East Coast Hard Clam Selective Breeding Collaborative-NYSG

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A. Clemetson, H. Yang, K. Bunting-Howarth, R. Shuford

East Coast Hard Clam Selective Breeding Collaborative: Research Updates

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County of Barnstable Massachusetts

Antoinette Clemetson
Sea Grant New York

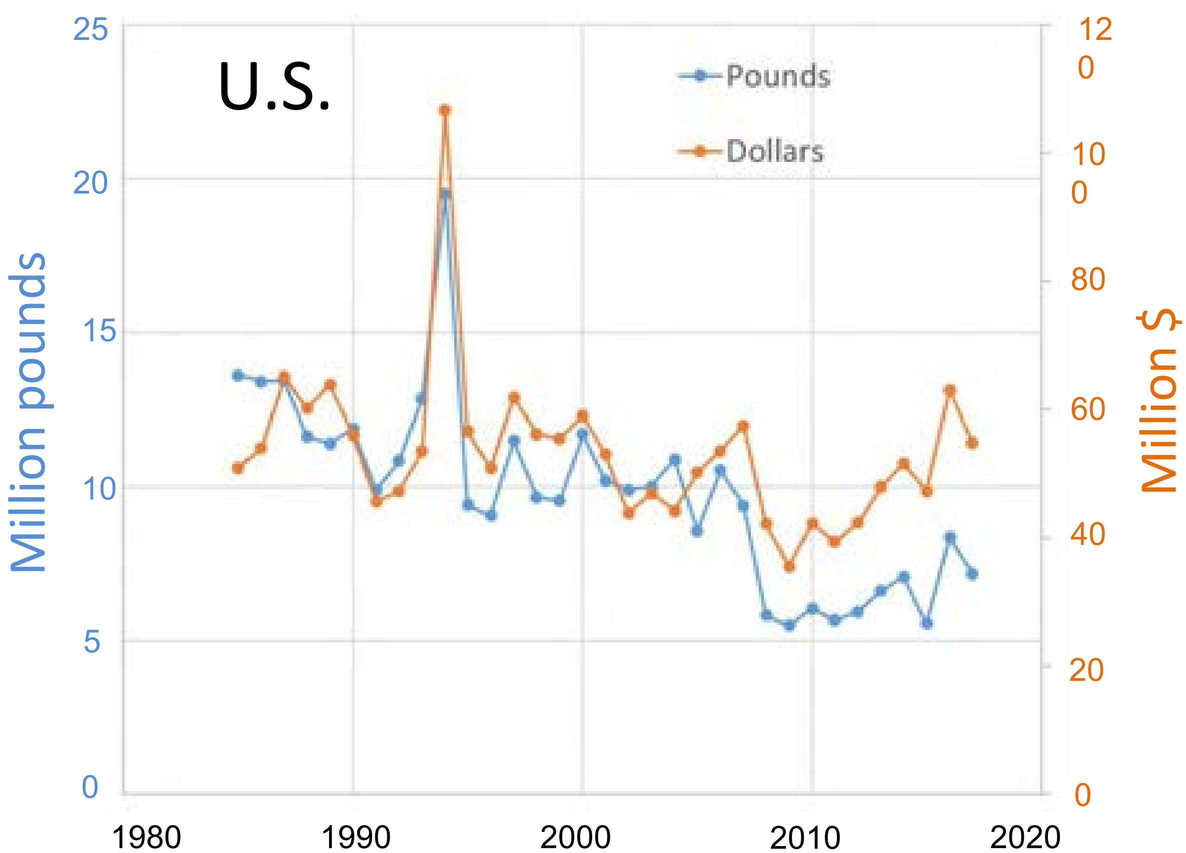
Ximing Guo
Rutgers

Sea Grant Aquaculture Research Symposia, 11/3/2021

Partners

- **Advisory panel**: Pete Rowe (NJSG), Dina Proestou (USDA), Brent Vadopalas (WASG), Karen Rivara (ECSGA), Joseph Vinarski (FMF), Wade Carden (NYSDEC)
- **Research team**: Bassem Allam, Emmanuelle Pales Espinosa, Sarah Farhat, Arnaud Tanguy, Kimberly Reece, Jan McDowell, Huiping Yang, Leslie Sturmer, Gregg Rivara, Joshua Reitsma, Michael Deluca and Ximing Guo
- **Extension team**: Antoinette Clemetson, Katherine Bunting-Howarth, Pete Rowe, Lisa Calvo, Leslie Sturmer, Bruce Barber, Karen Hudson, Joshua Reitsma
- **Industry members**: Industry partners in each of the 5 states (private growers, town hatcheries)

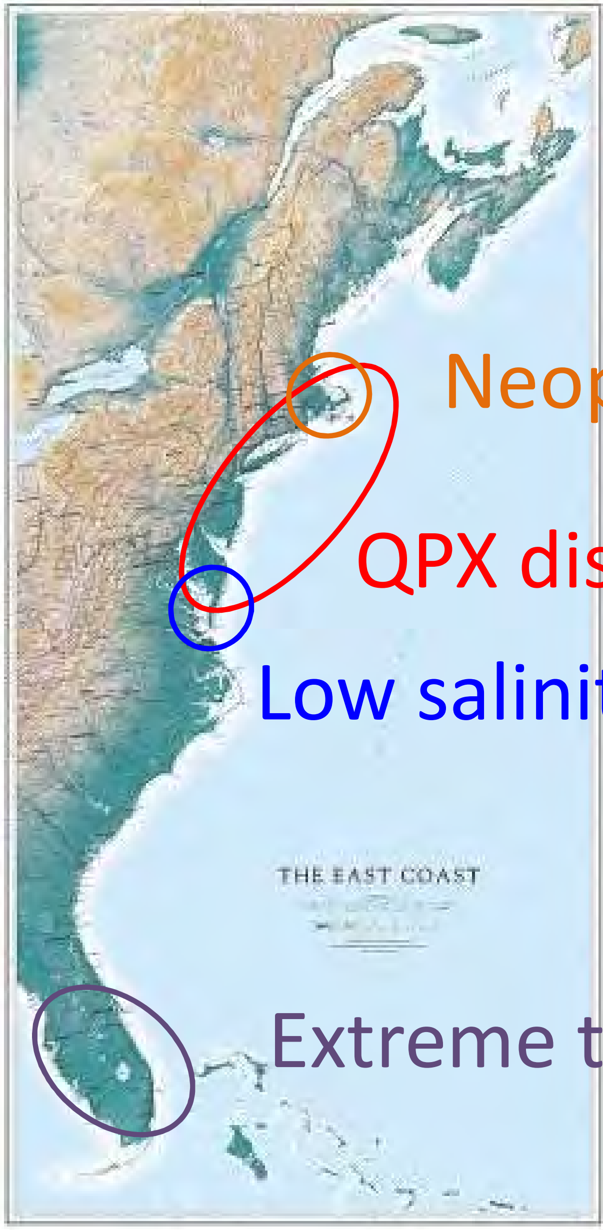
The hard clam (northern quahog), *Mercenaria mercenaria*



VA

Aquaculture production in VA.
Hudson 2019

Some of the hampers to clam aquaculture growth



Market constraints

Predation

Disease outbreaks

Extreme environmental factors

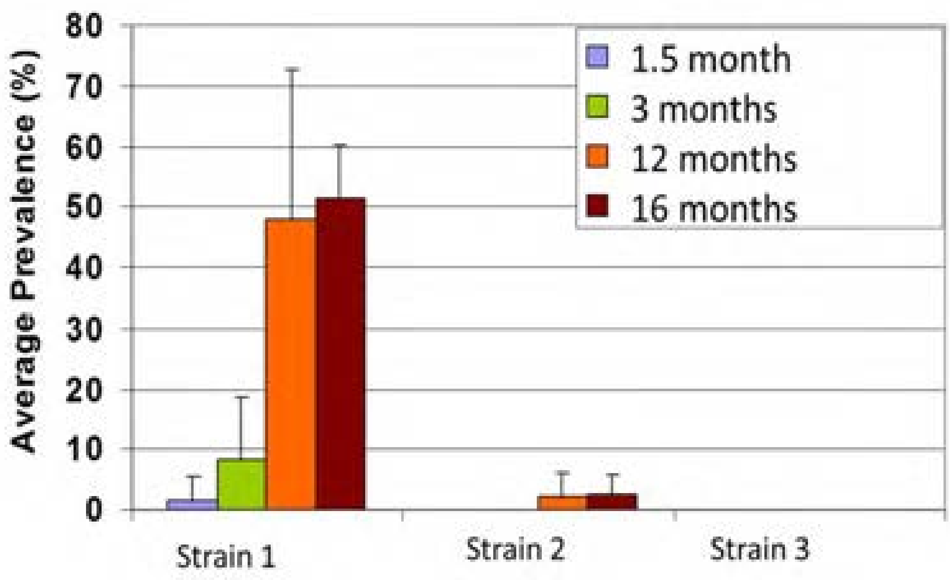
Overall objective:

Establish selective breeding programs to produce better adapted strains to the various growing landscapes

How we got here?

Clams are not all equal towards QPX

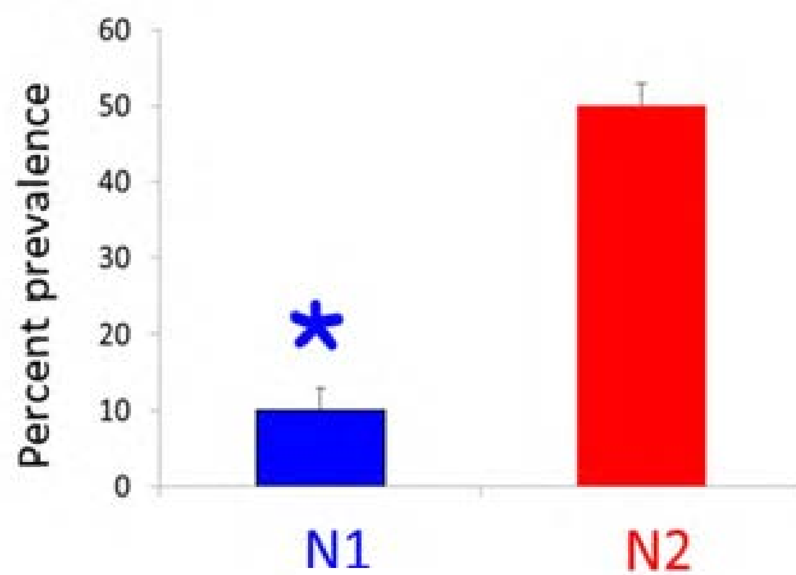
Experiment 1 (deployed in NY)



Dahl et al. 2010

Seed type

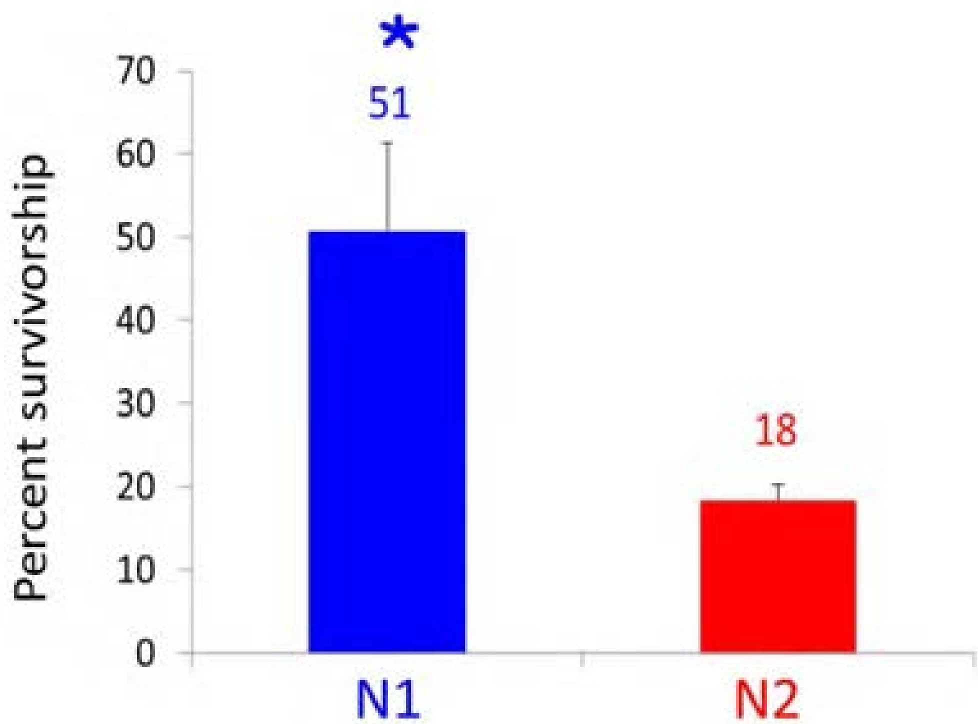
Experiment 2 (deployed in MA)



