearby upland habitat (tree cavities) for nesting. Additionally, high-quality wetland habitat with high quality adjacent uplands meets all the requirements for many invertebrate and amphibian species, all of which spend some portion of their life cycle in upland habitat. Invertebrate species are in turn preyed upon by reptiles, amphibians, and small fish, which are then preyed upon by larger fish, birds including herons and cormorants, and mammals including mink and weasel. If quality habitat exists that allows species that function as the food web base to flourish, then those species preying upon them will also increase.

Literature Cited

Metzler, K. J. and D. L. Wagner. 1998. Thirteen of Connecticut's most imperiled ecosystems. Internal report of the State Geological and Natural History Survey of Connecticut Department of Environmental Protection, 79 Elm Street, Hartford, Connecticut.

Connecticut Department of Energy and Environmental Protection. Connecticut’s Comprehensive Wildlife Conservation Strategy. 2005. Connecticut Department of Energy and Environmental Protection, Wildlife Division, Bureau of Natural Resources, Hartford, CT.

The Natural Diversity Data Base

A review of the DEEP Natural Diversity Database (NDDB) records indicate that many state-listed species, as well as a rare habitat, an Acidic Atlantic White Cedar Swamp occur in this watershed.

The state threatened purple martin (*Progne subis*) occurred along Lower Bolton Lake a number of years ago. The purple martin is a colonial nesting bird that relies entirely on man-made structures (martin houses, hollow gourds, etc.) for nesting habitat. If the purple martin house no longer exists along Lower Bolton Lake, installation (and maintenance) of one along any of the three lakes might benefit this species (see attached fact sheet in the Appendix for additional information).

Southern bog lemmings (*Synaptomys cooperi*), a special concern species, are closely associated with wetlands such as bogs, fens, hardwood swamps with hummocks, and wet meadows. These lemmings live, tunnel and burrow deep in decomposing leaf mold. They feed on leaves, stems, and seeds of grasses and sedges, fungi, moss, bark, ground pine and occasionally insects. To minimize impacts to bog lemming habitat, any ground disturbing activities within the watershed should include standard protocols for protection of wetlands. These protocols should be followed and maintained during the course of the ground disturbing activities. Additionally, all silt fencing should be removed after soils are stable as to not impede wildlife movement between uplands and wetlands.

Wood turtles (*Glyptemys insculpta*), a special concern species, require riparian habitats bordered by flood plains, woodlands or meadows. Their summer terrestrial habitat includes pastures, old fields, woodlands, power line cuts and railroad beds bordering or adjacent to streams and rivers. Wood turtles have been known to travel up to 300-meters from aquatic environments in search of terrestrial nesting sites. Their hibernating habitat includes tree-lined rivers with undercut banks and muddy bottoms. Wood turtles hibernate submerged in tangled tree roots or in deep pools from 1 November to 1 April. Conservation of riparian habitat may benefit this species. (See Appendix for a CTDEEP fact sheet.)

Eastern box turtles (*Terrapene carolina carolina*), a special concern species, require old field and deciduous forest habitats, which can include power lines and logged woodlands. They are often found near small streams and ponds. The adults are completely terrestrial, but the young may be semi-aquatic. They hibernate by digging down into the soil from October through April. They have an extremely small home range and can usually be found in the same area in consecutive years. This species is dormant from November 1 to April 1, It has been negatively impacted by the loss of suitable habitat thus conservation of contiguous tracts of box turtle habitat would be beneficial. (See Appendix for a CTDEEP fact sheet.)

Merycomyia whitneyi is a state special concern Tabanid fly. Little is known about its life history but it is associated with minerotrophic bogs/fens. (*Minerotrophic* - located in depressions that receive surface runoff and/or ground-water recharge from surrounding mineral-soil sources. Nutrients are more abundant and water is more alkaline.) This record is from a wetland associated with the Bolton Lakes. Activities that protect the water quality and vegetated edges of bogs, fens and other wetland types within the watershed may benefit this species.

Sargus fasciatus is a state special concern soldier fly. This record is from the cedar swamp. In general, soldier flies are found in shrubby or herbaceous inland wetlands. Their larvae pupate in the mud along the water's edge. Activities that protect the water quality and vegetated edges of the cedar swamp and other wetland types within the watershed may benefit this species.

Acidic Atlantic White Cedar Swamp (AAWCS): Several areas of Acidic Atlantic White Cedar Swamp (AAWCS) have been documented within the Bolton Lakes watershed. These uncommon swamps, dominated by Atlantic white cedar (*Chamaecyparis thyoides)*, typically occur on decomposed peats and mucks in areas where water is stagnant or slow-moving. Like other wetlands, AAWCSs provide groundwater storage and also serve as natural impoundments which absorb stormwaters and help to mitigate flooding. Furthermore, the carbon-rich soils on which they occur also assist in the purification and protection of vital ground- and surface-water stores.

AAWCSs also provide habitat for wildlife, including some regionally rare species. Although not documented at this site, notable species exclusive to AAWCSs are Hessel's hairstreak butterfly (*Callophrys hesseli)* and the ringed boghaunter (*Williamsonia lintemi*) .
(See the following websites for more information on these species - http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/williamsonia-lintneri.pdf and
http://www.naba.org/chapters/nabambc/construct-species-page.asp?sp=hessels-hairstreak

To prevent impacts to AAWCSs, avoid alterations to the hydrology and water chemistry of these wetlands by minimizing the impacts of both surface runoff and residential wastewater.

Considerations may include;

- Avoiding lake draw-downs, Often used to control nuisance aquatic vegetation, lake draw-downs can impact AAWCSs by lowering the water table. Atlantic white cedar may become stressed or die under these conditions, allowing for other tree species (i.e. red maple) to dominate over time.
- Limiting the number of stormwater discharge points located upstream or in close proximity of AAWCSs,
- Designing or retrofitting stormwater management systems to reduce scouring of wetland habitat and minimizing inputs of pollutants to waterways.
- Limiting the number of septic fields within a fixed distance of waterways or AAWCSs. Residential wastewater contains nutrients which can reduce the growth of sphagnum while encouraging the growth of invasive or 'weedy1 species which are often more apt at sequestering nutrients.
-

Should you have additional questions on AAWCCs, please contact Nelson DeBarros at nelson.debarros@ct.gov.

Natural Diversity Database information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Natural History Survey and cooperating units of DEEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field Investigations. Consultations with the Database should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Database as it becomes available.

This is a preliminary site review and is not a final determination. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to the DEEP for the proposed site. Please be advised that should state permits be required or should state involvement occur in some other fashion, specific restrictions or conditions relating to the species discussed above may apply. In this situation, additional evaluation of the proposal by the DEEP Wildlife Division should be requested and species-specific surveys may be required, If the proposed project has not been initiated within one year of this Wildlife Division review, you should contact the NDDB for an updated review.

If you have any additional questions, please feel free to contact Laura.Saucier@ct.gov, please reference the NDDB number (201206437) when you e-mail or write.

Planning Considerations

Site Description and Overview

At the request of the Bolton, Vernon, Tolland, and Coventry Conservation Commissions, an Environmental Review Team (ERT) was convened to study and report on the status of the Bolton Lakes Watershed that spans all four towns. The goal of the team is to update the previous 1978 Environmental Review Team Report for the watershed.

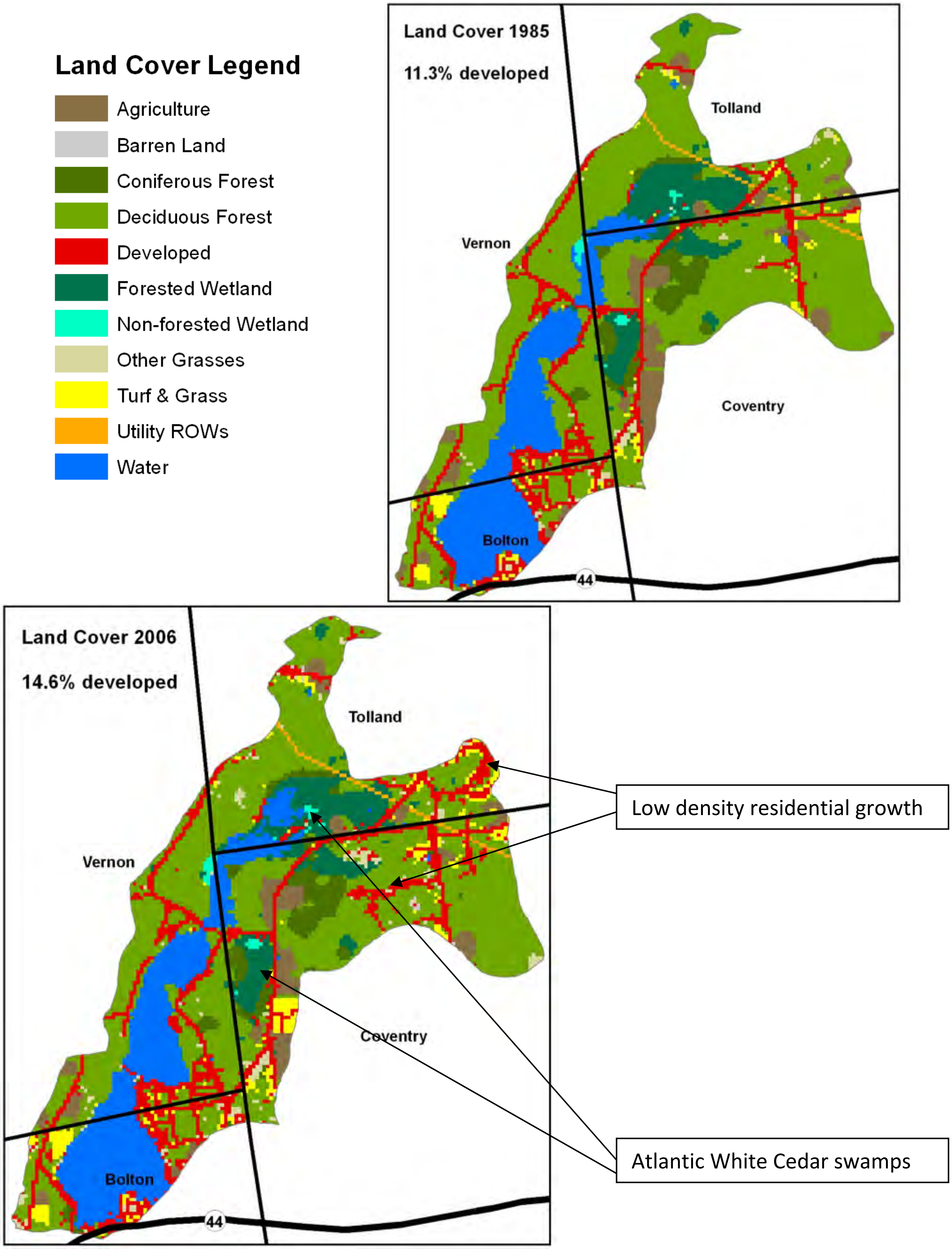
The approximately 2,000 acre watershed is in the upper portion of the Thames River Major Basin. Its western edge is the border of the Connecticut River Major Basin. Lower Bolton Lake flows to the southwest into Bolton Pond Brook and onward to the Hop River, Willimantic, Shetucket, and Thames Rivers.

Land Cover in the Watershed

The watershed is predominately forested with high density residential development in the shorefront areas and low density residential development in the upper watershed. Lower Bolton Lake has been recently sewered with plans to expand sewer service to the residences around Middle Bolton Lake. State Route 44 runs through the lowermost portion of the watershed. Additionally, there are two Atlantic White Cedar (*Chamaecyparis thyoides)* swamps of state-wide ecological significance: a 33 acre cedar swamp in Coventry near Cedar Swamp Road and Vernon Branch Road, and a 75 acre cedar swamp in Tolland off of Cedar Swamp Road.

Between 1985-2006, the basin went from 11.3% developed to 14.6% developed (source: UConn CLEAR). Most of this growth is attributed to low-density residential development in the Towns of Tolland and Coventry in the uppermost reaches of the watershed. The shorefront areas in Bolton and Vernon have also seen some new development but this is comparably much less than in Tolland and Coventry over this time period.

Studies have shown a direct correlation between the percentage of development in the watershed and water quality with more development leading to greater problems with water quality. Despite the introduction of a sewer to address failing septic systems, the level of development and impervious cover in the watershed can still lead to negative impacts to water quality. Recommendations to address this issue are included in the section titled “Planning Recommendations”.


