Candlewood Lake

Water Quality Protection Issues

King's Mark
Environmental Review Team Report

King's Mark
Resource Conservation and Development Area Inc.

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Environmental Review Team Report

Prepared by the
King's Mark
Environmental Review Team
Of the
King's Mark
Resource Conservation and Development Area, Inc.

For the
Candlewood Lake Authority
And the
First Selectman
New Fairfield, Connecticut

August 2009

Report #349

Acknowledgments

This report is an outgrowth of a request from the Candlewood Lake Authority and the New Fairfield First Selectman to the King's Mark Resource Conservation and Development Area (RC&D) Council for their consideration and approval. The request was approved and the measure reviewed by the King's Mark Environmental Review Team (ERT).

The King's Mark 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 Tuesday, September 16, 2008.

Nicholas Bellantoni	State Archaeologist UCONN – Office of State Archaeology (860) 486-5248
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I would also like to thank Larry Marsicano, executive director, Candlewood Lake Authority (CLA), Mark Howarth, assistant director, Candlweood Lake Authority (CLA), Cynthia Stevens, Ball Pond Advisory Committee, Jim McAlistister, CWI and lake resident, Alex Messerle, lake resident and Citizen News reporter, John Hodge, First Selectman, New Fairfield and Tim Simpkins, director of health, New Fairfield, for their cooperation and assistance during this environmental review.

Prior to the review day, each Team member received a summary of the ERT project with various maps and a scope of work outlining the information desired from the Team members. During the field review Team members were given

additional information such as reports and studies previously completed for the lake and watershed.

Although the CT Department of Environmental Protection formally declined to participate on this ERT project several DEP staff members did set up a meeting to discuss their possible input outside of the ERT process. Those attending the meeting held on October 15, 2008 were Susan Peterson, watershed coordinator, Dave Dembosky, LID specialist, Charles Lee, lake management and Peter Aarrestad, fisheries biologist. They should be contacted individually for any follow-up.

Following the review, 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 town. This report identifies the existing resource base and evaluates its significance to the proposed problems, and also suggests considerations that should be of concern to the town. The results of this Team action are oriented toward the development of better environmental quality and the long term economics of land use.

The King's Mark RC&D Executive Council hopes you will find this report of value and assistance in studying lake and watershed issues and identifying additional research and education necessary for community support and involvement.

If you require additional information please contact:

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Introduction

Introduction and Objectives

The Candlewood Lake Authority (CLA) with an endorsement from the First Selectman of New Fairfield has requested Environmental Review Team (ERT) assistance in reviewing and making recommendations that the CLA and communities surrounding the lake should consider with the goal of protecting and improving water resources while being sensitive to community concerns.

The request identified four major issues: 1) assistance in assessing the environmental knowledge base on Candlewood Lake, Squantz Pond, Pond and their mutual watershed; 2) assessment of the justification for recent local regulatory recommendation to mitigate nutrient and other nonpoint source pollution export to those waterbodies; and 3) recommendations on other measures that Candlewood Lake and Ball Pond communities should consider for the long-range health of these important water resources.

The three sections of this report focus on stormwater management, land use, phosphorus, property values and their relationship to water quality. Additionally, in the Appendix is a brief report with recommendations for cultural resource management.

The ERT Process

Through the efforts of the CLA and New Fairfield Officials this environmental review and report was prepared for the Candlewood Lake Authority and Town of New Fairfield.

This report provides an information base and a series of recommendations and guidelines which cover some of the topics requested. Team members were able to review maps, plans and supporting documentation provided by the town.

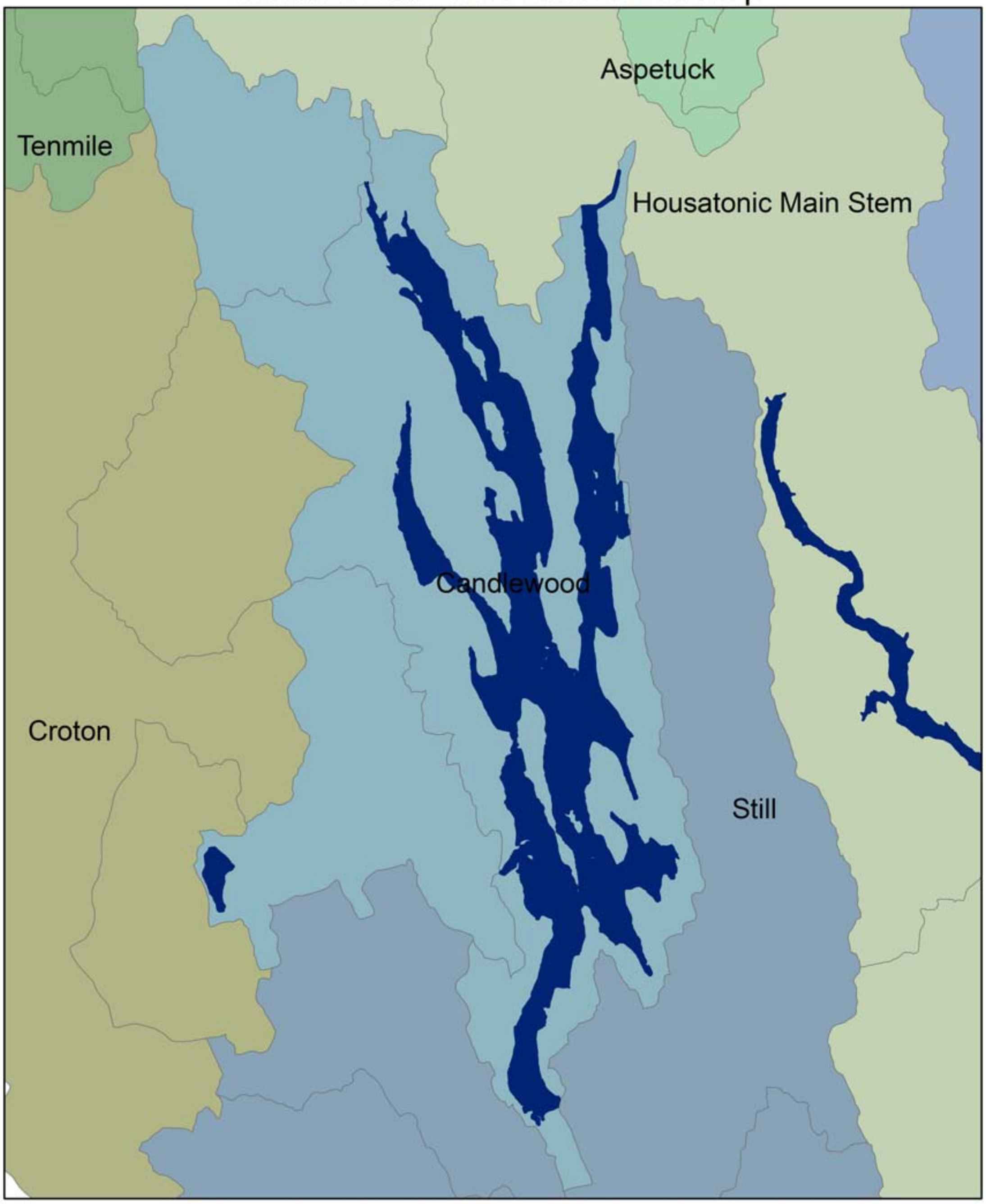
The review process consisted of four phases:

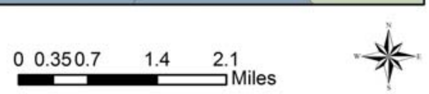
1. Inventory of the site’s natural resources;
2. Assessment of these resources;
3. Identification of resource areas and review of available plans; and
4. Presentation of education, management and land use guidelines.

The data collection phase involved both literature and a field review. The field review was conducted Tuesday, September 16, 2008. The emphasis of the field review was on the exchange of ideas, concerns and recommendations. Being on site 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.

Candlewood Lake Watershed Map





Stormwater Management and Water Quality

Introduction

Research on water quality in Candlewood Lake indicates that the lake is trending towards a eutrophic condition (Frink and Norvell, 1984, Canavan and Siver, 1995, Marsicano et. al. 1995 and CLA, 2007). The trophic classification trend indicates that the lake is under stress from high nutrient levels, jeopardizing many of its public uses and its value to surrounding communities. Pollutants entrained in stormwater runoff and directly entering the lake degrades water quality (Arnold and Gibbons, 1996). While stormwater management is very important, you can not look at it in isolation as there are other environmental factors that contribute to water quality problems. Aging residential septic systems can also be a large contributor to water quality degrading compounds and this topic has been well researched in the Candlewood Actions Plan (CLA, 2002). Following the recommendations in the action plan will go a long ways toward protecting Candlewood Lake from the negative impacts of aging septic systems. The focus of this section of the ERT report will be on mitigating the effects of water quality degrading compounds transported directly to the lake in stormwater runoff.

