

SCIENCE COMMUNICATION DEVICES AND OUTREACH PROJECTS ON HARMFUL
ALGAL BLOOMS IN THE FINGER LAKES

A Portfolio

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of
Master of Professional Studies in Agriculture and Life Sciences
Field of Natural Resources

by

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ABSTRACT

Harmful algal blooms (HABs) affect all 11 of the Finger Lakes in New York State. The cyanobacteria that make up the majority of HABs biomass produce microcystin, which makes blooming water bodies hazardous to the health of humans and animals that encounter them. However, the Finger Lakes Region is economically reliant on the use of the lakes for tourism-based businesses. Both climate change and current land management practices create conditions that encourage the growth of HABs on the Finger Lakes, leading to lost workdays and reduced capacity to function for businesses supported by lake tourism. This portfolio is a collection of science communication devices and projects—methods of educating the public about the risks and causes of HABs—directed towards residents and visitors of the Finger Lakes. The goal of these materials is to create behavioral changes that prevent HABs in the future. Each is accompanied by a brief description.

BIOGRAPHICAL SKETCH

Adele Hancock is completing her Master of Professional Studies in Natural Resources at Cornell University, with a concentration in Sustainable Systems and Water Resources Management. She completed her Bachelor of Science in Biology and Bachelor of Arts in Health, Medicine, and Society at Lehigh University in May of 2021.

DEDICATION

For Ozzie, golden hair surprise.

ACKNOWLEDGMENTS

My thanks to Katie Fiorella, my advisor, for her guidance and advice throughout my time at Cornell. Thank you to Rebecca Schneider for helping me find a pathway (perhaps a ditch) to follow, and a very special thank you to Steve Morreale, the heart and soul of the M.P.S. program, who gave us all a community to thrive in.

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LIST OF ABBREVIATIONS

HABs: Harmful Algal Blooms. Populations of cyanobacteria visible to the naked eye that can be toxic to humans and animals

CLWN: The Cayuga Lake Watershed Network, a local education and advocacy organization serving the whole Cayuga Lake watershed.

CSI: Community Science Institute

IG: Instagram

FB: Facebook

GIS: Geographical Information Systems

LULC: Land Use Land Cover

BACKGROUND

In 2021, Cayuga Lake had 102 reported Harmful Algal Blooms. In 2020, 87 reported blooms, 2019, 69 blooms, and in 2018, 46 (CSI). In the past few years, there have been 100s of days of closed beaches and health warnings, and each year that number has only increased. Unfortunately, this is not an easily solved problem—both treatment and prevention pathways are complex and difficult to navigate. The blooms are not an unnatural phenomenon in and of themselves, but the frequency and quantity of blooms is far outside the bounds of what has been historically recorded, implying that a dramatic change to the watershed has occurred and is contributing to the persistence of seasonal blooms (Krztoń et al., 2019). Health, safety, and the continued thriving of the Finger Lakes region relies on the prevention of future HABs.

Since 2017, all 11 of the Finger Lakes have experienced at least one HAB, and for many of the lakes they have become a persistent nuisance (FLLT). Blooms pose serious risks to people and animals that interact with the lake—the cyanobacteria (not algae) that compose HABs in the Finger Lakes produce a cyanotoxin called microcystin, a liver toxin that is unsafe to ingest, inhale, or have direct contact with (Trevino-Garrison et al., 2015). Contact with the blooms can cause liver damage, skin irritation, stomach problems, and breathing problems, and have been known to cause the death of humans who drink water contaminated with it as well as dogs who swim in it, and proceed to lick the microcystin out of their fur (Trevino-Garrison et al., 2015). HABs have the biggest impact on life within the lake, as a bloom can also deplete the oxygen in a patch of water and, combined with the release of toxins, leads to the mass death of fish, aquatic mammals, and birds (Keliri et al., 2021). To protect the public from the dangers of HABs when blooms occur, areas of lakes will be closed, and swimming advisories posted to prevent people from being in water while microcystin is present. However, businesses that are dependent upon

the use of the lake suffer from these lost days—HABs discourage people from visiting the area and using the lake, meaning fewer trips to wineries, rented paddleboards, or stays at vacation homes (Bechard, 2019).

There are methods of treating a lake for HABs once they have begun blooming, but the practices are flawed. Water treatments like hydrogen peroxide and chlorine dioxide may kill cyanobacteria, but can cause more problems—the death of cyanobacteria leads to the rapid release of the cyanotoxins stored in the cells, increasing the toxicity of the bloom, and antimicrobials can also kill other important organisms in the lake (Piel et al., 2021). Other techniques like ultrasonic treatment have limited success outside of a laboratory and may also have unknown unintended consequences for the life of the lake (Park et al., 2017). Prevention remains the primary solution for eliminating HABs, a task easier said than done. HABs are caused by the eutrophication of the lakes and warm temperatures (Roger W. Bachmann & Lawrence A. Bull, 1995). A warming climate has meant an increase in the number of days per year where the lake is warm enough to support a bloom, and centuries of nutrient laden runoff from an increasing amount of developed land has allowed the Finger Lakes to collect the large quantities of phosphorous needed by cyanobacteria to grow (R. T. Oglesby, 1978). Nutrient pollution comes from all over the watershed—agricultural, urban, and industrial land use still contributing the most to the lake eutrophication (Glibert, 2020). With the hopes of preventing future pollution to the lakes, I have created science communication outreach projects on HABs, in the interest of making residents and tourists of the Finger Lakes aware of why the area is experiencing HABs, what they should be cautious about, and what they can do to prevent future HABs in the region.

My work this past year on the prevention of harmful algal blooms on the Finger Lakes has centered predominantly around Cayuga Lake. This focus on HABs began as coursework, (in particular, the Owasco HABs Fact Sheet) and continued into my work this summer as both the Outreach Intern for the Cayuga Lake Watershed Network (CLWN) and a Research Aide for Dr. Rebecca Schneider. As part of my position with the Watershed Network, I assisted in the function of the HABs monitoring program—CLWN is part of one of most robust HABs monitoring program of all the Finger Lakes, alongside Discover Cayuga and the Community Science Institute (CSI). Run predominantly by the work of volunteers, this HABs sampling program monitors nearly all thirty-eight miles of Cayuga Lake and is one of the many reasons for the community interest in lake health.

