WATER QUALITY OF FOUR ESTUARIES

IN COASTAL STONINGTON & MYSTIC, CT

2014

CUSH, INC.

CLEAN UP SOUND & HARBORS

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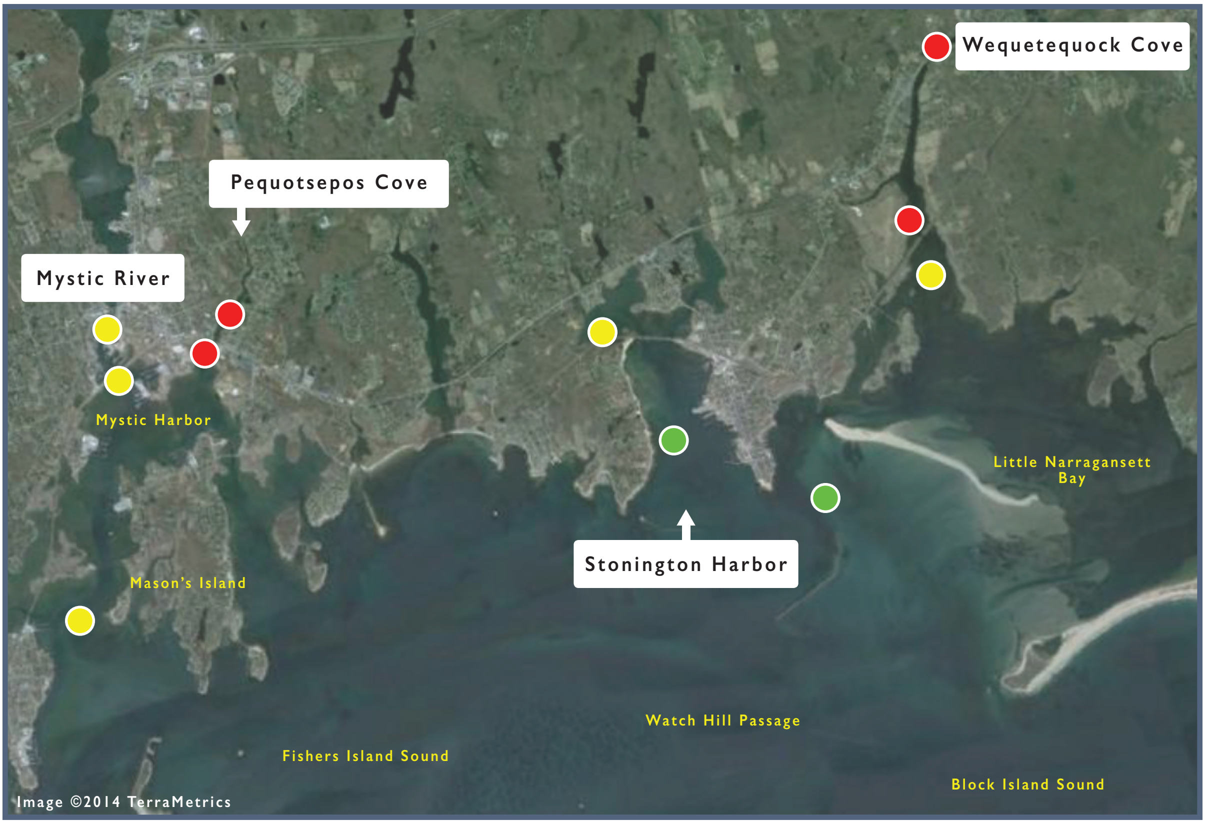


= GOOD = FAIR = POOR

CUSH ESTUARY MONITORING SITES

This report adds monitoring results for 2014 to those contained in our previous report, "Water Quality of Four Estuaries in Coastal Stonington and Mystic Connecticut, 2008-2013" (available at http://www.CUSHinc.org). The purpose of our monitoring program is to assess the current and long-term health of local waters, to identify any ongoing trends, and to track identifiable sources of pollution. Our methods and quality control are those developed by the University of Rhode Island's Watershed Watch (URIWW) program (http://www.uri.edu/ce/wq/ww).

