MICHAEL A. PASCUCILLA

A PH.D. THESIS, RESEARCH TO PRACTICAL PUBLIC HEALTH POLICY

CLIMATE IMPACTS, WATER QUALITY AND CITIZEN SCIENCE IN COASTAL SOUTHERN CONNECTICUT: A REVIEW OF FACTORS SUPPORTING PRACTICAL PUBLIC HEALTH ENGAGEMENT

OVERVIEW - CITIZEN SCIENCE & CLIMATE CHANGE IN SOUTHERN CONNECTICUT

East Shore District Health Department (ESDHD) initiated a series of Climate Change Awareness Research Projects.

Projects have evolved to include citizen science “hands-on community engagement”.

- *Local* neighborhood residents & businesses actively participate and donated funding.
- Research Projects include –

    - Worlds First Solar-Electric Pump-out Boat
    - DNA Microbial Source Tracking Water Sampling & Community Clam Digs
    - Preemptive Beach Closure Policy
    - Photojournalism Climate Change Initiative

Empower our communities through informed decision making with the underlining themes:

- **Trust**
- **Transparency**
- **Innovation**
- **Sincerity (Human Component)**

PROJECTS EVOLVED INTO PH.D. RESEARCH THESIS

- The genesis of the Climate Change Awareness Projects became apparent when we identified that climate change was not well understood in the community.
- There was a lack of a sense of urgency around climate change.
- ESDHD recognized the need to increase the conversation around this critical topic with an emphasis on ***Community Engagement.***

MERGED CLIMATE CHANGE & CITIZEN SCIENCE

The withering tree has potential to be revived – Heather Soroko

"For there is no Rank in Natural Knowledge of equal Dignity and Importance with that of being a good Parent, a good Child, a good Husband, or Wife, a good Neighbour or Friend, a good Subject or Citizen." - Benjamin Franklin, 1760

CITIZEN SCIENCE - PUBLIC HEALTH EVOLUTION…

- Citizen science (CS) refers to the participation of the public in engaging and contributing to the sharing and acquisition of information.
- History - Dates back to Aristotle, 1,200 in Japan, 1600's in the U.S. Benjamin Franklin, 17th century in the U.K.
- CS is done in collaboration with scientists and researchers who offer guidance and leadership, along with coordination of a project (National Geographic, 2021).
- European Citizen Science Association, under the direction by the Natural History Museum London developed the 10 Principles of Citizen Science, an easily understood, universal standard was formed and provided in 26 languages (Robinson et at. 2018).
- The Ten Principles of Citizen Science also inspired and shape the U.S. agenda on citizen science (Robinson et al. 2018).

RESEARCH SUMMARY

Title:

- Climate impacts, water quality and citizen science in coastal southern Connecticut: A review of factors supporting practical public health engagement

Author's Intended Research Purpose:

- Conduct a qualitative ten-year data review of six research outputs to explore the relationship between climate change and citizen science of the research outputs with a focus on how to implement successful public health practical policy. To include/acknowledge the ongoing research studies as discussed.

Thesis:

- Explored best strategies for community understanding and participation, investigate the association linkages between stakeholder participation and education, and examine the relationship between local public engagement and successful public health academic research in a timely manner.

- **Critical aims/goal appraisal:**
  - Developed a systematic executive framework that pulls together the citizen science literature from each study/patent output, with a comprehensive review clearly identifying the research limitations, gaps, and complications as well as the opportunities for successful, practical-based public health policy implementation.

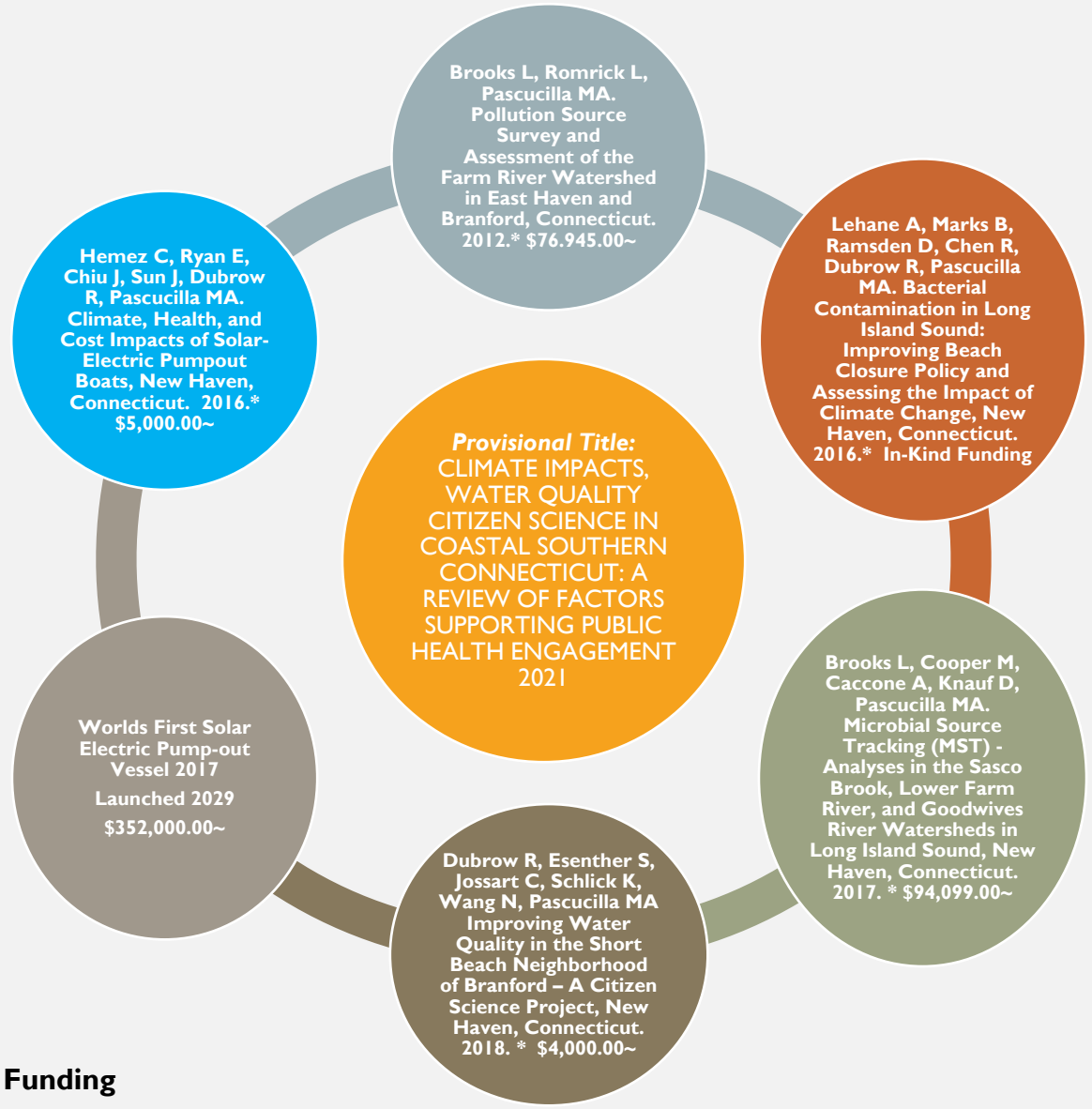
Research Objectives:

- How can governmental agencies earn local community trust towards improved public health policies leading to a better quality of life outcomes through citizen science?
- What approaches can governance take to harness and mobilize the energy of scientific "boots on the ground" localism to improve specific environments and climate change concerns, while promoting public health initiatives and local research?
- Does innovation and creativity in public health solutions inspire and engage local communities for support?

