Winter 1-17-2020

Mussel Sector: Maine in 2020

Carter Newell

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Carter Newell, Ph.D, Pemaquid Mussel Farms www.pemaquidmussels.com

Development goal: 5 fold increase in production within 10 years to $15 million annually

Mussels are good for you: superfood!

Nutrition Facts

Serving Size: 3 oz (85g)

Amount Per Serving	
Calories 146	Calories from Fat 34
	% Daily Value*
Total Fat 3.81 g	**6%**
Saturated Fat 0.72 g	**4%**
Trans Fat	
Cholesterol 47.6 mg	**16%**
Sodium 313.65 mg	**13%**
Potassium 227.8 mg	**7%**
Total Carbohydrate 6.28 g	**2%**
Dietary Fiber 0 g	**0%**
Sugars	
Sugar Alcohols	
Protein 20.23 g	
Vitamin A 258.4 IU	5%
Vitamin C 11.56 mg	19%
Calcium 28.05 mg	3%
Iron 5.71 mg	32%

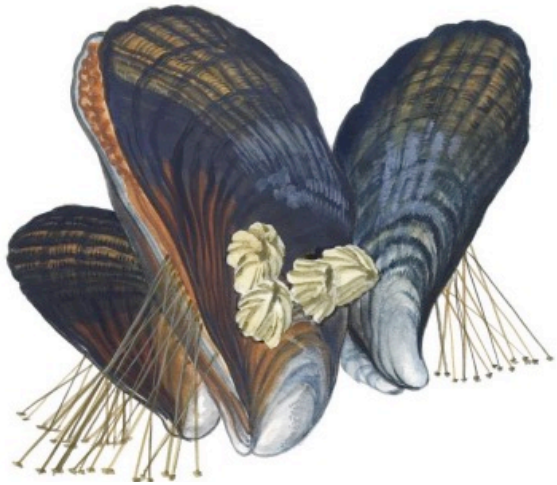
- High in Protein
- Low in Calories
- Good source of Omega-3 fatty acids (heart healthy)
- Good source of vitamin B-12, vitamin C, vitamin A, iron, selenium, calcium iodine and zinc

Farmed mussels are sustainable

Monterey Bay Aquarium
Seafood Watch

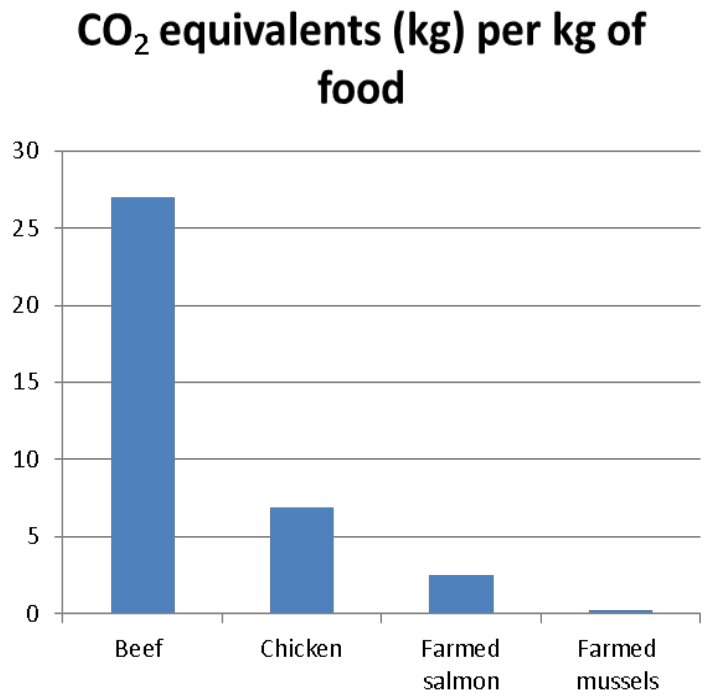
Farmed Mussels

Mytilus spp., *Perna* spp.

