CONNECTICUT SEA GRANT PROJECT REPORT

Please complete this progress or final report form and return by the date indicated in the emailed progress report request from the Connecticut Sea Grant College Program. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Nancy Balcom nancy.balcom@uconn.edu, Associate Director, Connecticut Sea Grant College Program. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Nancy Balcom at (860) 405-9107.

Please fill out all of the following that apply to your specific research or development project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter:

Date of Report submission:

Project #: # LI-00A00168 Check one: [ ] Progress Report [x] Final report

Duration (dates) of entire project, including extensions: From [**01-Mar-2019**] to [**28-Feb-2021**].

Project Title or Topic: **The Long Island Sound Respire Program**

Principal Investigator(s) and Affiliation(s):

1. **Penny Vlahos, Department of Marine Sciences, University of Connecticut**

2. **Michael Whitney, Department of Marine Sciences, University of Connecticut**

3. **Jamie Vaudrey, Department of Marine Sciences, University of Connecticut**

A. COLLABORATORS AND PARTNERS: *(List any additional organizations or partners involved in the project.)*

All of the project work is in collaboration with the CT DEEP monthly water survey cruises.

B. PROJECT GOALS AND OBJECTIVES:

B. Objectives:

1) To measure respiration rates and biological oxygen demand (BOD) at 10 Long Island Sound (LIS) water quality stations over the project period.

2) To measure key biogeochemical parameters at these stations (pCO2 and total alkalinity (TA)), in addition to those already measured in the LIS surveys (pH, nutrients, dissolved oxygen (DO), chlorophyll a and organic carbon).

3) To conduct incubations on dissolved and particulate organic carbon (DOC, POC) that measure degradation rates at 10 sites across LIS to complement respiration studies.

4) To evaluate the above values across LIS spatially and temporally to begin the foundational work for a combined LIS biogeochemical model that considers respiration in terms of season (i.e. temperature (T), salinity (S), stratification), location, depth, DOC and POC lability and important biogeochemical parameters.
5) To conduct a LIS DO balance for LIS from 1991 to present.
6) To ascertain the utility of adding respiration and/or inorganic carbon components to the Long Island Sound Water Quality Monitoring Program.

C. PROGRESS: (*Summarize progress relative to project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.)*
Our last sample collection date was in October 2021. All samples collected have been analyzed in the laboratory and data analysis is in progress. The project has met its goals and has had significant outcomes.

This research project has resulted in the first comprehensive and simultaneous alkalinity and carbonate system parameter distributions in LIS. The study managed to maintain its carbonate system work throughout COVID and in the potential long term addition of carbonate system parameters to the LIS water monitoring program which PI Vlahos's team has proposed as a result of the study. The study identified significantly low seasonal aragonite saturation values along the LIS central axis that persist longer than hypoxic conditions and is proposing that aragonite saturation be used as an indicator to set new TMDLs for LIS. This work has resulted in several conference presentations, one published and 1 submitted manuscript to date. There are at least two more planned manuscripts to be submitted in 2022.

Some major outcomes of this work include exciting new sampling parameters to be integrated into the LIS water quality sampling protocol. The EPA has proposed adding total alkalinity and dissolved inorganic carbon measurements to their regular water quality surveys. This sets forth a new scope in the LIS water quality surveys that includes long term acidification and buffering capacity in the time series. We are very proud of this achievement.

A Second major achievement is that this work has led to the expansion of carbonate system parameters in LIS embayments which are expected to have more severe seasonal lows in aragonite saturation and therefore shellfish integrity. Our recently funded LISS Alkalinity in Long Island Sound Embayments (ALISE) project is currently underway. Though the scope is modest at this stage we are dedicated to expanding this work.

Another major output of this work is to propose new targets for future nitrogen TMDLs in LIS. We will continue to pursue this.

D. PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS AND PATENTS: *(Include published materials with complete references, as well as those which have been submitted but not yet*

published and those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)

List of publications/presentations: *DG student lead author

Journal Articles (List URLs):

1. **Whitney, M.M., Vlahos, P. (2021) Reducing Hypoxia in an Urban Estuary Despite Climate Warming. Environ. Sci. & Technol. 55 (2), 941-951. DOI: 10.1021/acs.est.0c03964**

2. ***Barrett, L. Vlahos, P., Whitney, M.M., Vaudrey, J. (2022) Alkalinity and carbonate system trends in Long Island Sound. Estuaries and Coasts (submitted).**

Conference Papers: **NA**

Proceedings or book chapters: **NA**

Web sites, Software, etc.:

https://env.chem.uconn.edu/the-long-island-sound-lis-respire-program/

Technical Reports/Other Publications: **This report**

Other Products (including popular articles): NA

Publications planned / in progress:

At least 2 more publications are planned for 2022 submission

- ***Barrett, L. Vlahos, P., Whitney, M.M., Vaudrey, J. (2022) Respiration Rates in the Long Island Sound Estuary (in prep)**
- ***Barrett, L. Vlahos, P., Whitney, M.M., Vaudrey, J. (2022) Trends and predictions of Long Island Sound Alkalinity Parameters. (possible title and planned publication)**