There is a large accumulating body of research that demonstrates the negative impacts of development on the water quality of open water resources (see “Land Use Change and the Quality of Stormwater Runoff” section below). Currently, a significant portion of the Candlewood Lake Watershed is classified as high and medium density development (Ponak, Marsicano, 2008). High and medium density development can contribute to water quality problems if measures are not taken to treat stormwater runoff (see “Sustainable Development and Retrofit Techniques” section below). Candlewood Lake is a very striking open water resource which has attracted intense development on its shores and adjacent areas. Its mere presence in a healthy state likely adds tens of million dollars to the local economies (National Park Service, 2001). Intense development in the near shore environment can have substantial negative impacts on a lake (examples in Connecticut include Highland Lake, Lake Pocatapaug and Pachaug Pond). Development in the near shore area does not leave much space to install mitigation measures between development and the lake (see Non Point Source section below). It is important to note that given the compact size of Candlewood Lake’s watershed, development and land use changes anywhere in the watershed can create problems in the lake if mitigating techniques are not implemented (see Sustainable Development section below). Currently, land use regulations targeted at protecting the lake have only been updated in two of the five towns surrounding the lake, representing only 14% of the watershed. The following issues should be considered if or when land use regulations are updated in the towns surrounding Candlewood Lake.

Watershed Characteristics

Candlewood’s relatively small lake to watershed ratio in combination with the pump-up facility from the Housatonic River can only produce enough water to flush the lake out once every 3.3 years. In other words the average time from when the water enters the lake to the time it exits to the Housatonic River is 3.3 years. This gives Candlewood Lake one of the longest resident times as compared with all the other lakes in Connecticut. When stormwater runoff containing non-point source pollutants (see NPS discussion below) such as nutrients, metals and sediments are allowed to wash directly out of the watershed and into the lake, they have years to react and cause water quality problems. Candlewood, like many lakes, does exhibit "internal loading" which supplements the lake with nutrients that degrade water quality. Pollutants and nutrient loading from the watershed will only continue to supply the internal loading process, and further degrade water quality and provide nutrients that will promote excess aquatic algae growth. Sediments from soil erosion along with various pollutants that attach themselves to the sediment particles are carried to the lake. The accumulation of these particles and pollutants will create more areas in the lake that can support weed growth. Therefore every effort should be made to stop pollutants entrained in stormwater runoff from getting into the lake.

Land Use Change and the Quality of Stormwater Runoff

There have been a number of comprehensive studies conducted over the last 30 years that demonstrate the effects of land development on water quality. The impacts of land development on water quality are well documented and compiled in the following resources:

1) The National Stormwater Quality Database - September 2005 – Version 1.1
   http://rpitt.eng.ua.edu/Research/ms4/Paper/Mainms4paper.html
2) Results of the National Urban Runoff Program (NURP) – December 1983
   US Environmental Protection Agency, Water Planning Division.
3) University of New Hampshire Stormwater Center 2005 and 2007 Annual Reports, http://www.unh.edu/erg/cstev/
4) New York Stormwater Management Design Manual, August 2003
   http://www.dos.state.ny.us/lgss/stormwaterpub/index.html
5) Impacts of Impervious Cover on Aquatic Systems, 2003
   Center for Watershed Protection Research Monograph No. 1.

There are many more case studies and continuing research that currently exist. However, the documents listed above do a good job of compiling relevant studies and research that provide a good cross section of the negative effects of development on water quality.

Residential development that generates uncontrolled and unmanaged stormwater runoff will carry pollutant loads that degrade water quality. The term commonly used for surface water that gets contaminated in this manner is Non-Point Source (NPS) pollution, because they do not originate from one central source. The United States Environmental Protection Agency defines NPS pollution as follows:

Non-point source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS 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 lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. These pollutants include:

- *Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;*

- *Oil, grease, and toxic chemicals from urban runoff and energy production;*
- *Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks;*
- *Salt from irrigation practices and acid drainage from abandoned mines;*
- *Bacteria and nutrients from livestock, pet wastes, and faulty septic systems;*
- *Atmospheric deposition and hydromodification are also sources of non-point source pollution.*

Ongoing research at many academic institutions, such as the University of New Hampshire Stormwater Center, the Stormwater Engineering Group at North Carolina State University along with the Wisconsin Department of Natural Resources have documented the adverse impacts stormwater pollutants can have on our environment.

Studies conducted by the University of Connecticut Cooperative Extension System demonstrated that the extent of impervious surface on site is directly correlated to the degradation of water quality due to stormwater pollutants (Arnold, Gibbons 1996). Other research conducted by Roger Bannerman at the University of Wisconsin (Bannerman, 1993) indicates that non-impervious, but disturbed areas, such as lawns, are relevant contributors to NPS Pollution. In addition, some of these same institutions mentioned above are researching and evaluating many different types of stormwater treatment systems (see discussion below) in real world conditions to demonstrate how effective the systems are at removing various pollutants from stormwater runoff (StormCon, 2008).

The major categories of pollutants found in non-point source runoff include pathogens (disease causing microorganisms), nutrients (e.g. nitrogen and phosphorous) toxic contaminants like metals and hydrocarbons as well as sediments and debris (Arnold and Gibbons, 1996). High concentrations of pathogens routinely close swimming areas after runoff events. An abundance of nutrients create algae blooms and promote aquatic weed growth, while sediments and debris destroy fish breeding habitat and metals are toxic to many types of aquatic life.

Stormwater management in many neighborhoods surrounding the lake consists of piping stormwater runoff directly to the lake or directly to streams that feed to the lake. This creates a direct connection between NPS pollutants entrained in stormwater (listed above) and the lake. With no intermediate stormwater quality management measures, polluted water enters the lake ecosystem and acts to degrade water quality in Candlewood Lake. Water quality and aquatic weed growth problems created by NPS pollution require that the Candlewood Lake watershed communities take action to mitigate further degradation of the lake resource.

Sustainable Development and Retrofit Techniques

There has been a large body of research compiled on the efficiencies of many stormwater quality management measures commonly constructed throughout the United States. Both the University of New Hampshire (Stormwater Center) and the University of Connecticut, College of Agriculture and Natural Resources (Jordan Cove Urban Watershed Project) have years of research that document the efficiencies the stormwater renovation methods listed below. One of the goals of implementing sustainable development techniques is to interrupt the direct connection between stormwater runoff from impervious and regraded surfaces, and wetlands / water resources. In other words, disconnect polluted stormwater runoff from the lake and its feeder streams. Breaking this connection requires the use of the following stormwater renovation techniques in both new development and in the retrofitting existing development. The creation of impervious and regraded surfaces is unavoidable in development. However, there are a multitude of stormwater quality management techniques that can reduce and in many cases eliminate the negative impacts of stormwater runoff and NPS pollution. It is important to note that the LID measures described below have been shown to be much more efficient at pollutant removal from stormwater runoff as compared to conventional and manufactured systems (UNH Stormwater Center, 2007 and Jordan Cove, 2008). The three major types of storm water treatment practices are:

1) <u>Conventional Structural Systems and Practices</u>
    a. catch basins (with sumps)
    b. wet detention ponds
    c. stone and vegetated swales
    d. oil and grit separators
    e. street sweeping
    f. dry detention ponds

2) <u>Manufactured Systems</u>
    a. hydrodynamic separators
    b. underground filter and infiltration systems

3) <u>Low Impact Development (LID) systems</u>
    a. bioretention areas (ex. rain garden)
    b. extended wet detention ponds
    c. constructed wetlands
    d. subsurface flow gravel wetlands
    e. vegetated filter strips
    f. surface sand filters or media filters
    g. infiltration systems
    h. pond/wetland system
    i. permeable pavement and porous concrete

While some treatment systems can be used as a ‘stand alone’ device, it is important to design a storm water treatment system that uses multiple treatment measures in series (Bioretention Manual, 2002). This ‘treatment train’ approach enhances the amount of pollutants that are removed by the systems and also provides redundancy in the treatment process (StormCon, 2008).

Case Studies and Conclusion

Water quality improvement and preservation is very important to Candlewood Lake and the surrounding communities (DeLoughy and Marsicano, 2001). The following are two case studies of regulation updates that have taken place here in Connecticut that illustrate the innovative and effective mechanisms being implemented for the purpose of water quality protection.

Town of Tolland Connecticut

The following Case Study was taken from a paper entitled “Ahead of the Curve – Tolland, Connecticut Adopts Low Impact Development Regulations” prepared by Steve Trinkaus, PE, of Trinkaus Engineering, LLC. and presented at the 2008 International Low Impact Development Conference in Seattle, WA. The Town of Tolland CT Land Use Staff, Planning and Zoning Commission and Inland Wetland Agency were concerned about the record residential growth that had occurred through 2000. The town’s land use staff and commissions understood the negative effects of developments on water resources in town and were well schooled on how effective current stormwater quality management measures were. However, they were unable to convince developers to incorporate LID stormwater quality management design elements into their site plans. The land use department and commissions would regularly hear things like:

- These Low Impact Development type systems don’t work.
- We don’t understand how these systems work and don’t want to be responsible for them when they fail.
- This technology will not work in Connecticut. While used in Maryland (Home of LID), we are in a different geographic area.
- They won’t work in the winter.
- They are a maintenance nightmare.
- The infiltration systems won’t work in our soil conditions.
- My client is concerned about the cost of LID systems, both construction and long-term maintenance.
- I don’t want to be the first in Connecticut to design and build LID systems and be responsible for one.

