Science & Technical Advisory Committee
TEAMS Online Meeting
February 24, 2023 – Meeting Summary

In Attendance:
STAC Members: Jim Ammerman, Vincent Breslin, Chris Conroy, Carmela Cuomo, Sylvain De Guise, Kristin DeRosia-Banick, Dianne Greenfield, Jim Hagy, David Lipsky, Darcy Lonsdale, Kamazima Lwiza (New York Co-chair), Robin Miller, Jim O'Donnell, Bradley Peterson, Paul Stacey, Kelly Streich, Mark Tedesco, Jim Turek, Maria Tzortziou, Penny Vlahos (Connecticut Co-chair), Nils Volkenborn, Mike Whitney, Emily Wilson, Chester Zarnoch

CAC Liaisons to STAC: Sarah Crosby (The Maritime Aquarium)

Others: Mary Arnold (NYSDEC), Zosia Baumann (U Conn), Jordan Bishop (NEIWPCC), Robert Burg (LISS/NEIWPCC), Katherine Canfield (EPA), Finnian Cashel (EPA), Mel Cote (EPA), Greg Dietl (Cornell), Melissa Duvall (EPA), Syma Ebbin (CTSG), Richard Friesner (NEIWPCC), Lillit Genovesi (NYSG), Elizabeth Hornstein (NYSG), JeanAnn Johnston (NYSG), Shauna Kamath (NYSDEC), Ben Lawton (EPA/ORISE), Peter Linderoth (STS), Bill Lucey (STS), Cara Manning (UCONN), Catherine Matassa (UCONN), Katie McFarland (NOAA), Jon Morrison (USGS), Esther Nelson (EPA), Katie O'Brien-Clayton (CTDEEP), Meghana Parikh (NOAA), Jimena Beatriz Perez-Viscasillas (NYSG), Sara Powell (NYSG), Matthew Pruden (Cornell), Kaylan Randolph (UCONN), Luciana Santoferrara (Hofstra), Samara Scantlebury (NYSDEC), Sarah Schaefer-Brown (NYSG), Lane Smith (NYSG), Alexa Sterling (EPA), Cayla Sullivan (EPA), Elizabeth Suter (Molloy), Samantha Wilder (IEC), Gregory Wilkerson (NYCDEP), Kimarie Yap (IEC)

Presentations:
2023-25 LISS Research Competition Results and Potential Fellowship Options (De Guise, Shuford)

Introductions, Updates: Penny Vlahos, UCONN (STAC CT Co-Chair)
Penny started the meeting by announcing that this was the first STAC meeting where we will be hearing from new investigators.

Brief LISS Program Update: Mark Tedesco, EPA
Mark noted that the LISS base budget had increased from $30M to $40M for an annual total of $60M when the infrastructure funding is included. He does not expect such budget increases to continue but hopes for a period of stability. This additional funding has enabled the program to take more focused approaches to addressing critical issues such as eelgrass acreage, coastal resiliency, wetland restoration, and increased monitoring and modeling to prepare for future nutrient reductions. Mark invited anyone with a topic of interest to contact Jim Ammerman or himself and said that the program hoped to establish seamless connections among the STAC and science community with managers and science communicators. (Penny mentioned a notice in

the chat for the Long Island Natural History Conference on April 28th, https://seatuck.org/2023-li-natural-history-conference/).

Results of the LISS Research Competition: Sylvain De Guise, CTSG; Becky Shuford, NYSG
Sylvain reviewed the results of the 2023-2025 research competition based on the RFP released in 2022 by Connecticut and New York Sea Grants on behalf of the Long Island Sound Study. Twenty-five pre-proposals were submitted and 18 were recommended for full proposal submission based on the recommendations of a diverse panel for program relevance. Seventeen full proposals were received and reviewed by a review panel emphasizing merit and hypothesis-driven research. The nine top proposals were funded, ranging in cost from $39k to $909k with an average of $467k. Not all available funds were allocated as the panel did not think that additional proposals warranted funding, and unallocated funds will be carried over to future competitions. Sylvain briefly summarized the nine funded proposals and noted that four were from Connecticut, four from New York, and one from Massachusetts. In addition, five projects will focus on water quality, four on habitat, and one project on communities.