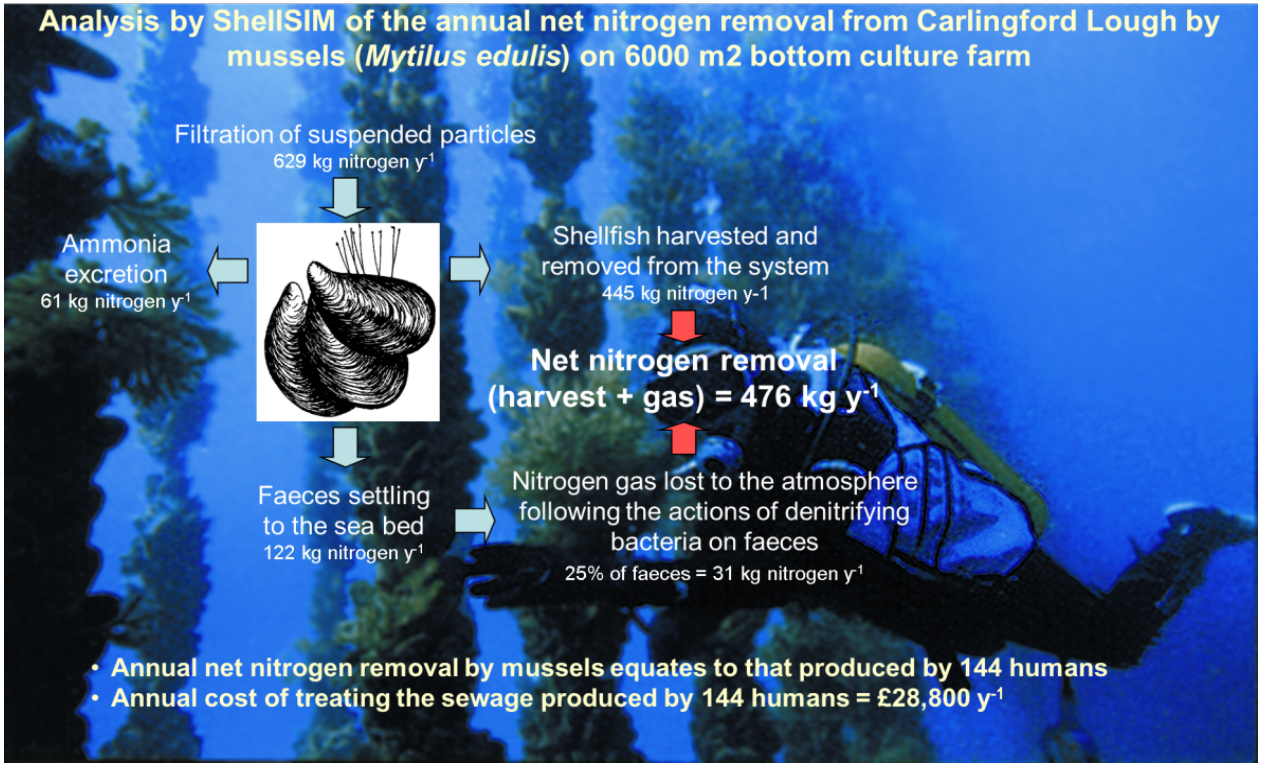


Monterey Bay Aquarium
Seafood Watch

BEST CHOICE

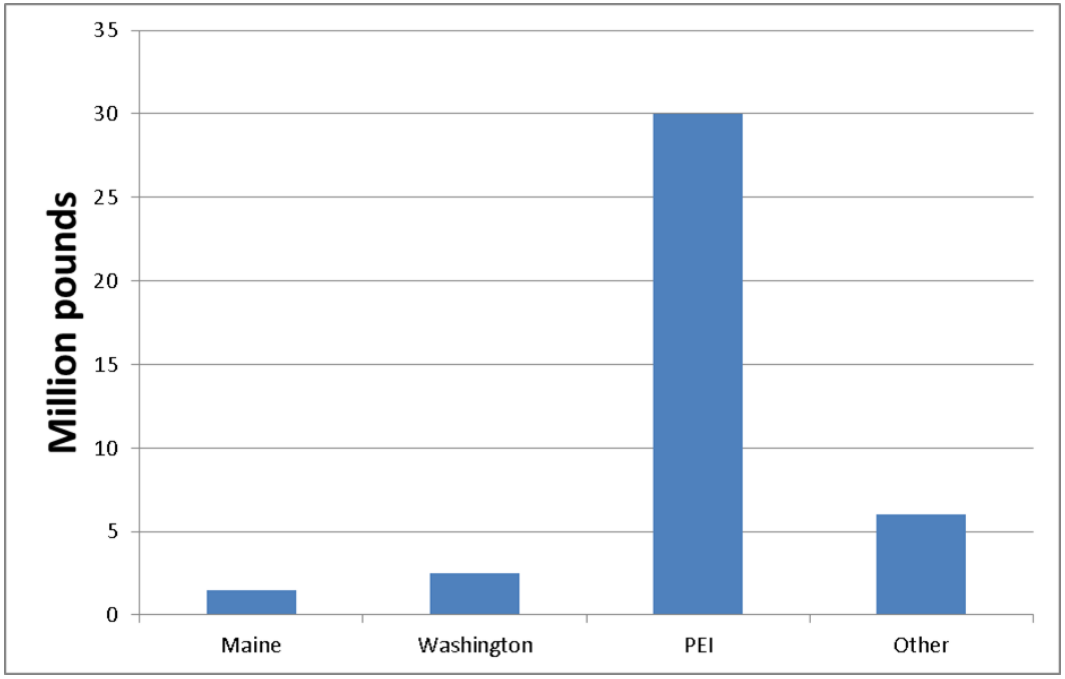


- Mussels improve water quality by reducing turbidity and increasing light penetration for submerged aquatic vegetation (SAV's)
- They reduce nitrogen causing coastal eutrophication
- They increase the biodiversity and biomass of marine organisms where the farms are located*
- They are a cold water species and grow in temperatures under 20 C



*Smaal, A.C., Ferreira, J.G., Grant, J., Petersen, J.K. and Strand, Ø. eds., 2018. *Goods and services of marine bivalves*. Springer

Maine and U.S. mussel production lags way behind imports



World production of farmed mussel is over 3.5 BILLION pounds

Is there a demand for high quality mussels from Maine?