Patents: *(List those awarded or pending as a result of this project.)* **NA**

Presentations and Posters: *(Include name and date of the conference or meeting, whether it was a talk or poster, if it was invited, and who the presenter was.*)

1. ***Barrett, L.,Vlahos, P. (2021) Internal consistency of the inorganic carbon system in Long Island Sound.Biennial Coastal and Estuarine Res. Fed. (CERF November 2021).**
2. ***Barrett, L. Vlahos, P. (2021) Over-specification of the inorganic carbon system of Long Island Sound. Am. Soc. of Limnol. & Ocean. (ASLO February 2021).**
3. ***Barrett, L., Vlahos, P., Vaudrey, J.M.P., Whitney, M.M. Long Island Sound Hypoxia National Coastal & Estuaries – Restore Americas Estuaries Summit On-line Conference. (Thursday October 1st 2020)**

4. ***Barrett, L., Vlahos, P., Vaudrey, J.M.P., Whitney, M.M. Biogeochemical Controls on Pelagic Respiration Rates in Long Island Sound AGU – Ocean Sciences, San Diego CA, 2020 CP13C-01 Monday, 17 February 2020 14:00 - 14:15 oral presentation SDCC - 11A, UL**
5. ***Barrett, L., Vlahos, P. Shell Day. CT Shellfish Commission, January 11, 2020, New Haven, CT.**

E. FUNDS LEVERAGED: *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

The acquisition of the Hydros Alkalinity Analyzer brought us to the attention of the DOC/NOAA/Northeastern Regional Association of Coastal Observing Systems (NECAN) Total Alkalinity Blitz Citizen Science Event (Shell Day). Our group was the central analysis center for the state of Connecticut on August 23rd , 2019. Citizen Science Groups from across CT collected water samples that were then delivered to our lab and analyzed for total alkalinity. The event was a success and the integration of the entire northeast data set is currently underway. Lauren Barrett presented these results at the January CT Shellfish Commission meeting in New Haven. We expect these efforts to be expanded in future years.

16th ANNUAL GATHERING OF SHELLFISH COMMISSIONS
Saturday, January 11th, 2020, 9:30 a.m. to 2:30 p.m., The Jones Auditorium - Connecticut Agricultural Experiment Station, 123 Huntington St, New Haven, CT 06511New Haven, Connecticut.

Barrett, L., Vlahos, P., Shell Day - University of Connecticut

F. STUDENTS: ***(****Document the number and type of students supported by this project.)*
*Note: **"Supported"** means supported by Sea Grant through financial or other means, such as Sea Grant federal, match, state and other leveraged funds. "**New"** students are those who **have not** worked on this project previously. "**Continuing"** students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.*

Total number of **new*** K-12 students who worked with you:
Total number of **new** undergraduates who worked with you:
Total number of **new** Masters degree candidates who worked with you:
Total number of **new** Ph.D. candidates who worked with you:

Total number of **continuing**** K-12 students who worked with you:

Total number of **continuing** undergraduates who worked with you: **(2) Mackenzie Blanusa and Rebha Raviraj**
Total number of **continuing** Masters degree candidates who worked with you: **(1) Mary McGuinness**
Total number of **continuing** Ph.D. candidates who worked with you: **(1) Lauren Barrett**

Total number of volunteer hours:

*(Note: *__New__ students are those who have not worked on this project previously. **__Continuing__ students are those who have worked on this project previously.)*

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles related to this project.

Student Name: **Lauren Barrett**
Degree Sought: **PHD**
Thesis or Dissertation Title: **The Biogeochemistry of Long Island Sound (TBD)**
Date of thesis completion: **NA**
Expected date of graduation: **2025**

G. VOLUNTEER HOURS:

(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?)

- **Summer REU (15 hours) year 1, NOYCE SHOLAR (12 hours) year 2**
- **Graduate students (45 hours) year 1 (60 hours) year 2**

H. PICTORIAL: Please provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CTSG publications, websites and presentations.

Figure 1: Lauren Barrett measuring continuous alkalinity on the Hydros FIA in LIS surface water

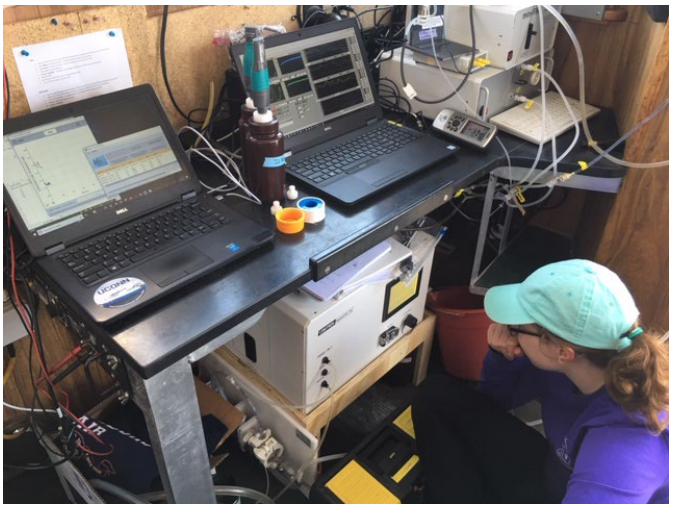

Figure 2: Lauren Barrett and Raul Flamenco (summer REU student) measuring respiration in surface and deep waters from Rosette samples.

