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April 30, 2015

Secretary Mark Belton
Department of Natural Resources
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Secretary Ben Grumbles
Maryland Department of Environment
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Director Nicholas DiPasquale
Chesapeake Bay Program Office
410 Severn Avenue
Annapolis, Maryland 21403
agreement@chesapeakebay.net
dipasquale.nicholas@epa.gov

Re: Comments on Chesapeake Bay Program Draft Management Strategies

Dear Secretaries Belton and Grumbles and Director DiPasquale:

The Clean Chesapeake Coalition[1] (the "Coalition") respectfully submits the following comments on the Chesapeake Bay Program Draft Management Strategies. This letter does not comment on specific strategies, but instead, urges a refocusing of the watershed strategies as set forth more fully below.

Dredging needs to occur upstream of the Conowingo Dam. Scour during major storm events reverses the recovery of the Bay and constitutes a 5-10 year set-back each time such an event occurs. Exelon Corporation and the United States Army Corps of Engineers ("USACE") are opposed to dredging above the dam. There are two principal reasons for their opposition:

(1) The accumulated sediments contain toxic chemicals including pesticides and herbicides, acid mine drainage including sulfur and coal, and PCBs. A party that undertakes the removal of such sediments will assume responsibility for the proper disposal of such sediments should such sediments leech or cause other environmental problems in the future. Liability for issues related to such

[1] Current members: Allegany County, Caroline County, Carroll County, Cecil County, Dorchester County, Frederick County, Harford County, Kent County, Queen Anne's County, and Wicomico County.

sediments may be strict liability in perpetuity under current laws. Given the specter of incurring strict liability in perpetuity, it becomes evident why no one wants to remove sediments from above the dam. The toxins in such sediments, nevertheless, are released into the Bay during scour events and harm Bay flora and fauna. The legal landscape must change so that the parties that engage in dredging above the dam will not have liability for the toxins in the sediments. Protocols for testing and deposition of the sediments must be established by the state and federal regulators. As long as such protocols are implemented by the dredging parties, such dredging parties should be absolved of further liability for dredged sediments that are removed and kept from ever reaching the Bay.

(2) There is a dearth of places to place dredged material. A federally funded economic incentive program for the development of innovative uses of dredged sediments should be established. Private entities and educational institutions should compete for such funds for the development of innovative uses of dredged sediments. Successful pilot studies should then be able to compete for federal funding for dredging. Some of the federal funding for dredging below the dam should be allotted for dredging above the dam.

Attached are satellite images of the Bay from April 13, 16 and 18, 2015.[2] The images depict the deadly plume of sediments and pollution that are deposited in the upper Bay each spring as a result of increased flows from the melt of winter snow and ice combined with April showers. Flows through the Conowingo Dam increased to as high as 175,000 cubic feet per second during this period and the visible sediment and pollution plume extended from the mouth of the Bay to the Wye River. The upper Bay experiences such impact annually. If action to dredge the Conowingo Pond and to reduce the source of such annual pollution is not taken, billions of dollars of expenditures by Marylanders to reduce pollution in the upper Bay will be meaningless, just as they have been over the past three decades.

Coalition counties have to compete with Pennsylvania for economic development and to maintain their current base of taxpaying commercial businesses and residential citizens. Such counties have spent billions of dollars to implement stormwater management practices and to meet National Pollution Discharge Elimination System ("NPDES") requirements that no Pennsylvania or New York jurisdiction in the Bay watershed is required to meet or even to approach. Coalition counties cannot continue to make such expenditures because such expenditures preclude their ability to compete for economic development and do little to meaningfully improve the water quality of the upper Bay given the impact of pollutants from the

[2] For USGS charts *see*: http://waterdata.usgs.gov/md/nwis/uv?cb_00060=on&cb_00065=on&format=gif_default&site_no=01578310&period=&begin_date=2015-04-09&end_date=2015-04-18. For satellite images *see*: http://mddnr.chesapeakebay.net/eyesonthebay/satellite.cfm.

Susquehanna River watershed in Pennsylvania. The lakes and reservoirs behind the hydroelectric dams in the lower Susquehanna River are full, no longer have any trapping capacity, and contribute pollutants that spew into the upper Bay during moderately high flow events that occur several times each year. If federal and state regulators continue to allow Pennsylvania and New York jurisdictions and the energy companies do little to nothing to reduce their pollution contribution to the Bay, Coalition counties cannot continue to make expenditures that will yield no meaningful improvements to the water quality of the Bay.

Attention and funding needs to be focused on one of the major sources of pollution contributed by Maryland to the Bay.[3] Millions of gallons of raw sewage from Baltimore County, Baltimore City and the Washington Suburban Sanitary Commission wastewater treatment plants ("WWTPs") spill into Bay tributaries annually as bypass during storm events because of combined sewer/sanitary lines, failing sewer lines and failing sewage pumping stations. All three governmental agencies are under consent decrees to correct such problems. All three agencies are woefully behind in implementing corrective actions.[4] There is a serious funding shortfall. Instead of appropriating flush tax funds and other funds to upgrade WWTPs to ENR treatment capability and to correct failing septic systems, funds should be focused on correcting such massive raw sewage/untreated industrial waste discharges, which are poorly documented and largely ignored. Such massive discharges are much more harmful and toxic and are of much greater magnitude than discharges that receive BNR versus ENR treatment and discharges from failing septic systems. Attached is a poster that outlines this issue.[5]

Combined stormwater and sewer systems in Bay watershed states regularly overflow during significant storm events, discharging raw sewage into Bay watershed tributaries as WWTP bypass. The Maryland Watershed Implementation Plan ("WIP") calls for spending $3.7 billion on failing septic systems that contribute an infinitesimal amount of pollution to the Bay in comparison to the pollution discharged to the Bay in bulk quantities during such bypass storm

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[3] *See* the Consent Orders entered in: U.S. District Court for the District of Maryland Civil Action Nos.: PJM-04-3679; 1:05-cv-02028-AMD; and JFM-02-1524.

[4] Additionally, the Environmental Integrity Project and the Potomac Riverkeeper have sued the WSSC for discharging millions of pounds of alum laden sediment into the Potomac River from the WSSC water filtration plant near Seneca south of Poolesville. Such discharges dwarf the impact of failed septic systems. *See Potomac Riverkeeper, Inc., et al. v. Washington Suburban Sanitary Comm.*, U.S. District Court for the District of Maryland Civil Action No. 8:14-cv-00417-TDC.

[5] For video coverage of the August 12, 2014 sanitary sewer overflows in Baltimore City, *see* link: https://www.youtube.com/watch?v=0lFrn8RRY3w. For general information on various instances of sewage overflows in Maryland, *see* the following articles: "Five Million Gallons of Sewage Spills Into Potomac River," available at http://dcist.com/2014/05/five_million_gallons_of_sewage_spil.php; "500 Million Gallons of Sewage Overflows So Far in Maryland This Year," available at http://cbf.typepad.com/bay_daily/2011/09/maryland-is-on-pace-this-year-to-have-the-most-sewage-overflows-in-at-least-six-years-according-to-the-maryland-department-o.html; "Sewage leaks foul Baltimore streams, harbor," available at http://articles.baltimoresun.com/2011-12-10/features/bs-gr-sewer-leaks-20111210_1_sewage-leaks-sewage-overflows-raw-sewage; and "August downpour results in sewage overflow of 12 million gallons," available at http://articles.baltimoresun.com/2011-12-10/features/bs-gr-sewer-leaks-20111210_1_sewage-leaks-sewage-overflows-raw-sewage.

flows.[6] There has never been an organized and concerted effort by the NPDES regulatory agencies to quantify such bypass and determine the harm posed by such bypass to the Bay. The failure for decades to upgrade sewage systems that are close to or more than a century old and regularly discharge raw sewage into the environment from leaking, cracked, separated and deteriorated sewage pipes, dysfunctional pumping stations and storm surge bypass is inexcusable.[7]

Spending $3.7 billion on failing septic systems (the plan under the current Maryland WIP) before addressing the damage caused by failing sewage systems and bypass makes sense only from the perspective of regulatory agencies and environmental groups that want to see the Bay continue to remain in its current state so that such agencies and entities can continue to receive taxpayer funding to study the problem and grow their operational budgets in the name of continuing efforts to "save the Bay." The failure to address real problems for decades, while addressing *de minimus* sources of pollution, such as failing septic systems, is why the Bay is no better off today than it was 40 years ago when the first Bay agreement was executed by watershed states.

Oyster restoration through oyster cultivation needs to be implemented and natural oyster bars that have been removed from harvest and placed in "sanctuaries" need to be restored to the public for oyster cultivation. Oyster cultivation includes periodic dredging, rotational harvest, shell replenishment, and seeded shell relocation with natural spat/oyster larva. The Coalition has addressed this issue in further depth in the white paper that is attached hereto.[8] The Coalition introduced legislation for implementation of an oyster cultivation program during the 2015 session of the Maryland General Assembly (*see* House Bill 638). Bay wide oyster restoration is a win not only for the natural environment, but also for the economic, social and cultural environment of the State. Oyster cultivation should enable the State to meet the waste load allocations required by the 2010 TMDL without any additional programs or efforts that have not already been implemented and funded. Oyster cultivation could be accomplished for a fraction of the cost of the current sanctuary program. Oyster cultivation should significantly reduce the cost to achieve compliance with the 2010 TMDL.

Maryland Department of Natural Resources ("MDNR") oyster sanctuary program should not be expanded beyond Harris Creek and the Little Choptank River, and funding for the expansion of that program into the Tred Avon River should be diverted to an oyster cultivation program (*see* above paragraph). Attached is a letter with exhibits that details some of the folly of

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[6] *See* Septic "Facts" attached hereto.

[7] *See* attached select testimony of Mayor Richard Gray, City of Lancaster, Pennsylvania, from the Congressional Field Hearing on May 5, 2014 regarding "Finding Cooperative Solutions to Environmental Concerns with the Conowingo Dam to Improve the Health of the Chesapeake Bay." Mayor Gray testified about Lancaster's century old sewage system with combined sewer and stormwater flows that regularly discharges millions of gallons of raw sewage into the Conestoga River during storms.

[8] *See* the attached Oyster Restoration and Management Plan prepared by the Coalition.

the oyster sanctuary program implemented in Harris Creek and the Little Choptank River.[9] Before consideration of further expenditure on the oyster sanctuary program, the study on the effectiveness of the program in the Little Choptank River and Harris Creek should be completed and reviewed. The study and data used to establish the initial reference points upon the initial establishment of those sanctuaries should be provided with subsequent data and studies generated after the sanctuary was established. All work undertaken in each sanctuary should be documented, including any dredging to clean bottoms and shell.

State officials from MDNR and the Maryland Department of the Environment ("MDE") should meet and coordinate with county government officials before deciding on and implementing projects to improve the water quality of the Bay and funding such projects. Many of the Coalition counties have specific ideas about projects that could lead to water quality improvements in a much more cost effective manner than the BMPs required by State and Federal regulators. By way of example:

(i) Counties with land in the Coastal Plain geologic formation would like to use switch grass in the drain fields of failing septic systems to absorb unbonded nitrogen in the ground/groundwater. Switch grass has a deep root system – 8-12 feet deep. The root system would draw and absorb free nitrogen from the ground/groundwater for use by the plant thereby removing the free nitrogen at a fraction of the cost of the septic system BMP that MDE has mandated. Twenty or more (20+) drain fields of switch grass could be established for the cost of one new septic system, and the switch grass could be maintained (*i.e.*, cut) for no additional cost to the property owner while the BMP septic system will have annual operation and maintenance costs of between $500 and $1,200.

(ii) Farmers have ideas about different stormwater catch basin systems that a farmer could install to catch and utilize nutrient rich run-off in lieu of stormwater management practices required as BMPs.[10] They cannot obtain permission to utilize such alternative measures. Different practices should be considered for farms in the Coastal Plain geology and farms in the Piedmont geology. Different requirements should be considered based on differences in location and proximity and differences in natural attenuation and dilution.

(iii) One Coalition County in the Piedmont geology has undertaken stream maintenance and restoration activities and activities to sheet stormwater flow that it feels have meaningfully reduced sedimentation, yet it cannot get credit for its efforts because such efforts are not recognized as BMPs.

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[9] *See* attached comment letter from Dorchester County Council to USACE and MDE dated May 9, 2014.

[10] *See* the website of Queen Anne's County farmer Sam Owings (High Impact Environment, Inc.) who developed an inexpensive yet effective system for nutrient reduction in agriculture stormwater runoff - http://www.highimpactenvironmental.org/.

The proverbial statement, "one size does not fit all" is equally applicable when it comes to solutions that could effectively reduce the impact of stormwater runoff. The Federal and State regulators assert that local government support, action and expenditures are imperative to achieving pollution reduction to the Bay. Indeed the Bay watershed agreement acknowledges as much. Yet, local governments are not afforded credit for innovative solutions and there is no watershed wide clearing house of proposed alternative actions with pilot projects allowed, funded, and tracked for success.

The focus and attack on septic systems, Maryland's requirement of tiered land use plans and Maryland's push for local government stormwater management implementation of environmental site design (ESD) to the maximum extent practical (MEP) for new development and redevelopment is all about growth control; it has little if anything to do with making meaningful improvement to the water quality of the Bay. Taxpaying citizens have been fleeing urban areas that have failed to maintain and improve their sewage systems, stormwater management systems and water treatment plants as taxes and service fees are raised in an attempt to address and to fund such issues. The easy way for governments to try to reverse such urban flight is to adopt programs such as tiered land use requirements, onerous septic requirements and a stormwater management program requiring ESD to the MEP; and to impose such requirements in suburban and rural communities while allowing urban areas to ignore such requirements, and to allow urban communities to increase sewer connections and to increase population and engage in redevelopment without first making the expenditures necessary to stop raw sewage discharge from failing systems and to stop pollutant discharge from water treatment plants. Such programs are implemented in an attempt to preclude economic development in suburban and rural counties and channel economic development in the urban centers so that such urban centers can attempt to grow the revenue base necessary to attempt to reverse numerous problems attendant in such urban centers. The Coalition counties recognize that economic development is necessary everywhere for communities to thrive and continue to maintain the revenue base necessary to pursue programs to improve the water quality of the Bay. Economic development should not be stifled with programs that affect only rural and suburban communities and do nothing meaningful to improve the water quality of the Bay.

Coalition counties are required to maintain and impose ESD to the MEP on developments and renovations that will not meaningfully impair water quality under former (*i.e.*, 2000) stormwater management requirements. Yet, development and redevelopment in urban centers is allowed without compliance with ESD to the MEP or the improvement of failing sewage systems. An example is the Amazon Distribution Center located just yards away from the Potapsco River in Baltimore City which has been exempted from compliance with ESD to the MEP, even though construction of the distribution center did not commence until 2013. Thousands of new connections and thousands of new users are being allowed and encouraged to connect to the failing sewer systems in Baltimore City, Baltimore County, and the Washington Suburban Sanitary Commission jurisdictions before the necessary improvements to those systems are made. The pollution that will be discharged into the Bay from such new connections dwarfs any pollution to the Bay that will emanate from failing septic systems or from the economic development that is being prevented by ESD to the MEP and tiered land use plans in suburban and rural communities. Economic development in those urban centers is no more important than economic development in the more suburban and rural jurisdictions of the Coalition counties. The impact to the Bay of such urban development is much greater than the impact to the Bay of development halted by new septic requirements, and the imposition of ESD to the MEP and tiered land use plans.

Maryland has imposed stormwater management and NPDES requirements on Coalition counties that are much more restrictive and expensive to implement than the requirements in neighboring Bay watershed jurisdictions in Pennsylvania, Virginia, Delaware, and West Virginia, making Coalition counties unable to compete with those jurisdictions for economic development. The solution is not to prevent economic development in Baltimore City, Baltimore County, and the Washington Suburban Sanitary Commission counties (*i.e.*, Prince George's and Montgomery Counties). The solution is:

A. To prioritize expenditures so that resources are spent on programs that will reduce the most significant sources of pollution (*e.g.*, the failing sewage systems in Baltimore City, Baltimore County and the WSSC jurisdictions) before attacking minor sources in rural and suburban counties.

B. To allow flexibility in remedial action, so that economic development in suburban and rural counties is not precluded. For example, where good soils capable of binding nitrogen and ample land are available to sheet and offset stormwater runoff, septic and stormwater management requirements should be relaxed. Again, the application of uniform requirements that do not recognize and account for real differences in the scope and magnitude of pollution are silly and of negligible benefit to the natural environment, while paralyzing the economic, social and cultural environment of Coalition counties.

C. To promote oyster restoration, a solution to scour in the reservoirs of the lower Susquehanna River, and other large sources of pollution, so that draconian measures on small source contributors is unnecessary.

There is a need to continually examine "pollution solutions" and determine whether such solutions are effective and are really solutions. A few examples are set forth below.

(a) Wooded buffers should be required around all Bay tributaries and drainage swales. The wooded buffers pose several problems. First, when trees/branches fall into a stream, such large impediments divert the water and dam constricted areas of the stream where they are transported during high flow events. The water in the stream than has to navigate around such impediments during the next high flow event, causing significant erosion of the banks around such impediments. The trees shed leaves and branches. Those leaves and branches fall into the water and are transported to flats (often in the Bay), during high flow events where they decompose anaerobically depleting the oxygen in the water and emitting sulfides and other acids that are toxic to marine life and aquatic vegetation. The Coalition has spoken with Tim Visel, an aqua culturist and former NOAA employee who is engaged in oyster restoration efforts in the Long Island Sound. He has studied the effects of sapropel (anaerobically decaying plant vegetation) on shellfish and aquatic habitats and has exposed the detrimental impact of wooded buffers on efforts to restore oyster bars and marine habitats in the Long Island Sound.[11]

(b) Farmers should engage in no-till farming to reduce soil erosion. Phosphorus binds to ions in the soil. When no-till farming is utilized, the soil is not turned, and the top layer of the soil becomes saturated with phosphorus while the lower layers become phosphorus depleted. Over-fertilization results in attempts to maintain yield.

(c) Nonindigenous phragmites was introduced to and planted in the Bay to restore wetlands. We now spend millions of dollars to kill such phragmites, which has had a detrimental impact to the Bay.

Well-meaning regulators regularly impose requirements without thorough study or consideration of long term and unintended impacts or the differences of any benefit that might be achieved dependent on local conditions. Such regulations can cripple the economic, social and cultural components of the human environment while failing to meaningfully enhance the natural environment. We do not need the fad-of-the-day solution from regulators with a political agenda and incomplete knowledge and understanding of different natural, economic, cultural and social outcomes of their "check-box" "one-size-fits-all" solutions. The regulators need to sit down with impacted industries (*e.g.*, watermen, farmers, developers and local governments and determine what will be of benefit to the locale in question given the unique features of such locale and the efforts a local government can and will undertake to offset long term and unintended consequences.

There are sources and contributing factors to the degradation of the water quality of the Bay that may be significant and that are being ignored for reasons of political expedience. For

[11] Some of Mr. Visel's reports are attached hereto, including: "When It Came to Fish and Shellfish Did We Take Out the Wrong Nitrogen?"; IMEP #27; "The Sapropel – Sulfur Cycle and The Nitrogen TMDL Recent Studies Concerning Nitrogen Source Identity Did we protect the wrong scallop grass and remove the "good" nitrogen?"; IMEP #32; and "High Heat and Organic Loadings Complicate Nitrogen Limits Nitrogen TMDL Input Models Need to Include Sapropel Why We Need to Look at the Saprobien System Discussion Paper EPA DEEP Long Island Sound Study Habitat Restoration Work Group."

example, what is the impact of the white phosphorus deposited by the United States Army in the Bay? This issue was incompletely and improperly studied in the 1990s.[12] A recently published book titled *Death of the Chesapeake Bay, a History of the Military's Role in Polluting the Bay*, discusses the types of military wastes and ordinance placed in the Bay and some of the environmental impacts of such ordinance.[13] The impact of phosphates leaching from white phosphorus and mustard agent deposited/buried in the Bay may significantly eclipse the impact of the phosphorus runoff from farms in terms of serving as a source of phosphates that contribute to algae blooms that decompose and deplete the supply of oxygen in Bay waters.

Other well-meaning government programs have contributed to the degradation of the water quality of the Bay. The deepening of the Chesapeake-Delaware Canal and the removal of the locks from the canal have contributed to the degradation of the water quality and to fundamental changes in the Bay estuarine. Governor Agnew convened a panel of scientific experts to study the impact of widening deepening the channel in the Chesapeake-Delaware Canal and removing the locks. Those experts warned that the upper Bay would be deprived of the beneficial flushing and oxygenating impacts of the influx of cold oxygen rich fresh water that annually enters the Bay from the snow melt in the Susquehanna River basin. Much of that water now flows into the canal and the Delaware Bay as a result of the deepening and the removal of the locks. Such high flows no longer flush the northern Bay in the spring. Many of the deepest areas of the northern Bay no longer benefit from the cold oxygen rich waters that would settle in those deep spots in the spring and gradually warm and oxygenate the shallower Bay waters in the summer months. The saltwater intrusion is driving further up the Bay, causing a general increase in the salinity of the Bay. One of the non-indigenous species, the cow nose ray, which rarely was spotted in the Maryland portion of the Bay due to lower salinity levels is now quite commonly encountered in the Maryland waters of the Bay. This species uproots SAV as it scours the floor of the Bay for clams, oysters, mussels and crabs. It is an efficient and devastating predator.

Finally, after two years of exposing the problem of scour from the reservoirs behind the hydroelectric power dams in the lower Susquehanna River, there has been federal and state acknowledgement that such scour has a detrimental impact on the Bay's ecology and on

[12] *See* EPA Superfund Record of Decision R-03-91//126 (1991): Aberdeen Proving Ground (Michaelsville Landfill), EPA ID: MD 3210021355, OU 04, Aberdeen, Md. 09/27/1991 and EPA Superfund Record of Decision R03-96/229 (1996): Aberdeen Proving Ground (Edgewood Area) EPA ID: M2210020036 OU 09 Edgewood, Md. 09/30/1996. Post employees advised that there is a 15 acre white phosphorus dumping area in the swamp/shallows at the mouth of Mosquito Creek and that barges filled with munitions and drums of white phosphorus were buried at that location. No tests for water soluble phosphorus were performed. None of the recommended follow up studies were conducted. If you speak with watermen who are knowledgeable of the Mosquito Creek – lower Specuite Narrows area and have a federal license to work the area, they will confirm that metal/zinc coated crab pots and line chains corrode rapidly when set in that area.

[13] Albright, Richard "*Death of the Chesapeake, A History of the Military's Role in Polluting the Bay*" (1st ed. 2013) (ISBN-10:: 11118686270; ISBN-13:978-11118686270)

downstream Bay restoration efforts.[14] Are the ratepayers who benefit from the inexpensive power generated by those hydroelectric plants, as well as the ratepayers who benefit from the nuclear power produced at Peach Bottom Nuclear Power Plant and from the power produced by the Muddy Run power plant, neither of which would have sufficient water without the reservoir created by the Conowingo Dam, going to contribute to the costs to restore the Bay from the damage that has been caused by such dams.[15] The water from such reservoirs is the feedstock that enables such companies to generate lower cost electricity. Cost certainly is one impediment to the implementation of water quality improvement measures. The inequity of the costs borne by Marylanders in comparison to the costs incurred by out-of-state residents in the Bay watershed that benefit from conditions that contribute to the degradation of Bay water quality could be addressed by contributions from such power companies to programs such as oyster restoration through oyster cultivation in the upper Bay, which would combat the detrimental effects and loss of habitat caused by scour from the floors of the reservoirs/ponds/lakes created by such power companies.

The "save the Bay" agenda and management strategies over the last four decades has not resulted in meaningful and lasting improvement to the overall water quality of the Bay. The currently espoused strategies are destroying the seafood and agricultural industries and the economic, cultural and social heritage and the recreational endeavors that have sustained the Bay for over two centuries. It is time to rethink and reprioritize the strategies that will be funded and implemented to restore the Bay. Meaningful input from effected local governments should serve as the lynchpin for Bay restoration efforts. The one-size-fits-all top-down dictates of Federal and State agencies has wholly failed to yield any meaningful improvement to the water quality of the Bay.

The Coalition counties respectfully request an additional sixty (60) days to comment on individual draft management strategies. The number of strategies and the volume of pages of information that must be digested before meaningfully commenting on individual strategies makes the time allotted to submit comments woefully insufficient.

The Coalition counties again thank the Secretaries of DNR and MDE and the Director of CBP for providing this opportunity to comment and provide input that might impact the future direction of programs undertaken to help restore the Chesapeake Bay.

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[14] *See* attached hereto MDE letter of Support for Senate Joint Resolution 1 dated February 3, 2015 and EPA letter dated April 20, 2015 to the Federal Energy Regulatory Commission's Conowingo Dam Final Environmental Impact Statement. Both letters acknowledge the issues involved with sediment scour from the Conowingo Reservoir.

[15] Peach Bottom, Muddy Run and Conowingo dams sell their power to the PJM consortium. The waters of Pennsylvania and Maryland (*i.e.*, Susquehanna River) provide the feedstock free of charge to Exelon from which this power is generated. This power is less expensive than power generated from fossil fuels because there is no cost for the state resource which enables such power generation. The entire grid should contribute to dredging behind the hydroelectric power dams in the lower Susquehanna River since they benefit from the low cost and reliable electric power generated as a result of those dams. For information on the PJM, *see* link: http://www.pjm.com/.

Sincerely,

CLEAN CHESAPEAKE COALITION

Ronald H. Fithian
Chairman and Kent County Commissioner

cc: Lauren Taneyhill, Chesapeake Research Consortium
Clean Chesapeake Coalition Counties

58599.10:173832

FINDING COOPERATIVE SOLUTIONS TO ENVIRONMENTAL CONCERNS WITH THE CONOWINGO DAM TO IMPROVE THE HEALTH OF THE CHESAPEAKE BAY

Monday, May 5, 2014

U.S. Senate
Subcommittee on Water and Wildlife
Committee on Environment and Public Works
Darlington, Maryland

The subcommittee met, pursuant to notice, at 9:57 a.m., in the Conowingo Visitors Center and Recreation Office, Hon. Benjamin Cardin, chairman of the subcommittee, presiding.

Present: Senator Cardin [presiding].

STATEMENT OF THE HONORABLE RICHARD GRAY, MAYOR,
CITY OF LANCASTER, PA

Mr. Gray. Thank you, Senator. My name is Rick Gray. I've been the mayor of Lancaster now -- I'm in my ninth year as mayor of Lancaster. We appreciate you inviting us here today on an expert panel -- I'm not sure I'm an expert -- but to tell you what we're doing in the city of Lancaster.

First of all, we appreciate your efforts to improve public understanding of the environmental challenges presented by the Conowingo Dam. We look forward to working together to improve the ecological health of the Chesapeake Bay.

This is not a new problem in Lancaster. In 1906, the city council debated whether or not to separate our storm water and waste water system and decided at that time that $2 million was too much to spend on it. Minutes from a 1927 Lancaster city council meeting noted that, quote, "The meandering course of the Conestoga Creek formerly was a source of pride and largely used for recreational purposes. The continually increasing discharges of untreated sewage and industrial wastes have polluted this stream to a serious degree," end quote.

The minutes cite sludge deposits, oil slicks, and other pollutants that, quote, "do not disappear," end quote, before reaching the Susquehanna River and flowing into the

Chesapeake Bay. That was in 1927. No one did anything.

Nationwide, industrial pollution has been largely eliminated because of the Clean Water Act. That said, storm water continues to be the main source of pollution of the majority of the 40,000 water bodies that are documented as impaired. Our storm water engineering practices have not changed in four decades since the Clean Water Act went into effect. It is time to rethink how we approach storm water management and to protect our most precious resource, clean water.

Today, the City of Lancaster is responsible for between 750 million and a billion gallons of polluted water flowing into the Conestoga River and eventually into the Chesapeake Bay. This is common in historic cities that rely on combined sewer systems to collect and transport both domestic sewage and rain water flowing from downspouts, streets, sidewalks, parking lots, and over impervious surfaces into storm drains.

There are 50 combined sewer communities in the Chesapeake Bay watershed alone. Eighty-five percent of the time, the city's treatment facility is able to manage and clean the volume of water flowing through this combined system. Still, during heavy rain storms and other wet weather events, the system becomes overwhelmed and, by design, untreated storm water and sewage is allowed to overflow into the rivers.

The problem of storm water runoff and combined sewer overflow is not going away, nor will our responsibility to help clean and restore the Bay. To address these issues, we began with two important questions: One, can the city realistically eliminate 750 million to a billion gallons of storm water runoff in 25 years using green infrastructure? Two, can this approach provide more benefits per dollar than traditional gray infrastructure alternatives?

We've found that the answer to both questions is yes. Lancaster's experience shows that green infrastructure can be used to manage and reduce storm water runoff in a way that is both cost effective and responsible. Simply stated, green infrastructure prevents storm water from entering the sewer system using natural systems such as absorption or infiltration into the soil or into the atmosphere. This allows storm water to be treated as intended.

Over the past three years, the City of Lancaster has invested in green infrastructure projects to demonstrate the effectiveness of this technology. Lancaster currently, per capita, has more square feet of green roof than any other city in the United States -- advantage of being a smaller city with that type of statistic. Still, we're there.

Basically, green infrastructure lets the storm water go where it would have gone prior to our paving the planet and preventing its absorption into the ground. Efforts are underway in our neighborhoods to engage the community, and the question is how do we pay for the green infrastructure. We've instituted a storm water utility with a storm water management fee. The fee is levied on property owners based on the amount of uncontrolled impervious area on their property.

In closing, we can have clean water if we want it, not because of federal mandates but because we have an ethical and moral obligation to do right by our children and grandchildren. I would say this, Senator. Maryland is extremely important to us from this perspective, those of us who want to do something about it in Pennsylvania. If the people in Maryland don't indicate an urgency with the Chesapeake Bay, the people in Lancaster are not going to care at all about it. They really aren't.

So what happens in Maryland directly affects our political ability to do these things in Pennsylvania, and we look to Maryland for leadership and really being out in front on these types of issues. So, again, technology has given us the power to preserve our water resources and at the same time create a more livable, sustainable, and economically viable future for generations to come.

[The prepared statement of Mr. Gray follows:]

Senator Cardin. Mayor Gray, I particularly appreciate your testimony and your leadership on this issue. You're absolutely right. Maryland is going to do what's right, and what you're doing in Lancaster is really commendable. So I'm glad I take my grandchildren there frequently to see Lancaster.

Mr. Gray. I'll be sure to come downtown when you do so.

[Laughter.]

Senator Cardin. Secretary Gill?

and evaluating and making changes is already in place in terms of our managing our resources going forward.

Senator Cardin. So that'll be part of that process in revising, perhaps, even the TMDLs.

Mr. Gill. Yes, it will, Senator.

Senator Cardin. Thank you. I appreciate that.

Mayor Gray, your testimony is very compelling about the fact that if we can reduce the amount of pollutants going in upstream, the problems at the dam are going to be more manageable.

Mr. Gray. Absolutely.

Senator Cardin. And it's a lot more cost effective to do it at the local level than it is to try to figure out what happens now that we have all this trapped sediment.

Mr. Gray. Yes. On the other hand, Senator, it's a cost that financially strapped cities and communities in Pennsylvania have a difficult time realizing. For example, in Lancaster County -- and we're considered one of the biggest polluters of the Bay, the county -- the farmers will tend to point at the city and say the city is the problem. We've resisted doing the same. Rather than that, we say, "You have a problem. We have a problem. You deal with yours. We'll deal with ours." So rather than point fingers at people, let's just take care of it and get it done.

But other communities in Pennsylvania have looked at our green infrastructure plan, which is about 250 pages long. And it was developed with the idea in mind that smaller communities -- not Pittsburg and Philly, but the rest of our cities -- could look at it and use it, not even just in the Chesapeake Bay watershed, but in the entire state.

We're promoting that through the League of Municipalities in Pennsylvania. They've recently started a sustainability program that includes looking at green infrastructure and looking at storm water disposal. So it's happening upstream, but it's a difficult battle.

One final thing. We don't talk about the Chesapeake Bay, generally, when we go out and talk to neighborhoods. If we green a park -- at one park we have, almost 4 million gallons a year was put into storm water -- or with storm water disposal underneath some basketball courts with a drain field. What we do is put a big sign up for the new park, "Green Infrastructure at Work," so that people equate green infrastructure with a new park or a new intersection.

We use what's called integrated infrastructure. Any public improvement we do, we look at it from a green perspective. How can we incorporate greening into this? And, again, even an intersection change -- how can we make it green? So it's been successful, and people see improvements in the community. They might not care about the Chesapeake Bay. They care about the park down the street. So it's been working for us so far.

Senator Cardin. You're absolutely right. People identify with their own community, and the way that you've done that is very successful.

I should point out that when Colonel Jordan was talking about up to $3 billion for the dredge project, I was thinking of how we could use that money in the state revolving fund to help in regards to dealing with waste water treatment or how we could perhaps put more money into the new regional conservation programs under the Farm Act that help the Bay farmers in dealing with their nutrient control issues. Putting money into those programs will help us a great deal in reducing the ingredients that are going into our fresh water that's causing the problems on the Susquehanna as far as the dam is concerned.

Dr. Boesch, I want to talk a little bit more about -- I really do appreciate your explanation. As I understand it, we really don't have good hard evidence on the nutrient issues coming in from the Susquehanna, particularly during scour events, as to the impact it has on the overall health of the Bay. At least, that was not the focus of the study that was done by the Army Corps.

As I understand it, there are two factors here that seem to be coming into play. When you get a rush of fresh

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

April 20, 2015

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE, Room 1A
Washington, DC 20426

Subject: Final Multi-Project Environmental Impact Statement for Hydropower Licenses Susquehanna River - York Haven, Muddy Run, and the Conowingo Projects, Pennsylvania and Maryland, CEQ# 20150065

Dear Secretary Bose:

In accordance with Section 102(2) (c) of the National Environmental Policy Act (NEPA), 42 U.S.C. § 4332(2) (c), Section 309 of the Clean Air Act, 42 U.S.C. § 7609, and the Council on Environmental Quality (CEQ) regulations, 40 CFR Parts 1500-1508, the United States Environmental Protection Agency (EPA) has reviewed the Final Environmental Impact Statement (EIS) for the above-referenced projects and is providing the following comments.

As you are aware, the Final EIS is for the Federal Energy Regulatory Commission (FERC) relicensing of three hydroelectric facilities located on the Susquehanna River below Harrisburg, Pennsylvania. These projects are: the York Haven Hydroelectric Project, the Muddy Run Pumped Storage Project and the Conowingo Hydroelectric Project (Conowingo). The York Haven Hydroelectric Project, located in the City of York, in York, Dauphin, and Lancaster Counties, Pennsylvania, is owned and operated by the York Haven Power Company. The Muddy Run Pumped Storage Project is located in Lancaster and York Counties, Pennsylvania and the Conowingo Hydroelectric Project is located in Cecil and Harford Counties, Maryland; both are owned and operated by Exelon.

FERC issued a Draft EIS on July 30, 2014 and EPA provided substantial comments in our letter of September 29, 2014. Earlier recommendations for the scope of the EIS with additional information on the Conowingo Dam's effect on the Chesapeake Bay was shared in a correspondence of August 6, 2013. In the September 29, 2014 letter, EPA raised significant concerns including the need for:

- A comprehensive, up-to-date assessment of the sediment and nutrient dynamics and management options on the lower Susquehanna River and the Chesapeake Bay.
- Expanding the project study area to include those parts of the Chesapeake Bay where there are documented adverse water quality and aquatic life impacts due

to the loss of sediment and associated nutrient trapping capacity behind the Conowingo Dam.

- The recognition that the 85 year presence of the Conowingo Dam has profoundly impacted the sediment and nutrient management of the Chesapeake Bay Watershed and bears a portion of the responsibility to a long term solution.
- Acceptable ecological flows, fish passage, and fish stranding measures.
- An Endangered Species Management Plan for bog turtles
- An assessment of the effects of PCBs (particularly from sediment residing behind the Conowingo Dam) on water quality and the natural resources in the Susquehanna River and the Chesapeake Bay
- An assessment of the effects of climate change on the Susquehanna River and the Chesapeake Bay over the course of the decades-long license for the Susquehanna River Projects.

In addition, EPA rated the Draft EIS as an Environmental Objection 2 (EO-2). The EO rating meant that the review had identified significant environmental impacts that should be avoided in order to adequately protect the environment. Further, the 2 rating indicated that the Draft EIS did not contain sufficient information to fully assess environmental impacts that should be avoided to fully protect the environment.

After a review of the Final EIS, EPA stands by our comments on the relicensing conditions of the Susquehanna River projects presented in our letter September 29, 2014. EPA recognizes and appreciates that FERC has agreed to require additional bog turtle survey and protection in the project area. EPA is disappointed that other issues were not adequately addressed; summary of our comments are provided below:

The geographic scope of the project. While the Final EIS does recognize the Lower Susquehanna River Watershed Assessment (LSRWA) study which indicates that the Susquehanna River projects may have an effect on water quality in the upper Chesapeake Bay, the Final EIS geographic scope of study remains limited to the Susquehanna River itself, and does not include the Chesapeake Bay. EPA continues to have concerns with FERC's limited scope because the impacts of the Susquehanna River Projects on the Chesapeake Bay may go beyond what was assessed in the LSRWA and may include additional effects from climate change and/or PCB transport.

Conowingo Dam water quality mitigation measures for the Chesapeake Bay. As stated previously, during the Conowingo Dam's 85 year presence, it has had profound impact on the sediment and nutrient management of Chesapeake Bay Watershed and bears a portion of the responsibility to a long term solution. The LSRWA demonstrated the direct connection between the presence and operation of the Conowingo facility and increases in sediment and associated nutrient pollutant loads to the Chesapeake Bay during storm flow events.

As stated in the EPA letter of September 2014 on the Draft EIS, it is appropriate for the facility to be part of the long term mitigation and solution to water quality issues. Contributions of sediment and associated pollutants and material scoured from behind the dam that will result from significant storm events jeopardize attainment of water quality standards. Efforts to address sediment and nutrient issues upstream, downstream and at the hydropower facilities are critical.

It would be helpful for the public to understand the approach expected to be taken by the Conowingo facility's operator to address the requirements of the State of Maryland for a water quality certification under Section 401 of the Clean Water Act. It is our understanding that the application was considered incomplete by the State of Maryland and that additional study is needed (and underway) to assess water quality impacts of the Conowingo Dam.

The Conowingo Dam Flow Management Plan, fish passage and fish stranding measures. These issues continue to be unresolved with US Fish and Wildlife Service (USFWS) and the Pennsylvania Fish and Boat Commission. It is recommend that FERC continue to work with the resource agencies to negotiate an agreement. As stated in the EPA September 2014 letter, adoption of the flow estimate and flow management plan recommended by the USFWS would serve to address some environmental issues resulting from the Conowingo Dam's modification of flow regime.

PCB assessment. EPA continues to believe that FERC should provide a comprehensive environmental assessment of all possible known impacts not only to provide environmental information to the public but also for the lead agency to make an informed decision on the proposed project. As stated in the FERC response (to EPA on our Draft EIS comments), PCB contamination is a basin-wide issue; and since the sediment behind the Conowingo Dam is in dynamic equilibrium and PCBs tend to adhere to sediment, there is raised concerned that this could contribute more to this contaminant's mobility in the environment. For instance, though reduced levels of PCB contamination may be expected to enter the aquatic system due to improved stormwater or contamination controls, existing sediment behind the Conowingo Dam contains elevated levels of PCBs. Scouring events such as occur during storms are likely to mobilize the stored contaminants, enabling them to travel beyond the Dam. Assessment of the prolonged release of the contaminant and implications to the downstream cleanup goals should be considered.

Climate Change Assessment. According to the 2014 National Climate Assessment report (U.S. Global Change Research Program, GlobalChange.gov), our region is experiencing and is expected to continue to experience heat waves of greater frequency, intensity and duration, extreme precipitation events, and also sea level rise and land subsidence. These climate change events are and will have a profound impacts on infrastructure, hydrologic flow regimes, fisheries and the ecosystem as a whole. As stated in our September 29, 2014 comment letter on the Draft EIS, by not considering the potential effects of climate change, there can be no assurance that FERC has included adequate measures for protection of threatened and endangered species, migration of fish and eels, recreational use of the water body, and protection of water quality standards (including those of Maryland and Virginia in the Chesapeake Bay mainstem). This is particularly concerning since the Exelon operating license will be in effect for 30 to 50 years.

Thank you for allowing EPA the opportunity to review and comment on the Final EIS for the Susquehanna River Hydroelectric Projects. EPA Region III would be pleased to discuss the recommendations for additional study and planning outlined above. It is requested that these issues be addressed before a Record of Decision is prepared. We are available to meet in-person and suggest that an interagency discussion would be beneficial to the project development and relicensing process. If you have any questions, please contact me at 215-814-2702 or have your staff contact Kevin Magerr at (215) 814-5724 or magerr.kevin@epa.gov.

Sincerely,

John R. Pomponio, Director
Environmental Assessment and
Innovation Division

cc: Secretary Ben Grumbles, Maryland Department of the Environment

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Detailed Background Testimony in SUPPORT of House Bill 638

Natural Resources – Oysters – Shell Seeding, Shell Replenishment, and Rotational Harvest

Oyster Restoration and Management Plan

House Bill 638 ("HB638") implements an oyster restoration and management plan designed to restore and then to maintain the historic oyster bars in the Maryland portion of the Chesapeake Bay using methods that are proven to work. Restoration of the oyster bars will be a win for the environment, as oysters filter and remove suspended solids (*i.e.*, sediments), nitrogen and phosphorus from the water, which are the three pollutants targeted by the U.S. Environmental Protection Agency's ("USEPA") 2010 Chesapeake Bay Total Maximum Daily Load ("2010 TMDL"). Restoration of 10% of Maryland's historic oyster bars will enable the State to meet the requirements of the 2010 TMDL and is the most cost effective way to achieve compliance with those requirements. Restoration will also provide a significant economic benefit. The commercial seafood industry, the maritime industry, hardware and supply businesses, transportation businesses, and the tourism and retail seafood industries will benefit significantly from the revival and maintenance of the historic oyster bars.

Summary

The oyster is nature's filter of the Chesapeake Bay, removing nitrogen, phosphorus, sediment, and carbon from the waters in the Bay. A mature oyster (approximately 3" long) filters 50 gallons of water a day. Suspended solids (*i.e.*, sediments) are coagulated by the oyster and discharged as pseudo feces. Oysters eat phytoplankton (*i.e.*, algae) thereby absorbing nitrogen and phosphorus. Carbon absorbed from carbon dioxide in the water and suspended solids is used in the shell which is composed of calcium carbonate.

USEPA has acknowledged that Maryland could meet its allocations under the 2010 TMDL for the removal of nitrogen, phosphorus and sediments from the Bay by restoring 10 percent of the historic oyster bars in the Maryland portion of the Bay.

Sediments, two oyster diseases, (Dermo and MSX), the discontinuation of the shell replenishment program and the seeded shell relocation program by the Maryland Department of Natural Resources ("DNR"), and sulfides from decaying organic matter greatly diminished most of Maryland's historic oyster bars. The oyster harvest for the 2004 - 2005 harvest season reached an all-time low of less than 30,000 bushels.

The oyster population was so decimated that DNR permitted the dwindling ranks of Maryland watermen to engage in oyster cultivation through power dredging on several historic oyster bars in the Choptank River, the Honga River, Fishing Bay, the Tangier Sound around South Island and Smith Island, and the lower western shore. Nonetheless, DNR has since taken the position that oyster cultivation through power dredging would contribute to the further overharvest of oysters and the complete death of Maryland's historic oyster bars where power dredging is permitted.

Contrary to DNR's prediction, oyster cultivation through power dredging has restored each historic bar that has been cultivated. During the 2013 - 2014 harvest season, over 500,000 bushels of oysters were harvested. DNR's latest oyster survey (the 2013 Oyster Survey) details how the areas that have been cultivated through power dredging have recovered, have the greatest biomass of oysters and have the highest spat sets (the growth of baby oysters) in the Bay.

In the sanctuaries created by DNR disease is on the increase, oyster biomass is low and spat set is low, even though the sanctuaries created by DNR are on those historic oyster bars least affected by adverse environmental conditions that were the most productive habitats.

This proposed legislation accomplishes the following:

1. HB638 reopens many of the historic oyster bars in Maryland to oyster cultivation by power dredging. The legislation leaves to DNR the historic oyster bars in Harris Creek in Talbot County and the inland portion of the Little Choptank River and the portion of the Choptank River around the Horn Point facility in Dorchester County. (DNR already has fouled Harris Creek and the Little Choptank River by importing sediments mined in Florida and dumping them in those rivers, as well as crushing historic bars with granite dumped in those rivers). DNR's monitoring to date shows that DNR's restoration activities have allowed disease to return in such "sanctuaries" and that such sanctuaries have low spat sets and a diminishing biomass. Those sanctuaries will remain off limits to all commercial activity so that DNR may attempt to establish the value of such sanctuaries. Additionally, the proposed legislation retains the sanctuary within 400 yards of the Oxford Federal Laboratory (NOAA).

2. HB638 revitalizes the county commercial oyster committees, clarifying how election to such committees by county commercial oystermen is undertaken and giving such committees a managerial interest in the health and vitality of the historic oyster bars in their county waters by:

    a. Empowering the committees to undertake shell replenishment and seeded shell relocation programs;

b. Requiring the committees to establish a rotational harvest of the bars in their county waters, thereby assuring that 20% of the productive bars in county waters will not be open for harvest during any single harvest season once the bars are revitalized- DNR is provided a default so that if the County oyster committees fail to close 20% of the productive bars on a rotational basis, DNR may do so; and

c. Allowing the committees to restrict the method of harvest on 20% of the productive bars in their county waters to less efficient gear types than power dredging.

Detailed Analysis and Explanation of HB638

Watermen's Oyster Cultivation Program Implemented by HB638:

Oysters live and reproduce on the floor of the Bay. As the water warms to about 70 degrees (Fahrenheit) oysters release sperm and eggs into the water. Fertilized eggs generally form into larva in 6 - 12 hours. The larva float and move in the tidal currents for 2 - 3 weeks while they develop a shell and a foot and become large enough and heavy enough to sink to the floor of the Bay. After 2 - 3 weeks, the baby oyster sinks to the floor of the Bay searching for a hard surface, most preferably another oyster shell, on which to attach. When it finds another oyster shell, it secretes a glue to attach and continues to mature, no longer having any mobility.

An adult oyster, particularly in the colder months, can keep its shell closed and survive on the water retained in its shell for about three weeks. Younger oysters cannot survive quite so long.

Oysters can live in brackish water with only 4 - 5 parts per thousand (ppt) of salt and in full salt water (35 ppt of salt).

Oysters are killed by the following:

1. Sediments. Sediments are solids suspended in the water column (that sometimes coagulate) and fall to the floor of the Bay (in calmer slower flowing water) on top of and around the oysters and/or are filtered and secreted by the oysters as pseudo feces.[1]

[1] Sediments destroy oyster habitat in at least three ways:

1. Sediments smother oysters and oyster beds;
2. Oysters filter (*i.e.*, remove) suspended solids (*i.e.*, sediments) from the water and excrete those solids as pseudo feces, which are generally a dark blackish dirt pellet and when there is a lot of sediment in the water, oyster beds can quickly become engulfed and buried in pseudo feces;
3. Oyster larva (*i.e.*, baby oysters) need a hard clean surface on which to attach (set or strike) and mature. The best surface for spat to attach to and to mature is the shell of existing oysters. When oyster beds are covered with sediments and/or decaying algae blooms and encrusted in their pseudo feces, spat cannot attach or strike on such shell and grow into new oysters.

