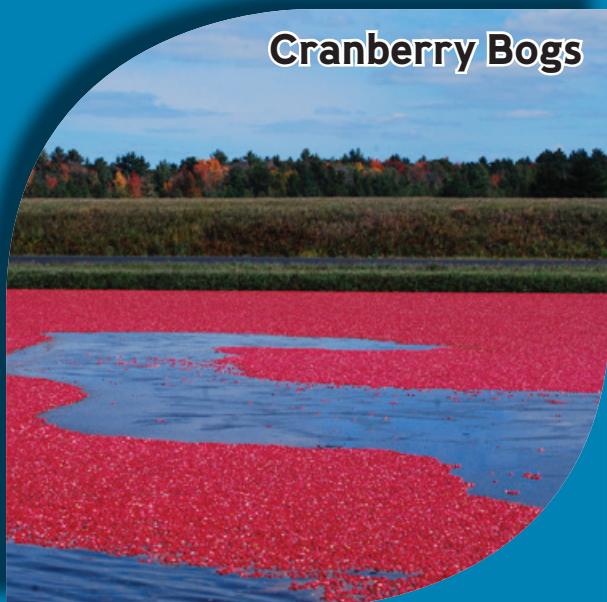




COALITION Quarterly

NITROGEN REMOVAL PILOT PROJECTS: Where, Why and How?



BCWC Annual Open House
on June 27th , see page 7
BCleanWater.org

A Note from The Helm

We now have almost two years of weekly, in-depth monitoring data on the Three Bays Watershed, which is the Town of Barnstable's most troubled watershed. While concerning, this data provides a baseline of information, which can be used to assess the performance of various nitrogen removal pilot projects we are working to install and test throughout the watershed.

This newsletter's focus is on four of the pilot projects we are most excited about implementing. Each project was designed and selected as a direct result of the monitoring we have done to date married with consultation with our scientific partners. Together these nature-based approaches should help us create a roadmap to allow this watershed to move from worst to first, the first one to use such a collection of alternative treatment systems.

The approach we are taking is unique and holds promise for other Cape watersheds, as well as for degraded waters nationwide and around the world. This potential is why we have garnered the attention of, and partnership with, both the U.S. Environmental Protection Agency's Office of Research and Development (U.S. EPA) and The Nature Conservancy (TNC).

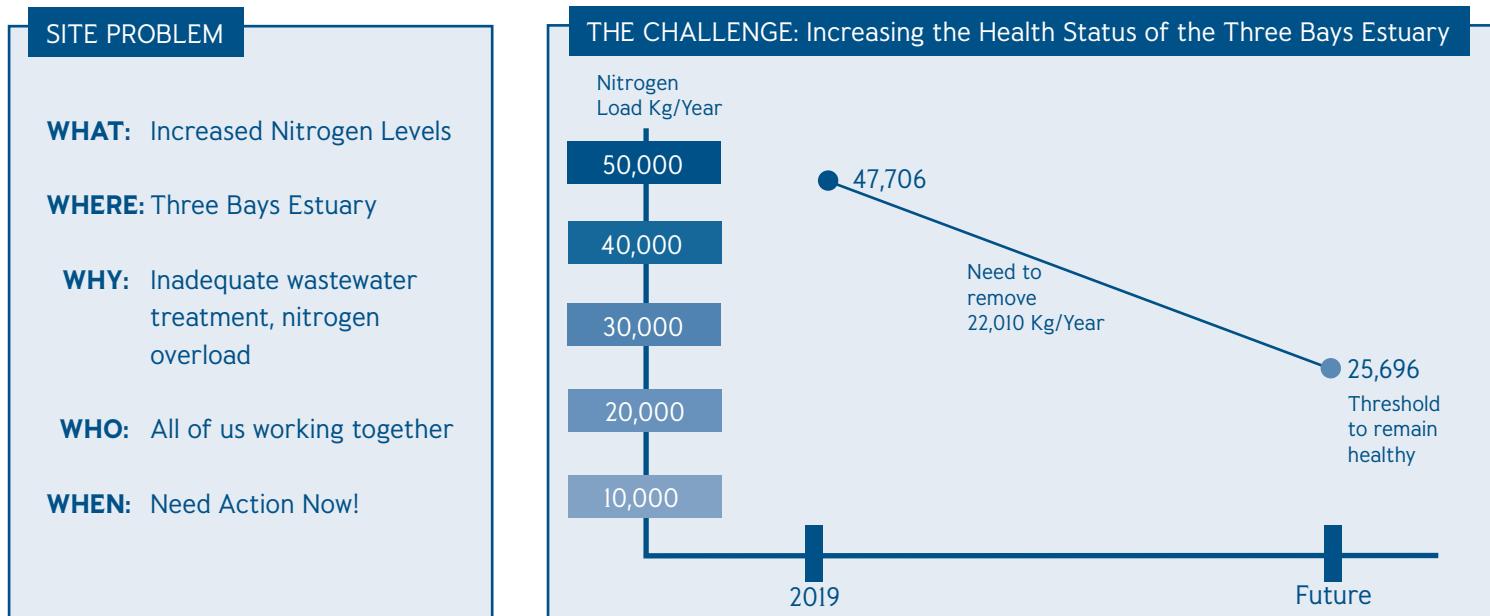
Our upcoming Annual Open House features a panel with representatives from the U.S. EPA and TNC discussing why they are working here in Barnstable in the Three Bays Watershed.