Land Cover Legend
Agriculture
Barren Land
Coniferous Forest
Deciduous Forest
Developed
Forested Wetland
Non-forested Wetland
Other Grasses
Turf & Grass
Utility ROWs
Water
Land Cover 1985
11.3% developed
Tolland
Vernon
Coventry
Bolton
44
Land Cover 2006
14.6% developed
Tolland
Vernon
Coventry
Bolton
44
Low density residential growth
Atlantic White Cedar swamps

Current Zoning

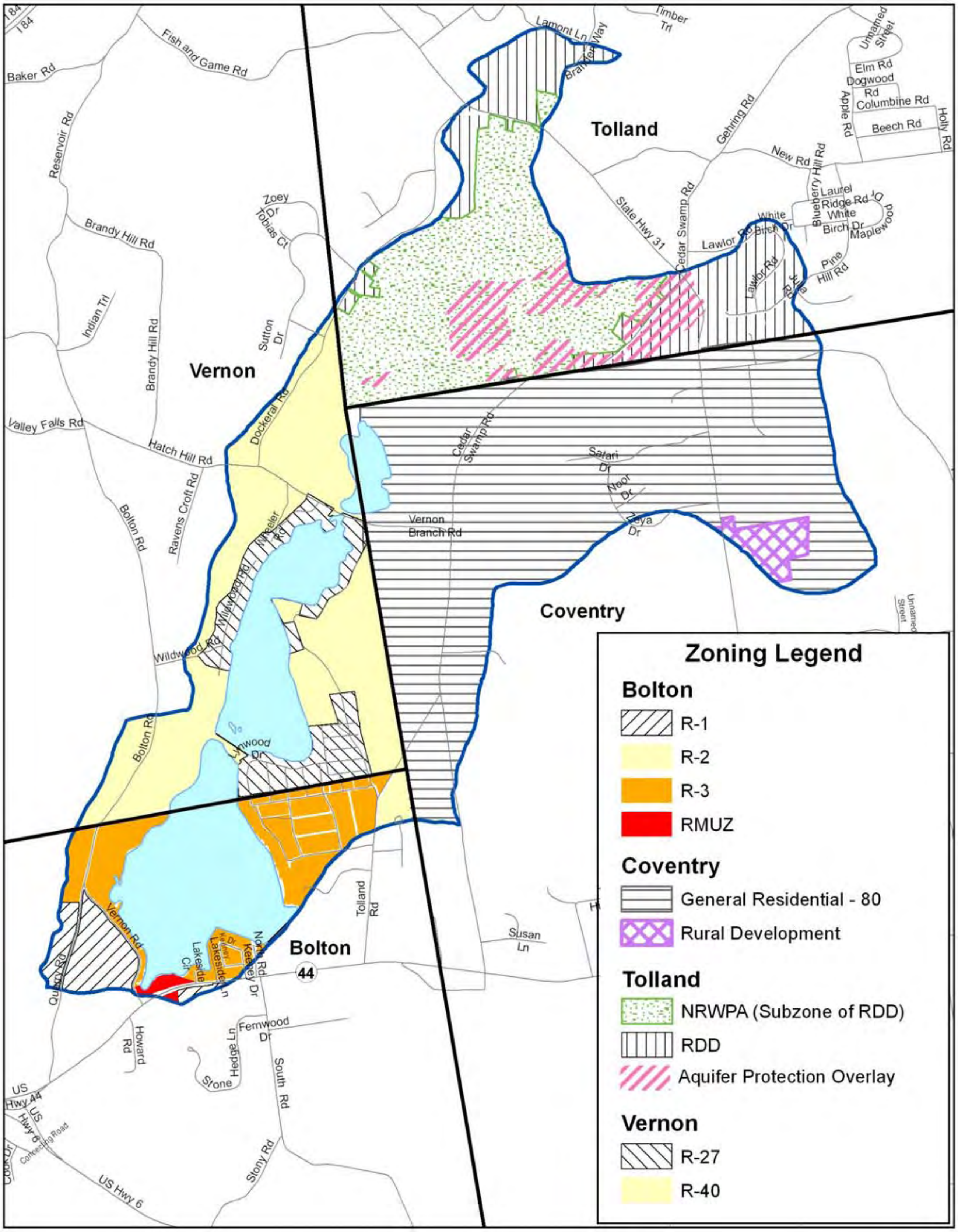
The zoning classifications for the four towns in the watershed are depicted on the following page.

Bolton: The zoning in the Bolton portion of the watershed is mostly R-3, a residential zone with a minimum lot size of 22,500 s.f. Other zones in the watershed include R-1 and R-2 (both residential zones with a minimum lot size of 40,000 s.f.), and a small RMUZ or Rural Mixed Use Zone on Route 44. One of the two properties in the RMUZ is a multifamily residence.

Coventry: The zoning in Coventry is mostly General Residential – 80, a residential zone with a minimum lot size of 80,000 s.f. A Rural Development Zone is located on Route 31. This zone permits small-scale industrial and manufacturing uses.

Tolland: The zoning in Tolland is mostly RDD or Residential Design District. The minimum lot size is 40,000 s.f. for open space developments and 87,120 s.f. for traditional developments. The NRWPA or Natural Resource Protection Area is a subzone within the RDD that shows areas that are particularly sensitive to development due to their natural resource value. The uses permitted in the RDD are also permitted in the NRWPA but additional care must be taken to protect the natural resources. Within the RDD/NRWPA, there is also an Aquifer Protection Overlay Zone that includes areas of stratified drift thought to be capable of providing future water supply. Uses that are capable of contaminating ground water (such as gas stations and dry cleaners) are not permitted in this zone.

Vernon: The zoning in Vernon is R-27 a residential zone with a minimum lot size of 27,000 s.f. and R-40 a residential zone with a minimum lot size of 40,000 s.f.

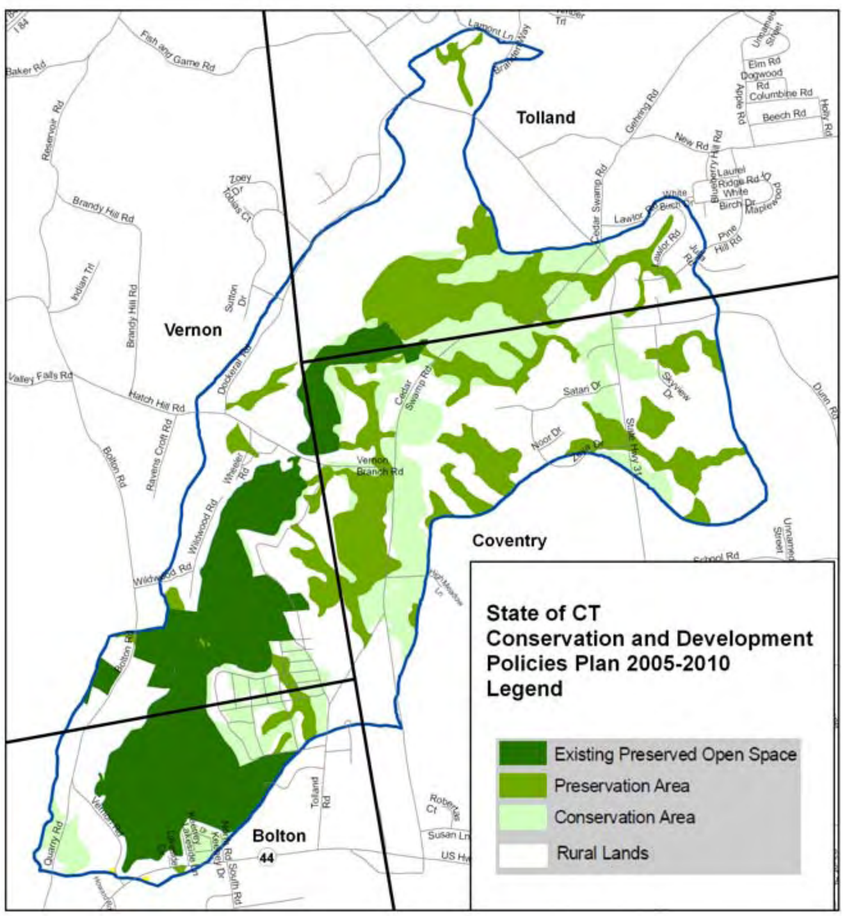

Tolland
Vernon
Coventry
Bolton
Zoning Legend
Bolton
R-1
R-2
R-3
RMUZ
Coventry
General Residential - 80
Rural Development
Tolland
NRWPA (Subzone of RDD)
RDD
Aquifer Protection Overlay
Vernon
R-27
R-40
Fish and Game Rd
Baker Rd
Reservoir Rd
Brandy Hill Rd
Indian Trl
Valley Falls Rd
Hatch Hill Rd
Bolton Rd
Ravens Croft Rd
Dockerel Rd
Wildwood Rd
Lynwood Dr
Vernon Rd
State Hwy 31
Cedar Swamp Rd
Vernon Branch Rd
Safari Dr
Noor Dr
Lawlor Rd
Gehring Rd
New Rd
Pine Hill Rd
Timber Trl
Lamont Ln
Tolland Rd
Susan Ln
Howard Rd
Hedge Ln
South Rd
Stony Rd
US Hwy 6
US Hwy 44
Fernwood Dr
Lakeside Ln
Keeney Dr
North Rd
Quarry Rd
44

Consistency with State, Local and Regional Plans of Conservation and Development

State Plan 2005-2010

The Bolton Lakes Watershed is identified on the State of Connecticut *Conservation and Development Policies Plan 2005-2010* Locational Guide Map as Rural Lands, Conservation Areas, Preservation Areas, and Existing Preserved Open Space. The general policies for these areas are below. Since the 2005-2012 plan was adopted, Bolton receive an interim update that created a Rural Community Center designation on Route 44 but this did not affect the Bolton Lakes Watershed.

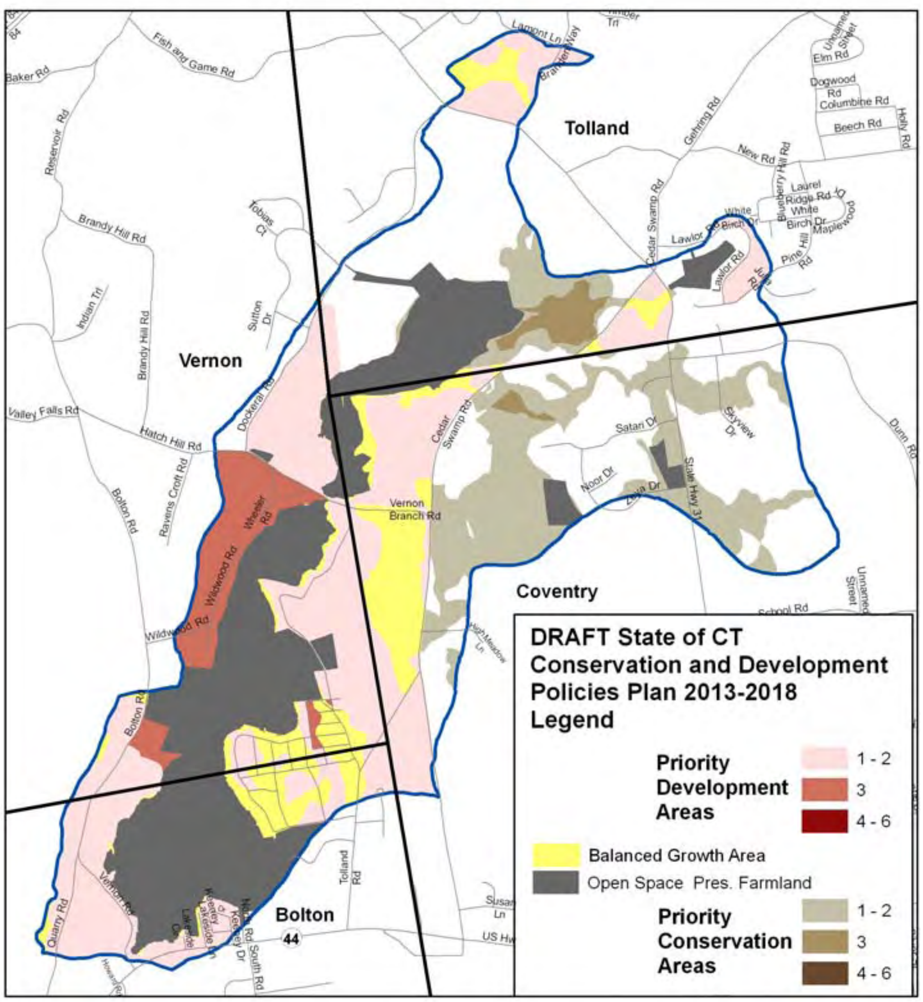
"Existing Preserved Open Space" – Support the permanent protection of public and quasi-public land dedicated for open space purposes.
"Preservation Areas" – Protect significant resource, heritage, recreation, and hazard-prone areas by avoiding structural development, except as directly consistent with the preservation value.
"Conservation Areas" – Plan for the long-term management of lands that contribute to the state's need for food, water and other resources and environmental quality by ensuring that any changes in use are compatible with the identified conservation value.
"Rural Lands" – Protect the rural character of these areas by avoiding development forms and intensities that exceed on-site carrying capacity for water supply and sewage disposal, except where necessary to resolve localized public health concerns.