Besides the sheer number of new building lots being created, there was also concern about protecting the natural resources of the town, particularly with regard to water quality. The town planning staff was directed by the Planning & Zoning Commission to form an Ad Hoc Committee to review the existing zoning regulations to address residential growth issues. A committee was formed consisting of town staff, members of various commissions and the public to look into this issue. One of the main conclusions of the committee was that it would be important to create a map of sensitive watersheds, habitats and wildlife corridors to delineate a Natural Resource and Wildlife Protection Overlay Zone to help guide growth. This type of zoning looked at wetlands, sensitive open water resources, steep slopes, ledge outcrops and soils throughout the town. This mapping was prepared by the Town’s GIS Specialist. One of the purposes for the creation of the Overlay Zones was to preserve critical stream corridors to protect and enhance surface water and groundwater quality. While this overlay zone identified the environmentally sensitive areas, there were other issues that needed to be addressed which included:

1. How do you address Non-Point Source (NPS) pollution from development?
2. How do you address Water Quality Issues associated with all types of development?
3. How do you get your regulations to be functional to address these issues without becoming a political football?

The Town contracted with an engineering firm to assist in creating regulations and a drafting a Design Manual. The new regulations require everyone proposing land use changes in the town to use the Town of Tolland's Low Impact Development Stormwater Treatment Systems Performance Requirements Road Design and Stormwater Management Design Manual (Trinkaus Engineering, LLC. January 2008). The design manual gives the town the authority to require proven Low Impact Development and Environmental Site Design strategies and stormwater quality management measures that are appropriate to protect adjacent natural resources. The design manual also provides land developers with clear unambiguous guidance so they have the both the tools and mandate to propose effective stormwater treatment systems. In addition, Performance standard for the removal of common stormwater pollutants are specified in the Design Manual.

Town of Columbia Connecticut

Imbedded in the Columbia Zoning Regulation there is a Section 21.4 titled - Columbia Lake Watershed Protection Overlay Zones on the Residential Agricultural District: Zoning Regulations for Zoning Compliance for New Zoning/Building Permits.
The intent and purpose of this section of the zoning regulations is 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".

and 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 regulations require the use of LID techniques similar to the ones mentioned in the Sustainable Development section above. However, it takes lake water quality protection one step further by requires a pre and post development pollutant loading analysis of any project proposed near the Lake Columbia. It is important to note that the regulation also require that a project demonstrate with calculations that the project will reduce phosphorus loads by 10% as compared to pre-development conditions. Currently there are models available that can calculate pollutant loads for both natural and developed site condition. These models can be used to predict the pollutant removal efficiencies of proposed stormwater treatment systems to ensure they are protective of surrounding water resources.

Given the intrinsic value Candlewood Lake provides to the surrounding communities, the five towns adjacent to the lake should adopt regulations similar to the town case studies described above. This will likely be the most important tool to slow down and even reverse the Lakes current trend toward an unpleasant eutrophic classification. The proposed New Fairfield Waterfront Residential District regulations do a good job of addressing the water quality problems from an impervious surface management perspective. However, the regulations should go further with the best management practices (BMPs) section to manage stormwater runoff that is inevitably created. The regulations should require the use of the listed BMPs and refer users of the regulations to design manuals that illustrate how to construct these BMPs properly.

Water quality improvement and preservation is very important to Candlewood Lake and the surrounding communities (DeLoughy and Marsicano, 2001). An easy way to get LID measures implemented on up coming land use projects would be to adopt the 2004 Connecticut Stormwater Quality Manual (CT DEP) into the five towns regulations, and requiring the design standards be adhered to. Currently, the manual is being treated as guidelines and the principals contained in it are not commonly implemented (see Town of Tolland case study above). By requiring land use change proposals to meet the design requirements in the 2004 CT Stormwater Quality Manual, many of the sustainable techniques mentioned above will be used and water quality will be protected.

To better target lake water quality management resources CLA should perform a nutrient budget for Candlewood Lake and watershed. There was a nutrient budget accomplished in 1971 (Frink, 1971). However, the model used assumptions from other Connecticut lakes. The CLA should create a new nutrient budget model only using data collected from the Candlewood Lake Watershed.

References

Jordan Cove Urban Watershed Project 2007 Annual Report, 2008, University of Connecticut, College of Agriculture and Natural Resources.

University of New Hampshire (UNH) Stormwater Center 2007 Annual Report, 2007, University of New Hampshire Stormwater Center.

Impervious Surface Coverage – The Emergence of a Key Environmental Indicator, 1996 Arnold, Chester L. and Gibbons, James C. APA Journal.

Bioretention Manual, 2002, Program and Planning Division, Department of Environmental Resources. Prince Georges County, Maryland.

Economic Evaluation of Candlewood Lake, 2001 – Sara T. DeLoughy, Marsicano, L.J. Ancell School of Business, Western State University prepared for the Candlewood Lake Authority.

Estimating Total Phosphorus Exports on a Sub-region basis in the Candlewood Lake Watershed, 2008. Marsicano, Larry and Ponak, Kristen of the Candlewood Lake Authority.

Low Impact Development Stormwater Treatment Systems Performance Requirements Road Design and Stormwater Management Design Manual, 2008, Steve Trinkaus, PE, CPESC, CPSWQ - Trinkaus Engineering, LLC.

Water Quality of Candlewood Lake and Squantz Pond Monitoring 2003-2006, 2007, prepared by the Candlewood Lake Authority for the Towns of Brookfield, Danbury, New Fairfield, New Milford and Sherman.

2004 Connecticut Stormwater Quality Manual, 2004, Connecticut Department of Environmental Protection

Action Plan for preserving Candlewood Lake, 2002, Prepared for the towns of Brookfield, Danbury New Milford, New Fairfield and Sherman by the Candlewood Lake Authority.

The Economic Benefits of Protection Virginia's Streams Wetlands and Lakes and The Economic Benefits of Better Site Design, 2001, State of Virginia, Department of Conservation and Recreation

Use and Economic Importance of the West Branch of the Farmington Rivers, 2001 National Park Service and American Rivers

Zoning Regulations of the Town of Columbia, Connecticut, Revised 2007

Preparing a Valid Pollutant Loading Analyses, StormCon 2008, Proceedings.

Candlewood Lake, A Tentative Nutrient Budget, 1971, Frink, Charles R.

Chemical and Physical Properties of Connecticut Lakes, 1984, Frink Charles R. and Norvell W.A., The Connecticut Agricultural Experiment Station, Bulletin 817.

Use and Economic Importance of the West Branch of the Farmington River, 2001, American Rivers and the National Park Service, www.nps.gov/ncrc/portals/rivers/projpg/farm.pdf

Impacts of Impervious Cover on Aquatic Systems, 2003 Center for Watershed Protection Research Monograph No. 1, Center for Watershed Protection, www.cwp.org

Sources of Pollutants on Wisconsin Stormwater, 1993, Bannerman, Roger T. University of Wisconsin and Wisconsin Department of Natural Resources.

Land Use and Water Quality

Introduction

In August 2008 Connecticut NEMO* was asked to participate in an Environmental Review Team assessment of Candlewood Lake watershed. Specifically, the Team asked to review and make recommendations regarding appropriate mitigation measure that could be used to protect the water quality of the lake. A tour of the lake watershed was conducted on September 16, 2008, followed by a review of the studies, plans and regulations of Candlewood Lake. Of particular concern to the local participants was a new overlay zone being proposed in New Fairfield for lake protection.

In the review below, NEMO will primarily look at the watershed from their area of expertise, namely the link between land use and water quality. This section will look at the existing state land cover within the watershed and will then review the current research looking at land cover indicators of water quality. Finally, NEMO will make specific recommendations of what the next steps could help to further the common interests to protect the lake resource.

State of the Watershed

To get a better understanding of the conditions within the watershed, it's helpful to see how the land is used. A recent study conducted by the University of Connecticut's Center for Land Use Education and Research (CLEAR) documents the land cover changes in Connecticut in the 21 years between 1985 to 2006. Land cover shows the amount of the land that is "covered" with a particular landscape type, such as forest or developed land. This differs from the concept of "land use" which is focused on what is practiced or permitted in a given area.