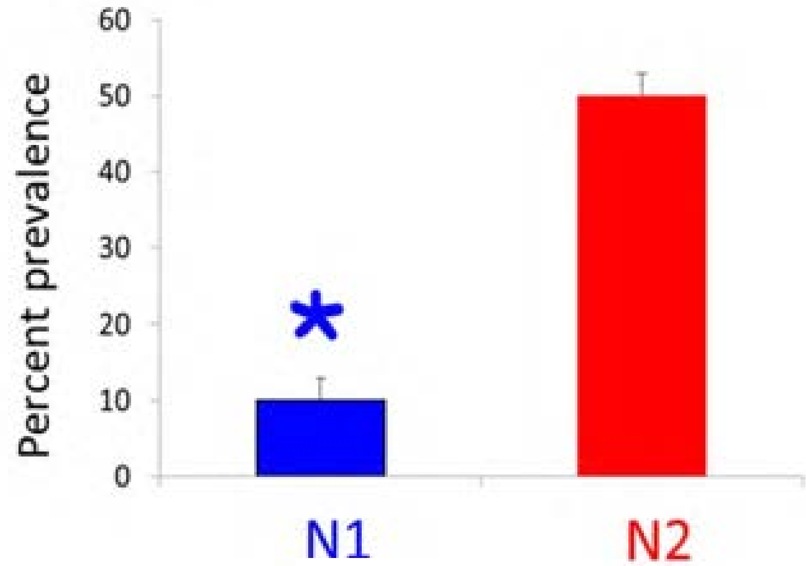
Seed type

Farhat et al. 2020

Clams are not all equal towards QPX



Experiment 2 (deployed in MA)



Seed type

Farhat et al. 2020

Develop heat-resistant strains for southern growers

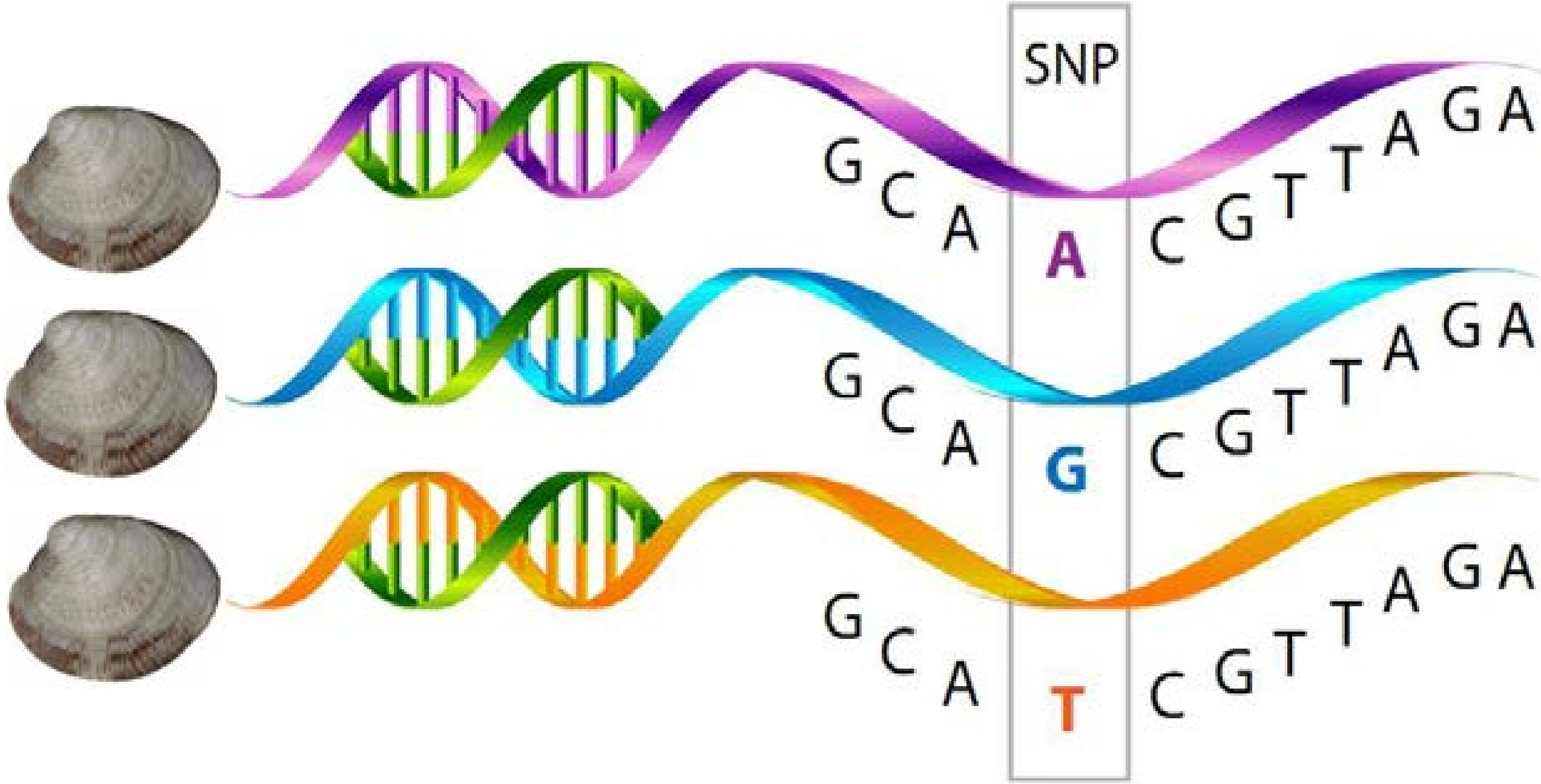
- Previous effort:
  - Hybridization (with *M. campechiensis*)
  - Evaluation of heat shock protein as biomarker
  - Transcriptome analysis for marker identification

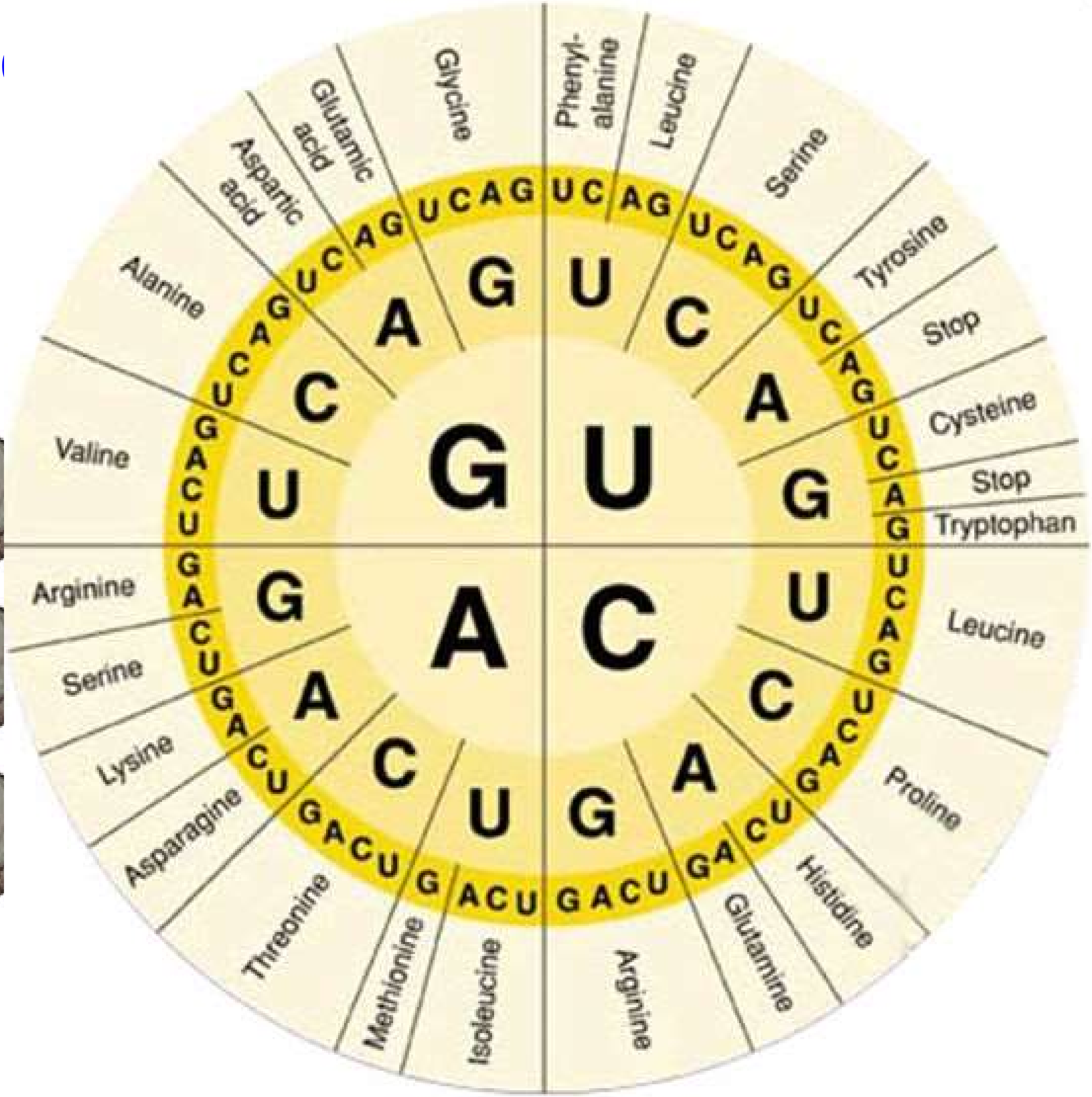
FIGURE 1. From left to right: samples after 8-months of growout of *Mercenaria mercenaria* (*Mm*), hybrid (♀*Mm* x ♂*Mc*), hybrid (♀*Mc* x ♂*Mm*), and *M. campechienis* (*Mc*).

Strumer et al. 2010

Our approach: Use of genetic features associated with resistance to improve breeding

Single nucleotide polymorphism (SNP)




G
U
A
C
Phenyl-
alanine
Leucine
Serine
Tyrosine
Stop
Cysteine
Stop
Tryptophan
Leucine
Proline
Histidine
Glutamine
Arginine
Isoleucine
Methionine
Threonine
Asparagine
Lysine
Serine
Arginine
Valine
Alanine
Aspartic
acid
Glutamic
acid
Glycine

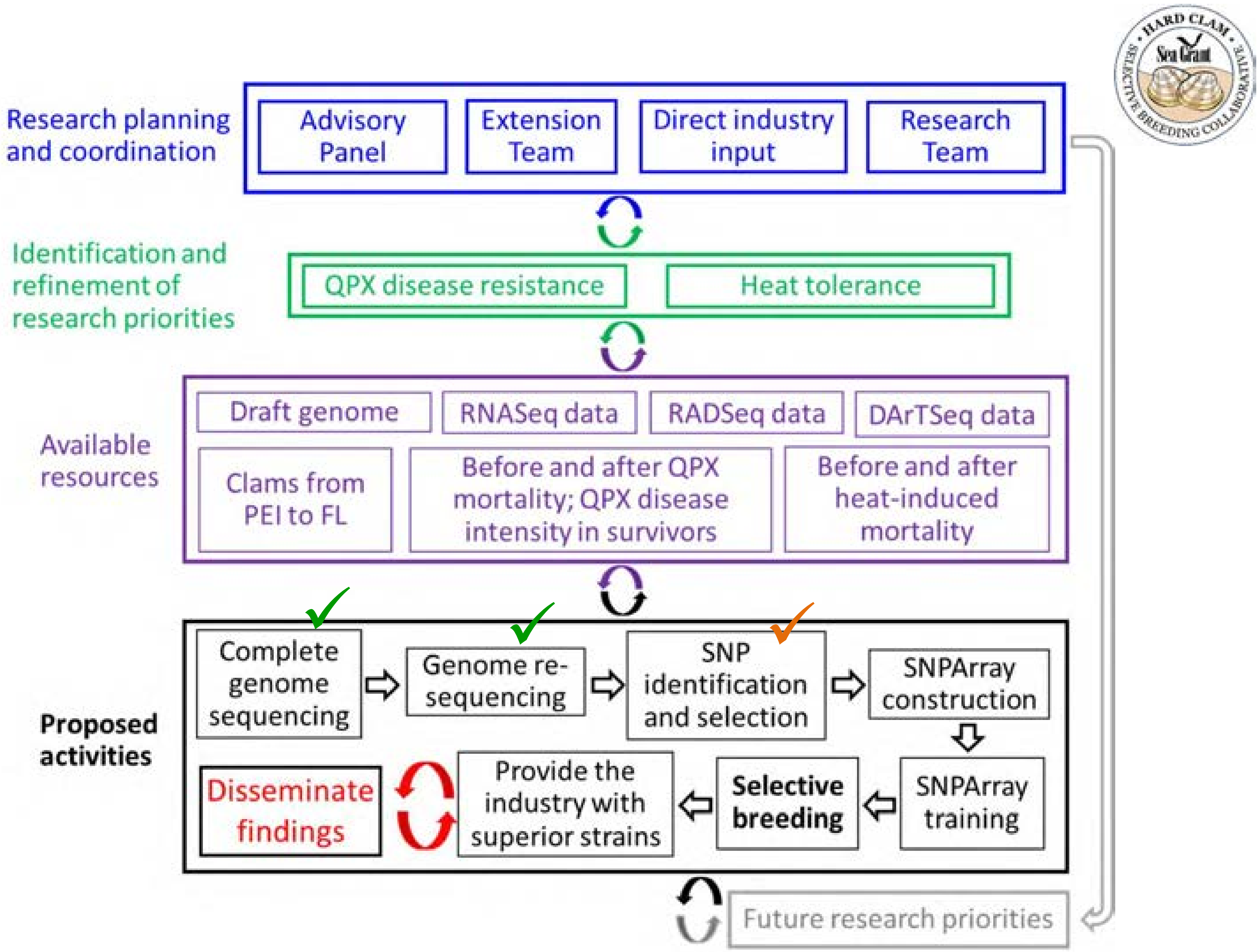
A

A

A

Specific objectives of this NOAA collaborative

- Sequence, assemble and annotate the hard clam genome and develop a cost-effective genotyping platform (SNP array) for *M. mercenaria*
- Use this tool to enable genome-assisted selection for QPX resistance and heat tolerance
- Build a regional hard clam breeding program linking scientists, extension and the industry