Draft State Plan 2013-2018

The State of Connecticut *Conservation and Development Policies Plan* is in the process of being updated for the years 2013-2018 (Final Plan adopted 6/5/13, this section of the ERT was written 12/11/12). The new draft plan shifts the policy for the Bolton Lakes Watershed from fully conservation-oriented to partially development-oriented. The new designations for the watershed include: Priority Development Areas, Balanced Growth Areas, Priority Conservation Areas, and Open Space/Preserved Farmland. The general policies for these areas are below:

"Priority Development Areas" - Development activities consistent with the State C&D Plan growth management principles would be supported.
"Priority Conservation Areas" - Conservation activities consistent with the State C&D Plan growth management principles would be supported.
"Balanced Growth Areas" – These areas meet the criteria of both Priority Development Areas and Priority Conservation Areas. Actions in these areas must provide balanced consideration of all factors in determining the extent to which it is consistent with the policies of the State C&D Plan.
"Open Space Preservation Farmland" – These areas are already permanently protected open space.

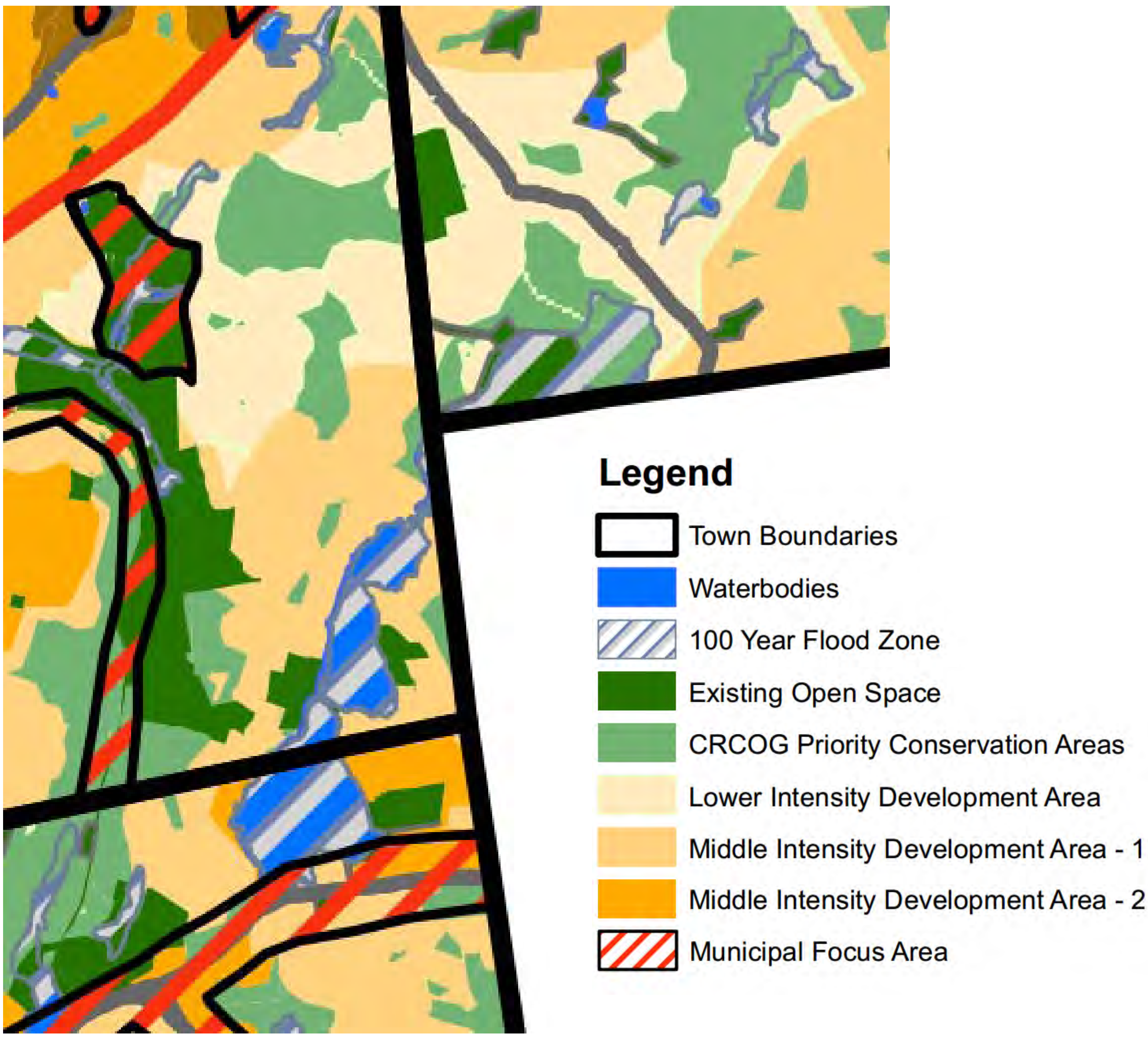


Regional Plans

CRCOG:

The Bolton Lakes Watershed in Bolton, Vernon, and Tolland has various designations on the *Capitol Region Plan of Conservation and Development 2009 Land Use Policy Map.* The general descriptions of these designations are on the following page.

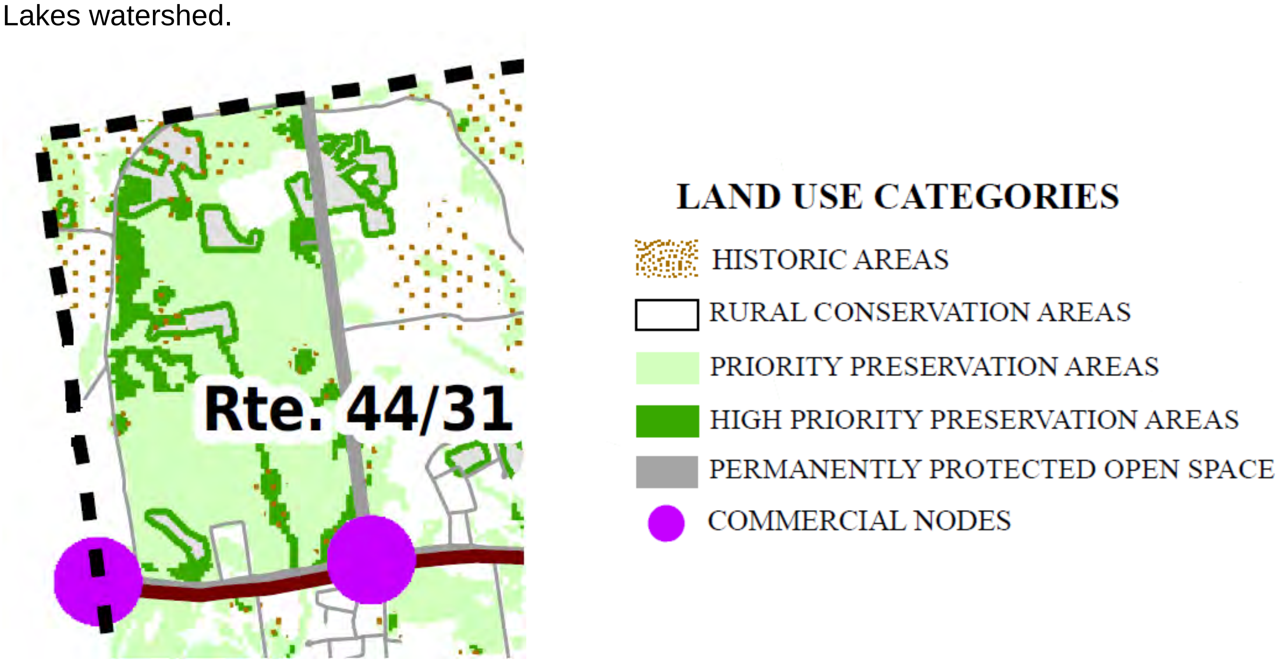
The lower watershed is mostly identified as Middle Intensity Development Areas 1 & 2. The upper watershed is largely designated as CRCOG Priority Conservation Area, Flood Zone, and Lower Intensity Development Area. Municipal Focus Areas (places of interest for municipalities for conservation or development but that do not rise to the level of regional interest) are also identified on Bolton Road in Vernon and Route 44 in Bolton.



1) “Existing Open Space” designation includes private, municipal, and state open space.
2) “CRCOG Priority Conservation Area” designation includes those forested or wetland areas, located at least 500’ from development, that are not currently protected, and that contain at least one of the following features: potential rare or threatened species, potential habitat area, aquifer protection area, prime farmland soil or that abut protected lands. The CRCOG Priority Conservation Areas layer also contains lands identified by planners and commissioners as priority lands for conservation efforts that are not currently protected or designated as conservation land.
3) “Lower Intensity Development Areas” are open land that may be cultivated or sparsely settled and have town roads, very low-density residential detached housing, agricultural buildings or other buildings that are 1-2 stories in height.
4) “Middle Intensity Development Areas – 1“are primarily detached single family houses and/or neighborhood scale commercial establishments and/or industrial establishments surrounded by lawns and landscaped yards. Buildings may be 1-2 stories.
5) “Middle Intensity Development Areas –2”allow greater intensity of mixed use; buildings may be totally residential or a mix of office/retail/residential or small lodging depending on market demand.
6) “Municipal Focus Areas” have been identified by town planners and include existing or potential conservation greenways, open space connections, commercial, retail or mixed-use centers, traditional neighborhood developments, village greens, village centers, historic areas, transit oriented developments and technology or business centers.

WINCOG:

The portion of the Bolton Lakes Watershed that is in Coventry is identified in the Windham Region Land Use Plan as Priority and High Priority Preservation Areas, Historic Areas, Rural Conservation Areas, and Permanently Protected Open Space. The general policy for these areas is to discourage development and to promote the conservation of natural and cultural resources. Commercial Nodes exist nearby on Route 44, but these are not within the Bolton Lakes watershed.



Municipal Plans

Bolton:

The Bolton Plan of Conservation and Development 2005 has no future land use map. The 2005 plan anticipated changes as a result of the sewer extension to Bolton Lakes, including that a higher density of development could occur and that the value of lakefront properties would increase to the extent that the land values may exceed the value of the existing structures on the lots.

Recommendations from the plan that are relevant to the Bolton Lakes Watershed include:

1) The Planning and Zoning and the Inland Wetlands regulations should be reviewed to address the potential for increased pollution and more intense uses adjacent to lakes and ponds. Homeowners and users should be aware that pesticides, fertilizers and herbicides used on lawns and gardens near significant water resources have the potential to leach into the lake and harm the water quality, plant and fish life in it. Development designs for properties near significant water resources should include natural buffers between houses and the waterfront in order to reduce the potential for harmful runoff into the significant water resources.

2) The zoning regulations for the residential portions of the sewer service area should incorporate special permit requirements to discourage new development on older, unoccupied properties that cannot support septic systems and do not conform to the current zoning regulations. Properties outside of the sewer service area should not be allowed to connect to the sewers unless the water pollution control authority and the town agree that a sewer connection is the only feasible means to correct a proven public health problem.

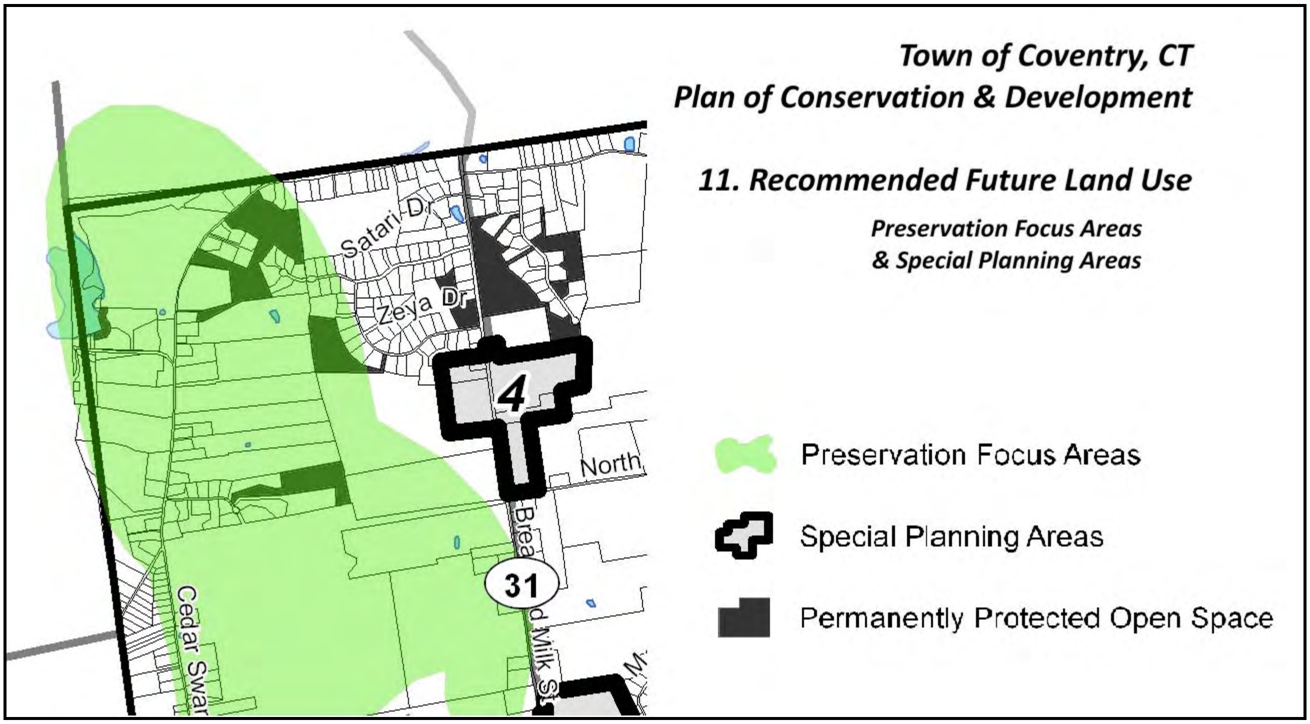
3) The zoning regulations for the business and industrial portions of the sewer service area should encourage new development for both developed and undeveloped properties. Consideration should be given to creating new business and industrial zones for the sewer service area that could allow a greater variety and density of uses than in the non-sewered areas.