MAJOR FINDINGS

In all CUSH sites except those in tide-dominated outer Stonington Harbor, overall Aquatic Health Index scores declined between 2013 and 2014. The decrease was driven primarily by high levels of chlorophyll-a and especially of dissolved inorganic nitrogen. In some sites, oxygen saturation also declined.

NEW IN 2014

As CUSH volunteers continued to monitor local waters in 2014, we took some steps to refine our ability to characterize the water quality of our four local estuaries: Stonington Harbor, Mystic River, Pequotsepos Cove, and Wequetequock Cove. To test the reach of tidal flushing, the Lambert's Cove site was moved from the east end of the Cove, which receives the full force of strong Harbor flood tides, to the more sheltered west end. After two years of sampling closer to shore at Murphy's Point (Brewer Yacht Yard), CUSH decided that the original location, near the outfall of the Mystic sewage treatment plant, provides more useful information. In Old Mystic, we added a Whitford Brook site just downstream from its confluence with Haley Brook, to evaluate the major source of fresh water to the Mystic River. And we report on recent conditions in Oxecosset Brook at Route 1, a Wequetequock Cove feeder stream monitored since 2013.

THE AQUATIC HEALTH INDEX

To describe and compare the water quality of each site, we use the Aquatic Health Index (AHI), developed for New England waters by the Buzzards Bay Coalition (MA) and the Salt Ponds Coalition (RI). Based on summer measurements of dissolved oxygen, organic and inorganic nitrogen, and chlorophyll-a as a measure of microscopic algae, each site is assigned an overall AHI score between zero and 100, the worst to the best (Callender, 2008). Zero represents severe degradation (very <u>high</u> nitrogen and algae, very <u>low</u> oxygen) that is harmful to aquatic life, while 100 represents excellent water quality fully supporting abundant and diverse aquatic life. Scores above 65 are considered Good, those below 35 Poor, and those between 35 and 65 are Fair.

WATER QUALITY INDICATORS

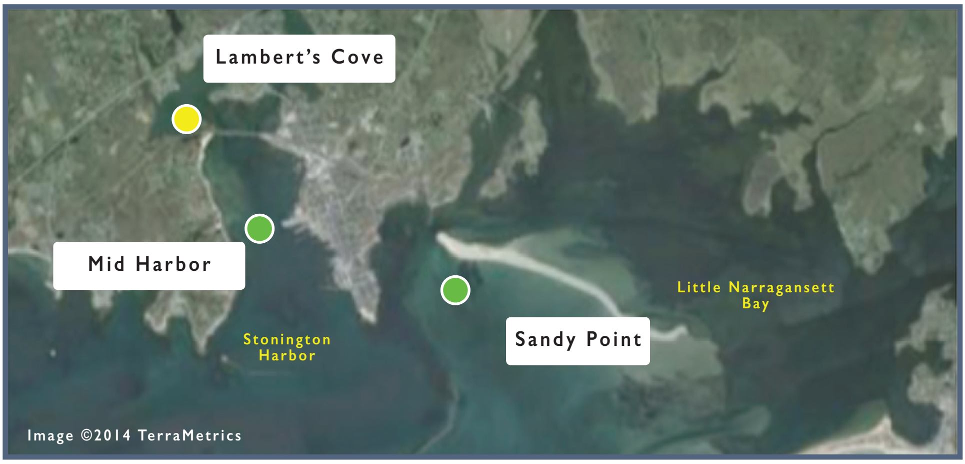
Dissolved inorganic nitrogen (DIN) often reaches coastal waters in runoff carried by fast-running tributaries. In the relatively warm, calm waters of coves and inlets, the DIN fertilizes microscopic algae, which are detected by measuring the *chlorophyll-a* they produce. *Organic nitrogen* is nitrogen that is, or once was, part of a living organism; it may originate either in the sediments or in runoff containing leaves, grass clippings, dead plants or animals, animal droppings, or sewage. Algae represent organic nitrogen produced within the embayment in response to DIN entering from the land. Dissolved oxygen is essential for most aquatic life and is a measure of how well the ecosystem can resist the damage done by nitrogen and algae (Buzzard's Bay report, 1992-1998). Because warmer and saltier water holds less dissolved oxygen than cold, fresh water, the measured oxygen concentration is expressed as *percent oxygen saturation,* the amount a sample actually contains compared to the most it could hold at its temperature and salinity. We also include water-quality standards for dissolved oxygen itself, and we track fecal bacteria, which can contaminate shellfish and close swimming beaches.