Discussion:
-Penny Vlahos asked about the left-over funds and Sylvain replied that the panel was firm that lower quality or non-hypothesis-testing proposals would not be funded and that there was no problem with the unspent funds being carried over to the next research competition, just some administrative adjustments.
-Carmela Cuomo asked about how many funds were unspent and if non-hypothesis-testing proposals were monitoring proposals. She also asked about the review panel and whether it included outside scientists. Sylvain replied that this was the largest amount of research funding available to date in this competition and over $1M remained unspent. He agreed that non-hypothesis-testing proposals were largely monitoring and said that the review panel included outside experts and avoided conflicts of interest.
-Mark Tedesco agreed that this was the largest amount of research funds available so far and since some remained unspent it would ensure significant continued available funding for the next round. He noted that this recent RFP had emphasized the connection between research and management more than in the past and the effort required to link researchers with managers provided an additional challenge to researchers in preparing their proposals.
-Kamazima Lwiza asked if the matching funds requirement could also influence the number of proposals received. Mark replied that match was always an issue and certainly could have an effect. He noted that the program subsidized the match for the research program by requiring only a 25% match, while the overall program had to show a 40% match, the difference is usually provided by an overmatch from the state agencies. Occasionally, however, availability of matching funds may determine what projects go forward.
-Mel Cote asked about when the next grant cycle would occur. Sylvain said that that LISS research RFPs alternated years with the Sea Grant research RFPs. Jim Ammerman noted that the next LISS research RFP would be released in just over a year.

-Carmela Cuomo asked if each individual award had to meet the match or just the overall program. Mark replied that fortunately the program just must meet the aggregate match so that is why the match requirement for the research program can be less than the required overall match. Sylvain added that the research grants had been getting larger and more complex over time but that the investigators were still able to find the matching funds for the projects that they wanted to pursue. Sylvain also thanked Syma Ebbin and Lane Smith, the CT, and NY Sea Grant Research Coordinators respectively, for the difficult tasks of finding reviewers and panelists to review the proposals and for providing summaries of useful reviewer and panel comments to both funded and non-funded investigators alike.

Long Island Sound Study Renaming Project: Rob Burg, LISS/NEIWPCC

Rob said that last October the Management Committee had requested that LISS study a potential name change as originally mentioned in the new communications strategy document. The concern was that the term "study" dates to the 1980s and is confusing and outdated. It also makes it a challenge for our outreach staff to explain who we are and promote our successes, though rebranding takes time and money. Our current name is an outlier from the names of the other National Estuary Programs, most of which are called "Programs" or "Partnerships". Rob had our web developer produce layouts for five different potential names and presented them as examples. He then ran an online poll for STAC members to express their preferences. Long Island Sound Estuary Partnership and Long Island Sound Estuary Program got the largest number of votes, though keeping the current name was also an option at the bottom of the list that not everyone may have seen. Rob will continue his informal surveys with other work groups as part of information gathering. Mark Tedesco also mentioned that he was working with others at EPA to make sure that changing the name did not interfere with the program's Congressional appropriation which includes the current name and that the timing of any name change should probably be coordinated with any other significant changes such as a new CCMP.

(Complete STAC poll results for 27 responses: Long Island Sound Estuary Partnership, 40%; Long Island Sound Estuary Program, 33%; Long Island Sound Partnership, 0%; Partnership for Long Island Sound, 14%; Long Island Sound Restoration Partnership, 7%; Long Island Sound Study, 3%.)

Discussion:

-Carmela Cuomo noted that "program" implies government as the main source of funding which accurately describes the current LISS, whereas "partnership" may imply more diverse sources of private funding, such as foundations and other sources. There was some discussion and probably general agreement, though others pointed out that significant matching funds and program implementation were provided by non-governmental partners.

-Kamazima Lwiza asked how the final decision would be made and Rob said that the top two choices in the poll were likely to be considered, as well as issues like the one raised above. Mark Tedesco added that other issues, like acronyms and similarities to other names would also be considered.