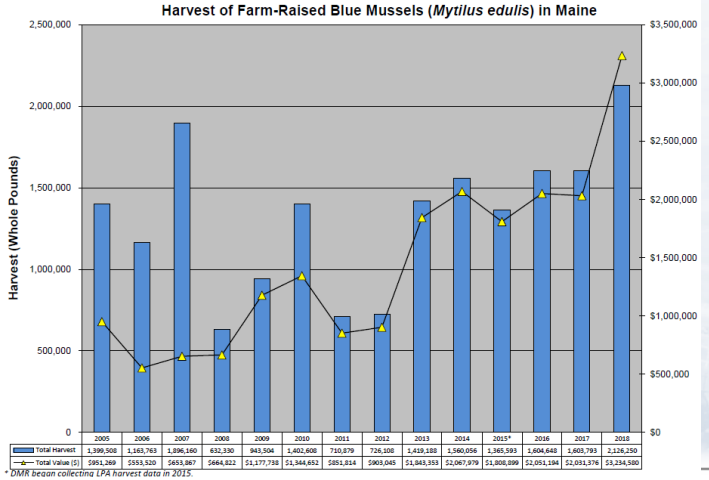
Projected 10-fold demand increase for Maine rope-grown mussels

The PAST

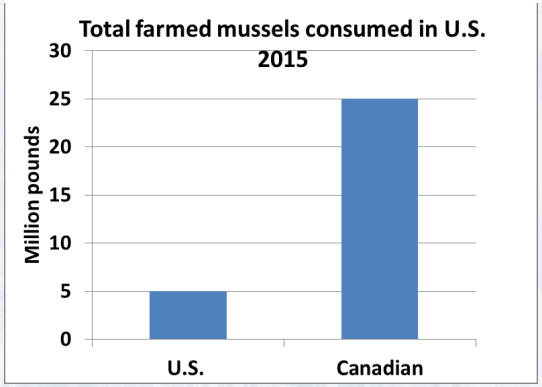
Total Maine farmed about **500,000 lbs**

Total wild about 12 million pounds