HARD CLAM
Sea Grant
SELECTIVE BREEDING COLLABORATIVE
Research planning and coordination
Advisory Panel
Extension Team
Direct industry input
Research Team
Identification and refinement of research priorities
QPX disease resistance
Heat tolerance
Available resources
Draft genome
RNASeq data
RADSeq data
DArTSeq data
Clams from PEI to FL
Before and after QPX mortality; QPX disease intensity in survivors
Before and after heat-induced mortality
Proposed activities
Complete genome sequencing
Genome re-sequencing
SNP identification and selection
SNPArray construction
SNPArray training
Selective breeding
Provide the industry with superior strains
Disseminate findings
Future research priorities

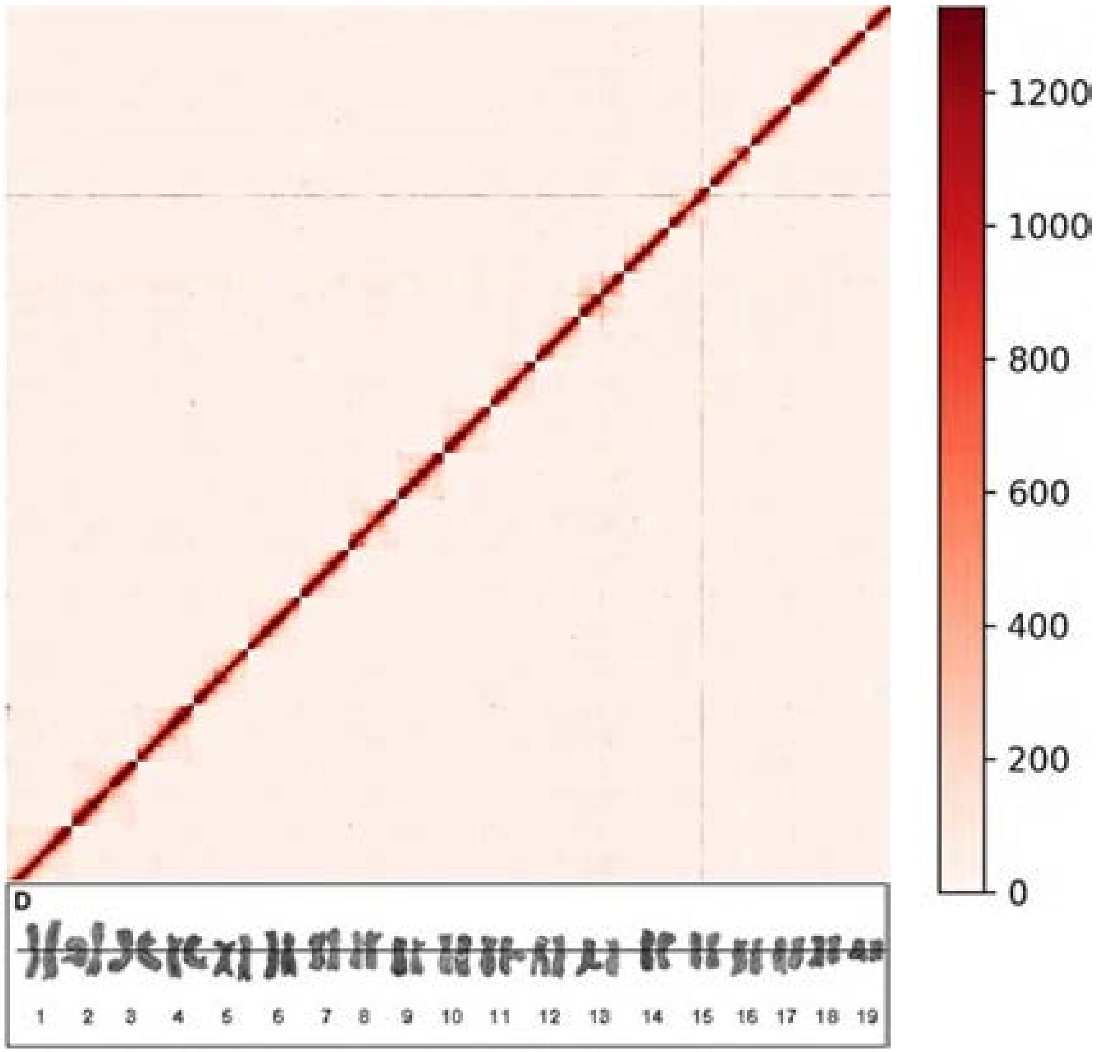
Chromosome-level assembly produced

PACBIO

illumina

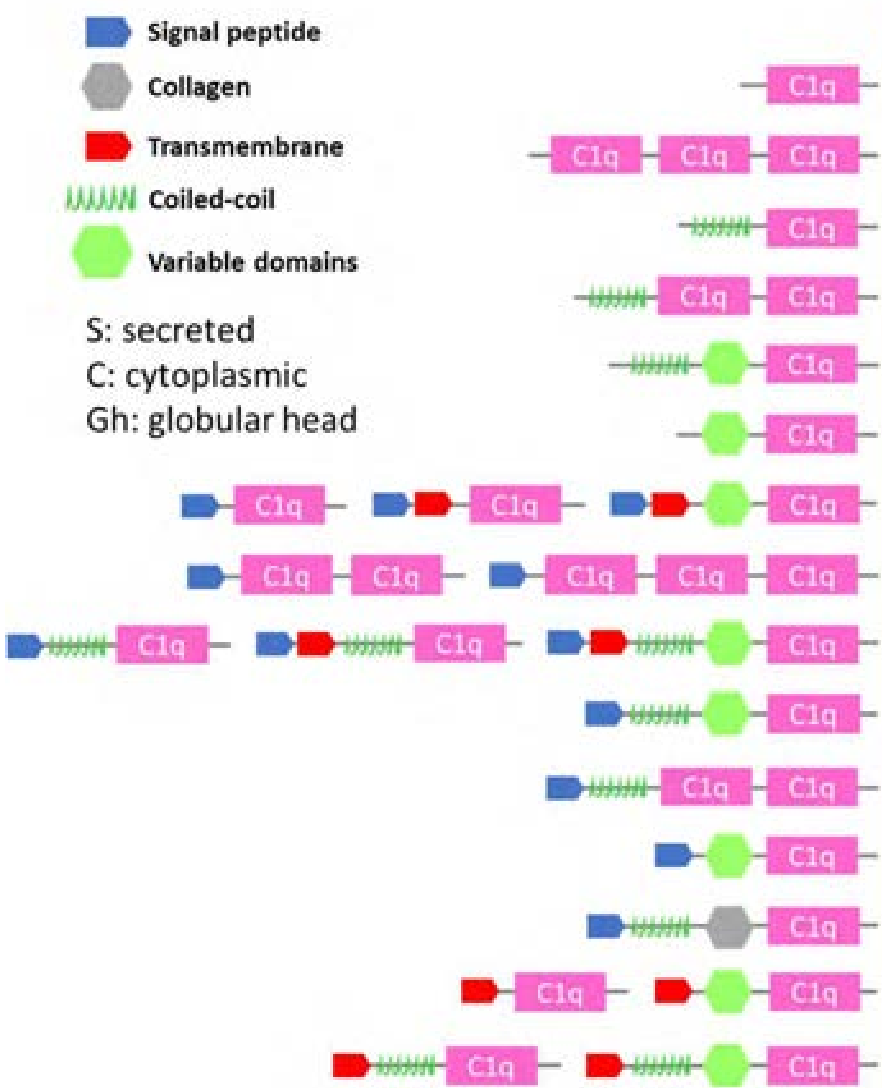
Hi-C Technology

10 x technology



Karyotype from Wang and Guo, 2007

Broad diversity of complement 1q proteins (over 400 c1q domain-containing genes)



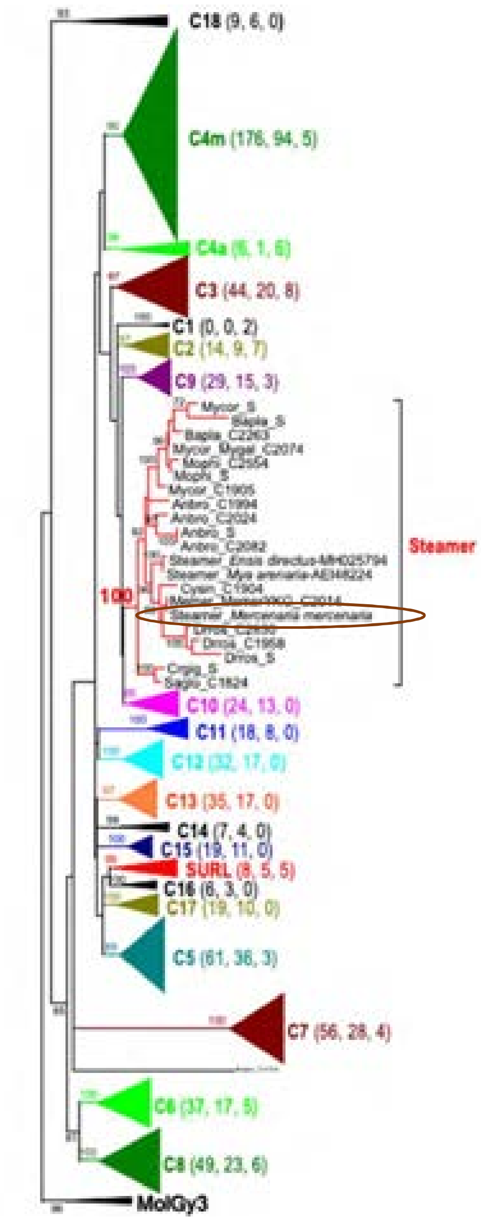
Type	Localization	#	#	#
cghC1q	Cytoplasmic	106		
multiC1q	Cytoplasmic	3		
cC1q-like type 2	Cytoplasmic	29		
multiC1q-like type 2	Cytoplasmic	1		
cC1q-like type 2	Cytoplasmic	13		
cghC1q	Cytoplasmic	19		
sghC1q	Extracellular	33	3	3
smultiC1q	Extracellular	1	1	
sC1q-like type 2	Extracellular	157	8	4
smultiC1q-like type 2	Extracellular	2		
sghC1q	Extracellular	9		
sC1q-like	Extracellular	2		
tmghC1q	Transmembrane	10	1	
tmC1q-like type 2	Transmembrane	3	2	

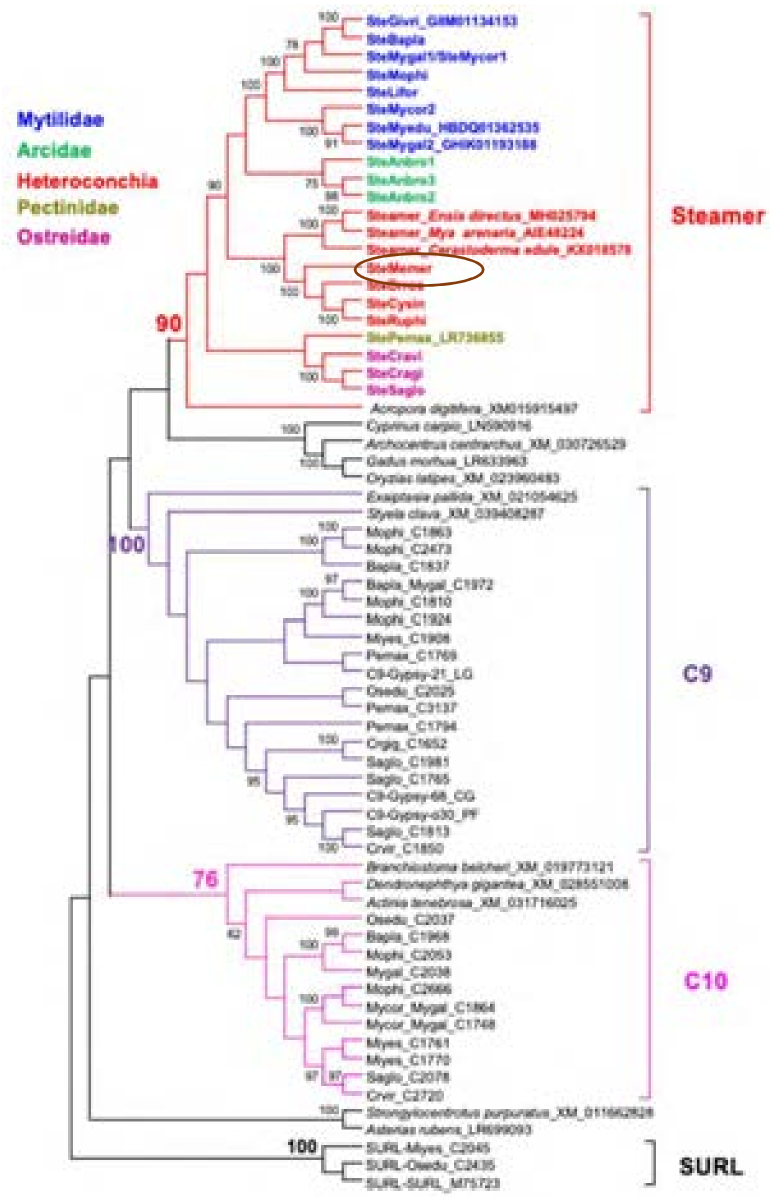
Empirically shown to bind QPX

Tumor necrosis factor (TNF) domain-containing genes

	Aplysiida	Mytiloida					Pectinida		Ostreida				Arcoida	Cardiida	Myida	Venerida						
Orthogroup	Aplysia californica	Mytilus coruscus	Mytilus galloprovincialis	Limnoperna fortunei	Modiolus philippinarum	Bathymodiolus platifons	Pecten maximus	Mizuhopecten yessoensis	Saccostrea glomerata	Ostrea edulis	Crassostrea gigas	Crassostrea virginica	Anadara broughtonii	Sinonovacula constricta	Dreissena rostriformis	Lutraria rhynchaena	Archivesica marissinica	Cyclina sinensis	Ruditapes philippinarum	Mercenaria mercenaria	**Total**	
TNF Mollusca																						
OG0000926	1	5	8	4	4	3	8	13	2	2	3	3	4	3	14	3	6	3	2	**3**	**94**	
TNF Bivalvia																						
OG0000639	0	3	9	2	5	2	0	0	1	2	1	1	3	5	11	14	4	6	9	**24**	**102**	24%
OG0000960	0	1	2	1	0	0	0	0	0	1	1	1	3	0	0	16	1	6	11	**22**	**66**	33%
OG0004827	0	0	0	1	1	1	0	0	0	0	0	0	0	8	2	2	1	15	1	**2**	**34**	
OG0017573	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	**2**	**7**	
TNF Heteroconchia																						
OG0005640	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	3	**12**	**20**	60%
OG0014042	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	2	**2**	**13**	
OG0015779	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	**2**	**9**	
OG0015781	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	1	2	**2**	**9**	
TNF Specific to Mercenaria																						
OG0034212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**	**2**	
OG0028962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**	
OG0043344	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**	
OG0043346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**	

