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## Your Classroom and Aquaculture - Making Connections through Place-based Learning

Morgan Cuthbert

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# ***Your Classroom and Aquaculture - Making Connections through Placed-based Learning***

January 24th  
The Darling Center



# What is Applied Learning or Problem Based Learning?

## Citizen Science

- Projects in which volunteers/students partner with scientists to answer real-world questions.

## Problem based learning:

- Students apply knowledge and skills gained from traditional classroom learning to hands-on and/or real-world settings, creative projects or independent or directed research.

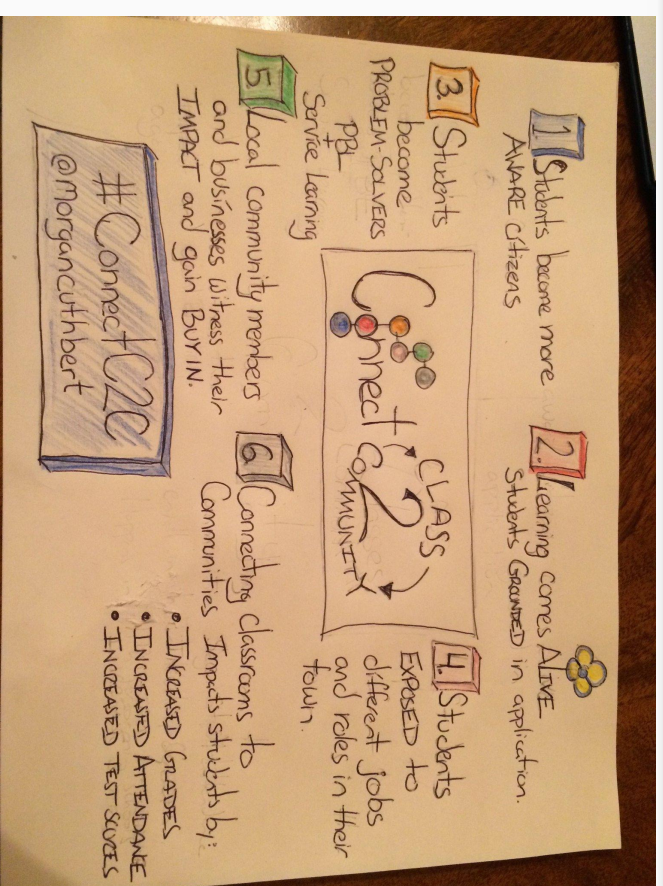
-From SUNY NY Project based learning



# What is Citizen Science or Problem Based Learning?

## Words associated with it:

Aware citizens	Authentic
Engaged	Connected
Application	Invested
Problem solvers	Partner
Service learning	Memorize → Understand
Community involvement	Creative
	Exposure
	Community Buy-in
	Empowerment





Let us give you an example?



<https://bre.is/wyeZBAqq>  
Yarmouth Shellfish  
Nursery

## Our Story... It started with Our Community's Problem in 2013

In the last decade, European Green Crabs have been destroying coastal flats all along the eastern seaboard.



Soft-shell clam population has been in a steep decline in Yarmouth and around the State.



**DOWNEAST INSTITUTE**  
FOR APPLIED MARINE RESEARCH & EDUCATION

In 2013, our team collaborated with local scientists to conduct a study evaluating how Yarmouth clam flats are affected by the green crabs.