2. Anaerobically decaying plant matter. Leaves, twigs and sticks, dead plants, and decaying algae blooms that fall to the floor of the Bay where oysters live and decay. Such matter may initially decay aerobically, thereby depleting the oxygen in the Bay waters. Ultimately, such plant matter decays anaerobically, and the bacteria and enzymes that accomplish the decay release sulfide. Sulfide is one of the most toxic substances to marine life. Sulfide will kill mature oysters over time and will quickly kill oyster eggs/sperm, larva and oyster spat. This decayed matter becomes what is known as sapropel or euphemistically as “black mayonnaise.”

The best way to recover historic oyster beds is to expand the areas where oyster cultivation is permitted. Just as an orchard needs to be mowed, pruned, sprayed and harvested (*i.e.*, cultivated) to survive and thrive and a farm field needs to be disked (and occasionally tilled), seeded, weeded, irrigated and harvested (*i.e.*, cultivated) to survive and thrive, an oyster bed needs to be cultivated in order to survive and thrive.

Oyster cultivation has rapidly and successfully restored thriving oyster beds to the Bay and, in the past, has enabled established oyster beds to survive diseases, fresh sets (an influx of fresh water during years with unusually high precipitation that keeps the brackish water lower in the Bay) from high rainfall and drought conditions. Oyster cultivation consists of:

(1) <u>Dredging</u>. An oyster dredge is a rake that is up to a 42” long (sometimes with longer curved tines) and a mesh bag that is attached to the back of the rake and has a chain attached to the bottom of the bag so that the bag remains open and moves along the floor of the Bay as the rake is pulled across the oyster bed. The rake is pulled over the oyster bed by chains and/or ropes attached to a boat. The tines of the rake pop the oysters out of the pseudo feces in which they have become encased/buried and pulls them above the sediments that cover them so that they can be captured in the bag located behind the rake. The bag and rake are lifted to the surface when the captain perceives that the bag is filled with loosened oysters. As the bag is pulled to the surface, sediments, dead algae blooms and decaying plant matter that have become caked onto the oyster shell are washed from the shell. The bag is emptied onto a culling board. The captain and/or his crew then cull the materials from the bag by hand. The culling process further cleans and removes debris from the oysters. Oysters that are larger than 3” long are kept and harvested for sale. The oysters that are smaller than 3” long and the empty shell are slid off the culling board back into the water. The young oysters (less than 3” long) and shell that are returned to the Bay are washed again as they sink back to the floor of the Bay and come to rest on top of the sediments, dead algae blooms and pseudo feces that had previously covered and encased them. This process unburies, cleans and fluffs the shell and young oysters so that spat will attach to them during the next spawning season.

(2) <u>Shell Replenishment</u>. Shell replenishment returns harvested oyster shell to the natural historic oyster bars. The shell is purchased from shucking houses and is obtained from shell recycling programs. If it is important to return shell to the oyster beds because

oyster larva strike on (*i.e.*, attach to), survive and grow the best on oyster shell as opposed to any other substance.

(3) Seeded shell relocation. A seeded shell relocation program involves obtaining and placing shell on oyster bars that have conditions favorable to having oyster larva strike on shell and then moving such shell with spat to other oyster bars to mature. Certain areas of the Bay have conditions that are more favorable than other areas for oyster larva to survive and to attach to shell. Oyster larva is more susceptible to environmental conditions that can lead to their death than are mature oysters and juveniles that are maturing.

Low concentrations of salt, more rapid currents and lower tidal influence in the upper Bay can hinder oyster larva from surviving long enough to strike on mature oysters or from remaining in proximity of the oyster bar long enough to strike, particularly during rainy wet years.

Where dead and decaying plant matter and algae settle, anaerobically decompose and release toxic sulfide can vary from year to year and from period to period based on weather conditions and on where there is a proliferation of submerged aquatic vegetation (SAV), particularly eel grass and phragmites.[2] SAV slows the tidal flow of water that cleanses and oxygenates the Bay and captures/traps decaying leaves, plant matter and algae blooms and is more highly resistant to sulfide than marine life and other SAV species. Oyster bars that are subject to sulfide wash from anaerobically decaying plant matter and algae blooms will not propagate and renew because the sulfide wash will kill the oyster larva and spat that cannot survive for three weeks during warm, stagnant dry summer propagation periods. Those types of conditions are less prevalent in the middle and lower Bay and in certain areas of the Bay. This program allows watermen, who are familiar with the prolific spawning bars from culling during the winter harvest season, to set some of such bars in reserve for depositing shell to be seeded and later moved to bars with a less favorable summertime spawning environment to ensure that all bars have an influx of oyster spat to enhance propagation and long term survival.

Dermo and MSX are more prevalent and more devastating to the oyster population in waters with a higher concentration of salt. Spawning potential is enhanced in waters with higher concentration of salt. This program allows shell to be placed for seeding in waters with higher concentrations of salt and then moved to bars with lower concentrations of salt that are less hospitable for the survival of Dermo and MSX to mature.

[2] More dead leaves and plant matter have entered the Bay in recent years as programs to propagate wooded buffers along streams and drainage ditches have led to an increase in the amount of plant matter being washed into Bay tributaries.

Watermen are attuned to the changes in environmental conditions on the Bay and where favorable and unfavorable conditions for the spawning and maturation of oysters are during differing conditions due to drought, wet years, changes in the prevalence of SAV, areas of decay and sulfide release because they work the Bay daily year after year and their livelihood is dependent upon being attuned to such seasonal and cyclical changes.

Through a seeded shell relocation program, in conjunction with the establishment of a rotational harvest, watermen can ensure that oyster bars survive and thrive under less than favorable environmental conditions by moving shell and oysters to bars with more favorable habitats for spawning, or maturation, so that over time all bars will remain robust even though conditions will not be favorable for particular bars during particular periods.

When Chris Judy was the head of the shell program in the late 1960s and early to mid- 1970s, he operated a seeded shell relocation program that helped bars survive the devastating impact of Hurricanes Agnes (1972) and Eloise (1975) and maintain harvests at 2 million bushels per year or more. When Mr. Judy was removed from his position as the head of the shell program and DNR discontinued the seeded shell relocation program, harvests declined to all-time low of approximately 25,000 bushels (2004) and an all-time low oyster biomass.

Oysters did not begin to recover until after dredging was reinstated on the bars in the southern portion of the Maryland Bay. Shell replenishment will be required to maintain the comeback such bars have made. Seeded shell relocation programs will be necessary in addition to dredging, to bring back the bars north of the Bay Bridge due to the environmental impacts from the Conowingo Dam, fresh sets and the sewage system overflows that regularly release raw sewage and untreated industrial wastes into the Gunpowder, Patapsco and Severn Rivers.

Harvesting on a rotational basis will accomplish several objectives:

1. Removal of 20% of the beds per year will provide a reservoir of beds with mature oysters more than three inches long/three years old. This will provide beds with high spawning potential and beds with high water filtration ability to clean the Bay. Closed beds can be utilized in the seeded shell relocation program as beds with high spat sets can be put into rotational harvest and perform as seed beds for other beds that are less advantageously located from a spawning habitat perspective.

2. Rotating the harvest will ensure that beds are not out of harvest for such a long period that the mature oysters become weaker and less disease resistant or that the beds become silted over or engulfed in sediments, pseudo feces and sapropel from decaying plant matter and algae blooms.

3. Removal of 20% of the beds from harvest will keep the ranks of commercial harvesters more stable as all available stock will not be subject to harvest. There will not be incentive for more persons to try to become involved in harvest after "good years" and there will be incentive for harvesters to hang on after bad years as beds in reserve can be opened for harvest in subsequent years.

4. A rotational harvest will ensure that beds are regularly cultivated, so that they remain vibrant, but will guard against overharvest.

5. A rotational harvest will help to keep the market from being flooded with oysters during good harvest years, thereby maintaining higher and more stable per/unit pricing.

6. A rotational harvest, coupled with a seeded shell relocation program, should allow year - to - year harvest levels to be more consistent, making Maryland harvesters a more stable and reliable source of supply, which should enhance the marketability of the Maryland product.

DNR was empowered to set up a rotational harvest system but it never did so. Instead, DNR used its power to declare harvest reserve areas to permanently remove historic bars from harvest. Such bars have become silted over, sapropel contaminated, have higher levels of disease, and have lost oyster biomass, spawning ability and filtration capability. HB638 requires a rotational harvest with a bar not being able to be kept out of harvest for more than three harvest seasons.

Limiting up to 20% of a county's beds to more restrictive gear types than dredging equipment should further enhance the ability to guard against overharvest, to stabilize and optimize yearly harvest level, so that market prices remain robust, and to stabilize the number of harvesters.

Allowing county commercial oyster committees to manage county beds gives the county watermen a proprietary interest in their county beds without closing the beds to the public and without creating a leased bottom system that provides beds to the politically connected in a patronage/crony reward system. This proprietary interest will foster enforcement efforts, as county watermen will have an incentive to work with DNR to eliminate the harvest on closed beds and restricted equipment beds since doing so ultimately will benefit the county watermen by ensuring that the resource has long term viability and health, from which they will benefit in future years due to the harvest rotational system and gear restrictions established by the county committees.

Oyster cultivation through dredging, culling and seeding with natural spat (as opposed to hatchery spat purchased from Horn Point) restored the oyster biomass on oyster beds in the areas of the Tangier Sound portion of the Bay off of Somerset County and Wicomico County and in the Fishing Bay and Honga River areas of the Bay in Dorchester County and Wicomico County where DNR permits dredging. The annual oyster surveys conducted by DNR establish that there have been dramatic increases in oyster biomass and oyster harvests on those beds where dredging has been allowed. The positive economic, social and cultural impact has been as dramatic as the increase in biomass.

DNR Sanctuary Program:

DNR posits that before European settlers came to the United States, oysters were thriving in the Chesapeake Bay, therefore, in order to restore oysters, DNR must establish sanctuaries where oysters can live without interference from humans.

DNR has prohibited anyone from harvesting oysters on historic oyster beds where DNR has prohibited harvesting, designating such bars as sanctuaries. DNR's hypothesis is that if it closes the historically best producing oyster bars by prohibiting harvest, dumps hard substrate (granite) over existing oysters and shell in historic oyster beds, and then dumps shell and hatchery larva or hatchery seeded shell on top of the substrate, it will create an oyster reef that sits above the floor of the Bay and serves as a habitat for other fish species in addition to oysters. The theory is that by stopping harvest and creating a man-made reef in an attempt to replicate a pre-colonial environment, DNR will restore the oyster beds in conjunction with other fisheries.

In fact, the sanctuary program is a money pit that is destroying historic oyster bars, polluting the Bay, costing tens of millions of dollars, and putting commercial watermen out of business, closing shucking houses and devastating the seafood industry. Equally troubling, oysters are not thriving in the sanctuaries; instead, the incidence of oysters infected with Dermo is increasing, and mature oysters in the sanctuaries are dying out and not reproducing.

Preliminarily, man is in the United States to stay and the landscape will never return to how it was before European settlers began inhabiting the United States. Given the volume of sediments that are generated from human activity (*e.g.*, the Conowingo Dam; agriculture; residential, commercial and industrial development and activity, etc.), the Chesapeake Bay will not return to the pristine (sediment and algae bloom free) pre-developed state of the pre-colonial United States. Because pre-settlement conditions cannot be duplicated, the sanctuary concept is doomed to failure.

Moreover, a study of environmental history would show that the health of different oyster bars was cyclic and the contours of the Bay itself changed over time due to naturally occurring events. Studies of the Long Island Sound show that as oyster bars flourished and began to rise above the floor of the sound, they trapped plant debris that were washed down the tributaries and reduced the energy of cleansing tidal flows. As the plant debris built-up, anaerobically decayed and released sulfides, the oysters died and the base of the shell structures covered by the "black mayonnaise" of sapropel dissolved and the structure sank into the sapropel.

Man has materially altered the natural course of the Bay with development and cultivation of the land. We have to dredge to maintain navigable channels in the Bay. We have to engage in beach replenishment to keep the shoreline from moving in Ocean City. In the

1970s, DNR planted phragmites to stop shoreline erosion and to restore wetlands. Today, DNR and other governmental agencies spray herbicides to eradicate the phragmites, which has proven to be environmentally detrimental.[3] Today we plant eel grass, which will prove to be as environmentally detrimental as phragmites. Government agencies have a history of engaging in actions deemed to provide benefits to the natural environment that over time prove to be detrimental.

DNR's oyster sanctuaries have the following problems:

1. The majority of the sanctuaries are not worked. Sediments, dead plant matter (leaves, twigs, branches, uprooted SAV and uprooted shoreline vegetation) are washed down the tributaries during storms and fall out of suspension in the water column and cover the floor of the sanctuaries. Algae blooms die and fall to the floor of the sanctuaries. The sediments cover the oysters and prevent oyster larva (baby oysters) from striking on the oysters and shell in the sanctuaries. The decaying plant matter and algae blooms settle on, over and around the oyster bars, anaerobically decay, and release sulfide that kills the oysters and other marine life. As the oysters and shell are buried in sediments, decaying plant matter and dead algae blooms, the habitat disappears and the shell and oysters are lost.

2. The oysters in the sanctuary grow old because they are not harvested. As is observed in all species, the aged have poorer immune system functionality and become more susceptible to disease. The spread of Dermo and MSX is on the rise in the sanctuaries.

3. In the sanctuaries that DNR has worked, DNR's "restorative" actions are problem causing and further destroy habitat as is explained more fully below

<u>USACE/DNR Foreign Substrate Program:</u>

Under the foreign substrate program, DNR and other federal agencies are purchasing different types of substrate that is not naturally found in the Bay. To date, millions of tons of granite and slurry from a Florida swamp quarry have been dumped in Harris Creek and the Little Choptank River.

No pilot test was performed on the granite to determine whether wild oyster larva from the Bay would attach to it or whether hatchery larva would attach to it in the Bay. Much of the granite that was placed sunk into the floor of the Bay.

DNR now claims that the granite was dumped on historic oyster beds to raise the new beds that DNR hopes to form above the floor of the Bay. A sediment plume formed in the water

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[3] DNR now publishes guidance on how landowners can eradicate phragmites. *See* link: http://www.dnr.state.md.us/wildlife/Plants_Wildlife/phrag.asp.

where the granite was dumped because the granite was not washed before being dumped and was coated with fines. The purported purpose of dumping granite on the floor of the Bay on top of historic oyster beds was to raise the new beds that DNR plans to form above the floor of the Bay. In many cases, the granite has crushed and compacted the oysters and shell on which it is dumped. Creating elevated beds will serve to reduce the energy of tidal flow and will act as a fence to trap and to hold plant debris that is washed into the Bay and decaying algae blooms that fall to the floor of the Bay. Again, as such plant matter and algae blooms decay are trapped and held by such elevated structures, instead of being washed down the Bay to the deep channels with tidal currents and storm surges, the sulfide that is released during the anaerobic decay process will kill all marine life in the vicinity of such matter.

The material imported from the Florida swamp quarry was supposed to be washed fossilized oyster shell that was on average three inches long. Such material was not properly inspected. Such material was not washed. Such material failed to conform to the DNR contract specifications and the specifications of the USACE permits allowing such materials to be dumped in the Bay. After the nonconformity was raised with DNR and USACE, DNR requested and USACE granted a change to the requirements of the permit so that the slurry actually imported did not facially violate the permit. This material was full of fines. The material significantly polluted every area where it was dumped and the plume of pollution could be observed in the water three-quarters of a mile away from where such materials were dumped in the Bay. No analysis of the material actually imported was performed to determine whether it harbored biological or chemical pollutants.

Tens of millions of dollars have been spent on the substrate program. No pilot test was performed before making such expenditures to determine whether such programs create a structure on which oysters could spawn, mature and thrive. This program simply is another money pit. More disturbing, some of the Bay's best natural oyster habitat has been destroyed and no commercial or economic benefit will be derived from the expenditure. There will not even be oysters to clean the Bay established by such expenditures. There of course was no cost-benefit analysis that supports the continuation of such a program.

<u>DNR Hatchery Program:</u>

The thrust of the DNR hatchery program is:

A. To hatch oyster larva in a controlled environment and then to release such hatchery larva over wild oyster beds in the Bay; and

B. To use hatchery larva to seed shell purchased and washed by DNR in order to form spat seeded shell that can be dumped on historic oyster beds in the Bay.

The hatchery program has been a money pit and historically has failed. That is because the hatchery environment is much more pristine and different than the natural environment of the Bay. The water in the controlled hatchery environment is filtered and oxygenated. The temperature of the water in the hatchery environment is controlled. There are no predators in the hatchery environment. The parasites and diseases in the hatchery environment do not mimic the parasites and diseases in the wild environment of the Bay. When hatchery bred larva and spat or seeded shell is moved from the controlled environment of the hatchery into the wild environment of the Bay there is rapid and very high mortality of the hatchery product.

Internal problems in the hatchery environment create further complications. A fungus in the hatchery environment killed the vast majority of hatchery of oyster larva that was produced in 2014 before it ever was released or used. Human error in cleaning, maintaining and monitoring hatchery equipment and vessels has resulted in significant mortality of the hatchery product.

Again, no cost-benefit analysis has ever been performed to support the continuation of the hatchery program. The program is a tax burden that has failed since its inception and is doomed to continued failure.

<u>DNR Aquaculture Program:</u>

DNR's aquaculture program is illegal and in violation of the public trust doctrine because it leases public bottom to a private person for the sole and exclusive economic and private benefit of such person. The State holds the tidal waters of the Bay and its tributaries in public trust for the citizens of Maryland. It cannot lease bottom and waters to private individuals, thereby favoring one person over the public at large. DNR can adopt reasonable regulatory limits equally applicable to all; it cannot confer special rights and privileges on favored persons.

Since colonial times, Maryland law has recognized that the sovereign (originally Caecillius Calvert, the Baron of Baltimore and now the State of Maryland) holds title to the lands below navigable tidal waters subject to the public rights of fishing and navigation in such waters. *Board of Public Works of Maryland v. Larmar Corp.*, 262 Md. 24, 35-36 (1971)(citing *Kerpelman v. Board of Public Works*, 261 Md. 436 (1971); *Sollers v. Sollers*, 77 Md. 148, 151-52 (1892); *Hawkins Point Light-House Case*, 39 Fed. 77, 79-80 (D. Md. 1889); *Hess v. Muir*, 65 Md. 586, 606-07 (1886)(Concurring Op. of C.J. Alvey); and *Brown v. Kennedy*, 5 H. & J. 195 (1821)); *Van Ruymbeke v. Patapsco Indus. Park*, 261 Md. 470, 476 (1971) (citing *Bowie v. Western Md. R. R. Ter. Co.*, 133 Md. 1, 7 (1918)). *See* Md. Decl. of Rights Arts. 5 & 6. The right of the public to fish in and navigate along tidal waters stems from the Magna Charta granted by King John to the Barons at Runnymede on June 15, 1215. *Lamar Corp.*, 262 Md. at 46 (citing *Bruce v. Director, Dept. of Chesapeake Bay Affairs*, 261 Md. 585 (1971)); *Van Ruymbeke*, 261 Md. at 475-76 (citing McHenry, *Ejectment Law of Maryland* (1822)). Article 5 of the Maryland Declaration of Rights adopts the common law of England as the law of Maryland, thereby adopting the public trust doctrine, which recognizes the public right to fish in State waters belongs to the people. More specifically, Article 5 provides, "That the Inhabitants of Maryland are entitled to the Common Law of England and … are also entitled to all property derived to them from, or under the Charter granted by His Majesty Charles the First to Caecillius Calvert, Baron of Baltimore." Md. Decl. of Rights Art. 5(a)(1). Article 6 of the Maryland

Declaration of Rights provides that the State holds such rights in public trust for the inhabitants of Maryland. Md. Decl. of Rights Art. 6 (stating in part, "That all persons invested with the Legislative or Executive powers of Government are the Trustees of the Public, and as such, accountable for their conduct …."). The right to fish in the navigable waters of the State, therefore, is a fundamental right that has been recognized and protected since the founding of the State of Maryland.

In *Bruce*, *supra*, a county watermen's association sued the State agency charged with enforcing the licensing statutes for crabbing and oystering in the Maryland portion of the Chesapeake Bay. Those statutes required a person to obtain a license to harvest crabs and oysters in the county in which such person resided and only allowed a person to harvest crabs or oysters in the county waters where such person resided. A person who did not reside in one of the 13 tidal counties could not obtain a license to harvest crabs or oysters. The Court of Appeals ruled that the licensing statutes were "invalid in that they represented an unreasonable exercise of the police power." *Bruce*, 261 Md. at 600. The Court observed that "the statutes set forth an unlawful classification of persons and discriminate not only among the several watermen of the 13 tidewater counties in which crabs and oysters are found in marketable quantities, but also between residents of those counties and those who reside in Baltimore City and the 10 remaining counties." *Id.* at 601. The Court explained that even if such statutes where enacted to promote the conservation of the crab and oyster resource, they unconstitutionally discriminated between the residents of the various counties and that such restrictions were not only arbitrary, they bore no relation to the public interest or any realistic connection with conservation. *Id.* at 602-603. The Court further ruled that the right of the people to the State's tidewaters for taking and cultivating fish was a property right. *Id.* at 608. If statutes that discriminated against the right and ability of residents of the different counties to participate in the public fisheries were unconstitutional, a statute, regulation or public contract not authorized by law that gives political favor to select individuals to such public fisheries most certainly is unconstitutionally discriminatory and invalid.

A fundamental constitutional right, the right to fish, cannot be abridged or infringed upon for any rational basis. Government action that abridges a fundamental right is subject to a higher level of scrutiny. DNR has a fiduciary duty to manage the fisheries in a manner that maximizes the benefit of those fisheries to the public at large. Leasing bottom to a private person for the economic benefit of that person subverts the public right and benefit in violation of the public trust doctrine.

<u>Meeting 2010 TMDL:</u>

The State could meet the nitrogen, phosphorus and sediment reduction requirements of the 2010 TMDL solely through oyster cultivation. Oyster cultivation is the most cost effective way to meet requirements of the 2010 TMDL and to remove nutrients and suspended solids from the water of the Bay.

Maryland's total nitrogen reduction goal by 2025 under the 2010 TMDL is 11.8 million pounds per year at a cost of over **$14.5 billion**. According to EPA, a tenfold increase in the Bay's oyster population (a revival of approximately 10% of the historic oyster bars) could remove 10 million pounds of nitrogen annually. The State plans to spend **$3.7 billion** on projects that will upgrade failing septic systems, which is estimated to reduce nitrogen loading to the Bay by 1.24 million pounds annually. The septic upgrade cost does not take into account the cost of electricity required by the septic system upgrades or the annually maintenance costs, which are estimated to be between $700 to $1,000 per system per year. Additionally, this **$3.7 billion** dollar septic expense will remove only nitrogen while doing nothing to abate sediment and phosphorus.

Commercial watermen, at no cost to the State or any taxpayers, already have increased the State's oyster population to perhaps over 5% of its historic levels through oyster cultivation. For an expenditure of no more than several million dollars, commercial watermen could easily restore more and maintain more than 10% of the historic oyster beds. Such beds would remove not only nitrogen, but also phosphorus, sediments and carbon required to meet the 2010 TMDL. Simply put, for .1% to .5% of the cost to upgrade septic systems, the State could meet all of the requirements of the 2010 TMDL. The tax and fee structure to raise such funds already is in place (*i.e.*, the commercial surcharge and the bushel tax). The economic activity and the State revenues that would flow from oyster restoration would result in a net gain to the State and local economies, making oyster restoration a no-cost remedy. Oyster restoration is a no-brainer.

Restoring a robust population of oysters in the Chesapeake Bay would yield significant environmental benefits. Oysters filter and remove sediments, nitrogen and phosphorus from the waters in which they live. USACE Final Environmental Assessment and Finding of No Significant Impact, Chesapeake Bay Oyster Restoration Using Alternative Substrate dated May 2009 (2009 EA), § 3.4.7 at 22 (oysters remove suspended sediments from the water and deposit them as pseudo feces), § 5.3.1 at 34 (oysters feed on phytoplankton – nitrogen removal); Chesapeake Bay Oyster Recovery: Native Oyster Restoration Master Plan, Maryland and Virginia dated September 2012 (2012 MP) § 4.4 at 69 (oysters filter water while feeding and remove sediments and other solids depositing what they do not ingest as pseudo feces), § 4.4.2 (oysters eat phytoplankton), § 5.7.1 at 168-69.)

Oysters also remove carbon dioxide from the water, which is converted into the calcium carbonate ($CaCO_3$) that forms the oyster's shell. (2012 MP § 5.7.1 at 168-69.) USACE estimated that if the oyster density in the Choptank River was increased to 10 oysters per square meter over approximately 5,000 acres, 50% of the summer input of nitrates and 350% of the summer inputs of phosphates entering the Choptank River from stormwater runoff would be removed from the river. (*Id.*) Juxtapose this approach to addressing phosphorus in the Choptank River to the approach reflected in the proposed phosphorus management tool (PMT) regulations/legislation.

EPA estimates that 1,000,000 market sized oysters (3" oysters) remove between 700 and 5,500 pounds of nitrogen from the Bay/Bay tributaries annually. 2010 TMDL Apx. U at U-2.) EPA set goals in the 2010 TMDL for oyster restoration. Specifically, EPA stated:

> Filter feeders [oysters] play an important role in the uptake of nutrients from the Chesapeake Bay and have the potential to significantly improve water quality if present in large numbers. The current goal for the Chesapeake Bay is to increase the native Eastern oyster, Crassostrea Virginia, population tenfold. A population increase of that magnitude could remove 10 million pounds of nitrogen annually (Cerco and Noel 2005).
>
> Stephenson (2009) estimates that the cost of total nitrogen reduction from oyster assimilation at $0 - $100 per pound. In comparison, agricultural best management practices (BMPs) costs in Virginia [in 2009] range from $4 to $200 per pound and urban stormwater BMPs can be $25 to more than $1,000 per pound or more (Stephenson 2009).

(*Id.*, Apx. U at U-1, U-2.) EPA contemplated and discussed Bay restoration programs that would give credits to jurisdictions undertaking the restoration of oyster beds in the Bay. (*Id.* at U-3 - U-4.) Oyster bed reclamation and restoration, therefore, is a viable and preferred method for restoring the water quality of the Bay and Maryland Bay tributaries.

The sediments deposited in the Bay during and in the aftermath of Hurricane Agnes in 1972 destroyed the oyster beds north of the Bay Bridge. (2012 MP § 4.6.3 at 83-84.) Sediments smother and kill oysters and prevent oyster spat from seeding because spat require hard clean shell on which to attach in order to grow new oysters. (2009 EA § 3.3.1 at 13 (sediments now cover most historic oyster beds and planted shell becomes covered in an average of 5.5 years); 2012 MP § 2.1.1 at 17 ("Shell is being lost due to burial by sediments. Larval oysters require hard substrate on which to settle to grow."), § 4.1.1 at 49 (sediments eliminate oyster habitat), § 4.1.1.4 at 56 (sediment smothers oysters), § 5.5.4.5 at 150 (oyster growth must exceed sedimentation rates in order for oysters to survive).)

<u>Oyster Cultivation Provides Environmental and Economic Benefit:</u>

The USACE has repeatedly recognized the significant economic, cultural and social importance that the commercial harvesting of oysters has on the human environment in Maryland counties such as Dorchester, Kent and other Coalition counties. More specifically, USACE has observed and concluded:

> The Eastern oyster is highly valued as a source of food, a symbol of heritage, an economic resource supporting families and businesses, and a contributor to the health of the Chesapeake Bay

> ecosystem. Harvesting, selling and eating oysters have historically been a central component and driver of social and economic development in the region. From the colonial period to the 20th century, oyster harvests supported a vibrant regional industry, which in turn supported secondary industries, fishing communities, and a culinary culture centered in the bivalve.
>
> Oysters are an economic resource that supports unique communities and an industry that is an important component of the region's heritage and identity. Within these communities, oysters are a source of income for families of watermen and those employed in the processing of oysters (*e.g.*, shuckers); they support multigenerational businesses and contribute to a regional economy. The seafood industry contributes approximately $400 million each year (State of MD 2006) to Maryland's total gross domestic product of $257.8 billion (http://www.bea.gov/regional/gsp/). In 2005, commercial fisheries landings (*i.e.*, the weight, number and/or value of a species of seafood caught and delivered to port) alone earned $63,699,831 million in the State of Maryland (NMFS, 2006). Direct users include watermen, oyster growers, and oyster processors, packagers, shippers and retailers.
>
> More than 6,600 watermen work Chesapeake Bay, providing seafood to 74 seafood processing plants in Maryland; these plants employ more than 1,300 people (Md. Seafood 2005). These jobs represent an assortment of positions, including day laborers, sales representatives, managers, maintenance workers, delivery personnel, and others.

(2009 EA § 3.4.5 at 20-21.)

> The historic watermen's communities along the Chesapeake's western and eastern shores offer an aesthetic charm and have contributed greatly to tourist-based industries in these areas. Traditional workboats operating in these areas bring aesthetic appeal to the region as well as cultural value.

(2009 EA § 3.4.7 at 22.)

> Oysters give people the opportunity to interact with the marine environment in the most salient way possible – through work. These communities have helped to shape the character of the Chesapeake Bay region. Oysters are also a natural resource that carries cultural meaning as one symbol of a productive, healthy,

> beautiful Chesapeake Bay. ... To incorporate cultural meaning into policy, all groups' knowledge and values (implicit and explicit) must be recognized and evaluated based on an understanding of (1) how each group understands and uses oysters, and (2) how each group's perception of oysters affects its understanding of, support for, or resistance to policies and programs designed to manage and sustain the Bay's natural resources.

(2012 MP § 4.7, Cultural and Socioeconomic Conditions at 85-87.)

In the 2012 - 2013 season, 341,000 bushels of oysters were harvested by Maryland watermen. More than 62% of the oysters were harvested where DNR has permitted dredging with power boats. (Tarnowski, Mitchell and Staff, Maryland Oyster Population Status Report 2013 Fall Survey at 1, DNR Publ. No. 17-8192014-723 (Aug 2014) (2013 DNR Oyster Survey).) This was the highest harvest since the 2000 - 2001 season. (*Id.*) The dockside value of the 2012 - 2013 harvest was $10.9 million dollars. (*Id.* at 15.) This was a $6.3 million dollar increase over the dockside value of the 2011 - 2012 harvest. (*Id.*)

The harvest in 2013 - 2014 was even more robust and profitable than the 2012 - 2013 harvest. In the 2012 - 2013 season, the average dockside price for oysters was $30 per bushel. With over 500,000 bushels being harvested and sold, the dockside value of the 2013 - 2014 harvest was over $15 million dollars. Again, this was another significant increase in the economic value provided by oysters to the local economy of Maryland counties.

The USACE 2009 EA makes a point that shucking houses once had an important place in the economics of the Bay, but that they have disappeared. J. M. Clayton, a Cambridge, Maryland seafood processor, announced plans to open a shucking house later this year for the 2014 - 2015 oyster harvest. This will be the first Maryland shucking house to do business in Dorchester County since the prior shucking houses closed almost 40 years ago (a few years after the devastation of Hurricane Agnes). In addition to being a boon to the Dorchester County economy, such a shucking house would provide a source of shell to be returned to the Bay to expand natural habitat.

The oyster harvest by Maryland watermen has been essential to the sustainability of their businesses and the economic, cultural and social survival of Dorchester County and other Coalition counties.

<u>Tangier Sound Success Due to Watermen Oyster Cultivation:</u>

In 1997, DNR allowed Maryland Watermen to resume oyster cultivation through dredging with engine powered boats in portions of the area known as the Tangier Sound in the southern portion of the Maryland Chesapeake Bay (*i.e.*, the Honga River, Fishing Bay, the lower Nanticoke River, the lower Wicomico River, the lower Manokin River, the Big Annemessex

River, the Little Annemessex River and Tangier Sound areas). As oysters and shells were unburied, washed of smothering sediments, pseudo feces and decomposing algae blooms and returned to settle on top of such sediments, pseudo feces and decaying algae blooms that formerly covered them, the habitat on the historic oyster beds was restored through the oyster cultivation process. More surface area was made available on which spat could strike.

Recovery started slowly and has continued to accelerate. For the first four years, watermen would dredge the beds over a period of 10 or more hours and cull only 3 - 4 bushels of oysters large enough to harvest. However, during those four years, the watermen observed that more and more oysters were growing and that it was only a matter of a few years before the biomass exploded where oyster dredging was occurring. Indeed, the annual oyster survey conducted by DNR established that there was a record harvest in 2001.

From 2002 - 2010, the diseases of Dermo and MSX took a toll on all of the oysters in the Tangier Sound and reduced the oyster population. Watermen continued to cultivate the areas where they were permitted to dredge (*i.e.*, power dredge, clean, cull, and fluff the oysters) so that their habitat was conducive to spat strike. The wild oysters on those bars that survived the diseases rapidly developed resistance thereto as older less disease resistant oysters were removed through harvest and younger more virulent oysters were returned through cultivation to restore the population. Sure enough, production and biomass began to increase, at first gradually, and then with persistent cultivation, much more rapidly. Since the 2010 - 2011 harvest season, the biomass of oysters where dredging has continuously occurred increased at an accelerated and dramatic pace. As DNR reported, "the 2013 Oyster Biomass Index, a measure of oyster abundance and weight, increased for the third consecutive year and is at its highest point in 21 years." (2013 DNR Oyster Survey at 1, 14.) This was the third consecutive year that the biomass increased. (*Id.* at 14.) There was a 32% gain in biomass between 2011 - 2012 and 2012 - 2013. (*Id.*)

During the 2012 - 2013 season, 341,000 bushels of oysters were harvested by Maryland watermen. (2013 DNR Oyster Survey at 1, 15.) During the 2013 - 2014 season, over 500,000 bushels of oysters were harvested by Maryland watermen, and again, the vast majority of the harvest occurred on bars in the Tangier Sound that had been dredged. (Statement by DNR Shellfish Czar Mike Naylor based on the catch reports submitted by Maryland watermen.) The recovery of historic oyster beds in Maryland is attributable to the oyster cultivation accomplished by dredging by Maryland watermen.

USACE acknowledges that oyster dredging pulls and cleans shell buried in sediments and has rehabilitated oyster beds that have been smothered by sediments and are dying. (2009 EA § 4.1 at 25; *see also* 2009 EA § 5.6 at 40.) USACE acknowledged that the oyster dredging program conducted by Virginia watermen in the Great Wicomico River restored the oyster beds in the Bay and the mouth of that river bed. (2012 MP § 5.2.3.1 at 100.)

Oyster dredging was first legalized in the 1860s and occurred for over 100 years with millions of bushels of oysters being harvested in the Bay through the 1960s. It was not until

Hurricane Agnes and the massive quantity of sediments deposited on the floor of the Bay in the aftermath of that hurricane (36 million metric tons of sediments - in many cases over a foot of sediments) that the oyster habitat in Maryland was destroyed and the harvest of oysters sank to its former lows after the turn of the new century. After Hurricane Agnes, oyster dredging by sail provided insufficient power to unbury the smothered beds; resulting in a massive die out of the oyster biomass in the Bay and a massive degradation of water quality and oyster habitat. (2012 MP § 2.1.4 at 21, § 2.2.4 at 28, § 4.4 at 70, § 4.6.3 at 83-84.)

The USACE Master Plan Champions Oyster Cultivation:

> In trap estuaries, a thin layer of shell could be applied to certain areas prior to spawning and if needed, fresh shell could be applied to some areas that have been previously shelled by ... DNR or private leaseholders. ... Once these spat grow large enough to survive handling, the thin-shelled areas could be harvested using traditional methods by local watermen and moved to areas outside the trap estuary, but within the same or higher salinity regime, in order to plant them on other bar bases.
>
> For this purpose, trap estuaries are referred to as "incubator systems", and could potentially become the seed source used to enhance populations of native oysters throughout the Chesapeake Bay.

(2012 MP § 5.2.2.1e at 97.) Again, this strategy has been successfully employed in Virginia (USACE's Great Wicomico restoration project) – 42,000 bushels of spat on shell were moved from that trap estuary to publically leased bars in the Great Wicomico River. (2012 MP § 5.2.2.1f.) USACE recommends such stocking with spat on transported shell. (2012 MP § 5.2.3.1 at 100.) Dorchester County, Kent County and other Coalition counties seek to restore this program in the Choptank River, the Little Choptank River, the mouth of the Chester River, and the historic oyster beds off of the shores of Kent County, Queen Anne's County and throughout the Maryland portion of the Bay.

USACE estimates that restoration through aquaculture and the import of foreign substrate will cost taxpayers between $870 million and $6.5 billion. For less than one tenth of that projected cost, the Coalition counties and their watermen will restore thousands of acres of historic bars through oyster cultivation accomplished by power dredging. The oyster beds will restore water quality in the rivers and shores of the counties because such oyster colonies will be capable of filtering the waters in the rivers and shores. Such projects will benefit the natural environment, the economic environment, the cultural environment, and the social environment of the Coalition counties and the State. The Coalition counties will achieve their TMDL objectives through oyster cultivation.

Conclusion

Oysters are of great ecological importance to the Bay; however, the Coalition believes that the State should encourage a boarder approach to oyster restoration than is currently being practiced and should champion the economic benefits to local fishing communities from a thriving oyster fishery.

The Coalition counties, especially those with economies and cultures tied to seafood harvesting, are unconvinced that the Chesapeake oyster will be meaningfully restored through hatcheries, state maintained sanctuaries and aquaculture. Ignoring Mather Nature's role and forsaking the voice of commercial watermen as a resource in oyster restoration will only limit successful outcomes.

There is no dispute over the ecological value of the oyster – Mother Nature's best filter – to the water quality of the Chesapeake Bay. Oysters naturally filter nutrients and sediment, but cannot survive the onslaught of sedimentation at the present rate. In the upper Bay, the Susquehanna River is the dominant source of sediment influx, supplying over eighty percent (80%) of the total sediment load in the area north of Annapolis. As explained above, one of the most significant "stressors" on oysters in the Bay today is sedimentation, particularly in the upper Bay where there is no longer oyster harvesting. Yet, the upper Bay contains the areas of Bay bottom most suitable to support oysters.[4] The vast quantities of Susquehanna sedimentation and Conowingo Pond scour have smothered the upper Bay and buried some of the most historically productive Bay bottom for oysters.

The process of oyster dredging cultivates once healthy oyster beds, uncovering the beds from smothering sediments and making available clean and natural shell substrate upon which spat can attach. Without the option of dredging, oysters do not stand a chance in the upper Bay. DNR currently allows oyster dredging in certain areas of the Bay – mostly in the southern areas of Maryland's portion. Unsurprisingly, in such areas where oyster dredging is permitted the oysters have thrived. For DNR to then deny power dredging in the upper Bay underscores the lack of a coherent, comprehensive Bay-wide strategy to give the oyster a fighting chance. For its unparalleled ecological value as a filter feeder and as a natural resource critical to many local waterside economies, the importance of the oyster and dredging as a means to help bring the oyster back cannot be denied.

Implementation of HB638 would be the least expensive solution on a cost per pound basis for achieving compliance with the 2010 Bay TMDL. Passage of HB638 would be a win for the natural environment, as well as a win for the economic, social, and cultural environment of the State.

[4] *E.g.*, Cultch, oyster rock, hard bottom, etc. *See* Figure 5-14; USACE Native Oyster Restoration Master Plan, September 2012.

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May 9, 2014

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Re: CENAB-OP-RMN (MD DNR/Alternate Materials/Little Choptank Rivers/Shallow Waters) 2007-03659-M36
Maryland Tidal Wetlands License No. 14-WL-0104/201362125

Dear Mr. Policarpo / Mr. Bereznak:

This letter is submitted for and on behalf of the County Council of Dorchester County (the "Council"), who are the elected officials that represent the citizens of Dorchester County, Maryland (the "County").

The Council, for and on behalf of the County, opposes any alteration, modification, or extension of Department of the Army Permit No. CEN-OP-RMN (Md. DNR/Alternate Material) 2007-03659-M24 (the "USACE Permit") that:

(1) Extends the area where alternate materials may be dumped;

(2) Allows materials to be dumped in shallower water;

(3) Allows the dumping of additional or alternate materials; or

(4) Extends the time when materials may be dumped.

The USACE Permit was issued without the requisite environmental impact statement having been conducted. The USACE Permit detrimentally impacts the human environment. The USACE permit is contrary to County policy and plans. The United States Army Corps of Engineers ("USACE") failed to coordinate with the County as mandated by federal law and regulations before issuing the permit. For all of the foregoing reasons, and as more fully set forth below, the USACE Permit should be revoked and withdrawn.

The Council, for and on behalf of the County, opposes the issuance of a new permit to replace the USACE Permit (*i.e., CENAB-OP-RMN (MD DNR/Alternate Materials/Little Choptank Rivers/Shallow Waters) 2007-03659-M36* (the "New USACE Permit")).

The Council, for and on behalf of the County, opposes the issuance of *Maryland Tidal Wetlands License No. 14-WL-0104/201362125* (the "Proposed License") or any renewal, modification or extension of Wetlands License No. 08-0045(R2) (the "BPW License") that:

(1) Extends the area where alternate materials may be dumped;

(2) Allows materials to be dumped in shallower water;

(3) Allows the dumping of additional or alternate materials; or

(4) Extends the time when materials may be dumped.

A. Under the USACE Permit and the BPW Permit, DNR is dumping tons of sediments that may be nutrient laden and otherwise polluted into the Bay.

Under the auspices of the USACE Permit and the BPW Permit, the Maryland Department of Natural Resources ("DNR") has been dumping tons of sediments that may be nutrient laden into the Little Choptank River, Harris Creek and the Chesapeake Bay, and is smothering thriving oyster beds. DNR's recent oyster survey of the Little Choptank River confirms that there is no reason for dumping such sediments in the Little Choptank River.

Attached as Exhibit A is a picture of what DNR represented to us would be the fossilized oyster shells being imported from a quarry in Florida that would be spread in the Little Choptank River at a meeting in Cambridge. Such fossilized shell was three inches long or longer and two inches wide or wider. It was completely free of mud and debris. (William Goldsboro of the Chesapeake Bay Foundation, as recently as May 5, 2014, represented to County Council member

Tom Bradshaw that the shell being deposited in Little Choptank River looked like what is pictured in Exhibit A. (*See* Exhibit B, to which Mr. Goldsboro attached the photograph that is Exhibit A.) Mr. Goldsboro was sadly misinformed.) Attached as Exhibit C is a picture of the fossilized shell from DNR's website that DNR represented is being imported from Florida and placed in the Little Choptank River.

Attached as Exhibits D and E are photographs of dirt encrusted shell that DNR depicted on its website and represented was being imported from Florida to be dumped in the Little Choptank River. DNR initially represented that such dirt encrusted shell would be washed before it was placed in the Little Choptank River so that it would look like what is depicted in Exhibits A and C before being dumped in the Little Choptank River. DNR later represented that it was placing fossilized shell that looked like what is pictured in Exhibits A and C into the Bay and that such shell was being washed at the Florida quarry before shipment and that the containers being used to transport the shell were washed.

Attached as Exhibit F is a photograph from the DNR website of a barge of the dirtballs that were imported from Florida and purportedly were waiting to be transported to Harris Creek in Talbot County, Maryland to be dumped in that creek. Several barges of the same type of dirtballs are being offloaded into the Little Choptank River off of the shores of Dorchester County. Again, DNR represented that the dirtballs pictured in Exhibit E would be washed to look like what is pictured in Exhibit C before being loaded onto barges for dumping in the Little Choptank River.

Attached as Exhibit G is a photograph of a barge of dirtballs similar to that depicted in Exhibit F and a crane platform to which the barge is tethered for unloading. The following link, http://www.wboc.com/story/25417789/dorchester-county-joins-together-to-oppose-dnr-project, is to a video of a news broadcast made by the Delmarva news station WBOC Channel 16. The video shows the dirtballs being picked up by the bucket of a crane, the bucket being moved over the Bay, the bucket being lowered into the surface waters of the Bay where the crane operator from Langenfelder was instructed by DNR to agitate the bucket up and down and back and forth in order to attempt to wash off some of the muck from whatever hard substances the muck might be covering, and then the bucket being opened to dump the muck balls onto teeming oyster beds in the Little Choptank River. (*See* Exhibits H-L, which are stills from the WBOC video showing such agitation of the dirtballs and the plume of sediments that is being generated during the agitation process.) Please observe the plume of clay and sediment that was generated during the agitation process has further fouled the waters of the Little Choptank River and the Bay and has polluted a vastly larger area than the area where the dirtballs ultimately were dumped. (*See* Exhibits M-Q, which are stills from the WBOC video depicting the sediment plume generated during the agitation process.)

Langenfelder allowed several Dorchester County watermen to come aboard its barge and to take samples of the dirt ball slurry that it was offloading into the Little Choptank River. One of the 5 gallon buckets of dirtball slurry collected from the barge by a waterman is depicted in the WBOC video. (*See* Exhibits R & S, which are stills from the WBOC video.) Attached as Exhibit T is a photograph of a tray onto which some of the dirtball slurry that was collected from the Langenfelder barge in the Little Choptank River were placed. We had the soils analysis laboratory of a local contractor analyze a sample of the dirtball slurry collected from the Langenfelder barge. The analysis disclosed that between 10% and 15% of the materials in the dirtball slurry sample were clay. Between 10% to 40% of the materials in the dirtball slurry sample consisted of silt, sands and silica. Approximately 32% of the materials in the dirtball slurry sample consisted of pebbles and slivers of what might have been fossilized shell. Only approximately 18% of the materials dumped into the Bay resembled to some degree the fossilized shell pictured in the hand of the man that is attached as Exhibit A or in Exhibit C, once it was washed and manually brushed and the clay, silt, sand and silica were removed from it.

To our knowledge, DNR has not conducted any analysis to determine how much nitrogen and phosphorus are bound to the clay, silt, sand and silica (*i.e.*, sediments) that compose the dirtballs being dumped into the Bay. To our knowledge, DNR has not conducted any other analysis to determine whether other pollutants (such as heavy metals) are part of the dirtball slurry that it is dumping into the Bay on top of thriving oyster beds. Tons and tons of these dirtballs are being dumped into the Little Choptank River by DNR. The plume of sediment will eventually settle out over a much larger area of the Little Choptank River and the Bay than the immediate place where they are dumped.

No spat (*i.e.*, oyster larva) will attach to and grow upon such dirtballs. No spat will settle and grow upon the oyster, oyster shells and other hard surfaces in the Bay and the Little Choptank River that are being covered by the sediment plume that is generated by this dirtball dumping process. Submerged aquatic vegetation that is covered by such sediment plumes will die. Nutrients bound to the clays, silts and silica that compose approximately 50% of those dirtballs will be released into the water due to the saline, alkaline, and warmer waters found in the Little Choptank River and the Bay and spurn the growth of algae that will die and further smother the oysters in the thriving oyster bars in the area and further deplete the water of oxygen through hypoxia.

We know that the historic oyster beds in the Little Choptank River are teeming with oysters. DNR recently conducted a survey which so affirms. (*See* Exhibit V.) On its website, DNR posted the following comment:

> [During the week of April 7, 2014,] the Miss Kay [(a DNR boat)] took scientists out for an intensive survey of the oyster bars throughout the Little Choptank Oyster Sanctuary. This was done to re-assess populations prior to oyster restoration activities proposed for the river.