- Can the human component of sincere communication form part of essential strategies in successful public health policies?

PH.D. PROPOSAL - COHESIVE BODY OF RESEARCH THAT INTERGRATES CLIMATE CHANGE WITH CITIZEN SCIENCE

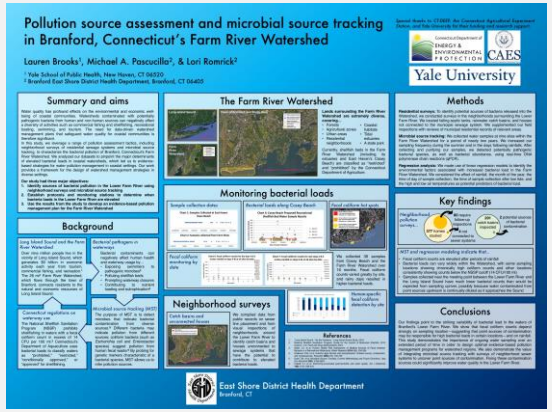
6 RESEARCH OUTPUTS OVER THE PAST 10+ YEARS



***Last/Corresponding Author & Public/In-kind Funding**

RESEARCH PROJECT STARTED IN 2010 & COMPLETED IN 2012

THIS STUDY SERVES AS THE FOUNDATIONAL PH.D. RESEARCH



Provisional Title:
CLIMATE IMPACTS, WATER QUALITY CITIZEN SCIENCE IN COASTAL SOUTHERN CONNECTICUT: A REVIEW OF FACTORS SUPPORTING PUBLIC HEALTH ENGAGEMENT 2021

Brooks L, Romrick L, Pascucilla MA. Pollution Source Survey and Assessment of the Farm River Watershed in East Haven and Branford, Connecticut. 2012.* $76.945.00~

- **Collaboration with Yale University on an DNA Microbial Source Tracking (MST)**
- **At the time, DNA MST was Non-Approval EPA Methodology**
- **Project was grant funded by State**
- **Presented in State & Local Venues**
- **Research Project & Local Clam Dig**
- **State of Connecticut Public Domain - Farm Viability Database**

***Last/Corresponding Author & Public/In-kind Funding**

RESEARCH PROJECT STARTED IN 2016

JOURNAL OF ENVIRONMENTAL HEALTH - FINAL PEER REVIEW

Bacterial Contamination in Long Island Sound:
Improving Beach Closure Policy and Assessing the Impact of Climate Change

Authors: Daryn Ramsden[1], Sarah Esenther[1,2], Brandon Marks[3], Aine Lehane[3], Rona Chen[1], Robert Dubrow[4], Michael Pascucilla[1,5*]

Summary

Currently, a beach is closed if enterococci levels are found to be above 104 colony forming units (CFU)/ 100 mL of marine bathing water during once weekly sampling. One major issue with the current protocol involves the time it takes for the water sample to reach the lab, for the assay to be set up, and the 24 hours it takes to run the test. This results in a greater than 24-hour lag time between a positive contamination result and closure of the beach; thus, the beach remains open to bathers to continue to swim in unsafe watersit takes for the water sample to reach the lab, for the assay to be set up, and the 24 hours it takes to run the test.

Aim 1: Based on retrospective data, to examine the relationship between weather-related and other variables and level of bacterial contamination in Long Island Sound bathing water.
Aim 2: To perform a critical review of saltwater beach closing policies in Connecticut and nationally, examining pros and cons of various policy options and making a policy recommendation for Connecticut beaches.

Background

Enterococci are bacteria within the genus Enterococcus. Enterococci are popularly used globally as fecal indicator bacteria (FIB) to assess water quality and determine if a water source is contaminated with feces.

There are many sources from which enterococci can enter a body of water;the most common include: animal agriculture runoff, wildlife, sediments, wastewater treatment plants, sand and beach sediments, central sewer failures, runoff from parking lots and recreational parks, septic systems, agricultural soils, and runoff from stormwater systems and streams (Byappanahalli et al., 2012).

1.Literature Review :We preformed a search for relevant journal articles and an Excel spreadsheet was then created to organize and list the identified journals and reports
2Key Informants Interviews:We spoke to representatives from 15 local health department over the phone from the end of March 2017 until the beginning of May 201
3.Qualitative and Quantitative Analysis;We created a summary table and summary graph of three components of beach closure policy that importantly had some flexibility. For quantitative, we conducted statistical analysis of bacteria samples and weather

rainfall and bacterial contamination at the public beaches of the East Shore, Guilford, and Madison Health Department
4.Data Collection: Data were collected from several sources: East Shore District Health Department (ESDHD), which covers the towns of Branford and East Haven, Guilford Health Department, Madison Health Department, CTDPH, and the National Oceanic and Atmospheric Administration (NOAA).
5Model formulation:Model formulation was carried out using both linear and logistic regression.
6Cut Point Selection: We built tables containing sensitivity and specificity values for each of the potential cut points. We included only the highest sample value at a given beach on a given day.

Suggestion as

Local Health Departments Included in This Study:
1. Implement preemptive beach closure
2.Consider issuing preemptive advisories
3.Testing: regular sampling
4.Revisionism of sampling procedures

State-level:
1.Facilitate future research
2.Investigate new methods for testing

Results and Conclusion

useful policy for health departments to pursue.The most important information we received from the key informant interviews was regarding the preemptive closure policies. Six of the 15 health departments interviewed had their own local beach closure policies based on rainfall. The rainfall threshold for closure differed across the six health departments. Preemptive closure can fill these public health gaps left by current procedure. Our investigation has found a positive relationship between rainfall and bacterial contamination at our sites of interest. As such, it is reasonable to expect that increases in extreme rainfall events due to climate change will be accompanied by more frequent and intense contamination events and elevated public health hazard. It was found through this data that regular sampling is still needed to detect contamination events due to unknown causes as well as to track the quality of the beach over time. Through the methods used for creating a cut point for each location it was realized that as the cut point increases, fewer contamination events are captured, as are fewer false positive.