During this internship, I also contributed to the social media presence, and proposed a pilot public awareness campaign to a local highway department in conjunction with my work with Dr. Schneider. For Dr. Schneider, I assisted in the continuation of her work on roadside ditches in New York, one of the many contributors to HABs on the Finger Lakes, by collecting and visualizing data from previous surveys and finding additional addresses for a statewide survey. As discussed in the proposal, roadside ditch management is a critical component of the prevention of nutrient pollution in Cayuga Lake, leading to its inclusion in my work. All this work has been condensed and summarized into this portfolio—the contents of which includes several fact sheets, social media posts, a GIS project, and a proposal.

Together, this is a multifaceted approach to preventing HABs. It creates public awareness of the issue, builds community to encourage working together towards water quality improvement, and provides potential solutions for various stakeholders to change their impact on the watershed. I also developed these projects with the intention of preventing the division of

local stakeholders. HABs have come with a lot of blame and accusations of misdoings on the part of stakeholders in agriculture and industry, which has slowed the progression of land management changes needed for HAB prevention. Continued movement on these projects would lead to changes in how land is managed in the Cayuga (and Owasco) watershed, preventing future eutrophication of the lake, and the HABs that result.

FACT SHEETS

Owasco Lake HABs Fact Sheet

What are Harmful Algal Blooms?

Harmful algal blooms (HABs) are communities of single celled algae (aquatic plants) that have rapidly grown to much larger populations than is normal. Populations become so large that these usually invisible creatures collect into visible clouding in the water, often looking like blue-green stripes in normally blue or clear water. The blooms consume all of the dissolved nutrients (nitrogen, oxygen, and phosphorous) in the water. If they use up enough of the dissolved materials, they can outcompete other species, causing fish to suffocate in low oxygen water. When these blooms occur, they also release toxins into the water that can be harmful to humans, pets, and wildlife, particularly animals living in the water that cannot escape the toxic conditions. These blooms can occur in fresh or salt water and are most common when water is warmer than usual during the hottest times of the year, around July and August. Blooms can be caused by native algae that is always in the lake, or by invasive algae that has hitchhiked into the water from dirty boats and equipment.



HABS on Owasco Lake. Credit: Matt Champlin

A blue-green bloom on Owasco Lake. Credit: OWLA



What causes HABs?

Algal blooms occur when nutrients like phosphorus and nitrogen become more concentrated in the water than usual. Low concentrations of these nutrients ordinarily limit algae growth, but when excess quantities of chemicals flow into the water, algae populations explode. High concentrations of nutrients end up in the water from several sources surrounding the lake, first accumulating in rivers and streams that flow into the lake. The extra phosphorous and nitrogen is called nutrient pollution, and it comes from human activity higher up in the watershed—places where water on the land is just beginning to collect into streams and creeks from snow melt. Even if it doesn't seem like it's near the lake, pollution from urban development, sewage/septic overflow, and farmland can collect in those streams and end up in the lake. Another key factor to HABs is temperature. Algae thrive in warm, late summer water. As the global temperature continues to rise, water temperatures also increase, providing more opportunities for HABs to grow.

GUIDELINES FOR

HARMFUL ALGAL BLOOMS

*PREVENTING NUTRIENT POLLUTION ON
OWASCO LAKE*

Why is preventing HABs so important?

The negative impacts of HABs reach many directions and impact communities in several different ways. The toxins produced by the blooms can poison fish, causing large populations to die and can lead some fisheries to close permanently when the fish become too contaminated to consume. HABs may discourage tourists from visiting an area notorious for algal blooms. The blooms smell like rotten eggs, are considered unattractive, the water can cause diarrhea, vomiting, and skin irritation, and have been known to kill pets that drink the water. HABs negatively effect local economies and daily lives by making what was once a gorgeous waterfront paradise into something potentially toxic and very unappealing.



A blue-green algae bloom on Owasco Lake. Credit: OWLA

Non-Point Source Pollution (NPS)

Non-point source pollution is water pollution that does not come from any single discernable place. Major contributors can be identified for a particular watershed, but unlike point source pollution, there is no one culprit. Often, the type of land use causing the pollution can be identified by what is polluting the water. The pollutants are sediment/soil, chemicals from urban areas, nutrients from manure and fertilizer, pesticides, and pathogens that end up in rivers and lakes either as runoff, or after being drained into soil and transported to a nearby stream underground. In urban areas, NPS comes from rain washing pet waste, household chemicals, or oil leaks from cars off the pavement and into the nearby soil or roadside ditches. In rural areas, pollution comes from applying chemical fertilizer, pesticides, or manure to crop land, and draining the water from the fields directly into roadside ditches. From here, these chemicals ultimately travel into the lake. The difficulty in preventing NPS is that many different places and actions are contributing to poor water quality. It is important that we try to reduce all potential sources of pollution. The focus of this fact sheet is on preventing agricultural pollution.



Diagram of the Owasco Lake Watershed. Credit: NYS DOS

SOURCES OF NUTRIENT POLLUTION

KEY TARGET FOR PREVENTION

Farm runoff
Sewage Overflow
Climate Change
Road salt
Industrial Production
Urban Development

What's happening to Owasco Lake?

Of the seven finger lakes, Owasco has historically had the worst ranked water quality based on algae levels, bacteria levels, nutrient concentrations and more. Despite being one of the smaller lakes, Owasco has an enormous watershed—205 square miles of the land surrounding the lake drain into the lake. With so much land contributing polluted water into such a small lake, the water of Owasco quickly gets saturated with nutrients, and algae begins to grow rapidly.

What can be done to prevent HABs?

CHANGES TO PROTECT THE OWASCO WATERSHED

Plant Cover Crops

Cover crops are crops planted on farmland during times when a field is not being used for profit. There crops are not meant to be harvested and sold, and are instead intended to improve soil and prevent soil erosion. Often plants like legumes, cereals, and forage grasses are used, or even a mixture. In New York, consistent rain keeps the soil wet enough to stay on the ground and not get blown away, but soil can still drain away into rivers and streams if it isn't bound into the root system of a plant. Other techniques of soil improvement include altering crop rotations and having no-till fields. Depending on farm needs, a sustainable field management can improve the amount of nitrogen and organic matter, assist weed control, prevent soil loss, and maintain moisture. Cover crops are also known to improve yield of corn by 3% and soy by 4.9% after 5 years.