Hypoxia Forecast Tool & Workshop Update: Cayla Sullivan, EPA

Cayla started by introducing the workshop and tool development teams. She then reviewed the

hypoxia reduction ecosystem target. While the reduction in hypoxia is ahead of the goal, there is still chronic hypoxia in the western Sound and some embayments so there are additional steps that need to be taken. There are two purposes of the tool: 1. Hypoxia forecasting to predict seasonal extent, duration, and frequency, and 2. Communication and engagement to effectively communicate with stakeholders and increase their engagement with identifying and implementing actions to reduce hypoxia. She showed examples of news clips highlighting hypoxia and HAB predictions from other coastal and Great Lakes systems demonstrating their significance as communication tools. Cayla mentioned the wealth of water quality and hypoxia data that separates the Long Island Sound from other ecosystems with hypoxia prediction systems. In the Gulf of Mexico, for example, there is only one shelf-wide hypoxia survey each year. In Long Island Sound with frequent surveys, we can use an iterative process which incorporates new data to update and improve predictions. While the technical approach for the forecast tool is still under discussion, it will: 1. Describe climatology, 2. Quantify and extrapolate trends, 3. Quantify relationships with drivers, 4. Be empirical/statistical, no mechanistic, and 5. Use Open Science Methods as the team is currently learning in an Openscapes course.

Calya described the workshop as bringing together those at the interface of science and practice to identify the best ways to engage stakeholders with a forecasting website and to improve public awareness about hypoxia in Long Island Sound. It will be an in-person workshop from 9 AM to 3 PM on May 23rd at EPA Region 2 Headquarters at 290 Broadway in Manhattan. The workshop agenda will: 1. Provide an overview of the forecast tool, intended use, and website, 2. Have small group discussions on defining the audience and messages, 3. Give presentations on building awareness of other current effective Long Island Sound communication tools, and 4. Finish with more small group discussions about designing tools. You can help by suggesting forecast approaches, providing available datasets, or recommending other LIS hypoxia-related tools. Contact Cayla (sullivan.cayla@epa.gov) with ideas or for more information.

Discussion:

-Mike Whitney and Kamazima Lwiza both supported the idea of a remote option for the workshop. Cayla responded that the workshop was in person because of the small group discussions but they would explore what the meeting room was capable of in terms of remote connections. Jim Hagy added that there was clearly interest in how we plan to make this forecast which is information that we can provide to anyone at any time and is probably different than the information that we are hoping to gain at this workshop. He said that the project goal is not to recreate anything that is already available but to become aware of useful resources and link to them online if possible. Jim asked that the project be informed of such resources.

-Katie O'Brien-Clayton asked if the project would use Jim O'Donnell's hypoxic area and volume project application and Jim Ammerman replied that they would likely use anything useful they could find.

-Dave Lipsky asked if this project would focus on the open waters of the Sound or also include the embayments? Jim Hagy replied that it would be very interesting to predict hypoxia in the embayments as well as the open Sound and he is attracted to doing that. Dave also asked about objectives for the accuracy of the forecasts, complaining that summer hurricane forecasts were

rarely accurate. Jim Hagy said that it was important to estimate the accuracy of the forecast and use inaccuracies in the forecast to explain the state of the science. He said that it was easier to hindcast rather than forecast because more tools were available for hindcasting. Jim said the goal was to increase scientific literacy and create a conversation around the issues.
-Jim O'Donnell said that he was skeptical about whether this forecast would be useful or not and he does not have the expertise to contribute to the engagement aspects which are the focus of the workshop but could contribute to the development of the forecast itself. Jim Hagy said he would be very willing to discuss the forecast development separately with Jim O'Donnell.

New Faculty Presentation: Oyster Pathogen Monitoring Using Third Generation Sequencers: Elizabeth Suter, Molloy University
Elizabeth started by acknowledging her two undergraduate students who had done most of the "dirty work" and the lab work for their undergraduate theses on this project. She started with a quick background on the historical ecosystem benefits of oysters in LIS and throughout New York Harbor but also how depleted their current numbers are and the challenges of restoration efforts. She asked the question of why some oyster reefs succeed and others do not. Local effects like temperature and nutrient dynamics probably play roles, but microbiology may also be important. She noted that we are trying to restore oysters to environments which are microbiologically very different than the environments where they thrived two hundred years ago due to human impacts on the ecosystem.

Increasing research suggests that an organism's microbiome, or microbial makeup, is important to its homeostasis. A normal microbiome disrupted by a foreign pathogen, or an opportunistic pathogen stimulated by stress to the organism can cause what is known as dysbiosis. There is evidence for dysbiosis in west coast oysters when placed under stress. Liz described her project in collaboration with the Billion Oyster Project as focused on two sites in New York City with major human influence, Lemon Creek Lagoon on Staten Island, and Sunset Park in Brooklyn. The latter is next to a sewage outfall and the former showed elevated temperatures. She later added a collaboration with a Rutgers graduate student and expanded sampling to a site in the Bronx on western Long Island called Soundview. She used new 3rd generation DNA sequencing to examine the rRNA gene with provided taxonomic information to the species level. This method is simpler, cheaper, and produces a long sequence read right at the bench top so can be used to detect pathogens by a variety of restoration practitioners.