## Resources Collected

### Data of Decline in Soft shell Clams Harvested:

2012 490,000 pounds were harvested in the Town of Yarmouth

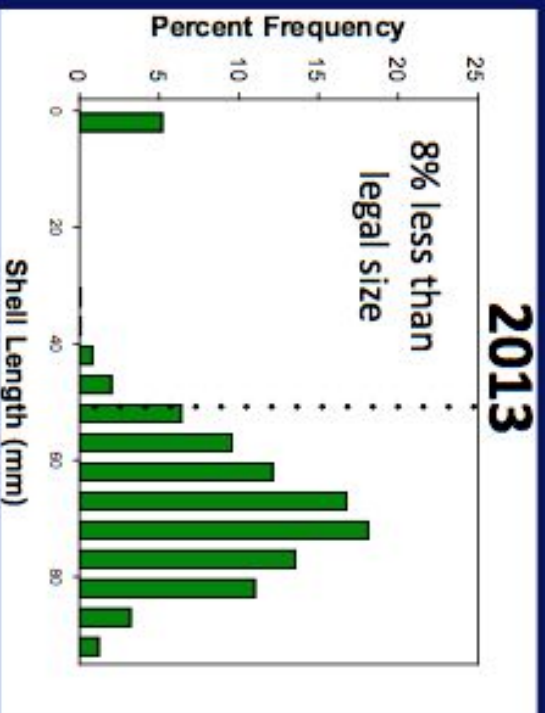
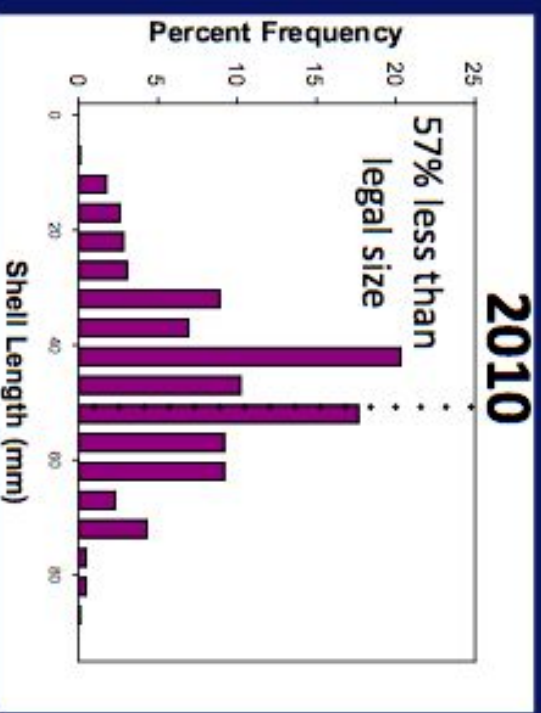
2013 441,000 pounds were harvested in the Town of Yarmouth

2014 389,000 pounds were harvested in the Town of Yarmouth

2015 149,000 pounds were harvested in the Town of Yarmouth.

2016 23,000 pounds were harvested in the Town of Yarmouth.