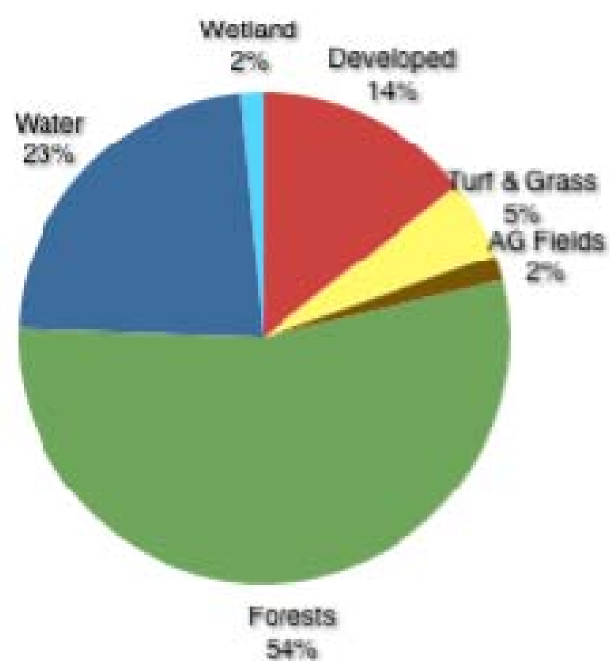


Figure 1. Percentage of land cover in the Candlewood Lake watershed in 2006

Figure 1 shows the current distribution of land cover classes within the watershed. Table 1 shows the number of acres and the percentage of the Candlewood Lake watershed for each land cover class for 1985 and 2006, as well as the amount of land cover change during the study. The study shows that over 14 percent of the watershed is covered with developed land, which is defined as the "impervious" surfaces of roads, rooftops, parking lots and other hard surfaces associated with human activity. This represented a 13 percent increase in development from 1985 levels. The amount of manicured turf, associated with uses such as lawns and golf courses, also increased during this period, showing a 5%, or nearly 300 acre, increase.

Table 1. Acreage and percentage of land cover in the Candlewood Lake watershed in 1985 and 2006.

Land Cover Type	1985		2006		Change	
	Acres	% of Watershed	Acres	% of Watershed	Acres	% Change from 1985
Developed	3,308.8	12.6	3,748.6	14.3	439.8	13.3
Turf & Grass	1,041.6	4.0	1,334.5	5.1	292.9	28.1
Other Grasses	97.1	0.4	121.9	0.5	24.8	25.5
Agricultural Fields	546.4	2.1	434.8	1.7	-111.6	-20.4
Deciduous Forest	13,265.6	50.6	12,667.2	48.3	-598.4	-4.5
Coniferous Forest	1,445.4	5.5	1,432.3	5.5	-13.1	-0.9
Water	6,025.5	23.0	5,959.6	22.7	-65.9	-1.1
Non-forested Wetland	7.1	0.0	8.0	0.0	0.9	13.1
Forested Wetland	408.2	1.6	389.4	1.5	-18.8	-4.6
Tidal Wetland	0.0	0.0	0.0	0.0	0.0	0.0
Barren Land	31.7	0.1	81.7	0.3	50.0	157.7
Utility ROWs	23.4	0.1	22.7	0.1	-0.7	-3.0
TOTALS	26,200.8	100.0	26,200.7	100.0		

This increase in development and lawns is balanced by losses the Agricultural Fields and Forest classes. Other classes also show a decrease. Water for example decreases in the watershed by nearly 65 acres. This is not an uncommon finding across the state and is primarily due to changes in the amount of annual rainfall in the years studied.

Figure 2 shows the distribution of land cover throughout the watershed in 1985 and 2006. The green colors show forested lands, with red and yellows showing developed and turf lands, respectively. In general, the watershed has considerable forested lands, but the developed lands appear most frequently next to Candlewood Lake and Ball Pond. Figure 3 shows the results of land cover change from 1985 - 2006. Figure 3A shows during what time period the new development occurred, with the colors denoting a specific time period. Figure 3B shows what land cover class was lost to development, with the colors denoting the specific land cover category. These figures further demonstrate what was outlined in Table 1 that a majority of the new development occurred in previously forested landscapes.

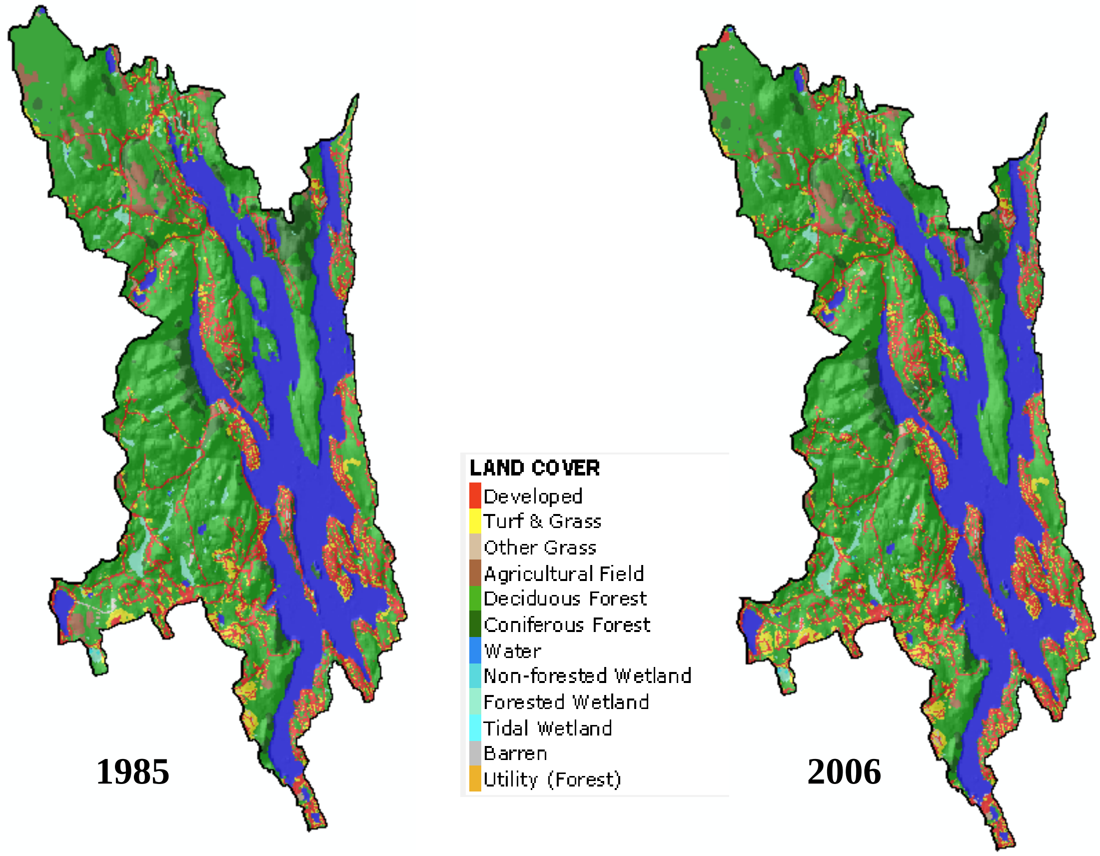


Figure 2. Land cover maps of the Candlewood Lake watershed in 1985 and 2006 with the underlying topography. Significant amounts of the watershed is forested.

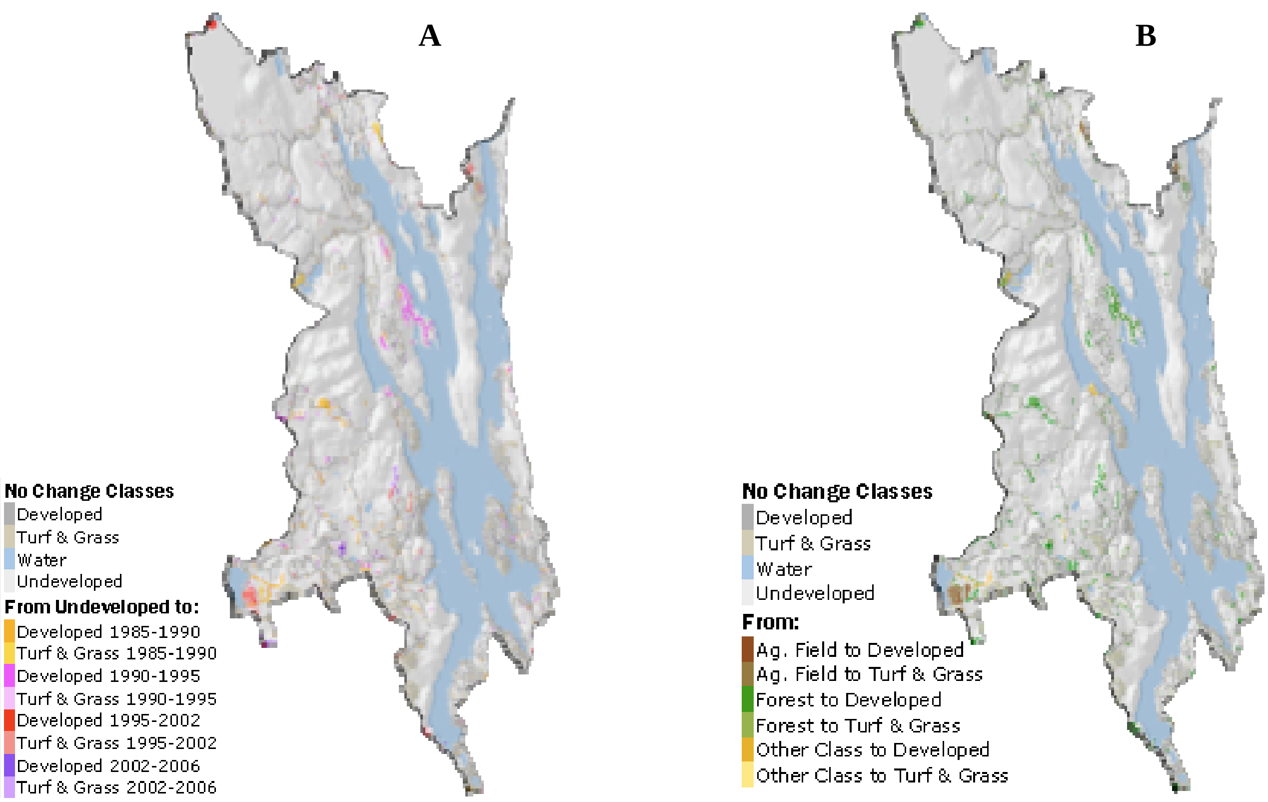


Figure 3. Land cover change maps of the Candlewood Lake watershed. Maps show when development occurred (A) and from what land cover class did the new development derive (B).