Liz's students spent significant time optimizing their DNA extraction protocol to make sure that it was gentle enough to allow long sequences to be read. They also optimized the PCR protocols to get consistent amplification results. She did the bioinformatics analysis with new open-source software available on GitHub and recorded the analysis in an online notebook. She then filtered the sequences based on size and quality, focusing on sequence reads of 4200 base pairs. Rarefaction analysis suggested that they were measuring the full diversity of the samples. The analysis also showed many bacterial species that you would expect to find in environmental samples and a wide range of species diversity among different oysters. Two species of marine animal pathogens each made up about a third of the bacterial species in a low-diversity oyster,

and other pathogens were also present. In comparison, a high-diversity oyster had a high diversity of beneficial probiotic bacteria, including *Lactobacillus* species, as well as other protective probiotic species and those involved in biogeochemical cycling. In summary, her lab built an efficient pipeline for DNA extraction, PCR amplification, and bioinformatic analysis for both pathogenic and beneficial bacteria in oysters, with all information documented online. Liz plans to analyze more oysters in the future and examine the threshold between diseased and healthy oysters as well as the pathogen abundance that becomes a population hazard. She concluded by acknowledging her collaborators and funders.

Discussion:
-There was a request to provide the link to the project or email it later and Liz said that she would email it later. (Link: https://lizsuter.github.io/projects/)
-A question was asked about any changes to oyster microbiomes in individuals chronically exposed to low oxygen levels. Liz replied that she was not aware of such studies but expected that there would be changes in the microbiomes just as there would be in anoxic sediments.
-Syma Ebbin asked if any of the oysters had Pea Crabs (which live within oysters) and if those oysters had different microbiomes. Liz replied that they had small samples of oysters with no Pea Crabs.
-Sylvain De Guise asked if Liz had examined the microbiome in oysters with known diseases like Dermo or MSX. She replied that she had not but based on the literature expected that the microbiomes of such oysters would be impacted.

New Faculty Presentation: Predators, Prey, and Changing Benthic Communities in Long Island Sound and Beyond: Catherine Matassa, UConn
Catherine's research focuses on predator-prey interactions and the ecology of fear as well as benthic community ecology including species interactions, community assembly, and climate change, the subject of this talk. She works in temperate intertidal and subtidal communities, largely in New England. Invertebrates, macroalgae, and salt marsh species are her focus. In this talk she will address changes in benthic communities over space and time using both experimental and observational approaches. One of her study areas is the rocky shores of the Gulf of Maine, where many species are found throughout the Gulf, but the community composition varies greatly with latitude, changing in relative composition and abundance. So why are the same species appearing in different abundances in different locations? She uses manipulative experiments to test how regional processes like larvae recruitment interact with local processes. The northern Gulf is dominated by seaweed and the southern Gulf by sessile invertebrates.

Catherine has measured barnacle recruitment throughout the Gulf of Maine since 2015 on experimental plots that are cleared every fall and photographed every spring after annual barnacle recruitment is complete. There is greater recruitment on exposed vs. protected sites and especially as you go further south. This variation helps to direct the differences in community assembly processes moving south. Barnacles are among the first organisms to settle on rocky shores and serve as facilitators for recruitment of other less tolerant species in the intertidal.

Barnacles are also important prey items for predatory crabs and gastropods. She has done experiments on how recruitment intensity impacts community succession including how consumers interact with recruitment to drive local processes. She manipulated recruitment to be high or low and then allowed or excluded consumers. Though consumers decreased barnacle density in the north and south parts of the Gulf, they increased barnacles in the central area by reducing competition. High barnacle recruitment facilitates recruitment of mussels and macroalgae but is dependent on barnacle recruitment intensity and the interaction with consumers. The overall goal of these experiments is to demonstrate how regional processes like connectivity and larval dispersal can impact events at a local scale.