> As anticipated, **oyster populations in the Little Choptank have increased dramatically** since 2010. Patent tong sampling found many very large oysters and densities of up to **several hundred oysters per square meter**. Observed **mortality levels** continue to be **low**, and samples often have more live oysters than shell – a sign of a **thriving reef**.
> While the footprints of the remaining bars are very small compared to their historical acreage, the remaining reefs show no signs of burial or unusual disease mortality. On the contrary, **these reefs are thriving!**

(Emphasis added.) (Exhibit V.) Divers have affirmed that the historic bars in the Little Choptank River are thriving with oysters. During the summer of 2013, a local waterman fishing with a rod and reel caught a five gallon bucket of oysters five inches long and longer where Lengenfelder is dumping the dirtballs being imported from Florida by DNR.

Clearly, and by DNR's own admission, there is no need to dump more sediments into the Little Choptank River to cover up the thriving oyster reefs that are currently found in the river. Half of the materials that DNR has imported are sediments that are probably nutrient and pollutant laden. Likewise there is no need to pay for exorbitantly expensive aquaculture spat to populate the reefs in the area. Reducing sediments and pulling and rinsing the currently buried shell above the sediment that currently covers such shell is all that is necessary to expand the currently thriving oyster bars in the Little Choptank River.

For the past 15 to 20 years, County farmers have been increasing the width of the vegetated buffers between their farm fields and drainage ditches/swales and tributaries in order to reduce the amount of sediments and nutrients in stormwater runoff to the Little Choptank River and the Bay, which reduces their harvestable land and thus their earnings. Publicly operated wastewater treatment plants in the County have spent tens of millions of dollars to reduce the nutrients and sediments in their discharges. Millions have been spent to plant cover crops and implement nutrient management plans and agricultural best management practices to reduce sediment and nutrient discharges to the Little Choptank River and the Bay. MDE is directing the County to spend millions of dollars to remove pounds of sediments and nutrients that might still be entering the Bay from County shores.

Under the above referenced permits, DNR is dumping tons of sediments that undoubtedly are nutrient laden and undoubtedly contain other pollutants into the Little Choptank River and the Bay. It is patently absurd that County residents are being taxed and charged to remove sediments, nutrients and pollutants from the Little Choptank River and the Bay and, at the same time they are being taxed and charged to dump sediments, nutrients and pollutants imported from a quarry located in a Florida swamp right back into the Bay.

B. The Florida swamp quarry where the dirtballs originate.

Attached as Exhibits 1 and 2 are pictures of the swamp quarry in Florida from which the dirtballs being dumped into the Bay have are being mined. DNR published the pictures on its web site to show the origin of the dirtballs that it is importing. Such wetland swamps traditionally serve as filters for all of the nutrients and pollutants in local waterways. It is clear upon looking at the dirtballs on the barges being dumped onto the Little Choptank River, (*See* Exhibits F, S, T and U that the dirtballs have been dug directly from the partially submerged strata of the quarry and have been transported and loaded directly onto the railcars that transport such dirtballs directly to Maryland without first having been washed. All of the nutrients and pollutants from the Florida swamp are being imported to the Little Choptank River and the Bay.

C. The USACE Permit and the BPW Permit, as well as the proposed new permits, violate the 2010 TMDL and Executive Order 13508.

DNR is spending millions of dollars to import and to dump tons of sediments that probably are nutrient laden and contain other pollutants into the Little Choptank River and into the Bay. In December of 2010, the U.S. Environmental Protection Agency issued Total Maximum Daily Load for the Chesapeake Bay and the Bay tributaries (the "2010 TMDL"). The Maryland Department of the Environment ("MDE") has declared the Little Choptank River and other Bay tributaries in Maryland as impaired waters. The State is required to reduce the sediments and nutrients being dumped into the Bay pursuant to the 2010 TMDL and the State Watershed Implementation Plan that implements, at the State level, the 2010 TMDL.

The USACE Permit and the BPW License authorize the dumping of "marl" into the areas where the permits authorize dumping. "Marl" is defined as a deposit of crumbling earthy material principally composed of clay with magnesium and calcium carbonate that is used as fertilizer in lime deficient soil." *McGraw-Hill Dictionary of Scientific and Technical Terms*, 2nd ed. at 980 (1978). The 2010 TMDL in conjunction with the State WIP and Excutive Order 13508 should serve to prohibit the importation and dumping of fertilizer, sediments and nutrients from Florida into the Little Choptank River and the Bay. If they do not, then it is arbitrary and capricious of MDE and USEPA to require local expenditures to reduce the introduction of sediments and nutrients into the Little Choptank River and the Bay while permitting and licensing the import and dumping of foreign sediments, nutrients and pollutants into the Bay. USACE should exercise its authority under Special Condition 5, including Special Condition 5.c, of the USACE Permit, to suspend and revoke the USACE Permit, because the permit was issued before, and did not account for, the 2010 TMDL or the State Watershed Implementation Plan. Certainly, no knew or revised permits should be issued.

It should be further noted than nothing in the USACE Permit of the BPW Permit expressly authorized the dumping of fossilized oyster shell in the Bay of the Little Choptank River. The permits authorize the use of non-oyster shell material.

It should be further noted that the purpose of the USECA permit is: "To plant up to 1.5 million cubic yards of alternative (non-oyster shell) materials within the Maryland charted oyster bars in the Chesapeake Bay for the purpose of rehabilitating oyster bar habitat to work towards the re-establishment of an abundant and self-sustaining oyster population." USEAC Permit Project Description.

DNR has described the historic oyster bars in the Little Choptank River as, "thriving!" USACE should suspend the USACE Permit until DNR has fully delineated the "thriving" oyster reefs in the Little Choptank River. Nothing should be allowed to be dumped under the USACE Permit on any thriving reef. USACE has the authority to so suspend the USACE Permit under Special Condition 5 of the USACE Permit.

D. The oyster sanctuaries created in conjunction with the permits are contrary to the public interest and vitiate County policy.

The County has a Right To Work – Seafood Industry Policy. Dorchester County Code Chapter 126. (Exhibit 3.) This Chapter of the County Code declares the County's policy "to preserve and encourage the development and improvement of its waterways for the harvest of seafood" and "to reduce the loss to the County of its commercial seafood and fishing industry." This policy was adopted by the County in 2005.

The County has adopted Resolution No. 549, which reiterates and reaffirms the County's Right to Work Seafood Industry Policy. (Exhibit 4.)

The permits authorize projects that remove waterways and the seafood, including oysters and crabs held in public trust by the State for County and State residents from the fishery by permitting the creation of oyster "sanctuaries" and by permitting the destruction of thriving oyster reefs and crab hibernation grounds by allowing DNR to dump materials in the Little Choptank River and the Bay that will crush and smother such thriving oyster bars and reefs and bury hibernating crabs so deeply under such materials that they will suffocate and be unable to surface, grow and reproduce. It also permits the introduction of sediments and pollutants into such waterways that will smother and kill submerged aquatic vegetation, which serves as an essential component of the crab habitat, Such sediments, when dumped on existing oyster beds, make the beds unable to support oyster spat. The nutrients and pollutants in the materials allowed to be dumped spawn algae blooms that deprive the water of the oxygen necessary to support crabs and oysters and drive out other fisheries. The larger materials allowed to be dumped pursuant to the USACE and BPW Permits snag and tear crabbing lines and so materially alter the historic bottoms of the river and the Bay that the watermen no longer know where to find crabs for harvest if in subsequent years crabs migrate back in to the river after those that hibernated in the river perish due to suffocation and being crushed.

E. The Permits and the projects that the permits enable severely impact the County's human environment.

The County is rural. The agricultural and seafood industries are the primary economic engines on which the economy of the County and the fiscal health of the County depend. The majority of the secondary businesses in the County are dependent upon production in the seafood industry and from farming. The fabric of the communities in the County rely upon strong agricultural output and seafood harvest. Hardware and supply stores and mechanic and repair businesses primarily serve fishing and agricultural businesses and the individuals who work for such businesses. Local businesses process, store and transport agricultural and seafood harvests. Local financial institutions have significant investments in agricultural and seafood businesses and in individuals whose income is dependent on agricultural and/or seafood businesses.

The County is protected almost exclusively by volunteer fire companies. Those companies rely on membership and support from individuals dependent on agricultural and seafood businesses.

The social, cultural and economic fabric of the County is dependent upon the health and vitality of the agricultural and seafood businesses in the County. Even the tourism businesses in the County rely upon the charm and harvests of farmers and watermen to attack patrons. For hundreds of years, the oysters, clams and crabs harvested from the Choptank River and the Little Choptank River, as well as the Bay and other Bay tributaries, have provided the stock on which the social, cultural and economic environments in the County are dependent.

The state manages such fisheries in public trust for the citizens of the County and across the state. The creation of oyster sanctuaries deprives County citizens of resources that are essential to the County's human environment and violates longstanding County policy that has been codified in the County Code and recognized by the County's elected officials. (*See* D. *supra*.) *See, e.g., Bruce v. Director, Department of Chesapeake Bay Affairs*, 261 Md. 585 (1971); *Board of Public Works of Maryland v. Larmar Corp.*, 262 Md. 24, 35-36 (1971)(citing *Kerpelman v. Board of Public Works*, 261 Md. 436 (1971); *Sollers v. Sollers*, 77 Md. 148, 151-52 (1892); *Hawkins Point Light-House Case*, 39 Fed. 77, 79-80 (D. Md. 1889); *Hess v. Muir*, 65 Md. 586, 606-07 (1886)(Concurring Op. of C.J. Alvey); and *Brown v. Kennedy*, 5 H. & J. 195 (1821)); *Van Ruymbeke v. Patapsco Indus. Park*, 261 Md. 470, 476 (1971) (citing *Bowie v. Western Md. R. R. Ter. Co.*, 133 Md. 1, 7 (1918)). *See* Md. Decl. of Rights Arts. 5 & 6.

When federal and state agencies approve permits and programs that deprive the citizens of the County of fishery resources on which their social, economic and cultural livelihood is dependent, such agencies and such agency action cripples the human environment of the County.

USACE and MDE wholly failed to conduct any environmental impact statement and to make any attempt to coordinate its agendas and policies with the policies and concerns of the Council and the County. In so doing, USACE and MDE/DNR/BPW have ignored their duties and obligations under the National Environmental Policy Act and the regulations of the Council on Environmental Quality that implement NEPA. The USACE and BPW Permits should be suspended or revoked until requisite environmental impact statements have been prepared and USACE, MDE, and DNR have pursued ever practical means to have any actions undertaken by and any permits approved by such agencies reach consistency with the County policies discussed in D. *supra* and attached hereto as Exhibits 3 and 4.

F. Further discussion of the concerns already submitted to USEAC and MDE.

Navigability – DNR represented that the materials being dumped in the Little Choptank River will not raise the bottom elevation more than eighteen inches (18"). The manner of placement, *i.e.*, the random dumping of tons of material per bucket from the bucket of a platform crane does nothing to suggest that dispersion will be uniform or measured. Mounds of materials are being haphazardly scattered across the bottom of the Little Choptank. Nothing is being done to ensure that navigable channels are maintained.

Process of dumping – As barges of material are run into ever shallower areas, the barges and the tugboats pushing the barges will scrape and scar the bottom and will uproot submerged aquatic vegetation and kill flora and fauna on which buckets full of materials are haphazardly dumped, or that barges or tugboat bottoms crush or uproot. Such indiscriminate dumping undoubtedly will kill existing aquatic life, *e.g.*, submerged aquatic vegetation, crabs, oysters, etc. Consideration, study and minimalist approaches must take place so as to reduce the destruction of existing species and their respective structures. The dumping of the alternate substrate material and/or shell must receive heightened scrutiny so that existing aquatic life is not destroyed. Furthermore, the successful revitalization of targeted oyster populations must be given optimal potential for success, which will undoubtedly result from careful and strategic dumping of the oyster shell, although ideally no alternate substrate material would be dumped at all.

Out-of-State untested materials – DNR is dumping dirtballs mined from a swamp quarry in Florida into the Bay and the Little Choptank. More disturbingly, it has directed the contractor to attempt to wash the materials by agitating them in the Bay and the river just prior to dumping. DNR has not tested to determine the percentage of sediments on the dirtballs it is importing and dumping. DNR has not tested to determine the level of nutrients and pollutants in the dirtballs that it is importing and dumping. DNR has not tested to determine whether there are any toxins in the dirtballs that it is importing and dumping. No one else is allowed authorized to dump sediments and pollutants as is being done by DNR. USACE, MDE and the State have not taken any action to determine whether DNR is abiding by the terms of its permits or whether DNR is violating the terms of its permits.

2009 Environmental Report – The 2009 environmental report relied upon by the USACE and and MDE is misapplied and is insufficient regarding the proposed expansion of the Little Choptank River project. The report was conducted in 2009 on a different species of oyster (*i.e.*, non-native) and did not address the materials that DNR currently is importing and dumping in the Bay and the river. Failure to prepare the appropriate and statutorily mandated environmental impact statement ("EIS") is inexcusable. An up-to-date and properly targeted EIS is necessary to furnish protection for Maryland's waters and aquatic life from the consequential actions that will undoubtedly result from the materials that are haphazardly being washed and dumped in the Bay and the Little Choptank River.

Watermen Reclamation – Like a farmer tilling a field, watermen should be provided the opportunity to cultivate oyster bars; this practice is required to achieve a revived oyster population. Watermen have showed on numerous instances the positive impact of their efforts and dredging of oysters. By removing the buried oysters from the sediments and placing them on top of the soil, watermen have provided great benefit to the revitalization of oyster populations throughout many tributaries of the Bay.[1] The removal of oyster bars from productive harvest and instead being placed in sanctuaries is problematic in that it burdens the revitalization of oyster populations rather than increases it. Watermen should be permitted to cultivate the bottoms so as to utilize the most productive and cost-effective approach to increasing oyster populations. Through such an approach the goal of oyster restoration is achieved, all the while providing economic opportunity through one of Dorchester County's most influential industries (*i.e.*, the seafood industry).[2]

Taking of best natural harvest and natural spat areas – The Little Choptank River historically and for decades has served as one of the areas where watermen imported shell to be seeded with natural and indigenous spat before collecting such shell and transporting it to the bars in the northern portion of the Bay for maturation and harvest. This program had multiple benefits. First, the oysters on shell seeded and then transported to the upper Bay grew better and were more disease resisten than the oysters in the more saline water of the Little Choptank and the lower Bay. Second such natural spat were hardier, more disease resistant and much less expensive than fishery spat. Third, the program kept the bars in the upper Bay vibrant and productive, and provided an alternative population and an alternative indigenous spat set of native oysters when oysters in the lower Bay were affected with diseases not as prevalent in the upper Bay. Fourth, the process produced more oysters and better harvests at lower cost and without the risk of the introduction of new diseases from foreign waters and swamps.

[1] For example, the Honga River and the Little Choptank River.
[2] The seafood industry represents close to half of Dorchester County's economy.

Commercial watermen enhance the environment and commerce – Allowing commercial watermen to harvest the oyster bars, as opposed to using a sanctuary approach, would allow for both environmental and economic returns. The approaches utilized by watermen have repeatedly shown that their efforts aid oyster revitalization. An increased oyster population brings greater filtering abilities, which then in turn provides better water quality. All the while watermen are allowed to harvest oysters and earn a livelihood. Sanctuaries and alternate substrate material, as is currently proposed for Little Choptank, on the other hand leads to no economic benefit and detrimental environmental impacts, as evidenced by the attached exhibits.

Coordination – USACE, MDE and DNR have failed to failed to properly coordinate with the Council and other concerned local interests throughout the Little Choptank River oyster restoration efforts. As a result of this lack of coordination, the statutorily mandated process of reconciliation of competing local, federal and State policies has not occurred and outcomes that pursue every practicable means to reach consistency have not been investigated, let alone reached. The permits were issued in violation of a number of federal statutes and regulations. The revised permits are being considered in violation of a number of federal statutes and regulations. The Council request that you suspend further action on the permits until meeting and fulfilling your statutory obligations to coordinate with the Council. A letter from the Council shall be forthcoming shortly that further explains and details the process that must be implemented before taking further action on the requested permits and/or making any modification or revision of the existing permits.

CONCLUSION

For all of the reasons set forth above, the Council requests you to suspend all previously issued permits for dumping materials in the Little Choptank River or the Bay, including but not limited to the USACE Permit and the BPW Permit. The Council further requests that you not issue any new or revised permits.

The Council further requests you provide the names and contact information of the persons responsible for enforcing the current permits.

The Council further requests that you prohibit the continued dumping of sediments and pollutants in the Bay and the Little Choptank River by DNR.

The Council further requests that you prohibit the washing of fossilized shell in the Bay and the Little Choptank River and that you require than any fossilized shell that is dumped by DNR in the Bay or the Little Choptank River be fully washed and free of sediments and pollutants before it is introduced to the waters of Maryland.

The Council further requests that you prohibit the dumping of materials on thriving oyster reefs and bars.

The Council further requests that you prohibit any dumping of materials prior to June of any year or after October of any year so that hibernating crabs are not killed by such dumping.

The Council further requests that you immediately suspend the USACE Permit pursuant Special Condition 5.c and re-evaluate the impacts of the 2010 TMDL, the State Watershed Implementation Plan, and the activities actually being conducted by DNR.

The Council thanks you in advance for your time and attention to this matter of great significance to the citizens of Dorchester County and the State. Please let us know what you are willing to do to address the above noted concerns in a quick and efficient manner.

Very truly yours,

Jefferson L. Blomquist
For and on behalf of the County Council of Dorchester County

cc: County Council of Dorchester County
Joseph Gill, Secretary of DNR
Robert Summers, Secretary of MDE
Joseph D. Davia, Chief Maryland Northern, USACE

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EXHIBIT
A

Jeff L. Blomquist

From: Charles D. MacLeod
Sent: Monday, May 05, 2014 2:03 PM
To: Jeff L. Blomquist; Michael V. Forlini; Gordon P. Smith
Subject: FW: Little Choptank
Attachments: FL fossil shell.JPG

Importance: High

FYI – see what CBF says.

Charles D. MacLeod
FUNK & BOLTON, P.A.
210 South Cross Street, Suite 101
Chestertown, Maryland 21620
410-810-1381

From: Tom Bradshaw [mailto:rgcs5106@comcast.net]
Sent: Monday, May 05, 2014 1:26 PM
To: Charles D. MacLeod; 'Captain Scott Todd'
Subject: FW: Little Choptank
Importance: High

This is what the Bay Foundation says about the project.

Tom

Dorchester County Council District 5
Tom Bradshaw
5106 Rhodesdale Vienna Road
Rhodesdale, Maryland 21659
410-943-1212 Home
443-515-0612 Cell
Email tbradshaw@docogonet.com

From: Bill Goldsborough - ext. 2160 [mailto:BGoldsborough@cbf.org]
Sent: Monday, May 05, 2014 12:01 PM
To: Tom Bradshaw
Cc: Alan Girard
Subject: RE: Little Choptank

Hi Tom.

My name is Bill Goldsborough, and I run CBF's fisheries program including our oyster restoration work in both MD and VA. Thank you for your email to Alan. I don't profess to have all the answers, but I will share my thoughts on this issue.

Substrate to rebuild the bottom in our natural oyster bar areas is the biggest limiting factor for restoration. Through the harvesting and shell mining activities of the last 200 years, we have worked down the bottom from very high relief reefs that had accumulated over millennia to the relatively flat oyster bars of today that are often prone to siltation. Everyone agrees that natural oyster shell is the best material to use, but, as I'm sure you know, shell supplies are very limited today. CBF has been looking at possible alternatives at our Oyster Restoration Centers in MD and VA for the last ten years or so. We have looked at clam and conch shell, recycled concrete, limestone marl, and cast concrete modules with either pea gravel, marl pieces or shell chips in them as aggregate. The Corps of Engineers has also looked at slag and granite. Most of these options are similar in makeup to oyster shell and can be used in certain situations, but all have their downsides, including processing and transportation costs.

Relic shell dredged from upper bay deposits was used for several decades for repletion activities ("Langenfelder shell"), but those deposits are pretty much played out or occur in sensitive habitat areas. One large deposit at Man-o-War Shoals could yield modest quantities if a permit were issued, but there are controversial habitat and fishery conflict issues to work out there. Previously planted relic shell can be recovered from under layers of silt in many areas, but these are mostly in harvest areas and therefore only available to the industry to be re-planted in harvest areas. The bottom line is that there is no perfect answer, and, in my opinion, all viable possibilities need to be utilized, because the need is so great.

My opinion on the fossil shell the state has imported from Florida is that it is potentially one of the best alternatives we have seen, particularly because of the partnership with CSX Railroad which made the transportation affordable. I have seen barge loads in person and have some samples (a photo I took is attached, fyi). There is no doubt these are as labeled: fossilized oyster shells. They are a little thicker and heavier, but otherwise they look just like oyster shells. When the watermen opposition to their use materialized, I have to admit I was perplexed, because, as I said, I think they are a great alternative. I am not aware of a major problem with sediment associated with these shells, but I will look into it. My guess is that any such sediment was settled into the deeper part of the load, but if it is substantial, we would certainly support action to address it, and I expect the state would also. At least I think it behooves us to try to make it work. And I would add, whenever Langenfelder shell was planted in the past, it, too, would leave a temporary plume from fine materials associated with it. I can also say that one of the other concerns I have heard about the FL shell – that it could bring in disease – is unfounded. There is zero chance of that happening.

I am interested in your reference to rice clams having been seen in the annual oyster survey. The report on the survey is due out soon, and I will look for that reference and the biologists conclusions about its significance. Notwithstanding that, I would agree with your assessment that it probably means good water quality, at least in the location they were found and for the time period they had been there. My guess is it was a somewhat shallow site, however, because I doubt the oxygen concentrations in deeper water would have supported clam recruitment. Still, any small clams is a good thing as their numbers have been on the downside in recent years.

I hope these thoughts have been helpful. I am happy to offer anything further that might be helpful.

Best,

Bill

From: Alan Girard
Sent: Thursday, May 01, 2014 3:43 PM
To: Tom Bradshaw
Subject: RE: Little Choptank

Hey, Tom. Good to hear from you!

I've passed this on to our fisheries folks to get their take, but it might be a bit until I get a response. The results of the annual blue crab winter dredge survey are in and folks are busy analyzing the findings.

The preliminary analysis is that the news for crabs is not good. The population appears to have dropped slightly below the safe level for adult females, which means it is officially "depleted." However, crabbing pressure appears to have been within sustainable levels in recent years, so other factors besides harvest are likely involved. One of those is the cold winter which killed an estimated 28% of adult crabs in Maryland waters.

Normally, the crab population would be resilient to such natural factors, but it is likely that the continued poor quality of the habitat for crabs and other species in the Bay has made the population more vulnerable. For example, underwater grasses, which protect crabs from predation, are at about 20% of historic levels throughout the Bay. Also, low oxygen dead zones from too much pollution reduce the forage available to crabs by killing clams, worms and other invertebrates. These impacts that originate from inadequate treatment and management of pollution sources in many parts of the Bay watershed are just one example of why we are so focused on encouraging everyone from Pennsylvania and New York to Maryland's Eastern Shore to do their part for clean water. The stakes are just too high for our local watermen and the Bay itself to ignore sources of pollution we know are there and must be addressed.

Will try to see if we can get the report of dirty shell confirmed – certainly don't want that along with the other sources of pollution locally and elsewhere making things worse.

Hope you're high and dry!

From: Tom Bradshaw [mailto:rgcs5106@comcast.net]
Sent: Thursday, May 01, 2014 2:03 PM
To: Alan Girard
Subject: Little Choptank
Importance: High

Alan;
I just wanted to touch base on this project in the Little Choptank. I know that we don't agree on some of the issues regarding the health of the bay. I want to know what you feel about what the state is putting overboard in the name of oyster restoration. We were told that the fossilized shell was washed, but I was informed yesterday that the shell that was going over was dirty and brown in color. The shell was dunked into the water a couple of times to "clean" them and then put on the bottom. I was also informed that this process caused a brown plume in the water. How can this be considered healthy for the Little Choptank, let alone the bay. I have also heard that the last NOAA survey done from aboard the MISS KAY held the discovery of what they called rice clams in their tong rig. I have always been told that if these clams were in a river bottom that the water was good.

Tom

Dorchester County Council District 5
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Maryland Oyster – DNR Facebook Post (December 20, 2013)

EXHIBIT C

Close up of the oyster shells. The species is Hyotissa haitensis, which lived in the gulf during the late Pliocene into the Pleistocene geological epoch, roughly 2-4 million years ago.

Maryland Oyster – DNR Facebook Post (December 20, 2013)

Thousands of tons of shell waiting to be loaded.

EXHIBIT
tabbles
D

Maryland Oyster – DNR Facebook Post (December 20, 2013)

It only takes a few minutes to place 100 tons of shell in each gondola car thanks to these massive loaders.

EXHIBIT E

Maryland Oyster – DNR Facebook Post (December 20, 2013)

2,500 tons of shell on the barge, waiting for the tugboat to push her to Harris Creek.

EXHIBIT F

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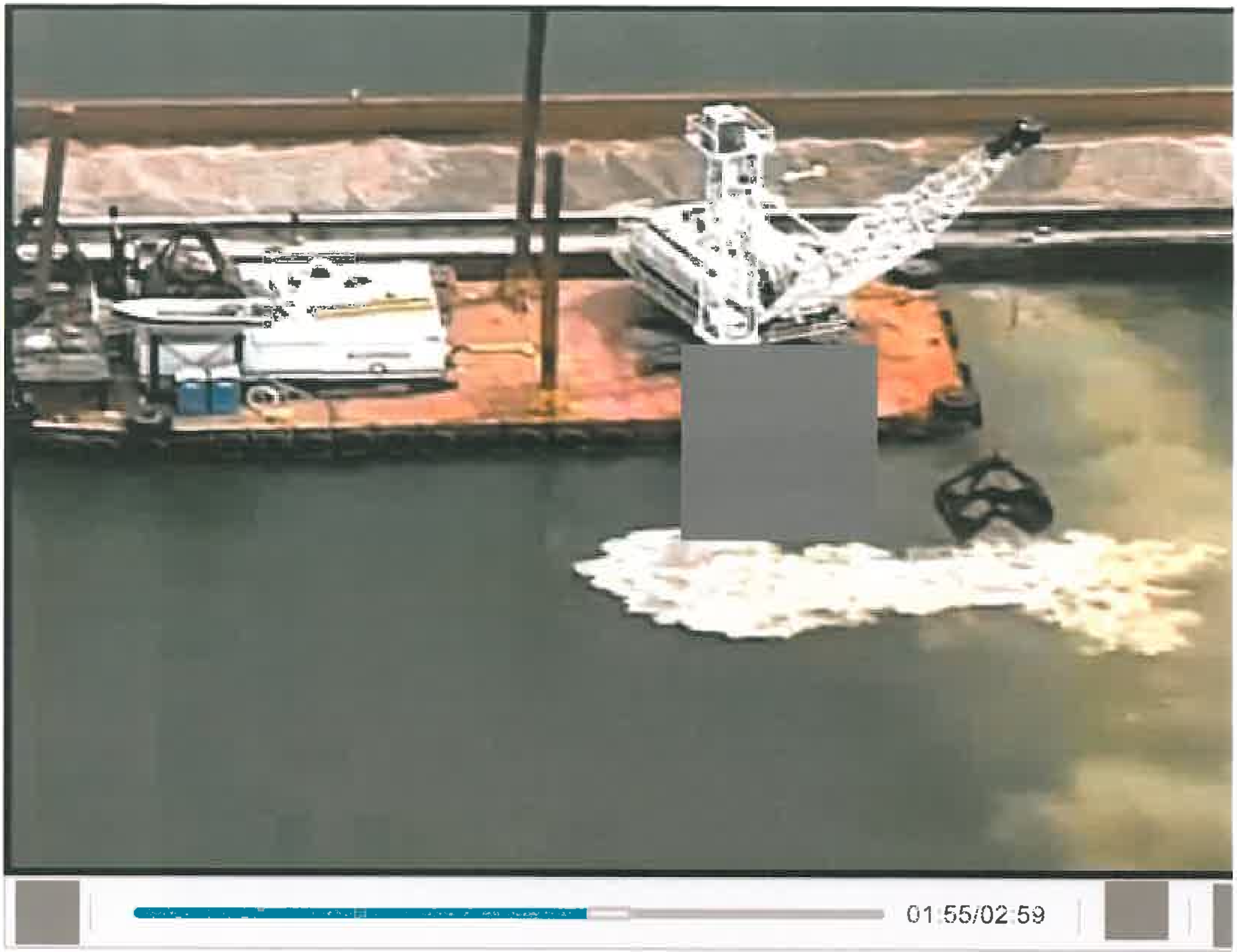

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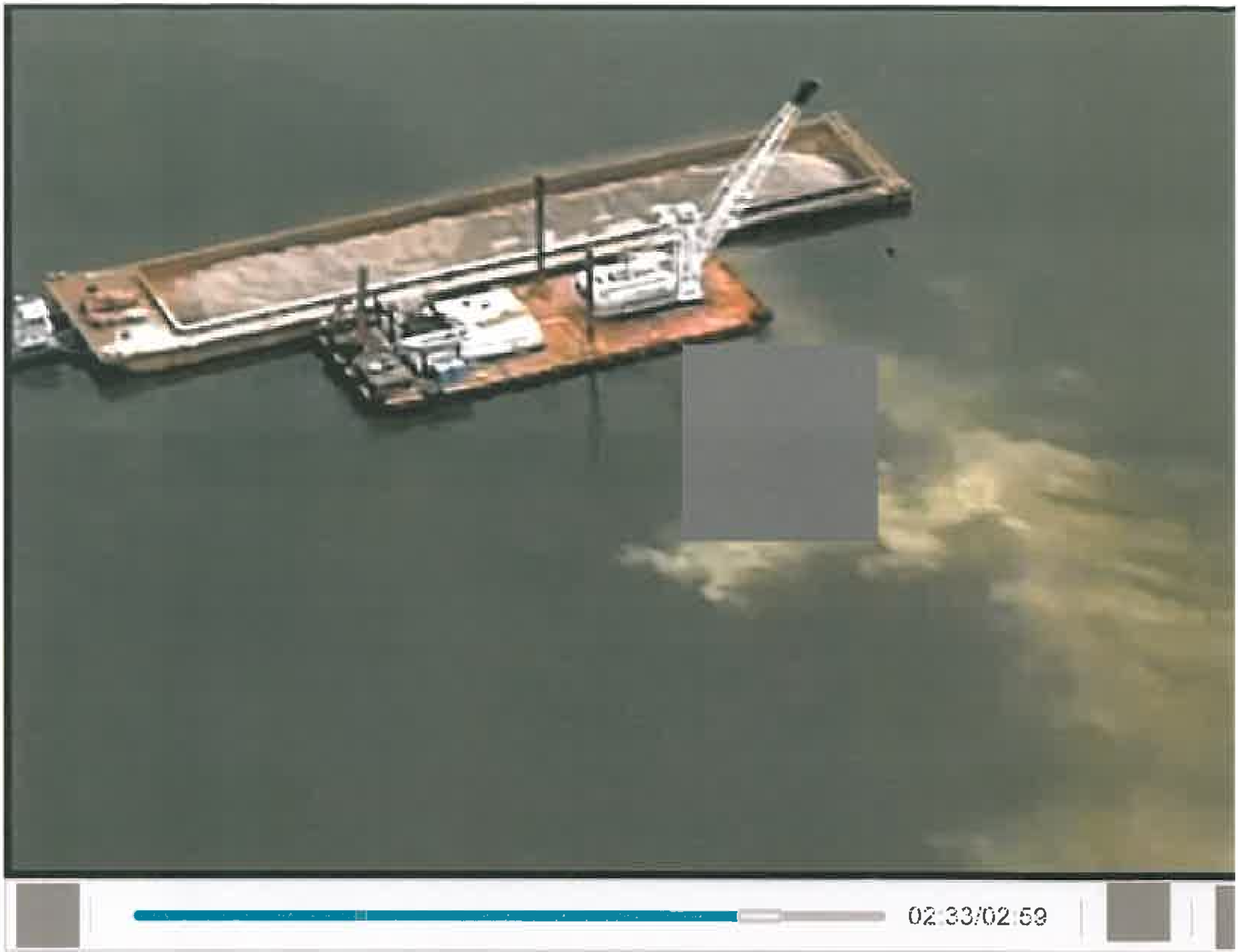

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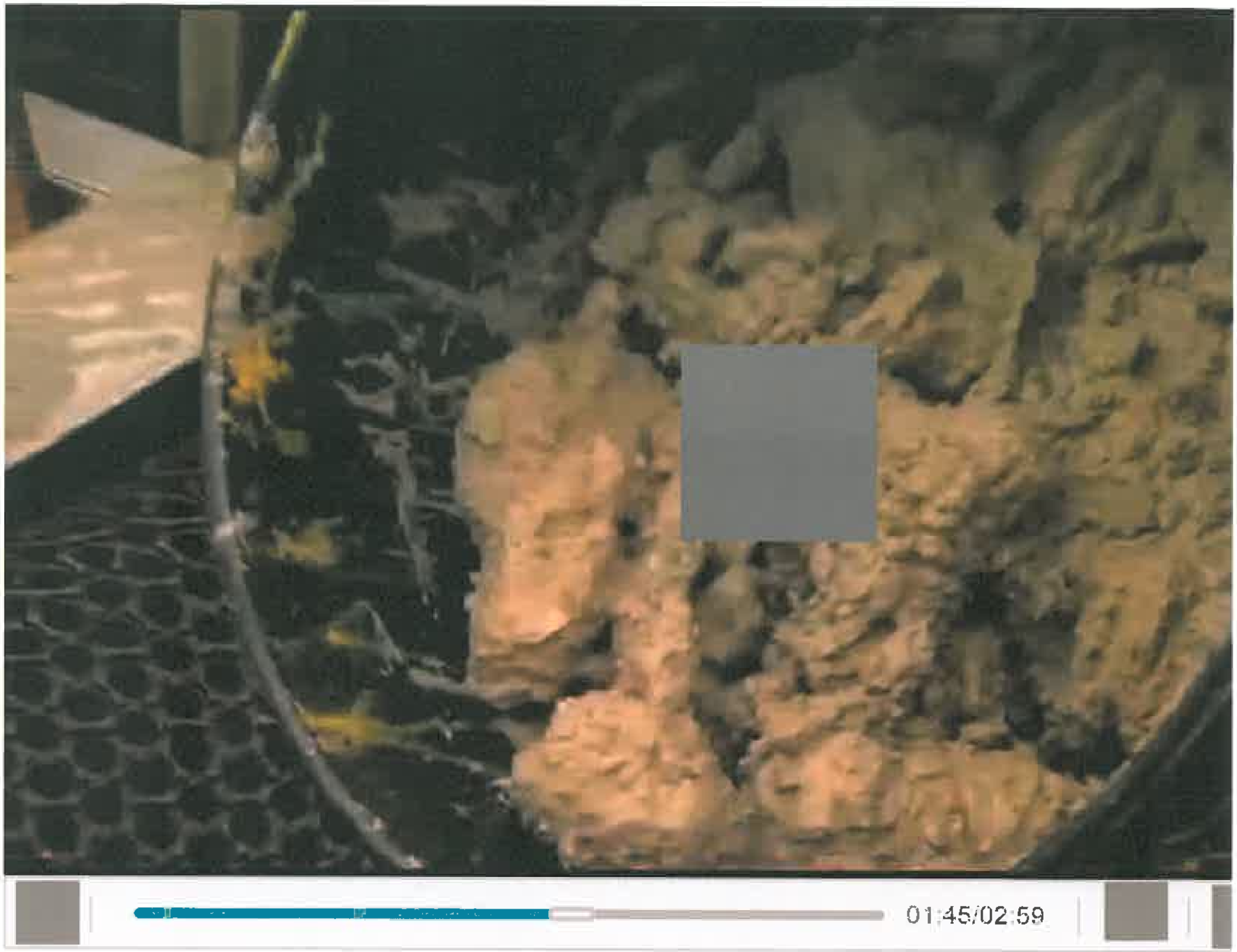

EXHIBIT

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Last week the Miss Kay took scientists… - Maryland Oysters – posted April 15, 2014 at 7:26 am

Maryland Oysters added 2 new photos.
April 15 at 7:26am · Edited ·

Last week the Miss Kay took scientists out for an intensive survey of oyster bars throughout the Little Choptank Oyster Sanctuary. This was done to re-assess populations prior to oyster restoration activities proposed for the river.

As anticipated, oyster populations in the Little Choptank have increased dramatically since 2010. Patent tong sampling found many very large oysters and densities of up to several hundred oysters per square meter. Observed mortality levels continue to be low, and samples often have more live oysters than shell- a sign of a thriving reef.

While the footprints of the remaining bars are very small compared to their historical acreage, the remaining reefs show no signs of burial or unusual disease mortality. On the contrary, these reefs are thriving!

Like · Comment

Pei-Pei Heikkinen, Becky Banwarth Thur, Jesse A. Briggs and 20 others like this.

34 shares

EXHIBIT V

Last week the Miss Kay took scientists… - Maryland Oysters – posted April 15, 2014 at 7:26 am

34 shares

Scott Todd The proposed restoration project for this area is still a disaster waiting to happen. The existing shells that have sanded over could be recovered at an enormously cheaper cost. It boggles the minds of everyone in this area that a project of this magnitude could be undertaken with out any input or consideration to local waterman, property owners or our County Commissioners . This is insane. These areas are the best natural seed producing bars in the bay and are in grave danger of being just forever. Please reconsider this project immediately.
April 15 at 8:06am · 11

Burl Lewis You admit the remaining bars footprints are very small compared to historical acreage but show no signs of burial??? Are you serious??!! The reason they are smaller is because the states took away waterman's ability to harvest there. Harvesting brings oysters an shells up cleans them and redeposits them on top of sediment. The same sediment that has buried those bars making their footprint smaller. A great example would be the expansion of oyster bars in areas where power dredging is legal. Not to mention I would put the spat catch rates on harvested bars against the spat set on sanctuary bars anytime!!
April 15 at 9:21am · 7

Paul West Scott is there any way you can talk to these "scientists" w/o govt intervention or are they govt employees? Just trying to get a handle on the food/money chain here. Who is benefitting from this BS? You said once but I forgot.
April 15 at 9:44am · 2

Chuck Collier That's natural bottom that was taken from us look at the spat set……. There's nothing like that on the sanctuaries they created thus proving that mother nature just needs to go through her cycles she has gone through for years.
April 15 at 10:51am · 2

Chris Lingerman Well said Berl and Scott!!!
April 15 at 11:11am · 2

Larry Boo Powley D_n_r said historically there are 200,000 acres of oyster beds in the chesapeake bay. But now due to sedimentation there are only 36,000 acres left. So instead of putting stones so they can sink due to sedimentation. Open it up for oyster dregeing bring all the old shells to the top so they can catch spat . Just take old larger oysters don't cost tax payers.and watermen and county benefits.
April 15 at 1:00pm · 1

Victor Jones I agree with you boo …I have been saying that for years. Open up the old oyster bars for power dredging wouldn't cost the state of md a dime.They would get bar cleaning done for no cost to the state…no brainner
April 15 at 3:07pm

Jeff Anthony Thats to Easy…
April 15 at 3:46pm · 1

Pat Thompson Awesome.
April 16 at 10:03am

Ryan Baxter The watermen that were hand tonging this area were making the bar more productive every year. they were bringing up and throwing back shells and small oyster that were cleaned by this cultivation action. the oysters you see are a result of this.When dnr throws fossolized trash and riprap to cover this bar it will slowly revert back to a unproductive and silted over bar .million wasted again. David Baxter Queen Anne Maryland.
April 17 at 3:11pm · 1

Maryland Oysters Using harvest data reported through oyster sales, the highest harvest in the Little Choptank River since 1985 was in the 1998/99 season when 84,100 bushels were harvested. In 2005/06 season it was down to 3,543 bushels. The last season watermen had full access to the river- the 2009/10 season, the total harvest was 923 bushels. In the span of 11 years of continuous oyster harvesting, oyster harvests in the river dropped by 99%.
April 17 at 3:58pm

Burl Lewis That is because hand tonging was the only gear allowed in the Little Choptank. Most waterman opted to harvest in rivers where power dredging was

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Face

Last week the Miss Kay took scientists… - Maryland Oysters – posted April 15, 2014 at 7:26 am

Maryland Oysters Using harvest data reported through oyster sales, the highest harvest in the Little Choptank River since 1985 was in the 1998/99 season when 84,100 bushels were harvested. In 2005/06 season it was down to 3,543 bushels. The last season watermen had full access to the river- the 2009/10 season, the total harvest was 923 bushels. In the span of 11 years of continuous oyster harvesting, oyster harvests in the river dropped by 99%.
April 17 at 3:52pm

Eng
Fac

Burl Lewis That is because hand tonging was the only gear allowed in the Little Choptank. Most waterman opted to harvest in rivers where power dredging was allowed because it is easier work. Harvest levels mean nothing if you do not include effort in the equation!!!
April 17 at 4:07pm

Burl Lewis Compare the numbers from the Little Choptank with the numbers from the same years in areas where waterman actually worked.
April 17 at 4:09pm

Ryan Baxter when you u make a rebuttle to an accurate statement include all viable info I talk.ed directly to the handful of tongers that worked the area . Totals were on the increase.The year of the closure was really looking good.So you are seeing the benefits in your pictures. As Burl Lewis states power dreadging became the norm in the choptank region.Dave Baxter Queen Anne md
April 17 at 4:45pm

Maryland Oysters http://www.dnr.state.md.us/…/2012_FallSurvey_Report.pdf All the data can be found here. This Fall Survey Oyster Report is where anyone can access information about oyster harvest, disease, population, and more.
April 17 at 4:46pm

Ronnie Clement So Maryland Oysters, did harvest in the Little Choptank drop by 99% in 11 years because oystermen went to different tributary's to catch their oysters? or because the oystermen caught all the oysters in the little Choptank? Do you have any records that show how many waterman were working the little Choptank in the years you posted (98-99,05-06,09-10)?
April 18 at 5:55am

Ronnie Clement TO answer my own question, the watermen simply went to other places where they could use easier methods of harvesting their oysters such as dredging. 11 years, harvest dropped by 99%.The oyster population didn't drop by 99%. If anyone wants to know why they left here to power dredge in other areas. Google or even Youtube handtong and power dredge oysters and see what sets them apart.
April 18 at 6:10am

Ronnie Clement Hey Maryland Oysters my tax dollars are paying you!!! So i want to know from YOU, did the harvest in little choptank drop 99% because the oystermen quit harvesting here or was it because the oysters vanished?? Let me know!!!!!!!!!
April 18 at 11:41am

Maryland Oysters The answer is in Table 2 of the Fall Survey Report. Oyster harvest dropped because the population dropped, as reflected by the very low spat counts in prior years (which results in fewer havestable adults 2-4 years later).
April 18 at 2:31pm

Ronnie Clement Population dropped which caused harvest to fall. You still can not accurately rely on the information you gave for the sole fact that you have no records of how many boats were working there in the years you posted. thanks for replying.
April 18 at 4:11pm

Maryland Oysters We do have records of how many boats were working, you can get that from the buy tickets. But that's not something that would normally be reported because everyone recognizes that boat days and harvest relate directly to one another (more boat days results in more harvest). Below some population level, people quit oystering because it's just not worth it anymore financially.
April 18 at 4:38pm

Maryland Oyster – DNR Facebook Post (December 20, 2013)

The quarry from which the shells are being mined. — at 30.017159,-84.612345.

EXHIBIT 1

Maryland Oyster – DNR Facebook Post (December 20, 2013)

Shells come from the darker, partially submerged layer. 30 feet of overburden needs to be removed to access this layer.

EXHIBIT 2

Dorchester County, MD
Monday, September 30, 2013

Chapter 126. RIGHT TO WORK - SEAFOOD INDUSTRY

[HISTORY: Adopted by the County Council of Dorchester County 9-27-2005 by Bill No. 2005-10. Amendments noted where applicable.]

§ 126-1. Findings and policy.

A. It is declared policy of Dorchester County to preserve, protect and encourage the development and improvement of its waterways for the harvesting of seafood. It is the purpose of this chapter to reduce the loss to the County of its commercial seafood and fishing industry by limiting the circumstances under which commercial seafood and fishing industry operations may be deemed to constitute a nuisance, trespass, or other interference with the reasonable practices associated with the preparation and activity of and to handle, harvest, buy, sell, load, unload, transport and process commercial seafood, including, but not limited to, boats leaving and returning at all hours, painting crab pots, chemicals, paints, dust, power tools, maintenance of boats and any and all other equipment, running and operation, noise, smell and presence of machinery and equipment associated with commercial seafood operating at any and all hours; provided that nothing in this chapter shall in any way restrict or impede the authority of the state and of the County to protect the public health, safety and welfare.

B. It is in the public interest to promote a clearer understanding between seafood industry operations and residential neighbors concerning the normal inconveniences of seafood industry operations which follow generally accepted seafood industry practices and do not endanger public health or safety.

C. This chapter is not intended to and shall not be construed as in any way modifying or abridging local, state or federal laws relating to health, safety, zoning, licensing requirements, environmental standards (including those standards which relate to air and water quality), and the like.

D. An additional purpose of this chapter is to promote a good neighbor policy by advising purchasers and users of property adjacent to or near commercial seafood operations of the inherent potential problems associated with such purchase or use. These potential problems include, but are not limited to, boats leaving and returning at all hours, painting crab pots, chemicals, paints, dust, power tools, maintenance of boats and any and all other equipment, running and operation, noise, smell and presence of machinery and equipment associated with commercial seafood operating at any and all hours. It is intended that,

EXHIBIT 3

through mandatory disclosures, purchasers and users will better understand the impact of living near commercial seafood operations and be prepared to accept attendant conditions as the natural result of living in or near rural and urban areas. However, this chapter shall be effective regardless of whether disclosure was made in accordance with § 126-5 herein ("Right to operate Seafood Industry and Real Estate Transfer Disclosure").

§ 126-2. Definitions.

As used in this chapter, the following terms shall have the meanings indicated:

COMMERCIAL SEAFOOD OPERATION

Includes, but is not limited to, all matters relating to the harvest of seafood in Dorchester County, including boats leaving and returning at all hours, painting of crab pots, bait, salt, paints, dust, power tools, maintenance of boats and any and all other equipment, running and operation, noise, smell and presence of machinery and equipment associated with commercial seafood operating at any and all hours but not limited to workers, boats, generators, ice making, refrigerated trucks, chum trucks, boilers, steam generators, cooking, fork lifts, heating equipment, cooling equipment, soft crab shedding equipment, tanks, pallets, cooking baskets and drums.

GENERALLY ACCEPTED SEAFOOD INDUSTRY PRACTICES

Those methods used in connection with the commercial seafood and fishing industries which do not violate applicable federal, state or local laws or public health safety and welfare and which are generally accepted commercial seafood and fishing practices in the commercial seafood and fishing industry. Generally accepted seafood industry practices include practices which are recognized as best management practices and those methods which are authorized by various governmental agencies, bureaus and departments. If no generally accepted seafood industry practices exist or there is no method authorized by those agencies mentioned herein which governs a practice, the practice is presumed to be a generally accepted seafood industry practice.

HEALTH OFFICER

The Director of the Health Department for Dorchester County or his designee.

LAND

All real property within the boundaries of Dorchester County and all territorial waters, rivers, bays and creeks located within Dorchester County.

§ 126-3. Limitation of actions.

A. A private action may not be maintained with respect to a seafood industry operation on the grounds that the seafood industry operation interferes or has interfered with the use or enjoyment of property, whether public or private, if:

(1) The seafood operation has been under way for a period of one year or more and if the operation or any future change in the operation did not constitute a nuisance from the date the operation or change in the future operation began; and

(c) Two members shall be appointed to serve a three-year term.