Based on this we suggest that:

1. For Branford, we recommend a cut point of 2.4 inches
2. For East Haven, we recommend a cut point of 1.5 inches
3. For Guilford, we recommend a cut point 1.4 inches
4. For Madison, there is no cut point

References:

Byappanahalli, Muruleedhara N., et al. "Enterococci in the environment." Microbiology and Molecular Biology Rev 76 (2012): 685-706.

Crowther J., Kay D., Wyer M.D., Relationships between microbial water quality and environmental conditions in coastal recreational waters: the Fylde Coast, UK. Water Res 35 (2001): 4029-4038.

Environmental Protection Agency. (2011, November 28). Ambient Water Quality Criteria for Bacteria.

Retrieved March 8, 2017, from http://water.epa.gov/scitech/swguidance/standards/uses/bacteria/upload/module_bacteriacriteria.pdf.

Environmental Protection Agency. (2012). 2012 Recreational Water Quality Criteria. Retrieved March 8, 2017, from https://www.epa.gov/sites/production/files/2015-10/documents/rec-factsheet-2012.pdf.

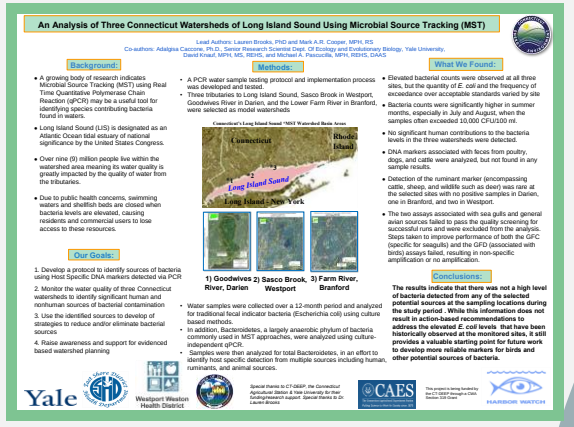
Yale University

- **Presented at 4+ Professional Venues (Additional State/local)**
- **State supported this research-based report as a model for other LHD's**
- **Local beach closure policies were implemented**
- **Example of Practical Public Health Research**

***Last/Corresponding Author & Public/In-kind Funding**

RESEARCH PROJECT STARTED IN 2017

JOURNAL OF ENVIRONMENTAL HEALTH - FINAL PEER REVIEW



An Analysis of Three Connecticut Watersheds of Long Island Sound Using Microbial Source Tracking (MST)

Lead Authors: Lauren Brooks, PhD and Mark A.R. Cooper, MPH, RS
Co-authors: Adalgisa Caccone, Ph.D., Senior Research Scientist Dept. Of Ecology and Evolutionary Biology, Yale University,
David Knauf, MPH, MS, REHS, and Michael A. Pascucilla, MPH, REHS, DAAS

Background:

- A growing body of research indicates Microbial Source Tracking (MST) using Real Time Quantitative Polymerase Chain Reaction (qPCR) may be a useful tool for identifying species contributing bacteria found in waters.
- Long Island Sound (LIS) is designated as an Atlantic Ocean tidal estuary of national significance by the United States Congress.
- Over nine (9) million people live within the watershed area meaning its water quality is greatly impacted by the quality of water from the tributaries.
- Due to public health concerns, swimming waters and shellfish beds are closed when bacteria levels are elevated, causing residents and commercial users to lose access to these resources.

Our Goals:

1. Develop a protocol to identify sources of bacteria using Host Specific DNA markers detected via PCR
2. Monitor the water quality of three Connecticut watersheds to identify significant human and nonhuman sources of bacterial contamination
3. Use the identified sources to develop of strategies to reduce and/or eliminate bacterial sources
4. Raise awareness and support for evidenced based watershed planning

Methods:

- A PCR water sample testing protocol and implementation process was developed and tested.
- Three tributaries to Long Island Sound, Sasco Brook in Westport, Goodwives River in Darien, and the Lower Farm River in Branford, were selected as model watersheds

Connecticut's Long Island Sound "MST Watershed Basin Areas

1) Goodwives River, Darien 2) Sasco Brook, Westport 3) Farm River, Branford

- Water samples were collected over a 12-month period and analyzed for traditional fecal indicator bacteria (Escherichia coli) using culture based methods.
- In addition, Bacteroidetes, a largely anaerobic phylum of bacteria commonly used in MST approaches, were analyzed using culture-independent qPCR.
- Samples were then analyzed for total Bacteroidetes, in an effort to identify host specific detection from multiple sources including human, ruminants, and animal sources.

What We Found:

- Elevated bacterial counts were observed at all three sites, but the quantity of *E. coli* and the frequency of exceedance over acceptable standards varied by site
- Bacteria counts were significantly higher in summer months, especially in July and August, when the samples often exceeded 10,000 CFU/100 ml.
- No significant human contributions to the bacteria levels in the three watersheds were detected.
- DNA markers associated with feces from poultry, dogs, and cattle were analyzed, but not found in any sample results.
- Detection of the ruminant marker (encompassing cattle, sheep, and wildlife such as deer) was rare at the selected sites with no positive samples in Darien, one in Branford, and two in Westport.
- The two assays associated with sea gulls and general avian sources failed to pass the quality screening for successful runs and were excluded from the analysis. Steps taken to improve performance of both the GFC (specific for seagulls) and the GFD (associated with birds) assays failed, resulting in non-specific amplification or no amplification.

Conclusions:

The results indicate that there was not a high level of bacteria detected from any of the selected potential sources at the sampling locations during the study period . While this information does not result in action-based recommendations to address the elevated *E. coli* levels that have been historically observed at the monitored sites, it still provides a valuable starting point for future work to develop more reliable markers for birds and other potential sources of bacteria.

Special thanks to CT-DEEP, the Connecticut Agricultural Station & Yale University for their funding/research support. Special thanks to Dr. Lauren Brooks

This project is being funded by the CT-DEEP through a CWA Section 319 Grant

Yale | Westport Weston Health District | CAES | HARBOR WATCH

Provisional Title: CLIMATE IMPACTS, WATER QUALITY CITIZEN SCIENCE IN COASTAL SOUTHERN CONNECTICUT: A REVIEW OF FACTORS SUPPORTING PUBLIC HEALTH ENGAGEMENT 2021

Brooks L, Cooper M, Caccone A, Knauf D, Pascucilla MA. Microbial Source Tracking (MST) - Analyses in the Sasco Brook, Lower Farm River, and Goodwives River Watersheds in Long Island Sound, New Haven, Connecticut. 2017. * $94,099.00~

- **Presented at 8+ Professional Venues (Additional State/local)**
- **This Research was a multi-collaboration between Government, Academia and Private Industry – Grant Funded**
- **Intent of study is to get States/US EPA to fund/provide DNA sampling as a Public Health Tool – Root Cause Solution**
- **To protect recreational Bathing Waters**
- **Expand sea farming in Long Island Sound – New York & CT**