Impacts of Land Cover on Water Quality

The close connection between water resource quality and land use has been known and studied for well over a century. Early researchers noticed that as landscapes developed, the quality of the nearby water resources degraded. Leopold (1968) postulated that the amount of development had a direct effect on the hydrology of the water body. Figure 4 shows the theoretical relation between a vegetated and a developed watershed in terms of the rate of flow from a given storm event. Watersheds covered with vegetation show a consistent base flow that slowly increases during a storm and then slowly decreases back to the base flow. In contrast, the developed watershed shows a much more rapid response to storms, giving higher, more erosive, “peak” flows and increasing the total volume of storm runoff.

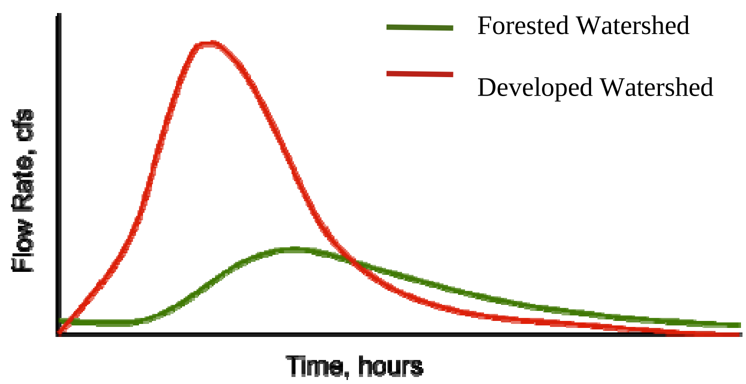


Figure 4. Relationship between hydrographs from developed versus undeveloped watersheds.

This change in the hydrology of a watershed has a profound effect on local lakes, rivers and streams for not only do these water bodies receive higher flows during rain events, but these increased stormwater flows carry a range of pollutants that degrade water quality. These stormwater-based pollutants, termed nonpoint source pollution, are an increasing source of concern for the country’s water resources (EPA, 2002).

More recent studies have begun to identify specific landscape indicators that have a direct, causal relationship with water resource quality. Three indicators in particular have been shown to have the most significant effect. These are impervious cover, forest cover and riparian buffers.

Impervious Cover

Impervious cover are surfaces that do not allow the infiltration of precipitation into ground, and include surfaces such as roads, rooftops, parking lots, or compacted soils. The connection between impervious cover (IC) and water quality was suspected for

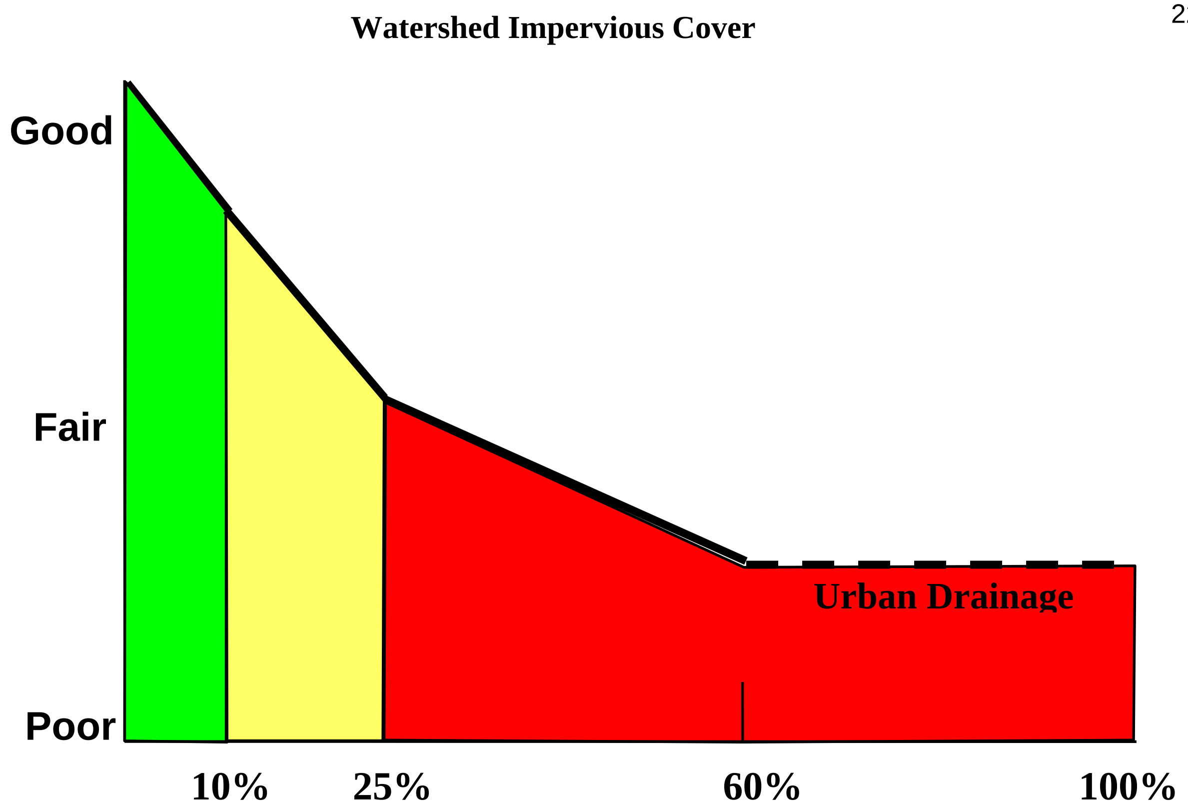


Figure 5. The Impervious Surface Model (ICM) proposed by the Center for Watershed Protection.

many years. Indeed, the purpose of most impervious surfaces is to shed water, so its direct relation to changes in watershed hydrology is intuitive.

Schueler(1994) first proposed a model based upon the relationship of IC to water quality. His initial survey of 30 national studies, later updated to over 200 studies (CWP, 2003), resulted in the impervious cover model (Figure 5). The model divides streams into three categories based on stream quality. In watershed that have less than 10% IC, stream quality is generally good to excellent; from 10 - 25% IC, stream quality becomes impacted by increased stormwater flows; and over 25% streams have lost most functions of a natural waterway and are serving primarily as urban drainage.

The intent of the Impervious Cover Model (ICM) is to provide decision-makers and resource professionals with a tool to evaluate the *potential* water resource impacts of development within a given watershed. The ICM applies only to 1st, 2nd and 3rd order streams. The "thresholds" of 10 and 25% IC are not strict dividing lines between the health states of streams, but are rather zones of expected transition and could vary significantly in individual watersheds (CWP, 2003).
In 2007, Connecticut's Department of Environmental Protection (DEP) published the results of a statewide study looking at the relationship of IC to aquatic insect (benthic macroinvertebrate) assemblages in certain stream segments (Bellucci, 2007). The study looked at 125 stream segments that met a pre-defined set of criteria and had a range of IC percentages in the upstream catchment. The researchers then evaluated the

“biological integrity” of each stream and analyzed the relationship of this measure of stream health to IC. The results of this analysis can be seen in Figure 6.