(d) After these initial appointments, all appointments shall be for a full three-year term.

(4) The Seafood Reconciliation Committee will conduct its proceedings in an informal manner and the rules of evidence shall not apply. In each case before it the Seafood Reconciliation Committee shall engage in nonbinding arbitration in controversies arising out of seafood industry operations, including but not limited to the invasion of property and personal rights by seafood industry operations.

(a) If the Seafood Reconciliation Committee or a court finds that the conduct of a party in bringing or maintaining an action in connection with a seafood industry operation was in bad faith or without substantial justification, the Seafood Reconciliation Committee or court shall require that party to pay to the owner of the seafood industry operation (or any other party opponent) the costs of the proceeding and the reasonable expenses, including reasonable attorney's fees, incurred by that party in defending against the action.

§ 126-5. Right to operate seafood industry and real estate transfer disclosure.

A contract or an addendum to the contract of sale for any real property in Dorchester County shall contain in conspicuous type the following disclosure statement:

RIGHT TO OPERATE SEAFOOD INDUSTRY REAL ESTATE TRANSFER DISCLOSURE

Notice To Buyer

DORCHESTER COUNTY ALLOWS SEAFOOD INDUSTRY OPERATIONS (as defined in the Dorchester County Seafood Industry Right to Work, Chapter 126 of the Dorchester County Code). You may be subject to inconveniences or discomforts arising from such operations, including but not limited to boats leaving and returning at different hours of the day, odors, fumes and noises associated with the maintenance of boats and any and all other equipment, noise, smell and presence of machinery and equipment associated with commercial seafood operating at various hours, including but not limited to workers, boats, generators, refrigeration, ice making, refrigerated trucks, chum trucks, all other trucks, boilers, steam generators, boats, cooking, fork lifts, heating equipment, cooling equipment, soft crab shedding equipment and lighting. Dorchester County has determined that inconveniences or discomforts associated with such seafood industry operations shall not be considered to be an interference with reasonable use and enjoyment of land, if such operations are conducted in accordance with generally accepted seafood industry practices. Dorchester County has established a reconciliation committee to assist in the resolution of disputes which might arise between persons in this County regarding whether seafood industry operations are causing an interference with the reasonable use and enjoyment of land or personal well-being and whether those operations are being conducted in accordance with generally accepted seafood industry practices.

RIGHT TO OPERATE SEAFOOD INDUSTRY REAL ESTATE TRANSFER DISCLOSURE

Notice To Buyer

Seller: Date:

Seller: Date:

I/WE ACKNOWLEDGE RECEIPT OF A COPY OF THIS STATEMENT:

Buyer: Date:

Buyer: Date:

IF YOU DESIRE LEGAL ADVICE, CONSULT YOUR ATTORNEY.

§ 126-6. Severability.

Should any provision, section, paragraph or subparagraph of this chapter, including any code or text adopted hereby, be declared null and void, illegal, unconstitutional, or otherwise determined to be unenforceable by a court having competent jurisdiction, the same shall not affect the validity, legality, or enforceability of any other provision, section, paragraph or subparagraph hereof, including any code or text adopted hereby. Each such provision, section, paragraph or subparagraph is expressly declared to be and is deemed severable.

§ 126-7. Section headings, chapter headings, titles.

Section headings, chapter headings, titles, etc. are for the purpose of description or ease of use and do not form a part of the text of this chapter or any code or text adopted hereby.

§ 126-8. Existing liabilities.

Except to the extent specifically provided herein, this chapter shall not discharge, impair or release any contract, obligation, duty, liability or penalty whatever existing on the date of its enactment. It is not intended hereby that the law of nonconforming use be changed, or that the court's rule of construction concerning the application of changes in the law during the pendency of actions be modified hereby, but simply that this chapter should not effect a change between private parties.

§ 126-9. Short title.

This chapter shall be cited as the "Dorchester County - Seafood Industry Right to Work."

RESOLUTION NO. 549

RESOLUTION OF DORCHESTER COUNTY MARYLAND INVOKING ITS AUTHORITY TO ENGAGE FEDERAL AND STATE AGENCIES IN THE COORDINATION PROCESS ESTABLISHED AND MANDATED BY FEDERAL AND STATE STATUTES.

The Dorchester County Council (the "Council"), which is the governing body of Dorchester County, Maryland (the "County"), does hereby Resolve to initiate the process of coordination by which it will engage federal and state agencies to coordinate with the County, government to government within the definition of coordination mandated by the Congress of the United States, and in support of the Resolution states as follows:

I. **FINDINGS**

The Council makes the following findings in support of and as the base for this Resolution:

A. Introduction

1. State of Maryland departments such as the Department of Natural Resources ("DNR"), the Maryland Department of the Environment ("MDE"), and the Maryland Department of Agriculture ("MDA") receive and heavily rely on federal funds; as a result when they initiate and implement the development of rules, regulations, plans, policies or management actions that mirror or assist in the implementation of federal statutes, rules and regulations, federal programs or policies or management actions, they are subject to the National Environmental Policy Act ("NEPA"), which includes coordination with local governments.

2. When a State department initiates development and implementation of a NEPA project, it is bound not only by NEPA itself but by the regulations issued by the Council on Environmental Quality ("CEQ"), the federal agency created by NEPA to oversee its implementation.

3. NEPA provides that human interests must be considered in making a balanced decision as to the advisability of development of a plan, policy, rule or regulation or management action so that the action is taken only after coordination in order to assure that the action results in:

> [C]onditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consist with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources.

42 USC § 4331.

EXHIBIT 4

4. The CEQ regulations include 40 CFR §§ 1508.14 and 1508.8 which define and insist that agencies protect the "human environment." 40 CFR 1508.14 provides:

> *Human environment* shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. (See the definition of "effects" (§1508.8).) This means that economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment.

40 CFR 1508.8, which is the lynchpin of 40 CFR 1508.14 provides:

> Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

5. The DNR, MDA and MDE have not engaged in the coordination of policy with Dorchester County regarding projects requiring compliance with NEPA. Those agencies are required to coordinate because they have been funded at least partially with federal dollars. Particularly hard hit by the failure to coordinate have been the commercial fishing industry and the farming industry of Dorchester County. Also adversely impacted are persons without access to publicly available wastewater treatment works.

6. Economic development generally within the County has been significantly adversely impacted by new stormwater management and septic requirements and will be even more detrimentally impacted by proposed "accounting for growth" regulations.

B. Commercial fishing economic disadvantage and harm to the County and its citizens

1. The history and culture of Dorchester County is founded on the practice of economically viable farming and commercial fishing use of the Chesapeake Bay and tributaries feeding the Bay.

2. For many generations, families have run the family fishing business from docks in the County, and said businesses have provided fresh fish, crabs and oysters for Maryland and the world.

3. Dorchester County at one time was the home to numerous seafood processing businesses, seafood wholesale and seafood retail businesses which are an essential component of the County's social, cultural and economic fiber.

4. Chapter 126 of the Dorchester County Code is titled "Right to Work – Seafood Industry" and declares the "policy of Dorchester County to preserve, protect and encourage development and improvement of its waterways for the harvesting of seafood … [and] to reduce the loss to the County of its commercial seafood and fishing industry by limiting the circumstances under which commercial seafood and fishing industries may be deemed to constitute a nuisance, trespass or other interference with reasonable practices associated with the preparation and activity of [seafood harvesting and processing]."

5. The market for Atlantic menhaden historically has been and remains economically viable. Menhaden is a fish that is used for many purposes and a fish that has been caught for years by commercial watermen working out of Dorchester County and stored, transported and resold by seafood businesses in the County.

6. The market for oysters, crabs, rockfish (aka striped bass), bluefish, red drum, perch and other species historically found in the Chesapeake Bay historically has been and remains viable, and visitors and seasonal residents of the County, as well as permanent residents of the County, patronize venues and establishments that provide seafood.

7. DNR has restricted the poundage of menhaden caught by County watermen in direct contravention of the Right to Work – Seafood Industry policy of the County. DNR has issued the restrictions purportedly in accordance with, and being driven by the fear of enforcement by the United States Secretary of Commerce of, a menhaden catch limit established by a compact agency that limits the pounds of menhaden that may be caught in Maryland waters.

8. The DNR restrictions on allowable menhaden catch and by-catch were not coordinated with the Council and, therefore, cannot lawfully be applied because of non-compliance with NEPA and CEQ §§1508.8 and 1508.14; and the

restrictions are not justified under the federal Regulatory Flexibility Act (5 U.S.C. 601-612). DNR's failure to coordinate the development of the restrictions with the County violates NEPA and CEQ requirements.

9. As of January 1, 2014, DNR will implement regulations that establish individual catch shares (aka "individual transferable quotas" or "ITQs") on County watermen that will restrict the poundage of rockfish a County waterman is permitted to catch in direct contravention of the Right to Work – Seafood Industry policy of the County.

10. In other jurisdictions where individual catch shares similar to the individual catch share system being implemented by DNR have been established, the commercial seafood industry has suffered significant economic detriment which is compounded by cultural and social detriment.

11. The Bay is teeming with rockfish. Dorchester County watermen have had to release large quantities of rockfish caught in the pounds nets that they maintain in the Bay. Other watermen and charter boat captains report reaching their catch allotments for rockfish within a couple of hours of leaving their docks. Dorchester County watermen report and verify that the quantity of rockfish in the Bay is upsetting the Bay's biomass balance. County watermen report and verify that upwards to two dozen crabs regularly have been counted in the bellies of 20+ pound rockfish that have been caught in the Bay during the 2013 season.

12. DNR has regulated Maryland watermen in a disparate and discriminatory manner by imposing restrictive and expensive harvesting methods and catch shares on the harvesting of menhaden, oysters, crabs and rockfish that are not imposed by Virginia, which shares the Bay and Atlantic coastal waters with Maryland, in direct contravention of the Right to Work – Seafood Industry policy of the County and in a manner that violates equal protection of the law guaranteed by the Maryland Declaration of Rights.

13. Recently, DNR personnel have explained to the media that Maryland fishermen have over caught menhaden according to federal guidelines, but that perhaps the federal authorities will not "fine" the State. There are no binding federal guidelines that require Maryland to impose the menhaden limitations and there are no such federal mandates, and so there can be no fines.

14. The State of Maryland has voluntarily placed rigid restrictions on fishing in Maryland to the detriment of its own citizens who reside, fish and live in Maryland and who contribute to the revenue from which vital County public health and safety services and vital County social, cultural and economic development services are funded.

C. **Agricultural economic disadvantage and harm to the County and its citizens**

1. Dorchester County is also blessed with a strong, rich farming tradition, which in the past has enjoyed economic success and has proven to be a reliable part of the tax base for the County.

2. Chapter 127 of the Dorchester County Code is titled "Right to Farm" and protects a person's right to farm and to engage in agricultural or forestry operation in the County. In Chapter 127 the County declares its policy "to preserve, protect and encourage the development and improvement of its agricultural land for the production of food and other agricultural products … [and] to reduce the loss to the county of its agricultural resources."

3. MDE and MDA, driven by the federal Environmental Protection Agency's 2010 Chesapeake Bay Total Maximum Daily Load ("TMDL"), have promulgated and proposed regulations regarding phosphorous used on farm fields and found on agricultural property that will threaten the economic viability of the County's agricultural businesses.

4. The regulatory agencies have created an asserted phosphorous problem in the farm fields in Dorchester County through past regulations and agency action that the agencies seek to address through the recently proposed phosphorus regulations.

5. Phosphorus in manures or fertilizers that is not absorbed by crops bonds with the ferric (iron) ions in the soil. Such bonding reduces the release of phosphorus into stormwater before it can be absorbed by agricultural crops.

6. MDA has discouraged such ionic bonding through the no-till practices that it has directed farmers to implement as a best management practice. When the earth is not turned by tilling, excess phosphorus cannot bind to the ferric ions in the soil because the bonding capacity of the top layer of the soil has been exhausted and the soil is not turned to recruit subsurface ferric ions for bonding. No-till farming has resulted in the saturation of the top layer of farm field soil with phosphorous.

7. Chicken farming is a component of the agricultural economy of the County. Chicken manure generally is higher in phosphorus concentration than nitrogen concentration. Farmers have been encouraged to use chicken manure to fertilize their fields so the manure is spread on fields where, theoretically, the nutrients in the manure will be absorbed. Composting of manure has been discouraged. Nutrient management plans ("NMPs") are based solely on nitrogen content without regard to phosphorus content. Farmers have been encouraged, to the point of intimidation, to apply significant quantities of chicken manure to the land so that such manure is "beneficially used" and disposed based only on the

nitrogen content of the manure and other soil additives. Through such best management practices, MDA and MDE encouraged the build-up of phosphorus in the farm fields by developing a NMP process that accounts only for nitrogen.

8. Such allegedly beneficial agricultural and environmental best management practices, which have been encouraged and required by MDA and MDE, have led to the build-up of the level of phosphorus in the fields of County farmers.

9. The combination of nitrogen run-off controls and the requirement of no-till farming by the State has put the farmers of Dorchester County in a direct catch-22 situation: Because nitrogen is severely restricted, farmers use more manures such as chicken manure which has a high phosphorous content and a lower nitrogen content; thus, there is less chance of nitrogen run-off when chicken manure is used. But, when the farmer is not allowed to till the soil, the higher free phosphorous content in the soil leads to more phosphorus stormwater runoff.

10. The beef, dairy and chicken commodities and products produced by farmers in Dorchester County feed the county, Maryland and the United States and provide essential sustenance to the nation. The businesses related to the production and refinement of such commodities and products are essential to sustaining a robust human environment in the County and beyond.

11. If left to develop and implement their own best management practices, farmers would avoid the imbalance created by government regulations as they have traditionally and historically done so throughout our history.

12. None of the states neighboring Maryland apply such a convoluted regulatory scheme to hamper farming viability; this results in an uneven, non-viable competitive disadvantage for the farmers of our County who suffer much higher costs of production than farmers in the less severely regulated neighboring states. It results in a regulatory imbalance that deprives Dorchester County farmers of equal protection of the law and due process of law.

13. The proposed phosphorus regulations being pushed by MDA pursuant to the State's Watershed Implementation Plan developed in conjunction with the Bay TMDL implementation program are in direct contravention of the Right to Farm policy of the County. The Right to Farm Act guarantees to Dorchester County farmers the right to use their land in a manner engaging sound land management practices for agricultural production, and is a stated guarantee that has a nexus to sound public policy in a field of land use law that traditionally has been with the purview of the state and local authority guaranteed by the Tenth Amendment to the U.S. Constitution.

14. There are no lawfully, constitutionally binding federal requirements that require MDA and MDE to impose the new phosphorus limitations that they are considering adopting in the County. The State of Maryland has voluntarily

undertaken to place such rigid restrictions on farming to the detriment of its own citizens who reside, farm and live in and contribute to the revenue base of the County from which vital local police power protecting public health and safety services and vital social and cultural services are funded, contribute vital resources to the County's human environment and lead to the preservation of rural and agricultural lands.

15. County history and investment in agriculture: Farming, including the production of dairy products, livestock grazing, poultry production, swine production, and crop harvesting, have constituted an integral part of Dorchester County's agricultural heritage. Dorchester County has invested millions of dollars during the past thirty-five (35) years to preserve more than 13,778 acres of land in agricultural preservation programs. To protect this heritage and mainstay of Dorchester County's cultural, social and economic environment, the County seeks to preserve such investment and such farming/agricultural resources by precluding regulations and restrictions that jeopardize the ability to local farmers to economically and productively make use of their agricultural lands and farming/food production operations.

D. Disparate and discriminatory impact on the human environment

1. For over three decades, the State and Maryland local governments have adopted more stringent environmental standards to improve the water quality of the Chesapeake Bay and the State and Maryland local governments have spent more money to improve the water quality of the Bay than the other States in the Chesapeake Bay watershed.

2. The allowable limits of total nitrogen, phosphorus and total suspended solids (sediment) that MDE requires in Natural Pollution Discharge Elimination System ("NPDES") permits that it issues to Maryland wastewater treatment plants in administration of the Federal Clean Water Act program for which MDE receives federal funding are much more stringent and substantially more expensive for Maryland local governments to fund and to implement than the limits required of local governments under the same Federal NPDES Clean Water Act programs being implemented in all of the other Bay watershed states.

3. The stormwater management requirements imposed by MDE under the Municipal Separate Storm Sewer System ("MS4") permits that it issues in administration of the MS4 Federal Clean Water Act program are more onerous and substantially more expensive to fulfil than the MS4 permits required by parallel MS4 programs being implemented in the other Bay watershed states.

4. The stormwater management practices that MDE requires persons engaged in development and redevelopment in this State under the Federal Clean Water Act programs that are funded in part by the Federal government and

implemented by MDE are much more stringent, restrictive and expensive to comply with than the stormwater management requirements imposed under the Clean Water Act program in other Bay watershed states.

5. The septic requirements and limitations that Maryland has imposed in its implementation of the 2010 Chesapeake Bay TMDL prepared by EPA are more onerous than the septic requirements of other Bay watershed states subject to the 2010 Chesapeake Bay TMDL.

6. MDE and EPA have declared Bay tributaries in the State of Maryland to be impaired that have significantly lower levels of total nitrogen, phosphorus and total suspended solids than the level of nitrogen, phosphorus and total suspended solids found in tributaries in other Bay watershed states that have not been declared to be impaired by EPA or the state environmental agency that implements the Federal Clean Water Act programs in those Bay watershed states. The "impaired" status subjects Maryland local governments to more onerous and more expensive program implementation requirements than are imposed and funded in other Bay watershed states.

7. The disparate and discriminatorily applied Clean Water Act/2010 Chesapeake Bay TMDL requirements applicable in Maryland in comparison to the other Bay watershed states has precluded the County from successfully competing for economic development with such neighboring Bay watershed states. This inability to compete caused by the disparate and discriminatorily more severe and expensive requirements imposed on Maryland citizens has had a detrimental impact to the aesthetic, social, cultural and economic environment of the County.

8. The Conowingo Dam (the "Dam") converted the lower Susquehanna River into a large stormwater management pond that Exelon Corporation, the Dam's owner, calls the "Conowingo Pond." The Dam widened the natural course of the river and increased the depth of the river. Widening and deepening the river slowed the rate of flow of water in the river, which allowed suspended solids in the river to settle (fall out of suspension) on the bottom of the reservoir and become "trapped" in the same manner that a stormwater management pond "traps" sediments.

9. Like all stormwater management ponds, the Dam has altered the otherwise normal or natural flow of water in the Susquehanna River. Like all stormwater management ponds that have not been maintained (i.e., periodically dredged of the sediments that accumulate in the artificially created reservoir), during significant storm events, accumulated sediments, laden with nutrients and other contaminants, have been scoured from the bottom of the Conowingo Pond and dumped in mass below the Dam, shocking the Maryland portion of the Chesapeake Bay with a blanket of deadly sediments.

Sediment Scoured from the Conowingo Pond During Significant Storm Events[1]				
Storm	Year	Month	Peak Flow Cu^3/sec	Volume of Sediment Scoured into Bay (Million Tons)
Hurricane Agnes	1972	June	1,130,000	20
Hurricane Eloise	1975	September	710,000	5
Unnamed	1993	April	442,000	2
Unnamed	1996	January	909,000	12
Hurricane Ivan	2004	September	620,000	3
Unnamed	2011	March	487,000	2
Hurricane Irene	2011	July	Unmeasured	Unmeasured
Tropical Storm Lee	2011	September	778,000	4
Hurricane Sandy	2012	October	Unreported	Unreported

10. Billions of taxpayer dollars have been spent to dredge the navigable shipping channels in the upper Bay and the channels into local marinas that have been clogged with sediments. The largest source, if not the sole source, of those sediments is the Susquehanna River, including scour from the bottom of the Conowingo Pond. Economically and environmentally, those sediments should be dredged from the reservoir behind the Dam where they have accumulated (approximately 9,000 acres or 3,600 hectares), not after they are dumped into the Bay and spread across approximately 4,479 square miles.

11. Exelon, a company with over $30 billion in annual revenues, receives at least two benefits from the Dam: (1) it produces 572 megawatts of electricity, which is enough electricity to power an average of 572,000 or more homes; and (2) it receives renewable energy credits that may be used or sold to offset air emissions from power plants that burn fossil fuels.

[1] Jeffrey Brainard, *Big Year for Bay Storms, Bad Year for Bay Sediment?*, Chesapeake Quarterly Vol. 10 No. 4, Dec. 2011. See link: http://www.mdsg.umd.edu/CQ/V10N4/main1/. *See also The Impact of Sediment on the Chesapeake Bay and its Watershed*: U.S. Geological Survey, June 3, 2005. See link: http://chesapeake.usgs.gov/SedimentBay605.pdf.

Sediment Loading from Storm Event Scour in Comparison to Average Annual Sediment Loading from Susquehanna River				
Storm	Year	Avg. Annual Sed. Load from Susquehanna River (Million Tons)	Sed. Load From Scour (Million Tons)	% of Avg. Annual Load from Scour
Hurricane Agnes	1972	1.5	20	1,333%
Hurricane Eloise	1975	1.5	5	333%
Unnamed	1993	1.5	2	133%
Unnamed	1996	1.5	12	800%
Hurricane Ivan	2004	1.5	3	200%
Unnamed	2011	1.5	2	133%
Tropical Storm Lee	2011	1.5	4	266%
Hurricane Sandy	2012	1.5	Undetermined	Undetermined

12. The photographs below were taken within 2-4 days after Tropical Storm Lee in September 2011.

13. Scour during significant storm events occurs in less than one week. Thus, in a matter of days, scour from the Conowingo Pond during a significant storm has added anywhere from 133% to 1,333% more than the average annual sediment loading from the Susquehanna River. Such loading results in a big die-off of oysters and underwater grasses in the Bay north of the Choptank River. In 1972, up to a meter of sediments was added to the floor of the upper Bay; two-thirds of that sediment was attributed to scour from the floor of the lakes and reservoirs behind the three dams in the lower Susquehanna River. During Tropical Storm Lee, over two inches of sediments were deposited on the floor of the upper Bay. In short, the shock effect of this rapid loading of scoured sediments is devastating to all fauna that cannot flee (swim) to the lower Bay and to all Submerged Aquatic Vegetation ("SAV") in the upper Bay. The oysters and SAV in the upper Bay and the upper Bay tributaries have never recovered from the devastation caused by the scour from Hurricane Agnes. SAV in the Susquehanna Flats was killed to pre-1985 levels (thousands of acres of SAV were killed) as a result of the two storm events in 2011.

14. The Dam traps the best sediment - sand - and releases the most damaging sediments - clay and silt - into the Bay. The Bay has thus been deprived of sand that is necessary: (1) to hold the roots of SAV during storm events; (2) to support the shell beds of oysters; (3) to fortify shorelines and thus reduce erosion; and (4) to cover and suppress the clays and silts that are washed into the Bay so that those clays and silts (a) do not continue to emit phosphorus and nitrogen bound to them in the Susquehanna estuary, (b) do not continue to agitate into suspension and cloud the Bay waters; and (c) do not deprive Bay flora and fauna of needed sunlight and habitat.

15. If the Conowingo Pond is not dredged and maintained, the Bay will never recover, and certain Bay restoration efforts and expenditures below the Dam will be in vain. The County, as a member of the Clean Chesapeake Coalition, has intervened in the relicensing of the Dam to urge the Federal Energy Regulatory Commission (FERC) to place conditions on the license to be issued that will require Exelon to dredge and maintain the stormwater management pond created by the Dam so that a blanket of deadly sediments cannot be scoured from the bottom of the reservoir and deposited in the Bay now with regularity and in devastating proportions during significant storm events.

16. The sediments that are scoured contain phosphorus that is bound to the sediments in the colder oxygenated, non-saline more pH neutral waters of the Susquehanna River but is released into the water in the Bay estuarine that is warmer, more saline, more acidic and less oxygenated. The nutrient and sediment loading from such scour events is substantially greater than the nutrient and sediment loading from activities in the County, including the agricultural activities in the County. Yet Exelon and the predecessor companies that have owned and operated the hydroelectric dams in the lower Susquehanna River have not been required to spend one penny to reduce the nutrient and sediment loading

and the damage to the Bay caused by scour and the lost trapping capacity of those dams. It is discriminatory to require home owners, farmers and small businesses in the County to expend proportionally much larger and more significant funds to remove a much smaller percentage of nutrient and sediment pollution to the Bay while allowing nutrient and sediment pollution to the Bay caused by Exelon's operation of the Dam to continue unabated.

17. Even though federal funds are heavily relied on MDA, MDE and DNR, those agencies have not applied a Regulatory Flexibility Act inquiry and analysis as to whether the Data Quality Act has been complied with as to verification of the data and information used by those agencies prior to imposing the regulations and requirements. Those agencies have not coordinated with Dorchester County during the development of the regulations or requirements as is required under NEPA for regulations promulgated with use of federal funds.

18. Rules and regulations of MDA, MDE and the Maryland Department of Planning (MDP) implementing the 2010 Chesapeake Bay TMDL are adversely impacting the human environment of the County.

19. The rules and regulations of DNR with respect to oyster bed reclamation, restoration and harvesting are precluding the County and its watermen from engaging in activity that would improve the water quality of the Bay while at the same time promoting the Right to Work – Seafood Industry policy of the County.

20. The "accounting for growth" regulations being promulgated by MDE and MDP will further disparately and discriminatorily impact the County and impede the County's ability to encourage economic development and compete with neighboring Bay states for economic development as those states do not have any similar requirements and EPA had not imposed any similar requirements under the 2010 Chesapeake Bay TMDL on such states. Ultimately, the County's human environment will be adversely, significantly and detrimentally impacted by such accounting for growth requirements.

II. THE RESOLUTION

A. WHEREFORE, based upon the above Findings, the Dorchester County Council does hereby resolve as follows:

1. BE IT RESOLVED THAT Dorchester County does formally establish the policy that all reasonable efforts be made by the County to protect the economic viability of commercial fishing and seafood harvesting for citizens of the County, and that regulations and restrictions on such fishing and harvesting be developed and implemented only after all data used for their development has been subjected

to peer review under the standards set by the Data Quality Act and by this County policy.

2. LIKEWISE BE IT RESOLVED THAT Dorchester County does formally establish a policy that all reasonable efforts be made to protect the economic viability of agriculture engaged in by citizens of the County, and that regulations and restrictions on farming and farm practices be developed and implemented only after all data used for their development has been subjected to peer review under the standards set by the Data Quality Act, by this County policy, and after comparison of and analysis of disparate impact on Maryland commerce as compared with the practices of surrounding and competitive states.

3. LIKEWISE BE IT RESOLVED THAT Dorchester County does formerly establish a policy that all regulations and programs undertaken to implement the State's Watershed Implementation Plan and/or the 2010 Chesapeake Bay TMDL be developed and implemented only after all data used for their development has been subjected to peer review under the standards set by the Data Quality Act, by this County policy, and after comparison of and analysis of disparate impact on Maryland commerce as compared with the practices of surrounding and competitive states.

IT IS RECOGNIZED BY the Dorchester County Council that these policies are age-old as far as reasonable protection of, and understanding the importance of, these two traditional economic and social mainstays of the Eastern Shore of Maryland and Dorchester County in particular. We should all be mindful of the fact that the Great Seal of the State of Maryland portrays a waterman and an agricultural harvester.

4. LIKEWISE BE IT RESOLVED that Dorchester County invokes the coordination authority provided for it by Maryland law and federal statutes beginning with the National Environmental Policy Act and including the Clean Water Act and the Magnuson-Stevens Act under which the above regulations are "justified". In enacting this Resolution, the Dorchester County Council is mindful of the fact that no federal or State agency coordinated with the governing body of this County during the initiation of, development of or implementation of these regulations on natural resource industries. No attempt was made by any state or federal agency to work with Dorchester County to determine whether there was a better management practice available to affect the natural environment while protecting the human environment as required by the NEPA regulations of the Council on Environmental Quality or to seek consistency.

5. LIKEWISE BE IT FURTHER RESOLVED that Dorchester County hereby engages the Maryland Department of the Environment, the Maryland Department of Natural Resources, the Maryland Department of Agriculture and the Maryland Department of Planning to coordinate with the Dorchester County Council in an attempt to reach some consistency with the policies of the County enacted by this Resolution and previously adopted by the County, including but

of the County, the County Master Plan, and the County Watershed Implementation Plan.

6. BE IT FINALLY RESOLVED THAT the Dorchester County Clerk serve on management of the Maryland Department of Environment, the Maryland Department of Natural Resources, the Maryland Department of Agriculture and the Maryland Department of Planning a copy of this Resolution, certified, and the letter of the local governing body inviting such department management to meet with the County Council to begin the process of Coordination.

Adopted this 7th day of January, 2014

ATTESTED BY:

~~Jane Baynard~~ Donna F Lane
~~County Manager~~
Executive Administrative Specialist

THE COUNTY COUNCIL
OF DORCHESTER COUNTY

Jay L. Newcomb, President

William V. Nichols, Vice President

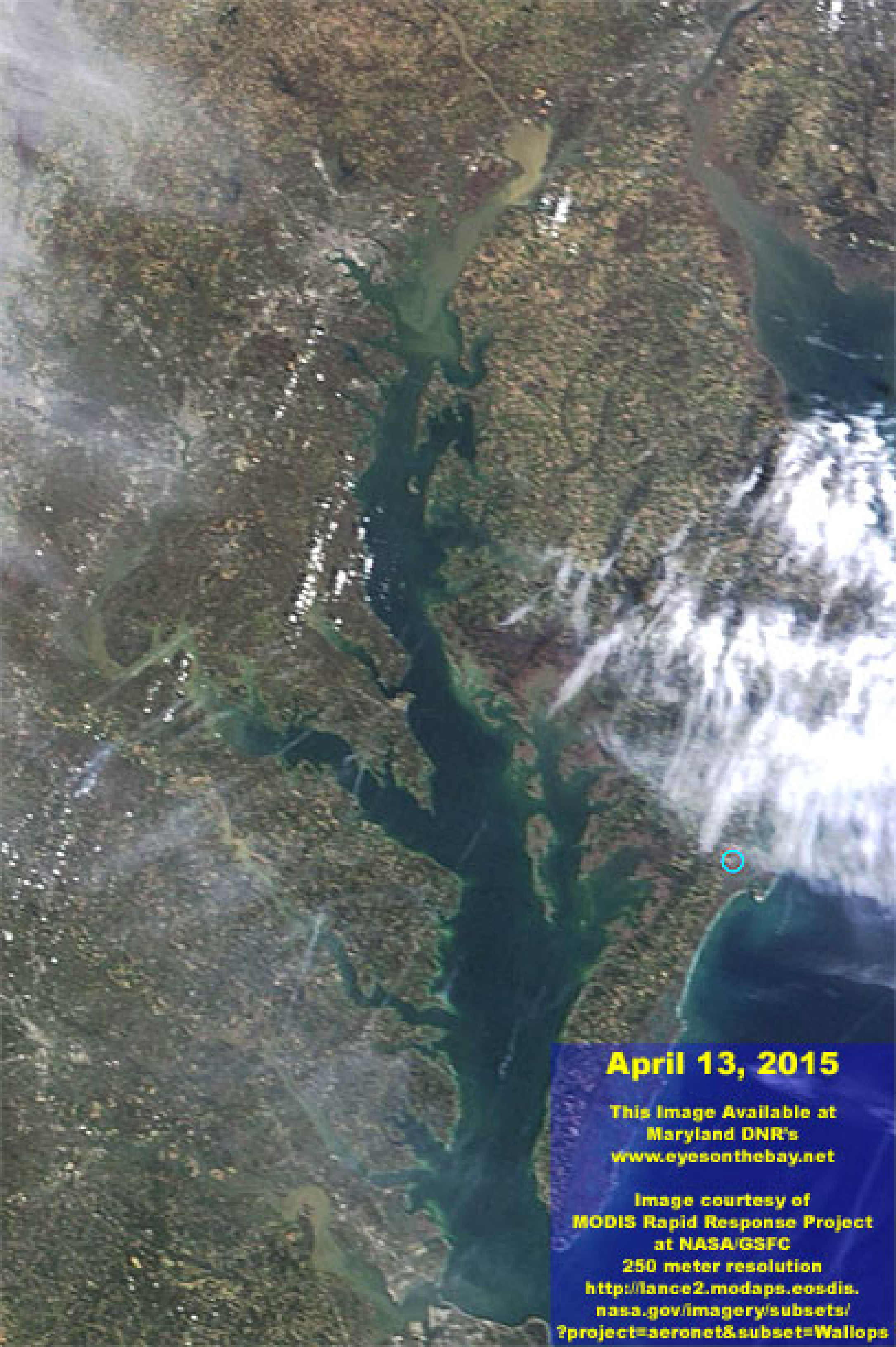
Tom C. Bradshaw

Rick M. Price

Ricky C. Travers

58599.007:158792v6

Resolution 549


April 13, 2015
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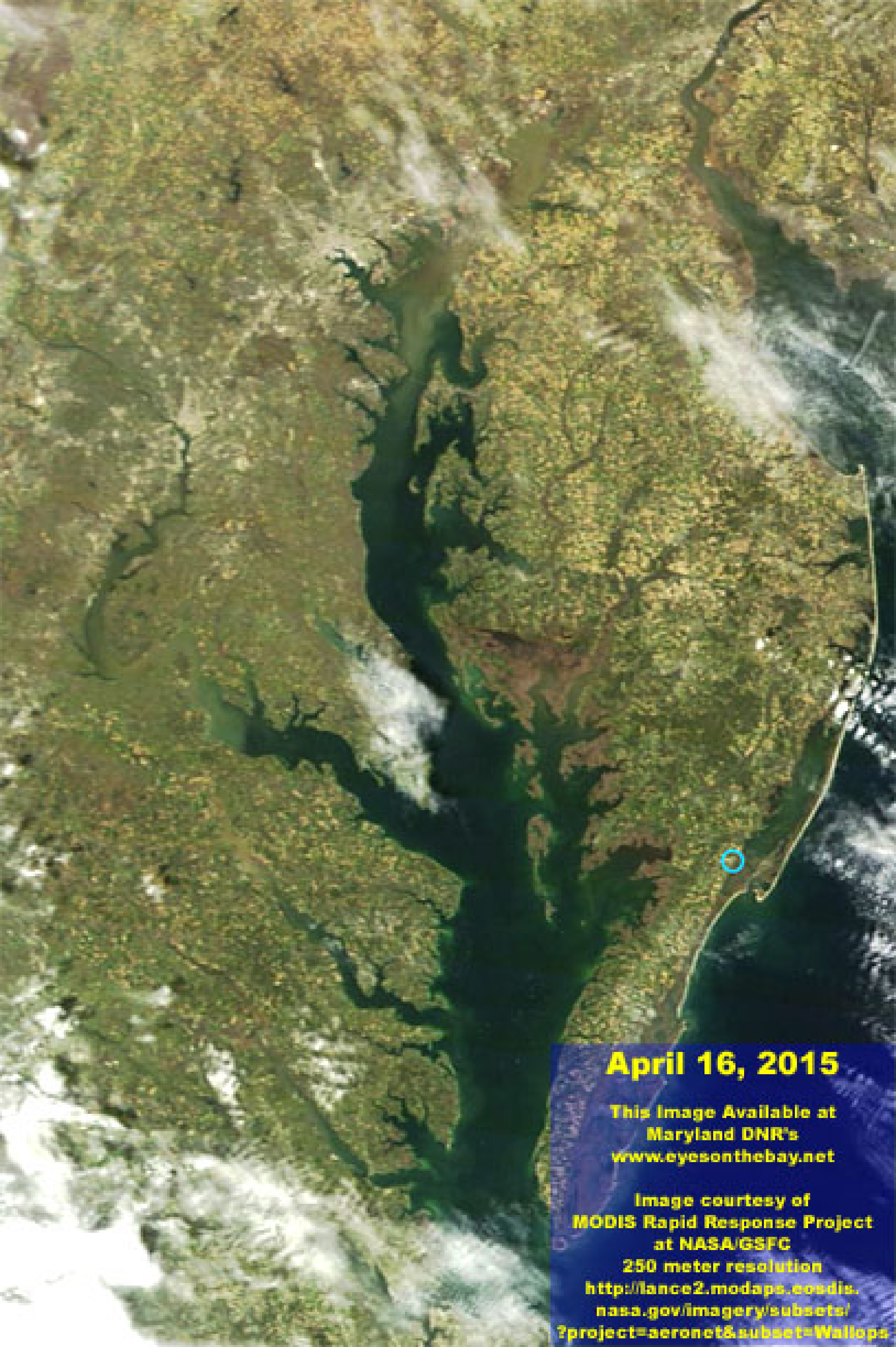
April 16, 2015
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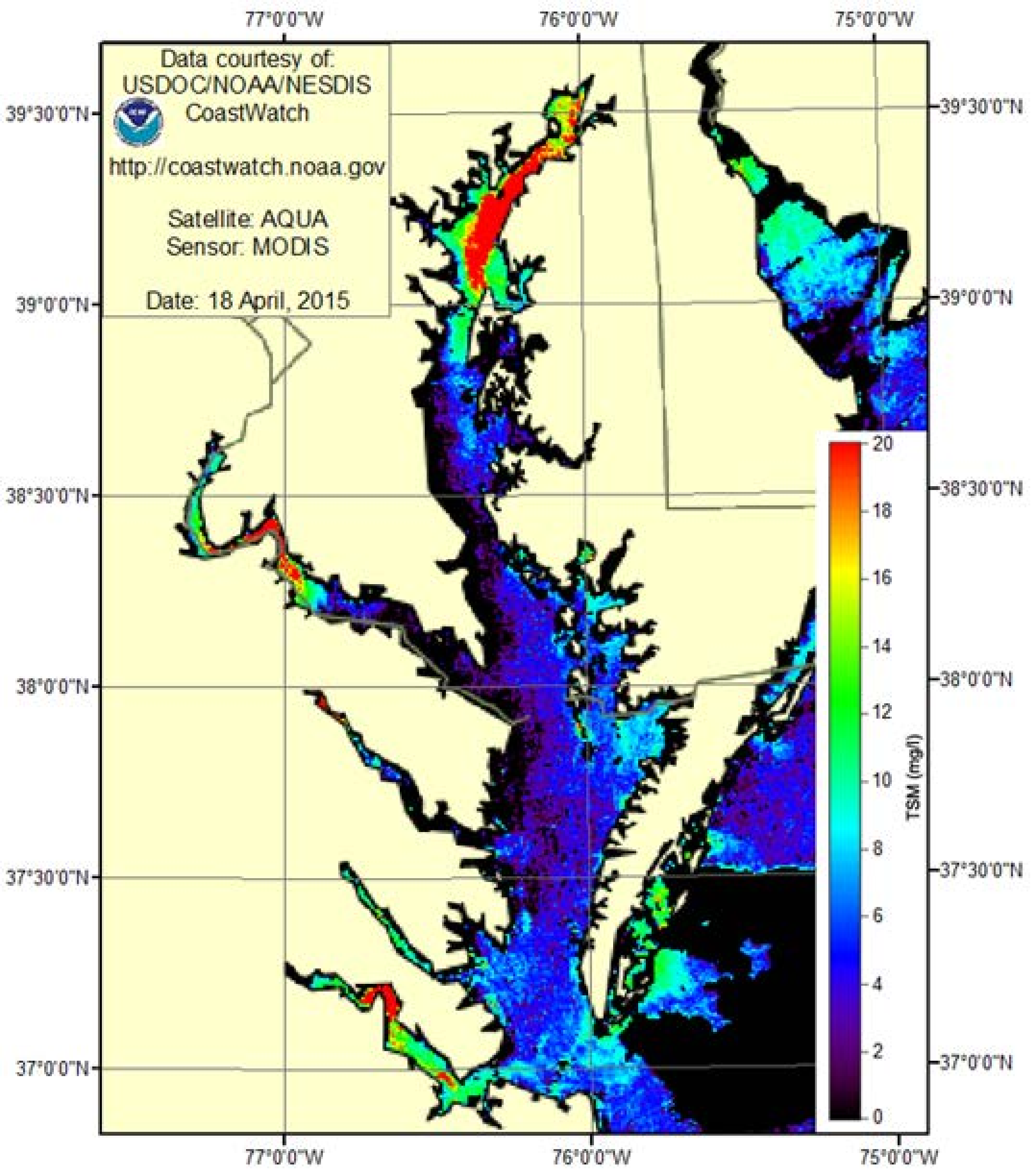

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Data courtesy of:
USDOC/NOAA/NESDIS
CoastWatch
http://coastwatch.noaa.gov
Satellite: AQUA
Sensor: MODIS
Date: 18 April, 2015
TSM (mg/l)
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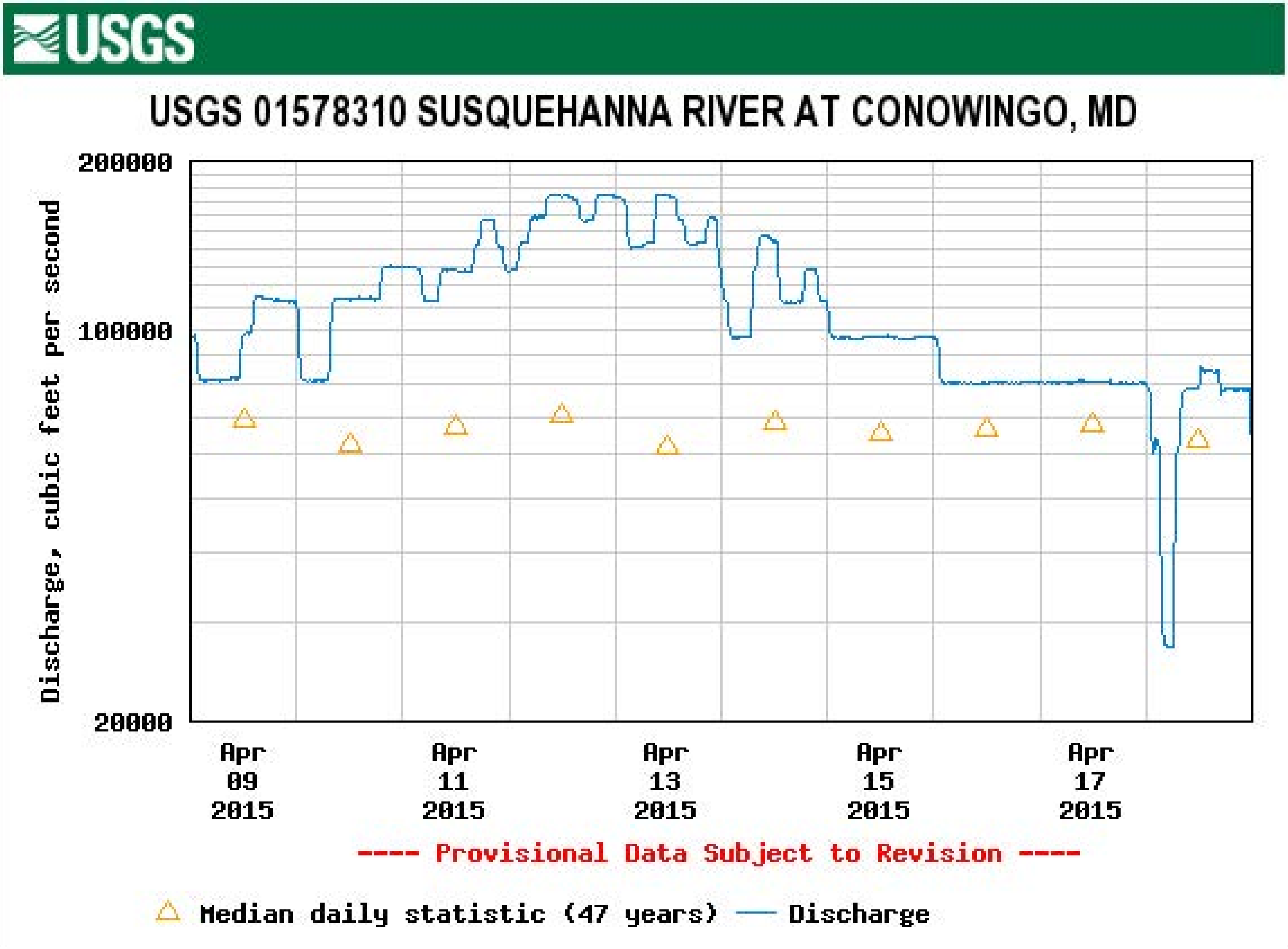
USGS
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200000
100000
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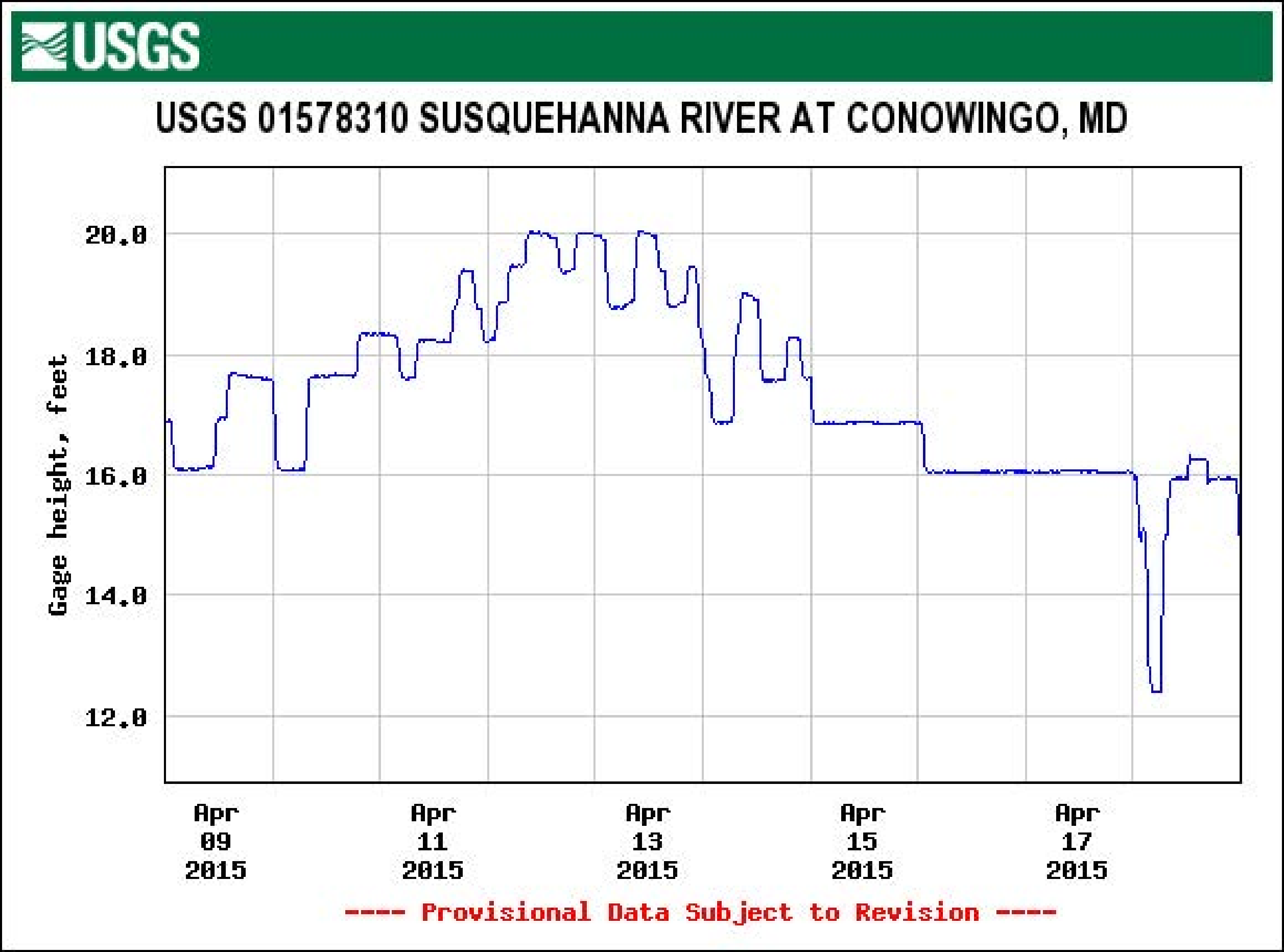
Discharge, cubic feet per second
Apr 09 2015
Apr 11 2015
Apr 13 2015
Apr 15 2015
Apr 17 2015
---- Provisional Data Subject to Revision ----
Median daily statistic (47 years)
Discharge


USGS
USGS 01578310 SUSQUEHANNA RIVER AT CONOWINGO, MD
Gage height, feet
20.0
18.0
16.0
14.0
12.0
Apr 09 2015
Apr 11 2015
Apr 13 2015
Apr 15 2015
Apr 17 2015
---- Provisional Data Subject to Revision ----

Septic "Facts"

According to EPA Bay TMDL (December 29, 2010):

Septic systems "have the **potential** to deliver nitrogen and phosphorus to surface waters directly **because of system failure and malfunction** and indirectly through groundwater....functioning systems do not contribute nitrogen and phosphorus loads to surface waters directly." (Subsection 4.6.4)

Septic systems accounted for 6% of TN loads from Bay watershed in 2009.