CONCLUSION

When the upper reaches of narrow, shallow coves are deprived of both fresh and salt water, pollutants and sediments accumulate, water temperatures rise, dissolved oxygen plummets, and aquatic wildlife habitat is destroyed (<u>http://watersgeo.epa.gov/mywaterway/docs</u>). Under these conditions, good water quality can only be restored by limiting the amount of nitrogen that enters the water via surface runoff and by taking steps to increase life-giving tributary flows by limiting upstream water withdrawals and flow restricting structures.

MONITORING RESULTS

STONINGTON HARBOR SITES
2014



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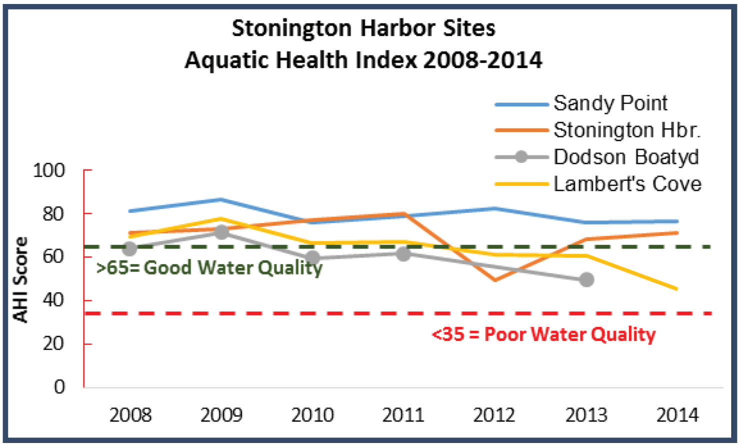


FIGURE 1

SANDY POINT / STONINGTON HARBOR / LAMBERT'S COVE

At the Sandy Point and Stonington Harbor sites, all component scores other than DIN remained generally good to excellent, resulting in overall AHI scores over 65 (Good; Figure 1). At the new Harbor site in western Lambert's Cove, farther from the strongest tidal flows, Poor scores for chlorophyll-a (microscopic algae) and oxygen saturation brought the overall AHI down to 45 (Fair-Minus)--a good reminder of the power of tidal flushing in the other Harbor sites, both for removing pollutants and replenishing dissolved oxygen.