Runoff from field in Iowa. Credit: Natural Resources Conservation Service

Sustainable Field Drainage Plans



Tile drainage system dumping water into a roadside ditch in Michigan. Credit: Agri Blogosphere

Tile drainage is a method of artificially draining farmland. Farmers want their fields drained so they can start planting as early as possible and need efficient ways of clearing water out of the fields. Draining allows farmers to increase profit, but the water cleared from the field is not simply gone. Unfortunately, the water from tile drainage is often dumped into roadside ditches, bringing water, manure, fertilizer, and soil into local rivers and streams. To prevent these pollutants from ending up in Owasco Lake, fields should not be drained when it isn't necessary and water that is drained from fields should not be drained into ditches, but instead collected and treated. Work with your local organisation to find a management plan that is specific to your watershed. The New York Department of Environmental Conservation (NYSDEC) has created a plan to manage HABs on Owasco Lake, following the Best Management Practices (BMPs) set by the NYS Soil and Water Conservation Committee.

Maintaining a farm that produces livestock, but does not pollute requires farmers to be attentive to their land. Current BMPs for manure include diverting natural streams that go through heavily used areas, re-grading land so water doesn't collect, and collecting manure, either to be removed from the farm, or to be put into a manure treatment system. Manure treatment systems like the anaerobic digester depicted on the right, reduce risk of disease and pollution, as well as the nuisance of odor. By collecting manure into a biodigester, it can be turned into an energy/heat source (biogas), a pathogen free fertilizer, and less bacteria and nutrients end up in the water. These practices have the added benefit of also improving herd health—keeping cows in dryer, cleaner conditions decreases opportunities for hoof rot and mastitis, improving the life of the animal, and farm profit.

Manure Management

Anaerobic Digestion

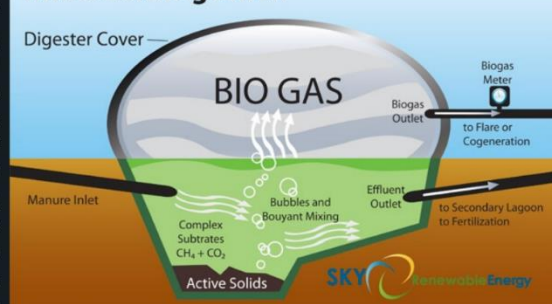


Diagram of anaerobic manure digester. Credit: Sky Renewable Energy

Ditch remediation

The quality of a roadside ditch also contributes to water quality. Current ditch management practices include scraping ditches and cutting them deeper when the flood. Both of these actions cause ditch deterioration, leading to more of the same problems, creating unsafe ditches that pollute the streams they drain into. Scraped ditches with exposed soil erode quickly, allowing soil sediment to get taken down stream and ditches without any plants growing in them funnel water through quickly, the high speed contributing to soil loss and reduced stability of the roadside. A scraped ditch also has a reduced ability to absorb water and whatever pollutants come into the ditch from the road (like road salt and leaked chemicals from vehicles) are channelled into local rivers and streams. A good roadside ditch has a trapezoid shape (flat bottom with sloped sides), a variety of plants growing in it, and is not any deeper than is necessary to contain water flow. Depth is dependent on the ditch, but is usually not much more than 18 inches. Ditches that fit the BMP guidelines are better at retaining water and preventing road flooding—the shape and plants growing in the ditch slow down the water, allowing it to be absorbed into the surrounding soil, instead of running straight into the nearest stream. Find out what your local highway department ditch management practices are and encourage improved ditch care.



An eroded roadside ditch. Cornell Local Roads Program

HOW CAN I GET ASSISTANCE?

Many of these actions cost money. However, there are organizations, both governmental and nonprofit, that can offer financial assistance to landowners looking to improve their impact on the watershed. Check out the NYSDEC website, OWLA, NYS Soil and Water Conservation Committee, and your local BMP guidelines to find cost-share opportunities.

Recreational activities on Owasco Lake. Credit (from left): DEC, Kerrie's Korner, CayugaEda



What are we doing?

CURRENT PROJECTS TARGETING OWASCO LAKE

- Ditch remediation program
 - The Owasco Watershed Lake Association (OWLA) began a ditch remediation program in 2019 that is still underway. Alongside the NYS DEC and Cayuga County Soil and Water Conservation District, OWLA has helped identify ditches that require remediation. A grant from the NYS DEC means that land owners can receive support for the costs of improvement.
- Research at Cornell University and Hobart and William Smith Colleges
 - Both Cornell University and Hobart William Smith Colleges have many projects focusing on Owasco Lake. These include research and outreach concerning about HABs, invasive species, water quality, watershed management, and agriculture.
- Citizen science programs and student education
 - OWLA is currently running an in school program that teaches seventh grade science classes about lake and water quality, as well as the basics of what a watershed is. Cornell and OWLA both run programs for people to collect water data.

REFERENCES

OWLA, NYSDEC, EPA, Cornell Cooperative Extension, NY AG BMP Catalogue, NH Ag BMP Catalogue, SARE

Adele Hancock

Your Ditch and You

Understanding who is responsible for maintaining roadside ditches is a key component to ensure their proper management. The Right-Of-Way (ROW) is the edge of your property that interfaces with the road, and includes the ditch. You own this piece of land, but the highway department is allowed to alter it so that roads can drain and remain safe.



What is the Right-Of-Way?

Re-thinking the ideal ditch



When a ditch isn't draining water off the road quickly, the first actions are usually scraping the plant growth out of it and digging deeper. However, steep sides, V-shaped ditches, and exposed soils can cause serious problems farther downslope. Instead of slowing down water movement, and allowing it to be absorbed into the soil, rapid flow in bare ditches erodes away the banks and bottom of the ditch, bringing soil and pollutants directly to rivers and lakes. A good roadside ditch has gently sloped sides, is no more than 1.5 feet deep, and has a continuous cover of grass and other plants. Plant roots help hold the soil in place and the vegetation helps filter out sediment and other pollutants. Together, these components will allow water to drain away from the road without negatively impacting water quality of the surrounding lakes and streams.

Learn more about our program



Dr. Rebecca Schneider
RLS11@cornell.edu



Visit Us At
www.clrp.cornell.edu



Cornell University

Your Ditch and You

What to know about your responsibilities as a land owner, and what you can do to improve your roadside ditch.



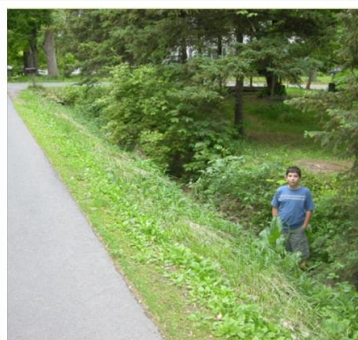
Less than 2 Feet Deep?