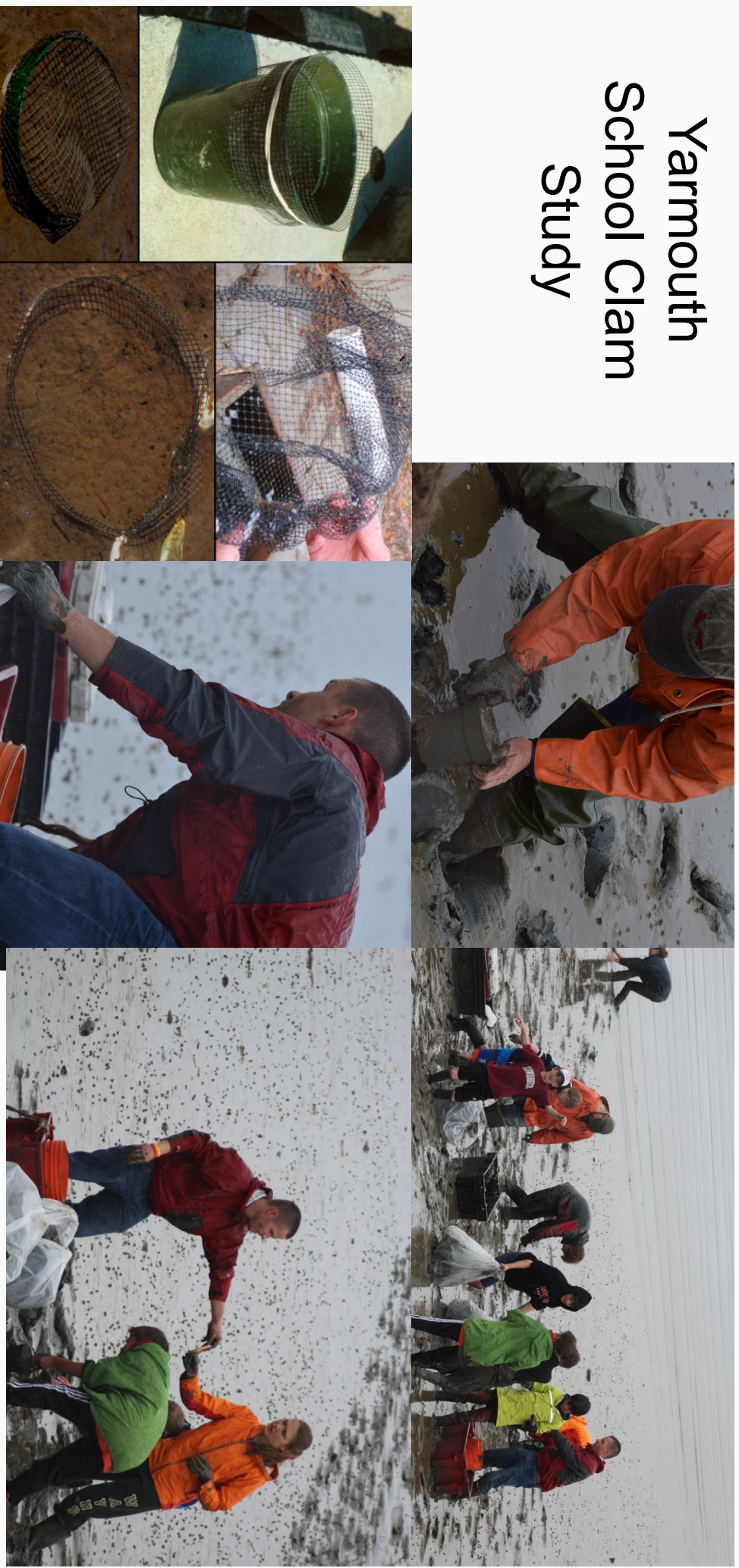
**95% Decline**





Photos of the 7th grade research experiment collaborating with DEI

## Yarmouth School Clam Study



# So what happened?

We were finalist in the Samsung Solve for Tomorrow Contest.



## Our Research Findings:

We found 5% percent survival of our own clams.

Milky ribbon worms

Green crabs

100+ native clam seed...Hope!

- Students were able to share their work and research at:
- Earth Day events sponsored by Sierra Club
  - Perloff Foundation Ecology Summit
  - GMRI - Annual Conference
  - K-2 Schools in Yarmouth District



## Jump to 2016... rethink ... ask more questions

Our team decided to change tactics and try the use of local aquaculture to help our town. We received a local grant to not only further our study, but teach others about the overall issue.



**Bob Miles & Son, Inc.**



We collaborated with the town, worked with the harbormaster and shellfish commission to get permits, and even partnered with local businesses to complete the site zoning, plumbing and electrical work.



Design and build an upweller system to grow juvenile clams where growth would be expedited and predators were not of concern.

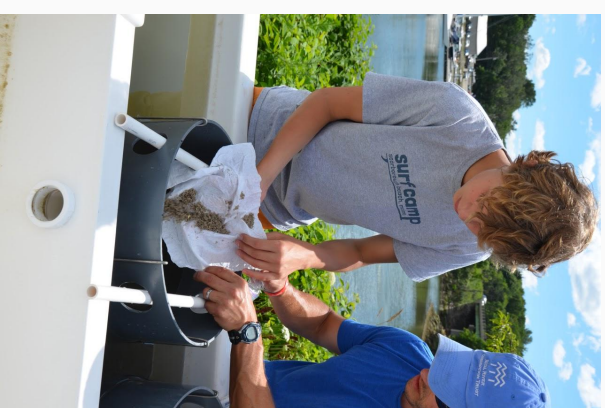




## Our study begins

Connected with the DMR and Maine Clammers Association. Given the green light to move ahead.

Quarter of a million clam seed acquired through DEI.



The clams grow....and they grow fast!

July 19th



August 1st



August 15th



September 16th



And here they are in  
October of 2016!

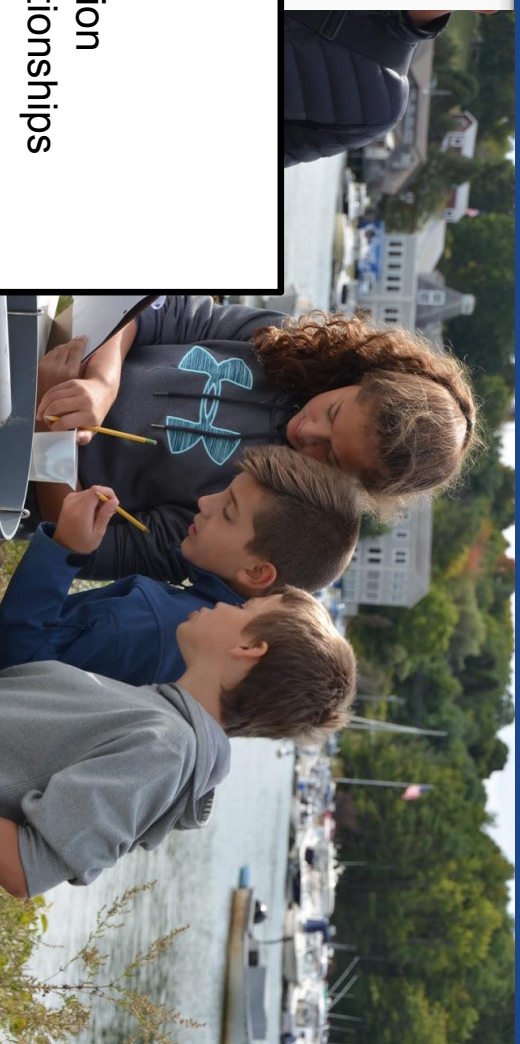




# Connecting to the 7th grade curriculum



Marine Ecosystems  
Life Cycles  
Climate Change  
Organism Identification  
Predator/ Prey Relationships  
Population Density  
Aquaculture  
Human Impact on the Environment  
Competition  
Salinity/ pH  
Invasive Species  
Data Analysis





## Current Citizen Science Links



Gulf of Maine  
Research Institute  
Science, Education, Community.