4) The zoning regulations for the sewered service area should be structured to avoid creating congested or hazardous traffic conditions.

Municipal Plans:
Coventry

The Coventry Plan of Conservation and Development was adopted in 2010. The Recommended Future Land Use Map from the plan identifies the Bolton Lakes Watershed as a Preservation Focus Area. This classification is due to several factors including the presence of: prime farmland soils, endangered species, unique forest stands, and unfragmented forest blocks. There are several tracts of permanently protected open space in the Bolton Lakes Watershed in Coventry.

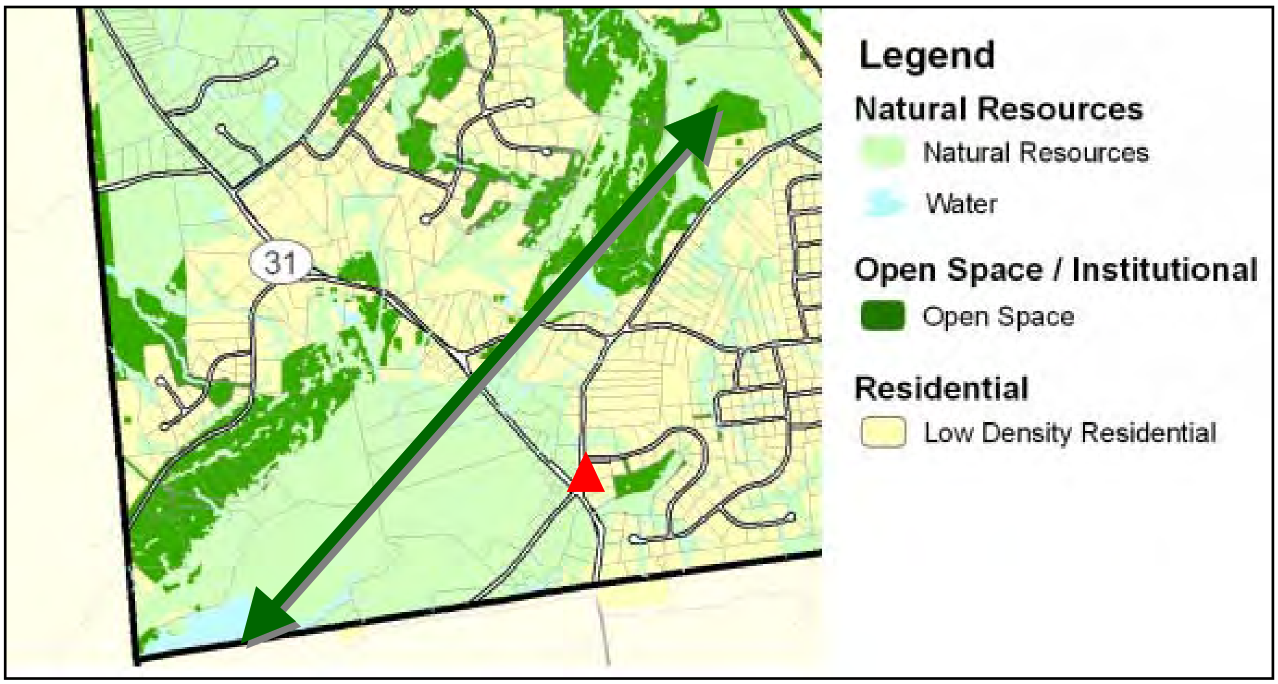
Approximately twenty acres of land within the watershed is included in the Coventry Plan of Conservation and Development as a "Special Planning Area for Growth and Infill". This is the same area currently zoned "Rural Development". It contains an existing commercial use. The general policy for Special Planning Areas is to promote economic development in a manner consistent with environmental constraints.



Municipal Plans
Tolland:

The *Tolland Plan of Conservation and Development* was adopted in 2009. The Future Land Use Map from the *Tolland Plan of Conservation and Development 2012* identifies the Bolton Lake Watershed as areas that are sensitive due to the presence of natural resources and areas that are high and medium priorities as future open space. There is a potential future greenway traversing the watershed in a south-west to north-easterly direction. Small areas of the watershed that are already developed are designated as low density residential (.5 dwelling units/per acre). The general policy for the Bolton Lakes watershed in Tolland is resource conservation and protection.

Additionally, there is an "area of septic concern" identified at the intersection of Cedar Swamp Road and Route 31.



Municipal Plans
Vernon:

The Vernon Plan of Conservation and Development was adopted in 2012. It states that the Bolton Lakes provide scenic value, wildlife habitat, and extensive recreational opportunities. The plan anticipates that the new sewer extension to Bolton Lakes will bring greater pressure for more dense development and will cause ground water to be transferred out of the Bolton Lakes Watershed.

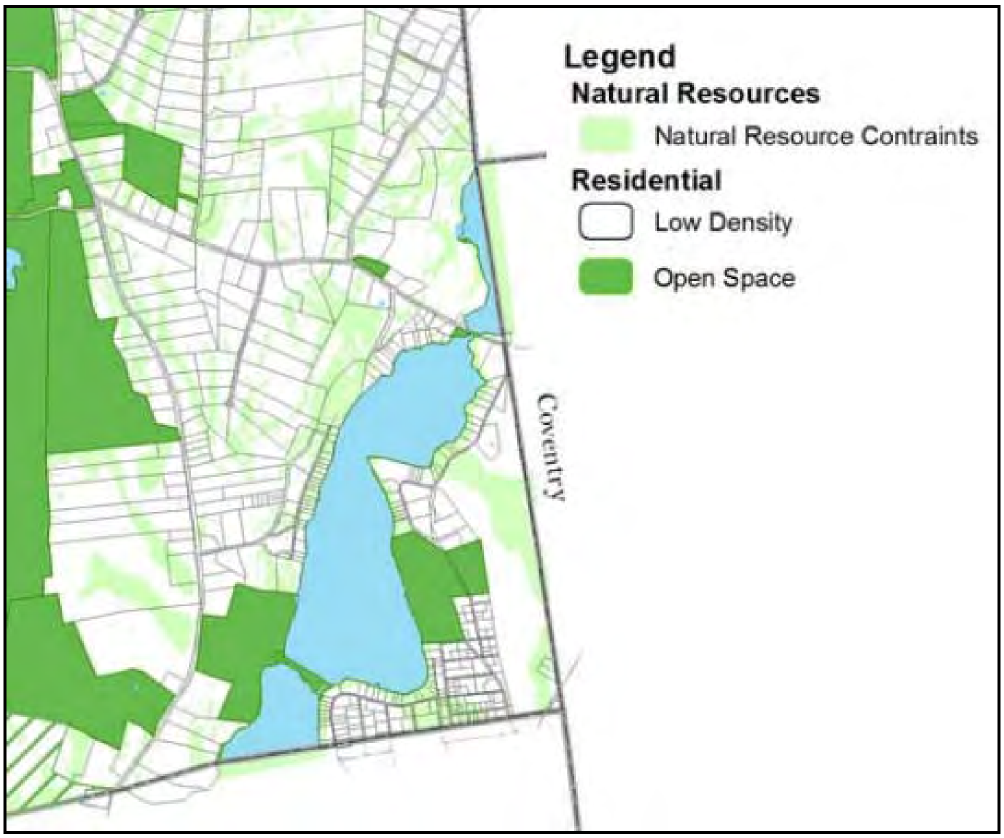
Recommendations from the plan that are relevant to the Bolton Lakes Watershed include:

1) The Town of Vernon should takes steps to ensure that sewer availability supports desired land use patterns rather than drive undesirable development.

2) Ground water levels should be carefully monitored to ensure that wells are not affected. Efforts to increase stormwater infiltration on site (e.g. LID) could help mitigate water losses.

3) The Town of Vernon should continue to work with the other communities in the watershed to reduce pollution potential, to determine optimal water levels for the lakes, and to maintain groundwater levels.

The Future Land Use Map from the *Vernon Plan of Conservation and Development 2012* identifies the Bolton Lake Watershed as Low Density Residential, Natural Resource Constraints, and Open Space.



Planning Recommendations

One threat to the Bolton Lakes Watershed from a planning perspective is the fact that the lakes are located within four separate municipalities. Two of the four towns do not specifically mention the Bolton Lakes in their Plans of Conservation and Development even though the lakes are found in all four towns. Due to this division of planning authority, it is likely that only a cooperative intermunicipal solution with all four towns participating will achieve the desired planning outcome.

One potential cooperative intermunicipal solution could be a four-town watershed protection zone. An excellent model for such a zone (albeit one that was only adopted in one town) is the Columbia Lake Watershed Protection Overlay Zone (Sec 21.4.1 of the Columbia Zoning Regulations). This zone regulates the amount of phosphorous contained in stormwater runoff and requires a 10% reduction in phosphorous for every zoning permit issued. The goal of the zone is to allow for some development while gradually reducing the amount of phosphorous in stormwater runoff through the use of low impact development techniques.

> Columbia Zoning Regulations - Columbia Lake Watershed Protection Overlay Zone - Excerpt
> 21.4.1 Intent and Purpose
>
> It is the intent of this section to promote the health and general welfare of the community by preventing the nutrient enrichment or contamination of Columbia Lake to ensure a present and future high quality lake resource for a variety of valuable functional uses including recreation and habitat. The Lake Protection Areas are designated as overlay zones on the Residential Agricultural or RA District.
>
> The purpose of this section is to facilitate the adequate provision of clean water by prohibiting, within the Lake Protection Areas, land uses which can contaminate water resources and by regulating other land uses which may have the potential to contaminate or down grade existing water resource quality.
>
> The Columbia Lake Ecosystem is a high quality mesotrophic, dimictic lake. The Lake exhibits mean Summer Transparency greater than 4m; Minimum Transparency exceeding 3m between Memorial Day and Labor Day, and greater than 1 mg/L of dissolved oxygen to a depth exceeding 6m at all times. Columbia Lake is capable of supplying habitat to an array of desirable wildlife species, water-based recreational activities, and influences the value of real property and quality of life in the Town of Columbia. Its protection is critical.
>
> Columbia Lake is highly susceptible to increased enrichment with nutrients, particularly phosphorus, because of its mesotrophic productivity state, morphometry, and hydrologic relationships. Preventing eutrophication is critical to maintaining the functional value of Columbia Lake. Columbia Lake is primarily supplied with water from precipitation that runs off from land surfaces within the watershed. The three Lake Protection Sub-Areas indicate immediate areas which drain directly to Columbia Lake, areas which drain through more extensive flow paths to tributary streams, and more remote areas which first drain to a large wooded swamp (providing natural renovation capacity for runoff water quality).

The 1978 Environmental Review Team Report listed management considerations that are still relevant today. Some of these recommendations (particularly those concerning septic system maintenance) have been or will soon be superseded by the installation of sewers. Many of the other recommendations are still very relevant, including those paraphrased below.

1. Develop a regular maintenance program for culverts and storm drainage systems.

2. A wide vegetated buffer strip of 150’ should be required to protect the lake from runoff.
3. Parking areas and roads should be kept to a minimum size.
4. Expansive cuts to vegetation should be avoided.
5. Homeowners should be educated on their roles in maintaining lake water quality, especially concerning the application of fertilizer.

In the 1978 report, it was envisioned that these recommendations could be carried out by a watershed organization. Watershed groups have been formed but none include representatives from all four towns at this time. The existing watershed groups should consider allying and recruiting members from the non-participating towns. Alternatively, the Conservation Commissions from the four towns could ally and meet to discuss implementing the management recommendations for the Bolton Lakes Watershed together.

In the present day (2012), abundant resources exist that can provide assistance in the application of the 1978 management techniques as well as newer ones such as impervious pavement and rain gardens.