Mow or weed-whack your ditch, but keep at least several inches of plant growth. Consider planting flowers or attractive ground covers along the ditch slopes.

Pick up any trash that may have dropped from containers on collection day, or fallen from vehicles. Don't let it wash downstream.

Redirect gutter drains away from the roadside ditch, and into a rain garden so that rain can infiltrate underground and recharge the groundwater, instead of contributing to stream flooding.

If you are installing tile drains in your lawn or field, don't direct them to discharge into the ditch. Instead route them to a bioswale on site.



More than 2 Feet Deep?

Slightly widening your V-shaped ditch will allow re-configuring it into a trapezoid shape that allows mowing.

Maintain as well as you can safely.

Talk to your highway staff about options to reduce the depth, such as bioswales.

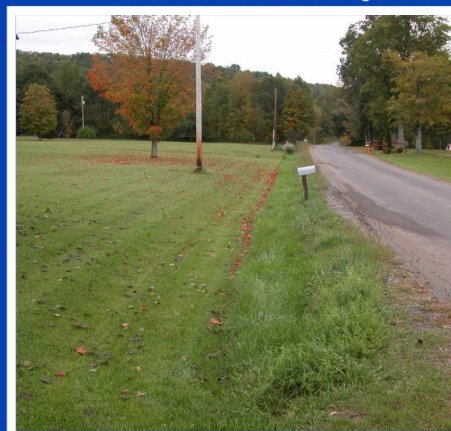
Reach out to your county's Soil and Water Conservation District staff to assist with funding repairs that will help reduce flooding and pollution.

What to do if my ditch is...

Your best plan of action depends on what your ditch looks like. Shallow ditches require some maintenance, but deeper ditches may require more extensive reconstruction.

If your ditch poses a safety hazard, and you are worried that you or someone else could be injured because of it, report it to your local highway department.

Pictured: shallow ditch with vegetation

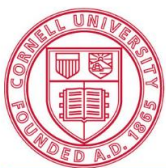


Keep in mind, your highway department is not able to prevent your neighbors from draining or damming water on their land and letting it impact the flow of water onto your property. Landowners have the legal right to alter water patterns to develop land.

Fact Sheet Design: A. Hancock

Photo credits: R.L. Schneider

Boardman Creek Survey Results



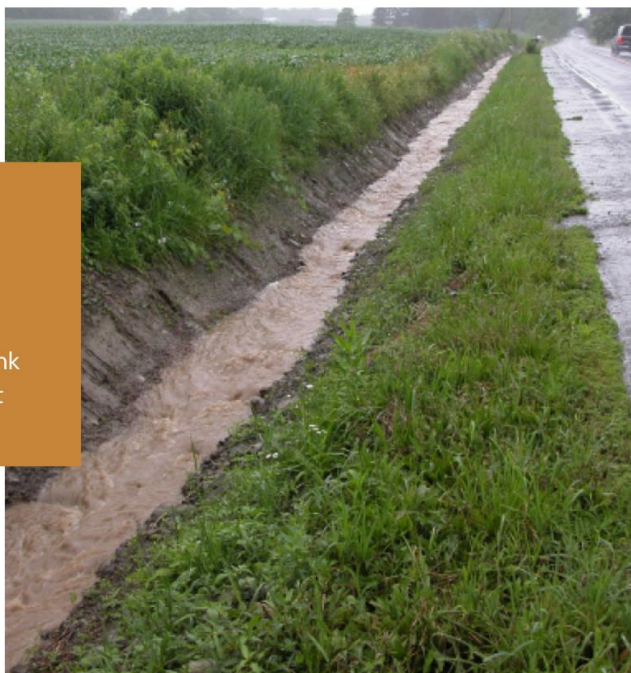
Cornell University

ROADSIDE DITCH SURVEY RESULTS

These graphs are the results of our landowner survey in the Boardman Creek watershed. Thank you for filling out your survey and your interest in learning more!

Thank you!

Your survey response is greatly appreciated! With your help, we are working to improve roadside ditches and water quality all over NY.

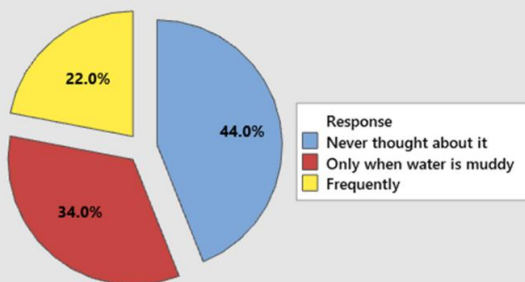


WHY ARE WE SURVEYING?

Ditches are often ignored in the discussion of improving water quality, but they actually play a vital role in preventing water pollution. When functioning properly, a roadside ditch can filter water, recharge groundwater, and keep roads safe for driving. When poorly managed (as seen on the left), they can contribute to flooding and water pollution, and can become dangerous. Best ditch management involves multiple stakeholders, including private landowners, like you, who own and interact with ditches on a daily basis. This survey helped us understand landowner perspectives on their ditches.

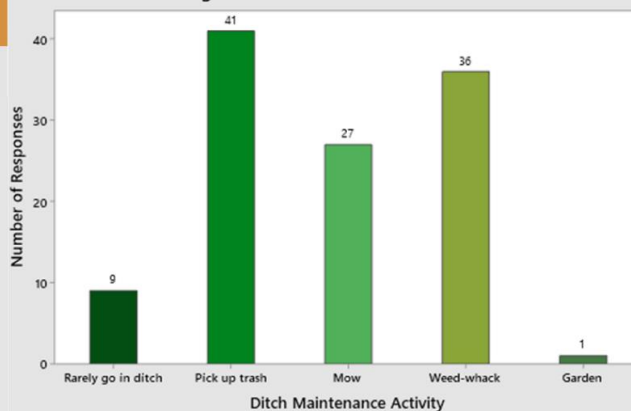
HOW DID LANDOWNERS RESPOND TO...

WATER QUALITY?



DITCH MAINTENANCE?

Which of the following activities do homeowners conduct in their ditch?