Sea Grant  
Maine  
at the University of Maine

MAINE SEA GRANT  
Marine Science for Maine People

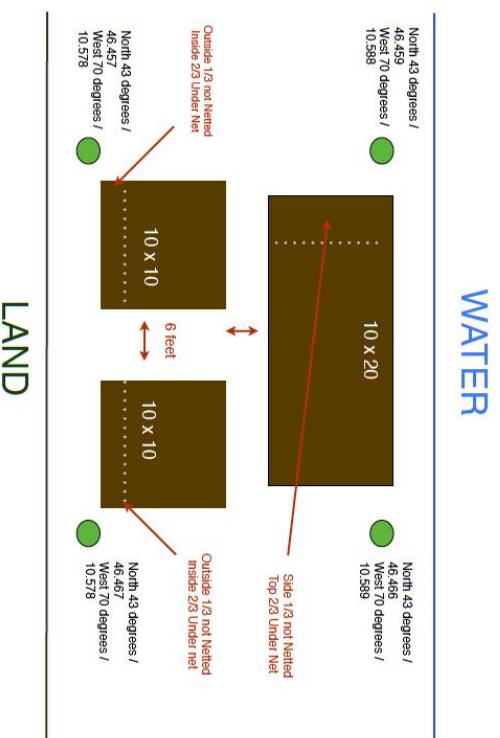


UNIVERSITY OF  
NEW ENGLAND

INNOVATION FOR A HEALTHIER PLANET

Sings of the Seasons  
Vital Signs pilot  
Growing Kelp  
Monitoring Buoy System

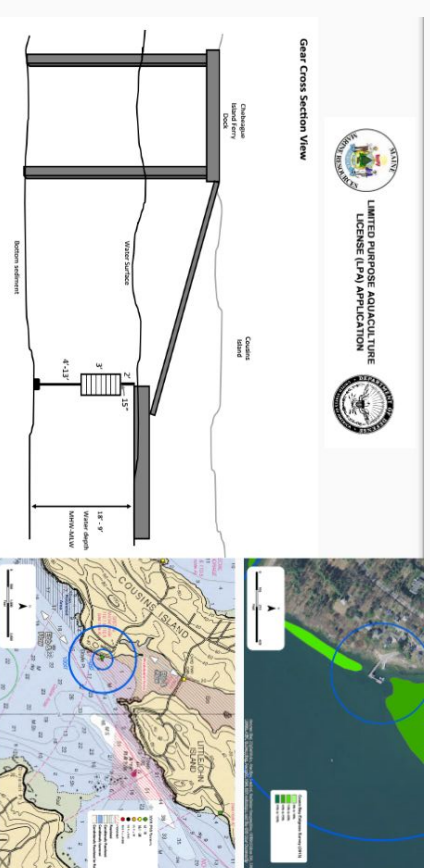
We wanted to dig deeper and form our own plot study.



## Plot Study:

Will the size of seed transplanted increase survival rate of clams?

Will the netting of plotted areas increase survival rate of clams?





# Study Findings - Research Articles - REAL Audience

## Broad Cove Study - Yarmouth, Maine

September 9th- May 21 2017

Yarmouth Shellfish Nursery Scientist: Grady Welch, Connor Senger, Duncan Hinkbeek,  
Katherine Blaschke, Ben Cox Faxon  
Yarmouth Shellfish Nursery Director: Morgan Cuthbert

### Overview:

The Yarmouth Shellfish Nursery has picked up with Manomet, a non-profit focused on environmental research and sustainability. We are replicating an experiment in the mudflats at Broad Cove, a tidal flat on the coast of our small town Yarmouth. We will compare data at the end of the study in the spring to recent results Manomet has collected. Our study plans to explore the population density and survival rate of soft shell clams, *Mya arenaria*, in open and covered plots. We will be also incorporating two different sizes of soft shell clams (large which has been grown to 2 cm and small which is 1 cm) We have three plots designated, each covered only 1/3 of the plot area in order for our control. We somehow had incorrect net sizes along with some measurements, so we had to incorporate open spaces into our experimental design. Each plot is covered around 70%. However, we did lose our protective netting 2 weeks before we were supposed to remove it due to the October Storm in 2017.