MYSTIC RIVER AND PEQUOTSEPOS COVE SITES
2014

= GOOD = FAIR = POOR

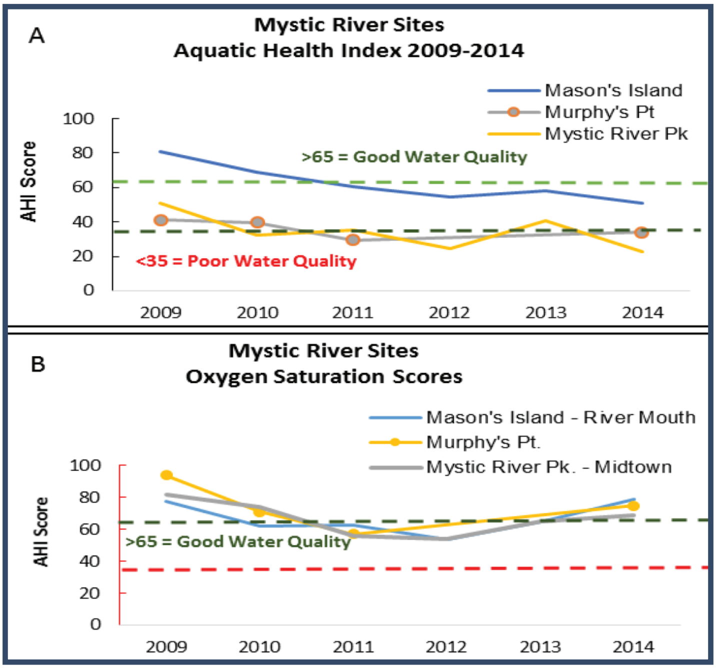


FIGURE 2

Overall AHI scores (Figure 2A) for the Mystic River declined in 2014, with DIN and chlorophyll-a concentrations reaching record highs even while oxygen saturation increased (Figure 2B). At all sites, including a dock at Mystic Seaport tested for a limited set of indicators, dissolved oxygen samples were at or above 4.8 parts per million (ppm), the range of good content for aquatic life, with summer averages over 6.0 ppm. Fecal bacteria were well within the limit for safe-swimming, though not for recreational shellfishing.

Here the lesson of the new Lambert's Cove site must be applied to the Mystic River: Just as water quality was lower in the Cove's sheltered west end, pockets of lesser water quality undoubtedly exist along the River shore, away from the fast-flowing channel. A reminder that the only way to ensure the health of both Harbor and River is to reduce the ongoing DIN load from sources related to human activity.

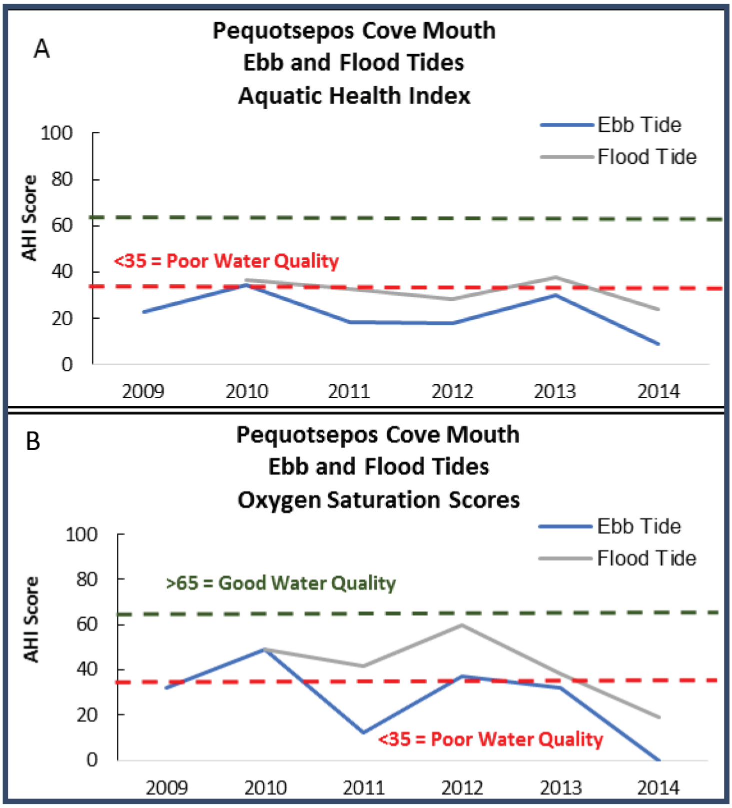


FIGURE 3

The Pequotsepos Cove site is monitored on both ebb and flood tides from the north side of the Route 1 bridge. Flood tide samples reflect the quality of the waters entering the Cove from both Fishers Island Sound and the area north of Mason's Island. In this Cove, 2014 AHI scores for DIN and oxygen saturation hit record lows in both ebb and flood tide samples. Oxygen saturation scores (Figure 3B), which are based on the two lowest values, were somewhat different on ebb and flood tides. However, summer averages of dissolved oxygen itself were almost identical at 4.3 and 4.6 ppm, within the stressful range for aquatic life and a third lower than the dissolved-oxygen averages in midtown Mystic sites. The flood-tide results are surprising in light of the strong currents flowing directly into the Cove from Fishers Island Sound.