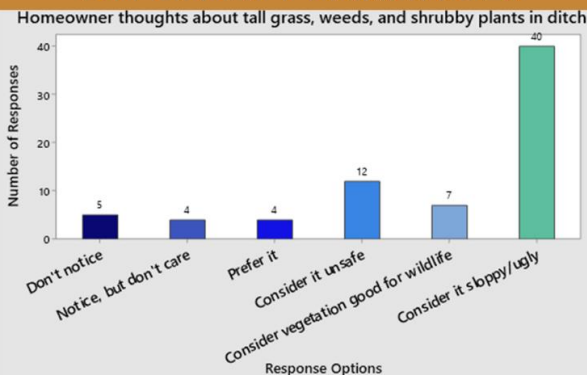


BIGGEST CONCERNS

Here is the list of ditch-related concerns identified by landowners around Boardman Creek. Of the provided options, people were most interested in **trash accumulation**. The most frequent write-in responses were about **blocked ditches** and **property flooding**.

- **55%**—trash accumulation
- **41%**—ditch flooding into the road
- **34%**—pollutants in the ditch
- **34%**—land eroding into ditches
- **26%**—ditches causing driveway/roadway collapse
- **26%**—ditches too deep
- **17%**—eroding ditches causing pollution
- **12%**—ditches are too shallow
- **10%**—had no concerns

DITCH APPEARANCE?



Our survey shows that landowners care a lot about their ditches and water:

- 56% think about ditch water quality
- 84% do some type of ditch maintenance
- 69% were interested in learning more about how to improve their ditches
- 34% are unsure of Right-of-Way width

WHAT WILL WE DO WITH THIS INFORMATION?

The information we've learned from this survey will help us to collaborate with town highway staff to find the resources they need to address all of our concerns and improve ditch management

WHERE TO GO NEXT



WHO WE ARE ROADSIDE DITCH PROGRAM

We are faculty and staff from Cornell University focused on improving roadside ditch management to reduce flooding, improve water quality, and keep our roads safe.



THANK YOU FOR YOUR SURVEY RESPONSE

We appreciate you taking the time to get back to us. In return, we will do our best to improve your ditches and water



Designed by A. Hancock



Dr. Rebecca Schneider
RLSTI@cornell.edu



www.SustainableWaterResourceManagement.info
<https://cals.cornell.edu/nysltap-local-roads>



HARMFUL ALGAL BLOOMS

Information for your visit to Cayuga Lake

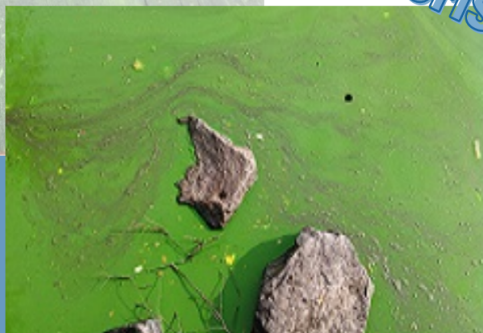


What are they?

Harmful Algal Blooms (HABs) happen when naturally occurring cyanobacteria populations grow to dangerous levels. At normal population levels, these organisms are harmless and invisible. At bloom levels, which generally happen in warmer water in mid to late summer, they form visible clouds and produce toxins that can be dangerous to human and animal health. Avoid going in the water when a bloom is occurring.

What do they look like?

HABs are generally recognized by the stripes they make in the water. Other possible appearances are pea soup, spilled paint, and green dots or clumps.



**TAKE PHOTOS!
REPORT BLOOMS!**

Created by
Adele Hancock

Contact Info

CLWN: www.cayugalake.org

CSI: www.communityscience.org

Poison Control: 1-800-222-1222

Report Blooms! Help us track by
emailing us at:

habshotline@gmail.com



What should I do?

- If you see a HAB, do not drink or swim in the water
- If you or a pet has been swimming in a bloom, rinse the water off with clean water, and make sure to wash your hands before eating
- If you begin to experience symptoms (diarrhea, vomiting, skin irritation, etc.) **seek immediate medical attention**
- Report water that looks suspicious—even if you aren't sure it's a bloom, it's better to report it, so a sample can be taken

The Owasco Lake HABs fact sheet was created for the course Dr. Schneider taught Spring '22, Water Resource Management in a Changing Planet. The assignment required a four-page fact sheet on a current water management issue. I selected Owasco Lake as the focus because of its long history of water quality issues, as well as water management programs to improve water quality. This fact sheet includes an explanation of HABs, their causes, non-point source pollution, and a series of recommendations for landowners in the Owasco Lake watershed.

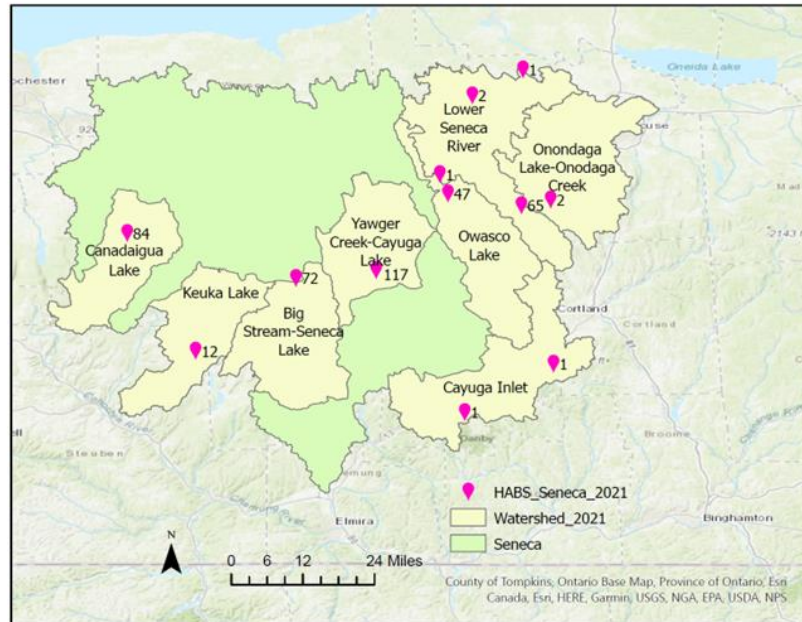
The Your Ditch and You and Boardman Creek Survey Results Fact Sheets were both created as part of my work on Dr. Schneider's roadside ditch research. These are planned to be sent out to residents of the Boardman Creek watershed in the towns of Covert and Trumansburg, who completed a survey in Spring of '22 asking questions about their roadside ditch's management and water quality. The Boardman Creek Survey Results explains to residents what the survey they answered found. The Your Ditch and You sheet explains to property owners what their Right-of-Way is and what ideal ditch management practices are then provides solutions to residents who find that their ditch management could be improved. This fact sheet is planned to also be sent out to the respondents of a similar statewide survey. At the time of writing, feedback from some stakeholders has not been received, so these fact sheets may be edited further before being mailed.