### Purpose:

To test the survival rate of a soft shell clams, *Mya arenaria*, in netted plots of varying population density and size of seed.

### Experimental Design:

Coordinates of Total Plot Area (Top to Bottom, Left to Right)

- North 46.459° West 70.588°
- North 46.466° West 70.589°
- North 46.459° West 70.578°
- North 46.469° West 70.578°

Plot 1:

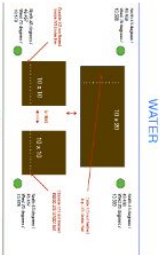
- Plot Area: 10ft by 20ft
- Net Area: 20 ft by 6ft
- Clam Size: Medium (2017 Seed)
- Number of Clams: 1,000

Plot 2:

- Plot Area: 10 ft by 10 ft
- Net Area: 6 ft by 10 ft
- Clam Size: Large (2016 Seed)
- Number of Clams: 1,000

Plot 3:

Clam Density vs. Worm Density		
Plot Number	Starting Population Density of Clam (Clam/ft <sup>2</sup> )	Population Density of Worms (Worm/ft <sup>2</sup> )
1. Medium	5	0.6
2. Large	10	1.87
3. Small	10	0.2



Broad Cove Broad Clam Data		
Plot Number	Area of Plot (ft <sup>2</sup> )	Average Number of Dead Clam per 20cm
1. Medium	200	12
2. Large	100	1
3. Small	100	0.8

Estimated Data		
Plot Number	Estimated Percent Survival Rate	Estimated Percent Clam
1. Medium	12.44%	26.44%

Clam Species Found		
Plot Number	Number of Midge Ribbon Worms per Plot	Total Number of Midge Ribbon Worms
1. Medium	3	120
2. Large	5	187
3. Small	1	20

WATER

LAND

### Conclusion:

- Large clams have a higher population density, ignore average size range in the "Medium Plot" as only one clam was found that was 20 mm. 12 mm was biggest clam. The same is true for the small plot regarding the largest clam, 12 mm.
- Density and size of large clams could provide easy food for midline ribbon worms. Population could not survive the smaller clams (where there was no midline ribbon worm) for the smaller clams were more susceptible to the European Green Crabs. Possibly the mid size clams survived for density in plot was lower, consequently making it more difficult for the worms and crabs to find food.

- 26 % of our clams were actually present in the plot. Future in error (a) we may not have counted totally crabs/clams or other shells. Even though we set in 5,000 clams total, 781 remained. This means a majority either washed away, were crabs beyond recognition, pulled up by tides (there was a large clam incident in the center of the cove). Even though survival rate was high, setting rate will proved to be an issue despite our careful attempts to help them settle. A good portion of each plot was covered under a net for the first 2 months.
- The number of Quabags, which were consistently larger in size than the softshell clams, were approximately 3 times less prevalent than the soft shell clams that survived. This competition could have put stress on our clams.

### Broad Cove Plot Study: September 2017-May 2018

This data showed similar results from the Piggy Cove study. *Caprellidae* larvae, the Midline Ribbon worm, appeared to be a significant factor in determining survival rate for all clam sizes. Unfortunately, we were unable to set our second question comparing protected vs. unprotected clams due to the fact that we lost our covering around 1 month and a half after the setting of our clams due to the massive wind storm in late October. But upon analyzing the data, we noticed an unexpected trend. The population densities of both species and the clams size appeared to differ survival rate. If all test conditions were the same, one would expect the population density of the clams to be the same as the population density of the worms. However, the European Green Crabs and Midline Ribbon Worms. However, the midline size clams exhibit a plot where the size of the area, hunting becomes less efficient, and therefore the worms aggregate in the plot that has a higher clam population density. This is exemplified by the fact that the number of *Caprellidae* was around triple the density in plot two than in any other plot. Consequently, it would seem logical that therefore the percent survival rate of the large clams should be 1/3 of that of the medium clams, but we must also account for the fact that more medium size clams were susceptible to predation by the European Green Crabs while the larger clams, who were consistently around 3 mm greater than medium clams, proved less susceptible. We believe the reason for this is that the larger clams were more difficult for the crabs to eat. The midline size clams were more susceptible to the European Green Crabs. However, the mid size clams survived for density in the small plot proved to be close in size with medium sized clams. Instead of the Midline Ribbon worms engaging the small clam population as it did with the smaller clams, it was the European Green Crabs leaving the small

## Rethinking - 2017 restorative sea farming



### Maine isn't doing enough to protect Gulf from effects of climate change

Some say the state needs more funding to collect data, monitor waterways and assess the impact of acidification.