Catherine has now adapted this approach to LIS which has a wide range of benthic habitat and species types whose changes are well documented over time. A notable example is the shift from mussel beds to slipper shells *(Crepidula fornicata)* in silty and sandy bottom environments, particularly in the eastern Sound. These habits are vastly different in their food webs and ecosystem functions, so such shifts are not trivial. She is investigating high-resolution synthetic aperture sonar (SAS) to see if she can distinguish between these two types of communities by developing simulated biotic targets of the two types and then using SAS to survey know habitat types in eastern LIS and using an ROV for ground truth. They were able to distinguish the two different community types with the SAS but found only mussel hash and no live mussels with the ROV, though beds of slipper shells (Crepidula) were readily apparent. They are currently studying the slipper shell beds and comparing diver surveys before and after shipboard SAS measurements to measure correlations. They are also comparing 2021 and 2022 mosaics to look for changes. Scuba surveys also showed juvenile mussels which had not reached adulthood, an important future question is what is happening to them post-recruitment. Catherine then concluded with acknowledgments.

Discussion:
-Cayla Sullivan asked if Catherine could share the link for the map of LIS seafloor sediment and Catherine said it should be available from the LIS mapping collaborative, but she would provide it. (Link: https://lismap.uconn.edu/background/)
-Carmela Cuomo asked if Catherine was familiar with the massive Crepidula beds which have appeared off Milford Point in the last 25 years and Catherine replied that she was collaborating with Peter Auster and Ivar Babb on the mapping project and was aware of the changes in the western Sound as well, including the large Crepidula beds. The are not unique to LIS but are appearing in the southern Gulf of Maine as well.
-Ben Lawton asked about the reasons for the transitions and Catherine replied that the feeding strategies of the two groups were quite different and there has also been a documented decline in blue mussels in the Gulf of Maine in the last two decades. Warming could be part of the reason and it may just be the opportunism of Crepidula or something more specific.

LISS Fellowship Options: Sylvain De Guise, Connecticut Sea Grant
Sylvain said that he was presenting a summary of LISS fellowship options in the last few months, in no special order. He briefly described six potential options as listed below:

1. Undergraduate summer fellowship—stipend for summer experience
2. Graduate research fellowship—requires project proposal and mentorship plan
3. Graduate summer research fellowship—summer support for ongoing project
4. Graduate policy fellowship—policy experience for current graduate students
5. Post-graduate policy fellowship—year of policy engagement for recent graduates
6. Graduate communications fellowship—graduate students engage in a year of communications activities

All these fellowships would require recruiting both mentors, such as STAC members, and students for these fellowships. These may or may not be of interest to the STAC, so Jim Ammerman will shortly conduct a poll to gauge opinions of the STAC members only (results below). The poll will provide only one choice, not a ranking. Sylvain pointed out that the fellowships would provide support to students for a specific learning experience with a project and mentorship plan and not a grant to faculty, which is much more difficult to administer. (Complete STAC poll results for 26 responses: 1. Undergraduate summer fellowship, 26%; 2. Graduate research fellowship, 19%; 3. Graduate summer research fellowship, 19%; 4. Graduate policy fellowship, 19%; 5. Post-graduate policy fellowship, 7%; 6. Graduate communications fellowship, 7%.)

Discussion:

-A student asked whether the fellowships could provide support to those students in the US on F1 or J1 visas? Sylvain replied that it would not be a problem for students in good standing in their institutions but if the fellow were hosted at a federal agency with restrictions, those restrictions must be honored.

-Kamazima Lwiza said that he liked all the options but also suggested an annual fellowship for one or two high school science teachers which would show students a potential career path. Sylvain said that such a fellowship was possible but also started a discussion about the accessibility of fellowships. For instance, would graduate fellowships limit accessibility because the faulty member would already be required to have a project? Penny Vlahos replied that summer research fellowships for graduate students or undergraduates would be particularly useful for students lacking summer support.

-Dianne Greenfield asked if students involved in any LIS research regardless of funding source be eligible for support and Sylvain replied yes, his thought was to broaden opportunities. There was also a suggestion to broaden potential mentors beyond academics.

-Penny suggested that summer fellowships would be easier to manage as they would be one cycle a year which could be closely monitored and have a mentorship plan and a final product, such as a poster session. Sylvain mentioned that they have experience running multiple fellowship programs and could construct this one however desired.

-Peter Linderoth supported the idea of a fellowship for high school teachers which could help students get the right background for a career path in environment science or related fields of

interest. Penny mentioned that such a fellowship would be a good opportunity for peer mentoring.
-Sylvain said that this was meant to initiate a conversation, not decide on specific plan. He suggested starting with one or two of these options and moving forward from there. Kamazima said that the undergraduate summer fellowship was probably the simplest, but also liked the policy fellowship as we have a deficit in that area. Jim Ammerman agreed, stating that the recent research proposals often did not make sufficient management connections.