Phylogenetic relationships of bivalves Gypsy retrotransposons





Genome paper recently submitted

BMC Genomics

Comparative analysis of the Mercenaria mercenaria genome provides insights into the diversity of transposable elements and immune molecules in bivalve mollusks

--Manuscript Draft--

Manuscript Number:	GICS-D-21-00500

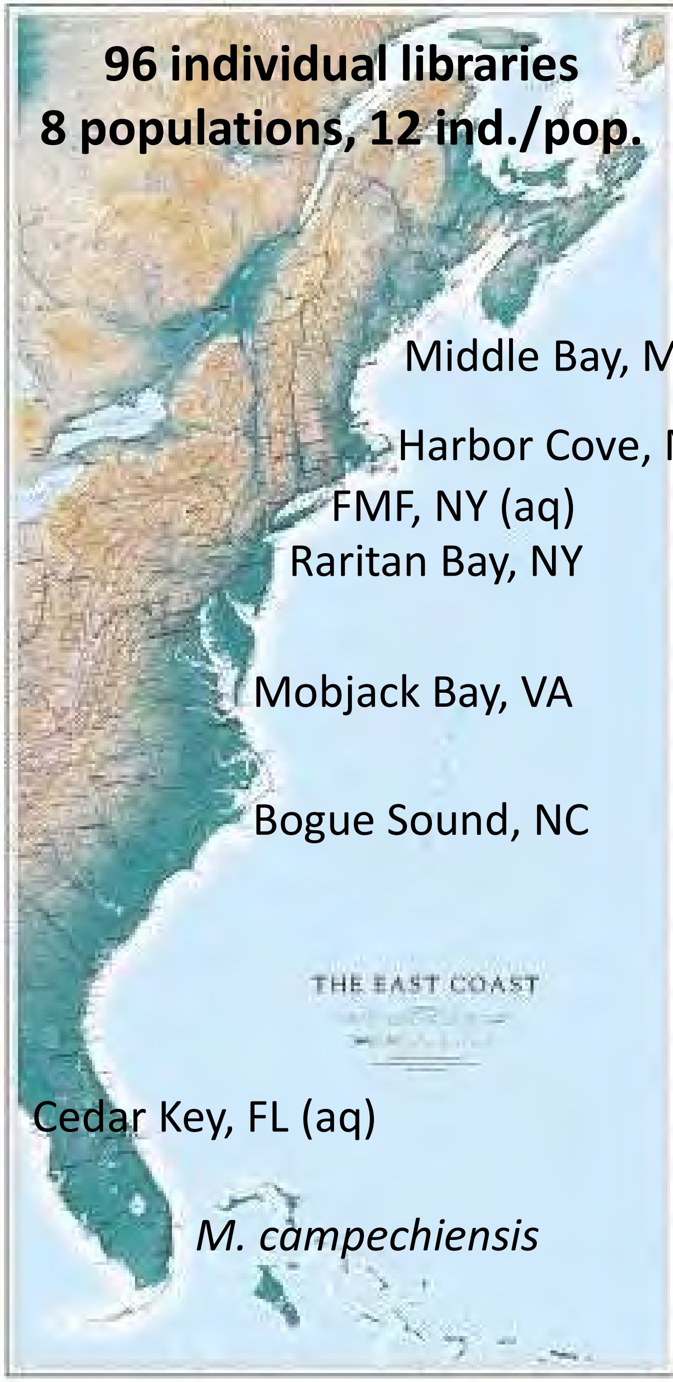
Sarah Farhat[a], Eric Bonnivard[b], Emmanuelle Pales Espinosa[a], Arnaud Tanguy[b], Isabelle Boutet[b], Nadège Guiglielmoni[c], Jean-François Flot[c,d] and Bassem Allam[a*]

a Stony Brook University School of Marine and Atmospheric Sciences

b SORBONNE UNIVERSITÉ

c,d ULB UNIVERSITÉ LIBRE DE BRUXELLES

Genome re-sequencing: sampling



Genome re-sequencing: workflow

96 individual libraries
8 populations, 12 ind./pop.
~5,300 Gbase

7 Pooled libraries
29-50 ind./pool
~1,000 Gbase

Read alignment (BWA)

Data manipulation (SAMtools)

Variant calling (GATK – HaplotypeCaller)

SNPs annotation (SnpEff)

SNP filtering (Plink)

Remain to be done

- **Select** most informative SNP to use on the SNP Array
- **Train** the SNP array using clams with various levels of QPX and heat resistance (training populations = 2 x 1,000 clams)
- **Select** and **Genotype** the breeding populations (2 x 300 clams)

Contents lists available at ScienceDirect

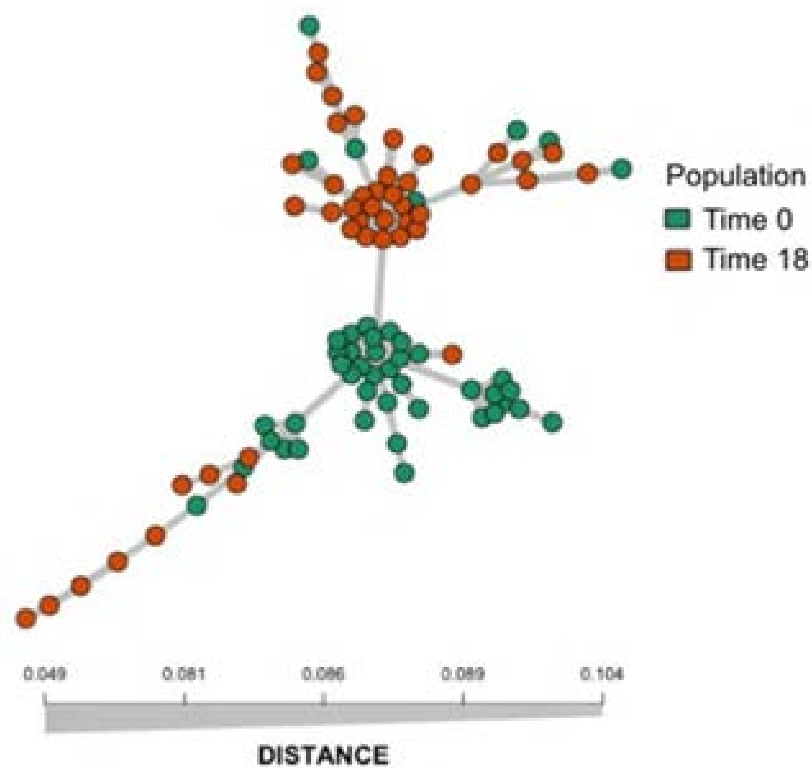
2020 Genomics: 112(6): 4887-4896

journal homepage: www.elsevier.com/locate/ygeno

Identification of variants associated with hard clam, *Mercenaria mercenaria*, resistance to Quahog Parasite Unknown disease

Sarah Farhat[a], Arnaud Tanguy[b], Emmanuelle Pales Espinosa[a], Ximing Guo[c], Isabelle Boutet[b], Roxanna Smolowitz[d], Diane Murphy[e], Gregg J. Rivara[f], Bassem Allam[a,*]

A set of VIP SNPs have been generated using independent tools (RADSeq)



Thank you for your attention!

Extension activities are next

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Developing a framework to transfer hard clam selective breeding research to industry

SEA GRANT HARD CLAM SELECTIVE BREEDING HUB

Antoinette Clemetson | Lisa Calvo | Josh Reitsma| Peter Rowe | Rebecca Shuford | Leslie Sturmer

www.HardClamHub.org

Email: HardClamHub@gmail.com

HARD CLAM SELECTIVE BREEDING COLLABORATIVE

Sea Grant

Collaborators

Goals

Process

Progress

Next Steps

Sea Grant 2019 Aquaculture Collaborative Program (Hubs) Virtual Symposium   November 3, 2021

Sea Grant Hard Clam Selective Breeding Collaborative

This collaborative functions as a partnership involving Sea Grant College Programs: New York Sea Grant, New Jersey Sea Grant, Woods Hole Sea Grant, Virginia Sea Grant, and Florida Sea Grant, Stony Brook University's Marine Animal Disease Laboratory and other research institutions, Cooperative Extension, not-for-profits, an advisory panel, and private sector.

Sea Grant

Stony Brook University
School of Marine and Atmospheric Sciences
MADL
MARINE ANIMAL DISEASE LABORATORY

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

RUTGERS
New Jersey Agricultural Experiment Station

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

UF | IFAS
UNIVERSITY of FLORIDA

MOLLUSCAN SHELLFISH
Aquaculture & Restoration
Laboratory

Cornell Cooperative Extension
Suffolk County

VIMS | WILLIAM & MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE

CNRS • SORBONNE UNIVERSITÉ
Station Biologique de Roscoff

GULF SHELLFISH INSTITUTE
Research for Sustainable Aquaculture & Healthy Ecosystems

Hub Collaborators

Sea Grant Team	Research Team	Advisory Panel	Industry Partners	Affiliates
Dr. Rebecca Shuford NY Sea Grant	**Dr. Bassem Allam** SBU Marine Animal Disease Laboratory	**Dr. Peter Rowe, Chair** NJ Sea Grant Consortium	NY: Frank M. Flowers & Sons Inc.	Dr. Bruce Barber Gulf Shellfish Institute (Florida)
Antoinette Clemetson NY Sea Grant	Dr. Emmanuelle Pales Espinosa SBU Marine Animal Disease Laboratory	Dr. Rebecca Shuford NY Sea Grant	NJ: Parsons Mariculture	Dr. Arnaud Tanguy Station Biologique de Roscoff (France)
Dr. Katherine Bunting-Howarth NY Sea Grant	Gregg Rivara CCE of Suffolk County	Wade Carden NYS Department of Environmental Conservation	VA: Cherrystone Aqua Farm	
Dr. Peter Rowe NJ Sea Grant Consortium	**Dr. Ximing Guo** Haskin Shellfish Research Laboratory	Dr. Dina Proestou USDA Agriculture Research Service	MA: Aquaculture Research Corporation (ARC)	
Lisa Calvo NJ Sea Grant Consortium	Lisa Calvo, NJ Sea Grant Consortium	Dr. Brent Vadopalas WA Sea Grant	East Coast Shellfish Association	
Leslie Sturmer FL Sea Grant	Michael Deluca, Rutgers University NJ Aquaculture Innovation Center	Joseph Vinarski Frank M Flowers & Sons Inc.		
Joshua Reitsma Woods Hole Sea Grant and Cape Cod Cooperative Extension	**Dr. Kimberly Reece** Virginia Institute of Marine Science	Karen Rivara, President ECSA Aeros Cultured Oyster Company		
Paul Focazio NY Sea Grant (Comm Unit)	Jan McDowell Virginia Institute of Marine Science			
Christopher Gonzales NY Sea Grant (Comm Unit)	Karen Hudson VIMS Marine Science Advisory Program		N= 25	
	Leslie Sturmer FL Sea Grant			
	Dr. Huiping Yang University of Florida			