Lastly, the Short-Term Cayuga Lake Visitor was created as part of my internship with CLWN. This fact sheet is intended for the volunteers who participate in the HABs monitoring program run by CSI and CLWN, so they may print out these sheets and give them to visitors on Cayuga Lake. It provides salient information on what HABs are, why they're dangerous, and what to do if you encounter a HAB.

GIS

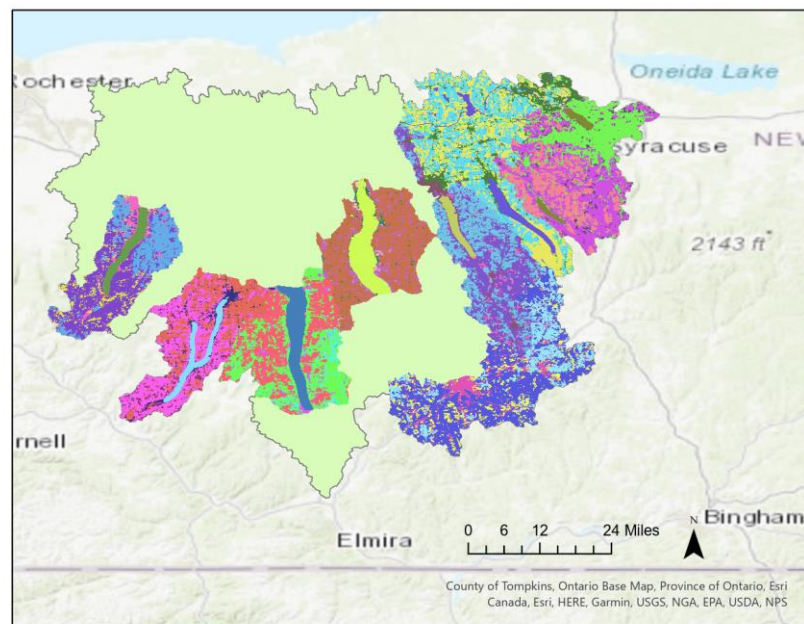
This GIS project was performed to see if there was an association between the Land Use Land Cover composition of a watershed and the number of HABs experienced by that watershed.

Seneca Watersheds with HAB Reports in 2021



Outlined sub watersheds with the number of reported HABs in 2021

LULC Rasters of Seneca Watersheds with HABs

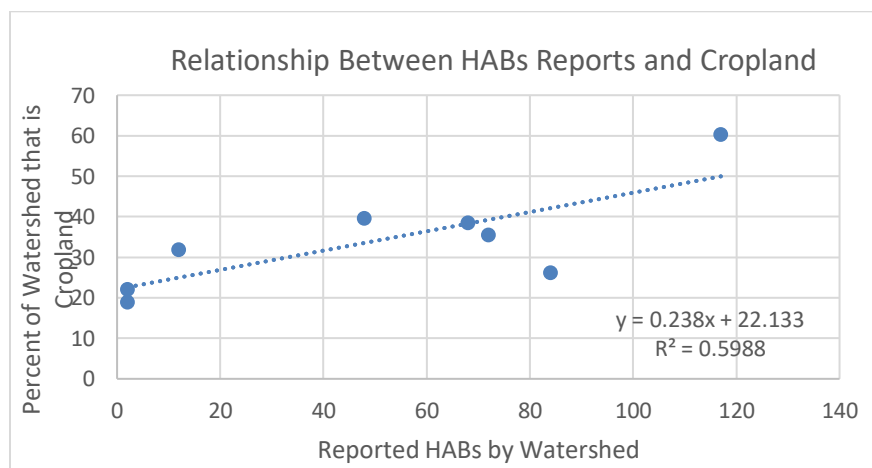


(Each of the 8 rasters has different coloring symbology)

Display of the land use types of each sub watershed

While GIS is a particularly useful for analysis and visual representations of data, this project does not function well as a science communication tool. Some of this is due to my rudimentary GIS skills compared to the task at hand, and some because the chosen comparison—LULC to HABs—is nearly impossible to connect as directly as described. The cause of HABs is more complex than just land use and there are far too many confounding variables to render this comparison useful. As for the maps resulting from this project, they’re very difficult to glean information from as a reader. The map showing LULC raster layers has no legend because all eight of the sub watersheds are shown in a different color scheme—as a result it is unlikely for someone viewing the map to understand what the colors mean without further explanation. The map of Seneca watersheds with HABs in 2021 is clear and does provide information for a viewer but is not accurate to what it is trying to represent. The sub watersheds used for analysis split some of the finger lakes into several segments, while a more accurate analysis would look at the whole watershed for each lake.

Ultimately, this project also had mostly inconclusive results. The analysis, a series of linear regressions of the relationships between HABs and land use types, showed that HABs were most associated with cropland, but not strongly associated with cropland.





This project would have been a much more successful science communication tool if the watersheds were adjusted to include the whole lake, maps were made with a lay viewer in mind, and the analysis adjusted for other variables.

SOCIAL MEDIA POSTS

Meet the Interns Series


Eden



EDEN LEWIS
Youth Outreach Intern

"For this summer's internship, I want to rethink and learn new ways of reaching young people. Historically and presently BIPOC communities are left out of conversations regarding climate change. My goal is to ensure that the Youth Outreach Plan allows all youth to feel valued and included in environmental and climate justice movements."

EDEN LEWIS
Youth Outreach Intern



Adele



ADELE HANCOCK
Community Outreach Intern

"As the Community Outreach Intern, I'm striving to strengthen and build new connections between the people living in the Cayuga Watershed and CLWN. I want to help people learn about what is happening in their watershed, and what they can do to help improve it's future."

ADELE HANCOCK
Community Outreach Intern



Maria



The “Meet the Intern” posts were made in conjunction with a “Meet the Staff” Series published by the Cayuga Lake Watershed Network on Instagram, Facebook, and CLWN Newsletter. In 2022, CLWN hired a new Steward/Executive Director, after around 15 years with the previous Steward. Between a new Steward and three new interns, it was important for us to familiarize the community with our faces and our individual missions. Of the interns, this was most important for Eden and me, as we interacted regularly with a lot of residents of the Cayuga watershed and wanted to make sure that our work was associated with CLWN’s efforts. In posting on social media, our goal was to reach the network of people who already followed CLWN’s activities, as well as grow the network’s community, hopefully reaching an expanded audience. For this series, each post was published to Instagram, added to the CLWN daily story, saved to a permanent ‘Meet the Staff’ story, and simultaneously published to Facebook.