Production starting to rise



Most mussels imported



The PRESENT

Only about 1 million lbs. worth $2 million rope grown

The FUTURE

Demand for **$15 million** rope grown

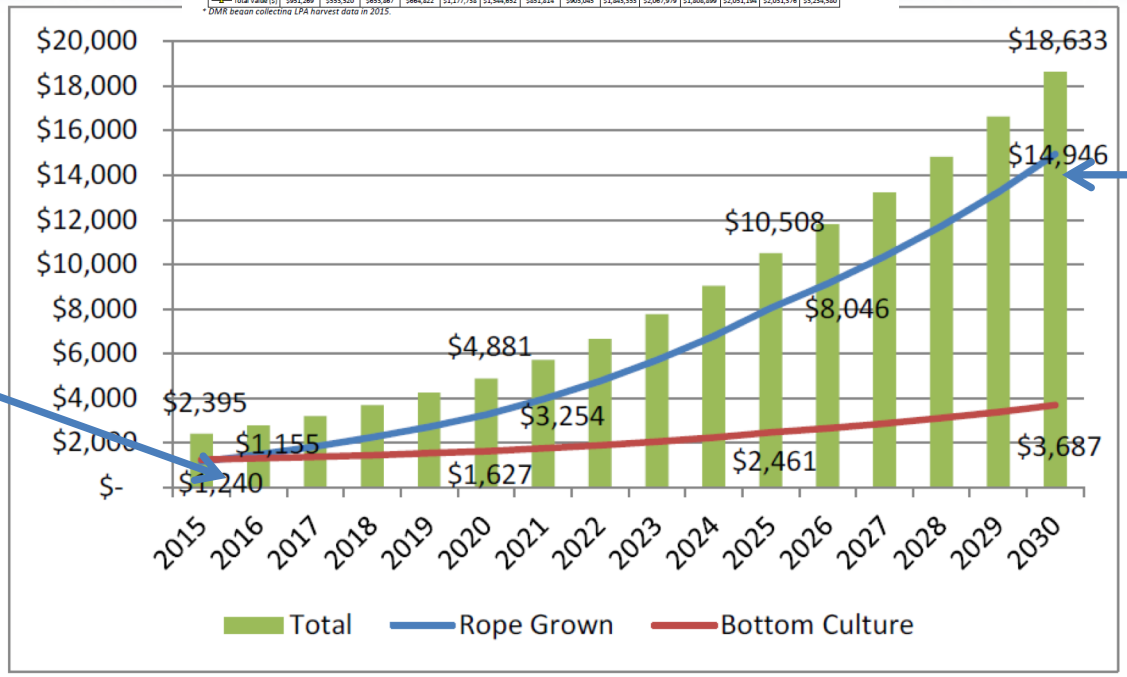
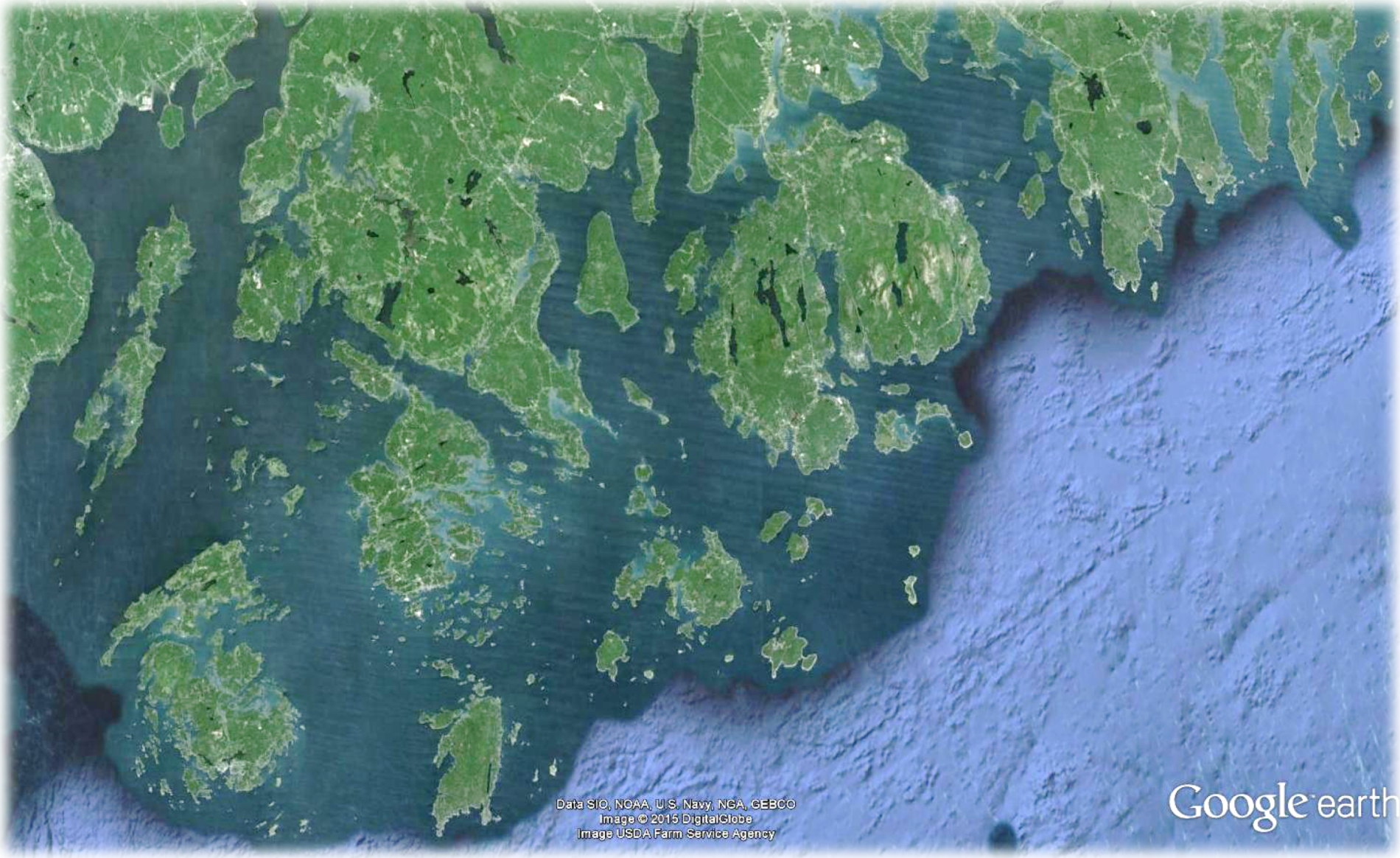