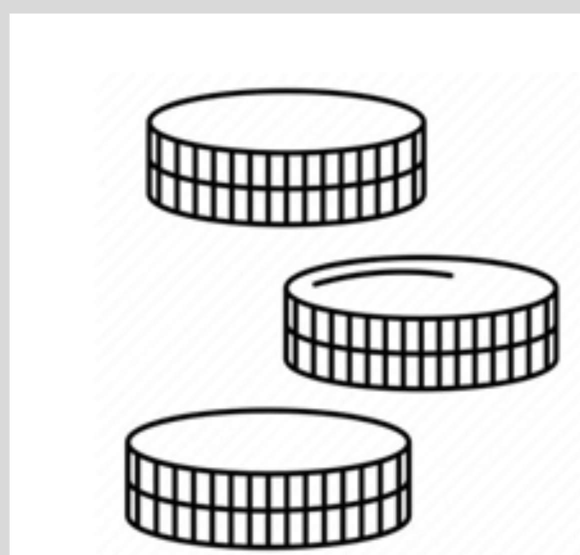
PROJECT GOAL

SELECTIVE BREEDING PROGRAM

BEYOND AWARD

RESEARCH → MAINTAIN BROODSTOCK LINEAGE → APPLY RESEARCH

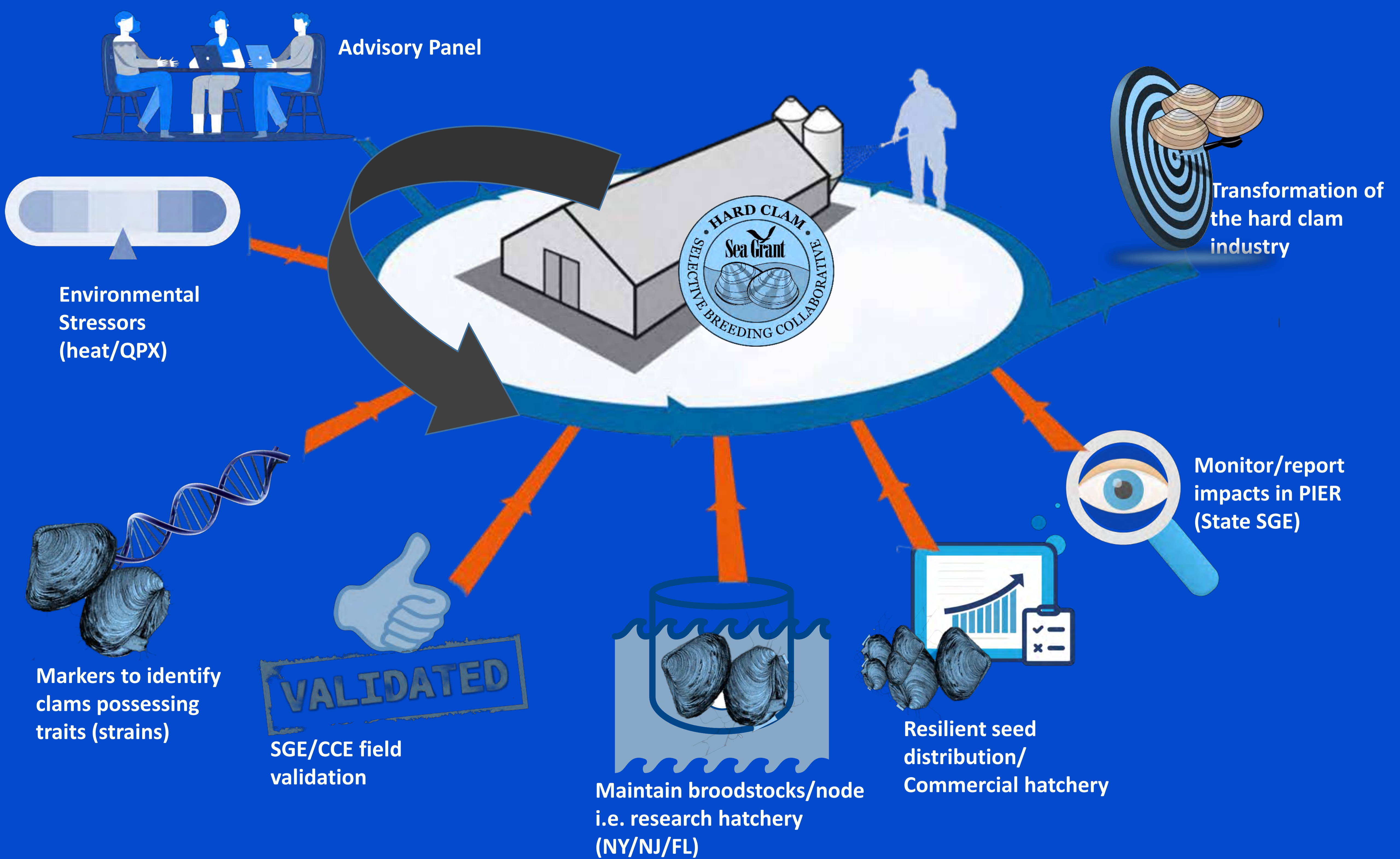
Strains resistant to stressors



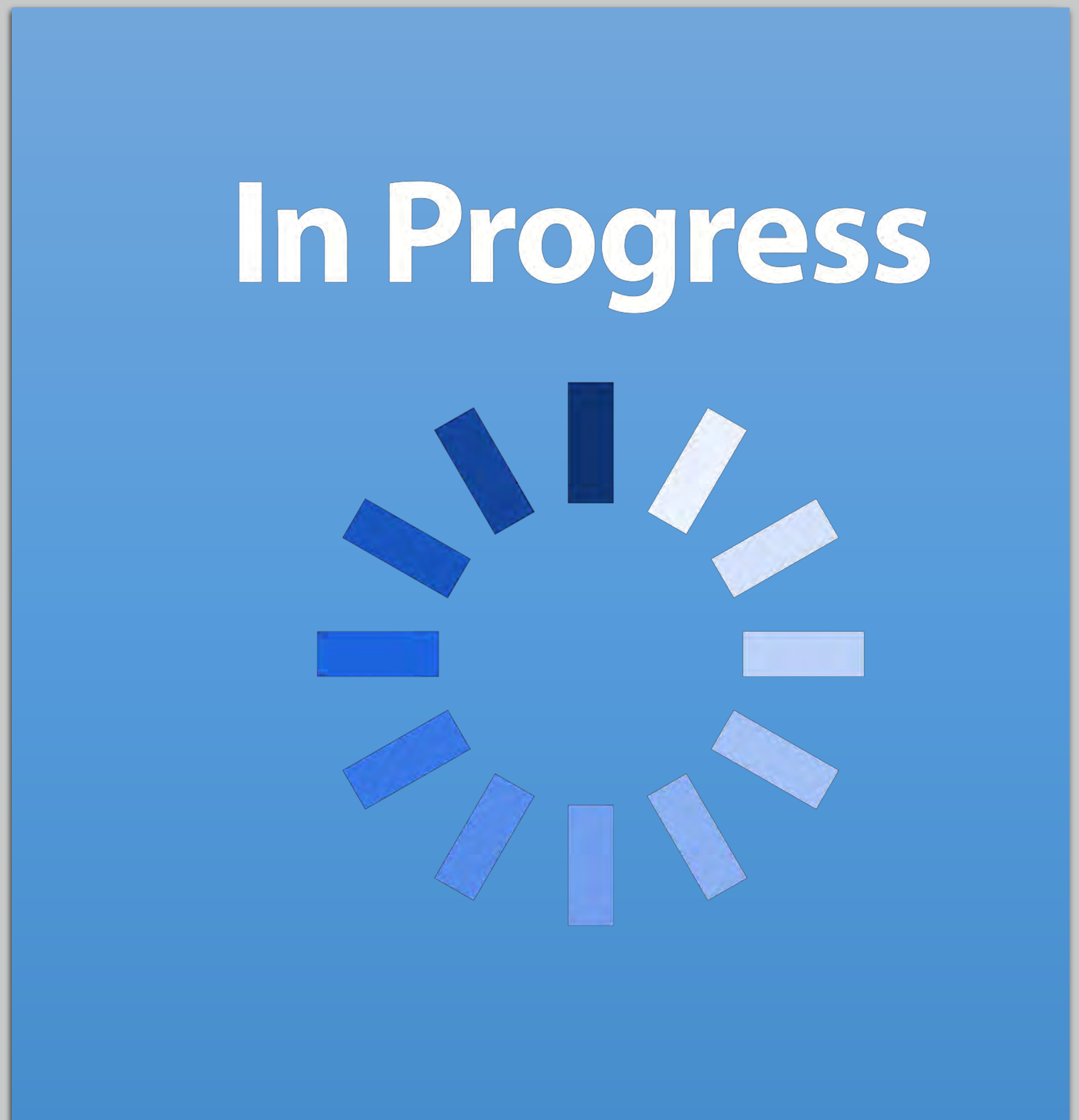
Research hatchery network

Mechanism to transfer strains to industry

SELECTIVE BREEDING PROGRAM FRAMEWORK aka "Process"



- **Research**
  - o Dr. Bassem Allam’s Update
- **Advisory Panel Meeting**
  - ✓ Winter 2020, Fall 2021
- **Project Team Workshop (annual)**
  - ✓ Winter 2020, Spring 2021
    - o Plan of Work
    - ✓ What is the Hub?
    - o How will industry access this program?
    - o Measure success/Impacts & Accomplishments
    - o Industry Needs Assessment Survey



➢ **Identify specific tasks extension and communications workplan development**

What is the Hub: public interface

www.HardClamHub.org **Email: HardClamHub@gmail.com**

- **Website is a tool to communicate with stakeholders**
  - Report on progress
  - Archive factsheets, media articles
  - Convey instructions about accessing breeding program
- **Electronic mailbox**
  - Stakeholders communicate with Hub
  - Request information, speakers
- **Graphic creates visual identity**
  - Visual cue (icon) to build brand trust
  - ✓ Unites collaborators while maintain their autonomy

HardClamHub.org

What are challenges to establish this hard clam selective breeding program

"In order to elevate industry, the Hub must educate, build trust, and develop a plan to engage these stakeholders in the breeding program"

EDUCATE

- Industry is unaware of the hard clam breeding hub
- Stakeholders don't understand why use selective breeding
- Reluctance arising from GMO confusion
- How to present project diverse expertise, stakeholder, and research objectives
- Technology seems unapproachable (to nontechnicians)

TRUST

- Adoption of selectively bred clams
- Will growers be open to these selectively bred clams
- Growers reluctance to share broodstock lines
- Who are breeders
- Growers may prefer using local broodstock
- What if these strains don't perform as well as expected

PLAN

- How will industry access breeding program
- Development of broodstock and transfer seeds locally
- How/who will maintain broodstock lineage after project
- Will broodstock and/or progenies require special handling

How will we know this effort is successful?

Defining Impacts & Accomplishments

TIMEFRAME	METRIC	INDICATOR
IMMEDIATE/SHORT TERM (3-year project implementation)	• Broodstock strains	Research hatcheries maintaining lineage

	• Tools created
	  o Genome
	  o SNP chip
	  o GEN1 lineage
	• Research Hatchery Plans
	• Website
		• Clams expressing traits (THTI=T and S stressor success)
		• Robust SNP Array
		• Improved survivorship
		• Industry buy-in/support for the program
		• Industry sharing animals for genotyping
		• Publications

MEDIUM TERM
(5 years post-project after broodstock technology is transferred to industry)
	Research Hatchery network (maintaining broodstock lineage)	• Lineage available for evaluation in field (via sentinel farms)
		  o Performance of strains against other stocks used by industry
		• Hard Clam Hub viewed as trusted, credible source for science-based information to advance industry
		  o Build capacity to provide timely response to new challenges
		  o # stakeholders accessing breeding program
		• Adoption of strains by 30% of industry
		  o # commercial hatcheries distributing seeds
		  o # seeds produced
		  o Percent (or #) growers using progenies
		• Reduction in loss from disease/heat improves production

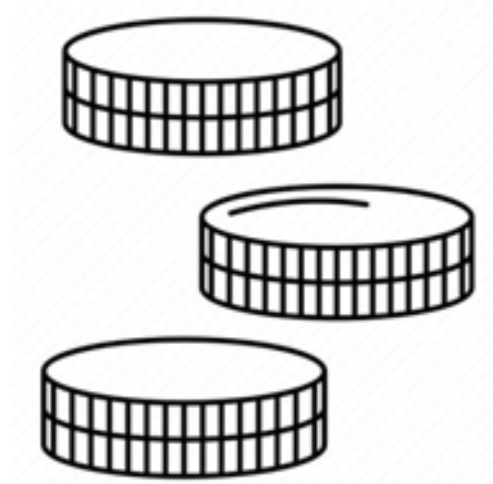
LONG TERM (Several years after project maturation with economic return and market changes)	**Transform hard clam industry**	• Increase in production and sales by growers (30%?) • Increase in survivorship and/or growth rates • Increase in # growers/farms to reverse plateau experienced in in NE

Anticipated Accomplishments & Impacts

SHORT

MEDIUM

LONG



- **Research tools created**
  - ✓ Genome (pub)
  - ✓ SNP array chip
  - o GEN1 lineage
  - o Broodstock strains
- **Mechanism to transfer research to industry (how will industry access breeding program)**
  - o Research hatchery plans
- **Build industry trust (start)**

3 years

- **Research hatchery network**
  - o Maintain broodstock lineage
  - o Transfer research (strains) to industry
- **Sentinel farm plots**
  - o Field monitoring to assess strain performance against other stocks used by industry
- **Capability to provide timely response to address new challenges**
- **Build industry trust (ongoing)**

5 years

- **Hard clam industry is transformed**
  - o Reduction in mortality attributed to disease and heat
    - ➢ Measurable increase in survivorship and/or growth rates
  - o Increase in # farms using these strains
    - ➢ Positive change on plateau observed in NE hard clam production
    - ➢ Economic return and market changes