According to Maryland Phase II WIP (October 26, 2012):

"Septic system reductions of about **1.24 million pounds** [of nitrogen] are estimated from the proposed Final Target strategy. The Final Strategy increases septic system connections by 42,442, and septic system upgrades by 181,366 between 2010 and 2025. In addition, the Final Strategy calls for septic pumping of about 58,496."

WIP costs to 2025 for septic upgrades, connections, pumping: **$3.7 billion**

Using the following unit cost estimates (per MDE):

$13,000/system for upgrades (x 181,366)	$2,357,758,000
$30,000/system for connection to WWTP (x 42,442)	$1,273,260,000
$500/system for pumping (3x) (x 58,496)	$ 87,744,000

Cost per pound nitrogen reduction: **$2,984** [$3,700,000,000 ÷ 1,240,000 lbs.]

Total MD Final Target nitrogen reduction to 2025: 11,831,000 lbs.

Source Sector:	Agriculture	4,743,000 lbs.
	WWTPs	3,818,000 lbs.
	Stormwater	2,201,000 lbs.
	Septic	1,240,000 lbs.

According to MDE:

About 420,000 septic systems in Maryland; 52,000 located in the Critical Area

"The typical septic system does not remove nitrogen, instead delivering about **24.32 pounds** of nitrogen per year to the groundwater. An upgraded, nitrogen-removing septic system cuts a system's nitrogen load in half." (MDE website)

6% of Maryland's nitrogen pollution reaching the Bay comes from septic systems.

According to new Septic (BAT) Regulations:

"Reducing the nitrogen discharged by [septics] has been identified as an action **necessary** as part of Maryland's Watershed Implementation Plan in order to meet water quality standards. The Department [MDE] has determined that requiring nitrogen removal technology for [septics] is **necessary** to protect the waters of the State from contamination."

"There is no corresponding federal standard to this proposed action."

(COMAR notice June 1, 2012 (MD Register Vol 39, issue 11)

Per MDE, a BAT system could cut septic system nitrogen pollution by 50%.

According to Septics Bill (SB236 of 2012 Session):

"WHEREAS, As required by EPA, Maryland submitted and EPA approved Phase I Watershed Implementation Plans (WIP) which allocate the allowable pollution load among different sources and identify strategies for reducing nutrients and sediments that harm the Chesapeake Bay;"

"WHEREAS, Without action to reduce the nitrogen loads from new development served by on–site sewage disposal systems, the Phase II WIP will force other sources, such as wastewater treatment plants, urban stormwater, and various agricultural sources to reduce their loads even further, constraining economic growth and placing additional burdens on the agricultural community and other sources;"

Fiscal Policy Note (SB236):

The bill is a local government mandate.

State expenditures associated with achieving various Bay restoration goals and mandates *may decrease* to the extent that the bill results in a **significant reduction** in nutrient effluent from septic systems and stormwater runoff…"

"Local expenditures *may decrease* due to savings associated with implementing State and federal environmental mandates…"

State and local WIP price tags indicate otherwise

"This bill may result in a **significant reduction** in nutrient loads to the Chesapeake Bay watershed…"

Fiscal Policy Note (SB391/HB106):

"State expenditures associated with achieving various Bay restoration goals and mandates *may increase* to the extent the repeal results in the elimination of **significant reductions** in nutrient effluent from septic systems and stormwater runoff..."

"Local expenditures *increase* to implement other measures necessary to achieve State and federal environmental mandates…"

"Chapter 149 is estimated to result in a **significant reduction** in nutrient loads to the Chesapeake Bay watershed…"

According to MDP - Report to General Assembly (February 1, 2013):

"**SB236** [the 'septics bill' from last session] gives Maryland **the best chance to restore its streams, rivers and estuaries**…"; quoting the Administration, saying: "Among the big four causes of pollution in the Bay, septic pollution is the one area where so far we have totally failed… It's the fastest growing cause of nitrogen pollution in our Bay, and it's only getting worse….If we don't act now, new septic systems are projected to account for three fourths of the increase in nitrogen pollution over 25 years."

Septics bill will purportedly stop as much as **1.1 million pounds** of nitrogen from polluting the Bay by 2035 (about **50,000 pounds per year**).

(Note: This amount represents the urban stormwater and septic tank nitrogen loads to surface waters from 50,000 households served by septic tanks.)

According to MDP (loading methodology):

9.5 lbs N per person using conventional septic system
assumed household size of 2.56 in 2010 =
24.32 lbs. N per household generated at septic tank;
assume 50% of the N load arrives at the edge-of-stream (surface water) =
12.16 lbs. nitrogen per septic household/year;
total annual nitrogen load from existing septics = 5,107,200 lbs. (420,000 x 12.16)

Conclusions:

Per State Phase II WIP (2010-2025):	1,240,000 lbs. nitrogen reduction (82,667 lbs./year)
Per Septics Bill (to 2035):	1,100,000 lbs. nitrogen prevention (50,000 lbs./year)

All this for 2,340,000 pounds of nitrogen over the next 15-25 years…

While **131 million pounds** of nitrogen are loaded into the Bay annually from the Susquehanna River and behind the Conowingo Dam sits **670,000 tons** of nitrogen.

MARYLAND DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard • Baltimore MD 21230
410-537-3000 • 1-800-633-6101 • www.mde.maryland.gov

February 3, 2015

The Honorable Joan Carter Conway, Chairperson
Members, Senate Education, Health, and Environmental Affairs Committee
Miller Senate Office Building, 2 West
Annapolis, MD 21401

Re: Letter of Support, *Senate Joint Resolution 1 – Conowingo Dam – Sediment and Nutrient Pollution (National Chesapeake Bay Preservation Act of 2015)*

Dear Chairperson Conway and Committee Members:

The Maryland Department of the Environment (MDE) has reviewed Senate Joint Resolution 1 (SJ 1), entitled *Conowingo Dam – Sediment and Nutrient Pollution (National Chesapeake Bay Preservation Act of 2015)*, and would like to offer our support for this resolution.

The intent of the proposed resolution is to urge the United States Congress to authorize a review of studies related to the Conowingo Dam for the purpose of initiating and funding a project by the U.S. Army Corps of Engineers to address the buildup of sediment and associated nutrients behind the dam in order to minimize the pollutant loading reaching Chesapeake Bay from the Susquehanna River.

The resolution recites information about the impact of the Conowingo Dam on Chesapeake Bay from the draft *Lower Susquehanna River Watershed Assessment*, dated October 2014. That report, a joint effort between the U.S. Army Corps of Engineers, MDE, and other State and federal agencies, was the result of several years of study. It assessed sediment trapping capacity of the Conowingo Dam and the impact of scouring events on water quality in Chesapeake Bay. The report further evaluated a number of strategies for managing the sediment and nutrients trapped behind the dam, including no action, watershed sediment management, strategic dredging, extreme dredging, and sediment bypassing. The draft report was released for public comment, which ended on January 9, and is expected to be finalized in the summer of 2015.

The Department supports this resolution. The resolution brings attention to the importance of addressing the buildup of sediments and associated nutrients behind the Conowingo Dam. It specifically references the *Lower Susquehanna River Watershed Assessment*, which found that the pollution sources from the lower Susquehanna watershed continue to have a significant detrimental impact on Chesapeake Bay water quality, which is exacerbated by major scouring events. It is important to address the impacts of the deposition of sediment from behind the dam on Chesapeake Bay to ensure we are successful in our Bay clean-up efforts.

By passing this resolution Maryland will bring additional attention to this issue at the federal level. The resolution will reinforce our efforts to ensure that our federal partners remain engaged and continue to assist in ensuring this important issue is addressed. Additionally, it will put the United States Congress on notice that they need to be full partners in this effort, including lending financial assistance to the U.S. Army Corps of Engineers.

Thank you for your consideration of this information. We will continue to monitor SJ 1 during the Committee's deliberations, and I am available to answer any questions you may have. Please contact me at 410-260-6301 or lisa.nissley@maryland.gov if you would like to discuss any of these issues further.

Sincerely,

Lisa Nissley

Lisa Nissley

cc: Lee Currey, Director, Science Services Administration

High Heat and Organic Loadings Complicate Nitrogen Limits Nitrogen TMDL Input Models Need to Include Sapropel Why We Need to Look at The Saprobien System Discussion Paper EPA DEEP Long Island Sound Study Habitat Restoration Work Group

Submitted by Timothy C. Visel[1]
The Sound School – 60 South Water Street
New Haven, CT

September 2013
For Review and Discussion
Revised for Capstone Project Investigations, March 2014
Blue Crab Appendix Attached August 2014

Abstract

The Saprobien System (1909) offers an interesting look at long term habitat reversals. In the historical reports about early studies that lead up to the development of Saprobien System were the reports of fishers, fish wardens, and river keepers in Europe. They reported upon the impacts of high temperatures and organic matter loadings to European river fisheries, habitats and the association of temperature to them is now over a century old. Although here in Southern New England we had The Great Heat beginning in 1880, Europe and especially Great Britain had "The Great Stink" beginning in 1858. Here the Thames River with vast amounts of organic matter putrefied in high heat sending nauseating "bad airs" onto London Streets that were so intense, sheets soaked in vinegar were hung over Parliament windows in an attempt to quell the stench. (Cairns and Pratt, A History of Biological Monitoring Using Benthic Macro Invertebrates, 1999). The Saprobien system classified habitats by the amount of organic matter that overwhelmed a streams natural ability to clear it and listed temperature as limiting oxygen (see Kolkwitz and Masson 1909).

Although the Saprobien system would be modified many times, its first premise included time, as "self purification" of organic wastes, animal and human sewage, and in time slowing moving rivers could "recover" from organic pollution to pre event status. Unfortunately in high heat, the fish (certain species) had long since "vanished" and one of its primary initial indicators was fish species "zones" and the ability to survive in stressful conditions. The presence of intense odors of dead fish often compelled "such studies."

The events that drive our habitat intervention unfortunately are historically both most severe and public. Hugh Hammond Bennett, in his attempts to gather a national consensus here about soil loss and habitat conditions of the growing dust bowl in the

[1] The proposal to review the role of Sapropel deposits to Nitrogen Total Maximum Daily loads nor low oxygen release of nitrogen compounds from them does not reflect the EPA/DEEP Habitat Restoration Workgroup nor has consensus been reached regarding the existence of Sapropel in near shore coastal habitats of Long Island Sound.

1930s was unsuccessful in Congress until a huge dust storm actually hit Washington, DC. Alerted of its Capitol approach by colleagues in field stations, he timed a congressional debate hearing for 2 pm and arranged for drapes to be removed from the windows and tables pushed to them. At 10 a.m. in the morning D.C. street lamps came on, residents were frightened by darkening of the sun, people swarmed hospitals with respiratory distress coughing and eyes watering from the dust as Congress started the debate over a national soil conservation program at 2 pm. Bennett is told to have addressed the group and said something to the effect, "Gentlemen, this is the situation that I have strived to communicate to you, as you can now see, it is here." Legislation for the Soil Conservation Service was approved shortly later. The truth of the matter was by the time the Soil Conservation Service was created the drought that had occurred for decades was beginning to moderate. With good soil conservation and management practices (and the rain of course) badly eroded fields began to heal and then hold soil and plants again. Climate conditions were changing and we did not have at the time a sense of environmental history.

Introduction

In the marine field we also react slowly to such large habitat changes. After returning to the University of Connecticut in 1983, I had worked briefly with Richard Loring of then Culture Clam in Barnstable, a hatchery producing hard clam seed on the Cape.

Hard clam (Mercenaria mercenaria) inshore sets had largely failed on Cape Cod and the hatchery produced "seed clams" for a growing Quahog aquaculture industry. Soon my work with area fishers I learned that widespread hard clam sets had mostly stopped on the Cape and the need of hatchery produced seed soon increased. My interest in the box culture of clams and the soil growth characteristics in them grew; when I returned to Connecticut many formerly productive inshore coves and bays for hard clams that had also become nonproductive. Upon the request of the Waterford –East Lyme Shellfish Commission, (Robert Porter, chairman), a similar culture experiment was conducted in Smith Cove, a westerly lobe of Niantic Bay. Several thousand Mercenaria seed were purchased and planted in a wood rectangular box placed with j hook re-rod metal stakes, similar then to the Wellfleet method; we wanted to be able to then return to the same location to monitor growth. Several months later we returned to check on the growth of clams but instead found a black soupy leaf mixture that had covered the culture box. The characteristic sulfur smell soon became noticeable as we examined the clams, most had died, and the shells were soft and chalky. Below surface leaf deposits a black jelly and greasy material had formed – termed Sapropel.

The blanket of oak leaves no doubt had suffocated the clams and now the acidic conditions from the oak leaves themselves had eroded shells. In many instances the clams had become smaller. It was disappointing for Mr. Porter to see this type of acidic bottom, it certainly wasn't like the one he had experienced growing up on Niantic Bay. Smith Cove had a sandy and shelly estuarine bottom then. It was now a soft organic filled mucky organic bottom, the habitat clock for that habitat succession period had long expired. We did scrape this sapropel off and found black stained sands below with an occasional empty clam shell. It was obvious that this area once supported clams sets, but habitats now contained Sapropel. He tried to save as many clams as he could but was interrupted by a neighbor dragging a tarp full of leaves to dump in the cove, and the discussion then became somewhat "heated." I left and later Bob told me that after the leaf burning ban, neighbors just started dumping leaves into the cove, believing the tides would "take them out to sea." We had no idea at the time how leaves would impact the clams, but taking what I had learned on the Cape, we changed the soil for some gravel and bagged sand, and as John Hammond and George McNeil suggested, mixed in some crushed clam shell (obtained in buckets from Harborside Seafood in RI). It came as an aggregate (mostly driveway material) and we mixed that in to this "new bottom," Clam growth of the remaining clams was nothing short of spectacular; I wrote this restoration project up in 2005 and presented it in 2006 at the International Conference for Shellfish Restoration in Charlestown, South Carolina.[1]

Although the hard clams grew well in the culture box, when planted into the adjacent open areas, they did not grow and eventually died off. Although Bob blamed the neighbors for the leaves, trees had grown up along the entire Niantic Bay and the marine soil itself had changed; it was acidic and under the remaining eelgrass patches we did find buried dead hard shell clams. The clock of habitat succession had simply run out for hard clams. In this section of Niantic Bay, the ice filled cooler and stormier 1960s had gone and with them hard clam habitats, but continued shellfish survey work showed Niantic Bay now had a huge set of sub tidal soft shell clams, (steamers) in areas of no leaves. Bob was surprised to see them, as when he was young, steamers (Mya) were rare and largely nonexistent in Niantic Bay, to him, it was perplexing to see a reversal of species and habitat types over several decades. In the marine environment our dust storms are our forest fires and hurricanes and the winter equivalent Nor'easters, our floods. It's not that acidic bottom conditions were unknown, David Belding at the turn of the century properly identified the negative impacts of organic acids upon shellfish in marine soils (1910-12) but only recently has acidic soils been reviewed in regards to shellfish sets (Dr. Mark Green, St Joseph College Maine). The source of the acid conditions, I feel can be attributed to leaves and organic matter that in oxygen limited conditions formed Sapropel. And, it is not just one event usually, but habitat reversals sometimes take decades.

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[1] Source: Connecticut Shellfish Restoration Projects Linked to Estuarine health by Timothy c. Visel, Coordinator, The Sound School Regional Vocational Aquaculture Center, 60 So. Water Street, new Haven, CT 06519. (tim.visel@new-haven.k12.ct.us).
A series of CT Sea Grant/Extension shellfish restoration programs for hard clam (Mercenaria mercenerica), soft clam (Mya arenaria), oyster (Crassostrea virginica), and bay scallop (Arogopectin irradians) were coordinated with local municipal shellfish commissions in the 1980s. Potential candidates for projects were identified by local environmental fisheries history, shellfish maps, natural beds and local shellfish surveys. Several restoration projects were undertaken with federal, state and local agency assistance. Results were highly site-specific; some yielded almost immediate positive results and some were complete failures
Predictions/suggestions by the local residents and resource user groups were often confirmed; therefore, their importance and contribution should not be overlooked. Environmental fishery history reviews can be an important tool in understanding the declines in shellfish production from near shore areas. As much information as possible should be obtained before attempting shellfish restoration programs. In this way, scarce shellfish restoration resources can be maximized.
"Connecticut Shellfish Restoration Projects Linked to Estuarine Health" 11:30 Plenary Concurrent Session E "Small Scale Approaches to Shellfish Restoration" – 9th International Conference on Shellfish Restoration; November 15-19, 2006, Charleston, South Carolina, USA

One of the chief aspects of the Saprobien System is time for "self" purification for habitats to "restore" themselves to a certain expected level of habitat quality. In marine studies this puts researchers at a great disadvantage; we need much longer periods of study (time) to review changes. In 1990, few saw the lobster die off of 1998 and a decade later, a surge of blue crabs. I didn't either, but I would very much recall the habitat reversal pattern. Just as Bob Porter returned to his hard clam grounds of the 1960s, that habitat had "succeeded" as new trees grew up and matured, although neighbors dumping leaves certainly had helped speed the succession process. The previous sandy/shelly habitat now contained what fishers call "Black Mayonnaise."

The entire state of Connecticut was recovering its forest canopy, once largely cleared for agriculture; the stormy period of the cooler 1950s and 1960s was over. Leaves now collected over marine soils once cleared by waves and the areas that obtained the least energy. In 1935, agricultural fields occupied 67% of Connecticut's land acreage; by 1985, only 13% (Lewis, 1980). Many rivers blocked by tidal restrictions (undersized culverts and poorly designed railroad crossings) dams or had long connections to the sea, slowly started to fill with organic matter, primarily leaves. This can also happen during long periods of heat, or when sand waves or sand bars can be driven into the mouths of rivers and coves creating a "sill" or bar partially blocking tidal exchange. Alewife Cove between Waterford and New London is an excellent example of sand bars restricting tidal exchange and buildup of black mayonnaise behind them. The formation of a barrier sill reduces flushing so trapped nutrients and organic matter collects even faster, as organic matter builds that reduces hydraulic capacity as less oxygen containing sea water is exchanged during tides and coves "fouled." In hot weather these organic accumulations can act as nitrogen sink or storage capacity. As Sapropel builds it allows sulfate reducing bacteria to shed ammonia compounds fueling additional vegetation. Most Connecticut lake associations have experienced sulfur rich (toxic) Sapropel deposits and have them periodically removed or cleared by dredging. In this case the dam also acts to accumulate organic debris which rots in low oxygen conditions.

Some of these coastal storm blocking energy case histories can be found in colonial New England with examples opening of salt ponds. Salt ponds cut off from cooling ocean exchange in high heat putrefied, and fish kills called black water kills were common. These habitat changes were so quick, they were very noticeable (did not take decades to occur) and local interests acted and unblocked or "breached" them. The opening inlets that were important to local herring runs, as herring rights (alewife) were subject to public bidding and franchises. A short case history of Quiambaug Cove in Stonington Connecticut mentions the use of oxen. The restoring of tidal energy has been a part of New England's salt pond fisheries history.

What was once a small concern of the river oyster tongers of the 1930s and 1940s; tons of leaves now buried river oyster beds in the 1980s. As temperature warmed into the 1980s and 1990s, those leaves rotted and Sapropel formed first in the quiet coves and head waters of tidal streams. The people who noticed it first, as bad smells foul or "sour" bottoms in the marine fisheries were the quahogers, bay scallopers and winter flounder fishers. They could see habitat change over time and had vested interest in habitat quality of their fisheries. No one I feel was expecting what paved streets, a renewed forest canopy and a regional leaf burning ban would have upon the Alewife fisheries. I was to witness that on Cape Cod and to the long hot period and relatively few storms that was to bring a surge of blue crabs in Connecticut not seen here since the last Great Heat. A huge habitat reversal from the 1950s and 1960s was happening. The age of the lobsters in Connecticut had now ended, and the age of the blue crab just lay ahead.

The Saprobien system offers us a different approach one that looks at temperature (climate) and energy and the ability to remove organic waste in all moving streams. Although researchers Kolkwitz and Masson (1909) used biological indicators to describe the qualification of habitat quality, the basic reasons were biological reduction processes that first consumed oxygen and then sulfate naturally recovered as self purification is still important today.

The Danger of Sapropel

Sapropel is a natural substance that occurs naturally in high heat. Dead zones or low oxygen conditions were also present in the 1950s and 1960s (it's just that they were much smaller). It wasn't that this situation was unknown to marine researchers; it was in fact in a book titled Estuaries (George H. Lauff, 1967 – American Association for the Advancement of Science #83, Washington DC, 1967- W.K. Kellogg Biological Station). It did get a mention on page 378. "To some extent, the reduction in photosynthesis and dispersal of bacteria laden debris particles reduce the oxygen "tension" of the estuary. Because of waves and water movement however, low oxygen conditions are rare in estuaries except where the flow rate is low. This sometimes occurs the near the bottom, especially at low tide and at night (Day 1952)." Thus the often common reports of "low tide" smells of Connecticut salt mashes during August.

But low oxygen zones were not of great significance in the 1950s and 1960s, four factors would greatly change that, the warming period post 1974, the dramatic drop in the number of storms (CT DEEP has an outstanding reference table that anyone studying climate and energy pathways should look at, it is titled the Coastal Hazards Library), the return of forest cover leaves and the paving of road surfaces would all combine in a much different estuarine organic matter input than during the North Atlantic Oscillation of the 1950s and 1960s. It just didn't register on the radar then as a concern. In fact some Long Island Sound researchers felt the Sound was "nitrogen limited." As tree canopies rebuilt and roads were constructed, the first brown water reports can be found (mostly from trout fishers) first during the 1880-1920 periods when New England brook trout habitat failed (too hot) and then again in the late 1970s and the heat retuned.

Rains then started to wash huge amounts of leaves (accumulated in heat and few storms) into estuaries, mostly oak and maple leaves, both with a pH less than four such as vinegar. Roads provided a conduit that led directly to water sheds that carried ground up street leaves, stems and sticks that the Cape Cod fishers in the 1950s termed "oatmeal" chaf into streams. This slurry of brown fall leaves carried pigments tannin a "bio pigment" that is brown thus the brown water or chocolate flood waters – often a frequent report after heavy rains.

Some of the first instances of Sapropel toxicity can be traced to the agricultural applications of "marine mud." Coastal farmers in the lower Connecticut River had harvested what was called north of Connecticut "mussel mud" for fertilizer- the "older" the Sapropel the more sulfuric acid it contained – (CT Agricultural Experiment Station Report, 1879) Connecticut River area farmers soon learned that old Sapropel was not only foul smelling (sulfur compounds of the infamous rotten egg order of the Great Heat), but deadly to all crops. The putrefied organic matter that had proved to be deadly to field crops was worse behind mill dams, as its age tended to increase sulfide levels. From lack of oxygen and little disturbance leaves collected behind dams and putrefied when it became very hot and coastal storms declined. Barrier beach inlets also "healed" and these natural features acted much like natural dams and trapped organic matter behind them. Soon "chocolate waters" became "black waters" and fish kills with pungent sulfur smells increased. When heavy rains occur after a period of low coastal energy and high heat, they can carry vast amounts of resuspended Sapropel downstream – killing fish and shellfish below. Sulfide winter kill events are still recorded in Massachusetts- mostly in coastal salt ponds.

This is something that the July 2011 Blue crab reporters mentioned several times this "brown water" and also this year (2013) in the Connecticut River, it was brown for weeks. Our trees have helped oxygen depletion worse and even the dominant tree species have a role. Oak leaves resist oxygen decomposition processes their cellulose structure quite simply is tough – hard to break down by oxygen reducing bacteria, instead they become food for another different type of bacteria – once that reduce organic matter by way of sulfur in the absence of oxygen. It is the process that releases waxy hydro carbon molecules from cellulose digestion and gives sapropel its greasy feel. It is even possible to identify vascular plants sources (P. A. Meyers organic geochemistry 2003). So how much impact does this leaf matter have in estuaries, I believe it to be tremendous, perhaps equal to or surpassing the negative effects of human nitrogen inputs especially when indexed with temperature and energy and begs the question of the role of energy and temperature into the TMDL nitrogen pollution issue.

In the 1950s and 1960s, Connecticut's coast sustained a series of powerful storms and it was cold, and cold water contains more oxygen (inverse solubility law, the colder the water the more oxygen it can hold). Leaves just didn't hang around and pile up. They quite simply were consumed by shrimp or were washed away by the storms estuarine bottoms were firm and often shelly (alkaline conditions) as reported by fishers, waters were cold so the increase of trees (leaves) and roads many "storm water" carrying organic oatmeal into bays and coves largely went unnoticed except by perhaps trout anglers who watched trout streams and alewife runs on Cape Cod destroyed by leaves. Later the shellfishers noticed it covering river oyster beds, followed by the winter flounder fishers who reported fin rot in fish caught in areas now covered by acidic black mayonnaise and acidic marine humus much from oak and maple leaves now properly termed "Sapropel."

Fishers frequently noticed the toxic sulfide impacts after heavy rains as the organic matter putrefied and turned brown to black. When Sapropel (called Black Mayonnaise along the coast) is disturbed it often emits a sulfur smell. These habitats were reported to be toxic to Brook trout at the turn of the century and created the transplants for more heat tolerant trout spears such as Brown and Rainbow trout.

In the 1970s the water warmed, energy stopped, roads were in place at the same time Connecticut's forest recovered from agricultural cutting of the previous two centuries. Leaf litter and organic matter accumulated in watersheds for decades.

After heavy storm rains organic matter rushing in storm water discharges clogged trout streams, and later alewife runs. Then came the prohibition on burning leaves – an increasing fall activity for many New England homeowners. I don't think anyone really anticipated the impact that would have in the coastal region. I can remember my father who was an avid trout fisher complaining bitterly about the destruction of "natural drainage" and its impact upon trout stream habitats in the 1940s. I had no idea how that observation would influence my later natural science research efforts. So I feel it was the trout fishers who were the first impacted by the return of the forests, and storm water from roads which now made fly fishing only viable upon the largest latest ponds. The days of clear out open streams for agriculture were coming to end, habitat succession was in full swing post War World II, and as the forest returned, more roads were being built. Trout habitat now came under attack by increased leaves, and "storm water" that carried those leaves into the brook trout habitats. Trout habitats were greatly impacted but nothing would rival the impacts of leaves to alewife runs which remains a huge issue even today. Some alewife runs are totally blocked by leaves (and fallen trees and branches) while others filed with a century or more of street sand. While fish ladders are installed the habitat quality of such runs are often ruined by silt and leaves. The leaves of course also rot in high heat and continue degradation downstream with sulfur residues. In this case leaves could have been classified as a pollutant – at least in terms the alewife especially habitat quality alewife runs into old mill ponds which may now contain several feel of Sapropel behind them. It is often described as a "sulfide block" and if strong can kill fish outright.

The much colder 1870s saw Connecticut streams ice covered and cold water ice "caps" did help clear streams of organic matter and help Brook trout habitats recover. Ice over streams had already been linked to a Venturi effect of creating tremendous scouring currents. George McNeil a oyster grower that spent his final years growing oysters in Clinton Harbor recounted how heavy rains while ice still covered the lower Hammonasset River cleaned and washed upper oyster beds while the lower beds – not ice covered were blanketed with three to four feet of black leaves. If the leaves were not moved they would have suffocated the lower oyster beds – he had noticed a dramatic increase in leaves and suspected that leaves were being dumped into the river as it was taking longer and longer for them to disappear. He saw the return of leaves as a growing problem to oyster culture in coastal rivers and bays in many areas.

Habitat Succession was occurring and oyster growers were some of the first one to record it. This habitat change mirrors that a century ago. Some of the first warnings about "stagnant waters" can be found in the United States Fish Commission reports of the 1880s. Here manure waste from dairy farms rotted and became a nutrient source in estuaries.

Connecticut a century earlier had now become a productive dairy state, lands were cleared beyond that of the first agricultural settlements to industrial scale as a war recovering nation found many southern farms ruined. Here would be another warm period with organic matter – manures. Fishers also noticed the problem with factory wastes as water courses delivered this pollution "to them." The waters were often tinted from chemical dyes - waste cellulose paper, pulp or chemicals. Rivers and streams merely became natural conduits to carry polluted wastes to the seas. But they also noticed those dairy farms and the industrial practice of using streams to carry manure wastes. A sludge (often black) was linked to dairy farm manure in Groton, Connecticut in the 1880s. Shellfishers on Long Island had complained about Sapropel formation from Duck Farm operations located in areas of low energy. In one of the more significant habitat case histories involving putrefied organic matter (US Army Corps of Engineers – New York District, Suffolk County New York, Appendix D 2009 is found regarding the Long Island Duck farms. In the 1950s and 1960s discharged duck form waste occurred into sluggish coves were unsuited to naturally clear such organic matter. Similar problems confronted many of the first cultured Atlantic Salmon operations in the North Atlantic. As organic matter accumulated "duck sludge" under went classic sulfate reduction as sulfur reducing bacteria increased the presence of hydrogen sulfide. Not unlike observations of the Narrow River in Rhode Island or interviews with Niantic Bay, Connecticut residents "sulfide fogs" could discolor paint on homes or acid drips below street lights destroy car finishes. Page 16 of the 2009 study of this sludge problem mentions complaints of paints on homes being discolored – referenced in 1964 and 1972 reports. By the late 1960s the Federal Water Pollution Control Administration had already recommended removal (by dredging). Once sapropel forms, it can exist for centuries and become increasing acidic from slow sulfuric acid build up. Although most of the Long Island duck farms have now closed, the sapropel (mentioned as sludge) remains and becomes more toxic to marine life as sulfur bacteria increase. Heavy organic matter accumulations that reduce tidal energy (flushing) can accelerate this process. They by hydraulic flow reduction extend the time required for such sludge to be eventually be reduced. The description fits sapropel and the impact of organic decomposition is noted in the report below.

> "Particles of decomposing organic matter created blankets of sludge that consisted of a homogeneous, black, plastic material with a strong, unpleasant odor."

Sapropel as it ages also naturally complexes metal ions, so it is not uncommon to find elevated metals in them. Some of the first research (EPA 1982) looked at sapropel as a natural process for metal remediation processes.

After 1972 the public policy debates of controlling pollution – often "manmade" soon eclipsed natural conditions of forest cover, temperature and energy pathways. But high heat and natural organic loadings does influence nutrient availability and habitat change in Long Island Sound now linked to seafood abundance. The nitrogen input TDML discussion for example needs to be broadened to include climate patterns. Although the public and environmental policies of the last half century has placed most of the pollution emphasis upon "us" as the chief modifiers of coastal environments when in fact a long term environmental review is much less clear. That's why we need to look at the Saprobien System and the impact of Sapropel to fish and shellfish habitats. This review may shed some light on natural habitat factors first identified in the 1950s and 1960s as Sapropel.

"During anaerobic conditions particularly in summer, organically rich sediments may decompose to form Sapropel. This is a blue – black substance containing hydrogen sulfide and methane. It has been suggested that fossilization of Sapropel results in the formation of oil." (Pg 40, The Ecology of Inland Waters and Estuaries Reid 1961).

When temperatures rose and energy levels decreased estuaries soon became Sapropelic and within decades sapropel would become a dominant habitat type. One of the signs of Sapropel in hot weather is the smell of sulfur or "stinks" a mixture of methane and sulfides that many reports refer to us the "rotten egg smell." Sapropel – rich in nitrogen compounds was used as fertilizer for hundreds of years. Its formation and function as a nitrogen sink needs to be included in Long Island Sound studies.

A question remains if we gave natural climate patterns a free pass when it came to habitat succession and nitrogen levels.

Always welcome suggestions, comments. I can be reached at tim.visel@new-haven.k12.ct.us

The following appendix is excerpts from Blue Crab reports (2013) some include discussions of Sapropel.

The Search for Megalops – Program Report #1

2013 – Blue Crab Year

April 17, 2013

Could the 2013 blue crab year answer climate change habitat questions?

At the turn of the century winter flounder fishers and bay scallopers found disappointment in many Connecticut coves and bays. Following the cold and storm filled 1870s the 1880s and 1890s were much warmer and then very hot. The 1896 and 1898 heat waves in New England were record breakers for their time. Bays and coves turned black and began to smell of sulfur, the rotten egg smells so common along the shores. Besides the Blizzard of 1888, the Portland

Gale of 1898 (most likely a November hurricane) and two gales of 1903 and 1905, the 1880 to 1920 period was relatively quiet, storm free. But with this period came heat waves that killed hundreds of people. National Public Radio NPR has a comprehensive report on the career of Theodore Roosevelt during The Great Heat Wave of 1896 in New York City. The eastern CT fyke net fishery for winter flounder had largely failed by 1910 – bay scallops were practically nonexistent.

But fishers also noticed some distinct habitat changes then; eelgrass which was almost cleared completely out of the coves by the 1870s storms was back and formed huge dense monocultures (meadows), Brant feasted upon this eelgrass and populations of Brant soared as conditions now favored lush eelgrass growths. Eelgrass meadows trapped organic matter, not disturbed by storms which then rotted and turned black in high heat. Oyster fishers at the time complained the most about these "new habitat conditions" and the first reports of ruinous black "mud" came from Great Salt Pond research in Rhode Island (1898) and the work of Rhode Island Experiment Station run by Dr. G. W. Fields. Organic matter washed into streams with manure, a dairy industry practice then and formed a slurry of rain driven organic oatmeal[2] that buried previous "hard" bottoms and now were soft and sulfur smelling which killed river oyster beds. In the high heat this organic material started to rot and produce hydrogen sulfide, as recorded by the coastal residents who reported the "marsh stinks" the infamous rotten egg smells. That happens today also, and surprisingly Niantic Bay, Connecticut had a brush perhaps with hydrogen sulfide toxicity in August 2009. Then newscasts WTNH-New Haven contained reports of blue crabs crawling on land to escape the "low tide" Niantic Bay (River) waters with pungent smells. (Blue Crabs Picking Land Over Niantic, Friday August 7, 2009 by Jamie Muro). I believe this to be similar to more southern crab "jubilees" when blue crabs walk ashore by the tens of thousands. The August date and very hot temperatures suggests a hydrogen sulfide toxic "event."

When coves turned black, sulfate reduction processes accelerated and fish kills soon followed- that was the 1890s. These conditions persisted into the 1920s (Grabau 1921).

But as oyster fishers complained about black muds lobster fishers also watched as their fishery collapsed, and the lobster die offs peaked between 1898 and 1905. Bay scallopers also were out of business, not from overfishing but because instead of cold

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[2] *Oatmeal chap* is an old term for unconsolidated terrestrial brown organic debris, stems, leaves, barks; dead grasses are fractions of this substance.

water corraline reds algae and red weed (thought to be the real scallop grass) such as the deep water Narragansett bay scallop habitats were now covered with eelgrass and in high heat acidic conditions were lethal to bay scallop sets (dissolves shells). But as the bay scallop, lobster and inshore winter flounder fishers saw disappointing catches, those blue crabbing, catching soft shell clams, striped bass, and those involved in oyster culture on hardened bottoms were reporting very positive increases catches couldn't be better. And for every acre of oyster and clam shells placed on aquaculture acreage, it buffered acidic marine soils for hard shell clams while creating more habitat for winter flounder.

The year following the Portland Gale, the Connecticut oyster set (1899) was to be the set of the century, soft shell clams set heavy on Cape Cod, blue crabbing soared region wide north even into Buzzards Bay and during this heat, striped bass grew huge. Many Connecticut River clammers converted their skiffs into guide boats to take New York hunters duck hunting in Connecticut River marshes no longer iced in as before, and now early "hot" springs made duck hunting and turtle trapping the business of necessity not choice. Noank, once of the center of Connecticut's lobster fishery became a community of coastal cottages and the place to "torch light" blue crabs at night. Striped bass fishing became a popular past time for the then rich and famous. Many northern islands walking fishing "stations" were build (few storms) and the bait used to catch some of the largest stripers then that would be 2 pound lobsters or soft shell blue crabs. Fishers and hunters were in "The Great Heat," a period in New England's climate history of very warm hot summers and few strong storms. If you were to examine the lobster and blue crab fisheries today besides habitat quality indicators that are present today they will provide some answers to habitat questions asked over a century ago. What happened to the Southern New England lobster fishery in 1898 and a century later Connecticut again has experienced a lobster die off while an amazing surge in blue crabs. Why?

These habitat changes were signaled in both cases by the fisheries noticing bottom habitat changes, the muck that covered so many estuarine bay bottoms, and produced those sulfide smells, today that muck is called Sapropel and is the largest indicator we have to habitat reversals and fishery transitions. Fishers in New England wide raised the Sapropel alarm bell in the 1980s and looking back they were correct to do so. In one of the few case histories of this sulfur rich mud impacting fisheries could be the Long Island duck farms of the 1950s and 1960s. The appearance (or disappearance) of Sapropel may become a key indicator of climate induced habitat change. That case history is under review presently.

All About Sapropel – and Habitat Questions from Western Connecticut Crabbers

In July 2011 we had a large die off of adult blue crabs in western CT during a heavy rainstorm. It was hot; also a time of heavy West Nile reported chemical pesticide and reported application of brickets into street drains. A large migration of crabs had already left the Housatonic River and was heading east, and western Connecticut crabbing had been excellent following another great 2010 year. After the heavy July 2011 rain event, many western crabbers noticed a significant brown coloration to the water. This brown color is linked to the breakdown of oak leaves. Tannin, an acid, is very high in oak leaves. Some reported that the waters also “smelled” badly like sulfur. This hydrogen sulfide smell is attributed to coastal bodies of water and salt marshes in late summer when dissolved oxygen is at its lowest point. Bacterial processes in high heat and low oxygen tends to reduce organic matter (leaves) by bacterial reduction of sulfate releasing the hydrogen sulfide gas – thus the foul or rotten eggs smell. This smell (stink) was prevalent in the later stages of The Great Heat a century ago and noticed by coastal residents near marshes. That also occurs today and many coastal residents can confirm this late summer event. The rainfall may have dislodged rotting leaves increasing levels of hydrogen sulfide in tidal areas. The same areas that had been so productive for blue crabs can lead to high sulfide levels and might trigger these large late summer migrations.

Warm waters and few storms helps the blue crabs habitats but as with the lobsters, great catches are made just before a habitat crash – and the blue crabs in Connecticut might be facing a similar tipping point – an almost forgotten hydrogen sulfide toxicity in the water itself. This is due perhaps to the buildup of black sulfurous mud called Sapropel. In warm weather leaves and organic matter rots and produces Sapropel. It accumulates rapidly with few storms to wash it out it can reach several feet deep – locally it’s called *Black Mayonnaise*, and is often a dominant habitat type. Not too much is known about the extent of Sapropel deposits in Connecticut. Key scientists worldwide were looking at it just after The Great Heat 1880-1920, and had convened a world conference about sulfurous mud just prior to World War II. The conference (1938) papers were eventually printed in 1958 but by that time we were in the period of cold and numerous storms, the North Atlantic Oscillation. Estuarine habitats had reversed - Sapropel deposits were washed away and from bays, coves and salt ponds, and a new habitat type, estuarine bivalve shell now became dominant. Winter flounder was enhanced by firm bottoms estuarine shell, while blue crabs which need the Sapropel to burrow into during the winter – for long hibernation periods retreated -mostly and today to rivers and dredged channels. The onset of a habitat reversal had “helped” some species increase – up to a point. That seems to be the case with Sapropel, and now perhaps blue crabs.

In a Cape Cod study in the middle 1980s, a diverse habitat type produced the best diversity or biological richness. The observations included one quarter, hard mud, or sand, one quarter estuarine shell, one quarter vegetation, and one quarter small stones (or cobblestones) were the richest habitat areas in terms of biological diversity. When one habitat type dominated total abundance often remained about the same but diversity declined. A dominant habitat type – all yielded some organisms- except Sapropel. This habitat type tended to reduce diversity and in large deposits was vacant of most recognizable animal life forms.

Sapropel did contain eels and eelgrass together; it was felt to be important to habitat requirements of overwintering Blue Crabs who needed to hide from predators during

long winter hibernation. It was, however, a limiting habitat type and in large deposits devastating to most shore life, fishers often reported accumulating leaves first - the material that creates Sapropel. Oak and Maple leaves are naturally acidic and in poorly flushed coves and bays collect and rot in summer heat. This is the material that so many kayakers experience (not pleasant and often dangerous) in shallow warm waters. When oxygen levels normally lower in warm water, this organic matter cooks – rots as terrestrial compost- but here the reduction processes create a perfect storm of habitat failings or constituents, sulfuric acid, hydrogen sulfide, ammonium and now removes all oxygen. One long time winter flounder fisher, Louis Bayer, from eastern Connecticut (1980s) watched as his favorite winter flounder habitats were covered with “black mayonnaise” and once commented to me “this stuff is bad for fish” – I quickly agreed, it was.
In some bays Sapropel has past 25% coverage to as high as 50 % to 75%. Previous core studies do show episodic events in coves that have core samples layered then mud with estuarine shell. These habitat reversals could have happened before, many times in Connecticut’s fisheries habitat “history”.

In the late 1970s Sapropel seemed to increase along with Blue Crab increases – There appears to be a habitat connection with older blue crabs which tend to seek out these soft deposits in winter, but in late summer Sapropel becomes deadly. The compost residues from Sapropel has a role in acidification of estuarine soils – bivalve shell erosion, lowering oxygen and in the presence of ammonium which fuels brown algal blooms and hydrogen sulfide a lethal one-two knockout punch to many organisms we as a society value. Sapropel is now linked to the tremendous increase in necrotic fin rot disease in winter flounder populations during the same time, and an increase in the plant nutrient ammonium which favors the harmful brown algal species (HAB). HAB blooms have been shown to reduce bay scallop habitat quality.

As habitat quality for Blue Crabs increased, winter flounder habitat quality declined. Sapropel may even trigger mass movements of Blue Crabs by the presence of hydrogen sulfide levels in the water itself. That movement has happened the past three summers- although the 2011 “waves” were weak following a much colder winter, blue crabs could be moving to avoid hydrogen sulfide toxicity.

The Search for Megalops

Megalops Report #5

July 15, 2013

The 2013 Blue Crab Year

<u>Increased Rainfall, Heat and Sapropel Habitats</u>

Black mayonnaise (Sapropel) has been attributed to declining inshore fish, and shellfish habitat quality (Boston Globe article, 11/26/11) and accelerating nitrogen pollution Conservation Law Foundation report 10/30/2011. Coastal residents in many southern New England states now reference it as bottom changes. Its cyclic buildup is part of a natural process now linked to shedding excess nitrogen – ammonia compounds during high heat. The changes in bottom habitats in the 1980s were first observed by fishers, and necrotic fin rot, in winter flounder. Shell fishers then noticed declining bivalve sets and changes in bottom pH and smells would be minor to the enhanced sulfur reduction/nitrogen storage processes people couldn't see. The increase in sulfur gas would be associated to the "marsh stinks" a century ago. In recent times, the hydrogen sulfide gas of low oxygen reducing environments would create long periods of low oxygen and under the proper conditions create hydrogen sulfide "fish kill" toxic events, the "black water death" of the last century. But, Sapropel buildup is not a new occurrence and many of the first layers of Sapropel were found beneath eelgrass meadows. There are two basic types of Sapropel, forming and ancient. Sapropel can occur in cycles (such as today) much lower amounts from storms that tend to wash it from coves (see Megalops Report #3, June 12) or warm storm free periods in which it tends to accumulate.

Ancient Sapropel is found in deep marine seas and the bottom of lakes. It has over thousands of years become a organic rich high nitrogen material that when applied on farm fields especially cereal and vegetable crops can increase crop yields 30% to 75%. (Reference Lakes Bottom Deposits and Their Economic Value In Industrial Agriculture Sector Off Western Siberia 2011; Tatiana N. Serebriakova, Ph.D. or et al. University of Connecticut). Sapropel is now recognized worldwide for its ability to bank or store (sink) nitrogen compounds. This ability has not gone unnoticed and Sapropel has caught the attention of a growing worldwide organic natural food constituency who consider it to be a natural formed fertilizer supplement for artificial ones.

Most Sapropel forms at the deepest most oxygen deficient areas of lakes and ocean basins. The absence of oxygen is a key ingredient for Sapropel formation. But in the marine environment in high heat Sapropel becomes deadly and zones of oxygen depletion often have soft Sapropel bottom deposits. A shallow water estuary can often have sea grass (eelgrass) environments important to blue crab and other crabs species over it. It is a habitat type that can be influenced by rainfall. Large amounts of organic matter such as sticks, bark, leaves and dead grasses washing into shallow warm estuaries quickly can rot and decrease water exchange. Sapropel tends to absorb heat; soft patches of it with eelgrass were significantly warmer than sandy clear areas in surveys of Niantic Bay in the 1980s. In areas of "black mayonnaise" it was hot and seemed to drive colder-preferring species away from it. Many blue crabbers experienced Sapropel and most likely did not realize it at the time. It can get deep in slowing moving current flows in shallow areas. Several kayakers have had some close calls as well, believing bottoms to be firm only to find themselves stuck in "soupy black muck".

Sapropel has the following characteristics: it is acidic, black, jelly-like and often feels greasy to the touch. When disturbed it has a slight sulfur (match stick) odor and will, because of its low pH, quickly stain your hands. Because of its high sulfur content it is now suspected to be the source of the yellow coloring of the older yellow faced blue crabs (perhaps from overwintering?). In high heat Sapropel can be damaging in many ways; it can shed ammonia during sulfur reduction processes, a brown (HAB) algal nutrient. It produces both hydrogen sulfide gas (the marsh "stinks" of the last century) and sulfuric acid, and removes any oxygen for organic respiration in contact with water. Because of its tendency to form a jelly-like substance, it tends to collect in slow moving currents away from direct energy pathways; it can be found in the quiet upper reaches of coves and bays.