Integrated Watershed Management-Balancing Natural and Human Infrastructure: Paul Stacey, Footprints in the Water
Paul addressed the larger goal of providing "An ecosystem-based management alternative for biointegrity and nutrients". He acknowledged a LISS Enhancement Project which brought in the expertise of UConn CLEAR. He noted that a lot has changed in the 50 years since the adoption of the Clean Water Act and almost 40 years since the creation of the LISS. It has been a long time since we revisited the basic questions that guide our management of LIS and even more challenging to apply our science to effective management to solve our major problems. The 2025 CCMP revision may be a good opportunity for more than an update but instead a refresh going beyond the focus on nitrogen and eutrophication and directed at the looming biodiversity crisis driven by land use and climate change. Today he will address the scientific and conceptual foundation behind the project's management application the Local Watershed Assessment Tool (LWAT) and discuss its application to the Norwalk River Watershed as an example.

Paul briefly reviewed several past reports, including the 1988 National Research Council report, chaired by the late E. O. Wilson, which warned of the coming biodiversity crisis. In 2021, the Intergovernmental Panels on Climate Change and Biodiversity concurred that treating climate change, biodiversity, and human society in a coupled Social-Ecological System (SES) context is key to successful management interventions and outcomes. While the Biodiversity Panel stated that "Nature can be conserved, restored and used sustainably while other global societal goals are simultaneously met", it is a difficult fit with the regulatory aspects of the Clean Water Act in a period of rapid change and shifting baselines. There is also the issue of different spatial scales, though working on local solutions should hopefully yield aggregate benefits at larger scales. He then referred to a recent book on ecosystem management which used the SES model to develop a balance between the social and ecological systems as well as a 2013 Government Accountability Office (GAO) report about how to make the Clean Water Act more effective. While the GAO made several important recommendations, Congressional action is unlikely.

Paul's objectives for an ecosystem approach are to use a single stressor indicator for assessment, planning, and decision support which also incorporates multiple external drivers and pressures, relates to a robust response indicator of ecosystem health, incorporates a range of functional outcomes, is widely applicable through an eco-regional domain, and provides a simple and salient

management platform. The 2016 EPA Practitioner's Guide to the Biological Condition Gradient is a good place to start, it goes beyond nutrients to include the five major factors which determine biological condition (water quality, flow regime, energy source, physical habitat structure, and biotic interaction). If the landscape is managed for the desired biological condition outcomes, the water quality should meet aquatic life and human use goals and cascade downstream to larger water bodies like Long Island Sound. If the watershed is healthy so is the water body.

The well-known Biological Condition Index (BCG) is a causal gradient with six levels of a Stress Exposure Index (Watershed Condition) plotted vs. six levels of a Response Index (Biological Condition), such as the Macroinvertebrate Multimetric Index (MMI). This study devised a new stress index, the Combined Condition Index (CCI), to better quantify collective watershed stress. The new NOAA landcover dataset with 1-meter resolution also became available in time for this study which brought the analysis to the community and neighborhood level, which is essential for environmental justice outcomes. This is a great improvement over the previous 30-meter resolution. HUC-12 basins provide only a very coarse resolution but with the new 1-meter resolution CLEAR identified over 4,000 basins with a median size of only 500 acres. The CCI model was deliberately limited to just three different land cover classes, natural (a large group of many near-natural land cover classes), impervious (developed areas), and ag & ag-like (agriculture and developed open space including lawns). Weighting factors based on the relative pressure on stream biointegrity were given to each land cover class, 7 for impervious, 1 for natural, and 2 for ag & ag-like.

The CCI was calculated from a combination of the Watershed Condition Index (WCI) and the Buffer Condition Index (BCI) using the weights listed above. (Buffers have minimum recommended widths for various functions.) The MMI was used was used as an integrative indicator of ecological health with values from 0.0-to 1.0, CT DEEP's ambient biological monitoring program provided MMI data from 160 samples from 145 low order streams to pair with the CCI. The CCI-MMI relationship was statistically robust, with an R^2 of 0.49. The CCI was benchmarked with the Connecticut Tiered Aquatic Life Use Support criteria and sorted into Tiers 1-6, with 1 having the highest CCI benchmark. The "Streams of Hope" concept can be used to guide management, with Tiers 1 and 2 is managed for conservation, Tiers 3 and 4 for recovery BMPs like improving buffers, and Tiers 5 and 6 for mitigation. Setting standards and targets within this condition gradient is a state responsibility including public processes.