>5 years/decade

NEEDS ASSESSMENT

1 PURPOSE

Obtain industry buy-in for breeding program
Define traits producers hope to select
Stakeholder engagement, ensure products meet industry needs
What will industry gain from this effort
Identify outreach and communications needs
Prioritize desirable traits in clams to advance industry
Clarify structure of breeding operations

2 SCOPE

Commercial and municipal growers
State resource managers
Hatcheries, wholesalers, consumers, researchers.
Growers
Breeders (if any)
Seed suppliers

3 QUESTIONS

Identify most important traits to target for breeding
How would you support this breeding program
Managers: What's the greatest challenge facing the industry and how are your trying to solve it
Researchers: What are research needs and tools in 5-10 year timeframe
Consumers: Will you purchase these products, why/why not

4 TIMING

After results are available to report (~ 3 years)
Latter half of project implementation; need to continue post-project
Now/ASAP
Late fall when hatchery operations slow down

5 LIST

GSS, state agencies
NJ Aquaculture agencies
NJ Shellfish Growers Association
East Coast Shellfish Growers Association
MA Aquaculture Association
Cedar Key Aquaculture Association
LI Oyster Growers Association
LI shellfish managers groups (town municipalities)
Survey grower organizations and not individual growers

How will industry access this program

Next Steps

- **Field Validation (SGE/County); Fall ‘22**
- **Hatchery Plan Development; Sum ‘22**
  - ➢ Webinar series; leverage collaborator expertise (Winter 2021)
  - ➢ State SGE/research hatchery managers draft plan acknowledging
    - ✓ Autonomy/institutional policy
    - ✓ Capability/capacity (commercial hatchery/growers)
    - ✓ Temporal constraints
    - ✓ Handling/biosecurity
- **Industry Needs Assessment Fall ’22 (tentative)**
  - ➢ Commercial hatchery/breeders
    - ✓ Perspectives/input research hatchery plans
    - ✓ Future research needs/stressors

Photo Credit: Leslie Sturmer, FLSG

Thanks to NOAA National Sea Grant for funding this project, and our collaborators, industry, Sea Grant/County extension colleagues, researchers, not-for-profit organizations, and managers.

Questions

Join at slido.com
#905542

ⓘ Start presenting to display the joining instructions on this slide.

How has this presentation helped to improve your understanding about the Hard Clam Selective Breeding Collaborative?

ⓘ Start presenting to display the poll results on this slide.

slido

Suggest barriers, challenges, or concerns that could prevent the industry from accessing the selective breeding program.

ⓘ Start presenting to display the poll results on this slide.

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How can the Hard Clam Selective Breeding Collaborative address these issues that you identified, previously?

ⓘ Start presenting to display the poll results on this slide.

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What measures, actions, or policies could be considered to support the Hard Clam Selective Breeding Collaborative after conclusion of this award ?

ⓘ Start presenting to display the poll results on this slide.

https://app.sli.do/event/g4vqa3ai

Atlantic and Gulf Shellfish Seed Biosecurity Collaborative-NJSG

P. Rowe, R. Carnegie, B. Walton, D. Bushek

Atlantic and Gulf Shellfish Seed Biosecurity Collaborative

Peter Rowe (NJSG), **David Bushek** , Lisa Calvo & Lucas Marxen (Rutgers), **Ryan Carnegie** & Karen Hudson (VIMS), Robert Rheault (ECSGA), Lori Gustafson (USDA APHIS)
Wiliam Walton (Auburn /VIMS), Leslie Sturmer (UF-IFAS), Jerome La Peyre (LSU), Jennifer Pollack (TAMU-CC)

Sea Grant Advanced Aquaculture Collaborative Program

Atlantic-Gulf Shellfish Seed Biosecurity Collaborative

Sea Grant
NJ Sea Grant Consortium

RUTGERS
New Jersey Agricultural Experiment Station
HASKIN SHELLFISH RESEARCH LABORATORY

UF IFAS
UNIVERSITY of FLORIDA

VIMS | WILLIAM & MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE

AUBURN
AGRICULTURE

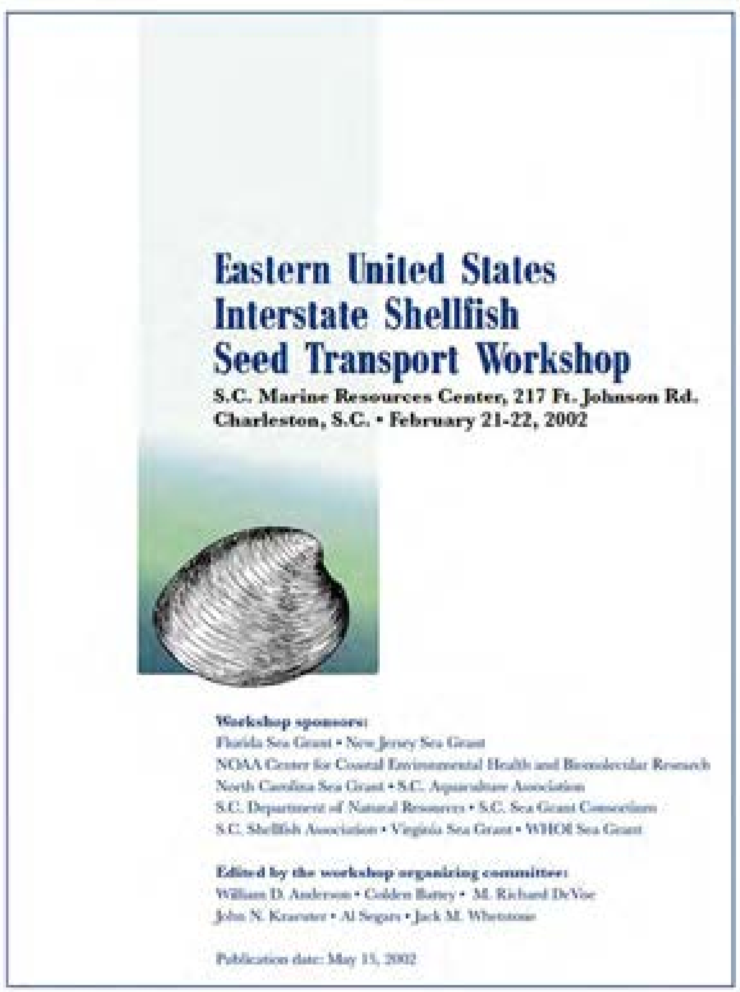
TEXAS A&M UNIVERSITY CORPUS CHRISTI | HARTE RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES

EAST COAST SHELLFISH GROWERS ASSOCIATION

USDA APHIS

LSU AgCenter
Research · Extension · Teaching

Motivation: A problem long recognized


Eastern United States Interstate Shellfish Seed Transport Workshop

S.C. Marine Resources Center, 217 Ft. Johnson Rd.
Charleston, S.C. • February 21-22, 2002

Workshop sponsors:
Florida Sea Grant • New Jersey Sea Grant
NOAA Center for Coastal Environmental Health and Biomolecular Research
North Carolina Sea Grant • S.C. Aquaculture Association
S.C. Department of Natural Resources • S.C. Sea Grant Consortium
S.C. Shellfish Association • Virginia Sea Grant • WHOI Sea Grant

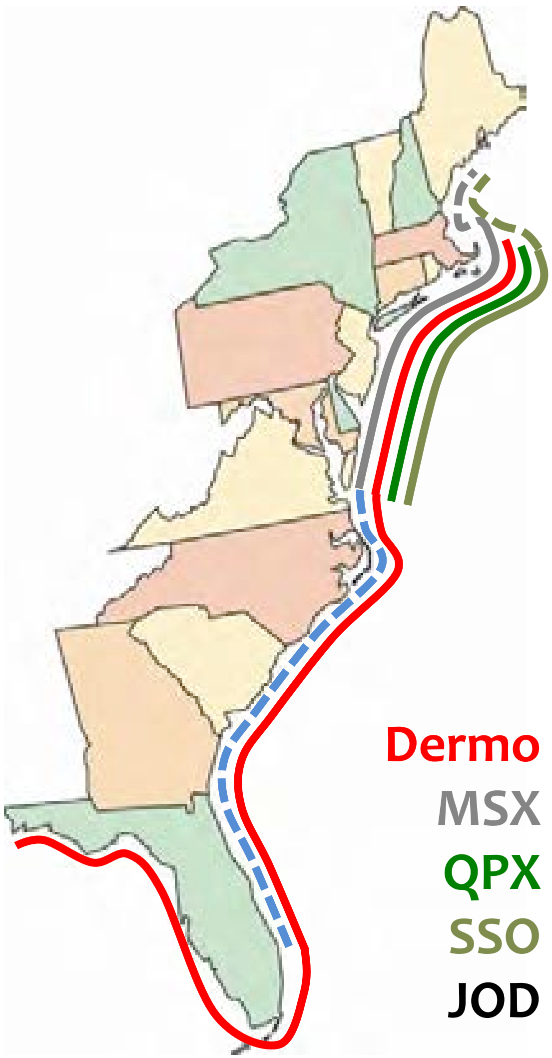
Edited by the workshop organizing committee:
William D. Anderson • Golden Battey • M. Richard DeVoe
John N. Kraeuter • Al Segars • Jack M. Whetstone

Publication date: May 15, 2002

- *Inefficiencies and ineffectiveness of regional shellfish health management have been known for decades*
- *"Batch certifications" problematic as a foundation for management*
- *Rapid growth of shellfish aquaculture has made this an acute concern for industry, and created acute biosecurity implications and risks*

2002 workshop prompted by emergence of QPX as a major concern at the time

Problems with status quo



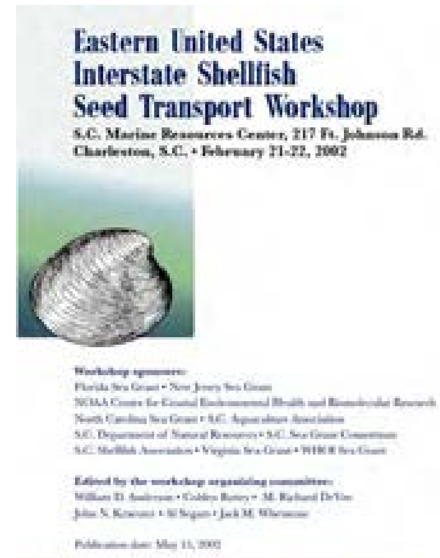
- *Growth outpacing biosecurity policy development*
  - Irrelevant regulatory system: pathogens don't recognize jurisdictional boundaries
- *Piecemeal surveillance of disease risk*
  - Independent, limited in scope
  - Not coordinated or accessible
- *Direct Costs*
  - Batch certifications can be cost prohibitive, and overwhelm agencies and laboratories
  - Zero tolerance policies unnecessarily limit commerce, restoration and enhancement
- *Indirect Costs*
  - Processing time limits timely responses to opportunities when little or no risk exists
  - Seed grows rapidly while awaiting results

Path Forward

- Enhance industry and resource sustainability
  - Develop more effective health management
  - lower costs (time and money)
  - improve biosecurity
- Promote an increased focus on surveillance of wild populations and farms
  - better understanding of pathogen distributions
  - improve alertness to emerging threats
- Streamline management and incentivize use of the most biosecure products from/for hatchery, nursery, farm and restoration
  - increased but less obstructive engagement of producers with shellfish health managers
  - creates a deeper, more systematic and sustained perspective on shellfish health in culture facilities
- Expand program regionally

Project journey began with a VIMS symposium

- Seed funds brought together:
  - Industry stakeholders
  - Pathologists
  - State regulators
  - Federal agencies (NOAA, USDA APHIS)
- Goal: Revitalize 2002 effort stimulated by QPX
- Needs identified:
  - minimum acceptable certification standards
  - recommendations for clear and effective <u>science-based</u> regulatory strategies
  - tools (e.g., database) and implementation framework


Eastern United States
Interstate Shellfish
Seed Transport Workshop
S.C. Marine Resources Center, 217 Ft. Johnson Rd.
Charleston, S.C. • February 21-22, 2002

Outcome: Four committees, three major grants

- **Shellfish Health Advisory Committee (voluntary)**
  - 13 members representing industry, regulation, extension, academia
  - Provide support for decision making of seed transfers
- **Molluscan Pathology Working Group (voluntary)**
  - Standardization of diagnostics
  - Information-sharing, annual updates on changes in status and trends
- **Hatchery Certification Working Group**
  - NOAA SG Aquaculture Impediments Grant: "*Establishing Shellfish Hatchery Biosecurity Certification Standards to Facilitate Interstate Transport of Shellfish Seed*"
- **Database/Zoning Working Group**
  - NOAA SK Aquaculture Project: "*Assembling the Best Available Science to Inform Interstate Transport of Shellfish Seed*"
- **Gulf Regional Expansion**
  - NOAA Advanced Aquaculture Collaboratives: "*Atlantic and Gulf Shellfish Seed Biosecurity Collaborative*"

Shellfish Health Advisory Committee

Name	Affiliation	State	Area
Debbie Bouchard	University Maine	ME	Pathology
Dave Bushek	Rutgers University	NJ	Pathology
Ryan Carnegie	Virginia Institute Marine Science	VA	Pathology
Tal Ben-Horin	North Carolina State	NC	Extension
Lisa Calvo	Rutgers University	NJ	Extension
Karen Hudson	Virginia Institute Marine Science	VA	Extension
Bob Rheault	East Coast Shellfish Growers	RI	Industry
Mike Congrove	Oyster Seed Holdings	VA	Industry
Julie Davis	Lady's Island Oysters	SC	Industry
Carolina Borque	Louisiana Department Fish and Wildlife	LA	Regulatory
Marcy Nelson	Maine Department Marine Resources	ME	Regulatory
Rebecca Thur	MD Department Natural Resources	MD	Regulatory
Lori Gustafson	USDA APHIS VS	Federal	Regulatory