I. **HONORS AND AWARDS**: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.*) Specify: **NA**

a) Name of person or group receiving recognition:
b) Name of award or honor:
c) Group or individual bestowing the award or honor:
d) What it was for:
e) Date:

J. **DATA MANAGEMENT PLANS:** Proposals funded in 2014-2016 and later cycles are required to have a data management plan in place. All environmental data and information collected and/or created must be made visible, accessible, and independently understandable to general users, free of charge or at minimal cost, in a timely manner (typically no later than two years after the data are collected or created). This is a reminder that your CTSG funded research data needs to be archived and accessible as outlined in the data management plan you submitted with your proposal. If there have been any modifications, adjustments or new information available regarding the location, timing, type, formatting

and metadata standards, content, sharing, stewardship, archiving, accessibility, publication or security of the data produced please elaborate here.

No modifications

FOR FINAL DEVELOPMENT AND RESEARCH GRANT REPORTS, PLEASE COMPLETE THIS SECTION:

K. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*

A significant priority in LIS is to improve water quality and understand the water chemistry in order to set appropriate TMDLS and to inform adaptive and sustainable development along its shores and drainage basin. Significant unknowns include and understanding of the respiration rates in LIS and to increase sampling resolution of data that is currently lacking but important to understanding the LIS system including alkalinity and carbonate system parameters.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*
The goals of the Respire Program included
1)To measure respiration rates and biological oxygen demand (BOD) at 10 Long Island Sound (LIS) water quality stations over the project period. 2)To measure key biogeochemical parameters at these stations (pCO2 and total alkalinity (TA)), in addition to those already measured in the LIS surveys (pH, nutrients, dissolved oxygen (DO), chlorophyll a and organic carbon). 3)To evaluate the above values across LIS spatially and temporally to begin the foundational work for a combined LIS biogeochemical model that considers respiration in terms of season (i.e. temperature (T), salinity (S), stratification), location, depth, DOC and POC lability and important biogeochemical parameters. 4)To conduct a LIS DO balance for LIS from 1991 to present. 5)To ascertain the utility of adding respiration and/or inorganic carbon components to the Long Island Sound Water Quality Monitoring Program.

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

This research project has resulted in the first comprehensive and simultaneous alkalinity and carbonate system parameter distributions in LIS. The study managed to maintain its carbonate system work throughout COVID and has resulted in the potential long term addition of carbonate system parameters to the LIS water monitoring program which PI Vlahos's team has proposed as a result of the study. The study identified significantly low

seasonal aragonite saturation values along the LIS central axis that persist longer than hypoxic conditions and is proposing that aragonite saturation be used as an indicator to set new TMDLs for LIS. This work has resulted in several conference presentations, one published and 1 submitted manuscript to date. There are at least two more planned manuscripts to be submitted in 2022.

Consider the following as they apply to your research and any related outreach/education.

- What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?

  Some major outcomes of this work include exciting new sampling parameters to be integrated into the LIS water quality sampling protocol. The EPA has proposed adding total alkalinity and dissolved inorganic carbon measurements to their regular water quality surveys. This sets forth a new scope in the LIS water quality surveys that includes long term acidification and buffering capacity in the time series. We are very proud of this achievement.

  A Second major achievement is that this work has led to the expansion of carbonate system parameters in LIS embayments which are expected to have more severe seasonal lows in aragonite saturation and therefore shellfish integrity. Our recently funded LISS Alkalinity in Long Island Sound Embayments (ALISE) project is currently underway. Though the scope is modest at this stage we are dedicated to expanding this work.

- What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?

  Another major output of this work is to propose new targets for future nitrogen TMDLs in LIS. We will continue to pursue this.

- What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?
- **We expect that this work will have long term impact on LIS water quality and ways we set new TMDLs. This project has led to further work in embayments which we expect will have additional impact on local communities in their adaptive management.**

- What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated? **NA**

J. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

The LIS Respire project has led to exciting findings in LIS water quality. These include the most comprehensive data on the buffering capacity and aragonite saturation values in LIS to date and reveals surprisingly widespread conditions of low carbonate saturation indexes across the western and central sound that co-occur with LIS hypoxic events. The project has identified and recommended new parameters that will be added to the LIS water quality monitoring time series, initiating a new era in LIS water quality analyses. The project was also able to discern the ranges and conditions for widespread variations in LIS respiration rates that naturally vary widely over daily cycles and to propose representative rates for LIS during across seasons. Finally the project has completed an oxygen balance for LIS documenting both success in hypoxia reductions over the last 20 years and identifies minimum new TMDLs to maintain this reduction over the next several decades.