How do nutrients fit into this picture? Total nitrogen (TN) correlates closely with CCI, with an R^2 close to 1. The CCI estimated TN load was comparable to USGS values and the SPARROW Model. The CCI target range in the middle tiers of 0.43-0.75 translates to a TN target range of 2-5 pounds/acre-year. The Local Watershed Assessment Tool (LWAT) is now available as an application which includes a story map overview, CCI dashboard and assessment interface, and a scenario builder. It provides an online tool to assess the health of local watersheds for

Biodiversity and TN. LWAT concurs with Connecticut's MMI predictive model with a median CCI value of 0.6. The Norwalk River Watershed was selected as an example for setting a eutrophication endpoint to improve Long Island Sound. The Norwalk River Watershed had a CCI of only 0.33 indicating a highly stressed system for biointegrity. However, the aggressive Best Attainable Condition (BAC) improvement scenario could raise it to 0.56. It would also lower the TN enrichment factor or total nitrogen yield from 6.4 to 3.4, but when the sewage treatment plant is included, the decrease would be only to 9.8 from 12.8, suggesting that further treatment plant and/or stormwater upgrades are necessary. The Norwalk River Total Nitrogen Load would also be significantly improved under the BAC scenario, but not if the sewage treatment plant is included. Nitrogen trading could be useful in the watershed, but sewage still dominates the overall nitrogen load. Paul listed the challenges to additional nutrient trading as a lack of regulatory drivers, no market support, and limited water quality capacity. However, under different regulatory and water quality conditions, the organizational capacity for expanded trading exists locally.

In summary, the LIS pre-TMDL nitrogen enrichment factor was 15 times the pre-colonial load and after spending $7B and meeting the TMDL, the enrichment factor is still 9, with a load of 37,000 tons of nitrogen per year. To greatly increase biointegrity and cure hypoxia, a further reduction of 20,000 tons would probably be required. Paul described a simple viable decision-support multitool for numerous applications and based on 1-meter resolution land cover data and the simplest explanations by Occam's razor. It is a nature-based application which is responsive to a changing world. He concluded that improving watershed health is the only way to meet biodiversity and pollution goals and targets for local basin and stream aquatic ecosystems. These management actions also contribute to health, welfare, and environmental justice outcomes of the local watershed human populations and these environmental benefits cascade down to larger waterbodies, ultimately including Long Island Sound.

Discussion:
-Penny Vlahos noted that Paul's presentation could easily lead to an hour discussion by the STAC and Paul replied that he thought a workshop was necessary in conjunction with the upcoming CCMP revisions.
-Kamazima Lwiza said that the presentation was great with a tremendous amount of information. He said that further discussion was needed but also had concerns with some of the assumptions. He wondered about the basis for the CCI weightings and said that the correlation between CCI and MMI does not necessarily imply causation, therefore a deeper analysis is called for. Paul responded that the CCI was an independent variable which measured external pressures and the MMI was the dependent variable. The weighting could be debated but is clearly very important.

Critical Assessment of Baseline Disease Dynamics of Natural Oyster Beds in LIS: Katie McFarland and Meghana Parikh, NOAA Fisheries

Katie started by explaining that the purpose of the project was to establish foundational knowledge to inform oyster restoration and aquaculture disease management and that the project was just beginning. Shellfish are important to LIS and provide 300 jobs and $30 M in commercial harvest to Connecticut alone. Natural, restored, and aquaculture shellfish provide ecosystems services including water filtration, nutrient mitigation, habitat provision, shoreline stabilization, and both shellfish and other fisheries production. Increased shellfish harvest is an ecosystem target of the 2015 LISS CCMP under the theme of Thriving Habitats and Abundant Wildlife. CT Sea Grant has recently released a Shellfish Restoration Guide and the Billion Oyster Project and other programs are all trying to increase shellfish populations. However, we have little information about how increases might influence oyster diseases and do not want to threaten the already thriving oyster industry in LIS.