The primary tributary stream to this cove is little Pequotsepos Brook, the only local tributary to meet EPA freshwater guidelines for total nitrogen and phosphorus; however, it enters the Cove as a small, shallow stream and contributes little volume or flow strength except after heavy rainfall.

WEQUETEQUOCK COVE SITES
2014

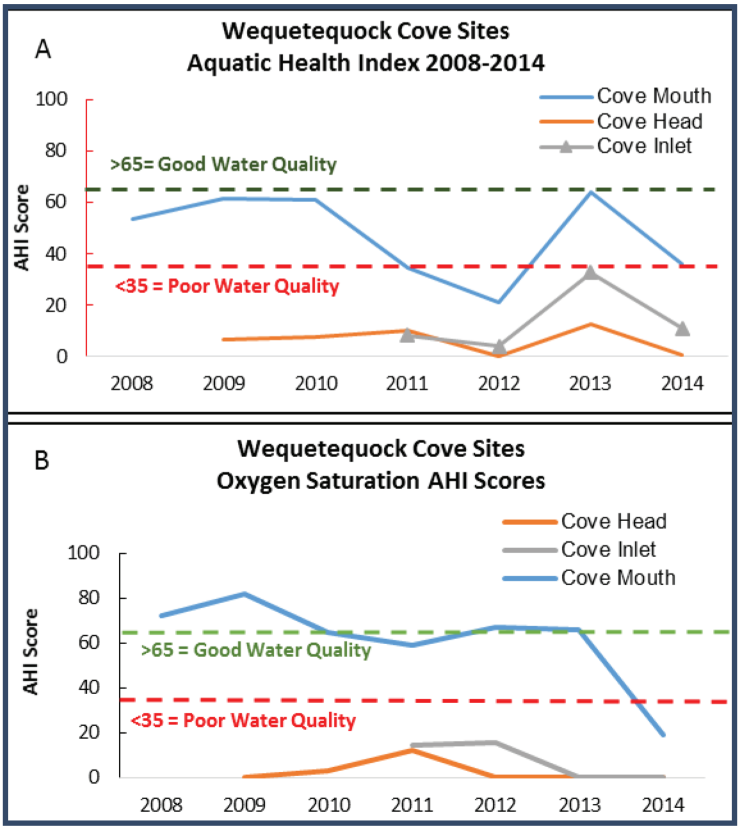


FIGURE 4

Overall AHI scores for Wequetequock Cove sites (Figure 4A) were fairly consistent until 2012, when they reached new lows before rebounding in 2013 only to crash again in 2014. Lower overall scores in 2012 reflected increased levels of both organic and inorganic nitrogen, while improved overall scores in 2013 were based on much lower levels of chlorophyll-a as well as nitrogen. Oxygen saturation scores changed little. As noted in the six-year report, the apparent improvement in 2013 was likely due to the effect of a growing infestation of macroalgae (seaweed) throughout Little Narragansett Bay, the lower Pawcatuck River, and up into the Cove. The crash of water-quality scores in 2014 was essentially a return to 2012 scores for chlorophyll-a and nitrogen, with an additional dramatic fall in ebb-tide oxygen saturation at the Cove mouth (Figure 4B). Oxygen saturation scores at the inner cove sites were already at zero and have remained at that level — on both tides in the case of the Cove head.