Fishers first noticed Black Mayonnaise in the early 1980s – especially bay scallopers. The increase of black mayonnaise was very alarming to the Hyannis Bay fishers on Cape Cod in the early 1980s as they had never seen it before become so thick so fast. Fishers who fished in Lewis Bay were the ones to correctly identify its source as deep brown waves of organic debris (sticks, stems, dead grass) – called oatmeal which in high heat turned black. In times of heat, a sudden rainstorm (or storm for that matter) could disturb these putrefied deposits releasing hydrogen sulfide and causing the large fish kills (black water deaths) from the past century. It was the Cape Cod fishers who found in places several feet of organic oatmeal that would turn black in August heat (1983).

This is the same oxygen deprived substance that collects in closed system aquaculture systems and makes changing filters (which also turn black with the same sulfur odors in them) in restricted air spaces so dangerous. The toxicity of such Sapropel formation and toxic hydrogen gas would cause tragedy at the University of Maine with aquaculture technicians (July 2002). Sapropel and the toxic sulfide formation can be very deadly not only to sea creatures but to us as well.[3]

The increase of Sapropel coverage of estuaries is the largest indicator of habitat change in the past century. The fishers on Cape Cod in the 1980s were right to be concerned about the formation of Sapropel, it would go on to devastate the bay scallop, quahog and winter flounder habitats within a decade. The increase in Blue Crab habitat quality was just beginning but as Sapropel accumulated its impact upon blue crabs would be accumulated by heavy rains – it is those times that hydrogen sulfide is washed from it – the black water death of the last century. Heavy Sapropel layers can be damaging to blue crabs as well. The heavy rains this spring could influence habitat quality into

[3] See Bangor Daily News July 31, 2002 – A sealed Aquaculture System used to recycle water for Halibut culture experiment had tested positive for hydrogen sulfide. The sludge had built up enormous hydorgen sulfide levels in the organic matter and when disturbed released toxins heavier than air that smell "similar to rotten eggs".

negative areas for the blue crab and we may have seen that happen in July 2011 – western Connecticut.

Lobster and Winter Flounder

If organic composts (Sapropel) is a key link to habitat reversals we should look to other species.

Sapropel and a fungus Saprolegnia is now linked to the winter flounder fin rot disease of the 1980s. And what locations showed the first signs of fin rot, they would be quiet coves and in low energy areas in which black mayonnaise first collected. Organic material is rich in bacteria and fungus and some of the first concerns come from lobsters caught over sewage sludge at the 105 mile off shore New York dumpsite. At the 1977 Rhode Island Fishermen Forums (once sponsored by Rhode Island Sea Grant), Jake Dykstra held up lobsters caught from the 105 mile dump site with shell disease. I had started lobstering in Long Island Sound in 1967 and had never seen anything like that. By 1982 the New Haven Harbor was showing winter flounder caught in the Morris Cove section had fin rot in 22% of the sampled winter flounder. It is a low energy area and offshore surveyed areas in higher energy zones at the same time showed much lower prevalence[4]. In high heat both fungus and bacteria thrive and in low oxygen marine environments this compost (black mayonnaise) quickly becomes Sapropel.

In the New England lobster fishery, shell disease first occurred historically in lobster pounds – enclosures in tidal creeks and salt ponds in which lobsters were "wet stored" like cattle pens to be sold at high prices in times of short market supply. These "pens" held lobsters for several months and fed, as usually poorly flushed bacteria and sludge soon built up on the bottom of these storage areas (personal observations, 1977). Bacteria in warm weather thrived and massive August lobster pound mortalities are documented in the fisheries literature. What was happening in a small habitat way would soon impact all of Southern New England, as energy (storms) slowed, and organic matter rotted in high heat – what Peconic Bay and Great South Bay fishers described to me decades ago – bay bottoms just turned black and went soft. With increasing heat into the 1980s, Sapropel deposits grew in poorly flushed coves, a habitat failure occurred first for winter flounder and later for lobsters. A key ingredient it seems was warmth, the warmer waters to the south had higher incidence of lobster shell disease than cooler waters to the north (Cobb Castro 2006).

Shell disease hit lobsters hard in Buzzards Bay in 1997, but stopped short of Maine waters (thought to be to cool). In 1998 the incidence of shell disease soared in the southern New England region as lobster stocks crashed. Shell disease is still with us – as the next section illustrates.

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[4] Incidence of Fin Necrosis In Winter Flounder, Pseudopleuronectes Americanus (Walbaum), from New Haven, Peter J. Auster, The University of Connecticut Marine Sciences Institute, Marine Research Laboratory, P.O. Box 278, Noank, CT 06340. Report to Schooner, Inc., 60 South Water Street, New Haven, CT 06519 1981

For more information about Sapropel, see “Sapropel and Climate Change – Fisheries Habitats Degraded by Putrefied Organic Debris in High Heat, Low Energy Conditions” available from the Sound School Adult Education program. Contact Sue Weber (susan.weber@new-haven.k12.ct.us).

The Search for Megalops
Program Report #7
August 16, 2013
The 2013 Blue Crab Year

Western Connecticut Blue Crab Habitat Failure and Recovery

One of the most interesting aspects of the natural ecology of embayment systems is balance, and the other is ecological voids. Nature hates a vacuum and that is true, but what takes years to happen can be gone in an instant and what happens instantly can take years to restore, in other words, we have habitat succession in the marine environment also.

One only has to look at terrestrial forest fires and marine hurricane impacts to experience this change. But what about the habitat succession; we can't see, we can see the impacts of beaches swept away by storms but will we see the kelp/cobble stone forests that often follow? Forest fires are terrible events for those in its path but years later species that needed grassland habitats thrive, while those that needed the forests before decline, a balance between habitat types and the populations that need each type? Do we know enough about habitat succession and population dynamics of marine fish and shellfish in the marine environment? No, absolutely not, we haven't even begun to understand it or study it for that matter. We learn about marine habitat succession from fishers, as we did first about terrestrial succession from hunters. Similar to terrestrial habitat succession, (drought and high heat precedes forest fires, while rainfall signals a long term renewal of the forest). Marine habitat succession is governed also by energy and temperature.

Hunters would head to grasslands to seek species that needed that habitat, fishers head to "structure" to catch species that need it. Talk about structure to any freshwater bass fisher, and you will soon find they are keenly aware as to the value of structure to overall fishing success.

But what about blue crabbing, what made the 2006 to 2011 blue crab populations soar in western CT? What do they need, what is their habitat balance in regards to habitat succession? These are questions that need answers if we are truly to understand one of the largest habitat reversals in a century.

Did western CT blue crabbers experience something of a habitat successional event in 2011, yes I believe they did.

Hydrogen Sulfide And Its Impacts Upon Estuarine Health

Sapropel and western CT river life systems may provide response to western CT blue crabbers. The truth of the matter is that we just don't know much about sulfide toxicity in western CT. It is an area of research that is lacking even into today.

In many respects my response to questions from the western crabbers in 2012 is a combination of several factors low oxygen, freshwater toxicity, chemical toxicity, hydrogen sulfide toxicity and disease.

While all of these factors should be considered, I believe low oxygen/hydrogen sulfide toxicity to be the primary reason for the apparent habitat failure. Many blue crabbers pointed to the West Nile treatments and that deserves a look and I did issue a special report (Pesticides and Blue Crabs on July 24, 2012) about this, I also looked at disease and habitat life cycle stressors including oxygen and chemical factors as contributing causative disease factors, but central and eastern blue crab populations remain to my knowledge relatively disease free. So I looked at a key concern of mine the habitat impacts of high heat, low energy and high organic deposition, particularly leaves oak and maple as acidic sulfur respiration pathways leading to hydrogen sulfide buildup and fish kills.

And, as I usually do, I look at what is in print, in the historical records and current research. After researching the problem for about a year in regards to western CT rivers and harbors, I found very little written about the impact of deep deposits of organic matter (leaves). And when pollution of rivers did grab a national attention here in the US, its focus was upon the chemical manmade aspect of non natural "polluting" substances, entering water courses not natural ones such as organics, leaves for example. A consensus upon pollution would itself contain a biased point of view, how could something "natural" also be considered a pollutant. This public policy component would initially tend to the analytical chemistry descriptions of measures for manmade substances for pollutants.

When examining the historical records it is important to recognize a resource bias in the scientific community at the turn of the century. During this period lakes were the resource of concern, still important for water powered machinery and drinking, however rivers or harbors were not high on the priority list. In fact, rivers were thought to be the best way of "receiving" factory wastes, so it was much to our repugnance a "reasonably use" of pollution policy existed. Until well into this century, one only has to read the three hour speech to the CT Agricultural Board in 1886 about pollution which the editor of the Hartford Courant, then Mr. J. B. Olcott described walking along the Quinnebaug River with cotton soaked in glycerin stuffed into his nostrils to block out the smell from the river. Not doing so would accordingly cause one to instantly wretch. This was a common practice during this time in Connecticut unfortunately along many riverfront factory communities. Therefore, is it not surprising that some of the earliest river studies of the biological impacts of river organic matter pollution came from Europe and not from the United States. Some of the first studies are from the Baltic region, especially Germany and Poland. River fisheries were very important in Europe (fisheries, drinking water) so impacts to them were first studied and the first research on the impacts of high organic matter is from them. The first formal study of putrefied organic matter, and biological impacts upon rivers was developed by Kolkwitz and Marsson at the turn of the century. In 1909, they developed what they termed, a Saprobien system for the assessment of organic pollution, and in the 1950s, 1960s and 1970s this bias (chemical not organic pollution) for lakes and not rivers continued here in the US. In the 1930s a worldwide conference about Sapropelic formation was held and at the urging of Parker D. Trask of the US Geological Survey just prior to World War II, the paper of recent Marine Sediments was finally printed in 1955. In 1971, H.B.N., Hynes of the University of Waterloo, Ontario, Canada, published his now famous book, "The Biology of Polluted Waters" (University of Toronto Press 1971) he mentions this bias in regards to the "well known" classifications of Saprobien System for rivers. "But perhaps well known is too strong an epithet to use because although it is widely used on the Continent, it is rarely mentioned by American or English authors." The Saprobien System as defined at the turn of the century will be recognizable as a slightly different system for lakes today, not rivers. And the largest constituent of Sapropel in CT now appears to be leaves, and depleted oxygen (warm water) conditions – "a habitat history" or much longer cooler and then warmer periods.

The basis of this classification system is the theory that when a river system receives a tremendous load of organic matter (leaves, grasses, bark, twigs, etc) it would result in a series of “zones” of decreasingly severe conditions for plants and animals downstream. A brief description of the Saprobien System is below:

PolySaprobic – Zone of gross organic pollution organic matter with little or no dissolved oxygen and the formation of sulphides (now sulfide).

MesoSaprobic – less organic matter and grades according to the numbers of indicator life forms

OligoSaprophic – The zone of recovery where the mineralization (breakdown) of organic matter is complete and oxygen content is back to normal and a full range of plants and animals occur.

In simple terms, western Connecticut rivers and estuarine areas could now be termed PolySaprobic, favoring the condition of sulfides and extremely toxic to blue crab Megalops and adults. It is now strongly suspected in the black water deaths (largely fish kills) at the turn of the century. It is suspected that floods following years of hot stagnant conditions ripped open Sapropel deposits (black gelatin) releasing enormous quantities of sulfides causing massive fish kills, by “black water” usually accompanied by strong sulfide rotten egg” smells. Passive deposition of leaves and organic matter in coves in Eastern CT such as the North, Middle and South Coves in Essex in which oak and maple leaves have collected are good examples. Over decades in areas even 10 feet in depth have layers of leaves, the western Connecticut rivers may have received just as much organic matter by active watershed transport, organic matter from storm water, and ripped into “brown bottoms” of organic oatmeal in just a few days.

I believe that is what the western Connecticut crabbers were trying to tell me in July 2011 (see Report #12, August 2, 2011; Report #14, August 19, 2011) that heavy rain had ripped into sulfide deposits killing crabs in place. Irene may have brought down additional organic compost then followed by Sandy. The sulfides now released by these organic deposits (warm water and less oxygen favors deadly Sapropel deposits) which lower pH levels could have resulted in a western Connecticut die off of blue crabs not seen here for a century. I will also add that lower pH tendencies to increase the toxicity of insecticides as detailed in label warnings. Many insecticides have both high heat and low pH application warnings.

In simple terms, it is as if someone dumped overnight 5 feet of compost on your yard, the lawn would quickly die, you could see it, and until it is raked off, no lawn. The same thing happens in the marine environment, usually not as dramatic as floods carrying down decades of built up watershed organic matter at a time, but a gradual build up as temperature rise rot. In this case, rotting leaves may have covered valuable blue crab habitat.

In periods of cold (more oxygen in water) and frequent strong storms Sapropel accumulations “melt” away as storm activity washes it from tidal areas. Several western crabbers have asked me about Sapropel (after Report #5) and many blue crabbers have seen it, but know it best by its common name, black mayonnaise. It is also in the location of blue crab populations making its toxic impact, event (storms and hot weather) temperature related. Organic deposits with sufficient oxygen (cooler water) seems to be a good blue crab habitat type but very deep deposits in hot weather tends to be Sapropel. That explains to some extent hot weather warm water blue crab jubilees down south or here in New England late summer and the turn of the century black water deaths. One of the most notorious black water deaths from the last century occurred on Long Island, New York in Moriches Bay between July 29 and August 4, 1917. Here tens of thousands of winter flounder died and then putrefied in the heat. Although today very little is written about Sapropel itself, in Southern New England from Cape Cod to Long island, in shallow warm coves and bays, with reduced tidal exchange, it has often become a dominant habitat type. It is in hot weather Sapropel is toxic to most forms of requiring oxygen marine life and sheds ammonia, a brown algal nutrient.

This also explains how great blue crab habitats such as those in pre July 2011 habitats quickly turned deadly for blue crabs resulting in a DIP "dead in place" blue crab observed die off.

More about Sapropel and Saprobien System in later newsletters.

IMEP #32
The Restoration of Natural Oyster Reefs with Venturi Lifts
A Proposal Restore Oyster Setting Capacity Lost by Harvest, Energy Restrictions and Freshwater Flooding 2010
Along The Gulf Coast – an oyster shell base cleaning And recovery program
Sent to the Louisiana Sea Grant Program – B. P. Oil Spill Restoration Proposal

Habitat Information For Fishers and Fishery Area Managers

Understanding Science Through History

(IMEP Habitat History Newsletters can be found indexed by date on

The Blue Crab.Info™ website: Fishing, eeling and oystering thread

And Connecticut Fish Talk.com Salt Water Reports)

Timothy C. Visel, The Sound School Regional Vocational Aquaculture Center, New Haven, CT 06519 – USA, June 2010
Sent to the New York Harbor School September 2010
Made Available to the Clinton and Madison Shellfish, The Nature Conservancy February 2011
Commissions 2012

Revised for Capstone Experiment September 2014 – Interested students in this Capstone Proposal please review an outline in the Aquaculture Office.

Preface

This paper was sent to the oil recovery team at B.P. following the 2010 Gulf Oil Spill and members of the Louisiana Sea Grant (Louisiana shell regulations from 1935 included in appendix) as a method to clean/restore buried oyster beds.

Since Irene, Lee and Sandy several requests have come in regarding the building of oyster reefs in high energy areas offshore (mostly energy modification/ shoreline protection) in medium energy areas, coves and bays for nitrogen removal, while others (mostly shellfish commissions) have inquired about low energy river restoration areas or how to clean existing shell bases of black mayonnaise. After Irene, Lee and Sandy, some rivers and coves have obtained tremendous amounts of leaves, in some cases several feet: Saugatuck River (Westport, Connecticut), Hamburg Cove (Lyme, Connecticut) and North Cove (Essex, Connecticut) appear to be the most impacted. As this leaf material is reduced, it is now suspected in periodic sulfide toxic washes that can kill oyster, spat, and blue crab megalops and in one case (apparently on the Black Hall River last year) hundreds of striped bass.

Note –

For oyster bed restoration (cleaning) the most important concept is to understand that moderate energy (cultivation, dredging for shellbase "stirring" and shell lifting) is how an oyster reefs "habitat clock" is extended. This however is contrary to many states anti disturbance bottom policies, however when examined for marine soil characteristics, pH pore water circulation, waxes (sticky bottoms) from leaves and sulfides these habitat protection policies conflict with plant and animal biology, a wax filled sulfide rich marine soil will not catch a good set, a strong storm (or dredging) will revive the soils setting capacity and gives rise to century old remarks by fishers that it is beneficial, to work the bottom – it is. Imagine where our society would be if terrestrial farmers were not allowed to cultivate earth soils, many of the same principles apply here. An ecological feature of shell base cleaning is the structural benefits of the reef (bed-bar) itself, as great diversity "biological richness" and habitat associations (services) to flounder, lobster and tautog are tremendous (although often not reported).

Leaves can reduce shell surfaces for oyster spat falls -

Removing leaves in cold, oxygenated water is far different than in warm water and if these habitat conditions are related to natural cycles (which I do believe they are), a larger habitat picture is now needed. Leaves being deposited on estuarine areas can be deadly to fish and shellfish species no matter the spot oyster cultivation aspects. It is very difficult with the enormous amount of literature out there to explain that in low energy, high heat conditions, eelgrass meadows once "clean and green" and helpful habitat wise to many species become "brown and furry" by trapping organics that create such high sulfide levels; it can actually kill eelgrass itself shellfish and fish larval stages and it seems it is a natural cycle pattern (I will let European researchers break that news) of habitat succession.

Only recently have environmental organizations in New England stopped planting eelgrass shoots into Sapropel high sulfur containing toxic (black mayonnaise) organic muck; it soon perishes from sulfide toxicity. Shellfishers of the Cape (Cape Cod) would look below eelgrass meadows only to see the remains of previous bottoms and suffocated shellfish populations below. That is why so many of our current eelgrass studies are so biased from short-term observations; they have little value in assessing long-term habitat quality. Eelgrass meadows in time become sulfide killing fields as they grow upward trap organics and become sulfur rich. Many in the research community knew about this decade ago as some now face increased questioning regarding the Sulfur/Sapropel cycle (Habitat Succession).

My point here is to say we need long-term views of habitat succession in general before oyster bed restoration should be attempted. Many areas may now be bathed in sulfide waters first described over a century ago. The Pattagansett oyster restoration project in East Lyme, Connecticut (1987-1989) is now under review for sulfide toxicity (toxic sediments) or a toxic sulfide wash after heavy rains. No matter the cleaning and shelling (catch planting of a small test area) it could not hold (The Pattagansett River) or catch an oyster set. A huge deposit of black mayonnaise surrounded the test area. I was suspicious of sulfide toxicity then but at the time very few organizations were looking at it, or it was dismissed as contrary to the acceptable norms of beneficial estuarine ecology during that time.

What was the source of all this organic matter? That would be leaves in a flow-restricted areas such as above a railroad causeway (tidal restriction). At that time such deposits were explained as dynamic equilibrium not detailing the negative sulfide impacts of subsurface formation of Sapropel. Black mayonnaise near the causeway was over 10 feet deep.

Hydraulic lift equipment could have restoration potential for shallow deposits but the amounts of organics dislodged by Irene, Lee and Sandy needs a review. Sulfide waters can ebb back and forth killing oyster spat. Shells come up clean and bright with "slip" but catch no set. It is very discouraging to see adult oysters living (they can for a while withstand low sulfide levels) but no set on cultch. Look for a calcite set on the very edges of older oysters or "mantle set." If you have a mantle or "lip" set changes are the spat can live the absence of a "lip" or "bill" set means the bed will slowly die. The sulfide waters now kill the spat but not the adults. Eventually the bed will become buried in organics as upward growth illustrated in Paul Galtsolf's 1964 bulletin, *The American Oyster:*

Cold and energy tend to reverse sulfide waters so you see a run up of oystering setting up to a point (sulfide rich) and then after strong storms, which clean oyster reefs allowing previously buried shell to catch a set (adult oyster s surviving for spat productivity). The 1898-99 set in Connecticut was large but for New Haven oyster growers it was the set of the century. George McNeil that after the Portland Gale (A November storm 1898) the set up the jingles was tremendous (jingles anomia simplex were comparatively rare and newer a source of cultch but the storm moved huge deposits jingles and the set inshore was thick off City Point (George McNeil 1980s).

This has happened before in Connecticut's oyster history according to George McNeil, this was noted a century ago. Some shell beds properly prepared, cleaned (called stirring with cotton mops) but got no sets. It was determined that "spawners" were needed to supply spat, but with what we know now, little, if any, spat would stay stationary but those beds, according to McNeil, the spawners that died were then abandoned; those beds in which the spawners lived continued to have promise. What these oyster farmers could have been struggling with is a toxic sulfide wash that killed oysters below and out of sight; they just didn't know it at the time. George McNeil's father was suspicious of the outer breakwaters removing storm energy and by 1905, New Haven's natural oyster sets started to fail. Instead the most productive seed beds were blanketed in a black ooze. New Haven's outer breakers did "break" the fury of our Northeaster's or hurricanes for that matter but in the process trapped millions of leaves flowing down the Mill and Quinnipiac Rivers*. By 1920 these oyster setting beds were gone.

Introduction

Rebuilding Natural Oyster Beds

Hydraulic escalator dredges can reach down at least a foot (personal communications, (Roger Kelsey, LIOF, 1984) and move sediment quickly re-suspending it with tides or currents. It is important to note that although organic matter will eventually rot and re-mineralize, the use of hydraulics is the equivalent of a snow blower in a snowstorm. It can clean/clear organics from large areas very quickly injecting alkaline water to reduce acidic (mostly sulfur) conditions. Venturi lifts can help bring shell up even off the bottom and replace it on firmer substrate. Because of the snow blower effect, oxygen levels in the immediate area will be depressed from natural bacterial and chemical oxidation. Although this soil washing or lifting has shown to improve clam sets, it was Clyde Mackenzie USFWS that demonstrated that "black shells" burned in acidic (black mayonnaise deposits) could be freed and biologically clean acid washed obtain spat falls when lifted above it (BCF, 1970).

When I was on the LIOF dredge vessel Quinnipiac in the early 1970s, it could move and clean oyster lots very quickly of drills, starfish and remaining fouling debris similar to Long Island Sound storms. Although the immediate clearing does suspend particles and sulfur bottoms once oxygen is introduced the acidic sulfur wash quickly becomes alkaline-like with seawater. pH impacts in cold water should be minimal. A "slip" develops on the shell from the acid cleaning it of algae and preparing it for spat falls. Few people realize that oyster beds are created from energy and from slowly die a lack of it, especially in high heat (see IMEP Newsletter #8 and Tabby Reefs #4).

A caution has to be extended with power lifts or dredging. If the surrounding bottoms have sulfide waters no oyster set will live in the area to set. That happened to me in Tom's Creek, a small 1-acre bed. Looking back I had properly shelled and cleaned it; I had some adults but was surrounded by black

* See note, This event was detailed by George McNeil and I was provided some articles about it. The New Haven Oyster War with the natural growthers was in fact started by leaves and the failing of the natural bed off oyster point (now City Point) from organics. This was presented to the New Haven Lions Club, October 6, 2011, George McNeil and New Havens Lost Natural Oyster Beds – 26 pages. Copies available from Sound School Adult Education Program.

mayonnaise deposits and most likely leaked sulfide in or over the clean shells, which equals no sets. On hot summer nights the acidic sulfide waters can kill the spat just after setting, same result. When you can smell hydrogen gas (the rotten egg smell), it is very likely that any oyster spat was killed.

I am in the process of renewing my notes from the failed East Lyme, Connecticut restoration project (1987-1989) in the Pattagansett River, not from the viewpoint of a lack of cultch (black shell) or spat, but enormous sulfide waters (toxic wash). That should be available in few months and also some Tom's Creek Habitat reports.

There is some historical evidence of "sulfide waters" but research in Rhode Island's Narrow River has shown that it can occur in poorly flushed water bodies that obtain leaf falls from surrounding trees too. Research found extremely high sulfide waters in the Narrow River 10 times that of the Black Sea (Gaines, Maritimes Vol 35 #2, May1991). Recent Information from Europe and Australia also are looking at eelgrass sulfide connections on tidal flats. Denmark will soon release research that points to eelgrass collapsing sediment pore space with sulfide and this has been documented "worldwide." Such eelgrass meadows became natures killing fields.

Large deposits of Sapropel (black mayonnaise) the remnants of organic wastes (much of it leaves) can produce sulfide wash for years; the oyster shells could be present, but sulfide will kill spats quickly in the summer as this material rots. Shell can be planted but oysters will not set (Observations from Tom's Creek, Madison, Connecticut, 1988). Additionally large masses of floating algae matter appeared after Gloria in Tom's Creek and other harbors were thought to have been released nutrient loads in the upper estuaries. Dark leaves covered Tom's Creek's oysters (in some places a foot or more) after heavy rains associated with Gloria. We need to know more about storm events dislodging Sapropel, which sinks nitrogen and phosphate for the sulfur cycle (sulfur waters). In high heat this material sleds enormous quantities of ammonia – nutrients for the harmful Brown Algal Blooms called HABs.

I asked two teachers here at the Sound School if they still teach or introduce the sulfur cycle anymore, their response was "not that much" and "most likely it has not been addressed" in terms of estuarine quality recently. The sulfur cycle has dropped off the radar so to speak and perhaps a key missing link in habitat restoration processes. The largest tool in our restoration toolbox is energy. Energy breaks the sulfur cycle, clears out accumulated organic deposits and restarts habitat clocks for many species. We call that dredging – natures Northeaster's that we initiate.

Natural oyster reefs are frequently a victim of their own success. They can, over time, build up to such an extent that they alter currents and block energy that redirects currents and flows so they actually fail over time. Oyster reefs are generally not sustainable. They grow, trap silt, mature, then fail and die releasing shells upon which new reefs can grow. This cycle repeats itself over long or short periods unless harvested. Oyster beds (bars or reefs, as they are called in the South) are built over tens if not hundreds of years. The first navigation attempts into Chesapeake Bay for example were blocked, not by shallow water, but by a series of oyster reefs that crossed the entry channels. Thus, some of the first navigable waterway projects were to remove natural oyster reefs, not to dredge channels. Buried shells in New York Harbor have been found at depths of over 100 feet.

In many cases Connecticut oyster growers of the last century would break through an oyster "crust" into soupy organic deposits properly termed Sapropel. George McNeil a retired oyster planter from New Haven and Clinton, CT described this condition decades ago. At this time oyster fishers thought that several "bottoms" could be in an area. And these crusts were over old bottoms. From core studies in several Connecticut coves leads to the fact precisely that newer "bottoms" were frequently over older ones. That has been verified by core studies layers of shell and then layers of organics – no shell. When dredges broke through shell was exhausted although today it is hard to determine if it was a 50 year bottom, 100 year bottom or perhaps even more. All that McNeil could tell me that it was a bad sign for the bed but thought that the layers was from storms in the past – they know how destructive they could be so it made sense that these bottoms were created by storms "energy." It's how the oyster companies first experimented habitat "hardening" or transitioning some soft bottoms into hard, they had seen such "second" bottoms themselves (George McNeil, 1980s).

The utilization of oyster producing areas for sets early on was recognized as shell dependent – remove all shell surfaces and the spat (larval oysters) have no place to grow. Floods and heavy rains can also carry vast quantities of organic matter – silt, soil, organic debris such as leaves which can blanket reefs with inches of sediment. Reefs will die and remain dormant until energy such as natural erosion, major storms (Hurricanes) or mechanical harvesting removes the silt and exposes oyster shell to setting capacity once again. This explains accounts of sudden "disappearance" and surprising "rebirth" of oyster reefs in the historical literature. In New England oyster abundance cycles are closely linked to periods of warmer temperatures and few storms. New England's oyster industry reached record highs during the so called Great Heat a climatic period of four decades roughly 1880 to 1920 then collapsed in the 1950s – a period of a negative NAO, colder winters and powerful storms. It recovered after the most recent negative NAO ended, with the 1973-74 the first widespread oyster set in two decades.

In northern latitudes oyster growth is restricted by weather, freezing and ice. In southern waters oyster growth is faster and reefs form much quicker. Sometimes in southern areas a single blade of grass can start a reef (bank) with oysters in clumps. Soft bottom reefs exist in the upper estuaries and hard bottom reefs are found in areas of greater wave and storm energy. It's safe to say that upper estuarine oysters provide the spat for the lower higher energy reefs. Their larval forms are usually swept away by tides and currents. This is especially true when deeper water reefs are destroyed either by natural or manmade events like hurricanes or over-harvesting*. Inshore beds often provide larval stock to replenish offshore areas. In the records of the oyster industry of the last century replacement shell became key to seed oyster production. The great heat saw record oyster sets but shell loss was enormous – hot water contains less oxygen and it is thought less buffering to acid formation. It is suspected in high heat the organic layers below consumed the shell from underneath giving the appearance of slump. It is interesting to note that this happened visually on salt marshes. Nicholas (1920) describes the formation of pans in salt marshes the period in which he makes his observations climate wise is at the end of the great heat. Here sulfate reductions of organic matter – pg 545 mentioned as rapid decay – affecting not only plants on the surface but "the underground parts" as well and that the surface of the marsh now sinks.

Nichols a keen observer also notes accidentally the toxicology of the mud flats themselves and giving a classic description of sulfide wash (toxicity) to plant seeds (sulfides are largely the cause of submerged vegetation die offs these appear to be roughly 50 year cycles) and noted the difference in them "these tidal flats of the lower littoral present a surface of soft blue black, "smelly mud" except for small patches these areas are void of vegetation pg 525.

In many conversations with natural growth seed oyster fishers in the 1970s they frequently mentioned this situation. George McNeil commenting one time that it seemed entire sections of beds disappeared and fell into a black ooze.

It may be that in high heat sulfate reduction now sealed from oxygen below by Sapropel had high sulfuric acid levels (like that found in Sapropel) and dissolved the shell from below, one example of this did survive and I wrote that up in a report mentioned previously titled New Havens Lost Natural Oyster Beds. When a large oyster bed in the upper Quinnipiac salt pond literally sank in the Quinnipiac River. This crust, was more prevalent on inshore beds especially if they were hardened (IMEP #4 Tabby Reefs). Not knowing the hardened habitat sealed the oxygen from below and created acidic conditions. The layers from shell midden examination in Maine points to huge periods of organic deposits and incredible oyster shell Sapropel "layer" formations. These layers were found in digging but much of most recent layers have also been found in deep coastal cores (see IMEP Newsletter #15 parts 1, part II).

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* Over harvesting is a term that is frequently misused – most over harvesting occurs often following habitat failures. In a review of the historical literature over harvesting is connected to sulfide and acidic shell loss which are climate and temperature dependent.

Although much focus has been spent looking at the top of oyster bars and shell removal by fishers information from accounts and references to Norway with marsh digestion of peat in high temperature (sulfate reducing bacteria consumed peat from below form a black liquid calling guttja) now point to a new direction we may have acid digestion of the shell itself. Some accounts of seed oyster fishers in the 1970s in Connecticut Richard Roberts told of similar instances in the Housatonic River where black mayonnaise advanced from edges and then buried the oyster reef. It seemed as though to him the "bed sank." The formation of oyster bars over Sapropel layers deposited from previous climate periods may therefore be a cycle leading to compression of the organic matter or by sulfate digestion of the organic matter in high heat.

We also have a terrestrial wood example of these sudden "slumps." Several New England home builders were the cause of similar incidents by burrying logs next to new home foundations – after years the logs decomposed and the ground suddenly collapsed – this practice is now outlawed. In one instance watering new planted bulbs resulted in weakening the crust of soil which then collapsed leaving the 10x20 five foot deep pit 20 years later (personal experience here).

Could something be happening to oyster bars in high heat I believe so, so many reports saying the same thing in a period of days an entire oyster bed disappeared. Although oyster harvesters were blamed for the oyster bed disappearance ("they left nothing but the roots of trees") I suspect the bed slipped into layer(s) of organic debris below. Cove studies conducted by Wesleyan University 1990-1992 confirmed shell/organic layers in all Connecticut coves surveyed. If organic digestion occurs on land, and in peat and salt marshes, I suspect it also occurs in these layers as well.

Shellfishers may not have caused all the shell depletion as previously reported. They may have experienced sulfate reduction in a different way during warm periods shell loss from sulfate reduction from below and shell loss from acidic waters above both connected to the reducing of organic matter. Buried oyster reefs tend to show "dog" oysters or shoe oysters – long thin oyster shells on top signaling slow burial of the reef but perhaps we need to include foundation layers were collapsing as well. High organic loading can deposit several feet of leaves and start the process (hundreds of years) again leaving a bivalve layer we now observe in modern core studies.

The source of oyster shells for aquaculture has always been somewhat controversial. In colonial times, settlers often burned them as a source of quicklime for "tabby", a primitive form of concrete. As transportation needs increased, oyster shells became the roadbed of choice as it packs extremely hard – just as it does in oyster reefs. A century ago oyster companies would plant millions of bushels of shells to harden bottoms for oyster culture in estuaries, on softer bottoms and to preface firm bottoms for an oyster spat fall.

Early aquacultural legislation often forbid other uses than for seed oyster collection. Several oyster producing states soon outlawed shells for driveways or roadways and others forbad burning it for lime. Connecticut did both. As far back as 1933, Louisiana has statutes which strictly regulated shell loss. Shell availability is the key – not spat. The concentrations of oyster spat are 100 to 500 greater in the South than in the North. It has always been the lack of clean shell to promote oyster culture that constrains the industry, not frequently the availability of spat. This leads to a habitat clock theory. A single female oyster can produce 60 million eggs. As a survival mechanism, larger oysters sense a shortage of eggs and change from males to females with lifespan up to 20 years. With clean shell surfaces the preferred settlement type, an entire industry soon depended upon buried shell or recycling shell for spat falls (see Appendix #1). We need to look at oyster beds as having a habitat clock that is dependent upon energy and temperature – not so much "us."

Most of the oyster restoration attempts have been to replace the shell base. Clyde Mackenzie, a biologist formerly with the U. S. Fish and Wildlife Service (today NOAA), was intrigued by the Connecticut Oyster Industry history of mining "fossil" shell from the Housatonic River and came to realize shell could be recycled by scratching it or digging it up and rebroadcasting it over the surface. He found (as did the industry before him) that buried black shells in an acidic environment (Sapropel) were biologically "clean" and useful for spat collecting. This method, however, was environmentally sensitive as it dislodged surface silt. At the end of his career, he modified hydraulic clam dredge pressure manifolds as a mud cleaning machine for Louisiana oyster beds. However, this raised environmental concerns and cleaning shells buried 1 foot or more never became a standard practice.

Replacing Shell or Manipulation of Habitat

Most restoration efforts today involve placing more shell over reefs or formerly productive areas. Large shells work best as they resist getting buried in soft sediments. Chips and shell fragments are easily buried so large quantities are needed. However, recycling of existing shell needs a lift technology to place shells on firm clean bottoms. This reuses valuable cultch (growth surfaces) which are frequently buried by additional shells. The best spat collection is, therefore, on firm or hard bottoms and various types of spat collectors can be found. In Japan clean bamboo stakes are driven into mud flats. In France unglazed roofing clay tiles are set down in rows. In colonial Connecticut Native Americans drove brush into the river flats to collect seed oysters (Poquonnock River, Groton). But nothing works as well as shell. Shell has been a major cost factor in restoration work and tremendous quantities are wasted. It's hard to judge depths when broadcasting from barges. Some areas may receive a foot or more and others nothing. Large areas are missed and/or shells are placed in unproductive areas. Omitting searches for available shell that just needs to be raised a few inches is a costly error, but until now that type of equipment has been largely beyond the reach of fishermen or industrial use. The weight of shells in self may create instability – as a crust of oyster over several feet of organic ooze. I myself dumped 5 thousand bushels into the upper reaches of the Poquonnock River in 1985 only to see it completely disappear. We also need to investigate the Sapropel – sulfur cycle for sulfide waters. Some oyster beds selected for restoration therefore my benefit from cores, to see what "bottoms" may lie underneath.

The Venturi lift recycles shell by lifting it up rather than placing more weight on the reef. Shell planting often causes existing shells to be buried even deeper. Thus, the key is to put a light, clean shell covering over the bed free of silt. When shell is planted on heavily silted beds, it sinks and becomes immediately silt-filled and of no use, especially if the reef profile is below surrounding areas. It can also be used to reclaim buried shell close to the surface – on bottoms with a shellbase or those that contain at least 30% sand. It can also dislodge leaves as I observed on the Quinnipiac in 1972 in New Haven Harbor.

Fresh river water in massive quantities flowing over oyster beds after an upstream deluge or fresh water release for flood control will lower salinity sufficiently to kill adults and bury the shells under silt and leaves carried downstream. In an effort to prevent surface oil migration into coastal marshlands, Louisiana created just such a mass die-off from low salinity by allowing massive flows of fresh water from the Mississippi River which then buried the oyster beds under inches of silt and organic debris.

Venturi lifts provide the least wasteful method to clean and clear oyster beds for new sets. It removes silt or muck, often referred to as "marine snow", as it lifts the shells up with the ability to collect and move them to other more suitable sites or return them to clean areas on the reef below. This cleaning aspect of a Venturi lift to remove debris is especially suited for oyster reef remediation – restoration.

Similarly, the most frequent causes of oyster set failure are cold water temperature and sudden influx of fresh water which kills the spat just as it kills the adults. Oysters have natural predators (besides humans) which should not be ignored, but most years live spat can be found in the water column looking for a place to set. Healthy oyster and clam beds are also ecologically important crab and fish habitats. The first venturi type of lift for the softshell clam industry was developed by a Fletcher Hanks[*]. Reports from managed use of venturi clam lifts for quahogs frequently report buried shell hash (broken pieces) being returned

[*] August 1958 Popular Mechanics, pg 124 – Jet Stream 6 to 12 feet down in Chesapeake Bay – A pump delivers 30 pounds of pressure to the manifold one clam boat can dredge (jet) 1200 to 1300 square feet/hoir with catches from 30 to 100 bushels /day (soft shells) Canadian tests 1958 clam breakage rate had dropped to less than one percent.

which helps facilitate denser hard shell clam quahog sets. The process however induces alkaline pH and dislodges acidic organic matter from marine soils. This shell hash also is home to dozens of organisms that find shelter and food in such created habitats. This use of hydraulics enhances shellfish sets by placing acidic buffering shell on the surface.

Although silt removal remains controversial in some areas, earlier reports that it devastates marine life were greatly inflated – often to prevent marina or boatyard expansion by dredging. Experience has shown that estuarine soil cultivation leaves a healthy clam or oyster bed with greater or equal biodiversity and reduced acidic organic cover (raised pH) with fish fleeing when they sense sulfide. With the high cost and low supply of available oyster and clam shells, better use of the existing shell supply is imperative. The use of venturi lifts should be investigated as part of the Gulf Coast oil spill recovery.

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Additional Information Added 2012 – This information was added after being sent to Louisiana Sea Grant.

Hydraulic Harvest Technology Utilized to Cultivate Marine Soils

It is ironic that Mr. Hanks invention (1956-58) the use of hydraulics water jets to harvest primarily soft shells with little breakage will possibly be remembered not for harvesting legal size clams but for opening a new field of bivalve marine soil cultivation. The use of water can reopen closed soil pores, modify pH and reverse biological oxygen demand in sediments. These conditions occur naturally after storms but with hydraulics marine soil cultivation has entered a new phase of planned management recruitment for shellfish seed/sets. The reduction of organic matter cannot offset sulfide toxicity and many bars have suitable shell they just contain sulfide at night. This needs to be investigated as well. Sulfide disappears as oxygen goes up on tidal flows improve. Shellfishers in New England have consistently reported that it was beneficial to “work the bottom” (soil) and they are absolutely correct. Harvest energy does prepare marine soils for sets, just as storms.

The ability to lift and clean shell material (hash) and recycle buried oyster shell base or cultch for reef building or oyster spatfalls in one tool in shellfish management tool box that may surpass all others.

Hydraulics can act much like a terrestrial leaf blower in river oyster beds when organic matter (primarily leaves) are deposited on them after heavy rains. For accumulations of one foot or less hydraulics also offers a chance to hold or reverse toxic Sapropel formation – also from leaves. It times of high heat and a renewed forest canopy oyster cultivation may take on more a lawn care attribute with energy (work) needed in order to sustain that habitat type. Mr. Hanks early work in this area is a historical breakthrough in this field of soil cultivation for Aquaculture.

By 1963 most of the "dry" dredges were put away and converted to "wet" dredges opening a new era of marine soil cultivation - for the first time sea farmers had a plow.

STATE OF LOUISIANA
DEPARTMENT OF CONSERVATION
ROB'T S. MAESTRI, Commissioner

Bulletin No. 23

FISHES AND FISHING IN LOUISIANA

1965

(reprinted with addenda)

Department of Conservation of Louisiana

Oysters

The oyster division is proud of the fact that it is the oldest division of the Department of Conservation, and marks the first organized effort in Louisiana to protect one of its greatest natural resources.

This division is responsible for the shellfish and water bottoms of the state, enforcing conservation regulations and collecting revenues due the state.

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ACT No. 67.

House Bill No. 338. By Mr. Thibodeaux.

AN ACT

1915 revised 1933

Section 3. That it shall be unlawful for any person, firm, association or corporation to export from this State any raw oyster shells. Such oyster shells are hereby declared to be the property of the State as one of its natural resources, necessary for use as cultch in the propagation and development of the oyster industry in the State in order that a valuable food supply for its citizens may be conserved and developed. Any surplus or raw oyster shells beyond the foregoing requirements may be used for road building purposes, or ground for use as chicken feed or fertilizer, or any other purposes, of material benefit to th e State or to its citizens. Any person, firm or corporation of this State, who shall lawfully take any oysters from any of the waters of this State, or lawfully acquire the same, shall have a qualified interest or property in the oysters so taken in the shells, which qualified interest may be sold or transferred to any other person, firm or corporation.

Section 15

All oysters taken from the natural reefs of this State shall be culled upon their natural reefs as taken, and all oysters which measure less than three inches (3”) from hinge to mouth, and all dead shells shall be immediately replaced and scattered broadcast upon the natural reefs from which they are taken. No captain or person in charge of any vessel, and no canner, packer, commission man, dealer or other person shall have in his possession off the natural reefs, any natural reef oysters not culled according to the provisions of this Act. Any excess of over five (5) per centum of dead shells and oysters under the size prescribed herein in any cargo lot of oysters shall be considered a violation of this Act, and any officer of the Department of Conservation of Louisiana is authorized to cause to be counted the whole or part of said cargo or lot of oysters at the expense of such person or vessel, to determine said percentage when found necessary; no oysters under one inch in length from hinge to mouth shall be counted, and each half shell of proper size shall be counted as one. All unculled oysters in the possession of any canner, shucker or catcher, shall be presumed to be natural reef oysters, and the onus shall be upon the accused to prove that they were fished from a private bedding or planting ground.

Comments to the Clinton Shellfish Commission 2007
Unpublished Paper – The Sound School Publications Website #12

In 2007, the Clinton Shellfish Commission was investigating the concept of recycling oyster shell prior to navigational dredging of the Hammonasset River and adjacent harbor areas. The lower Hammonasset River and Clinton Harbor areas had once supported a large recreational fishery for winter flounder, Pleuronectes americanus.

One of the best places to catch winter flounder was over or near the McNeil oyster beds in the lower Hammonasset River. In 1881 the entire Hammonasset River was designated as a natural oyster bed except for deeded ground on which Mr. George McNeil farmed oysters.

In the town of Clinton the association between oyster beds and flounder was well established in the 1950s – 1960s. Questions were raised by the Clinton Shellfish Commission as to the concept of recycling the oyster shell before navigational dredging and replacing or establishing new oyster shell/flounder habitats. Newer lift or hydraulic dredge applications were reviewed as a way to restore or create flounder habitats. Hydraulic lift technology has the potential to recycle shells or move shells prior to navigational dredging creating additional habitat or helping to restore flounder habitat indices known to support young of the year juveniles. Navigational dredging has been linked to restoring tidal flow energy and removing deep organic and lower pH accumulations. Restoration and habitat mitigation focusing upon channel edges and the recycling of oyster shell within the dredged area was reviewed. For a more detailed discussion of this type of habitat mitigation program, see Journal of Shellfish Research Vol 7, #2, 267-270, 1988.

Venturi Lift Dredges Can Harvest Oyster Shell

A Literature Review of the Ecological Effects of Hydraulic Escalator Dredging Maryland Dept of Natural Resources Fisheries Technical Report #48 2006

The dramatic reduction in harvest mortality by hand digging associated with the invention of the hydraulic soft shell clam dredge (30% to less than 5%) was attributed to a dramatic change in clam harvest technology – the soft shell clam could not withstand the hard clam dredge manifold pressures without damage so a new harvest dredge was designed, 50% of the hydraulic energy was designed as lift, with the remaining energy 50% cutting or jetting energy. This greatly reduced energy dispersal into the bottom itself washing the clams out with a less powerful jet. The hydraulic devices can be 3 basic types – all delivering energy into the soil as with hydraulic clam dredges. Suction dredges 50% delivery was jetting and 50% in suction pipe and venturi lift 50% delivery and 50% lift onto an open belt. Venturi lift dredges have been used in CT since 1963. The combination of a conveyor belt that delivers a stream of soft shell clams to the surface almost immediately caught the attention of the oyster industry. Some of the first oyster experiments were in Chesapeake Bay and Canada in the 1960s. A literature review of the ecological effects of hydraulic escalator dredges (Mitchell Tarnowski – Maryland Dept of Natural Resources revised 2006) references this potential on page 7.

"On the other hand, the hydraulic escalator dredge can retrieve previously buried shell, leaving it accessible to organisms. The Canadian Department of Fisheries demonstrated the dredge's ability to clean oyster bars (MacPhail, 1961). As a result of escalator dredging, Haven (1970) reported surface shell covering 20% of what had been bare sand bottom. Godcharles (1971) noted that buried shell had been dredged up and redeposited in and alongside the dredge track, leaving it exposed on the bottom. Although Drobeck and Johnston (1982) observed oyster shell on the escalator belt, there was no evidence of this shell at the substrate surface; only softshell clam shells were seen. Presumably the heavier oyster shell had been reburied in the deeper track of the softshell clam dredge. Apparently, cultch skimmed with a shallow dredge setting from a thick shell base would be less likely to get reburied because there is no sediment involved save what had been on the shells. A hydraulic escalator dredge recently was used to clean relict oyster bars in the seaside bays of Virginia (J. Wesson, VMRC, personal communication)."

Shell Washing and Hydraulic Harvesting of Oyster Shell – Galpin 1989 Riverman, Shellerman Sea History Summer 1989

The mining of fossil oyster shell helped the Connecticut oyster industry grow and has been part of the industrial practice here for over a century. First a separate business developed in the Housatonic River and supported what were called "Shellermen." Here at the turn of the century powerboats would prop wash heaps of fossil oyster shells into bars to be tonged or shoveled for oyster growers. It is reported that a team of 3 Shellermen could produce a thousand bushels of fossil shell each day (Philip Teuscher – Riverman, Shellerman Sea History #50 pg 18, 1989). As these shells were buried they contained no set. It is interesting to note that the same areas subjected to harvest energy for shell were also sites of productive fyke net fisheries for flounder and eels – habitat associations that continue today.

With the invention of diesel engines and improved pump/suction/lift technologies a mechanical suction dredge was developed to harvest fossil shell (1940s). First utilized to clean grow out grounds and reduce oyster drill populations before shelling they were modified in the 1970s to move oysters. A modified version called a suction "shell mining dredge" was built to reclaim buried shell on old oyster beds combined washing water jets and a suction pipe. (See New Haven's Oyster Industry by Virginia Galpin pg 47, 1989). The shell mining dredge can recover vast quantities of shell for cultch when dock dried. Its use continues today and is part of the recent success of the Connecticut oyster industry revival.