Climate Smart Suggestions Series

Homeowner Suggestions Part 1



WATERSHED FRIENDLY?

Ways to make sure your home isn't contributing to pollution in Cayuga Lake.

Low effort lawns



Chose a style of lawn that requires less care. Consider plants that don't need mowing, fertilizing, pesticides, or insecticides. Fertilizer is a major factor contributing to algal blooms!

Septic Inspections



Getting your septic system inspected by professionals every 2-3 years ensures it's running as efficiently as possible and not leaking nutrients and bacteria into the streams and lakes.

Want to do more for the watershed outside your home?



Connect with the watershed network and learn how you can help!
www.cayugalake.org

Homeowner Suggestions Part 2

WATERSHED FRIENDLY?

How to adapt your home to climate change in the Cayuga Lake Watershed.

Water Saving Appliances



Install appliances that use less water than their counterparts. Low flow shower heads, faucet aerators, and grey water collection devices all help reduce how much water your home uses.

Reduce impermeable surfaces



The Cayuga watershed is experiencing more intense storms as the climate changes. Choosing grass pavers or rain gardens instead of pavement and lawns can prevent flooding on your property.

Want to do more for the watershed outside your home?



Connect with the watershed network and learn how you can help!
www.cayugalake.org

Renter Suggestions

DID YOU KNOW?
There are steps you can take to protect water and conserve energy at home, whether or not you rent or own!

Energy and Water Conservation
Taking shorter showers and installing low-flow shower heads reduces water and energy use at home!

Short Showers
If you are on the public sewer system, your wastewater goes to a municipal treatment plant which uses lots of energy to clean that wastewater, so save energy by using less!

Low Flow Shower Head

When doing laundry, fill up your washing machine instead of doing smaller loads, and wait to run your dishwasher until it's full.

Fill 'em up!
Keep polluting chemicals out of your drains. Wastewater treatment is not perfect, and some chemicals still make their way into the watershed.

Don't drain dump

Want to do more for the watershed outside of your home?

Cayuga Lake Watershed Network

Connect with the watershed network and learn how you can help!
www.cayugalake.org

This series on “Climate Smart Living” is a rehashing of a worklet published by CLWN in 2021, titled “Watershed Living in a Changing Climate”. Climate change has already begun to impact the Cayuga Lake watershed, and the changes experienced by residents will only become more noticeable. Most notably, the region is experiencing more large precipitation events, leading to extreme runoff events, meaning the impact of land management is even higher on water quality. Much of these suggestions were first posted in the Climate Smart worklet as methods of preparing for how the watershed is expected to change but are also general

suggestions for preventing pollution and reducing energy and water usage. Water is not a rare commodity in this region, but we want to encourage residents to use less, as it is still a use of energy and provides more potential to introduce pollutants to our water sources.

It was also important in this series that renters were included, as they were not included in the worklet. Much of the watershed network's work focuses on the actions of homeowners, particularly those who live on lakefront property. This is a relatively small group of people, and in particular a group of people that can often afford to make large changes to their property to support watershed health. Renters in the watershed may not have the same ability to change their property, or financial means to change as much about their habits. As such, it was important to not just create content for renters in the watershed, but feasible suggestions. These posts were published to Instagram, and it should be noted that, while not visible in this document, the first slide in each of these is animated so that the speech bubble moves back and forth.

PILOT PROJECT

Proposal

Proposed Pilot Outreach Campaign for the Town of Ulysses Highway Department

Overview

The Cayuga Lake Watershed Network in collaboration with Rebecca Schneider at Cornell University, is proposing to develop a campaign to familiarize town residents across the watershed with their highway department staff. As a first step, this pilot is proposed for the Town of Ulysses, Tompkins County, to investigate the best plan of action for developing a larger campaign throughout the watershed. We are proposing to develop and execute this campaign in collaboration with Ulysses Town highway department staff. This goal of the campaign is to increase awareness in town residents of the critical support provided by town highway staff in management of roadside ditches, both for roads and water resources, as well as other critical services including emergency response during flooding and other crises. Highway departments have a large breadth of responsibilities of which most town residents are largely unaware. With chronic underfunding at the state and federal levels, increased public support at the local level could benefit highway departments and town residents alike. We believe that it is critically important that residents know more about their highway department, so that they become more willing to support their needs in the future. By building communication between these groups, water quality can be improved by collaboration, instead of allowing it to continue to degrade from lack of support.

Background

Roadside ditches are an often ignored, but major contributor to degraded water quality and flooding in NY State. Ditches can collect approximately 22% of the stormwater runoff in a

rural watershed and rapidly transfer that water to nearby streams, contributing to increased flooding. Along with the water, ditches capture and transport various types of pollutants collected along the way and shunt it rapidly to downstream rivers and lakes (Buchanan et al., 2013). Research indicates they collect sediment, nutrients, bacteria, and trash from the surrounding land. When best management practices are used, ditches can keep this pollution out of waterways, trapping sediment, filtering nutrients, and allowing water to be absorbed back underground where it can recharge groundwater. However, when best management practices aren't followed, roadside ditches can contribute to worsening water quality by eroding ditch banks which increases sediment pollution in the runoff, and by transporting pollutants rapidly to drinking water supplies. When NY highway staff were surveyed in 2014, almost half of the respondents reported that scraping ditches (without reseeding) was their primary management technique, leaving an estimated one third to one half of the ditches below good quality (Schneider et al., 2019). Given the more than 110,000 miles of town roads across NY, this finding suggesting that as many as half of the ditches in NY are polluting fresh water with soil, nutrients, road salts, *E. coli*, or other pollutants can mean serious degradation in water quality.

In the past 50 years, there has been a significant increase in extreme precipitation events in the Northeast—the heaviest 1% of precipitation events have increased over 50% in size (DEC, 2021). The average precipitation overall is slowly increasing, but the patterns of weather have changed much more dramatically, and now intense rainstorms test the abilities of current stormwater infrastructure to drain away from roadways. As these storms increase in severity, it becomes even more imperative that roadside ditches are efficient and functional at keeping roadways passable and residents safe. To improve ditch management, the Cornell Local Roads Program has an established outreach program for highway staff through the Annual Highway

School held in Ithaca, NY. There has been a growing discussion of best roadside ditch management practices during the trainings, making more highway superintendents aware of the contribution of ditches to water quality in lakes, streams, and rivers. However, there is currently little outreach for homeowners, who are also important stakeholders in ditch management through the tax base that supports the highway department as well as their cooperation in maintaining ditches along their own property.