1) The *2004 Connecticut Stormwater Quality Manual* provides guidance on the measures necessary to protect the waters of the State of Connecticut from the adverse impacts of post-construction stormwater runoff. This manual focuses on site planning, source control and stormwater treatment practices and is intended for use as a planning tool and design guidance document by the regulated and regulatory communities involved in stormwater quality management. The manual can be found online here: http://ct.gov/dep/cwp/view.asp?a=2721&q=325704

2) The most relevant and local resource is NEMO (Nonpoint Education for Municipal Officials) at the University of Connecticut. NEMO provides information, education and assistance to local land use officials and other community groups on how they can accommodate growth while protecting their natural resources, particularly water resources. NEMO is a part of the Center for Land Use Education and Research (CLEAR) and the Department of Extension at the University of Connecticut College of Agriculture and Natural Resources. Website: http://nemo.uconn.edu/

a. NEMO’s Low Impact Development (LID) Inventory, an online resource for researching LID installations, regulations, and contractors. http://clear2.uconn.edu:8080/tools/lid/

b. NEMO’s Planning for Stormwater website that provides site specific review considerations for LID in both residential and commercial settings. http://nemo.uconn.edu/tools/stormwater/index.htm

Archaeological and Historic Sensitivity

The Office of State Archaeology (OSA) had the opportunity to review the Lower, Middle and Upper portions of the above-named Environmental Review project for its archaeological and historic sensitivity. A review of the Office of State Archaeology's Site Files and Maps show ten (10) known pre-Contact Native American archaeological sites within the boundaries of all three lakes with the predominate locations associated with the Lower Lake. In addition, our files show 17 additional archaeological sites in close proximity to the project area. As a result, the areas of well-drained soils adjacent to the lakes are deemed highly sensitive for archaeological resources. These sites are primarily associated with Native American settlements dating to over 4,000 years ago.

The OSA files possess very good databases for the Lower and Middle Lakes due to archaeological surveys that have been conducted in association with the Bolton Lake Sewer Line project and the proposed I-84 highway project. Both surveys yielded many archaeological sites in the lake and Bolton Notch areas. The files have little information on the Coventry and Tolland portions of the watershed. However, review of topographic and environmental features associated with the Upper Lake also suggest a high sensitivity for archaeological sites, though archaeologists have not worked in this area, so the sites remain undiscovered.

Specific site locations are held confidential, but would be shared with the four municipalities should a proposed project be undertaken in the future.

The OSA is unfamiliar with the phenomenon of "roving islands" recorded from the former cedar swamp, so, unfortunately, they are not aware of any historical or archaeological significance to these unique features. However, due to what I assume to be wetland associations to the "islands", they may not be of "historic" origin, but rather of some "natural" explanation. (See an article in the Appendix from the Bolton Historical Society "Bolton's Mysterious Roving Islands.")

The Office of State Archaeology strongly recommends that any land use proposals for the Lower, Middle and Upper Lakes regions be reviewed by our office for potential archaeological sites. The high sensitivity for cultural resources suggests that any earth moving activities may impact below ground historic resources.

In this regard, the OSA would be pleased to work with the Watershed Committee and the four municipalities to promote an educational awareness of the lakes and their cultural resources, and we are prepared to review any proposed land use projects in the project area.

The OSA is available to provide further technical assistance to Towns of Bolton, Vernon Coventry and Tolland in this regard at any time.

Appendix

DEEP Responses to Bolton Resident Questions About Channel Catfish in Lower Bolton Lake – 8/2013

CTDEEP Purple Martin Fact Sheet

CTDEEP Wood Turtle Fact Sheet

CTDEEP Eastern Box Turtle Fact Sheet

Bolton Historical Society – Bolton's Mysterious Roving Islands

DEEP Responses to Bolton Resident Questions About Channel Catfish in Lower Bolton Lake

Compiled by Justin Davis, Fisheries Biologist – August 8, 2013

DEEP has stocked 17,000 channel catfish into Lower Bolton Lake since 2007 – this seems like a lot of fish. How many channel catfish are currently present in Lower Bolton Lake?

To determine the size of the channel catfish population in Lower Bolton Lake, DEEP conducted a "mark recapture" sampling program during May 2013. This month-long process involved capturing, marking, and releasing channel catfish, and then using the rate of recapture of marked fish to estimate population size. An Appendix providing more detail on the methods of this study can be found at the end of this document.

Based on this sampling, DEEP estimates that there were approximately 430 channel catfish present in Lower Bolton Lake during May 2013. This estimate may be somewhat conservative, but is almost certainly a reasonable approximation (see Appendix for further discussion). Although DEEP has stocked 17,000 channel catfish yearlings into the lake since 2007, it is apparent that, as expected, annual mortality from various sources (e.g. predation, harvest by anglers) is high enough to prevent the channel catfish population from becoming excessively large at current stocking rates. DEEP also, as expected, found no evidence of channel catfish natural reproduction. No channel catfish below the size range of yearling fish stocked into the lake (23-30 cm, or 9-12 inches) were collected during May 2013. It is highly likely that the smallest catfish collected during May 2013 were fish stocked in 2012 that experienced low growth over the ensuing year (analyses of channel catfish growth rates at Lower Bolton Lake are ongoing). As resources permit, DEEP will continue to sample channel catfish in Lower Bolton Lake to further assess the efficacy of current stocking rates.

Are channel catfish a significant source of nutrients at Lower Bolton Lake, and therefore a contributing factor in recent nuisance plant and algal blooms?

Concern that channel catfish are a significant source of nutrients at Lower Bolton Lake is a product of three inter-related misconceptions: 1) that the DEEP stocking program has produced an extremely large channel catfish population in Lower Bolton Lake; 2) that channel catfish excrete high amounts of nutrient-rich waste; and 3) that channel catfish have caused excessive "bioturbation" (bottom stirring) in Lower Bolton Lake, increasing water turbidity and releasing large amounts of sediment-bound nutrients into the water column.

The population estimate obtained during May 2013 belies the idea that channel catfish abundance in Lower Bolton Lake is excessive. To put the channel catfish population in perspective: based on electrofishing catch rates, we estimate that the largemouth bass population in Lower Bolton Lake is approximately 1,000-4,000 fish ≥ 20 cm or 8 inches (DEEP, unpublished data).. Bluegill sunfish, the most common fish in Lower Bolton Lake, have typically been 4-10 times more abundant than largemouth bass in recent electrofishing samples (DEEP, unpublished data). Considering these facts, the amount of fish biomass in Lower Bolton Lake attributable to channel catfish is not excessively large (see below for an estimate). There are several other nutrient sources at Lower Bolton Lake (e.g. septic tank leaching, fertilizer runoff, deep drawdowns of Middle Bolton Lake) whose contribution to the lake's nutrient budget almost certainly dwarfs that of channel catfish. We are unaware of any documented instances of a channel catfish population at the density documented in Lower Bolton Lake during May 2013 causing excessive nutrient loading. DEEP has annually stocked seven lakes other than Lower Bolton Lake (including two drinking water reservoirs) with channel catfish yearlings since 2007, none of which have shown signs of excessive nutrient loading as a result.

The role of fish in lake nutrient cycling has been the focus of much research and debate in the limnological field[1-13]. Our reading of the pertinent literature suggests that, in general, fish excretion makes a minimal contribution to nutrient availability in lakes. There are some exceptions to this general rule, one of the best studied being excretion by "benthivores", fish that feed almost exclusively by "rooting around" for prey in bottom sediment. The popular conception of catfish as "bottom-dwellers" could lead to the erroneous conclusion that channel catfish are benthivores and therefore a likely agent of nutrient mobilization into the water column; however, channel catfish are not the type of obligate benthivore (such as carp[5], roach[10] and bream[13]) typically cited as problematic in this regard (see below for further discussion of channel catfish diet).

We believe the misconception that channel catfish excretion is a significant source of nutrient loading at Lower Bolton Lake may also result from misinterpretation of literature regarding channel catfish farming. Channel catfish are often raised at high densities in aquaculture ponds, and strategies for managing water quality within such densely-packed ponds have been an active area of research[14]. As a result, an internet search for terms such as "channel catfish and ammonia" will return multiple results; however, these case studies invariably concern channel catfish farming ponds, not natural systems. It is important to make the distinction that high ammonia levels in commercial channel catfish ponds are a product of high fish densities – typically 1,500-5,000 lbs of fish per acre[15] – not the channel catfish themselves. Raising any fish species at such high densities would produce high ammonia levels. To put these densities in perspective: based on May 2013 sampling data and published channel catfish length-weight relationships[16], the channel catfish population in 175 acre Lower Bolton Lake currently constitutes approximately 750 pounds of fish – a density of 4.3 lbs/acre. Even if DEEP had stocked the lake with the customary 300 kg (661 lbs) of catfish yearlings in spring 2013, the density of channel catfish in the lake would only have risen (briefly) to 8 lbs/acre. This density is less than one percent of what is found in a typical commercial catfish farming pond.

Similarly, the idea that channel catfish are responsible for excessive bottom stirring in Lower Bolton Lake likely arises from misinterpretation of literature on "farm ponds" – small, privately-owned ponds typically ≤ 1 acre in size[17]. Stocking guidelines for farm ponds are widely available on the internet, and many recommend channel catfish as an ideal species[17-20]. Some guidelines do indeed warn pond owners that "in some shallow ponds...[channel catfish] may stir up the bottom and cause the water to become muddy"[19]. However, such problems are again attributable to excessive fish densities. Farm pond stocking guidelines typically recommend 100 channel catfish per acre as an appropriate stocking density (i.e. densities above 100/acre might be problematic). To put this in perspective, DEEP currently estimates that there are approximately 430 channel catfish in 175 acre Lower Bolton Lake – a density of 2.5 fish/acre. Annual supplementing of this population with the typical allotment of 2,800 channel catfish yearlings only briefly increases the density to 18 fish/acre. The problems that arise from placing hundreds of channel catfish in a small, shallow one acre pond are extremely unlikely to manifest themselves when stocking a much larger and deeper lake at a much lower density. As discussed previously, channel catfish are not the type of obligate benthivore typically cited as responsible for excessive bioturbation in lakes (see below for further discussion of channel catfish diet).

<u>Could cessation of channel catfish stocking and/or removal of channel catfish from Lower Bolton Lake improve water quality in the lake?</u>

DEEP does not believe that channel catfish contribute significantly to nutrient loading in Lower Bolton Lake, and therefore does not believe that the cessation of stocking and/or removal of channel catfish from Lower Bolton Lake constitute logical steps towards addressing the eutrophied condition of the lake.

On the contrary, it is possible that removal of channel catfish could have detrimental effects on water quality. Lakes that experience eutrophication and associated nuisance algal and cyanobacteria blooms can often be improved through selective reduction of fish biomass, a lake management strategy referred to as "biomanipulation"[21-23]. Biomanipulation entails removal of "zooplanktivores" (smaller fish that feed primarily on zooplankton) and also in some cases benthivores. Removal of zooplanktivores allows larger-bodied zooplankton to proliferate. Larger zooplankton in turn effectively graze down nuisance algae and cyanobacteria, improving water clarity and in some cases reducing the availability of phosphorus in the water column[24-26]. This phenomenon is known as a "trophic cascade", and has been well-documented in a variety of aquatic systems[27,28]. The primary benefit obtained from benthivore removal is decreased bioturbation. Reduced bioturbation improves water clarity and also reduces the mobilization of phosphorus from bottom sediments into the water column, thus decreasing the likelihood of algal blooms[25,29,30].

Selective fish removal can be accomplished mechanically (e.g. intensive netting) and/or through introduction of large "piscivores", fish that feed primarily on smaller fish. Channel catfish, although they remain generalist feeders throughout their lives and therefore always engage in some benthic feeding, generally begin to add fish to their diet once they reach 30 cm (12") in size (approximately the size of yearlings stocked into Lower Bolton Lake) and become increasingly piscivorous as they grow larger[31]. Channel catfish in Lower Bolton Lake are therefore a top-level piscivore that can exert predatory control over smaller zooplanktivorous fish (and are accordingly not the type of obligate benthivore typically cited as problematic in biomanipulation studies). Their presence can only be beneficial to maintenance of high zooplankton abundance and associated control over nuisance algae. Remediation of a eutrophied lake is often best accomplished through a combination of biomanipulation and reduced nutrient loading, and lakes experiencing high nutrient loading may be particularly sensitive to top-level piscivore removal[29,32,33]. Reduced channel catfish abundance in Lower Bolton Lake may therefore only impede the goal of remediating the lake's eutrophied state. In closing, we would like to note that channel catfish are among the large piscivorous fish that several water companies in Connecticut work cooperatively with DEEP to stock into their reservoirs to help maintain high water quality (Aquarion Water Company stocks walleye in Saugatuck Reservoir, South Central Regional Water Authority stocks walleye in Lake Saltonstall and channel catfish in the Maltby Lakes).

Could channel catfish stockings negatively impact other fisheries in Lower Bolton Lake? What is DEEP doing to monitor the status of Lower Bolton Lake fisheries?

DEEP generally uses two tools to monitor the status of Connecticut lake fisheries: boat electrofishing surveys that measure various biological attributes of fish populations, and angler surveys that assess how much fishing occurs for various species within a lake. Lakes that are under special management, such as supplementary stockings and/or special regulations, are typically sampled more often.