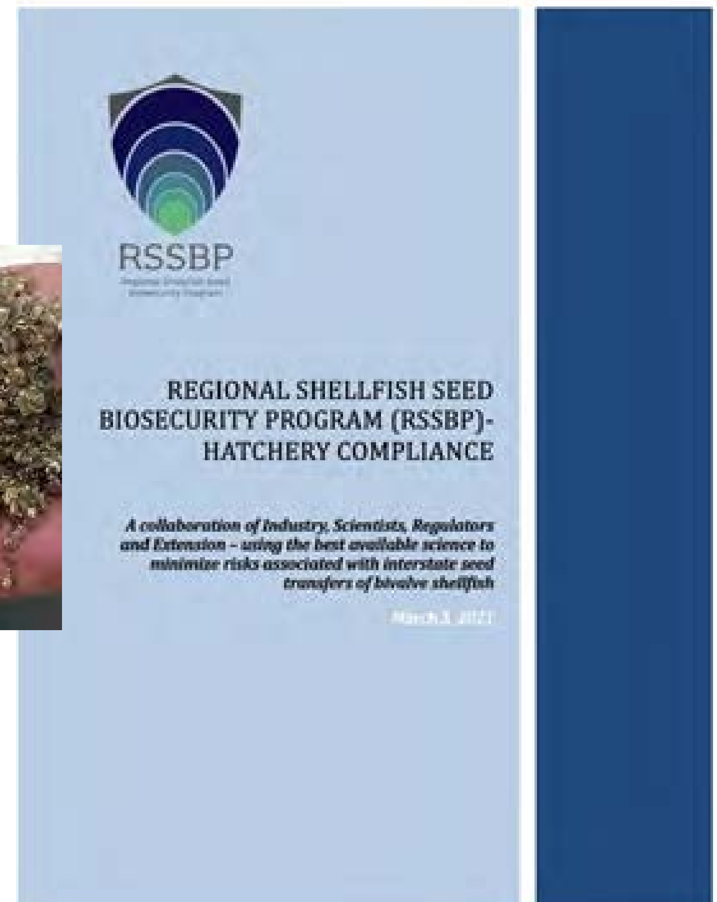
NOAA SG Aquaculture Impediments Grant
Establishing Shellfish Hatchery Biosecurity Certification Standards to Facilitate Interstate Transport of Shellfish Seed

Goal

- Establish a regional seed biosecurity certification protocol for hatchery products (e.g., gametes, larvae, early set)

Status - complete

- Created BMP guide, application, and audit process
- Piloted in winter 2020-21 with four hatcheries – all passed and used compliance documents this past season
- Contacting hatcheries to participate this winter


RSSBP

REGIONAL SHELLFISH SEED BIOSECURITY PROGRAM (RSSBP)- HATCHERY COMPLIANCE

A collaboration of Industry, Scientists, Regulators and Extension – using the best available science to minimize risks associated with interstate seed transfers of bivalve shellfish

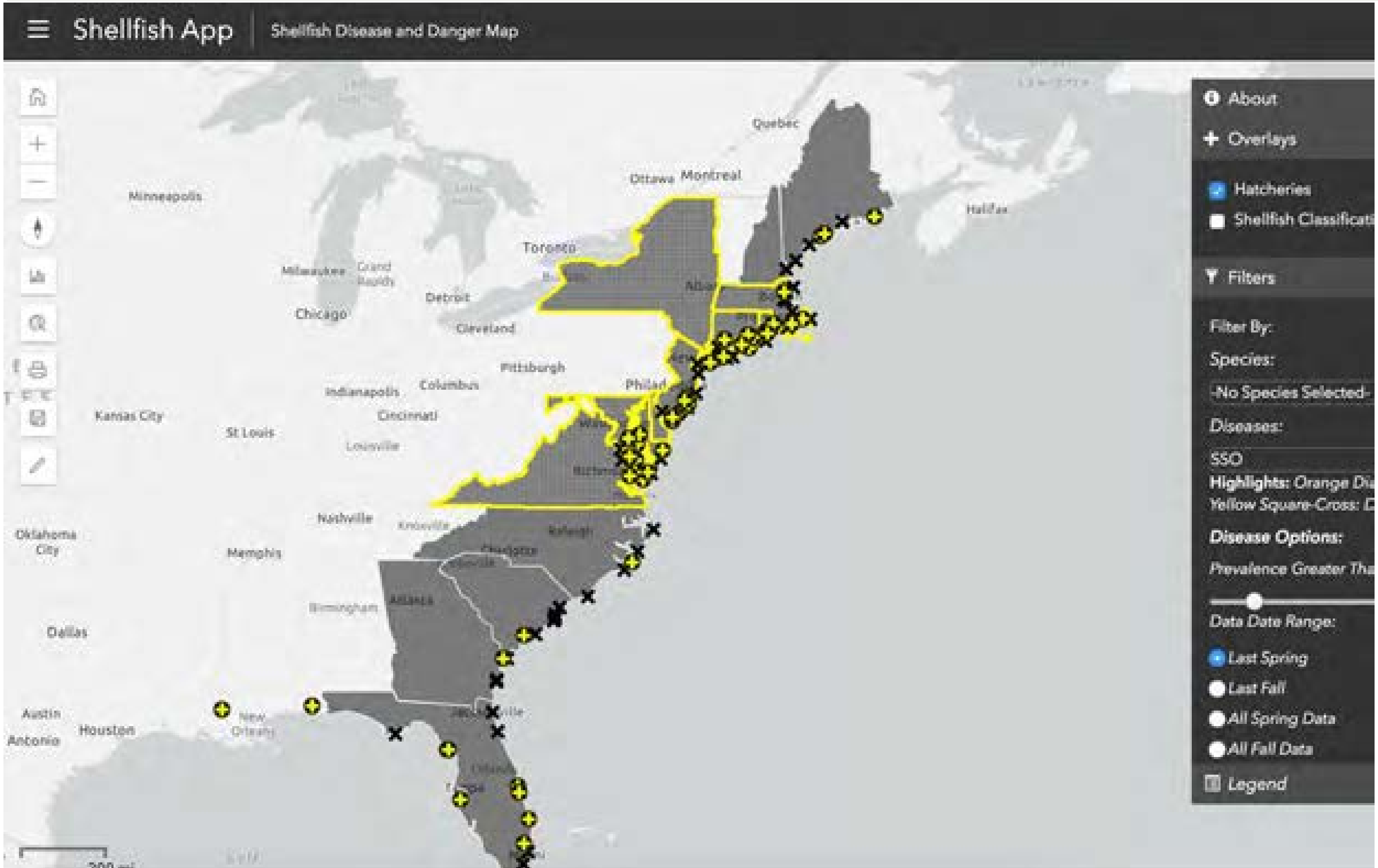
NOAA SK Project
Assembling the Best Available Science to Inform Interstate Transport of Shellfish Seed

Goal

- Develop an online portal for molluscan shellfish health
    - document known pathogen distributions
    - illustrate risk to inform shellfish seed importations

Status - ongoing

- Portal created with tools developed to compare source and destination pathogen profiles to assist risk assessment
- Data input ongoing
- Site to go public in January



Database showing sample locations, hatcheries, SSO distribution

Side panel allows user to select what they want to see.

User can zoom in and get summary data in various formats.

Re-Branding the Program

Regional Shellfish Seed Biosecurity Program (RSSBP)

Logo created for identity

- Easily recognized
- Conveys security
- Implies shellfish
- Green industry
- Blue economy

NOAA Advanced Aquaculture Collaborative Programs: Atlantic and Gulf Shellfish Seed Biosecurity Collaborative

Goal

Expand Shellfish Seed Biosecurity Initiative to Gulf States

Objectives

1) Collaboratively assess performance to date and applicability to the Gulf.
2) Expand database into Gulf.
3) Establish surveillance program.
4) Develop a future funding model.

Progress

- Rebranded the program and combined efforts into a single web portal
- Expanding database into gulf via existing data, collating data on cultured shellfish, and collecting new surveillance data
- NOAA SG Special Projects Grant: *Extension to Extension: Supporting the Rollout of a Regional Shellfish Health Initiative.* PIs Hudson and Calvo
- Initiating Gulf regulatory contacts
- Continuing all efforts to obtain surveillance data, certify hatchery compliance, and solicit regulatory input and participation

Gulf Hatcheries and Nurseries

FISH & WATER

Extension

Shellfish Seed Suppliers for Gulf of Mexico 2021

This list of shellfish seed suppliers was compiled by the Alabama Extension and is based on best available information and is not an endorsement or recommendation of any of the companies. In all cases, purchasers of seed are responsible for knowing state requirements and for having the necessary permits for transfers of seed. Check with suppliers and regulatory agencies at the time of your order.

Alabama

Auburn University Shellfish Lab (H, N)
*Sold for research only
150 Agassiz Street, Dauphin Island, AL 36528
Contact: Scott Rikard
(251) 861-3018 ext. 1, (251) 861-2344 (fax)
Types of seed or larvae sold: Oyster

Double D Oyster Company (N)
2830 Lawrence Steiner Road, Theodore, AL 36582
Contact: Doug Ankersen, (251) 591-7346
dougankersen@bellsouth.net
Types of seed sold: Oyster

L3 Hatchery (H, N)
10870A Beverly Road, Irvington, AL 36544
Contact: Lane Zirlott, (251) 379-4882
www.murderpointoysters.com
info@murderpointoysters.com
Types of seed sold: Oyster

Navy Cove Oyster Farm (N)
Contact: Chuck Wilson, (225) 892-6986
chuck.navycoveoysters@gmail.com
www.navycoveoysters.com
Types of seed sold: Oyster

Florida

Apalachicola Oyster Company (H)
456 Highway 98, Apalachicola, FL 32320
Contact: (850) 653-1223
hatchery@apalachicolaoyster.com
Types of seed or larvae sold: Oyster

Bay Shellfish Company (H, N)
P.O. Box 289, Terra Ceia, FL 34250
Contact: Curt Hemmel, (727) 309-1269
curt@bayshellfish.com
www.bayshellfish.com
Types of seed or larvae sold: Oyster, Hard Clam, Sun Ray Venus, Bay Scallop

Clamtastic (H, N)
P.O. Box 664, Cedar Key, FL 32625
Contact: Chris Topping or Anthony Hinkle
(352) 213-5999 or (352) 949-2233
clamtastic2000@yahoo.com
Types of seed or larvae sold: Hard Clam

Ewan Leighton (H, N)
270 Sea Dunes Drive, Melbourne Beach, FL 32951
Contact: Ewan Leighton, (321) 288-8201
ewan191@gmail.com
Types of seed or larvae sold: Sun Ray Venus, Hard Clam

Florida Shellfish (H, N)
12405 State Road 24, Cedar Key, FL 32625
Contact: Bill Knight, (352) 221-3702
Types of seed or larvae sold: Hard Clam

Great Florida Shellfish Company (H, N)
72 Azalea Circle, Tequesta, FL 33469
Contact: Tom McCrudden, (561) 702-8159
tommy@sunrayvenusclam.com
Types of seed or larvae sold: Oyster, Hard Clam, Sun Ray Venus

H indicates a hatchery
N indicates a nursery

ANR-2584

2021 Florida Shellfish Seed Suppliers

These hatchery and nursery operations are supplying molluscan shellfish seed to Florida growers this year. Contact suppliers for information on species, seed sizes, price, color variation and availability.