Meghana continued that there are three oyster diseases in this region that this study is focused on, Dermo, MSX, and SSO. Dermo is caused by *Perkinsus marinus,* is endemic to the East Coast, transmitted from oyster to oyster, and is a slow-killing disease with mortality about two years after infection. Management strategies involve delaying exposure and harvesting prior to morbidity/mortality. MSX *(Haplosporidium nelson)* caused major mortality in 1997, and transmission is poorly understood, but it often kills oysters within a year of infection. Management strategies are like those for Dermo, such as delaying exposure by moving to lower salinity or colder water. SSO *(Haplosporidium costale)* is like MSX, though mortality is earlier in the season, but management strategies are similar. SSO mortality is not yet apparent in LIS, though it is a problem in the Chesapeake and could become one in LIS with increasing temperatures.

There is data on the incidence of Dermo and MSX in LIS dating back to 1997, mostly from aquacultured oysters. Both show a significant recent increase in the 2019-2020 whose cause is unclear, and which has continued since. We understand a lot about disease progression and management in farmed oyster populations but not in unmanaged populations or restored reefs. Disease transmission between restored and aquacultured populations is also poorly understood. There is a need for risk-based guidance to understand and mitigate disease in restored oyster populations.

Katie followed with the project objectives, the first is to establish a baseline of disease prevalence and intensity natural thriving unmanaged oyster populations. They will also implement new molecular techniques including validating the new triplex qPCR method for rapid disease detection. The second object is to describe major environmental and biological characteristics associated with various disease burdens. These include typical water quality parameters as well as oyster biometrics such as bed density, mean size, reproductive fitness, and juvenile recruitment. Site selection is still in process, but Fairfield (Ash Creek) and Clinton have been tentatively identified in Connecticut. The site criteria include dense oyster populations with no

fishing pressure, potential sites in New York are still being evaluated. Oyster bed characteristics to be determined include the structure, oyster size, and distribution.

Meghana said that they planned to collect up to 30 oysters per month at each location and showed a photo of the characteristics of the oysters to be examined. They want to make sure not to disrupt the populations with their sampling. She showed a diagram of the qPCR process that they will use for disease testing. It has already been deployed by others and should greatly lessen the time required compared to the conventional method and be more sensitive. However, they will also use the classic culturing and histology techniques to compare with the molecular methods. Some of the recent increase in Dermo and MSX mentioned earlier may be due to the switch to molecular methods so comparison with the earlier methods remains important.

Oyster biometrics include general condition, with photos of fat, medium and watery oyster specimens shown. Reproductive fitness will be monitored by seasonal progress of gonad maturation. Histopathology will allow gonad staging and should provide information on the timeframe of spawning, which may be changing with increases in temperature. Katie added that they will be examining juvenile recruitment at each of their sites by deploying spat collectors. Areas with high natural recruitment will be good targets for restoring substrate. The growth of juvenile oysters will also be monitored and compared with water quality parameters. They will monitor temperature, a major determinant of disease, all year long, and other water quality parameters in all seasons except winter due to potential ice scouring. Oyster bed characteristics will be determined in the spring of 2023 and 2024, the collection of oysters for disease and reproductive fitness will occur in the spring through fall, and juvenile recruitment and growth will be measured in the summer and fall. Lab studies will be continuous once sampling has started.

Project outputs include: 1. Quantitative understanding of seasonal dynamics of disease, body condition, and reproduction. 2. Identification of key water quality and reef characteristics that relate to the population disease burden. 3. Establishment of a method for assessment of disease burden in future restoration projects, and 4. Agreements with agencies to incorporate disease prevalence information into future restoration planning. The goal is to inform restoration practices to preserve natural seed beds and protect the aquaculture industry in LIS. They concluded by thanking Milford colleagues and other collaborators.

Discussion:

-Paul Stacey complemented the study design and asked if the Ash Creek site was due to its urban location. Meghana replied it was largely logistics, it is an easily accessible site with a robust oyster population and local support for the project.

-Jim Ammerman commented that their potential eastern Long Island site was Centerport Harbor, right near his house.

-Kamazima Lwiza expressed concern about the use of HOBO loggers for temperature, wondering if +/- 0.2 degrees was sufficient accuracy. Katie replied that the HOBOs were backups to sondes with better accuracy but might be the only option in a cold winter with ice. She said they were open to suggestions for other inexpensive instruments and Kamazima suggested more frequent calibration with a Sea-Bird or other better sensors. Katie O'Brien-Clayton said that CT DEEP river monitoring was transitioning from HOBOs to something better, but she did not know the name and would provide the information later.
-Penny Vlahos thanked all the speakers for presenting and staying on time in this packed meeting agenda, and for good discussions. Kamazima seconded her.