***Last/Corresponding Author & Public/In-kind Funding**

PROJECT STARTED IN SPRING 2017

AMERICAN JOURNAL OF PUBLIC HEALTH – ACCEPTED MAY 2022

Yale
Improving Water Quality in the Short Beach Neighborhood of Branford, Connecticut – A Citizen Science Project
Sarah Esenther, Katie Schlick, Christopher Jossart, Ningjing Wang, Robert Dubrow, Michael Pascucilla
Sarah Esenther, Krystal Pollitt, Brian Leaderer
Introduction
Long Island Sound (LIS) has suffered elevated levels of fecal bacteria for decades and contamination from short-duration flow stormwater outfalls is a recognized contributor (Fig 1). In the coastal Short Beach neighborhood of Branford, Connecticut, the popular recreational beach has experienced high frequencies of elevated E. coli bacteria levels compared to nearby waters.
Fig 1. A Short Beach outfall discharging to LIS following a rain event
To better understand the influence of compromised stormwaters on local water quality in LIS, a team of four students under the guidance of an Yale School of Public Health Professor and the East Shore District Health Department 1) mapped local sewage disposal systems to assess possible sources of contamination and 2) utilized local resident capability and expertise by implementing a Citizen Science water sampling program.
Methods
Sewage Disposal Records
A 2017 Yale report identified leaking holding and septic tanks as a likely source of water contamination, a potential pathway for fecal bacteria to reach outfall flows. Due to neighborhood age, the type of sewage system used by 383 coastal properties was unknown. To assess these properties the student team reviewed records of permits, construction documents, sewage hookup requests, and ownership transferals maintained by Branford's Engineering Department. The sewage disposal method of properties without records was determined with a questionnaire asking residents their sewage disposal method and year of connection.
Citizen Science Water Sampling
The eight stormwater outfalls that flow directly into LIS were sampled by a team of eight Citizen Science volunteers assembled from Civic Association of Short Beach members and their contacts. The volunteers were trained and supplied a written protocol for sample collection, labeling, and delivery of water samples to the state public health laboratory, then tasked with collecting samples from any flowing outfalls after every rain event.
Fig 2. A map of Short Beach showing the eight sampled outfalls and sewage disposal methods determined from the records review and questionnaire
Results
Sewage Disposal Records
Of the 383 properties with unknown sewage system type, 325 were connected to public sewage (84.9%), 11 had septic tanks (2.9%), 2 had holding tanks (0.5%), and 45 (11.7%) were unknown (Fig 2). Thus, the study identified several aging coastal properties that lack public sewage access, posing possibly elevated risk of water contamination from failing septic systems or holding tanks. Most houses along public sewer lines are attached to the public sewer system with gasketed PVC and are considered unlikely to be dilapidated enough for substantial sewage leakage.
Citizen Science Water Sampling
Table 1. E. coli results from the eight outfalls, sampled on six dates (n/a indicates nonflow).
The volunteers and students collected a total of 24 E. coli water samples from outfalls on six different dates. The E. coli levels ranged from 270 to 24,196 MPN/100mL (mean = 4,930 MPN/100mL, standard deviation = 5,147 MPN/100mL) (Table 1). The Citizen Scientists also recommended policies for improving local water quality based on their experiences in the neighborhood, such as observing dog walkers discard dog feces into stormwater outfall grates, which the health department subsequently investigated.
Outcomes
Citizen Science Water Sampling
While neither the U.S. Environmental Protection Agency nor the Connecticut Department of Public Health (CT DPH) provide threshold guidelines for E. coli levels from stormwater outfalls, all samples exceeded the CT DPH's 235 MPN/100mL E. coli threshold for recreational waters. This suggests the outfalls could be a critical pathway for transfer of fecal matter and associated pathogens to recreational bathing waters.
Citizen Science Partnership: Lessons Learned
Lessons learned while working with Citizen Scientists during this project will facilitate future intervention design. Communication is essential with all volunteers: to maintain open communication and trust, volunteers need to feel the value of their contributions is recognized. To that end, the Citizen Scientists were honored at a local awards event. Engagement of dedicated community members from the outset of research design, establishment of all parties' expectations and a conflict-of-interest policy, and willingness of the health department to adapt in light of community knowledge and concerns are crucial to the vitality and sustainability of a relationship with the community.
Fig 3. One of students (left) meets with five of the Citizen Scientists from the Short Beach water sampling program
As some outfalls only flowed for 15 minutes following a rain event, many samples would have been unattainable without Citizen Scientists. Residents also expressed concerns at Civic Association meetings, including whether they may be forced into costly public sewer connections if failing septic systems were found at fault and lack of public access to past reports and data. The health department is committed to ongoing discussion, data sharing through its website, and sensitivity regarding its regulatory power to force public sewer connections, preferring to work alongside the community to achieve a mutually beneficial and mutually understood outcome.
Future Directions
• Citizen Scientists can increase data capture in water sampling, as well as in other public health programs relying on highly time-sensitive collections.
• While the Citizen Science campaign ended due to the Covid-19 pandemic, the intervention has the potential to be sustainable and discussion of reinstatement is ongoing.
Funding/ acknowledgements
This work was funded by the East Shore District Health Department and Yale University. We would like to thank the Civic Association of Short Beach, Toxicologist Dr. Stewart Chute, and staff of the Connecticut Department of Public Health's Recreation Program for their timely and conscientious analytical support, with special thanks to Environmental Microbiology Supervisor Kim Holmes-Talbot.

Provisional Title:
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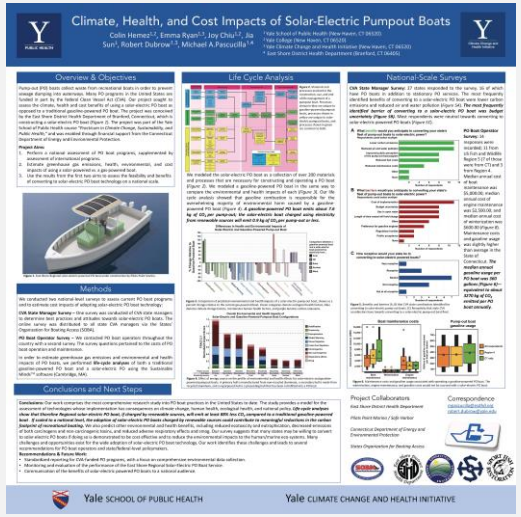
Dubrow R, Esenther S, Jossart C, Schlick K, Wang N, Pascucilla MA Improving Water Quality in the Short Beach Neighborhood of Branford – A Citizen Science Project, New Haven, Connecticut. March 2017. * $4,000.00~

- **Presented at 6+ Professional Venues (Additional State/local)**
- **Partnership - State Health & Yale University**
- **Grant Funded – Limited, with lots of in-kind support**
- **Citizen Science Community Research**
- **Research Led Practical Public Health Intervention – Expanded Public Sewers**
- **Study will continue this summer**