As noted repeatedly, all sites continued in 2014 to score well below 35 (Poor) for dissolved inorganic nitrogen (DIN), as they have in nearly all years since 2010 on both ebb and flood tides. Summer average DIN levels reached all-time highs in nine of 12 sites; at 714 ppb, DIN at the new Whitford Brook site in Old Mystic was five times higher than at midtown Mystic River Park. Although there is no EPA guideline for DIN in freshwater streams, the recommended limit for total nitrogen, 710 ppb, was exceeded by three of our four tributaries — Whitford, Pequotsepos, and Anguilla Brooks — while dissolved oxygen in all these fast-flowing streams averaged over 6.0 ppm. Oxecosset Brook is a special case, with relatively sluggish flow and spectacularly low dissolved oxygen, which in 2014 achieved an all-time low among CUSH sites at 2.2 ppm (near lethal). Like the oxygen findings at the mouth of Wequetequock Cove and Pequotsepos Cove on flood tides, these low levels require further investigation.

There are many possible reasons for water-quality changes, ranging from sediments roiled by boat propellers to boat waste discharges to leaking septic systems; however, when the change occurs throughout a large area and in water bodies of very different depths and flows, the weather must be a prime suspect. Southeastern Connecticut experienced extreme weather events in the years 2009-2013, mostly in the form of floods (2009 and 2010) or hurricane storm surges (2011 and 2012). The summer of 2014 was notable for its dry weather.

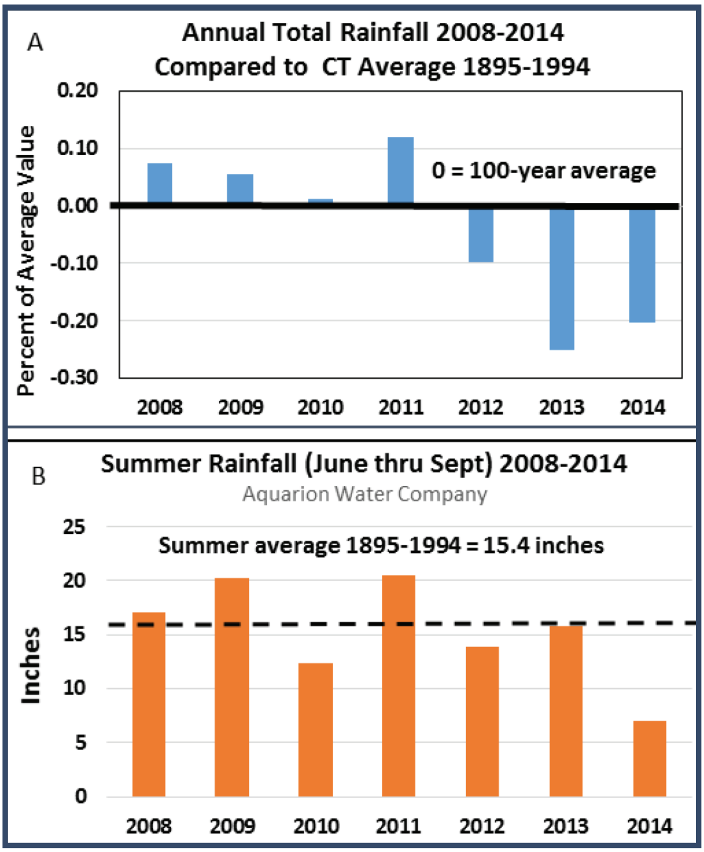


FIGURE 5

Figure 5A shows that total annual rainfall fell below the 100-year Connecticut average in 2012-14, following four years on the wet side of average. At 35.4 inches, 2014 total rainfall was more than the 33.6 inches received in 2013, but after a rainy March, only seven inches fell in all the summer months (Figure 5B), less than half the summer average. Scattered thunderstorms delivered only small amounts of heavy rain, and by late summer the tributary streams to the Mystic River and both small coves had either virtually or completely stopped flowing. This was of little consequence to the River, which is well flushed by the tide; however, it mattered greatly to the coves, where tidal flows are restricted by islands and especially bridges.