Given that Lower Bolton Lake is both a Bass Management Lake (special bass regulations) and a Channel Catfish Management Lake, it has been sampled frequently in recent years. DEEP conducted electrofishing samples at Lower Bolton Lake in 2007, 2008, 2009, and 2011. Our past research on predatory fish introductions (walleye and northern pike) has shown that any impacts to other fish species are generally not evident until 4-6 years post-introduction[34,35]. Given that channel catfish were first stocked in Lower Bolton Lake in 2007, the 2011 electrofishing sample is the first sample in which we might expect to see evidence for impacts of catfish stocking – and unfortunately, this sample was unreliable due to low water temperatures at the time of sampling. Therefore, at this point, DEEP is unable to make any statements concerning the possible impacts of channel catfish stockings on other fish populations in Lower Bolton Lake. However, DEEP plans to electrofish the lake in fall 2013, and will continue to sample the lake periodically in the future.

DEEP also conducted an angler survey at Lower Bolton Lake in 2010. Concerns have been raised that channel catfish have negatively impacted bass populations and therefore the quality of bass fishing in Lower Bolton Lake. A positive finding from the 2010 angler survey was that the average catch rate of "quality size" (≥ 12") largemouth bass by anglers targeting bass and fishing from boats (our standard index of bass fishing quality) was 0.55 fish per hour (DEEP, unpublished data). This is a fairly high catch rate: average catch rate of quality size bass was 0.36 fish per hour at 10 Bass Management Lakes surveyed during 2005-09[36]. Another relevant finding was the overwhelmingly positive response of anglers to the channel catfish stocking program. Anglers interviewed during the 2010 survey were asked "What is your opinion of the channel catfish program in this lake?" 70% of anglers responded that they were "In Favor" or "Highly in Favor" of the program, 27% had "No Opinion", and only 3% were "Opposed" or "Highly Opposed" (DEEP, unpublished data).

DEEP has also made multiple attempts to assess the channel catfish population in Lower Bolton Lake. Standard DEEP electrofishing methods do not effectively sample catfish species, and therefore when resources permit DEEP has experimented with various alternative sampling gears. Prior to the May 2013 population estimate, DEEP conducted hoop-net sampling during fall 2009[37] and trap-net sampling during spring 2011[38] at Lower Bolton Lake. Biological samples collected in spring 2011 are being used in ongoing analyses of growth and mortality rates of channel catfish at Lower Bolton Lake.

Should DEEP be stocking a non-native species such as channel catfish into Lower Bolton Lake?

While it is true that channel catfish are not native to Connecticut, they are not an "exotic" species. Channel catfish are native to much of North America east of the Rocky Mountains and from the Hudson Bay drainage to the Gulf of Mexico[31]. They have also been widely introduced throughout the United States – they are stocked by more states than any other warmwater fish[39] – and naturalized populations now exist in almost every state[31]. Within Connecticut, a naturalized population of channel catfish has been present in the Connecticut River since at least the 1960s[40] and, based on anecdotal reports by anglers, naturalized populations may also be present in the Housatonic and Thames River systems[37]. Channel catfish have been legally stocked by Connecticut landowners into numerous private ponds, and have also apparently been informally transplanted into many Connecticut lakes[37] (most likely by anglers).

The Lower Bolton Lake fish community contained several non-native fish species prior to channel catfish stocking. For instance, the two most popular sportfish species in the lake (largemouth and smallmouth bass) are non-native, as is the most abundant sunfish species (bluegill sunfish). Indeed, of the 11 fish species known to exist in Lower Bolton Lake prior to channel catfish introductions, five are non-native[41]. Lower Bolton Lake is not unique in this regard. Fish communities in many Connecticut lakes contain multiple non-native species[41]. This is partially attributable to the fact that DEEP and its predecessor agencies (State Board of Fisheries and Game, Department of Environmental Protection) have a long and successful track record of stocking non-native species (e.g. brown trout, rainbow trout, kokanee salmon, walleye and northern pike) into a variety of water bodies to enhance fishing opportunities for Connecticut anglers.

Taking a broader view, the popular assumption that all non-native species are uniformly "bad" and produce large-scale ecological disruption when introduced into new habitats is not well-supported by empirical studies[42-44]. In a recent commentary piece in the pre-eminent journal Nature[44], Mark Davis and several other leading ecologists argue that "Increasingly, the practical value of the native-versus-alien species dichotomy in conservation is declining, and even becoming counterproductive". This should not be read as a wholesale endorsement of all non-native species introductions. Rather, it highlights the fact that a prudent approach to non-native species introductions should include a careful consideration of the potential drawbacks and benefits, with attention to the relative probabilities of each. DEEP engaged in just such a process prior to inception of the channel catfish stocking program. In an Environmental Assessment (EA) prepared for the U. S. Fish and Wildlife[45], DEEP carefully assessed the potential negative consequences of the channel catfish stocking program and reached the conclusion that they were negligible.

Appendix: Catfish Population Estimate Methods and Results

The goal of this sampling exercise was to estimate the total number of channel catfish present in Lower Bolton Lake during May 2013. Twelve hoop nets and six trap nets were fished in the lake from 5/6/13 – 5/30/13 and checked twice per week. These gears were chosen because hoop nets are widely recommended as an effective means of collecting channel catfish in small impoundments[46], and DEEP has had prior success collecting channel catfish in Lower Bolton Lake using trap nets[38]. DEEP personnel also organized a volunteer angling trip to the lake on the evening of 5/17/13 (angling has proved to be an effective means of channel catfish collection for DEEP in the past[37]).

All channel catfish captured on each sampling occasion (i.e. a net check or angling trip) were counted, measured, and given a ventral fin clip to allow future identification of recaptured individuals. All recaptures of previously marked individuals were recorded on each sampling occasion. After workup, all catfish were released in the middle of the lake as releasing marked fish in the immediate vicinity of the gear might artificially inflate recapture rates and therefore produce artificially low population size estimates. The Schnabel population estimator[47] was used to estimate population size:

$$N = \frac{\sum_{i=2}^{t} n_i * M_i}{\sum_{i=2}^{t} m_i + 1}$$

where:
N = estimated population size
n_i = total fish captured on sampling occasion i
M_i = number of marked fish at large for sample occasion i
m_i = number of marked fish recaptured on sample occasion i
t = number of sampling occasions

Confidence intervals (95%) around this population estimate were estimated by treating the sum of recaptures (i.e. first term in the denominator of the equation above) as a Poisson variable[48].

A total of 139 individual channel catfish were caught during the sampling exercise (Table 1). The majority of catfish captured were between 40-50 cm (16-20") in length (Figure 1). Table 1 shows the calculations used to generate the Schnabel population estimate. We estimate that 428 channel catfish were present in Lower Bolton Lake during May 2013 (95% confidence interval = 269 – 713 fish).

This estimate may be somewhat conservative as it relied largely on a single type of sampling gear[49] that may under-sample smaller catfish[46,50]. Size-selectivity analyses (not shown here) indicate that channel catfish less than 40 cm (16") in length were probably under-sampled during the population estimate – i.e. they were not caught in proportion to their true abundance. Based on an exhaustive review of published channel catfish growth rates[31], it is reasonable to assume that the 23-30 cm (9-12") catfish yearlings annually stocked into Lower Bolton Lake reach 40 cm (16") in length within 2-3 years. Under this assumption, it is probable that only the 2011 and 2012 year classes of channel catfish were under-sampled during the population estimate. Therefore, while this estimate is likely conservative, it is not a gross underestimate.

Table 1. Estimate of channel catfish population size in Lower Bolton Lake during May 2013.

Date	Gear	Marked Catfish at Large (M_i)	Catfish Caught (n_i)	Recaptures (m_i)	Catfish Marked	$n_i * M_i$
5/6/2013	Nets	0	4	0	3[a]	0
5/9/2013	Nets	3	15	0	14[b]	45
5/13/2013	Nets	17	41	2	39	697
5/16/2013	Nets	56	7	2	5	392
5/17/2013	Angling	61	12	0	12	732
5/21/2013	Nets	73	13	2	10[b]	949
5/24/2013	Nets	83	13	3	10	1079
5/26/2013	Nets	93	16	4	12	1488
5/30/2013	Nets	105	18	3	15	1890
SUM			**139**	**16**		**7272**

Population Estimate = (7272) / (16 + 1) = **428**
Lower 95% Confidence Limit = (7272) / (26[c] + 1) = **269**
Upper 95% Confidence Limit = (7272) / (9.2[c] + 1) = **713**

[a]One catfish escaped before it could be measured and marked
[b]One catfish found dead in net, so could not be marked and released
[c]Upper and lower confidence limits for sum of recaptures taken from Appendix II in Ricker (1975)[48]

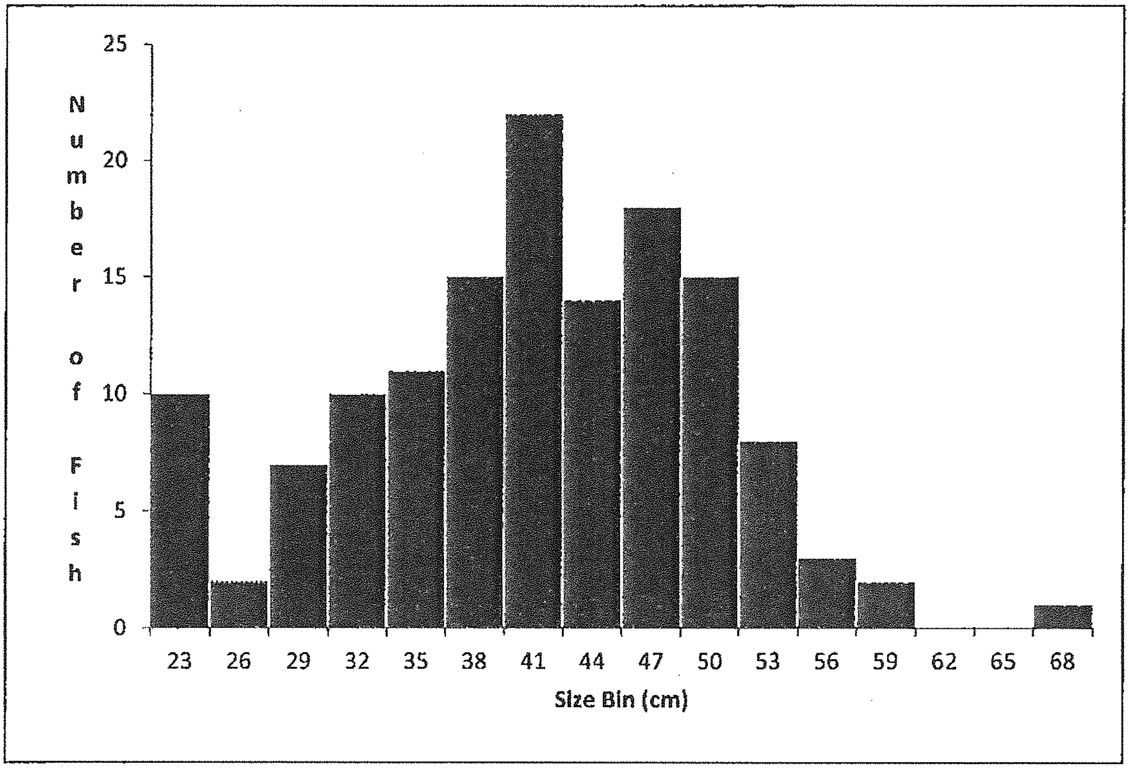


Figure 1. Size structure of channel catfish collected during May 2013 at Lower Bolton Lake (n=138 catfish). The x axis shows 3-cm size bins (e.g. "23" = 23-25 cm, "26" = 26-28 cm, etc.), the y axis shows the number of fish collected in each size bin.

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Connecticut Department of Energy & Environmental Protection

PURPLE MARTIN

Progne subis

State Threatened Species

Background

The purple martin is one of North America's most beloved songbirds. It is known for its skillful aerial exhibitions, tolerance of humans, and pleasant twittering call. Humans have long sought to attract purple martins. Native Americans hung hollow gourds in saplings or on poles to encourage nesting in their villages. When European settlers arrived in the New World, they also adopted the custom of hanging gourds for martins. Today, the entire eastern race of purple martins (east of the Rocky Mountains) is totally dependent on humans for supplying them with nesting sites in the form of specially-designed houses or hollow gourds. If humans were to stop supplying martins with homes, they would likely disappear as a breeding bird in eastern North America. West of the Rocky Mountains, purple martins largely nest in the ancestral ways, in abandoned woodpecker nest cavities or other natural cavities in dead trees or cliffs.

Purple martins have declined in numbers over much of their range, including New England and Connecticut. Competition from more aggressive, non-native European starlings and house sparrows for the nesting compartments people offer has contributed to this decline. Pesticide use and prolonged weather extremes (unseasonably cold, rainy periods, heat waves or droughts) also are responsible for reducing martin numbers.

Distribution in New England

This swift-flying bird is a seasonal Connecticut resident that arrives in New England during April to begin its breeding and nesting season. As long as conditions remain favorable, martins will return year after year to the exact same nesting location. Their range only expands if suitable habitat is no longer available at a previously used site or if new sites or artificial roosts nearby attract younger returning martins.

Vast congregations of purple martins begin their long southern migration in September to wintering grounds in South America, particularly Brazil.