***Last/Corresponding Author & Public/In-kind Funding**

PROJECT STARTED IN 2016

PUBLISHED IN 2020 – JOURNAL OF WATER PRACTICE AND TECHNOLOGY



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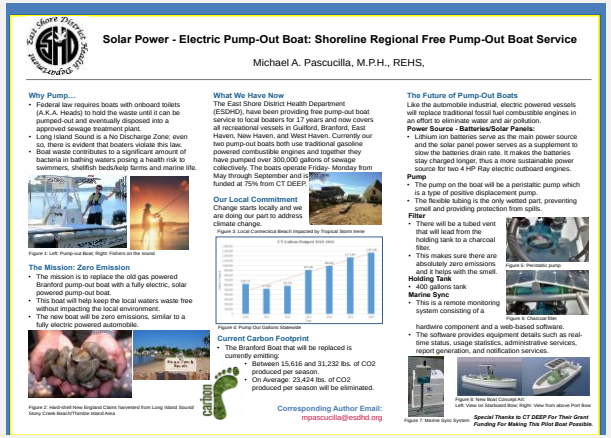
CLIMATE IMPACTS, WATER QUALITY CITIZEN SCIENCE IN COASTAL SOUTHERN CONNECTICUT: A REVIEW OF FACTORS SUPPORTING PUBLIC HEALTH ENGAGEMENT 2021

Hemez C, Ryan E, Chiu J, Sun J, Dubrow R, Pascucilla MA. Climate, Health, and Cost Impacts of Solar-Electric Pumpout Boats, New Haven, Connecticut. 2016.*
$5,000.00~

- **Presented at 15+ Professional Venues**
- **Goal - Promote this technology in recreational and working commercial vessels**
- **Included an environmental life cycle analysis**
- **First national survey of pump-out vessel programs**
- **Showcased the world' first solar electric operational pump-out vessel.**

***Last/Corresponding/ Author & Public/In-kind Funding**

PROJECT STARTED IN 2016
GRANT FUNDED – 302K / 50K LEVERAGED PARTNERSHIPS
THE WORLD'S FIRST FULL SIZE SOLAR ELECTRIC OPERATIONAL PUMP-OUT VESSEL



Solar Power - Electric Pump-Out Boat: Shoreline Regional Free Pump-Out Boat Service

Michael A. Pascucilla, M.P.H., REHS,

Why Pump…
- Federal law requires boats with onboard toilets (A.K.A. Heads) to hold the waste until it can be pumped-out and eventually disposed into a approved sewage treatment plant.
- Long Island Sound is a No Discharge Zone; even so, there is evident that boaters violate this law.
- Boat waste contributes to a significant amount of bacteria in bathing waters posing a health risk to swimmers, shellfish beds/kelp farms and marine life.

Figure 1: Left: Pump-out Boat; Right: Fishers on the sound

The Mission: Zero Emission
- The mission is to replace the old gas powered Branford pump-out boat with a fully electric, solar powered pump-out boat.
- This boat will help keep the local waters waste free without impacting the local environment.
- The new boat will be zero emissions, similar to a fully electric powered automobile.

Figure 2: Hand-shell New England Clams harvested from Long Island Sound/ Stony Creek Beach/Thimble Island Area

What We Have Now
The East Shore District Health Department (ESDHD), have been providing free pump-out boat service to local boaters for 17 years and now covers all recreational vessels in Guilford, Branford, East Haven, New Haven, and West Haven. Currently our two pump-out boats both use traditional gasoline powered combustible engines and together they have pumped over 300,000 gallons of sewage collectively. The boats operate Friday- Monday from May through September and is funded at 75% from CT DEEP.

Our Local Commitment
Change starts locally and we are doing our part to address climate change.

Figure 3: Local Connecticut Beach Impacted by Tropical Storm Irene

Figure 4: Pump-Out Gallons Statewide

Current Carbon Footprint
- The Branford Boat that will be replaced is currently emitting:
  - Between 15,616 and 31,232 lbs. of CO2 produced per season.
  - On Average: 23,424 lbs. of CO2 produced per season will be eliminated.

Corresponding Author Email:
mpascucilla@esdhd.org

The Future of Pump-Out Boats
Like the automobile industrial, electric powered vessels will replace traditional fossil fuel combustible engines in an effort to eliminate water and air pollution.

Power Source - Batteries/Solar Panels:
- Lithium ion batteries serve as the main power source and the solar panel power serves as a supplement to slow the batteries drain rate. It makes the batteries stay charged longer, thus a more sustainable power source for two 4 HP Ray electric outboard engines.

Pump
- The pump on the boat will be a peristaltic pump which is a type of positive displacement pump.
- The flexible tubing is the only wetted part, preventing smell and providing protection from spills.

Filter
- There will be a tubed vent that will lead from the holding tank to a charcoal filter.
- This makes sure there are absolutely zero emissions and it helps with the smell.

Holding Tank
- 400 gallons tank

Marine Sync
- This is a remote monitoring system consisting of a hardwire component and a web-based software.
- The software provides equipment details such as real-time status, usage statistics, administrative services, report generation, and notification services.

Figure 5: Peristaltic pump

Figure 6: Charcoal filter

Figure 7: Marine Sync System

Figure 8: New Boat Concept Art
Left: View on Starboard Bow; Right: View from above Port Bow

Special Thanks to CT DEEP For Their Grant Funding For Making This Pilot Boat Possible.

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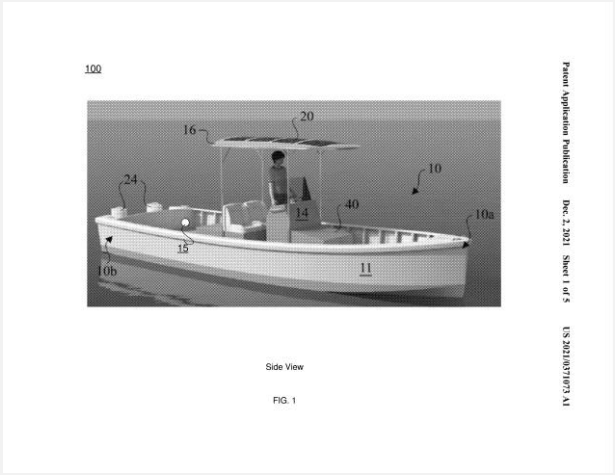
World First Solar-Electric Pump-out Vessel – October 10, 2020. $352,000.00~**