INCREASE FONT SIZE



### Shellfish can't keep up with shifting ocean chemistry

Some native species simply won't survive the changes in water chemistry that are on the horizon, researchers say.

LOCAL & STATE >  
Posted November 19, 2017

State largely ignores role as seas grow more acidic

What are we working on?

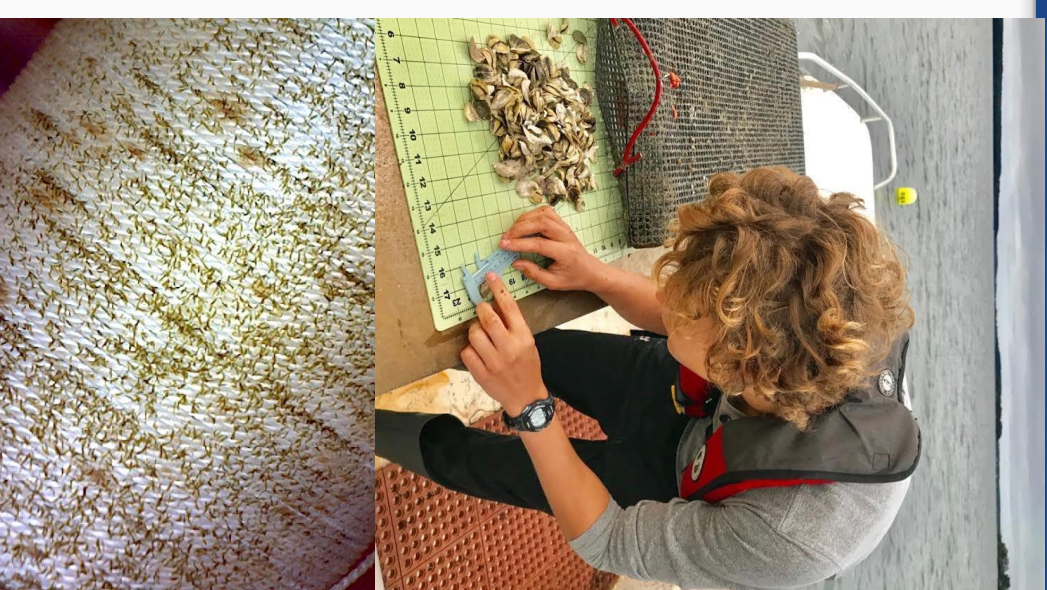
# Sustainable Ocean Farming

Oysters - filter water to 50 g/day

- Take nitrogen out of the oceans - cause of dead zones.

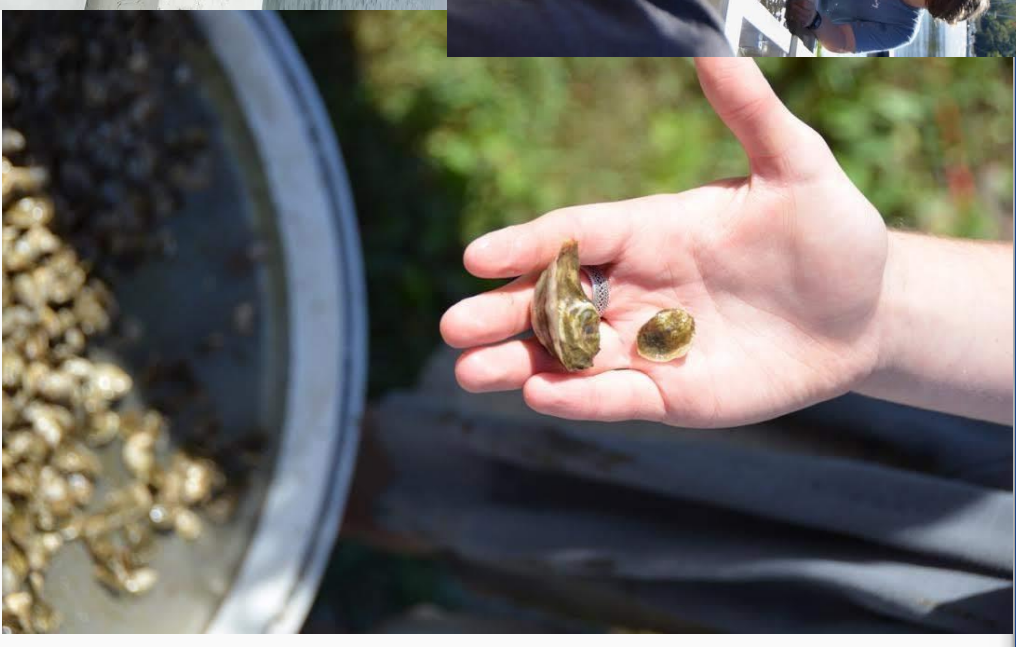
Kelp -

- Takes carbon out of the water
- Fast growing and creates a home for organisms
- Supplies oxygen