The results show a definite relationship between IC and the biological integrity of the water body. Connecticut uses a “pass/fail” water quality assessment using benthic macroinvertebrates, which have been shown to integrate the effects of pollutants and other conditions over time. Monitored streams that score less than 54% of a reference aquatic community fail the water quality criteria (WQC), while those streams greater than

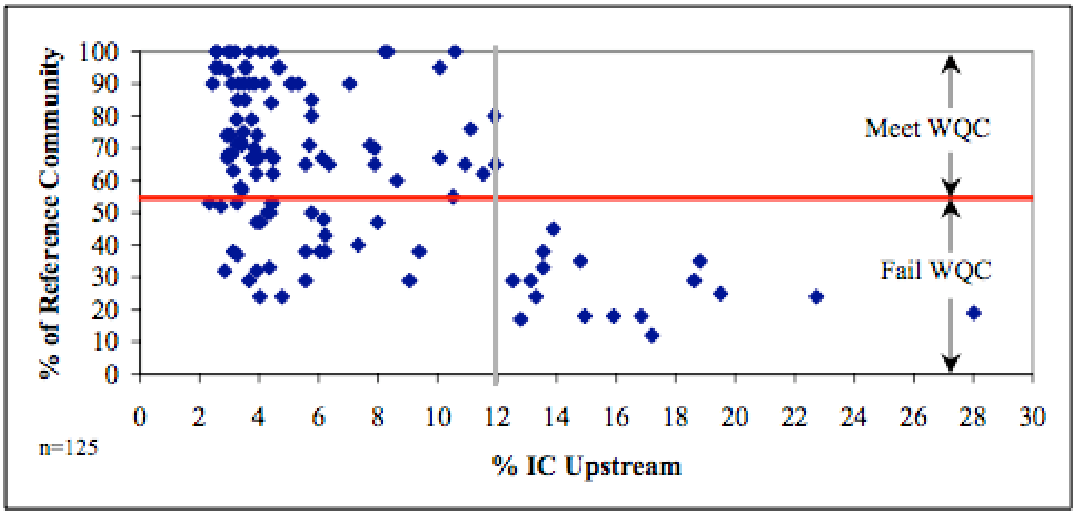


Figure 6. Plot of impervious cover (IC) upstream of monitoring locations and the % of reference macroinvertebrate community as assessed by CT DEP. Note that at 12% IC and above (grey line) none of the observed stream segments met the water quality criteria (WQC).(Bellucci, 2007)

54% pass the WQC. Figure 6 shows that no stream reaches in the study with greater than 12% IC upstream met the WQC. This study further confirms the relationship between IC and water quality.
Although the relationship between IC and water quality has been well documented in streams, less definitive work exists on the effect of IC on lakes. Existing reviews have shown that, in general, lake water quality negatively correlates to increasing IC in the watershed (CWP, 2003).

Of particular concern are sediments, nutrients, bacteria, chlorides, hydrocarbons and metals. Elevated phosphorous levels are a particular concern for lakes, and studies have shown that as IC in a lake’s watershed increases, so too does phosphorus export. (CWP, 2003).

CLEAR has used it’s previous land cover studies to assess the potential impervious cover percentages for Connecticut watersheds. The analysis of the Candlewood Lake watersheds using CLEAR’s prior 2002 land cover study can be seen in Figure 7. This analysis assigns coefficients of imperviousness that have been previously determined (Prisloe et al., 2003) to specific land cover classes. The sub-watershed basins that comprise the Candlewood Lake watershed are nearly all below the 10-percent impervious cover threshold as defined in the ICM, with some notable exceptions in the southwestern portion of the watershed.

Forest Cover and Riparian Buffers

Although IC has been widely accepted as having measurable impacts on the health of small watersheds, more recent studies have shown the importance of other watershed characteristics on water quality, showing that other highly managed land covers, such as turf and lawns, can have considerable water quality impact (CWP, 2008). Moreover, below the 10-percent IC threshold, the percentage of forest cover (FC) has been shown to be a better indicator of watershed health. This may explain the scatter of the data seen in Figure 6 below the 10-percent IC threshold.

Studies have shown that both the percentage of FC in the immediate buffer area and throughout the watershed have a positive influence on the water resource (Booth et al., 2002). Goetz, et al. (2003) found that streams within a watershed with 45-50 percent FC were rated as good to excellent. Further, streams with riparian buffers with 65-percent or greater FC were of excellent quality, while those between 45 and 65-percent were of good quality.

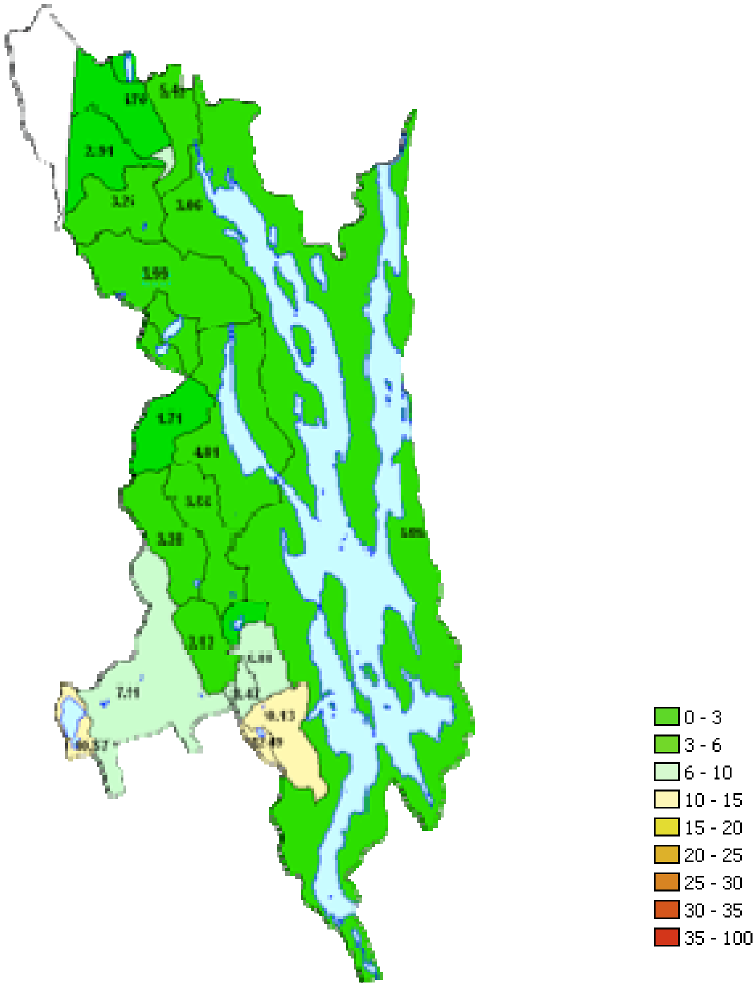


Figure 7. Impervious cover analysis using the Impervious Surface Analysis Tool developed by CLEAR and the NOAA Coastal Services Center. The analysis assigns previously derived coefficients of impervious cover to specific land cover classes. The 2002 land cover of CLEAR's original land cover study was used in this analysis.

Trees reduce the amount of storm water runoff in a number of ways. Canopy interception can capture up to 40% of the annual precipitation. Trees also absorb enormous amounts of water from the soil and evaporate this water through their leaves (a process called evapotranspiration). A single mature forest hardwood can transpire 100 gallons per day. Additionally, trees promote soil infiltration of precipitation by both attenuating runoff and increasing soil porosity. The increased organic matter of leaves increased water storage of the soils.

The upshot of the research is that land cover has a deterministic relationship to water resource quality. Since water directly interacts with the land it is, in effect, an integrator of the watershed's conditions. Although there are numerous caveats that must be kept in mind, this relationship between the land and water makes it critical that we take great pains in making changes to the land that ultimately changes the watershed's land/water equilibrium.

Addressing Water Quality Impacts

The University of Connecticut's NEMO program has for many years assisted communities in their quest to protect water and other natural resources, while preserving the ability of the community to grow. In general, NEMO promotes a planning approach to water quality protection, stressing the need of rational, science-based information in helping to derive achievable goals and objectives (Arnold and Gibbons, 1996). The need for good planning is followed by the development of key implementation steps that move the community closer to their identified goals. These steps may require changes to regulations and town policies, or new approaches to land development.

The past decade has brought the concept of "low-impact development," or LID, to the fore as an approach that can help communities reduce the impacts of development on water resources. The primary goal of all LID developments is to preserve the pre-development hydrology of developments through the use of dispersed, small-scale controls that encourage the infiltration and filtration of stormwater. Also important in this approach is to preserve or restore the pre-development vegetation and soil characteristics.

Impervious cover remains an important concept in stormwater design decisions; however, in terms of LID and stormwater it is important to distinguish between different types of IC. **Total IC** refers to the total amount or percentage of impervious surface found in an area, be it on a single lot or an entire watershed. **Effective IC** is that portion of the total IC that drains to the water resource. **Ineffective IC** is the portion of the total that drains to a pervious area, infiltrating or soaking into the ground. The concept of effective/ineffective IC is particularly important as designers develop strategies to manage stormwater onsite.

The Center for Watershed Protection suggests an approach to watershed protection that they call the Runoff Reduction Method (CWP, 2008). They propose a three step procedure for designing new developments that protect water quality. First is to focus on the existing environment and trying to conserve or restore forest cover and soils. Also important is to reduce the existing amount of impervious cover in the new design. Second, is to use stormwater practices that reduce runoff through the use of LID and other practices. Third is the use of pollutant removal practices to ensure that pollutants of concern are treated on site.

All of these approaches stress the need of two important goals in a watershed: protect and preserve forest cover and buffers, and the reduction in the amount of effective impervious surfaces. As noted above, watersheds with impervious cover under 10-percent are better served focusing on forest cover and buffer protection to preserve water resource quality.