SOLAR SHARK

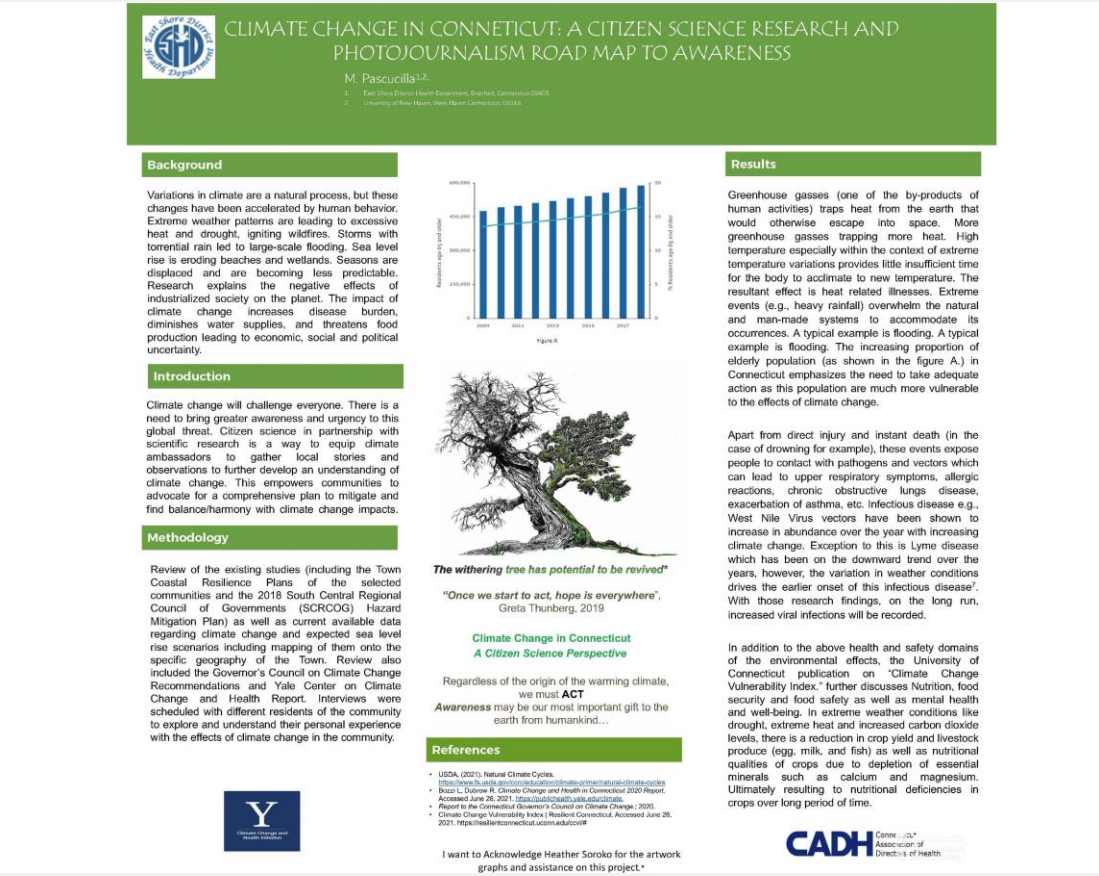
WHAT LIFE IS LIKE IN CONNECTICUT **NOW**

- Increasing temperatures
  - 3.0 – 3.5 degrees increase in the last century – 6 of the 10 hottest years since 2005.
- Rising sea levels and increasing flooding – 8–9-inch sea rise with high -tide flooding
- Erosion of wetlands, which are already under threat by human activities
- Modification of ecosystems – Seasons & Growing Timelines are shifting.
- Alterations in temperature and precipitation affect acute and chronic diseases
- Vector borne diseases are becoming more prevalent
- All in all, the balance of life in Connecticut is changing, and will continue to evolve…

(EPA, 2016, Bozzi et al. 2020)

ONGOING CITIZEN SCIENCE & CLIMATE CHANGE RESEARCH*

Project Title: *Climate Change in Connecticut: A Research & Photojournalism Road Map to Awareness*



CLIMATE CHANGE IN CONNETICUT: A CITIZEN SCIENCE RESEARCH AND PHOTOJOURNALISM ROAD MAP TO AWARENESS

M. Pascucilla[1,2]

Background

Variations in climate are a natural process, but these changes have been accelerated by human behavior. Extreme weather patterns are leading to excessive heat and drought, igniting wildfires. Storms with torrential rain led to large-scale flooding. Sea level rise is eroding beaches and wetlands. Seasons are displaced and are becoming less predictable. Research explains the negative effects of industrialized society on the planet. The impact of climate change increases disease burden, diminishes water supplies, and threatens food production leading to economic, social and political uncertainty.

Introduction

Climate change will challenge everyone. There is a need to bring greater awareness and urgency to this global threat. Citizen science in partnership with scientific research is a way to equip climate ambassadors to gather local stories and observations to further develop an understanding of climate change. This empowers communities to advocate for a comprehensive plan to mitigate and find balance/harmony with climate change impacts.

Methodology

Review of the existing studies (including the Town Coastal Resilience Plans of the selected communities and the 2018 South Central Regional Council of Governments (SCRCOG) Hazard Mitigation Plan) as well as current available data regarding climate change and expected sea level rise scenarios including mapping of them onto the specific geography of the Town. Review also included the Governor's Council on Climate Change Recommendations and Yale Center on Climate Change and Health Report. Interviews were scheduled with different residents of the community to explore and understand their personal experience with the effects of climate change in the community.

The withering tree has potential to be revived*

"Once we start to act, hope is everywhere",
Greta Thunberg, 2019

Climate Change in Connecticut
A Citizen Science Perspective

Regardless of the origin of the warming climate, we must **ACT**
Awareness may be our most important gift to the earth from humankind…

References

- USDA, (2021), Natural Climate Cycles.
- Bozzi L, Dubrow R. *Climate Change and Health in Connecticut 2020 Report*. Accessed June 26, 2021.
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- Climate Change Vulnerability Index | Resilient Connecticut. Accessed June 26, 2021.

I want to Acknowledge Heather Soroko for the artwork graphs and assistance on this project.*