The format will allow time for your questions and it will also feature the head of Barnstable's Department of Public Works discussing the Town's overall water and wastewater plan. This will illustrate the important potential for "nature-based" approaches as part of the Town's comprehensive plan.

The solution to this nutrient problem really comes down to a math equation. The next page illustrates the "Arithmetic" of the Three Bays Watershed.

I hope to see you on the water this summer!

A handwritten signature in black ink, appearing to read "Eric".

ARITHMETIC of Three Bays Watershed

Twenty years ago, the scientists at UMass Dartmouth's School of Marine Science and Technology (SMAST) began a study of all the estuaries on the Cape and Islands, the Massachusetts Estuary Project (MEP), at the behest of the State. The models involved in this work are still relevant today and a portion of this model is illustrated in Table 1 for the Three Bays estuary.

The model shows an annual nitrogen load of almost 48,000 kg, and a "threshold" of almost 26,000 kg. A threshold illustrates how much nitrogen an estuary can naturally accommodate while remaining healthy (and to comply with the Clean Water Act). Too much nitrogen leads to algal blooms, fish kills and worse.

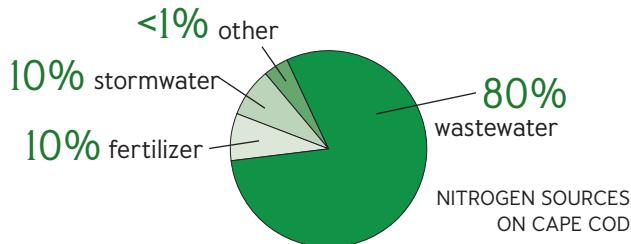
To maintain the overall health of the Three Bays estuary, you can see that approximately 22,000 kg of nitrogen must be removed annually. Table 1 also shows a breakdown of how much nitrogen needs to be removed from each waterbody in order to achieve stability. Keep in mind that this breakdown is not one to one math. Each waterbody needs to be addressed, as they are all connected.

Nitrogen in the Three Bays

existing nitrogen load **47,706 Kg/yr**

target removal **22,010 Kg/yr**

nitrogen reduction target **46%**



Marine waters

Estuarine - brackish waters

Groundwater - freshwater lens

TABLE 1

	Existing Load Kg/year	Threshold	Reduction Required
North Bay	10748	1631	9117
Prince Cove	4877	792	4085
Prince Cove Channel	2021	281	1740
Warren's Cove	4390	1844	2546
Marstons Mills Crescent	2662	1358	1304
Marstons Mills River	5299	4380	919
Little River	1446	1446	0
Cotuit Bay	7949	6707	1242
West Bay	6960	5829	1131
Total Three Bays	47706	25696	22010

Table 2 shows the main sources of nitrogen, including an estimated amount of nitrogen flowing from cranberry bogs into the Marstons Mills River, which delivers freshwater (and nitrogen) directly into the estuary. The bogs and the river act as a collection basin and delivery system for nitrogen flowing through the Three Bays Watershed. In this case, the nitrogen does not come from the bogs themselves, but rather from the thousands of septic systems which contribute to the groundwater naturally flowing into the bogs and river.