Flow restriction & stream flow and rainfall & water quality, or, what could possibly go wrong?

As CUSH's most impaired embayment and one for which we have considerable data, we can use Wequetequock Cove to explore the special relationship between all tidally restricted coves and their tributaries, starting with what is meant by the term "restricted." We have long known that flood-tide waters from Little Narragansett Bay reach the head of the Cove, because on flood tides the water there is deeper, dissolved oxygen is somewhat higher, and nutrient concentrations are lower. Figure 6 shows that at the Inlet site (about 0.4 miles from the railroad bridge) these flood-tide differences are sufficient to change the overall AHI from Poor to Fair-Plus; however, at the Cove head, a mile from the bridge, the AHI does not change at all between ebb and flood tides.

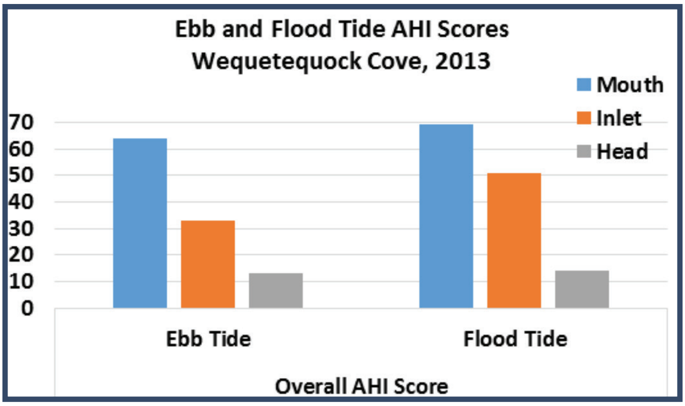


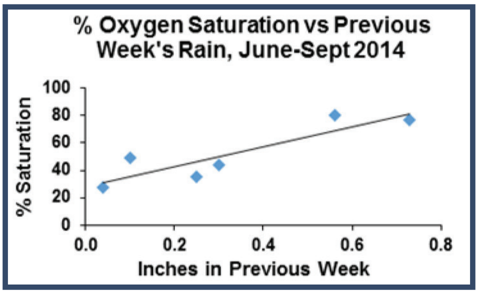
FIGURE 6

We know from the Harbor and River sites that strong flood-tide currents not only bring cleaner water into an estuary, but also mix with the existing water and transport contaminants out to sea, improving water quality on both tides. Without this tidal flushing action, the upper reaches of flow-restricted coves are utterly dependent on tributary flow to keep their waters capable of supporting aquatic life. And stream flow, in turn, depends on groundwater maintained by adequate precipitation.

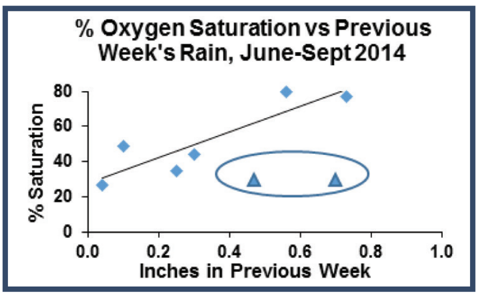
When the water table drops and streams stop flowing, cove waters become stagnant as oxygen is depleted and is not replaced. Dry weather is associated with some of our lowest dissolved-oxygen levels. From late August through mid-October 2014, Anguilla Brook at its entrance to the Cove consisted of 1-2 inches of fresh water overlying a shallow saltwater wedge. Although for most of its length the Brook averages at least 6 ppm dissolved oxygen, the bottom salt layer in 2014 ranged from 1.0 (lethal) to 4.1 ppm.

Stagnant Water

Occasional gentle summer rains increased the Cove's oxygen saturation, which rose with each small increase in rainfall. In the chart below, each dot is a water sample collected from the Cove head after varying amounts of rain. As each successively larger amount of rainfall soaks into the ground, the water table rises a bit more and the stream flow becomes stronger and faster, improving its ability to flush contaminants from the Cove.