Description

Purple martins are often called "dark swallows" in reference to their dark, glossy, purplish-blue plumage. Females and young martins are grayer and paler on their undersides than males. Purple martins are the largest member of the swallow family, ranging from 7.5 to 8.5 inches in length.

Females are often confused with their smaller relative, the tree swallow. The larger size of the martin and the grayness of its throat and breast distinguish it from the tree swallow, whose undersides are a vivid white. Male martins can be distinguished in flight from equally iridescent and similarly-sized starlings by their forked tail, longer wings, and typical swallow flight of short glides alternating with rapid flapping.

The complex song of a martin is a mixture of chortles and gurgles that begin with descending notes and end with a prolonged twitter. The call in flight is a jubilant twittering.

Habitat and Diet

Purple martins inhabit both urban and rural areas. They prefer open, grassy areas and forest openings near streams, rivers, marshes, ponds, or lakes. These openings provide a large "swoop zone" for catching insects. The most attractive backyard habitats include expanses of lawn or meadow near a large body of water.

Purple martins feed entirely on insects. Vast amounts of insects, caught in flight, are consumed daily. A popular misconception is that martins are a major predator of mosquitoes. Extensive studies of feeding habits have shown that mosquitoes make up less than 3% of the martin's daily diet. Ironically, martins consume large quantities of adult dragonflies and damselflies whose aquatic nymphs are major predators of developing mosquito larvae.

Life History

A purple martin colony is not an assemblage of birds that travels or functions as a flock. Rather, it is a random grouping of birds attracted to a favorable breeding site. Colony members arrive and depart independently of each other.

Purple martins seek natural cavities, gourds, or man-made apartment houses for nesting that are 12 feet or more above ground. In Connecticut, they only nest in man-made houses or hollow gourds. Martins will return to the same nest site year after year as long as the habitat conditions meet their needs. Purple martins exhibit a stronger communal lifestyle than most other birds and will nest in colonies of varying sizes. This weak sense of territoriality extends primarily to other martins and not to competitors like starlings and house sparrows.

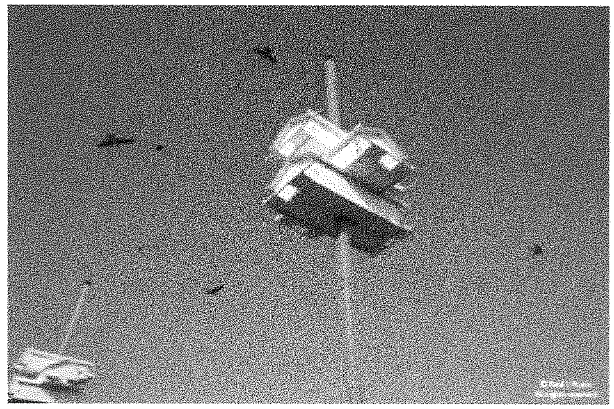
Male and female martins work together to construct a crude nest of grass and twigs set on a thin layer of mud. Mud is often banked up along the front edge to prevent the eggs from rolling out of the nest cavity. The female incubates an average of 4 to 6 smooth, non-glossy white eggs for 15 to 18 days. After hatching, the young remain in the nest for 24 to 28 days and are fed insects by both adults. Young martins may continue to roost in the nest at night after they are able to fly.

Establishing a Martin Colony

The best way to help increase the purple martin population is to establish and manage artificial nesting cavities. Successfully attracting and hosting a purple martin colony depends on selecting quality housing, having the appropriate habitat, and practicing active colony management.

The first step you should take is to learn as much as possible about the birds and their needs. A good place to start is the Purple Martin Conservation Association (PMCA), an international nonprofit organization dedicated to aiding purple martins through landlord education and scientific research. The PMCA Web site offers a wealth of information, including details and recommendations for housing.

Choose the right location. Martins have specific space and habitat requirements. Their housing should be located in the center of the largest open area available, about 30-120 feet from human dwellings, and near water. There should be no trees within 40 feet, preferably 60 feet. Housing height should be about 12-15 feet. Do not attach wires to the house or pole, especially if they lead to trees, buildings, or the ground. Predators can use the wires to access the housing.



Put up manageable housing. High quality aluminum martin houses that do not have continuous porches are recommended (these are available from PMCA), as are hollow gourds designed specifically for martins. Housing should have easy access to compartments and a pole that telescopes, or is equipped with a winch or lanyard. Paint houses and gourds white; white housing attracts martins best and reflects sunlight, keeping nestlings cooler. Compartment floor dimensions should be at least 6 inches x 6 inches, but larger compartments (7" x 12") are preferred and offer better protection from predators and rain. Larger compartments also are attractive to starlings, but a special, half-moon shaped entrance hole will minimize starling problems. Round entrance holes should be 2-1/8 inches in diameter, while starling resistant entrance holes (half-moon) should measure 1-3/16 inches. Round entrances should be about 1 inch above the floor; starling resistant holes should be 1/4 inch above the floor. Make sure there is adequate ventilation and drainage in each compartment.

Porch dividers are helpful additions to a martin house. They define territories, provide a barrier to prevent a pair's private space from being violated, and keep nestlings from wandering along porches or crossing over to other nests. The dividers also help attract martins to all available compartments.

Protect housing from predators. Provide external guards to protect against owls, hawks, and crows, as well as climbing animal barriers or guards to protect against snakes, squirrels, and raccoons.

Conduct weekly nest checks, daily walk-unders, and keep written records. Conducting nest checks is one of the most valuable practices landlords can adopt. Weekly nest checks will not cause martins to abandon their young. Rather, they'll help you discover any problems that occur in time to correct them, such as nest parasites. If parasites or wet nests threaten the survival of nestlings, replace the nest material with clean, dry wood shavings. You also should number the compartments and keep written records. Walk under the housing daily to look for plucked martin feathers, thrown-out nestlings, dropped insect prey, hatched eggshells, etc. The items you find are clues to what's going on and may alert you to problems that need attention.

Practice active management. Do not allow competing cavity-nesters to claim the house or gourds first; returning martins will bypass already occupied houses even if some compartments remain empty. Starlings and house sparrows will take over compartments, destroy eggs, kill or injure nestlings and adults, and prevent martins from nesting at unestablished sites. Use starling resistant entrances on the house compartments and house sparrow traps to reduce threats from non-native birds. If native birds (tree swallows, wrens, bluebirds, or flycatchers) try to nest in your martin housing, close it and put up single-unit boxes for these desirable species elsewhere on your property. Reopen the martin housing only after the new boxes have been accepted.

Keep martin housing in good repair. Prior to the nesting season, make sure that gourds and/or houses are cleaned, repaired, and painted (white exterior latex paint) and that all drainage holes are free of debris. Martin houses that are stored inside over winter will last longer.

Don't give up. If your martin house or gourds are not used the first year they are installed, do not be discouraged! Purple martins have a limited range in Connecticut and expand into new areas slowly. It may take several years before a martin house is occupied.

Monitoring Martin Colonies
Landlords with active purple martin colonies in Connecticut are urged to contact the DEP Wildlife Division at 860-675-8130 or dep.wildlife@ct.gov. The Division is attempting to document all of the colonies in the state.

Landlords also should contact the Purple Martin Conservation Association at martininfo@purplemartin.org or PMCA, 301 Peninsula Dr., Suite 6, Erie, PA 16505 (814-833-7656). PMCA sponsors several important projects in which martin landlords can participate. These projects will allow PMCA to obtain better continent-wide estimates of breeding success and population trends across North America.

The Wildlife Division would like to thank the Purple Martin Conservation Association for granting permission for the use of information from its Web site (www.purplemartin.org) to produce this fact sheet.

(Content last updated on March 9, 2011)

Connecticut Department of Energy & Environmental Protection

WOOD TURTLE

Glyptemys insculpta

State Species of Special Concern

Background
Wood turtles may be found throughout Connecticut, but they have become increasingly rare due to their complex habitat needs. Wood turtles also have become more scarce in Fairfield County due to the fragmentation of suitable habitat by urban development.

Range
Wood turtles can be found across the northeastern United States into parts of Canada. They range from Nova Scotia through New England, south into northern Virginia, and west through the Great Lakes region into Minnesota.

Description
The scientific name of the wood turtle, *Glyptemys insculpta*, refers to the deeply sculptured or chiseled pattern found on the carapace (top shell). This part of the shell is dark brown or black and may have an array of faint yellow lines radiating from the center of each chiseled, pyramid-like segment due to tannins and minerals accumulating between ridges. These segments of the carapace, as well as those of the plastron (bottom shell), are called scutes. The carapace also is keeled, with a noticeable ridge running from front to back. The plastron is yellow with large dark blotches in the outer corners of each scute. The black or dark brown head and upper limbs are contrasted by brighter pigments ranging from red and orange to a pale yellow on the throat and limb undersides. Orange hues are most typical for New England's wood turtles. The hind feet are only slightly webbed, and the tail is long and thick at the base. Adults weigh approximately 1.5 to 2.5 pounds and reach a length of 5 to 9 inches.

Habitat and Diet
Wood turtles use aquatic and terrestrial habitats at different times of the year. Their habitats include rivers and large streams, riparian forests (adjacent to rivers), wetlands, hayfields, and other early successional habitats. Terrestrial habitat that is usually within 1,000 feet of a suitable stream or river is most likely used. Preferred stream conditions include moderate flow, sandy or gravelly bottoms, and muddy banks.

Wood turtles are omnivorous and opportunistic. They are not picky eaters and will readily consume slugs, worms, tadpoles, insects, algae, wild fruits, leaves, grass, moss, and carrion.

Life History

From late spring to early fall, wood turtles can be found roaming their aquatic or terrestrial habitats. However, once temperatures drop in autumn, the turtles retreat to rivers and large streams for hibernation. The winter is spent underwater, often tucked away below undercut riverbanks within exposed tree roots. Dissolved oxygen is extracted from the water, allowing the turtle to remain submerged entirely until the arrival of spring. Once warmer weather sets in, the turtles will become increasingly more active, eventually leaving the water to begin foraging for food and searching for mates. Travel up or down stream is most likely, as turtles seldom stray very far from their riparian habitats.

Females nest in spring to early summer, depositing anywhere from 4 to 12 eggs into a nest dug out of soft soil, typically in sandy deposits along stream banks or other areas of loose soil. The eggs hatch in late summer or fall and the young turtles may either emerge or remain in the nest for winter hibernation. As soon as the young turtles hatch, they are on their own and receive no care from the adults.

Turtle eggs and hatchlings are heavily preyed upon by a wide variety of predators, ranging from raccoons to birds and snakes. High rates of nest predation and hatchling mortality, paired with the lengthy amount of time it takes for wood turtles to reach sexual maturity, present a challenge to maintaining sustainable populations. Wood turtles live upwards of 40 to 60 years, possibly more.

Conservation Concerns

Loss and fragmentation of habitat are the greatest threats to wood turtles. Many remaining populations in Connecticut are low in numbers and isolated from one another by human-dominated landscapes. Turtles forced to venture farther and farther from appropriate habitat to find mates and nesting sites are more likely to be run over by cars, attacked by predators, or collected by people as pets.

Other sources of mortality include entanglements in litter and debris left behind by people, as well as strikes from mowing equipment used to maintain hayfields and other early successional habitats.

The wood turtle is imperiled throughout a large portion of its range and was placed under international trade regulatory protection through the Convention on International Trade in Endangered Species (CITES) in 1992. Wood turtles also have been included on the International Union for Conservation of Nature's (IUCN) Red List as a vulnerable species since 1996. They are listed as a species of special concern in Connecticut and protected by the Connecticut Endangered Species Act.

How You Can Help

- Conserve riparian habitat. Maintaining a buffer strip of natural vegetation (minimum of 100 feet) along the banks of streams and rivers will protect wood turtle habitat and also help improve the water quality of the stream system. Stream banks that are manicured (cleared of natural shrubby and herbaceous vegetation) or armored by rip rap or stone walls will not be used by wood turtles or most other wildlife species.
- Do not litter. Wood turtles and other wildlife may accidentally ingest or become entangled in garbage and die.
- Leave turtles in the wild. They should never be kept as pets. Whether collected singly or for the pet trade, turtles that are removed from the wild are no longer able to be a reproducing member of a population. Every turtle removed reduces the ability of the population to maintain itself.
- Never release a captive turtle into the wild. It probably would not survive, may not be native to the area, and could introduce diseases to wild populations.
- As you drive, watch out for turtles crossing the road. Turtles found crossing roads in June

and July are often pregnant females. They should not be collected but can be helped on their way. Without creating a traffic hazard or compromising safety, drivers are encouraged to avoid running over turtles that are crossing roads. Also, still keeping safety precautions in mind, you may elect to pick up turtles from the road and move them onto the side in the direction they are headed. Never relocate a turtle to another area that is far from where you found it.

- Learn more about turtles and their conservation concerns, and educate others.
- If you see a wood turtle, leave it in the wild, take a photograph, record the location where it was seen, and contact the Connecticut Department of Environmental Protection Wildlife Division at dep.wildlife@ct.gov, or call 860-424-3011 to report your observation.