TABLE 2

	Existing Load Kg/year	
Nitrogen per person	1.9-2.3	Kg/year
Urine component of Wastewater	80	percent
Nitrogen per horse	40	Kg/year
Fertilizer Application Rate	3	Ibs/1000 SF-year
Fertilizer Export/Leaching	25	percent of applied
Fertilizer Attenuation	75	percent of applied
Stormwater Runoff	1.5	mg/liter
Cranberry Bog Outlet	8186	Kg/year

Nitrogen Removal Pilot Projects

INNOVATIVE/ALTERNATIVE (I/A) SEPTIC SYSTEMS

Targeted nitrogen removal rate: 75-90%

The best way to reduce nitrogen is at the source, whether it be residential or commercial wastewater treatment. Only municipal systems (sewering) or new, advanced on-site treatment systems can remove nutrients to the standards required to achieve the “threshold” levels shown in Table 1 on page 3. In practice, we will need a combination of traditional and new treatment approaches. Economics and geography will dictate different treatment methods within our watershed and other watersheds on the Cape.

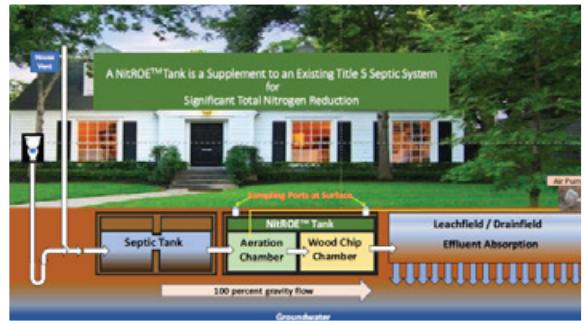
The Cape is home to a unique resource, the Massachusetts Alternative Septic System Test Center (MASSTC). This is a leading test site for innovative septic systems in the U.S. and worldwide. Currently, MASSTC is testing individual alternative systems that perform as well as best in class municipal systems. The success of these systems may allow us to deploy solutions where they are needed most: near our threatened estuary.

We plan to work closely with MASSTC, Mass Department of Environmental Protection (DEP), U.S. EPA and the Town of Barnstable to create a pilot program where we can monitor and track I/A systems in a real-world environment in our watershed. In addition, we are working with The Nature Conservancy to develop a financing plan to create a roadmap for widespread replacement of Title 5 septic systems with these alternative technologies.