The largest barrier identified by highway staff to the improvement of ditches was a lack of resources (Schneider et al., 2019). A second identified barrier was the Right-of-Way which is the strip of land adjacent to the road where the ditches are located – but in towns, this land is owned by the private landowner. Since town highway departments are funded through local taxes, it is important for private landowners to understand the critical connections between their ditches, highway practices, and water resources. We recently conducted two pilot surveys of private landowners concerning their awareness and attitudes about the roadside ditches on their property and the Right-of-Ways that encompass them. Our first survey of Tompkins County landowners had a 38% return rate, with responses from 120 residents. A second smaller survey was conducted just in the watershed of Trumansburg Creek, which runs through the Town of Ulysses and the Village of Trumansburg, before discharging into Cayuga Lake. The second survey had 56 respondents, a higher 48% return rate, with many similarities to the findings from the first survey. Specifically, in both surveys, landowners were generally uncertain about the width of the ROW and who was responsible for management. However, they cared about the appearance of their ditch, entering to remove trash and mow or weed whack. Landowners knew how their ditch was connected after it left their property but had rarely thought about the water flowing through it. Most landowners were concerned about pollution. In the first survey, 51%

indicated they would be willing to increase their taxes by 0.5% or more to support better ditch management, and 60% supported widening their ditch to improve ditch management. In the 2nd survey a slightly smaller percentage, 53% were unwilling to increase their taxes to support their highway department, but 56% also indicated that they think about the water quality in their ditches. Implementing best management practices such as filling in overly deep ditches and reseeded bare ground requires time, money, and effort from the highway departments. The larger survey across Tompkins County also found that 55% of respondents do not know who their highway staff are and have never interacted with them (Bonnier-Cirone 2022 in prep). To increase public support of highway departments town residents must be aware of the issues and how they can help.

Goal

Our goal is to build awareness and relationships between highway staff and the town residents who rely on them. As we develop outreach to both highway staff and homeowners, we want to ensure that the two work in cooperation, not separately, towards the goal of ditch stewardship. To do this, we need to find ways to facilitate the interaction between members of the public and those responsible for highway management.

Methods

To facilitate this conversation, we will create opportunities for town residents to learn about who the highway staff are in their town, what their responsibilities include. As a first step, we propose meeting with the Highway Supervisor to explore messaging and communications options. We also propose working with the Town Supervisor to explore using existing social media, including the town website and weekly digital newsletter. A larger communications campaign could include billboards, social media ads, radio interviews, and/or other advertising

tools. Another possible component of our outreach would be to conduct a series of open meetings, with the goal of introducing highway staff to people, and encouraging them to ask for more support from the town. The approach will be developed in cooperation with town officials and staff.

Through this campaign, we will encourage public interest in who maintains roads and ditches as well as other critical roles of the highway department staff. For example, we may advertise highway staff as ‘water stewards’ due to their part in ditch management, so that people may think more about how far reaching the actions the highway department are. We also want to highlight the key role that highway departments play in emergency response, like road closures. Highway departments have such a large breadth of responsibility that town residents are unaware of, and with years of the US underfunding highway departments on all sides, we see an important opportunity to strengthen support by town residents.

Progress

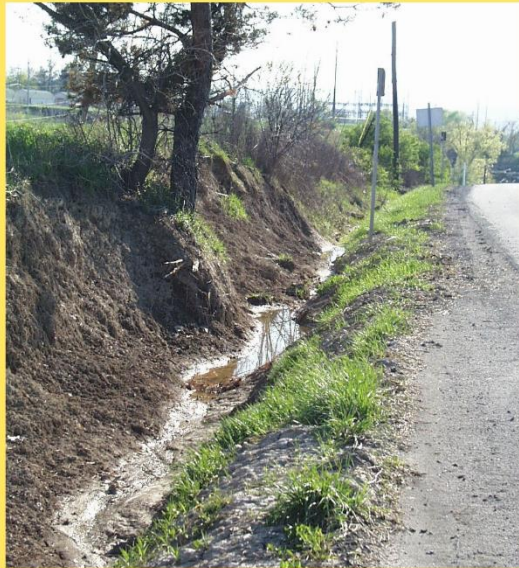
At the time of submitting this portfolio, this proposal has been seen by the Town Planner and Highway Superintendent. CLWN hosted a meeting with the Highway Superintendent, who was interested in doing this project with us. I presented on this proposal as part of the Watershed Internship Program (WIP) hosted by Discover Cayuga. Several water focused organizations and businesses in the Cayuga Lake Watershed sent interns to participate in this program, in which we learned how to best engage our community in watershed protection. Below is the poster used for

this presentation.

**Watershed
Internship
Program
by Discover
Cayuga**

**Summer Intern
Presentations**

Adele Hancock:
A proposal for a
public relations
campaign for the
town of Ulysses
Highway
Department. Used
to increase the
resources available
to the town
highway staff, so
that ideal ditch
management can
take place in the
Cayuga
Watershed.



The proper maintenance of roadside ditches is critical to the improvement of water quality on Cayuga Lake and prevention of Harmful Algal Blooms (HABs). On the left, we have a photo of a poorly managed ditch, and on the right, a ditch managed for watershed health. While important, it isn't always a simple or viable option for highway departments to maintain ditches in this manner.

ROADSIDE DITCHES

DISCUSSION

In the past year, I have developed this portfolio in the interest of preventing HABs in the Finger Lakes. The variety of methods and topics in these science communication devices and outreach projects were used to create a diverse body of work that would work to resolve the issue in several places at once. As mentioned before, the cause of HABs is complex, so it is not advisable to pick one single issue to focus on, when so many issues must be addressed to successfully prevent HABs. As I continue working for both CLWN and Dr. Schneider, I will continue to develop some of these projects, as well as create new projects with the same focus on preventing HABs.

In the future, it would be ideal to continue this work alongside some analysis of the effectiveness of each technique. If some methods of outreach and communication are noted as distinctly successful or unsuccessful, it can be used to adapt the prevention strategy to the best use of time and energy. HABs are dangerous and detrimental to the Finger Lakes, so it is imperative that work done to prevent HABs is done effectively and efficiently.

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