I was to be exposed to this technology during several trips aboard Long Island Oyster farms (L.I.O.F.) hydraulic vessel the Quinnipiac in the middle 1970s.

Adult Education Workshop – A Gathering of Shellfish Commissions April 28, 2007

Factors Associated with Determining a Commercial Oyster Set
Timothy C. Visel

<u>A Symbolic Relationship</u>

For over a century, Connecticut oyster growers would wait with anticipation over the success of the annual summer oyster set. In reality, two groups were anxious about the results. The first were the oyster growers who would plant the "seed oysters", then cultivate and protect them from predators and grow them to market size. The second were "natural growth" harvesters who would gather seed oysters and sell them to the growers. One had leased or purchased grounds (beds) and the other harvested from natural oyster populations called natural beds. The success of one was linked to the success of the other; between them, a commercial market for seed oysters existed.

The “Set”

The set occurred each summer with the natural spawning of oysters in creeks, harbors and rivers. First, eggs and sperm were fertilized in the water column and then matured. Next, this “spat” settled to the bay, cove or near shore bottoms looking for a place to “set.” Clean oysters shells were the preferred place to start the four-to-five-year process of growing to an adult. Oyster growers and natural growthers knew this, and laws were enacted concerning the return of shells to the water so that ample setting surfaces were present. Oyster growers would plant hundreds of thousands of bushels of oyster shell on owned acreage to supplement the natural set. The rate at which they would plant was 1,000 to 2,000 bushels of clean, dock dried “cultch” per acre.

In late June, Connecticut oyster growers would carefully look for signs of the first “spat fall” and would microscopically examine sampled shell surfaces looking for it. This event would signal almost around the clock shell planting, as the period of setting was limited and had a defined “window” of success. Shells planted too soon were subject to natural marine fouling and silt covering the shells with a slippery coating. Too early shell fouled with blue green bacteria. Too late and the young oysters had perished for lack of suitable substrate. It was a gamble that clean oyster shells would be on the bottom just as the oysters larvae stopped drifting in the water and settled to the bottom. A few days either way would make or break the commercial outcome five years later. By August, the oyster setting period was usually over, although some historical records mention a few sets in September and even one as late as the beginning of October.

What Is A Good Set?

According to George McNeil and Hillard Bloom, a good set was around 4,000 per bushel of oyster shells. Under 2,000 per bushel was seen to be the lower limit of purchasing “seed” oysters. It was anticipated that, at best, only 500 oysters out of 2000 would survive to market size (about twenty dozen per bushel) 6 to 8 thousand set per bushel was excellent, and over that “outstanding.” That may seem like a lot, but a bushel of shells can contain up to six hundred shells – or over a thousand potential setting surfaces. At 2,000 set per bushel, that would only be about 2 oysters per surface.

Determining the Set Count

Before seed oysters (newly set oysters on shells) were purchased, the set count needed to be calculated. Oysters were harvested from an area which was sampled. These samples combined to predict the average set per bushel. Shells would be collected from 5 bushels and each sampled until 5 coffee cans of shells would be taken. 25 coffee cans of shells equals that of one bushel – and the shells are "counted out." The other method is to take one coffee can or modified oyster can gallon from each bushel – count that out and multiply by 25. At about 20 shells to the can at 2 set/shell or 40 set/can x 25 = 1000 set/bushel or low to "poor." I have seen some shells with up to 50 set on each or 1000 set/can x 25 = 25,000 set/bushel which is outstanding.

{1970} "Oyster Culture in Long Island Sound" MacKenzie, Jr. records sets of up to 50,000 set/bushel.)

Price Paid By Volume

According to Richard Roberts, a natural growther for many years, it was too time consuming to count out each bushel of set, so the prices were paid on a per bushel or volume basis. If the set count per bushel was 2,000 and the price negotiated, then it is possible that 200 shells with an average of 10 set, or 2,000 could be combined with 800 empty shells or "blanks" in a bushel measure. Or it could be 1000 shells at 2/shell, the price would be the same, 2000 seed oysters in a bushel measure. If the set count dropped, a price was renegotiated. If the count dropped below commercial levels, buying from natural growthers would stop.

Buy Boats

To accommodate natural growthers in the 1990's, "buy boats" would sometimes be anchored close to the natural bed and deliveries made directly on the water. This assisted in the planting of oyster beds and subjected the seed oysters to a lesser degree of transportation damage. A "tally" or mark was kept and accounts settled at the end of the day. When seed oysters were plentiful, natural growthers would bring several boat loads of sets. In the evening, the day's purchase would be taken to oyster grounds, washed overboard and thus "planted."

River Natural Beds

What was a good set on offshore natural beds and commercially planted (shelled ground) beds was very different from natural beds in creeks and rivers. Here, oyster populations were subjected to terrestrial events, heavy runoff, silt, leaves and marine algae. Setting surfaces were often restricted to new shell growth around the mantle – so they have additional constraints and usually a much lower set count – 250 to as much as 750 set/bushel (up to 50% of the set can be on living oysters). Cycle Mackenzie, Jr. has done research on how to reuse buried shells and clean natural beds in preparation of spatfalls. In 1968, he observed that "black shells" obtained from muddy bottoms could be planted immediately and, being free of fouling organisms, would catch about as many spat as clean dock–stored shells.

River natural oyster beds have shown increased setting rates after modest cultivation schedules, suggested by Mackenzie, were implemented.

Sampling River Oyster Beds

Sampling creek and river natural beds was also more difficult. Although a smaller version of the oyster dredge was used, it often proved to be unreliable. It was Richard Roberts who showed me how to sample natural beds in rivers. This required, at times, a great deal of patience and hard work! To properly sample the bed, it was necessary that all the leaves and sticks be raked off first. The natural beds were often tightly packed, so the hand oyster dredge tended to bounce off the bed. It sometimes would take an hour or more of 30 second to one minute tows with a hand- hauled oyster dredge to clean sticks and leaves from the oyster bed. This was followed by another 30 minutes to an hour to break the edge of the bed loosening the oysters.

Care had to be taken not to “bill” the oysters, slicing off the tops by towing too fast. Once the oyster were loosened, you would start to “catch.” Only then would a sample accurately portray what condition or how abundant the oysters were. The main difference is that set/bushel counts were much lower but survival generally higher since starfish and oyster drills are largely absent from these areas. The chief cause of mortality in these natural oyster beds were from silt and organic debris burial.

For more information on the preparation and surveying oyster beds sets, please review – **Commercial Fisheries Review** (Jan. 1970, pages 27-40) OYSTER CULTURE IN LONG ISLAND SOUND, 1966-69 by L. Mackenzie Jr. Original publication – US Dept of Interior Fish and Wildlife Service #859, Bureau of Commercial Fisheries Biological Laboratory, Milford, CT 06460.

Appendix 3

A Historic Trilogy by Harold W. Castner
The Prehistoric Oyster Shell Heaps of the Damariscotta River

Just previous to the Civil War, Professor Chadbourne of Bowdoin College, made a thorough study of the deposits, and established for all time, conclusive proof that these shells had been left there as a result of ancient feasts, and at a time so far in the past, he dared not attempt computation. He found many individual piles of shells ten or fifteen feet in diameter and several feet deep. Beneath this, the soil was made up of a diluvial deposit of sand, gravel and rocks, resembling the land adjacent to the deposits. There were numerous bones of animals, birds and beavers, and even a sturgeon’s plate. A dark line ran through the bottom of the great mounds, showing the possibility of vegetable mould, formed during temporary abandonment of the place. Shells under this layer were decomposed, or turned to lime, as if acted upon by fire. He obtained shells of other types than the oyster and found some clam, quahog, and several kinds.

Despite the loss of hundreds of tons of shells by erosion and commercial uses, a great volume still stands exposed to view. Scientific investigation revealed that there were three distinct periods of construction of these heaps. In each case there was a period of abandonment, during which time a thick layer of vegetable mould accumulated over the shells. The lowest layer of shells extended over about one eighth of the present known area. This layer was about three feet thick, and at the base, many large tree trunks were found which had decayed to powder, leaving conical hollows around which the shells were packed. Directly above this layer was a strata of mould which was some five inches thick. It has been quite accurately determined that it takes about one hundred years to accumulate an inch of mould. We can, therefore fix the period of this first abandonment at about five hundred years.

The second layer of shells was larger and more extensive. This was about six feet thick and covered by mould to the thickness of about three inches, or, let us say, an interval of three hundred years of the second abandonment. In this second strata of mould were found trunks of large trees which were of unknown species in this climate. They were two or three feet in diameter and had grown up entirely over this second strata of shells. These trunks were better preserved than those of the first strata, but although they held their form, they easily crumbled in this hands.

The third strata of shells had a layer of about three inches of mould over it. An intimate study of this top layer of mould caused scientists to agree that it was about three hundred years ago when the last deposits were made, or at the time of the Wawenock Settlement, at this place of abundant food supply.

Note October

Tim Visel

The layers represented by this account most likely describes acidic sulfate soils captured by climate events. It is easy to understand “abandonment” as core studies showing similar layers in salt marshes and coves were largely not available to Mr. Castner. Is suspect that these layers if available today would resemble Sapropel.

When It Came to Fish and Shellfish Did We Take Out the Wrong Nitrogen?

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Nitrogen/Eelgrass TMDL Levels

Statement of Problem - While many US Communities spent hundreds of millions to remove water borne human nitrogen for removal and based TMDL allowances on only part of the nitrogen sources. The largest negative nitrogen habitat factor was from leaf and natural organic material in sediments.[1]

The eelgrass/nitrogen research controversy centers on the growing conclusion that we targeted the wrong nitrogen compound and chose the wrong environmental indicator to measure it, "Sediment sulfides were not examined during these case studies as no applicable data were available."

This is a statement that appears in a University of Connecticut eelgrass study that was referenced in a 2012 Nitrogen Review of the Nitrogen TMDL for Cape Cod. The problem is this study was a key reference as evidence that nitrogen reduction is beneficial and the reason (justification) to spend hundreds of millions (perhaps) billions citing eelgrass as an embayment health indicator, that concept of an eelgrass quality indicator now is subject unfortunately to scientific misconduct – citation or reference amnesia review.

Dozens of studies have indicated that most critical factor to eelgrass habitat quality is the amount of sulfides in the sediment; some date back to the 1980s. Important sediment sulfide studies that could have pointed the nitrogen/eelgrass research in a very different direction were "forgotten" and misrepresented[2]. This

[1] Also termed Benthic Flux, Sapropel, Black Mayonnaise, Guypta-See The Norwalk Hour 10/21/2012 Saugatuck River, Dick Harris, Southern Life University Newsletter, August 2011 Vol.14 #6 Sound School Southern New Haven Harbor Collaborative page 1., Dr. Vince Breslin.

[2] I am fully aware of the consequences of speaking out "early" on this issue; I have the "open classroom" drama that happened here in CT as a classic and often cited educational example. Educators who spoke up in the 1970s expressing concern about large general purpose rooms with hundreds of students in a large room without walls or partitions were immediately excluded from the decision making process. Decades later reflection upon the open classroom buildings does not share the early reported optimism, in fact, in most cases open classroom school construction projects are generally described now as "failures."

bias appears to have a foundation in numerous EPA TMDL documents – deliberate exclusions of second source generation nitrogen in the formation of TMDL limits.

We call second source generation organic material from leaves ammonia and sulfide purging, one of the most toxic of all substances to fish and shellfish.

Also implicated in this growing eelgrass/nitrogen controversy is the association of eelgrass and other submerged aquatic vegetation commonly called “SAV” to specific estuarine health indicators. SAV became an environmental lightening rod so to speak to galvanize public opinion and then public policy makers as to protect and conserve SAV habitat types. In New England, eelgrass was promoted to benefit the bay scallop, a much-admired delicacy in our bays and coves. While lightly populated SAV patches are beneficial as reef habitats in long periods of heat and little storm activity, dense SAV meadows collect organic matter, which then sheds ammonia in heat and purges toxic sulfides in winter. In the end SAV becomes natures sulfide killing fields signaling the end of periodic habitat succession. It is deadly to shellfish and finfish larval stages and sheds ammonia a key nutrient ingredient for brown algae also called Harmful Algal Blooms or “HAB” for short. A huge source of ammonia is second source generation from organic deposits and was not included in the TMDL process.

The shellfishers on Cape Cod correctly called the SAV/ shellfish relationship decades ago, but no one believed them. How could the shellfishers be correct when nearly all of the current scientific community was promoting the eelgrass/bay scallop model? In this situation, quite simply, the Cape Cod shellfishers “nailed it.”

Dense thick growths of submerged aquatic vegetation suffocates living shellfish and destroys habitat capacity for future populations.

The law of habitat succession or those of us who have fished and shell-fished in New England’s coves and bays and have seen eelgrass come and go in long term natural cycles share a different view[3]. The habitat history of eelgrass is very different than what have been portrayed to the public even to the shellfishing community itself. We know from historical records (mostly from the State of Massachusetts) that dense eelgrass meadows were not beneficial for shellfish populations and in fact now it seems that Bay scallops will set in eelgrass not as a preferred settlement type, but largely to escape toxic sulfide purging from the eelgrass meadows below. Early bay scallop studies clearly documented “blade attack” from crabs and that redweed also served as a settlement type for bay scallops, and the source of these reports were the bay scallop fishers from Niantic Bay itself. These reports and historical documents report that dense eelgrass monocultures destroyed numerous New England shellfish habitats were forgotten, a type of scientific misconduct.

[3] See meetings and minutes of EPA eelgrass research team.

EPA – Region I Eelgrass Nitrogen TMDL Controversy

It appears (with EPA Region 1 taking a lead position) EPA strongly promoted linkage to eelgrass health to bolster regulatory authority under the Clean Water Act[4], EPA Region 1 also strongly promoted the nitrogen TMDL without considering the sediment respiration (Benthic Flux) and now subject to pending litigation and allegations of scientific misconduct or at the least, suspect research methods. This is especially true in terms of the law of habitat succession (See Daniel Pauley, Shifting Baselines, 1995) or marine habitat succession.

Eelgrass Health Indicators are False

Eelgrass, like other terrestrial grasses have a habitat clock or in times of history subject to change "value" according to the law of habitat succession in the marine environment. That is, any habitat services must be indexed with habitat change as plant species mature and exchange dominance on land. Habitat succession in the marine environment does not stand still, therefore snapshots that portray a lasting goal or benefit or contain constant habitat values are misleading at best and biased for habitat succession. It is certainly something upon which not to base long term public policy objectives.

The scientific community last February was startled by reports from Denmark that eelgrass was dying off from sediment sulfide toxicity. For some of us following the eelgrass research since 2006 we were not surprised. Some of the historical research conducted a century ago (also in Massachusetts) by David Belding clearly detailed observance of eelgrass holding organic matter in high heat the source of sulfur emissions and negative changes or direct impacts upon shellfish species, all of them including bay scallop. In the end, the sulfur compounds (sulfide) became so high it killed off eelgrass directly or weakened it to increases of fungal/mold infections. While creating vast flats unable to sustain any shellfish sets, many researchers in the late 1990s identified the sulfide formation as a habitat constraint and toxic imparts to eelgrass itself. Some of this pioneer sulfide toxic research was conducted in Tampa Bay, Florida.

A Long Term Environmental History is Important to Coastal States

Beginning in 1880, and under the auspices of the Smithsonian, we saw the first U.S. records of fish and shellfish landings that could be indexed for climate/energy factors and important eelgrass observation[5] made but not

[4] See meetings and minutes of EPA eelgrass research team.

[5] Pauley defines a shifting baseline lack reference as a loss of the perception of change that occurs as each generation redefines what is considered "natural."

reported in the scientific literature – in fact, much of this could have been prevented by a good balanced long term environmental fisheries history. Nitrogen TMDL criteria formulated by ignoring organic primary and secondary source are incorrect and now the subject to scientific fraud investigations. An environmental history is very much needed as a bias in the research literature is being discovered in salt marsh studies (1971-1981) and also dredge windows (1985 to present).

Eelgrass and the Clean Water Act

In an attempt (it appears) to strengthen regulatory authority under the Clean Water Act, EPA regions promoted eelgrass as a habitat quality indicator organism and linked excess nitrogen as a factor in population dynamics. As human caused degradation to the environment had much more of a regulatory "standing" lessening human nitrogen inputs became a key EPA estuary health policy. A widening investigation of the policies and procedures utilized in determining nitrogen TMDL has been found to be insufficient as it largely excluded non-human or "nonpoint" services. Nonpoint source primary and secondary source nitrogen was omitted or minimized when in fact it had a huge role and warnings to that fact was first issued in the 1980s. We may never see the expected results from current nitrogen TMDL in fish and shellfish landings. This was confirmed in a GAO report issued last December.

GAO-14-80 Dec 2013 Report to Congressional Requesters

"The water resource experts reported that about half of the TMDLs they reviewed do not contain key features helping to ensure that implementations can be done, which leads to TMDLs that may do little to actually improve water quality," pg 41 GAO-14-80 EPAs TMDL program.

"TMDLs without certain key features may be unlikely to help water bodies" attain water quality standards and may potentially waste states limited resources ibid – pg 64.

Research Fund Bailout Request

In light of EPA misuse of historical information and bias with carefully scripted RFP nitrogen research proposals, omissions of both historic/period research and actions of public policy makers reflecting upon such research a funding relief action is required. Peer review from the scientific community itself is not sufficient against science/research misconduct as evidenced by this eelgrass case[6].

[6] Congress investigated EPA review panels and reaffirmed the National Academy of Science, National Research Council and the Science Advisory Board protocols which serves EPA were recoded in 2001 for conflict of interests. Findings showed transparency improved but did not exclude bias as qualified review members often worked or benefited from some of the same policies that were asked to review. That is currently under review for the 2012 Cape Cod TMDL review panel.

The Cape Cod Scientific Review panel for example (based upon public perception impartially) were often members or individuals who worked or received university grants or funds that created the body of work being reviewed. Unfortunately as a result of the eelgrass-nitrogen issue, we need checks and balances in the University process also; as public funding dried up in the 1980s, public university agencies/groups forged new relationships with granting agencies that transitioned from "publish or perish" to a much more colder "grants are gone". Some of the eelgrass/nitrogen researchers cannot take all the responsibility from a University system that encourages such grant efforts and relationships while at the same time turns away from the consequences of agenda based science, such as we now face with eelgrass/nitrogen TMDL issues brought forth in the New Hampshire Great Bay report last year.

Nitrate Reduction Removed Key Sulfate Buffer – Toxic Sulfides – We Targeted the Wrong Nitrogen Compound for Removal

As more information is available from overseas (mostly Denmark), the removal of nitrate in high heat facilitated the production of second source ammonia, in other words, it made low oxygen impacts only worse. In the marine environment during high heat, sulfur sediment reducers turn to nitrate when oxygen compounds are lowered (this is called limiting). Removing nitrate will allow sulfur-reducing bacteria to quickly access sulfate (electronic affinity), which is not limiting in the marine environment. Therefore nitrate reduction is now linked to increases in deadly sulfide/sediment formation. Sediments with high leaf content purge sulfides in winter and shed ammonia compounds in summer, which is now linked to the toxic brown algal blooms termed Harmful Algae Blooms (HABs).

Eelgrass-Nitrogen Federal Reimbursement Act (Proposed)

Research Amnesty- To Protect Researchers Who Did Not Have Editorial Control Over Contracted Research

Part 1 - Five years to amend or retract eelgrass/nitrogen studies – no professional misconduct; no loss of funding.

Any university researcher that amends or withdraws a published research article, bulletin or fact sheet shall have 5 years from the date of the act to do so, no professional misconduct will be instituted against such individual(s).

Public institutions may apply for reimbursement as per section 4 to prevent any loss of funds or when local, state county government agencies ask for refunds (which is now entering a review or stages of litigation on upgrades to existing septic systems i.e. Old Saybrook, CT and Great Bay, New Hampshire)

Part 2 - A requirement that all estuarine research be subject to an impartial "Environmental History Impact Statement" to bring balance to the NEPA Act.

The notion of all negative environment impacts must be attributed to human action has resulted in extreme conservation protection policies. Although public policy intervention in the 1950s and 1960s had firm foundations (Love Canal, New York and Cuyahogo River Fire, Ohio), this has created a "baseline dilemma" as historical reviews were eclipsed by human existence "insulting nature" which was used quite effectively with the eelgrass/nitrogen indicators.

Much of the basis of the NEPA Act was to ascertain any (all) human impacts to the environment, usually in response to coastal development. The requirement of Environmental Impact Statement or "EIS" needs to be balanced by a mandatory review of natural long-term climate and energy cycles for the coast. Much of the controversy and confusion surrounding the 1999-2004 lobster die-off for example a review of historical records would have shown that it resembled (precisely) the die-off of lobsters here before 1898-1905. In both cases blue crab abundance suddenly soared after each lobster die-off as what recently happened here again[7].

Records of Native American shell middens may represent one of the few unbiased measures we have in determining the natural cycles of fin and shellfish species abundance, free of human climate/energy change discussions. The need of a long-term, unbiased environmental history therefore is critical.

Part 3 - A ban on NGO (government agency organization) receiving natural resource funds research without economic gain/loss measures that show an economics return of 4 to 1 – that is for every dollar of public taxpayer funds must show an economic action of benefit of a multiplier of 4. The economic benefits shall be measureable in natural resource utilization generated dollars, not in kind, match dollars or "public good" dollars such as scenic vistas or reserves etc.

Part 4 - Equipment and Operating Reimbursement Act

4.1 - Any community, resident, local water treatment authority township or county shall have the right to apply for any expenditures made in response to a nitrogen TMDL that has been found to be the result of any fraudulent research or improper regulatory action.

4.2 - This reimbursement shall include public Universities whose research is challenged or retracted for a period of 5 years (loss of funds or reimbursement of funds).

Part 5 – Operating Cost Reimbursement 50 years

A. A public entity under section (1) that is eligible for equipment reimbursement shall have right to apply for the cost of maintaining that equipment for general accepted operating costs for 50 years from the date of this act. Any such operating grant for equipment will be in addition to previous act or law.

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[7] The DEEP Marine Fisheries office has 130 years of historical records of fish and shellfish reports, lobster hatchery records (hatcheries were built in New England following the 1898 lobster die-off) as well as hundreds of fish census files and thousands of other historical fin and shellfish reports.

B. This does not apply to private wastewater treatment systems, although they are eligible for the equipment reimbursement costs or treatment system improvements under section 4-1.

Summary

- The eelgrass/nitrogen habitat association is biased and incorrect (law of habitat succession) for Connecticut
- The nitrogen TMDL was determined largely upon human impacts masking long-term natural impacts and natural sources, mostly the high heat decay of leaves (Law of Habitat Succession – Natural Climate Patterns)
- The "funding effect" that has led to several Congressional reviews found compromised university sponsored research (agenda biased science that peer or review panels did not filter/discover) called a meta-analysis that supported funding agencies positions more than the scientific literature.
- Historical information and long-term climate and energy patterns were omitted from public policy discussions (this is still occurring in regards to the NAO – North Atlantic Oscillation) (Lack of long-term historical balance)
- Both the eelgrass/nitrogen indicator and TMDL nitrogen models are now subject to citation amnesia or reference negligence, a form of scientific misconduct, that "cherry picks" references that supports a point of view and ignores references (most pre-1972) that did not.
- Several researchers are afraid of University repercussions when this becomes widely known necessitating a "research amnesty"

The Western Connecticut Habitat Failure for Blue Crabs, August 2011
The Role of The Tannin –Sapropel Cycle in Habitat Reversals
A Capstone Proposal – Case History Discussions
Leaves and Brown Waters Hurricane Irene
Tropical Storm Lee
IMEP #27 - September 2014
Timothy C. Visel, Capstone Proposal Series The Sound School
60 South Water Street
New Haven, CT 06519

Interested students in researching the Tannin – Sapropel Cycle should email Tim Visel at tim.visel@new-haven.k12.ct.us

So many times in reviewing the history of fisheries I come across periods of dought followed by tremendous rainfalls and then the appearance of chocolate or "brown waters." The most famous incident is perhaps the upper Narragansett Bay Brown Water – Black Water Fish Kill and marine die off of August 1898. Dr. Scott Nixon wrote up the event in an extensive historical review called the "An Extraordinary Red Tide and Fish Kill in Narragansett Bay." Coastal and Estuarine studies Vol 35, pg 429 to 447, 1992.

Heavy rains on July 13, 1898 into the Providence River Watershed occurred before an intensive heat wave August 18 to September 5th 1898. A record rainfall contributed to a tremendous watershed removal of tannin – the final breakdown of wood tissues and in our area mostly leaves. Tannins (three major types) are brown and gives wood its typical brown hues. The New England region recorded intense heat waves in much warmer than average summers between 1895 and 1901 Narragansett Bay (Rhode Island of 1898) had climate enhanced algal blooms – frequently called chocolate tides or red waters. One event in particular was very severe and known as the Great Bay fish kill (Narragansett Bay Rhode Island). In July to September (1898) climatic events combined to produce a major toxic fish kill fueled by heavy rains that washed a huge organic wave of debris (human sewage also) down stream into upper Narragansett Bay. In July – August it was very hot and little wind or storm energy as this organic matter presumably putrefied. (It must be noted that relatively dry conditions before most likely lowered moisture in leaf litter and forest humis called duff). When heavy rains occurred this organic matter was "light" and therefore could quickly be moved into transport waterways. Fishers on Cape Cod called this light organic debris oatmeal or chaff.

Professor A. D. Mead of Brown University wrote up the 1898 event in an article titled "An Investigation of the Plaque which destroyed multitudes of fish and crustacean during the fall of 1898" and later submitted his article for Science Magazine (S. Nixon Coastal and Estuarine Studies – Novel Phytoplankton

Blooms Vol 35, pg 430 1992). The description of Professor Mead (1898) details the appearance of chocolate waters which signifies Tannin in huge amounts, followed by harmful algal blooms (HABS) and then sulfide induced toxicity from low oxygen conditions. Sulfide toxicity is often rapid and prevents the "flee factor" of declining oxygen levels – fish can move if the transition is slow but if quick fish and crabs often perish. One indication of sulfide events (other than the stench of sulfur) is the "Jubilee factor" blue crabs climbing out of the water which according to Professor Dr. Meads's account did occur. Dr. Nixon repeated Dr. Mead's account and his description which is still very valid today following a second very warm period in New England 1974-2004 is included below. A century later it is still valid and is repeated here.

Upper Narragansett Bay Fish Kill of 1898 – A Classic Tannin/Sapropel Case History

After heavy July 1898 rains – Dr. Mead Reports the following:

> "During the last two months the inhabitants of Rhode Island witnessed the following remarkable phenomenon. The water of a considerable portion of the Bay became thick and red, omitting an odor almost intolerable to those living near by. The situation became alarming when, on the 9th and 10th of September {1898}, thousands of dead fish, crabs and shrimps were found strewn along the shores or even piled up in windrows.
>
> During the last of August, throughout September and a part of October streaks of red or 'chocolate' water were observed from near Quonset Point and Prudence Island, north to Providence, and, on the flood tide, up to Seekonk River, nearly to Pawtucket, a range of about fifteen miles. In other parts of the Bay, as far as could be learned, the phenomenon had not been observed.
>
> On the 8th and 9th of September the water became extremely red and thick in various localities from East Greenwich to Providence, and the peculiar behavior of the marine animals attracted much attention. Myriads of shrimps and blue crabs, and vast numbers of eels, menhaden, tautog and flatfish came up to the surface and to the edge of the shore as though struggling to get out of the noxious water. Indeed, the shrimp and crabs were observed actually to climb out of the water upon stakes and buoys and even upon the iron cylinders which support one of the bridges and which must have been very hot in the bright sun."

The initial beginning of many fish kills is now likely rain swept Tannin contamination. Tannins are themselves not the direct cause but start a process for lack of a better term – The Tannin – Sapropel Cycle. Tannin acts to over load organic matter reduction processes and helps them become part of the Sulfur Cycle.

Three things need to happen to put the Tannin – Sapropel cycle "in play" for significant habitat change, a huge influx of Tannin dissolved or in leaf matter following a heavy rain, hot temperatures and low energy post signaling event. In simple terms the oxygen dependent bacteria that naturally breakdown organic matter – recycling it so to speak are just completely overwhelmed. The Tannins drive suspended organic matter out of the water making the situation even worse – high temperatures reduce available oxygen even more – further (oxygen inverse solubility law) and the bottom waters become oxygen depleted, then anoxic.

At the same time sulfides form near the bottom and the killing begins – slowly at first (those crabs and fish that can flee the area will do so) and if a storm comes it is enough to break up the sulfide layer (in the warm stratified waters layers of The Narrow River upper ponds – Pettaqaumscutt lake shores Rhode Island, Arthur Gaines reported sulfide levels 10 times that of the Black Sea (Maritimes Vol 35 #2, May 1991) and introduce cooler more oxygen containing waters, if not a bottom sulfide kill turns into a general system wide (especially in restricted coves and bays) fish kill. Greenwich Bay in Rhode Island suffered a Tannin – Sapropel sulfide fish kill in 2003 – also following hot weather and heavy rains.

Probably the most common acidic (also termed astringency) form of household tannins most people know (or did a century ago) is a product called Witch Hazel. The center for Witch Hazel production for a century or more was the Dickerson factories of Essex – Deep River area of Connecticut. It is traced to the area Native Americans boiling the roots of the Hamamelis - virginiana plants to obtain topical treatments.

In the riverine environment tannins are termed a "natural clarifier" that is its acidic character tends to cling to proteins and amino acids. As a wash therefore it left skin topical treatments feeling "clean" and refreshed. (No trade or product endorsement implied).

In the marine environment Tannin also cleans the water and causing dead algae (fresh or marine) to clump and drop to the bottom. Some recent papers refer to this as marine snow. If I continue this analogy – heavy rainfalls then create blizzards of dead organics falling to bay and cove bottoms, and Tannins jumpstart the Sapropel Cycle in warm low oxygen waters.

Fishers Make the First Tannin – Sapropel Connections

At the turn of the century it was alewife fishers and fishery managers, then called Alewife wardens, walked streams checking on alewife runs. The Great Heat 1880-1920, a climatic period of low rainfall and high heat, organic matter both manmade (refuse) and natural (leaves) filled many alewife runs. This is the result of low habitat energy – slow, murky waters carry less organic matter to the sea –

a problem that has plagued dike and canal builders since the start of recorded time. Over time these low energy waterways filled with organic matter which then turned into Sapropel. Some of the most visible impact of Tannin contamination was in the Alewife fisheries of Maine. Fishers and residents living along rivers and streams noticed the impact of saw dust (from lumber mills) entering water courses over a century ago. Tannins would quickly leech from sawdust staining waters brown and precipitate woody tissue to the bottoms (Tannin today are still referred to as nature's precipitate). As heat continued, toxic sulfides formed and ruined alewife runs.

In the twenty-eighth report of the Commission of Sea and Shore Fisheries of the State of Maine (1903-1904, August 1905 – Kennebec Journal Print) contains the comments of Alewife Warden, S.P. Cousins, on page 61 in the alewife section the following excerpts:

The report for the State of Maine has a division devoted to alewife fisheries a species of both value and concern. The report concludes that many of Maine's alewife fishways were hopelessly filled with organic debris (1903) and some had" no connection with the water" (sea) and takes aim at the organic matter increase from mills that had in many communities filled to block fish passage. On page 61 stating, " refuse from the mills obstruct the fishways and make them useless." The report now includes the report by Alewife Warden Cousins and his observations (Impact of Tannins – Reduction low pH).

"There are many who now assert that sawdust is not injurious to fish life, and naturally those are frequently mill owners, and their assertions have weight in that those most interested don't take the trouble to investigate the question and authoritatively refute these statements."

The question of sawdust pollution of fish streams has been, I will say, so conclusively determined by scientific experiment and investigation as to leave no doubt from interest or lack of information, I give the result of careful investigations of the effect of sawdust upon fish made by Dr. A.P. Knight, professor of Animal Biology, Queens University, Kingston, Canada, which sets at rest the question and conclusively proves how fatal to life is sawdust when allowed to enter fish streams (I now quote Dr. A.P. Knight):

> "When sawdust was allowed to lie in still water, or in very slowly running water, the most disastrous effects, followed the immersion of different animals in the poisonous mixture. Not merely did adult fish die in it, but fish eggs, fry, aquatic worms, small anthropods, animalcules and water plants. Nor was the cause of death due to suffocation from lack of oxygen because when air was made to bubble rapidly through the solution the final results were the same, the only difference being that death was somewhat delayed. No one could paint too vividly the deadly effects of this solution. Adult fish died in two or three minute, fish eggs in a few hours, fry and minnows in

> from ten to fifteen minutes, aquatic worms and insects, eight to twenty-four hours- aquatic plants in a few days. Every living thing died in it and if one were to judge of the effects by laboratory experiments above then the prohibitory legislation need no better defense" (referring to Canadian statues forbidding the throwing of sawdust into streams).

It was most likely the Bay scallopers who first noticed the "deadlines" in coves and bays. This was often described as a line on moving chains below which all marine life suddenly disappeared. The chain was devoid of life no barnacles, mussels and at times even algae. Instead the chain was often stained black and clean. Below which was often "foul smelling black bottoms" (John Farrington, personal communication, Borne Sandwich Shell Fishermens Meeting, Cape Cod, early 1980s). A shellfish survey in Centerville River found an abandoned Christmas tree from the year before while towing a hand hauled oyster dredge – the top branches were heavy set of bay scallops – below which the branches were stained black with no set. Shellfish nets hung from shellfish floats in Falmouth also showed above the bottom "deadlines" below certain layers seed shellfish perished (George Sousa, Falmouth Shellfish Officer, Personal Communication, 1982).

This describes the killing of marine life when hydrogen sulfide is dissolved into seawater. In summer, warmer temperatures blocked oxygen pathways into bottom waters and now rich in sulfide became poisonous and killed millions of bay scallop sets. In saline areas the hydrogen sulfide levels from toxic more dense sulfide waters below surface fresh waters. In times of rain, strong tides or storms this heavier black water or sulfide water comes to the surface killing fish and bringing with it the strong odor of sulfur.

These black waters still occur today in coastal coves and rivers. Some recent photographs picture black sulfide water as river under a river. In most cases, brown waters proceed black waters and the presence of Tannins, a sulfide trigger. Shellfishers on Cape Cod consistently noted the best areas for seed quahogs were those areas already covered by "shell hash" (Pleasant Bay Study, 1968, Massachusetts Marine Fisheries Bulletin). These bottoms were often described a "sweet" slightly alkaline which oysters and clams need so they do not dissolve on low pH bottoms. Sulfide/Sapropel bottoms contained no shellfish. The Tannin acidic role in hydrogen sulfide formation has been known for quite some time. The largest Tannin source in our New England area are Oak leaves. That is why after heavy rains, high energy streams turn brown – leaves rolled and pounded to release the brown Tannins, which can then jumpstart the Sapropel cycle.

This is a recent Wikipedia™ description, which fits the description of Blackwater a century ago frequently after brown water or chocolate water events:

“The leaching of highly water soluble Tannins from decaying vegetation and leaves along a stream may produce what is known as a blackwater – water flowing out of bays has a characteristic brown color from dissolved peat tannins. The presence of tannins (or humic acid) in well water can make it smell bad.”

Under the right conditions brown waters can be turned into iron sulfide (black) waters containing the deadly sulfide wash downstream or generating a sulfide block to returning Shad, herring and alewife.

Sulfide water in the 1960s was to kill crops in irrigated fields in southern states during warm weather. H.W. Ford and D.V. Carvert of the University of Florida Indian River Field Laboratory Fort Pierce (which I was to tour in 1973) produced a paper (Florida Experiment Station Journal Series #2509) titled “Induced Anaerobiosis Caused by Flood Irrigation with Water Containing Sulfides” pertaining to sulfide damaging citrus roots, often killing the plant. They observed much the same as Connecticut farmers noticed a century before – sulfides could kill most crops.

On page 107 of their report contains this statement after massive planting kills – “A heavy accumulation of gelatinous black insoluble iron sulfide had formed under the furrows. The layer was found to restrict the movement of water. Hydrogen sulfide released when the layer slowly oxidized could kill roots above the water table.” This description is very similar to the explanation of eelgrass death rings in the North Sea. Eelgrass patches started on sandy marine soils as the meadow grew Sapropel formed (organic matter trapped between the blades of eelgrass) and increased hydrogen sulfide until it became lethal to the first “set” of eelgrass forming huge rings as sulfide killed the oldest eelgrass first. (See Denmark Coasts Eelgrass Rings Jens Borum University of Copenhagen and Marianne Holmer University of Southern Demark).

In the 1980s as Sapropel covered previously hard and shelly bay bottoms. Winter flounder fishers also complained about bottoms becoming foul, leave covered and from time to time emitted strong smells. The 1972 to 2004 period would see huge habitat transitions from primarily harder firm shell containing bottoms to Sapropel which now covered shellfish beds – in terms of feet. It would proceed the winter flounder fishery collapse as critical sanding/shelly habitats reversed to those which rot the fins and caused necrotic lesions.

Fishers frequently report brown waters if the temperature is high enough and energy low (minimum tidal flushing or restricted flushing) can often lead to “black water” conditions and some of the most horrific fish kills. But heavy rains almost always proceed brown water events and this is the “flood waters release of tannins” was observed by so many western CT blue crabbers in August/September of 2011. The river most impacted by organic matter tannins both dissolved and hard forms (leaves) now appears to be the Saugatuck River in Western, CT.

Locked in the molecular weight of tannins are the waxes that give the slow reduction of it sapropel its shine. It is also the substance that reduces pore water circulation in marine soils and creates acidic conditions fatal to shellfish veligers and fish eggs. It is nearly always fatal to fish eggs. Earth Watch a local environmental organization who has been study water quality issues in western CT for decades noticed the old brown color in western CT Rivers after Irene and Lee adding that leafy build up on river beds is "uninviting" for bottom dwelling fish. Richard Harris commented in a Westport News Article (Not All Is Looking Up On The Saugatuck's Bottom," Oct 23, 2011) referring to now heavy leaf accumulations in the Saugatuck is quoted "It fouls the bottom, so the fish and lay eggs such as flounder and other bottom –dwellers can't use the bottom to raise their young use it as a nursery – "Basically once the bottom turns into that kind of condition for them its kind of hands off for them."

As a natural flocculant tannins contribute to oxygen depletion in bottom waters in regions of low tidal exchange concurrently as oxygen levels drop, sulfide levels rise. This happens in the shallow and most important habitats for many fin and shellfish species of "value" and that includes the blue crab. Tannins locked in organic matter (the leaves) can be released for days or months after a heavy rainfall). This brown water happens in freshwater lakes also as warm surface waters forms a barrier – a thermocline and isolates the bottom water from oxygen in air. As the summer progresses the bottoms of lake and reservoirs become extremely oxygen poor even anoxic or without oxygen. In the fall cool nights cause surface waters to cool quickly the surface waters to sink below (more dense) pushing the bottom oxygen poor water to the surface which can now appear brown or black. It is black because it contains sulfate of iron and hydrogen sulfide itself, the infamous rotten egg odor of the Great Heat 1880-1920.

Fall "over turn" or exchange of bottom sulfide waters (toxic to fish) if quick enough or continues under ice can cause a winter fish kill. The toxic sulfide wash or exchange can be just a few minutes to several hours and be gone leaving the dead fish behind with no apparent explanation other than it got really cold really quick and dead fish now float to the surface. Tides or river flows disperse the sulfides over time leaving no indication of the damage. Sulfide washes can occur after heavy rains which dislodge rotting leaves in brooks, and can block (if severe enough) returning shad and alewife – in this case it is termed a chemical or sulfide block.

Blue Crabs and Brown Waters – The Case of the "Jubilee"

Brown waters down south a century ago proceeded blue crab jubilees – in hot stagnant weather and following heavy rains (tannin input dissolved or hard) often caused a brown water event – low oxygen then sulfide resulting in the Blue Crabs fleeing the water (the excitement associated with the jubilee is that you could run to the shore and just pick up the blue crabs huddled on the beaches) itself. This is nearly always associated by the sulfide rotten egg odor hours to days later. As bacterial sulfur reducers now set into reducing nearly arrived tannins and leaves water turned black killing most living organisms. These fish kills could last for weeks as ammonia levels then increased creating red or brown algal blooms now (called Tides) which when dead continued the oxygen depletion by Tannins precipitating them now strengthening the sapropel cycle. Usually a strong storm, waves, or colder temperatures would introduce enough oxygen to stop the Tannin – Sapropel cycle but by then it was often too late, killing of fish and shellfish happens and if long enough even clams and oysters would die. Today such events evoke a manmade cause but frequently that is not the case. We can contribute no doubt (sewage overflows) but such sewage is high in nitrate which ironically helps buffers the sulfate reducing process. In other words nitrate in this case is the "good" nitrogen that can help break the Tannin – Sapropel cycle.

Available nitrate buffers or holds the sulfur bacteria reducers off – the oxygen reducing bacteria will go to nitrate (oxygen) compounds first for reducing organic matters, once oxygen is depleted bacteria that need oxygen look to oxygen compounds and nitrate is one of them. Once nitrate runs out the sulfate bacteria step in and simply put the oxygen dependant bacteria reducers now die and the far more damaging sulfur reducers now step up to finish the job by accessing sulfate. The oxygen dependent bacteria populations perish while sulfur reducing bacteria increase. The Tannin – Sapropel cycle by way of oxygen depletion and sulfur increases has killed more shellfish and finfish than we could ever do and it does it silently and out of view. Many fishers may observe or see it but until now lacked a name.

Observations of Fishers

Some of the first fishers to report about these The Tannin Sapropel event were eastern brook trout fishers. As waters warmed (1890s) bad smells emanating from trout brooks raised the first alarm – bells a century ago. As the climate warmed brook trout suffered a series of habitat extinction events. Fishery managers grew concerned and soon asked for the US Fish Commission for assistance with trout hatcheries at that time. They complied and many states built trout hatcheries but with the growing heat brook trout populations continued to decline. Several researchers now wrote about sewage fungus growing on rotting leaves and the smell of sulfur long before the development of the Saprobien classification system in 1909. The sewage fungus we call today sulfur reducing bacteria. As the years of heat continued the US Fish Commission suggested that Northeastern states introduce more heat tolerant species of Brown and Rainbow trout – which they did in the late 1870s and 1880s. As the heat continued many New England stream waters often became black and acidic as trout died by the thousands.

The Two Sides of Sapropel – A Public Policy Dilemma for Fishery Managers

Natural Sapropel is a substance that has two sides, one with oxygen it is a marine compost – a neutral to alkaline pH and black surface usually thanks to dissolved iron in seawater. Blue crabs crawl in it and fish swim over it, fish also hid almost submerged aquatic vegetation growing in it and although not the richest habitat type in regards to biodiversity it frequently has mud snails, an occasional blue mussel, and grazers shrimp and crustaceans such as green crabs. Thin patches help nourish submerged aquatic vegetation such as eelgrass making it a productive habitat for Blue Crab Megalops. Although not the best substrate for oysters if mixed with sand it can support dense sets of the soft shell clam called steamers especially after moderate storm events.

Oak leaves contain a hard to digest wax from the leaf itself and gives it a shine. This is what also gives Sapropel its often "greasy" description in the historical fisheries literature. When oxygen is short (limited) from biological or chemical oxygen demands restricted circulation or very hot water temperatures create low dissolved oxygen levels or when hypoxia occurs Sapropels other side comes out, the one with a sulfur. This side is a deadly as any toxic pollutant.

Sapropel Can Transition Habitat Value

What does Sapropel consist of and why is it important? In the marine environment adjacent to shore in quiet coves, bays and lagoons it is detrital remains (mostly leaves) that collect and overtime decompose simply put they rot. Other than some species of shrimp terrestrial organic matter in seawater is "different" often "tough to digest" and without oxygen warms and bacteria conduct the "reduction process" over much longer periods; it reduces organic matter back to molecules created by the plant tissue. In simple terms bacteria slowly "eat it," and in the process release chemical compounds, in the presence of oxygen – nitrates, amino acids (weak acidity) and long chain carbon molecules that are hard to digest – leaving them for other processes. These hard to digest molecules include waxes – belonging to a hydrocarbon classification called paraffin.

When oxygen is very short (limiting) a different process comes into view – sulfur reducing bacteria that utilize sulfate – not nitrate and in the process produce sulfides of iron not oxides. In this sulfuring reducing pathway comes a powerful toxin called hydrogen sulfide (10 times more toxic than cyanide) H_2S which is very deadly to marine organisms and enclosed air spaces even to us. That is that rotten egg smell in hot temperatures that often just proceeds a large fish kill most often reported in the fisheries literature. As the process continues sulfide levels can increase especially as Sapropel deepens – the paraffin (waxes) form a film (it gives Sapropel its shine and its greasy feel) and seals off the oxygen from sulfate organic matter. The waxes clog the circulation in the Sapropel itself overtime increasing sulfide levels that kills eelgrass. Beyond tidal turbulence or restricted circulation Sapropel forms (Sapro organic matter pelos meaning putrefaction Greek language roots) and becomes sulfur rich – it smells. The older and deeper it gets the more toxic with out oxygen it becomes. Now comes the worse part disturb the Sapropel – and introduce oxygen and you have a reaction that releases sulfuric acid and a dramatically lower pH then now happens – the acid dissolves estuarine bivalve shell (some times on contact). It can get down to a pH of 3 – deadly to most oxygen dependent larval forms. There is more, instead of nitrate production – Sapropel sheds ammonia and increases of that nutrient helps fuel red or brown algae blooms – robbing what little oxygen remains and the source of the black water deaths a century ago. The Tannins then remove dead brown algae as a precipitate which now strengthens the Sapropel cycle.

Sapropel can kill in three ways – a toxic substance, (gill exchanges) low pH, and oxygen depletion by way of ammonia induced algae blooms. It in the marine environment is a real habitat game changer equal to fishing as a resource based activity upon certain habitat types. Can we make Sapropel in the lab? Sapropel formation behind dams takes years so a few details for source supplies often requires these components. (I suspect large deposits of Sapropel have accumulated in the Conowingo Pond on the Susquehanna river). For laboratory use the following is needed.

1) Sea water (sulfate)
2) Organic matter source ground oak leaves, oatmeal, ground wheat – other organic compounds
3) Sulfur bacteria
4) Absence of oxygen
5) Sealable plastic tubs (3) small because of toxic gas these experiments must follow all appropriate laboratory PPE protocols.
    - Sulfur bacteria are present in small quantities under cobblestones on beaches (underside stained black a sign for absence of oxygen – better to start dried samples of concentrate (if possible) it takes years for cultures to grow in the wild.
6) An incubator for heating

Deep coastal coves of deposits can be examined for Sapropel and the deeper the core the more Sapropel evidence is often apparent.

Although Sapropel can also form in cold, it is a very slow process while heating quickens the process – drives off ammonia and hastens nitrate elimination – once all oxygen (elemental) and organic oxygen (locked in chemical compounds) is used up then sulfur reducing bacteria takes over putrefies the organic matter as it turns black in the presence of iron. Sulfur compounds increase as sulfate reducing bacteria breakdown it as a source of oxygen. Although sulfur reducing bacteria don't dominate in an oxygen sufficient time when oxygen becomes limiting they come back with a vengeance. The sulfur cycle once ruled the earth but now waits in isolated oxygen limited environments. We know those environments as coastal coves, bays and Sounds important to fisheries.