**Results

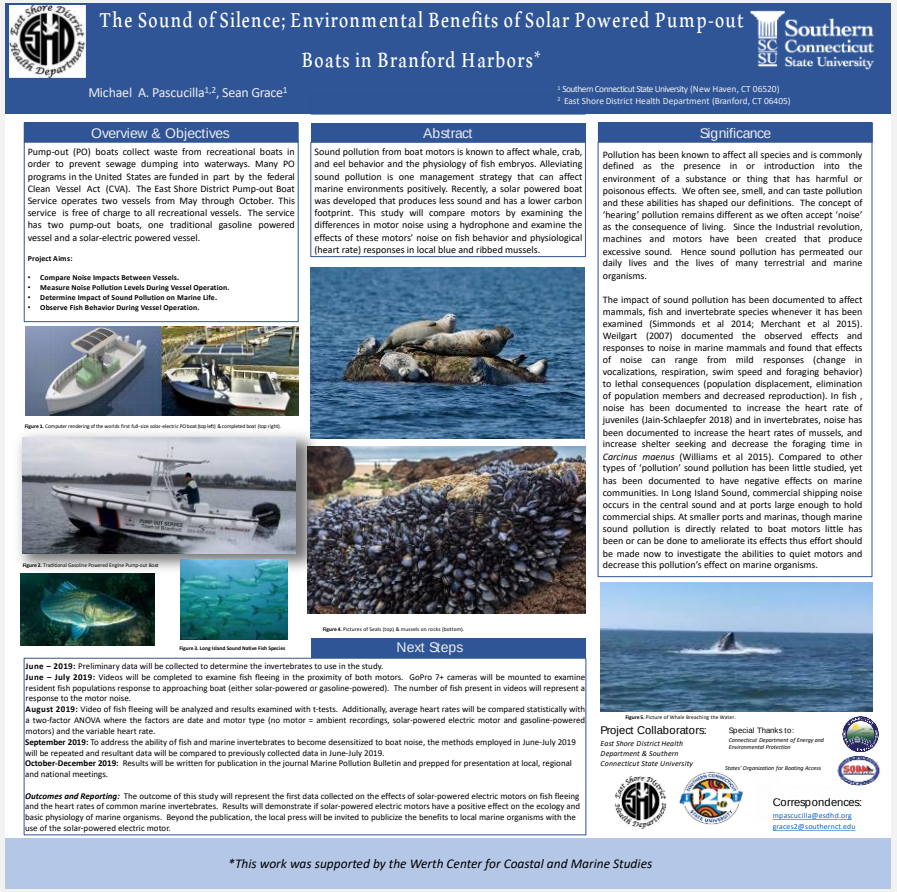
Greenhouse gasses (one of the by-products of human activities) traps heat from the earth that would otherwise escape into space. More greenhouse gasses trapping more heat. High temperature especially within the context of extreme temperature variations provides little insufficient time for the body to acclimate to new temperature. The resultant effect is heat related illnesses. Extreme events (e.g., heavy rainfall) overwhelm the natural and man-made systems to accommodate its occurrences. A typical example is flooding. A typical example is flooding. The increasing proportion of elderly population (as shown in the figure A.) in Connecticut emphasizes the need to take adequate action as this population are much more vulnerable to the effects of climate change.

Apart from direct injury and instant death (in the case of drowning for example), these events expose people to contact with pathogens and vectors which can lead to upper respiratory symptoms, allergic reactions, chronic obstructive lungs disease, exacerbation of asthma, etc. Infectious disease e.g., West Nile Virus vectors have been shown to increase in abundance over the year with increasing climate change. Exception to this is Lyme disease which has been on the downward trend over the years, however, the variation in weather conditions drives the earlier onset of this infectious disease[7]. With those research findings, on the long run, increased viral infections will be recorded.

In addition to the above health and safety domains of the environmental effects, the University of Connecticut publication on "Climate Change Vulnerability Index." further discusses Nutrition, food security and food safety as well as mental health and well-being. In extreme weather conditions like drought, extreme heat and increased carbon dioxide levels, there is a reduction in crop yield and livestock produce (egg, milk, and fish) as well as nutritional qualities of crops due to depletion of essential minerals such as calcium and magnesium. Ultimately resulting to nutritional deficiencies in crops over long period of time.

Paid Summer Stipend - NEHA & Yale University - $14,000.00~

Project Title: *The Sound of Silence; Environmental Benefits of Solar Powered Pump-out Boats in Branford Harbors*



The Sound of Silence; Environmental Benefits of Solar Powered Pump-out Boats in Branford Harbors*

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Overview & Objectives

Pump-out (PO) boats collect waste from recreational boats in order to prevent sewage dumping into waterways. Many PO programs in the United States are funded in part by the federal Clean Vessel Act (CVA). The East Shore District Pump-out Boat Service operates two vessels from May through October. This service is free of charge to all recreational vessels. The service has two pump-out boats, one traditional gasoline powered vessel and a solar-electric powered vessel.

Project Aims:

- **Compare Noise Impacts Between Vessels.**
- **Measure Noise Pollution Levels During Vessel Operation.**
- **Determine Impact of Sound Pollution on Marine Life.**
- **Observe Fish Behavior During Vessel Operation.**

Abstract

Sound pollution from boat motors is known to affect whale, crab, and eel behavior and the physiology of fish embryos. Alleviating sound pollution is one management strategy that can affect marine environments positively. Recently, a solar powered boat was developed that produces less sound and has a lower carbon footprint. This study will compare motors by examining the differences in motor noise using a hydrophone and examine the effects of these motors' noise on fish behavior and physiological (heart rate) responses in local blue and ribbed mussels.

Significance

Pollution has been known to affect all species and is commonly defined as the presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects. We often see, smell, and can taste pollution and these abilities has shaped our definitions. The concept of 'hearing' pollution remains different as we often accept 'noise' as the consequence of living. Since the Industrial revolution, machines and motors have been created that produce excessive sound. Hence sound pollution has permeated our daily lives and the lives of many terrestrial and marine organisms.

The impact of sound pollution has been documented to affect mammals, fish and invertebrate species whenever it has been examined (Simmonds et al 2014; Merchant et al 2015). Weilgart (2007) documented the observed effects and responses to noise in marine mammals and found that effects of noise can range from mild responses (change in vocalizations, respiration, swim speed and foraging behavior) to lethal consequences (population displacement, elimination of population members and decreased reproduction). In fish , noise has been documented to increase the heart rate of juveniles (Jain-Schlaepfer 2018) and in invertebrates, noise has been documented to increase the heart rates of mussels, and increase shelter seeking and decrease the foraging time in *Carcinus maenus* (Williams et al 2015). Compared to other types of 'pollution' sound pollution has been little studied, yet has been documented to have negative effects on marine communities. In Long Island Sound, commercial shipping noise occurs in the central sound and at ports large enough to hold commercial ships. At smaller ports and marinas, though marine sound pollution is directly related to boat motors little has been or can be done to ameliorate its effects thus effort should be made now to investigate the abilities to quiet motors and decrease this pollution's effect on marine organisms.

Next Steps

June – 2019: Preliminary data will be collected to determine the invertebrates to use in the study.
June – July 2019: Videos will be completed to examine fish fleeing in the proximity of both motors. GoPro 7+ cameras will be mounted to examine resident fish populations response to approaching boat (either solar-powered or gasoline-powered). The number of fish present in videos will represent a response to the motor noise.
August 2019: Video of fish fleeing will be analyzed and results examined with t-tests. Additionally, average heart rates will be compared statistically with a two-factor ANOVA where the factors are date and motor type (no motor = ambient recordings, solar-powered electric motor and gasoline-powered motors) and the variable heart rate.
September 2019: To address the ability of fish and marine invertebrates to become desensitized to boat noise, the methods employed in June-July 2019 will be repeated and resultant data will be compared to previously collected data in June-July 2019.
October-December 2019: Results will be written for publication in the journal Marine Pollution Bulletin and prepped for presentation at local, regional and national meetings.

Outcomes and Reporting: The outcome of this study will represent the first data collected on the effects of solar-powered electric motors on fish fleeing and the heart rates of common marine invertebrates. Results will demonstrate if solar-powered electric motors have a positive effect on the ecology and basic physiology of marine organisms. Beyond the publication, the local press will be invited to publicize the benefits to local marine organisms with the use of the solar-powered electric motor.