Figure 35. Projected Maine farmed mussel revenue 2015 - 2030 (best estimate scenario). Source: The Hale Group research

*GOMRI study by the Hale Group (2016)

Maine has vast amounts of semi-exposed bays suitable for mussel farming



Raft culture is the future (due to ducks)

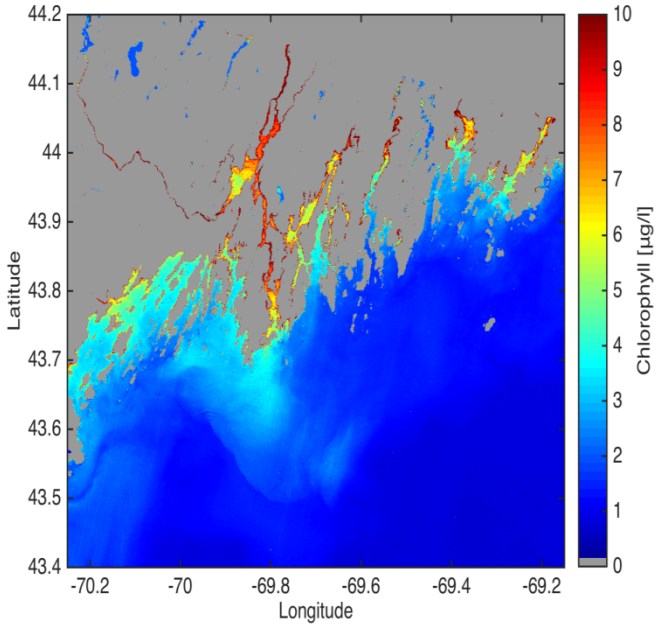
Bottom culture

Raft culture

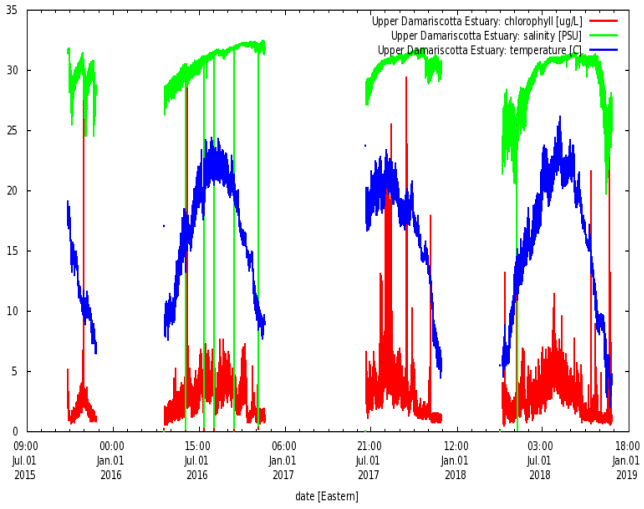
Longline culture

Advances in coastal oceanography and modeling in support of shellfish aquaculture development: NSF, Sea Grant

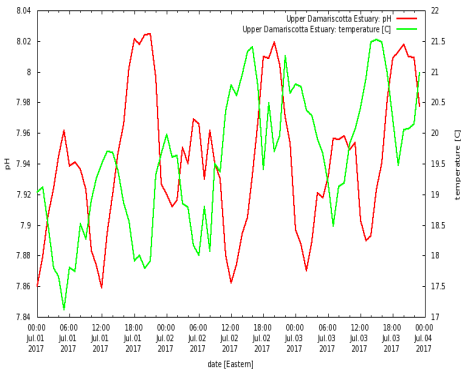
- **Remote sensing** of shellfish growth drivers (conditions which are optimal for shellfish growth and farm productivity): **SPATIAL COVERAGE**
- Use of continuous **monitoring buoys** in shellfish growing areas to understand what drives primary production and food quality in the coastal zone. **TEMPORAL COVERAGE**



Chlorophyll a mid-coast Maine

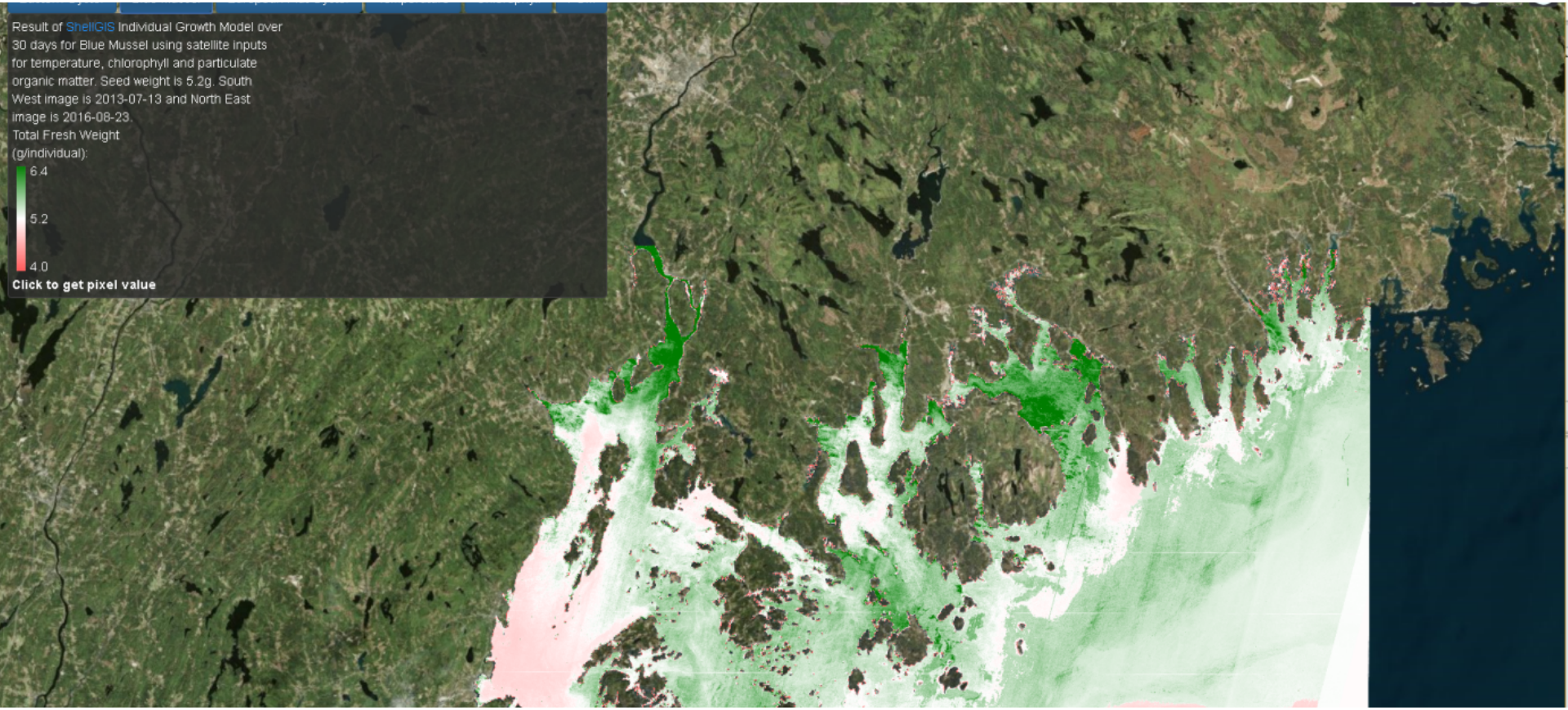


Temp, sal, chl a over 4 years



pH and temp over 2 tidal cycles

REMOTE SENSING AND MODELLING (shellsim applied to each pixel)
MAINE Relative growth of blue mussels based on satellite image of temp, chl a, and derived POM in Eastern Maine