## 2018 Summer/Fall - Oysters





# LPA Growth Analysis Study and Water Quality

Broad Cove LPA Data

Date	Time	Tide	Temperature (°F)	pH	Dissolved Oxygen (mg/L)	Average Oyster Length (mm)	Max Oyster Length (mm)	Min Oyster Length (mm)
9/5	6:36	Flow at 7.8 ft	70.0	8.16	6.3	27.5	33	21
9/12	6:23	Ebb at 1.3 ft	65.3	8.06	5.8	29.0	35	22
9/19	6:35	Flow at 6.7 ft	64.0	8.20	5.7	29.0	36	22
9/26	6:58	Flow at 1.0 ft	64.0	8.22	5.9	30.9	39	22
10/3	6:54	Ebb at 7.6 ft	58.6	8.22	5.5	32.6	42	22
10/9	18:08	Flow at -0.8 ft	65.8	8.17	6.8	32.5	40	25
10/17	7:47	Ebb at 6.4 ft	51.6	8.29	7.0	35.9	44	21
11/1	16:38							

Bridge LPA Data

Date	Time	Tide	Temperature (°F)	pH	Dissolved Oxygen (mg/L)	Average Oyster Length (mm)	Max Oyster Length (mm)	Min Oyster Length (mm)
9/5	8:00	Flow at 8.5 ft	68.0	8.07	6.9	29.3	34	22
9/12	6:47	Ebb at -0.8 ft	64.8	8.01	6.4	31.6	38	22
9/19	7:03	Flow at 7.8 ft	62.4	8.18	5.8	31.8	38	22
9/26	7:57	Flow at 1.7 ft	63.0	8.10	5.7	34.5	42	22
10/3	7:36	Ebb at 7.1 ft	55.9	8.16	5.7	34.4	44	22
10/9	18:28	Flow at -0.9 ft	64.9	8.20	6.9	36.6	46	28
10/17	8:10	Ebb at 7.4 ft	57.4	8.24	6.8	37.7	45	28
11/1	16:04	Flow at 8.0 ft	48.6	8.25	6.6	40.8	50	30



Bridge LPA Data and Water Quality

Date	Time	Tide	Temperature (°F)	pH	Dissolved Oxygen (mg/L)	Average Oyster Length (mm)	Max Oyster Length (mm)	Min Oyster Length (mm)
9/5	8:00	Ebb at 7.8 ft	69.3	8.06	5.9	31.5	39	22
9/12	6:47	Ebb at 0.5 ft	64.2	8.06	6.0	29.4	38	22
9/19	7:03	Flow at 7.2 ft	62.4	8.22	5.6	28.5	36	19
9/26	7:57	Flow at 2.5 ft	63.1	8.12	5.8	32.4	42	25
10/3	7:36	Ebb at 6.7 ft	55.2	8.17	5.9	33.5	44	23
10/9	18:28	Flow at -0.2 ft	64.6	8.19	6.9	33.3	44	23
10/17	8:10	Ebb at 6.0 ft	50.9	8.25	6.7	36.2	47	26
11/1	16:04	Flow at 6.9 ft	49.1	8.32	6.7	33.9	49	20