MILL POND

Targeted nitrogen removal rate: 25-50%

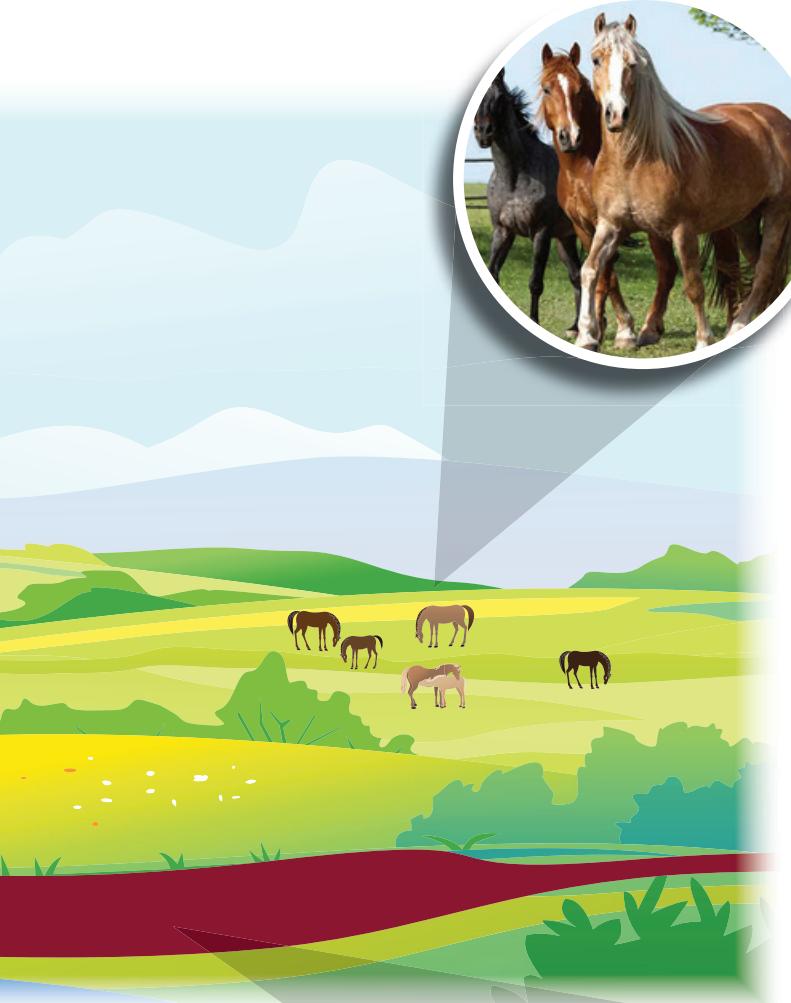
Mill Pond, located near the mouth of the Marstons Mills River, was once 8 to 12 feet deep. Today, it is only inches deep after being filled in with over 300 years of accumulated organic matter. We are working with the Town of Barnstable to develop an engineered restoration project for the pond, which includes dredging. The goal is to restore the pond to allow for natural attenuation of nitrogen, which occurs in ponds and lakes across Cape Cod.



Freshwater which is loaded with nitrogen will gasify naturally depending on certain conditions. Longer residency times allow these natural processes to occur. What does this mean? Because Mill Pond is so shallow, the water moves straight across the pond like a stream. Once the pond is dredged and deepened, the water will stay in place and circulate for up to a week. Almost half the excess nitrogen in our watershed passes through Mill Pond, so this effort could allow thousands of kilograms of nitrogen to naturally and harmlessly turn to gas. Most ponds on the Cape see nitrogen naturally reduced by 50 to 80%. Currently, Mill Pond only sees a reduction of 12 to 13%, because there is virtually no residency time for the water.

The planned, engineered restoration project should remove approximately 50,000 cubic yards of material from Mill Pond and increase residency time by almost 100-fold. Once the pond is restored, our scientists forecast a dramatic reduction in nitrogen entering the Three Bays estuary.

Seventy-eight percent of the Earth's atmosphere is comprised of nitrogen gas. In its gaseous form, nitrogen is harmless to the environment. Our pilot project efforts are focused on turning liquid nitrogen into gas using approaches borrowed from natural processes. We already rely on algae, bacteria and plants that live in our wetlands and ponds to naturally convert nitrogen to nitrogen gas. For systems that have become overloaded and unbalanced, like the Three Bays estuary, we are using nature to create a natural treatment system. Enhancing this natural cycle in freshwater ponds and cranberry bogs is one approach. A "wood chip bioreactor" sounds complicated, but in practice we are providing bacteria that "respirate" liquid nitrogen with the carbon source (wood chips) they need to grow. The bacteria convert the nitrogen into harmless gas. These nature-based approaches are what we plan to use for our alternative septic systems and horse farm projects.