Conclusions and Recommendations

Several communities within the Candlewood Lake watershed have adopted, or considered adopting, a waterfront overlay district. One of the primary stated intents of the districts is to mitigate storm water impacts through the control of impervious cover.

The proposed Waterfront Residential District for New Fairfield sets a maximum IC of 20-percent of the lot, with not more than 12-percent of the lot in effective IC. The overlay further allows for some flexibility of the IC standards if the applicant uses a specified set of best management practices.

The standards used and the practices put forward in the Waterfront Residential District are not outside of what is recommended in the stormwater profession or supported in the scientific literature. However, what a professional and scientific literature recommend and what a community perceives as “fair” can be very far apart. Overlay zones, by their very nature, tend to put a heavier burden of regulation on some landowners than others. Though few would disagree that lake front properties have very special benefits, it is more difficult to accept that along with these benefits come special responsibilities toward the lake resource.

Along with the responsibilities of lakefront property owners, all property owners within the watershed and indeed throughout town, need to share in the stewardship of the Candlewood Lake and other affiliated water resources. Low impact development standards, the protection and restoration of forest cover, and the use of best management practices are appropriate for use throughout the town in order to best protect the water resources for the region. Many towns with the state have taken this approach with considerable success (Rozum and Dickson, 2009).

In terms of additional studies and or actions to be taken, the following are recommended:

1. Update the IC analysis for the Candlewood Lake watershed using either high resolution aerials or CLEAR’s new land cover analysis

2. Conduct a forest cover analysis of the watershed using the “Leaf-Out” analysis suggested by the USDA Forest Service (Cappiella et al., 2005) to determine the potential loss in FC and the potential impacts on the watershed

3. Develop a voluntary “lake friendly” landscaping program based on the Candlewood Lake Buffer Guidelines” in the 2005 Candlewood Lake News. Ultimately the success of any water quality program is in the general acceptance of the tenets by the populace. Developing marketing and incentive programs can be a better approach to existing homeowners.

4. Look at planning and regulatory tools that help to promote the use of LID practices watershed or town wide.

CT NEMO – Nonpoint Education for Municipal Officials. A University of CT program for local land use officials addressing the relationship of land use to natural resource problems.

References

Arnold, Chester L. and C. J. Gibbons. 1996. Impervious Surface Coverage: the emergence of a key environmental indicator. J. Amer. Planning Assoc., 62(2):243-258.

Bellucci, C. 2007. Stormwater and Aquatic Life: Making he Connection between Impervious Cover and Aquatic Life Impairments for TMDL Development in Connecticut Streams. *Water Environment Federation*

Booth, Derek B., D. Hartley, R. Jackson. 2002. Forest Cover, Impervious-Surface Area, and the Mitigation of Stormwater Impacts. *J. Am. Water Res. Assoc*. 38(3):835-845.

Candlewood Lake Authority, 2005, Candlewood Lake Buffer Guidelines, *Candlewood Lake News*, 21(2).

Center for Watershed Protection. 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph No. 1. Available for download at www.cwp.org.

Center for Watershed Protection. 2008. Technical Memorandum: The Runoff Reduction Method. www.sotmwatercenter.net

Cappiella, K., T. Schueler, and T. Wright. 2005. Urban Watershed Forestry Manual, Part 1: Methods for Increasing Forest Cover in a Watershed. *USDA Forest Service*

Goetz, Scott J., R.K. Wright, A.J. Smith, E. Zinecker, E. Schaub. 2003. IKONOS imagery for resource managment: Tree cover, impervious surfaces and riparian buffer analyses in the mid-Atlantic region. *Remote Sensing of Environment* 88:195-208.

Leopold, Luna B., 1968. Urban Hydrology for Land Planning, Circular 554, Washington: U.S. Geological Survey.

Prisloe, Michael S., E.H. Wilson, C. Arnold. 2003. Refinement of Population-Calibrated Land-Cover-Specific Impervious Surface Coefficients for Connecticut. CLEAR Report.

Rozum, J. and D. Dickson. 2009. Taking Low Impact Dvelopment from Research to Regulations. *Planning Commissioners Journal*: 73: 17-19.(in press)

Schueler, T.R. 1994. The Importance of Imperviousness. *Watershed Protection Techniques* 1,3: 100-11.

Phosphorus, Property Values and Water Quality

Introduction

Numerous studies have shown how activities in lake watersheds can degrade water quality and aquatic habitats. Eutrophication and aquatic weed growth are two concerns of Candlewood Lake communities and, as both are accelerated by phosphorus, efforts are underway to reduce the amount of phosphorus entering the lake. The Candlewood Lake Authority (CLA) Action Plan for Preserving Candlewood Lake identifies some of the factors affecting the lake's water quality and provides a town-by-town analysis of how local land use regulations address them (Candlewood Lake Authority 2002).

The Connecticut Department of Environmental Protection (DEP) website provides an overview of why watershed management is important and describes how to prioritize efforts to protect water quality (see http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325622&depNav_GID=1654).
A Wisconsin shoreland zoning guide, available at http://www.dnr.state.wi.us/org/water/wm/dsfm/shore/documents/WT50597.pdf, provides a scientific basis for how shoreland zoning can protect lakes.

Structural controls to reduce phosphorus movement

The Wisconsin shoreland zoning guide mentions studies in Wisconsin and Maine that found phosphorus entering lakes increased up to 700% in response to development. Not only does new development create new sources of phosphorus, ranging from septic system effluent to lawn fertilizers, the developed landscape has much less ability to prevent phosphorus from entering a lake or stream.

One strategy for reducing the movement of phosphorus is to filter runoff by means of filter strips or riparian buffers. They can remove excess nutrients from runoff, but steeper slopes or higher phosphorus loads require wide buffers and they are less effective if runoff does not remain dispersed across the ground surface before reaching the filter strip. A report generated for the Eight Mile River Wild & Scenic Watershed Designation effort points out a number of buffer issues that should be considered (see http://www.eightmileriver.org/resources/digital_library/appendicies/09c3_Riparian%20Buffer%20Science_YALE.pdf).

Phosphorus Sources – Wastewater

In addition to using structural controls to capture phosphorus, it can be beneficial to minimize the amount of phosphorus released into a watershed. CLA's Action Plan for Preserving Candlewood Lake, the Wisconsin guide and other reports highlight that septic systems can be a significant source of phosphorus entering a lake. It is important to realize that, whether failing or not and whether maintained or not, septic systems release phosphorus to the environment and it can reach a lake.

The 1971 report Candlewood Lake: A Tentative Plant Nutrient Budget (Frink 1971) estimated that 23% of the phosphorus entering Candlewood Lake originated from septic systems. That study assumed that 10% of phosphorus from septic systems reaches the lake, with the remainder retained in the soil. As mentioned in DEP's Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems (see http://www.ct.gov/dep/lib/dep/water_regulating_and_discharges/subsurface/2006designmanual/designmanual2006.pdf), soil is capable of retaining essentially all phosphorus under the right conditions.

Although soil can have a high capacity for retaining phosphorus, there are limits. A study mentioned in the Wisconsin guide found significantly more phosphorus in aquatic plants, sediment and seepage water where groundwater flowed into a lake from lakefront having septic systems. The guide also mentions a Canadian study which found that all phosphorus from lakefront septic systems reached lakes in two areas having thin soils. One-third of the phosphorus from septic systems in thicker soils reached a lake. Since each household releases a few pounds of phosphorus per year in its wastewater, the actual amount retained in the soil is a critical factor in determining the amount of phosphorus reaching a lake.

Sewering is not necessarily a solution, both because of the cost and because sewering can fail to protect lake water quality, as described in the Wisconsin guide. Although nuisance plant growth was reduced at first when homes at a particular lake were sewered, plant growth eventually increased and phosphorus is almost as high as it had been. Sewers encourage intensive development and the additional phosphorus from new residential land use might overcome the benefits of removing septic system discharges.

Phosphorus Sources – Landscape Sources

Lawns and driveways are the source of a large proportion of the phosphorus in runoff from residential areas, according to the Wisconsin guide and a US Geological Survey report which is available at http://wi.water.usgs.gov/pubs/WRIR-99-4021/. A Minnesota stormwater management manual, available at http://wrc.umn.edu/outreach/stormwater/bmpassessment/assessmentmanual/index.html mentions that nutrient concentrations in lawn runoff are similar to those in advanced wastewater treatment plant effluent. Such runoff is a threat to lake water quality whether it enters a lake directly or first passes through streams or storm drainage systems.

A number of pollution prevention fact sheets are available at http://www.stormwatercenter.net and one (http://www.stormwatercenter.net/Pollution_Prevention_Factsheets/LandscapingandLawnCare.htm) focuses on landscaping and lawn care. It mentions that few homeowners know how much fertilizer their lawns actually need. Another survey it mentions found that only 21% of Minnesota homeowners believed that their own lawn contributed to water quality problems, while more than twice as many believed that their neighbor's lawns did.