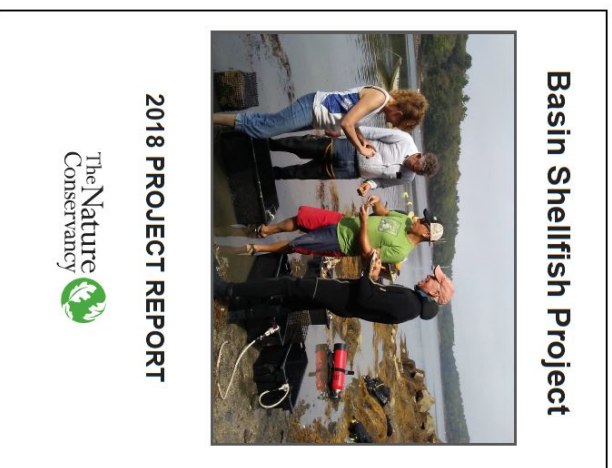
# Fall/Winter 19/20- Kelp

## Help from Sea Grant , Hurricane Island, Madeleine Point Oysters and UNE





## Next Steps 2020



# Partner with The Nature Conservancy Oyster Habitat Restoration and Quahogs

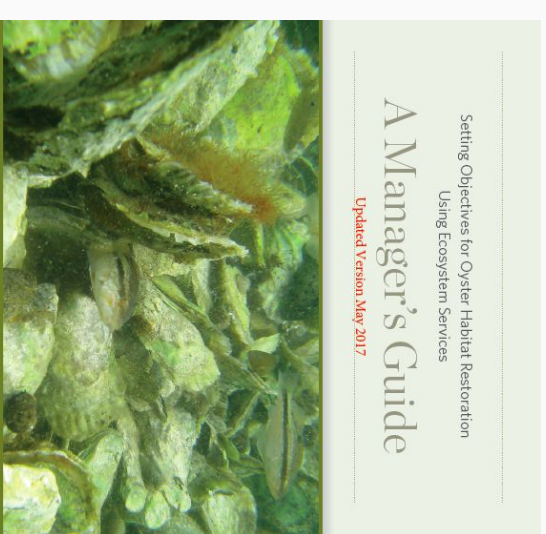


Figure 3. (Left to right) Mussels in tank at UNE; Mussels after pulled out of tank at UNE; Home

Share our learning with an authentic audience!

When  
children create  
for the world  
they make it  
**good.**

When children  
create only  
for their  
teacher they  
make it **good**  
**enough.**



Ruston Hurley @rushtonh

## Who did we work with?

We worked with local professors such as :

- Dr. Brian Beal of the University of Maine Machias
- Dr. Belknap of University of Maine system.
- Dr. Steneck of University of Maine system
- Dr. Jenn Page, Hurricane Island

- Maine Sea Grant
- Signs of the Seasons- Cooperative Extension

We also worked with the:

- Town Manager, Nat Tupper
- Shellfish Commission
- Harbor Committee
- Harbormaster, Officer Byron and


- Madeleine Point Oysters
- Basket Island Oysters
- The Nature Conservancy
- Antioch University

Officer Will Owen

Local institutions we worked with were the:

- |                                   |                                   |                           |
|-----------------------------------|-----------------------------------|---------------------------|
| ● Downeast Institute,             | ● Maine Campus Compact            | ● The Falmouth Forecaster |
| ● Maine Clamming Association      | ● University of New England       | ● Portland Press Herald   |
| ● Department of Marine Resources. | ● University of Maine             | ● Wolfe's Neck Farm       |
| ● Spatial Solutions - GIS         | ● Yarmouth Educational Foundation | ● New England Aquarium    |
| ● MEA                             | ● Samsung                         | ● Maine STEM              |
| ● Maine Public                    | ● Lexus Ecochallenge              | ● MAMMLE                  |
| ● Maine Institute for Aquaculture | ● Gulf of Maine Research Inst.    | ● WGME, WCSH              |
|                                   |                                   | ● SENCER                  |





"Our job is not to "prepare" kids for something; our job is to help kids learn to prepare themselves for anything."

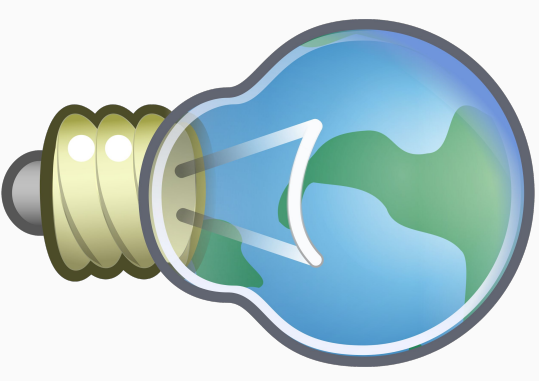
- Al Juliani @ajjuliani

[www.barradionetwork.com/Quoted](http://www.barradionetwork.com/Quoted)

## How is this learning different?

Overall life skills we feel we obtained:

- problem solving
- critical thinking
- working as a group
- summarizing data
- engineering designs
- connecting with nature
- connecting with our town
- speaking in front of group
- delegating tasks
- grit and perseverance
- working for more than a grade



## Top Skills for 2020 Workforce?

1. Complex problem solving
2. Critical thinking
3. Creativity
4. People management
5. Coordinating with others
6. Emotional intelligence

- *Forbes and Business Insider* - “The top 10 skills that will be in demand by all employers by 2020”



## ENGAGING STUDENTS

MEANS GETTING KIDS  
EXCITED ABOUT

OUR:

- CONTENT
- INTERESTS
- CURRICULA.

## EMPOWERING STUDENTS

MEANS GIVING KIDS  
THE KNOWLEDGE AND  
SKILLS TO PURSUE

THEIR: - PASSIONS  
- INTERESTS  
- FUTURE

KIDS NEED TO BE  
(EMPOWERED NOT ENGAGED)



**Take a risk!**

**Empower your students!**

**Connect with your  
community!**