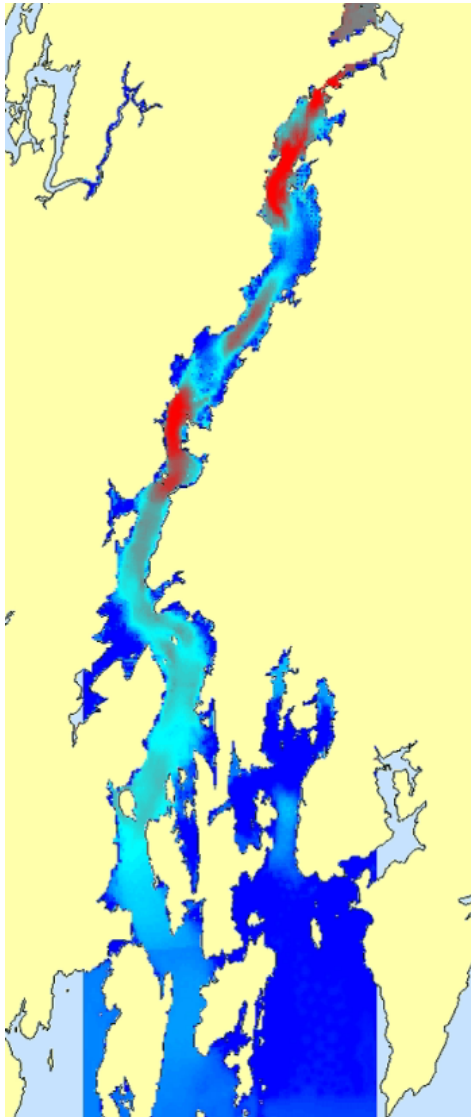
http://www.shellgis.com/examples/TFWMidMaine.html

Point and click to get growth results for 1 month

MAINE Bivalve production modeling in a GIS system populated with 50 m resolution mean water velocity, time series of shellfish growth drivers (temp, sal, chla, POM, SPM), seeding density

Predicted growth at all locations over a growing season

SHELLGIS
Blue mussel growth over entire estuary at seeding density of 200 m^{-2}



Needs time series of growth drivers

- Buoys
- Water samples

Needs modeled water velocities

Concept : New Technology

Technology readiness levels (TRL)*

- TRL 1 – **basic principles** observed
- TRL 2 – technology **concept formulated**
- TRL 3 – experimental **proof of concept**
- TRL 4 – technology **validated in lab**
- TRL 5 – technology **validated in relevant environment**
- TRL 6 – technology **demonstrated in relevant environment**
- TRL 7 – system prototype **demonstration in operational environment**
- *TRL 8 – system **complete and qualified***
- *TRL 9 – actual system **proven** in operational environment*

SUBMERSIBLE RAFT CONCEPT 2011

COMMERCIALIZATION 2017-2019

Valley of death

** From the Scottish Aquaculture Innovation Center (SAIC)*

Timeline

R

$600,000

D

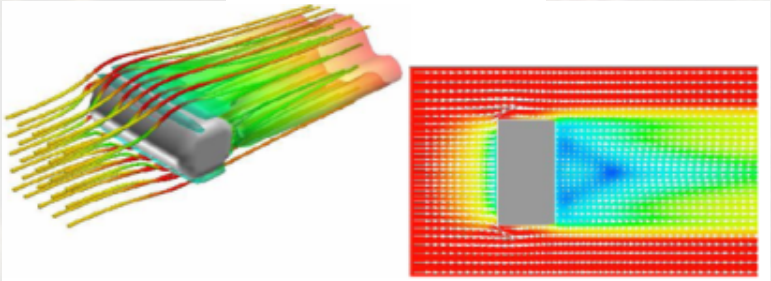
$1,500,000

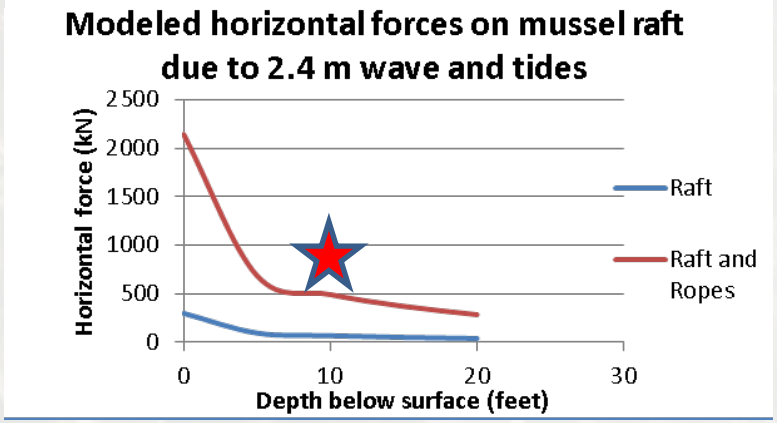
- MTI **Phase O** - $5,000 support for Phase I proposal – especially commercialization plan 2012
- USDA SBIR **Phase I** - $100,000 scale model testing, CFD models, raft design, blueprints, structural model 2013
- USDA SBIR **Phase II** - $450,000 materials testing, engineering, scale models, field testing of Mark I full scale raft 2014-2016
- MTI Business Accelerator Grant (**BAG**) - $50,000 patent applications, business plan, website, technology transfer, MCED Top Gun, commercialization 2014-2016
- 2 utility patents obtained
- Formation of **new** raft **company** Undine Marine 2016 and R+D partnership Pemaquid Mussel Farms
- Me Dept. Agriculture **Development grant** to Undine $50,000 matched by $30,000 for Mark II (2017)
- **Pemaquid Mussel Farms $1.5 Million commercialization (2017-2019) for 9 raft farm growing 500 tons per year.**
- Projected **$1.5 million annual sales** generating 25% EBITA, franchise model to $15 million annual sales (if successful)