Minnesota and Maine allow only phosphorus-free fertilizers for lawns. Minnesota's stormwater management manual says that phosphorus in runoff will decline by 1% to 20% immediately after a ban in phosphate fertilizers, reflecting the amount of applied fertilizer that previously would have been carried in surface runoff. Afterwards, phosphorus levels will decline slowly as phosphorus stored in the soil and plants is gradually lost. There were significant phosphorus reductions in a river of a city in Michigan that passed a phosphorus-free fertilizer ordinance and began public education campaign, (see http://www.stormh2o.com/blogs/john-t-lehman/river-phosphorus-drops-following-p-free-fertilizer-ordinanc.aspx). Communities in other states have passed similar ordinances.

In addition to septic systems, lawn fertilizers and other well-known sources of phosphorus, the Wisconsin shoreland zoning guide mentions that construction sites are the source of 35% of the sediment and 28% of the phosphorus entering lakes and streams in an area of southeastern Wisconsin. Construction sites are especially susceptible to stormwater erosion and two organizations, American Rivers and Midwest Environmental Advocates, recently published a local water policy guide, which is available at http://www.americanrivers.org/site/DocServer/Local_Water_Policy_Innovation_Stormwater_Oct_2008.pdf?docID=8401. It describes how communities can address stormwater with local policies or regulations and how community support can be mobilized.

Economic Value of Water Quality

Protecting water quality requires substantial effort, but the effort would be beneficial for Candlewood Lake communities for reasons beyond just the environmental and aesthetic values. As described in a recent article (see http://pubs.acs.org/doi/pdf/10.1021/es801217q), freshwater eutrophication in the US costs an estimated $2.2 billion annually. There are a number of reasons, but the loss of waterfront property value was considered the largest.

The CLA has studied the potential effect and surveys described in its 2001 report, Economic Evaluation of Candlewood Lake with Alternative Water Quality Categories; found that lakefront properties would lose 34% of their value if Candlewood Lake were impaired to the point of preventing swimming or boating (DeLoughy and Marsicano 2001). That is a similar result to an earlier study of four lakes in Connecticut, which found that properties would lose 36% of their value if swimming was not possible in those lakes (see http://www.ctlakes.org/How_Much_Is_A_Lake_Worth_To_You_UCONN_DEP_1-20[1].pdf).

Other studies have used a variety of methods to calculate lakefront property value losses resulting from declining water quality. Two from Maine are http://www.maine.gov/dep/blwq/doclake/econlong.pdf and http://www.umaine.edu/mafes/elec_pubs/miscrepts/mr398.pdf. Another study, from Wisconsin, reported that improving the quality of a lake's water will increase the value of properties near it (see http://academics.uww.edu/business/economics/FERC/reports/Delavan.pdf). Candlewood Lake properties might be especially susceptible to losses in value, because the Maine studies found property value losses are greatest for lakes that are already impaired. Candlewood Lake's clarity is already in the range where Maine research found property values are highly sensitive to further decline.

Excessive aquatic plant growth is considered a particular problem at Candlewood Lake, but less is known about the effect of such plant growth on property values. The amount of aquatic plant growth is difficult to quantify, unlike clarity, which is more easily measured and more consistent across a lake. A New Hampshire study considered only whether milfoil was or was not present at a lake and, although that is a rough measure, the study concluded that lakefront property values were 20% - 40% lower in lakes having milfoil. The authors acknowledged the uncertainty of their results and an unpublished study in Vermont encountered similar problems. Describing the difficulties another study encountered in calculating the economic damage of nuisance aquatic plant growth, the Maine Economic Impact of Lake Use and Water Quality Measuring review noted that plant growth doesn't affect all lakefront properties equally (see http://www.maine.gov/dep/blwq/doclake/econlong.pdf).

Various studies show that values of non-lakefront properties are affected less by declining water quality than the values of lakefront properties. The Candlewood survey, for instance, found that the loss of swimming opportunities would reduce non-lakefront property values by 21%, as opposed to the 34% loss of lakefront property value (DeLoughy and Marsicano 2001). Since lakefront properties suffer a greater loss of property value, the local property tax burden will shift to non-lakefront properties. The result is that non-lakefront property owners will pay a larger share of a town's taxes, even as their own property values decrease.

What Can be Done Now?

It would be beneficial to learn more about the concerns and desires of the community with respect to the ongoing effort to protect Candlewood Lake. The Minnesota Lakes Association has published a planning workbook, available at http://www.minnesotawaters.org/resources/Workbook.pdf, which includes a chapter about conducting property owners' surveys. Not only can such a survey identify which actions members of the community support or oppose, it can provide more information about how people use their property and the lake and what they consider to be problems. The workbook includes specific recommendations for constructing and conducting surveys and for interpreting results.

Possible Funding for Municipal Water Quality Improvements

The General Assembly's Office of Legislative Review assessed how other states fund invasive plant programs and its 2006 report, Funding for State Invasive Plants Programs, is available at http://www.cga.ct.gov/2006/rpt/2006-R-0026.htm. The report mentions the use of boat registration fees to support such efforts and, given the problems caused by invasive species such as milfoil, such a funding mechanism might also be viable in Connecticut. A deadline has passed to apply for DEP grants for invasive plant control projects on publicly accessible lands and waters (see http://www.ct.gov/dep/cwp/view.asp?a=2702&q=425512&depNav_GID=1641).

Another source of funding for water quality improvements is the Small Town Economic Assistance Program (STEAP) (http://www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793). STEAP can fund municipal capital projects and a recent example is Wolcott, which was awarded $250,000 in 2008 to engineer and install sediment separation systems for town roads at Hitchcock Lake. STEAP funding is limited to capital projects in municipalities ineligible to receive Urban Action funding and municipalities may receive up to $500,000 per year. With the exception of Danbury, the towns around Candlewood Lake are eligible for the program. Public Act 07-7 authorized $20 million for STEAP in both fiscal year 2008 and fiscal year 2009. Contact OPM for information on 2010 grant information.

Unlinked, Cited References

Candlewood Lake Authority 2002. Action Plan for Preserving Candlewood Lake. Candlewood Lake Authority, Sherman, CT.

DeLoughy, Sara T. and Marsicano, Laurence J. 2001. Economic Evaluation of Candlewood Lake with Alternative Water Quality Categories. Candlewood Lake Authority, Sherman, CT.

Frink, Charles R. 1971. Candlewood Lake: A Tentative Plant Nutrient Budget. The Connecticut Agricultural Experiment Station, New Haven. Circular 238.

Appendix

Archaeological and Historical Review

The Office of Stat Archaeology (OSA) and the State Historic Preservation Office (SHPO) had identified 25 archaeological sites associated with Candlewood Land and Squantz Pond Watersheds. These sites are primarily Native American campsites dating as early as 8,000 years and appear to be hunting/gathering/fishing camps utilizing the natural resources of the watershed when the area was a large interior marsh prior to the historic dams that created the lake. Some of the recorded archaeological sites represent outcroppings of bedrock which provided a natural shelter for mobile hunters/gatherers.

SHPO and OSA strongly recommend that Candlewood Lake Authority consider a professional archaeological survey for the watershed as an integral aspect of pre-development or land conservation planning. Grant funds can be utilized for a cultural resource management plan. Information can be obtained from SHPO's website

http://www.cultureandtourism.org/cct/

The OSA and SHPO are both available to provide technical assistance in the identification and evaluation of cultural resources on parcels proposed for development or conservation.

About the Team

The King's Mark Environmental Review Team (ERT) is a group of environmental professionals drawn together from a variety of federal, state and regional agencies. Specialists on the Team include geologists, biologists, soil scientists, foresters, climatologists and landscape architects, recreational specialists, engineers and planners. The ERT operates with state funding under the aegis of the King's Mark Resource Conservation and Development (RC&D) Area - an 83 town area serving western Connecticut.

As a public service activity, the Team is available to serve towns within the King's Mark RC&D Area - *free of charge.*

Purpose of the Environmental Review Team

The Environmental Review Team is available to assist towns in the review of sites proposed for major land use activities or natural resource inventories for critical areas. For example, the ERT has been involved in the review of a wide range of significant land use activities including subdivisions, sanitary landfills, commercial and industrial developments and recreation/open space projects.

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 site and highlighting opportunities and limitations for the proposed land use.

Requesting an Environmental Review

Environmental reviews may be requested by the chief elected official of a municipality or the chairman of an administrative agency such as planning and zoning, conservation or inland wetlands. Environmental Review Request Forms are available at your local Conservation District and through the King's Mark ERT Coordinator. This request form must include a summary of the proposed project, a location map of the project site, written permission from the landowner / developer allowing the Team to enter the property for the purposes of a review and a statement identifying the specific areas of concern the Team members should investigate. When this request is reviewed by the local Conservation District and approved by the King's Mark RC&D Executive Council, the Team will undertake the review. At present, the ERT can undertake approximately two reviews per month depending on scheduling and Team member availability.

For additional information regarding the Environmental Review Team, please contact the King's Mark ERT Coordinator, Connecticut Environmental Review Team, P.O. Box 70, Haddam, CT 06438. The telephone number is 860-345-3977.