CRANBERRY BOGS

Targeted nitrogen removal rate: 50-80%

The headwaters of the Marstons Mills River contain approximately 150 acres of cranberry bogs. We have been collecting water quality data at the bogs that shows more than 8,000 kg of nitrogen flows out from them into the Marstons Mills River each year. Most of this nitrogen originates from septic systems that discharge to groundwater that then flows into the bogs. The bogs contain wetlands and on old maps, the entire site was marked "ponds and wetlands". This is a collection area for the groundwater from much of the surrounding residential developments. Interestingly, the farmers tell us that while they used to apply fertilizer, little is now needed since the crops do well without needing additional nitrogen fertilizer.



This makes sense when we examine the results of our monitoring. Approximately 40% of the watershed's excess nitrogen load flows through the bogs and into the Marstons Mills River.

Our new understanding is that the bogs could play a vital role in reducing this same nitrogen load in our watershed. We are working closely with the farmers to examine a series of pilot programs that would allow for significant nitrogen attenuation to occur without negatively impacting their farming of the bogs. Wood chip-based bioreactors are just one of the half dozen pilot projects we are planning to install and test in these bogs.

HOT SPOTS: ONE EXAMPLE

Targeted nitrogen removal rate: 50-80%

We sample the freshwater flowing through the cranberry bogs and in the Marstons Mills River at 16 locations on a weekly basis. The river and its surrounding areas account for more than 50% of the nitrogen load entering the Three Bays estuary.

Our monitoring has led us to discover several "hot spots" along the river's course. The most troubling hot spot is a horse farm with 8-10 horses. Table 2 shows that one horse's liquid waste produces as much nitrogen as 20 to 40 people. During a heavy rain event, the monitoring just downstream from this farm revealed a nitrogen level six times the normal level recorded at this site. The river flow was also three times higher than normal.

Essentially, this one location may be contributing approximately one month's amount of nitrogen within hours.

We have consulted with scientists and engineers from the U.S. EPA, UMass, and Horsley Witten Group to develop and install a wood chip-based bioreactor that is designed to significantly reduce the nitrogen flow from storm water.

Field Notes from Meg

Introducing BCWC's AmeriCorps Member – Katie Evans

For the past 20 years, AmeriCorps Cape Cod has been serving the Barnstable County community and its residents. Barnstable Clean Water Coalition was lucky to be assigned Katie Evans as our AmeriCorps member for the 2018/2019 season.

Every Thursday, Katie has been tasked with tackling our weekly streamflow monitoring and water sampling along the Marstons Mills River. Katie wades out into the river and gathers streamflow measurements, water temperature, and water samples from 11 stations to determine how much nitrogen is flowing through the river and into the Three Bays estuary. This field work has been done in all weather conditions, including below-freezing temperatures and pouring rain!

Katie grew up in Rancho Santa Margarita, California with her parents and three brothers. She graduated from UCLA with undergraduate degrees in Geography and Environmental Studies. This fall, Katie will be attending the University of North Carolina Chapel Hill's Urban Planning graduate program with the hope of eventually returning to her West Coast roots in California where she hopes to

make a difference for the environment.

When she is not on AmeriCorps duty, Katie enjoys spending time with friends, listening to music, and reading. Her favorite part about living on Cape Cod is that she is always close to the beach.

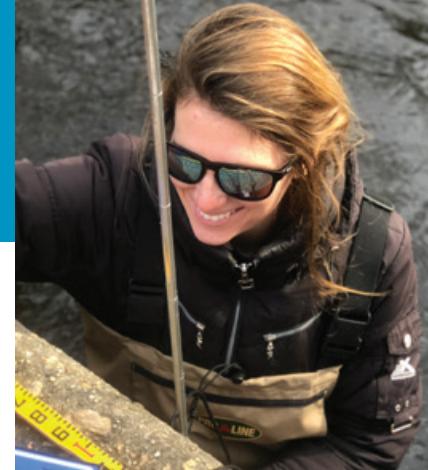
BCWC thanks Katie and wishes her lots of luck on her next adventure.