Late summer featured a number of short, intense thunderstorms, and when such storms occurred 1-2 days before sample collection in our narrow coves — but not in Harbor or River sites — striking changes were seen in water-quality indicators. Below is the above chart with post-thunderstorm samples included:



In this example, less than an inch of very heavy rain produced record low levels of dissolved oxygen and record high levels of total nitrogen, caused by bursts of surface runoff containing accumulated nutrients and debris. "Heavy" rain is defined as rain falling faster than 0.3 inches per hour. The effect of these short, sharp storms is not seen in samples collected a week after such storms; however, larger amounts falling at similar intensity can create longer-term decreases in dissolved oxygen, even in the Mystic River. Larger amounts can also erode stream banks and scour stream beds, transporting suspended sediments downstream to the coast.

In March, we captured a moment from one example of sediment transport, when an extremely heavy five-inch rain event carried suspended sediments into Wequetequock Cove at a rate of over 385 pounds per hour. Some portion of these sediments must have been deposited in the quieter waters of the Cove. After a similar storm in mid-June of 2013, the average summer ebb-tide depth in the Cove decreased by 30%, to less than 2.5 feet, and remained low at least throughout 2014. Decreased depth greatly increases the risk of boat propellers disturbing bottom sediments, destroying bottom habitats and the organisms that depend on them and releasing DIN to fertilize more algae and deplete more dissolved oxygen.

Was the summer weather described here an aberration? With exquisite timing, the National Climate Assessment (NCA) issued a statement in 2014 citing an increase of 71% in the frequency of heavy downpours across the Northeast, with further increases predicted (http://nca2014. globalchange.gov/). URI Watershed Watch has observed that the current pattern appears to consist of periods of extreme rain events followed by dry periods. By September, 2015, the Mystic River and both Pequotsepos and Wequetequock Coves were receiving little or no flow from their major tributaries; at the same time, the entire Connecticut coast was reported to be experiencing moderate drought (http://droughtmonitor.unl.edu/Home/StateDrought Monitor.aspx?CT), and the Connecticut Rivers Alliance was warning that a number of CT streams were at or near their lowest recorded flow rates (http://www.riversalliance.org/drought2.cfm).

REFERENCES

Callender, Edward, "The Aquatic Health of Rhode Island's Salt Ponds." Salt Ponds Coalition Newsletter (Spring, 2008), pp.4-7. www.saltpondscoalition.org. For further details, see www.buzzardsbay.org/eutroindex.htm.

Miller, DR.; Warner, GS.; Ogden, FL, DeGaetrano, AT, "Precipitation in Connecticut (2002). University of Connecticut Digital Commons Special Report 36

WHAT WE CAN DO

Be an advocate! Voice your water-quality concerns to your town and the CT Department of Energy and Environmental Protection. Support Low Impact Development (LID) strategies to reduce stormwater runoff (http://www.nemo.uconn.edu/ tools/publications.htm).

Manage lawns and gardens organically: Have your soil tested. Use only the amount of fertilizer you need, and use organic methods and organic slow release fertilizers. Eliminate the use of pesticides. Do not dump lawn clippings and leaves near water bodies.

Manage or eliminate sources of bacteria and excess nitrogen by monitoring septic systems, cleaning up after pets, and controlling surface runoff. For more information visit http://www.reducerunoff.org.

Practice clean boating by using pumpout facilities and non-toxic cleaning materials, containing all washings and copper paint removed from boat bottoms, and properly disposing of boat trash.

MISSION STATEMENT

The mission of CUSH, Inc. (Clean Up Sound and Harbors) is to protect Fishers Island Sound and its coves, inlets, bays, rivers, and harbors, and thereby contribute to maintaining healthy water for future generations. We pursue our mission through sustained water-quality monitoring and by promoting good environmental stewardship through public education, demonstration projects, and coastal debris cleanups.

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