Preliminary design work

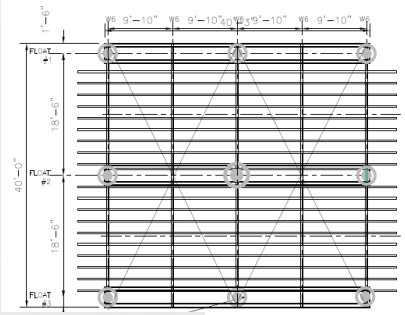
Materials testing: HDPE vs FRP

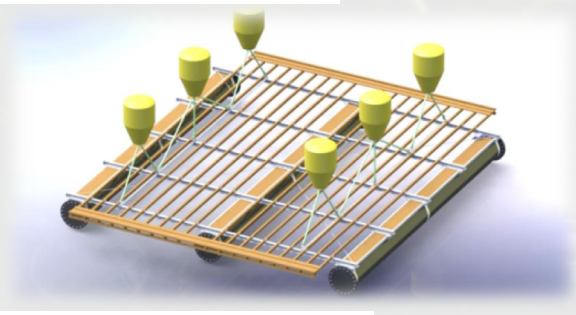
CFD analyses



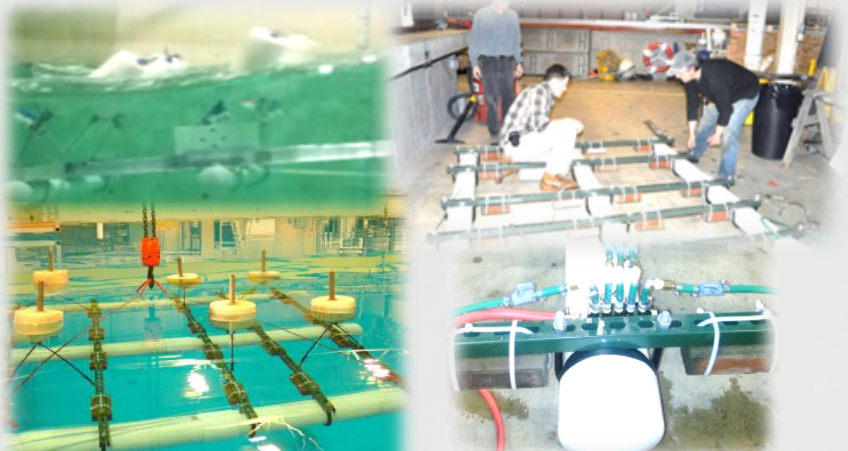


Structural and CAD Models

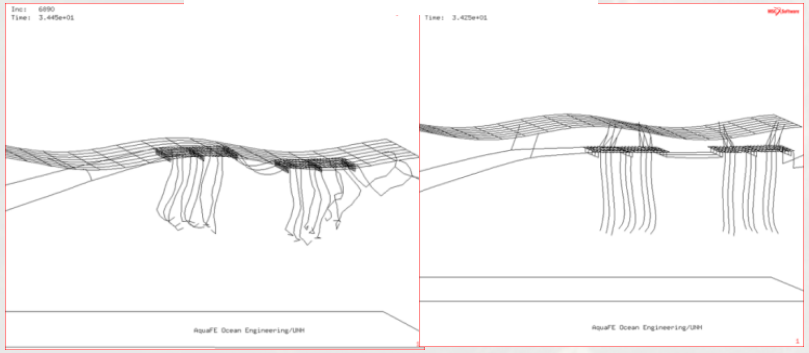




1/10 and 1/5 scale models



AQUA FE Model



Construction and deployment

- Modular components assembled at steel yard
- 1 ton plow anchors, lines and tension buoys assembled on barge
- Raft “kit” delivered at low tide, assembled, towed to site and tensioned in one day