AmeriCorps Cape Cod member Katie Evans collecting streamflow measurements in the Marstons Mills River

2019 Marstons Mills River Herring Count

Volunteers from BCWC and Barnstable's Department of Natural

Resources were ready to start their annual count of fish at the Mill and Middle Pond fish ladders on Monday, April 1st. Throughout the state of Massachusetts, there are 100 herring runs located in 48 towns. Per the direction of the Massachusetts Division of Marine Fisheries, the counting of river herring at these runs begins every year on the first day of April.



River herring spend their winters offshore in marine waters prior to moving into estuaries in early spring. Alewives are the first species to begin migrating upstream to spawn in freshwater habitats when water temperatures reach 51°F. We don't typically see herring at the Mill and Middle Pond fish ladders until mid-April. Imagine their surprise when volunteers spotted alewives traveling up the fish ladder and crossing into Mill Pond on the very first day of counting. Water temperatures were already over 51°F in the river at the beginning of April.

The herring continued to run strong throughout April and into May. Water temperatures continued to climb and by mid-April were over 57°F, which is optimal for the second species of river herring, bluebacks, to begin their migration.

By late-May, over 60 dedicated volunteers had counted over 4,500 herring at the Mill Pond fish ladder and over 2,400 herring at the Middle Pond fish ladder. These numbers far exceed the total 2018 count of 1,567 herring for the entire Marstons Mills River. We are hopeful that this year's increase in alewives and bluebacks is indicative of a rebound in the river herring population throughout Massachusetts.

BCWC wants to thank all the dedicated volunteers for standing outside daily from 7am to 7pm counting fish and collecting data in all weather conditions. Great job everyone!

Are you ready to volunteer your time for clean water? Visit BCleanWater.org to learn more and get involved today!



Get Involved #CleanWaterMatters – Upcoming BCWC Events

3rd Annual Barnstable Clean Water Coalition Open House Thursday, June 27th, 5:00pm to 7:00pm, Wianno Club, 107 Sea View Avenue, Osterville

Please join us for our annual open house to learn more about our work and an update on our upcoming nitrogen removal pilot projects with a panel of speakers including Dan Santos (Barnstable Department of Public Works), Tim Gleason (U.S. Environmental Protection Agency Office of Research and Development) and Alison Bowden (The Nature Conservancy). Light refreshments and beer/wine served.

Discover Barnstable! Talks Monday, July 8th and Friday, August 23rd, 4:30pm to 5:30pm at Bismore Park, Hyannis Harbor

Shelled Superheroes: Come discover the amazing array of shellfish that live beneath the waters of Barnstable with Shellfish Technician Elizabeth Lewis. Then visit a nearby oyster upweller with Heather Rockwell of Barnstable Clean Water Coalition and learn how these shelled superheroes are being grown and used to improve our local waters.



2nd Annual Clean Water Challenge Golf Tournament Monday, August 26th, 8:00am, Oyster Harbors Club, Osterville

Please join BCWC friends and supporters for a day of golf, lunch and awards at one of Cape Cod's exclusive courses.



9th Annual Paddle for the Bays: RACE Cape Cod Saturday, September 14th, 9:00am to 3:00pm, Oyster Harbors Club, Osterville

All paddleboarders and kayakers, individuals and relay teams, welcome! Beach Party with barbecue, live music and more!!



For more information on BCWC events or to register, visit BCleanWater.org



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Mission Statement

Barnstable Clean Water Coalition works to restore and preserve clean water in Barnstable. BCWC utilizes science as its foundation to educate, monitor, mitigate and advocate for clean water.

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#CleanWaterMatters

Thank you for joining us in the Race for Clean Water

Clear skies, great beer, yummy food, groovy music and over 700 participants made the 4th Annual Cape Cod Beer Race to the Pint an amazing event!

Thanks to all the runners, walkers, spectators, volunteers, staff and sponsors for making the day a huge success.

A special thank you to Beth and Todd Marcus and their Brew Crew at Cape Cod Beer and Pat Lentell of SEMC Sports for their incredible support of BCWC and our work to restore and preserve clean water.



We Are Always in the Race for Clean Water! Please support BCWC today with a donation in the envelope provided or online at

BCleanWater.org