Project Collaborators:
East Shore District Health Department & Southern Connecticut State University

Special Thanks to:
Connecticut Department of Energy and Environmental Protection
States' Organization for Boating Access

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* Unpublished Research

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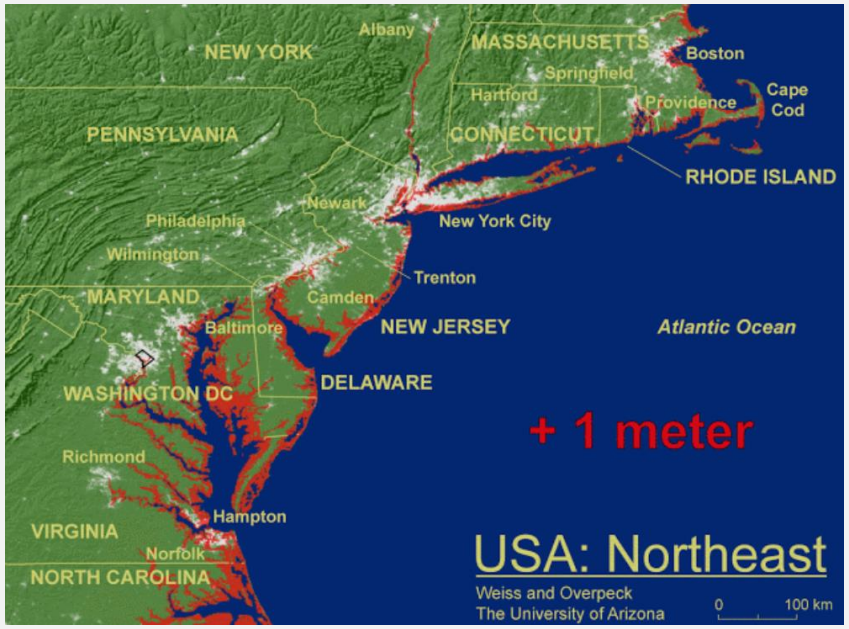
Impacts are now

https://health.clevelandclinic.org/living-with-lyme-disease-how-to-promote-long-term-healing/

Guilford/Branford, CT

https://www.livescience.com/heat-exhaustion.html



http://natureontheedgenyc.blogspot.com/2012/11/sea-level-is-rising-60-faster-than.html

PROJECT GOALS

Short Term Goals:

- Bring greater awareness to the changes already being seen and experienced in Connecticut.
- Build an inclusive constituency to increase the conversation around climate change.
- Engage with Connecticut residents to learn from each other, exchange ideas and brainstorm on ways to manage and possibly even mitigate climate change.

Long Term Goals:

- Learn ways to live with and possibly benefit from changes that may already be permanent.
- Develop policies to protect residents from extreme heat, flooding, changes in food production, etc.
- Understand it’s a natural cycle, however mankind's impact has accelerated increased changes.
- Hoping for the A-ha moment from their local, neighbor to neighbor community stories

OPPORTUNITIES RELATED TO CLIMATE CHANGE

Green energy

- Electric cars/vessels
- Wind Energy
- Solar Energy

Carbon Sequestration

- Kelp farming
- Algae research (Lamm, 2019)

Investment

- Education
- Housing resilience
- Financial firms investing in climate neutral/socially equitable projects

Legislation

- Improved/reduced packaging
- Funding for environmental education
- Climate sensitive zoning initiatives

https://www.smithsonianmag.com/innovation/could-offshore-wind-farms-actually-sap-rain-from-hurricanes-180970448/

PUBLIC HEALTH – OUR NEW CHALLENGES

Pandemic (COVID):

- Has changed our field
- PH Officials are not trusted
- Enforcement will not be our best tool (Look at vaccination rates/mandates)
- We must redefine our profession and engage all stakeholders, especially our Local communities
- Change must be at the ***Local*** level, supported at the State & Federal level

W.A.I.T. –***We All Impact Tomorrow***

- Climate Change Awareness
- Teach Essentialism (McKeown, 2014)
- Enhance concept of Reduce, Reuse, Renew

We choose to fight climate change, not because it is easy, but because it is hard. (Paraphrased from John F. Kennedy)

RECAP – A DEEPER DIVE

Evolved & Transitioned:

- After reviewing the body of research outputs, a pattern emerged over time as a foundation to successful outcomes. Citizen Science materialized.

Research Path Forward:

- While citizen science transpired and was clearly the adhesive to water quality and climate change research proposal, there were/are more layers to the research that developed and were explored.

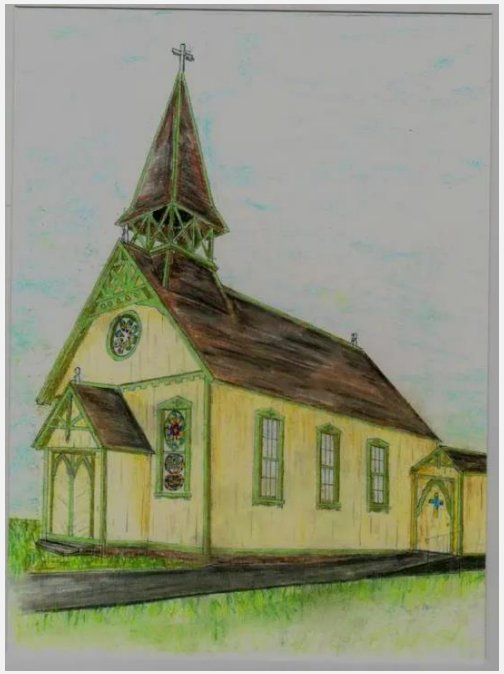
Literature Review:

- Conducted a deeper dive into the citizen science and climate change relationship within the overall cohesive body of research to provided clarity (warranted).
- Specifically, while my early research outputs only addressed stakeholder engagement at the margins, however, over-time, a common thread of citizen science and deep-rooted, community partnership and collaboration emerged/was evident.

- **Examination of Root Cause to Success:**
  - Explored the root cause of the studies success and their linkages. Multi-faceted and complex relationships are at the core for successful community-governmental project and partnerships. Flexibility and negotiation are also essential.

- **Research Gaps/Limitations:**
  - Citizen science has a place in public health, especially in government, however, it also has it limits and challenges that need to be properly managed.
  - Study design/factors need to be considered – demographics, political affiliation and region of America matter, to include education and affluent populations, etc.…

WE CAN'T DO IT ALONE - PUBLIC HEALTH EVOLUTION…



Founded in 1883, *Short Beach* Union *Church* continues to be the oldest running Non-Denominational *Church* in *Connecticut*.

Branford's First Community Clam Dig - Local Shellfishing Marketing & Promotion

Volunteer Collecting Water Samples

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A SINCERE THANKS TO OUR LOCAL CITIZEN SCIENTISTS QUESTIONS/COMMENTS