Seawater -

In the presence of iron hydrogen sulfide forms ferric sulfide and the blue/black color associated with Sapropel. Sulfate and iron compounds are not “limiting” and therefore have huge roles in the process. Iron is available as being a compound of minerals washed from land and is not generally considered “limiting.” Sulfate is abundant in seawater and is also not considered limiting. Temperature and oxygen levels can and do influence bacterial organic matter reduction and establish low oxygen or anoxic waters. Most reports tend to classify the anoxic types rather than detailing the basic changes in Sapropel formation. Few studies look at changes in land patterns for organic residues (forest humis, duff and leaf falls). Connecticut forests now recovered from the last century of extensive clearing for agriculture (mostly dairy farms) a reviewed forest canopy drops huge quantities of leaves and suburban leaves that fall on paved surfaces has quickened the deluge of organic matter into smaller streams. In some cases streams are choked with organic matter - Oyster River, Old Saybrook watershed and small brooks from Madison to Branford. They often contain deep, black deposits in the tidal regions. Occasional shellfish surveys find buried oyster beds beneath them.

Overseas it seems the link between organics, water temperatures and energy (rain falls) clearly exists. This is an excerpt from a paper about Australian Rivers:

“Black water events can provide a valuable source of carbon to rivers which can stimulate fish breeding and food production, but they can also create low levels of dissolved oxygen in water which can be harmful to fish and other aquatic species.

Black water usually occurs in flooded wetlands or floodplains, which have large accumulations of organic material. It can also occur in rivers if large amounts of leafy or woody material are washed in from storms.

The two most important factors influencing the development of black water are temperature of the water and the amount of carbon (i.e. leafy litter and woody debris) present. The heightened risk of black water events is influenced by increased amounts of organic material and rising air and water temperatures.

In 2010-11, black water affected sections of the Murray River (particularly large wetland areas such as the Barmah-Millewa and Koondrock-Pericotta Forests), Edward and Wakool river systems, Lower Darling and Murrumbidgee Rivers.”

Sapropel Creates Habitat Change

Estuarine habitat types such as submerged aquatic vegetation (eelgrass) first benefits from this compost deposits, but as it becomes sulfide rich can destroy it, marine soils of sand/pebbles can loose its ability to attract and sustain clam sets. Sulfide bottoms kill most larval stages upon contact. Marine soils can become clogged with waxes, becoming "sticky" or plastic when probed. Shellfish cannot set or live in Sapropel and the presence of soft muck filled bottoms has always been a concern on oyster reefs. In fact very few organisms can live in high sulfide habitats found in estuaries.

That is often perplexing to fishers and the general public – how could these soft deposits long championed as essential and occasionally be termed beneficial critical habitats for near shore species become so deadly? In general terms we opted for a short term habitat view – it appears as though habitat succession in the marine environment was forgotten. Habitats do change in the marine environment as they do on land, they are subject to destruction by energy (floods, storms hurricanes) and shifts in temperature. Species suffer habitat extinction events (called extirpation) but do so over much longer periods. There is a disconnect between today's environmental policy as well – most dredging activities are viewed in a negative regulatory view (very few publications highlight the benefits of marine dredging) because all bottom habitats are viewed as always important or necessary. As such only negative bottom in them aspects in my view have been studied while the positive energy habitat role dramatically under studied. There is a bias in the environmental literature that mirrors the bias in environmental policy. The disconnect is present with fishers following long term habitat conditions by direct observations, they often "see" the disconnect.

Fisher habitat observations are key to fully understanding marine habitat processes known as succession. One of the measures is the Tannin – Sapropel Cycle. Over time estuarine habitats in medium to low energy areas appear to "fail" for certain species. This is especially true for the areas we fish and therefore observe. Hard bottom habitats can (overtime) "reverse" and become soft or muck filled. Soft mud deposits with oxygen appear harmless and beneficial which is true but change when energy is applied they often now are termed "hard." Temperature/oxygen levels can fall and what was "good" bottoms can quickly become "foul" bottoms. You see this observation over time often in the same fishing location or spot, especially with clammers and oysters fishers. Most noticeable changes occur after energy, heavy rains or strong coastal storms.

Coastal residents often see this as well – shallow wood and leaf litter act as structure for fish and in the presence of oxygen shallow areas abound with small fish, kill fish, silver sides, small crabs, etc. At night in late August when water temperatures rise oxygen levels drop to low levels, Sapropel reduction increases and sulfate reducing bacteria generate sulfide gases and the marsh stink (smells) near dawn. But not all the sulfide comes out as a gas, some is dissolved in sea water and complexes in the soft bottom. If hot enough and long enough the smells can discolor house paints from coastal fog sulfuric acids damage car finishes and generate coastal comments long reported as – "the marsh smells" such as the Niantic Bay area in the 1970s and 1980s.

Long before sulfide kills fish and crabs they flee – clam and oysters can not and tolerate only short periods of sulfide toxicity it is only the huge long events – extreme heat, extreme low energy and "trapped" fish does the "killing" become in full view. In the morning sunlight restarts algal oxygen production and coastal residents (with smells gone) observe the shallows once again active with fish unaware of the habitat battles that occurred over night. They now contain fish and small crabs as before and the intense smell from the night before is dismissed. The habitat battle between sulfur and oxygen was out of sight and the sulfur cycle continues to be poorly understood by many coastal residents regarding these smells. Many Rhode Island Greenwich Bay residents experienced a smaller version of the 1898 Upper Narragansett Bay kill in 2003.

Organic Matter and Estuarine Habitats

The farm community a century ago recognized the danger of putrefied organic matter as fertilizer. Much different than surface composts – those exposed to oxygen reducing bacteria accumulations. The organic matter trapped by mill dams became so deadly unless it was allowed to freeze first and be treated with lime or oyster shells before application it was avoided. In the navigational dredging industry these sulfate acidic soils can ruin metal equipment. John Hammond on Cape Cod used this organic matter for growing tomatoes but mixed it with crumbly oyster shell to modify the acidity, his tomatoes patch was outstanding but farmers of the last century that utilized "marine mud" on thin glacial soils soon recognized its danger when it was allowed to age behind dams. It contained when exposed to air high amounts of sulfuric acid. Dams would collect the "fall lawn" leaves (and other woody tissue) and as the accumulation grew deeper stratifying the sediment into one with no or little oxygen sulfur compounds increased. The deeper they dug the more toxic the material became and today called sulfate acidic soil when exposed to air (Sapropel) oxidized producing huge amounts of sulfuric acid and often devastating low pH. But sometimes even green leaves – those that for some reason drought or winds deposit them into estuarine can cause sulfide toxicity. (Hurricane Gustav fish kill report and case history on the Atchafalaya Basin Keeper® website has an excellent write up.

Green Leaves and Hurricane Gustav Hits Louisiana

This case history involves a day-by-day timeline from when Hurricane Gustav hit Louisiana's coast September 1, 2008 as a strong category 2 storm, almost a category 3. This is a valuable report as it occurred in a relatively low population area and gives a detailed report on the impacts of leaves entering low energy waters.

On Monday, September 1st, huge amounts of green leaves into area waterways and forests, commonly known as the Atchafalaya Basin. Wednesday, September 4th – flooding occurs as heavy rains now enter waterways. On Thursday, September 5th, the water in wooded areas starts to smell “like raw sewage” and the writer refers to it as “the green manure effect.”

September 6th finds dead and dying fish – waters are flooding with millions of gallons of green leaves now going into the basin watershed.

The report continues, “the effect of green leaves in water is very different from dry, brown autumn leaves rotting the water. Fish are coming to the surface.”

September 7th reports dropping water levels but massive fish kills of shad, catfish, carp, buffalo white drum, perch (several species) and bass (all species). The only fishes that lived were garfish, bowfin and minnows.

September 8th – Pat’s Bay suffers 100% kill of all fish; horrible smell starts

September 10th – Black water comes out of Sorrel Shellfield Bayou. Black water mixes with muddy water of Bayou Sorrel. Egrets observed feeding on sick fish. Black water looks black and thick and smells like raw sewage. Fish are taking refuge in Mound’s Bayou.

September 13th – Hurricane Gustav makes landfall in Texas. Very strong winds push bad water back into basin worsening water quality that now has a horrible smell.

September 17th to 18th – Water quality improves. Fish again observed in some areas. Although in some areas it continues to be very bad – Shellfield.

Conclusion: “Our observations suggest that massive fish kills following hurricanes are caused by green leaves falling into the water and decaying” (Report of the Atchafalaya Basin Keeper®)

Other case histories involve the paper industry which uses a process that utilizes sulfate reducing bacteria to break down pulp wood chips (very similar to marine breakdown of leaves in the marine environment) to produce a thick, black water fluid called black liquor. Before paper industries regulated waste products (which they do today), they often discharged black water into rivers and streams. In one of the most detailed case histories (which is now available on the internet) titled “Defining a Nuisance: Pollution, Science, and Environmental Politics on Maine’s Androscoggin River.” In 2012, Wallace Scot McFarland in a paper on environmental history (Environmental History, 2012, 17(2), pages 307-335) details the social, regulating and economic issues confronting residents along the Androscoggin River, which at the time had several pulp and paper mills. It is some of the observations in the article (and this one in particular) highlights the Tannin (Brown water) Sapropel black water cycles.

This is the opening quote from the McFarland article:

"In 1941, along Maine's fetid Androscoggin River, houses freshly painted white turned black as hydrogen sulfide rising from the water reacted with paint, a direct result of polluting from upstream pulp and paper mills. Inside Leo Good's drugstore, the river odor was so strong that "people would order ice cream and go away without eating it."

Water quality problems were linked to several factors, including dams "as the number of dams multiplied, they reduced the Androscoggin's ability to process an increasing amount of organic matter and lowered dissolved oxygen levels" (The absence of "stream energy" is frequently mentioned in Saprobien System, 1909); and further, "the large amounts of organic matter in the waste that pulp and paper mills dumped into the river created a biochemical oxygen demand, lowering dissolved oxygen levels as the oxygen consuming bacteria digested the organic matter."

This environmental problem would continue for four decades.

The Rhode Greenwich By Fish Kill of 2003

In the summer of 2003 along the western shore of Greenwich Bay Rhode Island coastal residents witnessed the return of the Tannin – Sapropel Cycle – after a century at first they could smell it. It was a hot summer and heavy rains occurred the end of July – A September 2003 Rhode Island DEM report states "many noted a rotten egg smell associated with hydrogen sulfide (toxic to organisms) being produced by sediment chemistry and bacteria processes" (pg 3).

While the report correctly identifies much of the products of the Tannin Sapropel Cycle neither is mentioned in the report. Heavy rainfalls in watersheds containing forests always have tannin leaching into waterways. It is what turns coastal river waters brown even in winter. Residential property can also shed Tannin from leaves on yards in gutters and street basins. Almost every storm water street basin – containing leaves and water start Tannins and sometimes sulfides on their way to the sea. Shellfishers on Cape Cod noticed that roadway leaves – still at the time raked to side streets before the prohibition of fall leaf burning were ground by car tires into an oatmeal (brown) paste that after heavy rains accumulated in loose waves of chaff that soon turned black in Lewis Bay Hyannis (1982-83). In fact the paving of streets have greatly speeded the time it takes for tannins to arrive – acidic and a natural clarifier settling organic matter to bay and coves bottoms.

As the fish kill intensified in deeper Greenwich Bay (2003) waters reports include depth contour band of shellfish kills, mostly likely where sulfide rich waters stagnated in place killing shellfish on the bay bottom miles from the surface chocolate or grey waters. This killing continued as shellfish meats add "fuel to the fire" and accelerates sulfur reducing bacteria. I believe that a great number of dead crabs (including blue crabs) if dredged or caught in sampling trawl nets at that time would have been stained black by the sulfide.

As many older fish kills in the fisheries literature, it is almost nearly the same observations – it is remarkable as to the similarity of these events – rainfall, high heat, low energy.

The Greenwich Bay Kill Case Review

The first part of August 2003 the Providence area was hit by heavy rains and on August 7 to 8 nearly 4 inches in 24 hours on the range of a tropical system. It had been a hot summer with little in the way of strong winds or storms. Some highly sensitive small soft shell clams had died the end of July (Large fish kill often have precursor events - many of the large kills had smaller kills two or three years before, this is believed to be linked to transition of Sapropelic bottoms) observations include increasing algal bloom peaking around August 11 to 13th. These blooms are not sustainable and low pH restricts green algae but allows for browns to survive living off ammonia from the reduction of leaves. When they die they provide more "food" for now overwhelmed bacteria that reduce organic matter by oxygen – who are displaced by sulfur reducers. As sulfate reduction strengthens hydrogen sulfide kills living organisms who again create an even greater oxygen debt. Oxygen reducers can hang on for as long as the nitrate/nitrogen compounds hold out but once that is limiting they allow sulfate reducers to thrive and the hydrogen sulfide smells begin. In this case when oxygen is limiting nitrate buffers the sulfate reduction process. This is a natural selection process between two huge groups of bacteria – those that need oxygen and those who can access it by way of the sulfur cycle. It is the sulfur reducing bacteria that eat the leaves on the bottom in oxygen limited waters. They form the basis of the Sapropel Cycle in estuarine habitat and reverses thousands of acres of habitat unsuited for most estuarine species. Between 1980 and 1990 Sapropel would become the dominant habitat type in nearshore areas between New Jersey to Maine.

The report does a good job with the oceanographic factors: the heated, stratified cove surface water, weak tidal flows (low energy) and low oxygen, but misses the impact of organic matter loadings in low oxygen conditions.

The report focuses upon inputs from domestic septic systems, but the link to rainfall is tied to overflow wastewater treatment plants, which is an immediate event, but septic system nitrate levels when often rise 15 to 30 days after rain events. Nitrate would tend to reduce sulfate reduction and underestimates the rapid release of ammonia from organic reduction. Sapropel can release tremendous amounts of ammonia, fueling brown algal blooms. In fact, the organic loadings from watershed sources seems to be underestimated, noting the primary source of nitrogen to Greenwich Bay as 51% from septic systems while just a brief mention of the Providence River or terrestrial organics. I did not find an explanation for the source of sulfur in hydrogen sulfide. Organic matter from terrestrial sources (leaves) is not mentioned as a potential nutrient source (The Greenwich Bay Fish Kill, August 2003, Causes Impacts and Responses, Rhode Island Department of Environmental Management, September 2003).

Even “green leaves” (not those from fall drop or street basins) can provide a tremendous nutrient base and sometimes is termed “green manure.”

Tropical Storm Lee Western CT and Blue Crabs Kills

The remnants of Tropical Storm Lee hit the eastern seaboard on September 7, 2011 brought with it very heavy rains. This happened just a few days following Irene. The summer to date had been a hot one for Connecticut and much of the mid Atlantic states northward. When reviewing the impacts of rainfall upon blue crab habitats after July 2011 rain events the NOAA – National Climatic Data Center National review website has been a terrific help. It is possible to use this national overview site check the year and month database to look up significant weather events. The ability to cross reference blue crab observations against weather is a new field of habitat assessment and provides insight into major habitat reversals. The beginning of July was unusually dry and hot Portland Maine reached 100f on July 22nd. Connecticut was under a period of high heat and very dry conditions but not the entire state. Forest and leaf letter was also dry and heat weakens leaves – in long dry periods leaves will fall even when green. That would have a role with changes beginning July 26th to 29th as heavy thunderstorms rocked western CT.

A severe thunderstorm warning was issued on July 26th followed by a tornado warning at 5:57 am. The National weather service confirmed a tornado at Goshen New York 90-100 mp hour winds (NWS Public Statement 338 pm Saturday, July 30, 2011) Western Connecticut was hit the hardest, and flooded street basins (blocked by leaves) were frequent. Most of the central and eastern sections had little rain. Torrents of hot often brown water were reported by crabbers August 1st and 2nd. Several observations reported dead blue crabs and unusual smells. Rains on warmed surfaces (thermal shock) huge amounts of freshwater (salinity shock) was thought to be the cause of these dead crabs. However after a few days western blue crabbing dropped – suddenly. Irene came August 28 to 29 and Lee September 8th by September 9th some part of Connecticut had 8 inches of rain in ten days. (Burlington by August 29, 2011 8.71 inches) with much more after Lee which stalled over New York for days.

I missed the significance of a potential (July 26 to 30) huge sulfide event which after reviewing crabber observations which I do believed occurred then. After the sulfide event (I should have been suspicious from the reports of smells) then came Hurricane Irene – washing more organic matter and causing leaf fall and tree fall. Almost overnight the ground in much of Connecticut was covered in ripped leaves, bit of twigs – bark, needles and the like. Cars were covered with this organic wind blown paste and slurries of "oatmeal" ground leaves and organics clogged overflowing street basins as the heat continued. A final hit to many blue crab habitats was then Tropical Storm Lee although not as powerful as Irene a few days before bringing heavy rains to Connecticut and delivered a "broom clean" impact of sweeping much of the already down organic matter on the ground into streams. By September I was getting reports of leaves in dredged marina basins – several feet in some areas. By October large portions of the lower Saugatuck River appeared "dead" and covered in leaves. {Some of the same problems occurred in the Branford River and after Gloria (1985) and by 1988 bad smells were reported by trees and fell into the Branford River and blocked leaves National Guard Comes to Rescue, Branford Review August 10, 1988, Engineers to Remove Fallen Trees from River, New Haven Register August 5, 1988}.

Blue crabbing had been nothing short of fantastic as much of the 2010 year class (thought to be the largest since 1912) that over wintered in the lower reaches of river or dredged basins emerged in early spring. Crabbing started off slow (megalops reports 1 to 7 2001) but quickly picked up. After the reports of brown water crabbing dropped like a rock.

Hurricane Irene and Tropical Storm Lee Review

In June and early July blue crabbing was superb in western Connecticut. In July, before these two tropical systems hit the Northeast, western Connecticut sustained very heavy rains as a remnant cold front collapsed and stalled over western Connecticut for days. A "training effect" soon followed as thunderstorm after thunderstorm rode up along the stalled front for days of intermittent heavy rain. Waters turned brown and blue crabbers reported dead crabs in brown waters and the smell of sulfur. A huge wave of crabs left the Housatonic River and headed east toward New Haven (Megalops Reports, July 2011 – A write-up of these reports can be found in IMEP Habitat History Newsletter #22 found on Blue Crab Information™ 's Fishing, eeling and oystering thread). (I have followed these leaf accumulations and reports about them since). Some western Connecticut communities between the end of July thunderstorms (26 to 30) Irene August 28-29 and then Lee September 7-8 obtained more than 15 inches of rain.

I at first thought that this large movement of blue crabs was a seasonal or density dependent migration (too many crabs competing for the same habitat or interspecies competition) (July/August, 2011). I was wrong. I suspect today that what western Connecticut crabbers were reporting was a massive sulfide event brought down river by heavy rains triggers a migration out not quite a Jubilee but something close. Irene came and washed loosened organic material from watersheds after this July deluge followed by the remnants of storm Lee and by October 2011, several feet of leaves covered some blue crabbing areas. The blue crabs were long gone. Western Connecticut crab reports greatly declined and then stopped. Blue crabbing in the center and eastern parts of Connecticut slowed, but did not seem to drop that much. Western Connecticut crabbing has yet to recover from July 2011 and these rain events. Many areas I observe continue to have "black leaves" and gas discharges. Several areas in the central sections as well.

What about the Conowingo Dam and Sulfide Wash?

This dam and the organic matter trapped behind it (Conowingo Pond) has been posted on several websites. Since 1997 it looks like this will be a major case study for sulfur reduction. I have a couple of senior students interested in looking into this now. The Conowingo Pond has been in the news again lately and now shows up in many sites. The Conowingo Dam (Pond) case history will be an interesting one and perhaps as long as the public policy debates surrounding the Androscoggin River in Maine between 1889 to 1974. Fishers are correct in raising concerns about what lies under the Conowingo Pond accumulations if sulfide washes are released after heavy rains they would acidify marine soils far below the dam. Deep core sections were done in Connecticut's coastal coves (1990-94) they showed distinct layers of blue black organic matter and then layers of bivalve shell. Deep core sections behind the Conowingo could be just as interesting and any deep core sections (usually performed by the Army Corps of Engineers) would document organic (woody tissue twigs and leaves) and the sulfur cycle. In warm weather I suspect warm organic deposition sheds enormous quantities of ammonia (nitrogen) compounding the impacts down stream. Core tests and examinations may well answer many habitat impacts questions from Sapropel accumulations.

Always welcomes comments and suggestions. Tim Visel can be reach at
tim.visel@new-haven.k12.ct.us

The Sapropel – Sulfur Cycle and The Nitrogen TMDL
Recent Studies Concerning Nitrogen Source Identity
Did we protect the wrong scallop grass and remove the "good" nitrogen?

October 30, 2014

Tim Visel
The Sound School - 60 South Water Street, New Haven, CT 06519

Public CCMP Comments Submitted To Water Vision

A letter to the Long Island Sound Study
Consider suspending the CCMP process pending resolution to these questions – Tim Visel – Member CAC and Habitat Committees (Not the official viewpoint of these committees).

In about two months reports of research on the west coast looking at marine soil pore water (sulfides) will reinforce what Danish researchers reported last year regarding eelgrass death rings; eelgrass traps organic matter and causes a habitat reversal that favors sulfur-sulfide formation. The key to their findings is the nitrogen compound nitrate or its electronic affinity to buffer (slow or stop sulfate reducing bacteria) sulfide formation. What does this mean? Technically, we may have removed nitrate instead of concentrating on the most damaging nitrogen forms known as second source generation, sulfate digestion of organic matter producing ammonia. Several recent reports have highlighted the importance of second source nitrogen commonly called "benthic flux" and the need to index it against temperature for proper TMDL allowances.

In some EPA estuary programs eelgrass coverage (health) was linked to nitrate reduction, which actually is the chemical opposite for sulfate reducing bacteria in high heat. Removing nitrate in high heat from shallow, poorly flushed bays actually can increase sulfate to sulfide production, one of the most toxic substances to marine life. Eventually the sulfide level becomes so high, if oxygen or nitrate is limiting, the soil becomes toxic to the eelgrass itself. The very biology of eelgrass can start the process by collecting organic matter over time and can in fact become deadly in heat. This in fact is the focus of the Denmark study. Thus the long-term habitat services of eelgrass is largely opposite what assumed now that would exist in nature. We need to take a serious look at that, we may in fact over estimated the significance of eelgrass and missed several key segments in its overall life history.

Eelgrass Dies off in Climate/Energy Cycles -

Last year two Danish researchers put out several articles about sulfur eelgrass "death rings" and the toxic impacts of sulfide in eelgrass meadows at which at a certain time (habitat clock) eelgrass dies off naturally with the older Sapropel sulfide containing deposits first. Decreases in abundant nitrate levels could have assured eelgrass become the dominant plant species in Sapropel as eelgrass can sustain the highest sulfide levels; an unique survival feature of a grass that helps create the first Sapropel deposits. In high heat these deposits can shed enormous quantities of ammonia with damaging impacts to both plant and animal species.

The increase in eelgrass along our coast appears to be apart of a much larger and longer sulfur-sapropel cycle. Local Increases in eelgrass coverage could be explained simply that it is more sulfur/sulfide resistant and the effect of reducing nitrate would help eelgrass out complete other plant species. We would need to know more about the sulfide buried under the eelgrass meadows here before any assumptions can be made regarding nitrogen removal and eelgrass health. Without ammonia levels or Sapropel information increases in eelgrass may reflect only that they can withstand higher levels of sulfide before perishing which leads to a much more serious discussion on how accurate is our nitrogen TMDL. (Eelgrass health and nitrogen levels were closely linked by several EPA estuary programs, not just ours).

In reducing nitrate we may have assured eelgrass die offs – opposite the desired public policy benefit. Early research detailed the influence of sediment sulfide on seagrass communities (Calson et al 2003) listed the most critical factor in SAV distribution as sulfide. Eelgrass survival might be connected to the sulfide levels in the soil. That should take research precedence as we seek more information about eelgrass and its ability to live in high sulfide soils.

Why the Need for a CCMP Delay -

The exclusion of secondary source nitrogen (from organic matter digestion and production of ammonia) will open questions regarding yet perhaps another scientific amnesia conflict of interest in the eelgrass misconduct debate. Did the early researchers know the damaging aspects of terrestrial organic matter in high heat (sulfide levels) upon eelgrass growth? And if so and not included in our TMDL we have a compelling reason to halt the CCMP process right now until this question is fully reviewed.

Eelgrass Habitat History Incomplete -

Several estuaries here especially after recent coastal storms, have seen organic deposits (commonly called black mayonnaise) dramatically increase, but soon after paraffin sealed soil pore spaces as Sapropel forms. These deposits shed ammonia and purge sulfides. They may become in time to have an eelgrass crust. The source of much of these deposits in our region are oak leaves (or leaves in general) and after Irene, Lee and Sandy, the Saugatuck River was hit hard by leaves. As these leaves are broken down, secondary source nitrogen can overwhelm estuaries sustaining harmful algae blooms for weeks. These are called "HABs." Sudden and severe rainfalls can carry enormous amounts of organic matter into shallow and relatively poorly flushed coves and bays. We have a case history with the Long Island New York duck farms and the impacts long term from these organic deposits. Sludge which may have formed Sapropel.

If second source nitrogen was not included (and several significant EPA publications mention it is not) this will open a new round of questioning around the role of nutrient coordinators. Many may have forgotten "hard nitrogen" and not included it in to weigh TMDL allowances toward sewage treatment plants for larger regulatory control or Clean Water Act authority? At least one estuary program, Indian River lagoon in Florida is looking for funds to offset the costs of dredging. If indeed sulfate digestion of organic matter (Sapropel) was purposely omitted from the TMDL formulation and as suggested perhaps by EPA reports themselves and inappropriate guidance was in fact "weeded out" this begs the question that the TMDL was in fact flawed from the very start[*]? Certainly now in light of the Danish Studies cause a review of the linkage between nitrogen reduction and increases in seafood this relationship needs an immediate review in terms of coastal energy and temperatures over the long term.

With serious questions now regarding the habitat services of eelgrass, evidence that a huge source of estuarine nitrogen was perhaps overlooked in the TMDL process itself and the devastating role of nitrate as buffering the sulfur reduction cycle, I can't see how the study can present this CCMP to the Citizens of New York or Connecticut. We need to suspend the revision process, take a step back, take a hard look at TMDL goals and review the Sapropel/ Sulfur cycles before continuing any further CCMP discussions.

My view.

Tim Visel

Leaves From Trees Overwhelm Nitrogen Counts in Local Waters Supplemental Information. Additional public comments CCMP due November 8th 2014.

Tim Visel, CAC Member[*]

[*] "Within the U.S. EPA Regional Offices, there are Nutrient Coordinators who establish Regional Technical Assistance groups to assure that the best available current information is brought to the criterion development process, and inappropriate guidance is weeded out" (Seagrasses and Protective Criteria – A Review and Assessment of Research Status EPA, June 2009, pg 1.5).

[*] This report or presentation is not the official position of the Long Island Sound Citizen's Advisory Committee it is solely the viewpoint of Tim Visel, CAC Member.

Following the tropical systems (Irene, Lee and Sandy) many coastal Connecticut residents noticed distinct habitat changes, especially blue crabbers. Productive areas were now covered by leaves following the 2010 blue crab year (which was outstanding), now following these tropical systems, areas seemed to be filled with leaves, sometimes several feet from reports from fishers and published newsletters, the Saugatuck River was one of the rivers hardest hit. Ask any trout fisher in New England how fall leaf falls can impact trout habitats and they will tell you it can be devastating. This organic compost, termed black mayonnaise, in tidal areas can shed ammonia as part of the sulfate digestion process for years (personal observations).

In poorly flushed coves and bays a nitrogen “retention” time exists for this “hard” nitrogen and phosphate and in hot weather ammonia compounds increase fueling the brown algal strains many of which are termed harmful by habitat dominance or the fact that they contain toxins. In the current literature they are frequently termed “HABS.” A major paper, *Nitrogen Inputs to Seventy-Four Southern New England Estuaries: Applications of a Watershed Nitrogen Loading Model* (Latimer and Charpentier) (2010) apparently did not include or consider secondary source nitrogen although proposing that this study be used to guide nitrogen reduction programs in New England.

“The only nitrogen loading source not from the watershed is atmospheric disposition directly onto the water surface… and internal nitrogen regeneration from sediment and water column is not considered in this paper; however it is taken into account by the ELM. The sediment has been ascribed by others to be a net sink, except during summer periods where it maybe a net source in either case it is not new nitrogen; therefore it was not included (pg. 5)”

So if it is not waste water inputs, not atmospheric and not fertilizer inputs (based on commercial fertilizer application rates)(pg. 3) how are leaves and millions of yards of plant tissue included in the TMDL when they decompose in estuaries? How are these leaves measured when they enter into sulfate reduction processes or form Sapropel deposits? In other words a huge source of ammonia generation (second order) was not included in any nitrogen loadings that I can find and any TMDL based on it is woefully inaccurate in high heat almost to the point of it being meaningless - my view.

High Heat/Low Energy Conditions

Irene, Lee and Sandy washed millions of cubic yards of leaves into estuaries concentrating organic matter into streams that then deposited it on bay bottoms, a marine compost of unprecedented scale along the eastern seaboard. I can assure you that if someone dumped four feet of leaves on a lawn, it would take awhile for organic decomposers to break it down even in the presence of oxygen and any yard would be a recipient of new phosphate and nitrogen from not atmospheric, not waste water and not commercial fertilizer sources but it would be there nonetheless.

The absence of focus upon non-point source of “hard” nitrogen inputs for consideration in the TMDL is mirrored by the fact that some of these deposits can emit sulfide in winter, and naturally cause eelgrass to “die off” in cold waters. Thus the loss of eelgrass can be from both high heat sulfide formation and low temperature sulfide purging. Several recent reports reference these impacts.

A Review of Nitrogen – Eelgrass Linkages The Cape Cod Review Panel

In a major review of nitrogen second source generation (such as leaves) one review panel that occurred on Cape Cod in 2011 reveals much indecision as to whether it should or should not be considered as a significant nitrogen source (Massachusetts Estuary Project Linked Watershed Employment Model Peer Review, December 30, 2011). Referred to as benthic flux as an analytical measure, which as a misnomer, it actually does not take into its physical presence giving the public that it is much like a analytical temperature measure while it can accumulate several feet deep on bay bottoms (they have black mayonnaise on Cape Cod). On page 17 is found this statement,

“In the SMAST RMA4 water quality model, PON settling flux is represented implicitly as an adjustment to observed benthic regeneration fluxes. The observed benthic fluxes are discounted by an assumed PON settling flux so that when they are specified as a sediment-water input load to the model, the PON which has remained in the water column does not get double-counted. Basically, this approach ‘pre-calibrates’ the water quality model with a fixed value for PON apparent net settling velocity. A strength of this approach is that it is based on observed data for benthic fluxes, but a concern is that it is conducted outside the mass balance equation in the model. Consequently, there is no direct constraint to ensure that the correct adjustment has been made.”

New Hampshire Nitrogen – Eelgrass Review Panel 2012-2013

An eelgrass/nitrogen review was required by law (act) of the New Hampshire legislature and occurred in 2012 following controversy regarding the eelgrass/ nitrogen association and Congressional hearrings over scientific misconduct allegations (Joint Report of Peer Reviewing Panel – Numeric Nutrient Criteria for the Great Bay Estuary, New Hampshire, February 13, 2014). Although a very negative relationship exists between pore water sulfide levels and submerged aquatic vegetation and storms helps creates enhanced soil porosity freeing marine soils of sulfides (Belding, 1912) most eelgrass increases occur after storms (energy) that remove Sapropel deposits. Temperature and storms greatly influence the accumulation and presence of Sapropel. “Sediment quality” is never fully explained (p.18). Long periods of intense heat and few storm disturbances act to end eelgrass habitat succession, while cooler temperatures and storms act to restore it.

And in winter sulfide tension/affinity is reduced allowing sulfide levels to climb as such many die offs of eelgrass can be attributed to high heat sulfide toxicity – as a natural climate cycle over the winter. Many shellfishers have reported this sulfide or “dead” line decades ago on Cape Cod.

Identification of deep organics that contain Sapropel in Great Bay was perhaps the best opportunity to settle when Sapropel exists in our waters now that process lies perhaps with ongoing Conowongo Pond studies down south. Here sulfate is limiting so as any sulfur/sulfides would accumulate from leaves slowly being digested over time, perhaps decades.

It was unfortunate that the New Hampshire study did not contain a review of black mayonnaise deposits – as oak leaf waxes may have sealed them and created layers of Sapropel and high metal sulfides below. That was apparently beyond the scope of work of the eelgrass nitrogen review but Sapropel (sulfate digestion) adds to the nitrogen background levels with ammonia/sulfide toxic impacts to eelgrass populations. Although not directly covered in this assessment authors did mention it – as sediment pollution pg 19 (not described) or ammonium toxicity pg 26 (not described) further as chemical properties of the sediment (not described) sediment stability pg 28 (not described) sediment oxygen demand (SOD) and on page 31 is a statement that suggests Sapropel formation.

“With the exception of the nitrification process, nitrogen concentrations are not directly linked to DO, but are only indirectly linked through primary production and the subsequent sequence of physiological processes that utilize the produced organic matter. These include respiration, oxidation of DOC exudates, oxidation of POC, and sediment oxygen demand (SOD). Another necessary and confounding factor, with regard to lower DO, is physical stratification/vertical stability of the water column.

For the above reasons, development of scientifically credible statistical relationships between nutrient concentrations as a causal variable and DO as a response variable is difficult under any circumstances. In fact, even EPA itself was unwilling to demonstrate such relationship in its own guidance. A notable omission, not generally recognized, is the EPA Technical Guidance Document for Stressor-Response Relationships (EPA 2010b) does not contain a single example for dissolved oxygen as a response variable.”

Pg 32 Identifies the conditions of organic deposits but does not include leaves as a potential source of organic matter.

“Density stratification of the water column that isolates the bottom water from exchange with oxygen-rich surface water. Stratification is most commonly driven by salinity or temperature. Decomposition of organic matter in the isolated bottom water that consumes dissolved oxygen. In euthophic systems, organic matter is supplied in excess of what the system is normally able to process.”

Or again on pg 33 and “allochthanous” means – not formed in the region where found.

“If autochthonous primary production is the main source of organic matter to the Great Bay system and reductions in nitrogen loads lead to lower primary production then DO may improve. If allochthanous organic matter from terrestrial sources or municipal/industrial discharges is the main source, then the benefits of lowering nitrogen may be difficult to detect.”

Or if leaves enter the system in large amounts “the benefits of lowering nitrogen be may difficult to detect,” why? (It just begs the question). In the entire New Hampshire report I did not find the word leaf once but leaves do provide sources of nitrogen and phosphate as natural cycles that are influenced by climate and energy cycles. That should have been mentioned in plain language – (my view).

Deep core studies with tannin signatures are now also available. I suspect that leaves fall into watersheds there (Great Bay) as they do here in New England and layers that are carbon rich and the product of sulfide reducing bacteria can be found beneath any organic deposits labeled as Sapropel and not benthic flux. The deeper the core sections the higher sulfate reducing bacteria can complex certain metals – the deeper cores should have the highest metal fractions.

Or perhaps we should look now to the Florida Indian River Lagoon program just entering another yet review. This is an excerpt from a WFSU report by Sascha Cordner last December 11, 2013. Sascha Cordner – reporting.

“Dr. John Trefry is a Marine and Environmental Systems Professor at Florida Institute of Technology, who’s been studying muck in the Indian River Lagoon which he describes as “black mayonnaise.” “And, much like the algae bloom, it blocks sunlight and inhibits sea growth,” said Trefry.

Trefry says muck has been accumulating in the lagoon for decades, leading to a decrease in oxygen in the water. So, he says a multi-year effort is needed to help restore the system.

“We’re in a period of critical decline—and people are always saying it’s critical. This one is really bothering me, and I’m sort of someone who can tolerate a lot, but this is serious—and, muck has been accumulating for five or six decades. And, not it’s been spread over greater distances in the lagoon. So, let’s dredge. But, let’s make sure we get the upland areas from filling in again,” he added.”

Very recently the US Department of the Interior – U.S. Geological survey released a report titled Quantifying Benthic Nitrogen fluxes in Puget Sound Washington - A review of available data authors (By Richard W. Sheibley and Anthony J. Paulson)
On page two is found this statement which underscores the importance of "second source" nitrogen information and inclusion into the TMDL.

"In Puget Sound, Washington, ignoring or underrepresenting benthic flux as a source of N to marine waters can result in ineffective management actions and can lead to chronic water quality problems in sensitive areas. Shallow areas near the shores of Puget Sound are most likely to experience low levels of dissolved oxygen because of the combination of low relative circulation, warm summer water temperatures, and proximity to watershed nutrient contributions; sediment nitrogen fluxes may also dominate in these shallow areas."

Together the above concerns and the increase of information these past few months challenge many of the eelgrass/nitrogen assumptions and is why we need to suspend the CCMP process for a least one year, to be able to give all LISS committees time to process and review nitrogen and eelgrass habitat information. To include the CCMP process now would yield a document that would need to be completely overhauled and not truly representation of the best available information. That is why I urge again to suspend the CCMP process, take a year and look at the issues raised in the recent press and scientific literature. Other estuary programs are asking similar questions.

Tim Visel

Clean Chesapeake Coalition

Dedicated to improving the water quality of the Bay in a meaningful and cost efficient manner.

500 Million Gallons of Sewage Overflows So Far in Maryland This Year
Tom Pelton, Bay Daily, Chesapeake Bay Foundation, September 19, 2011

TABLE 2. WIP FUNDING REQUIREMENTS 2010-2025 ($ Billions)

AGRICULTURAL RUNOFF	$0.9
WWTPS	$2.4
STORM WATER	$7.4
SEPTIC TANKS	$3.7
TOTAL	**$14.4**

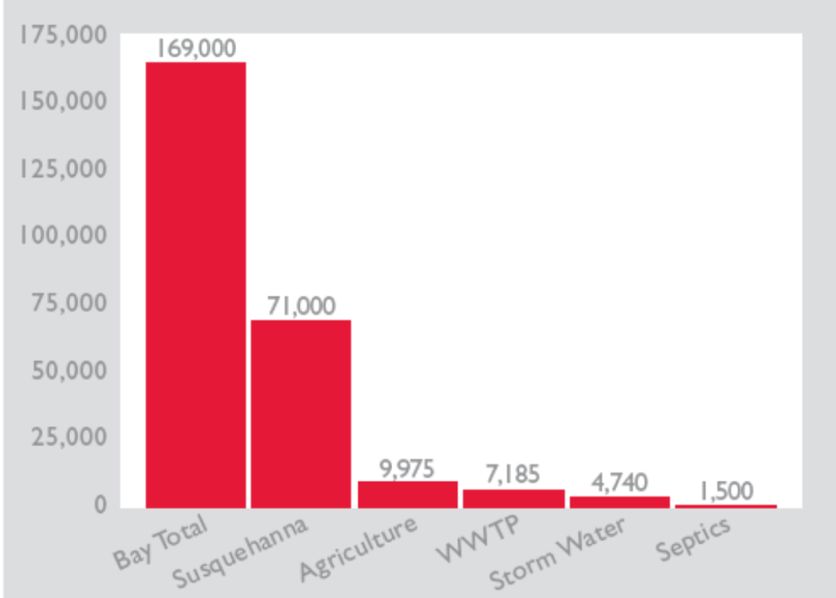
Source: Maryland Department of Legislative Services

Watermen annually must release menhaden that swim into their stationary nets in the shallow waters of the Bay because DNR declares menhaden in need

City works to stem flow of sewage into stream
Alex Gordon, The Baltimore Sun, June 28, 1996

$3.5 billion to be spent on failing septic systems that add much less than 1% of the total annual loading of nitrogen to the Bay and do not discharge directly into the Bay.

CHART 2. NITROGEN LOADS TO CHESAPEAKE BAY BY MARYLAND SOURCE (in Tons)



Sources: Chesapeake Bay Program: USGS & WIP Phase II

Sewage spills into Montgomery Creek that feeds into drinking-water supply
Katherine Shaver, The Washington Post, March 6, 2013

Thousands of gallons of untreated sewage poured into a creek in upper Montgomery County on Wednesday as utility crews searched for a break in a 16-inch sewer pipe, authorities said.

It marked the second day in a row sewage was leaking through the ground and spilling out of manholes near a sewage pumping station in Brookeville at a rate of 100 to 500 gallons a minute.

16.5 Million Gallons of Sewage Overflow Into Baltimore County Waterways
Doug Donovan, Perry Hall Patch, August 30, 2011

Nearly 17 million gallons of sewage overflowed Sunday into 10 different rivers and streams throughout Baltimore County as a result of at a dozen pumping stations, county officials reported Monday.

County officials also reported Monday night that they had discovered a "rupture in a 54-inch diameter pressure line" from the Patapsco Sewage Pump Station located east of Old Annapolis Road shortly before midnight on Sunday, according to a press release from the public works department.

"The pipe transports about 17 million gallons of sewage daily from the western half of the County to the Patapsco Treatment Plant in Baltimore City. The overflow is on-going," the county reported Monday night.

Does it make sense to spend billions on failing septic systems before stopping toxic sewage overflows to the Bay?

Sewage leaks foul Baltimore streams, harbor
Timothy B. Wheeler, The Baltimore Sun, December 10, 2011

Heavy rains routinely trigger big sewage overflows in Baltimore, but there is growing evidence that chronic leaks from the region's aging, cracked sewer lines are a bigger threat to public health.

Though storm-fed spills can be dramatic, Baltimore's' streams and harbor are also fouled on sunny days as storm drains yield grayish discharges that look and smell like sewage. That is what they are. Even the nearly $2 billion overhaul under way on the 3,100 miles of sewer lines in the city and Baltimore County won't be enough to make those waters safe, experts and activists say.

Sections ☰ The Washington Post Search Sign In Subscribe

Environmental groups to sue WSSC for illegal discharge of pollutants into Potomac River

By Max Ehrenfreund November 23, 2013 Follow @MaxEhrenfreund

Three environmental groups have filed a formal notice indicating that they intend ... its wat ... polluta ...

The or ... plant's ... ago ha ... phosph ...

Accord ... days b ... The W ... statement from a spokeswoman.

Based on the plant's records, the groups calculate that the facility added between 18 million and 30 million pounds of material to the river over the past four years, beyond what was in the water withdrawn for treatment.

Millions of gallons of raw sewage and toxic industrial waste overflow from the Baltimore City, Baltimore County, Montgomery County and Prince Georges County sewage system into the Bay annually.

August downpour results in sewage overflow of 12 million gallons
Timothy B. Wheeler, The Baltimore Sun, August 22, 2014

Baltimore city officials belatedly disclosed Friday that sewage overflows topped 12 million gallons during last week's downpour, four times what had previously been acknowledged. It was the most untreated waste reported spilled in the city in a single day since 2006, according to state records.

Blockage sends 50 million gallons of raw sewage into Gwynns Falls
Lynn Anderson, The Baltimore Sun, May 28, 2004

About 50 million gallons of raw sewage have spilled into the Gwynns Falls in West Baltimore as a result of a blocked sewer pipe that may not be fixed until tomorrow, city officials said yesterday.

"We don't have the equipment to get to the pipe," said George Winfield, director of Baltimore's Department of Public Works. He said that a contractor with machinery capable of digging more than 30 feet to reach the pipe won't arrive until tomorrow. About 8.5 million gallons of sewage are flowing into the stream a day.

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MARYLAND

UNITED STATES OF AMERICA,
Plaintiff,
and
STATE OF MARYLAND,
Plaintiff-Intervenor,
v.
MAYOR AND CITY COUNCIL OF BALTIMORE, MARYLAND,
Defendant.

Civil Action No.

CONSENT DECREE

Five Million Gallons Of Sewage Spills Into Potomac River
Justin Schuck, dcist, May 2, 2014

Five million gallons of sewage spilled into the Potomac River on Wednesday. DC Water reports that about 638 million gallons of combined sewage flows into the Potomac River annually due to rainstorms.

Raw sewage and industrial waste overflows from Baltimore City and Baltimore County kill hundreds of thousands of menhaden annually.

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MARYLAND

UNITED STATES OF AMERICA,
Plaintiff,
STATE OF MARYLAND,
Plaintiff-Intervenor,
and
ANACOSTIA WATERSHED SOCIETY, AUBUBON NATURALIST SOCIETY OF THE CENTRAL ATLANTIC STATES, INC. FRIENDS OF SLIGO CREEK, and NATURAL RESOURCES DEFENSE COUNCIL,
Plaintiffs-Intervenors,
v.
WASHINGTON SUBURBAN SANITARY COMMISSION,
Defendant.

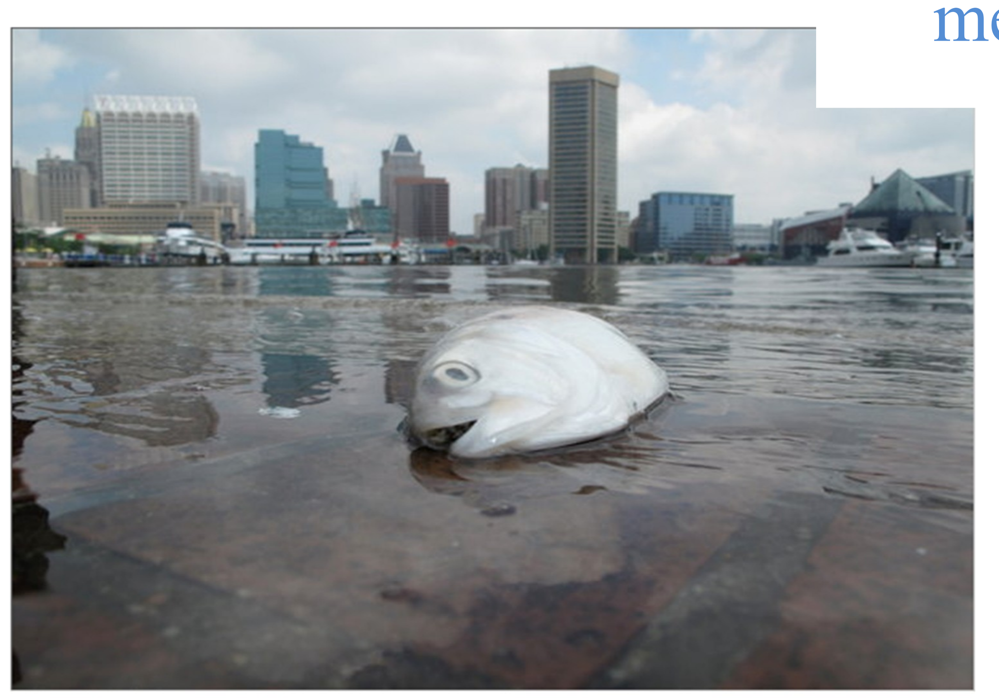
Civil Action No. PJM-04-3679

Judge Messitte

CONSENT DECREE

Baltimore City, Baltimore County, and the WSSC (Prince George's and Montgomery Counties) have been under consent degrees to stop the overflow of millions of gallons of toxic raw sewage into the Bay for over a decade and those jurisdictions have spent less than $2 billion over that period to begin to stop such overflows.

Possible source of Jones Falls pollution and Inner Harbor fish kill
Fern Shen, Baltimore Brew, July 19, 2013
A milky white effluent was seen flowing yesterday from a pipe near the Union Avenue bridge. Earlier, the effluent was a sickly orange brown.



Dead fish washed up on Inner Harbor lower promenade near Maryland Science Center. (Adam Lindquist, Waterfront Partnership)

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MARYLAND
NORTHERN DIVISION

UNITED STATES OF AMERICA and STATE OF MARYLAND,
Plaintiffs,
v.
BALTIMORE COUNTY, MARYLAND,
Defendant.

Civil Action No.

CONSENT DECREE

Sewage leak pours 36,000 gallons of waste into West Baltimore stream
Colin Campbell, The Baltimore Sun, October 23, 2014