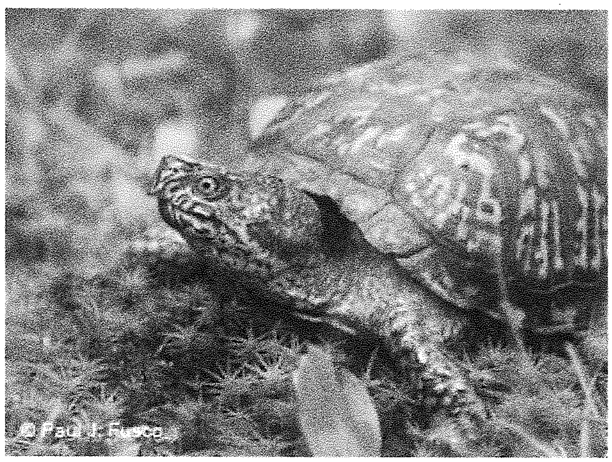
The production of this Endangered and Threatened Species Fact Sheet Series is made possible by donations to the Endangered Species-Wildlife Income Tax Checkoff Fund.
(4/11)

Connecticut Department of Energy & Environmental Protection

Eastern Box Turtle

Terrapene carolina carolina

State Species of Special Concern



Description
The eastern box turtle is probably the most familiar of the 8 species of turtles found in Connecticut's landscape. It is known for its high-domed carapace (top shell). The carapace has irregular yellow or orange blotches on a brown to black background that mimic sunlight dappling on the forest floor. The plastron (under shell) may be brown or black and may have an irregular pattern of cream or yellow. The length of the carapace usually ranges from 4.5 to 6.5 inches, but can measure up to 8 inches long. The shell is made up of a combination of scales and bones, and it includes the ribs and much of the backbone.

Each individual turtle has distinctive head markings. Males usually have red eyes and a concave plastron, while females have brown eyes and a flat plastron. Box turtles also have a horny beak, stout limbs, and feet that are webbed at the base. This turtle gets its name from its ability to completely withdraw into its shell, closing itself in with a hinged plastron. Box turtles are the only Connecticut turtle with this ability.

Range
Eastern box turtles are found throughout Connecticut, except at the highest elevations. They range from southeastern Maine to southeastern New York, west to central Illinois, and south to northern Florida.

Habitat and Diet
In Connecticut, this terrestrial turtle inhabits a variety of habitats, including woodlands, field edges, thickets, marshes, bogs, and stream banks. Typically, however, box turtles are found in well-drained forest bottomlands and open deciduous forests. They will use wetland areas at various times during the season. During the hottest part of a summer day, they will wander to find springs and seepages where they can burrow into the moist soil. Activity is restricted to mornings and evenings during summer, with little to no nighttime activity, except for egg-laying females. Box turtles have a limited home range where they spend their entire life, ranging from

0.5 to 10 acres (usually less than 2 acres).

Box turtles are omnivorous and will feed on a variety of food items, including earthworms, slugs, snails, insects, frogs, toads, small snakes, carrion, leaves, grass, berries, fruits, and fungi.

Life History

From October to April, box turtles hibernate by burrowing into loose soil, decaying vegetation, and mud. They tend to hibernate in woodlands, on the edge of woodlands, and sometimes near closed canopy wetlands in the forest. Box turtles may return to the same place to hibernate year after year. As soon as they come out of hibernation, box turtles begin feeding and searching for mates.

The breeding season begins in April and may continue through fall. Box turtles usually do not breed until they are about 10 years old. This late maturity is a result of their long lifespan, which can range up to 50 to even over 100 years of age. The females do not have to mate every year to lay eggs as they can store sperm for up to 4 years. In mid-May to late June, the females will travel from a few feet to more than a mile within their home range to find a location to dig a nest and lay their eggs. The 3 to 8 eggs are covered with dirt and left to be warmed by the sun. During this vulnerable time, skunks, foxes, snakes, crows, and raccoons often raid nests. Sometimes, entire nests are destroyed. If the eggs survive, they will hatch in late summer to early fall (about 2 months after being laid). If they hatch in the fall, the young turtles may spend the winter in the nest and come out the following spring.

As soon as the young turtles hatch, they are on their own and receive no care from the adults. This is a dangerous time for young box turtles because they do not develop the hinge for closing into their shell until they are about 4 to 5 years old. Until then, they cannot entirely retreat into their shells. Raccoons, skunks, foxes, dogs, and some birds will prey on young turtles.

Conservation Concerns

The eastern box turtle was once common throughout the state, mostly in the central Connecticut lowlands. However, its distribution is now spotty, although where found, turtles may be locally abundant. Because of the population decline in Connecticut, the box turtle was added to the state's List of Endangered, Threatened, and Special Concern Species when it was revised in 1998. It is currently listed as a species of special concern. The box turtle also is protected from international trade by the 1994 CITES treaty. It is of conservation concern in all the states where it occurs at its northeastern range limit, which includes southern New England and southeastern New York.

Many states have laws that protect box turtles and prohibit their collection. In Connecticut, eastern box turtles cannot be collected from the wild (DEP regulations 26-66-14A). Another regulation (DEP regulations 26-55-3D) "grandfathers" those who have a box turtle collected before 1998. This regulation limits possession to a single turtle collected before 1998. These regulations provide some protection for the turtles, but not enough to combat some of the even bigger threats these animals face. The main threats in Connecticut (and other states) are loss and fragmentation of habitat due to deforestation and spreading suburban development; vehicle strikes on the busy roads that bisect the landscape; and indiscriminate (and now illegal) collection of individuals for pets.

Loss of habitat is probably the greatest threat to turtles. Some turtles may be killed directly by construction activities, but many more are lost when important habitat areas for shelter, feeding, hibernation, or nesting are destroyed. As remaining habitat is fragmented into smaller pieces, turtle populations can become small and isolated.

Adult box turtles are relatively free from predators due to their unique shells. The shell of a box turtle is extremely hard. However, the shell is not hard enough to survive being run over by a vehicle. Roads bisecting turtle habitat can seriously deplete the local population. Most vehicle fatalities are pregnant females searching for a nest site.

How You Can Help

- Leave turtles in the wild. They should never be kept as pets. Whether collected singly or for the pet trade, turtles that are removed from the wild are no longer able to be a reproducing member of a population. Every turtle removed reduces the ability of the population to maintain itself.
- Never release a captive turtle into the wild. It probably would not survive, may not be native to the area, and could introduce diseases to wild populations.
- Do not disturb turtles nesting in yards or gardens.
- As you drive, watch out for turtles crossing the road. Turtles found crossing roads in June and July are often pregnant females and they should be helped on their way and not collected. Without creating a traffic hazard or compromising safety, drivers are encouraged to avoid running over turtles that are crossing roads. Also, still keeping safety precautions in mind, you may elect to pick up turtles from the road and move them onto the side they are headed. Never relocate a turtle to another area that is far from where you found it.
- Learn more about turtles and their conservation concerns. Spread the word to others on how they can help Connecticut's box turtle population.

The production of this Endangered and Threatened Species Fact Sheet Series is made possible by donations to the Endangered Species-Wildlife Income Tax Checkoff Fund.
(5/08)

Bolton Historical Society
Bolton, Connecticut

BOLTON'S MYSTERIOUS ROVING ISLANDS
by Hans DePold, town historian

(Published in the Bolton Community News, June 2004)

On Monday, Feb. 28, 1955, on page 4 of The Bridgeport Telegram, there appeared an article titled "Crane, Bulldozer Tear Apart Roving Island in Bolton Lakes." The action was taken under the supervision of the State Board of Fisheries and Game. The floating island had measured 125 feet long, 75 feet wide, and 7 feet thick. It had supported cedar trees (one 8 yards tall) that served as masts and sails to drive the island around Bolton Lake. It had become a favorite private spot for young Bolton boaters, explorers and lovers.

Bolton Lake was created in the mid-1800s as part of a system to provide waterpower to the mills of Willimantic before electricity, internal combustion motors, or even steam power. The prehistoric Mohegan tool-making site at Bolton's Cedar Swamp was submerged when the lake was created.

As darkness descended, factories would close shop and the lake outlet was closed, raising the water level. Then as daylight approached, the lake sluice gates would be opened, doubling the normal flow rate in the rivers powering Connecticut's industrial revolution. That was known as Connecticut ingenuity.

Bolton's roving islands were born when vegetation deposits created a layer of peat that had sufficient buoyancy to tear itself free from the bottom of the lake. Longtime lakeside resident Grant Davis noticed that they seemed to occur when the lake level changed. On occasion he's witnessed the lake giving birth and has had to raise his sailboat's dagger keel in those areas where infant roving islands were not yet fully surfaced. In the last 10 years he has seen one island about 7 yards across and a smaller one about 1 yard or more across. Native Americans called them "trembling earth," referring to the way they shook when walked upon.

Davis believes that lower lake levels decrease the overburden of the water that normally holds the peat down and compresses it. A lower lake level allows the peat to expand, increasing its buoyancy. Once part of the peat begins to tear away from the bottom, the water gets under it and there is no longer any overburden but just pure buoyancy force. Heavy soils drop away and a new roving island is born. Land plants like winterberry holly, highbush blueberry, arrowhead, fern, and broad-leafed cattail then take root and hold the island together. The island moves about with roots dangling downward like the tentacles of a large lake creature feeding beneath the surface. The islands may also be blown into shallow areas and can reattach for years.

In the rising evening mist, a roving island could be a haunting sight. They were primal forces silently creeping about the lake, obeying only natural laws of wind and water currents. As the Bolton Lake population grew, one very large roving island seemed to protest and sheared off more and more docks. Perhaps it had acquired some of the earth and spirit of the Native Americans interred beneath the lake. It would park itself wherever it pleased—it was just too bad if it chose your sandy beach as its new resting spot!

Soon this mother of all roving islands seemed to be friendless. No one had anything good to say about roving islands on February 28, 1955, when Bolton's largest recorded roving island trembled its last time and was laid to rest.

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About the Team

The Eastern Connecticut Environmental Review Team (ERT) is a group of professionals in environmental fields drawn together from a variety of federal, state and regional agencies. Specialists on the Team include geologists, biologists, foresters, soil specialists, engineers and planners. The ERT operates with state funding under the supervision of the Eastern Connecticut Resource Conservation and Development (RC&D) Area — an 86 town region.*

The services of the Team are available as a public service at no cost to Connecticut towns.

Purpose of the Team
The Environmental Review Team is available to help towns and developers in the review of sites proposed for major land use activities. To date, the ERT has been involved in reviewing a wide range of projects including subdivisions, landfills, commercial and industrial developments, sand and gravel excavations, active adult, recreation/open space projects, watershed studies and resource inventories.

Reviews are conducted in the interest of providing information and analysis that will assist towns and developers in environmentally sound decision-making. This is done through identifying the natural resource base of the project site and highlighting opportunities and limitations for the proposed land use.

Requesting a Review
Environmental reviews may be requested by the chief elected official of a municipality and/or the chairman of town commissions such as planning and zoning, conservation, inland wetlands, parks and recreation or economic development. Requests should be directed to the chairman of your local Conservation District and the ERT Coordinator. A request form should be completely filled out and should include the required materials. When this request is reviewed by the local Conservation District and approved by the ERT Subcommittee, the Team will undertake the review on a priority basis.

For additional information and request forms regarding the Environmental Review Team please contact the ERT Coordinator: 860-345-3977, Eastern Connecticut RC&D Area, P.O. Box 70, Haddam, Connecticut 06438, e-mail: connecticutert@aol.com.

About the Eastern Connecticut RC&D Area

Resource Conservation and Development (RC&D) is a program of the United States Department of Agriculture (USDA). The Secretary of Agriculture gave the Natural Resources Conservation Service (NRCS) [formerly the Soil Conservation Service] responsibility for administering the program. RC&D is unique because it is led by local volunteer councils that help people care for and protect their natural resources in a way that improves the local economy, environment, and living standards. RC&D is a way for people to work together to plan and carry out activities that will make their area a better place in which to live.

Interest in creating the Eastern Connecticut RC&D Area first started in 1965. An application for assistance was prepared and submitted in June 1967 to the Secretary of Agriculture for planning authorization. This authorization was received in August 1968. In 1983, an application by the Eastern Connecticut RC&D's Executive Council was approved by USDA and NRCS to enlarge the area to an 86 town region.

The focus of the Eastern Connecticut RC&D Program is to help people care for and protect their natural resources, improve local economies, and sustain a high quality of life. The program derives its success from its ability to connect individuals, communities, government entities, and grassroots organizations. These connections and partnerships enable the development of shared visions and resource networks that work toward a healthy future for Connecticut. Current members on the RC&D Council represent the Working Lands Alliance, The Last Green Valley, the Green Valley Institute, WINCOG, SECCOG, NECCOG, LCRVCOG, NorthCentral Conservation District, Eastern Conservation District and the CT River and Estuary Conservation District.
For more information please visit their website at: www.easternrcd-ct.org.