Performance and yield

Station keeping



Seed collection

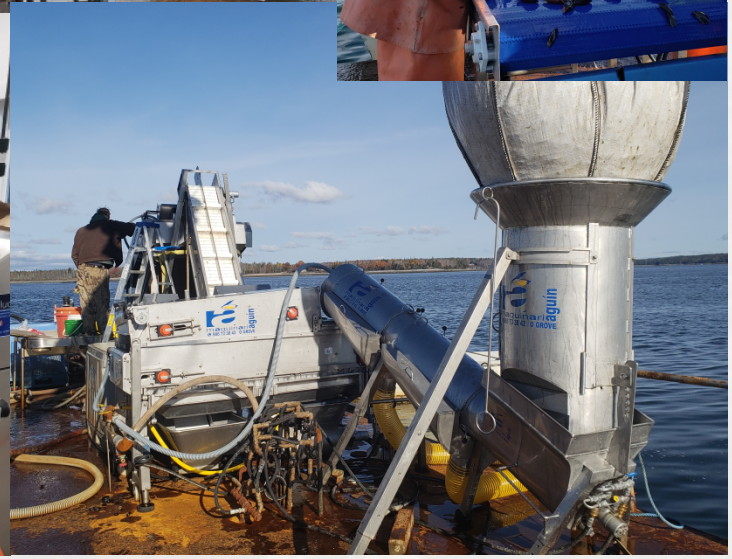
Feeding behavior

Commercialization requires integrated business plan

Economy of scale needed 9 rafts in a grid, advanced harvesting and processing machinery, bagging and cold storage distribution center

Processing at sea

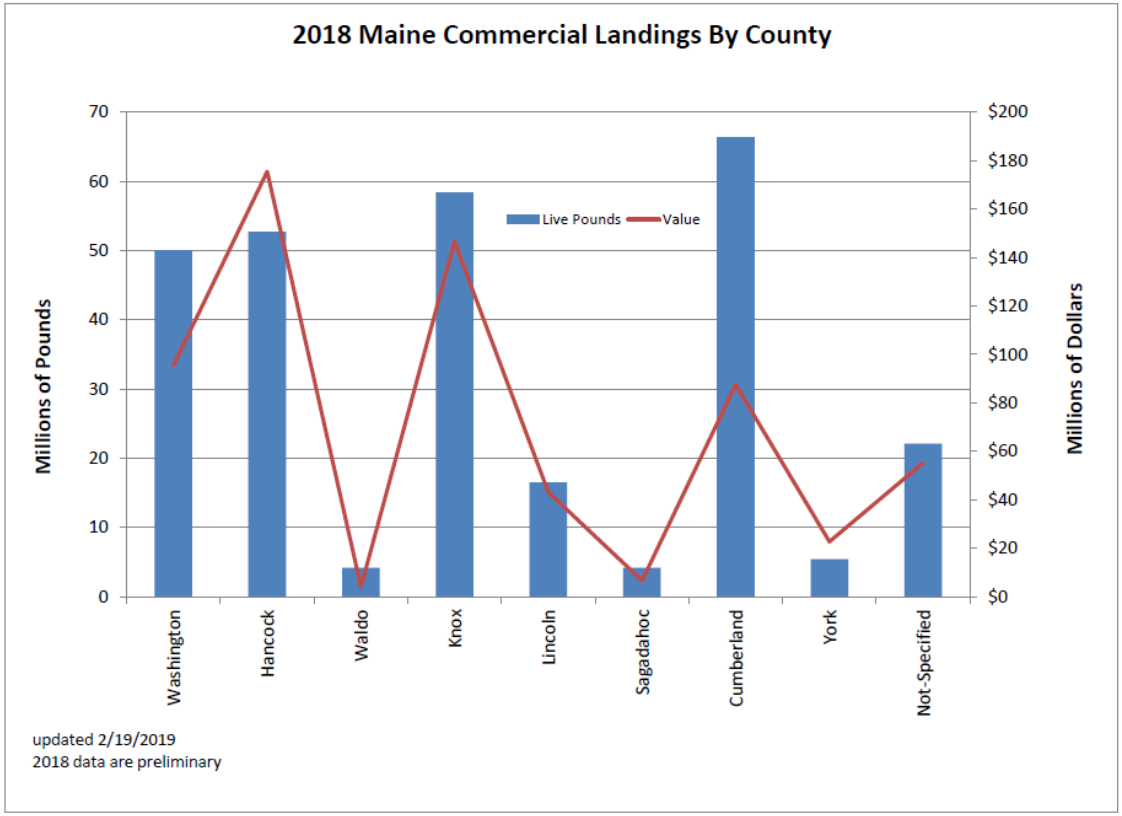
Packing, cold storage and distribution center



Bagging and tagging line

Workforce development and SES

Location of existing fishing fleet in Maine – locate the farms where there is an existing fleet of fishermen with local knowledge and infrastructure



New Zealand has a good model of **training** based on industry-supplied skills needed by the employees to carry out ocean based and land based operations

Fishermen training is not your typical STEM-based pathway and requires innovation

- Growing, harvesting and processing technology is key to maintaining a profitable business enterprise (tech transfer)
- Reducing risk from Eider Duck, starfish predators
- Storm damage
- Red tides, pollution closures
- Automation of predator net cleaning
- Automation of submerged aquaculture systems
- Ocean acidification and wild mussel seed
- Outcome based research model (SAIC, Scotland) the best way to go instead of single agency RFP processes
- Come to my session to learn more about optimizing seed collection, site selection, production technology and R+D priorities
- Development of value added products will double jobs and value in this sector

Where can we go from here?

- Use the husbandry questions from growers as a guide to research
- Learn more about our mussel growing areas
- Experiment with different strategies
- Collaborate across regions to test hypotheses and create a knowledge base for good decision making