Apalachicola Oyster Company - H
456 Hwy 98
Apalachicola, FL 32320
Contact: Teresa Jackson
(850) 274-1368
hatchery@apalachicolaoyster.com
Species: OY

Bay Shellfish Co. - H, N
P.O. Box 289
Terra Ceia, FL 34250
Contact: Curt Hemmel
(727) 309-1269
curt@bayshellfish.com
Website: bayshellfish.com
Species: HC, OY, SRV, BS, PA

Clamtastic - H, N
P.O. Box 664
Cedar Key, FL 32625
Contact: Chris Topping or Anthony Hinkle
(352) 213-5999 or 949-2233
clamtastic2000@yahoo.com
Species: HC

Ewan Leighton - H, N
270 Sea Dunes Drive
Melbourne Beach, FL 32951
Contact: Ewan Leighton
(321) 288-8201
ewan191@gmail.com
Species: HC

Great Florida Shellfish Company - H, N
72 Azalea Circle
Tequesta, FL 33469
Contact: Tom McCrudden
(561) 702-8159
Species: HC, OY, SRV, BA

Orchid Island Shellfish Co. - N
633 Old Dixie Highway
Sebastian, FL 32958
Contact: Ed Mangano
(772) 913-0053 or 589-5080 (Fax)
Species: HC, SRV

Pensacola Bay Oyster Hatchery - H, N
11 W. Garden St
Pensacola, FL 32502
Contact: Don McMahon
(850) 982-2623
Species: OY

Premium Seafood - H, N
7579 A1A South
Crescent Beach, FL 32080
Contact: Mike Sullivan
(386) 847-3202 (cell)
Species: HC

Seaventures Clam Co. - H
5600 US-1
Fort Pierce, FL 34946
Contact: Carolina Panoff
(833) 732-8368
Species: HC

Southern Cross Seafarms - H, N
12170 State Road 24
Cedar Key, FL 32625
Contact: Shawn Stephenson or Jon Gill
(352) 543-5980 or 543-5982 (Fax)
Website: www.clambiz.com
Species: HC, OY

Two Docks Shellfish, LLC - H, N
PO Box 9493
Bradenton, FL 34206
Contact: Brandyn Meisinger
443-624-2948
Species: HC

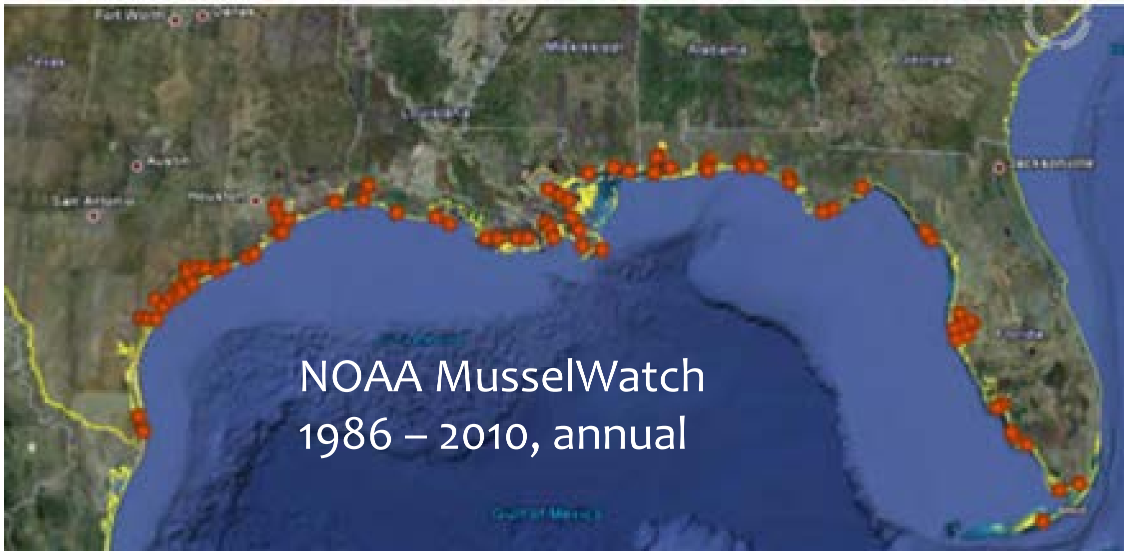
H - Hatchery
N - Nursery
Shellfish
HC - Hard Clam
OY - Oyster
SRV - Sunray Venus
BS - Bay Scallop
BA - Blood Arks
PA - Ponderous Ark

This list is provided as a service of the UF/IFAS Shellfish Aquaculture Extension Program. We do not sponsor or endorse any of these suppliers over any others. To obtain a list of East Coast shellfish seed suppliers, contact Doug Zemeckis with Rutgers Cooperative Extension, (732) 349-1152, or go to www.ecsga.org. Shellfish seed obtained from out-of-state suppliers must meet best management practices pertaining to both genetic protection and disease prevention. For more information, contact the FL Department of Agriculture and Consumer Services, Division of Aquaculture at (850) 617-7600, or visit their website, click on Best Management Practices, Chapter 5L-3.

UF UNIVERSITY of FLORIDA IFAS Extension

January 2021

What do we know about shellfish disease in the Gulf of Mexico?

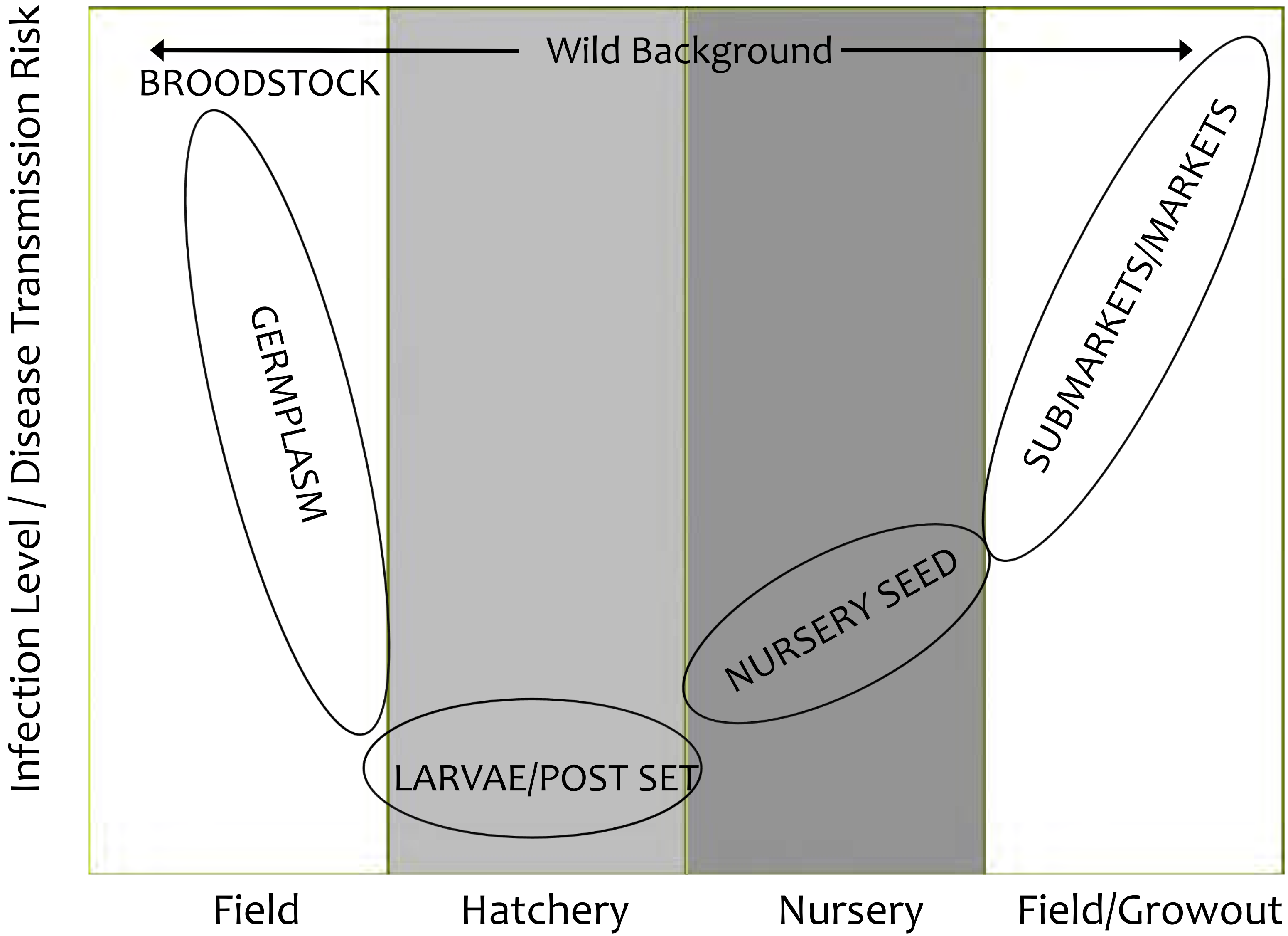


https://products.coastalscience.noaa.gov/collections/ltmonitoring/nsandt/data2.aspx

https://data.oystersentinel.cs.uno.edu/dermo

Surveillance strategy:
1. Summarize existing data
2. Conduct targeted sampling
   a. Regional differences
   b. Areas of likely transfer

What do we actually know about disease levels in hatcheries?



VIMS Samples, 2017-2019

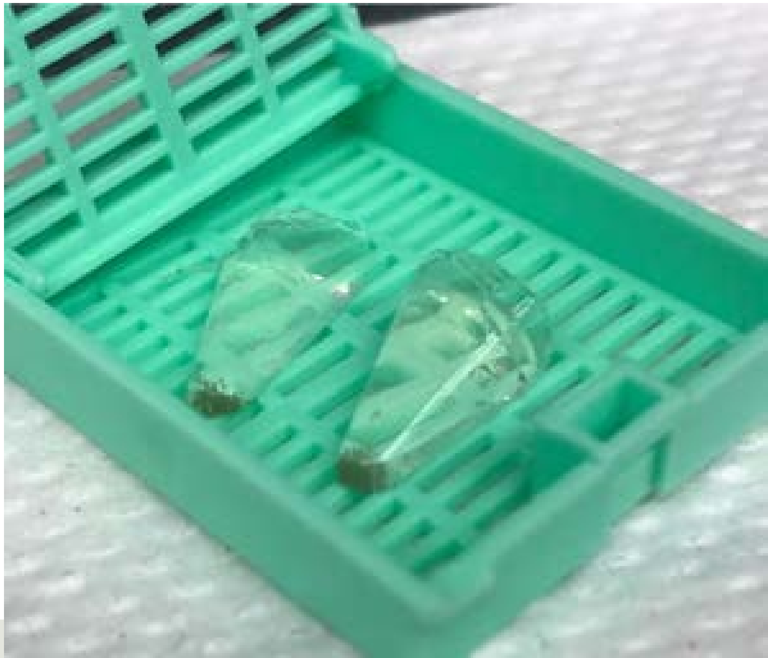
- 235 total "business as usual" submissions
  - 177 from Atlantic Coast
  - 146 oysters (*Crassostrea virginica*)

RFTM analyses for dermo in oysters

Perspective on Larvae

- 19 Gulf and Atlantic larval samples evaluated from 2017-2019
  - all negative by PCR

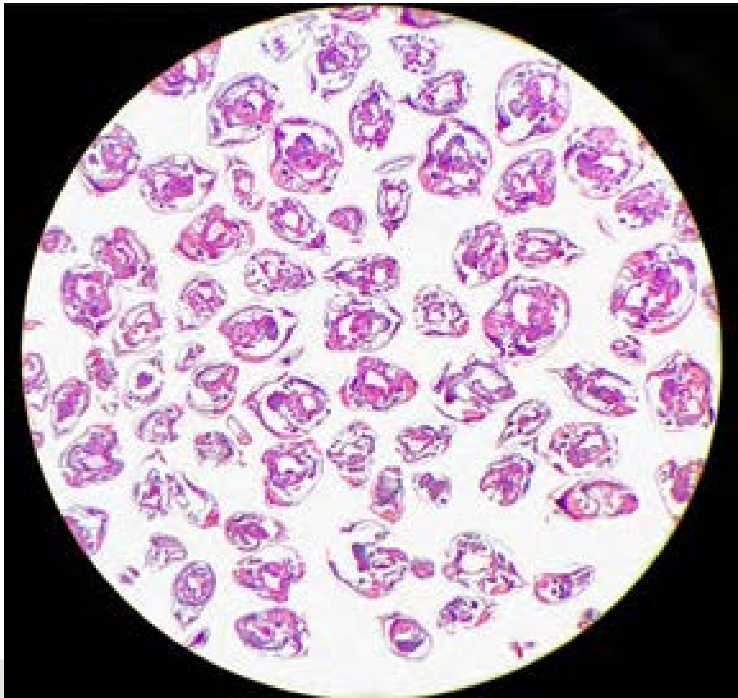
Oyster larvae enrobed in agar for histology



Small Seed, to 3.5 mm

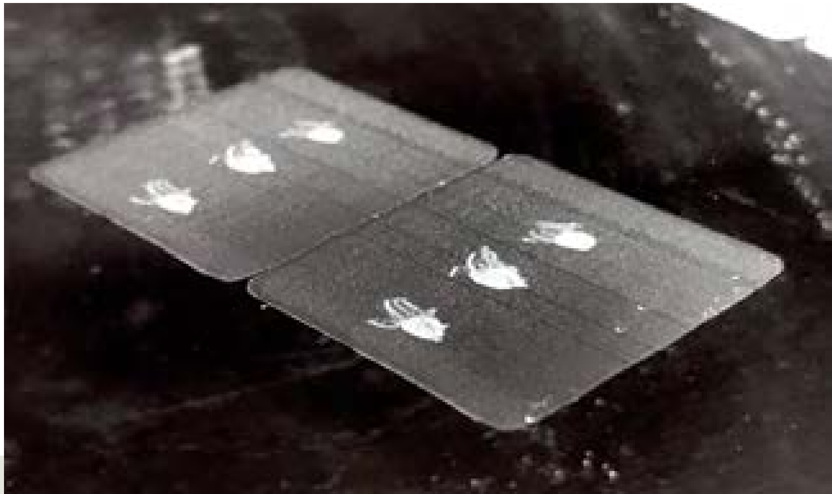
- 41 samples
  - no detection of dermo or MSX

Histology of oyster seed



Nursery Seed, ~4-20 mm

- 56 samples, 22 positive for dermo
- Max prevalence: 13.3%
- No infection reached moderate intensity (1 light-moderate)
- Most intensities rare
- No MSX



Large Seed and Submarkets, (to ~60 mm)

- 14 samples
- Maximum dermo prevalence 3.6%
- Only rare infections
- Even near-market-sized cultured oysters can have surprisingly low levels of infection

Vol. 10: 557–567, 2018
https://doi.org/10.3354/aei00290
AQUACULTURE ENVIRONMENT INTERACTIONS
Aquacult Environ Interact
Published December 13

Intensive oyster aquaculture can reduce disease impacts on sympatric wild oysters

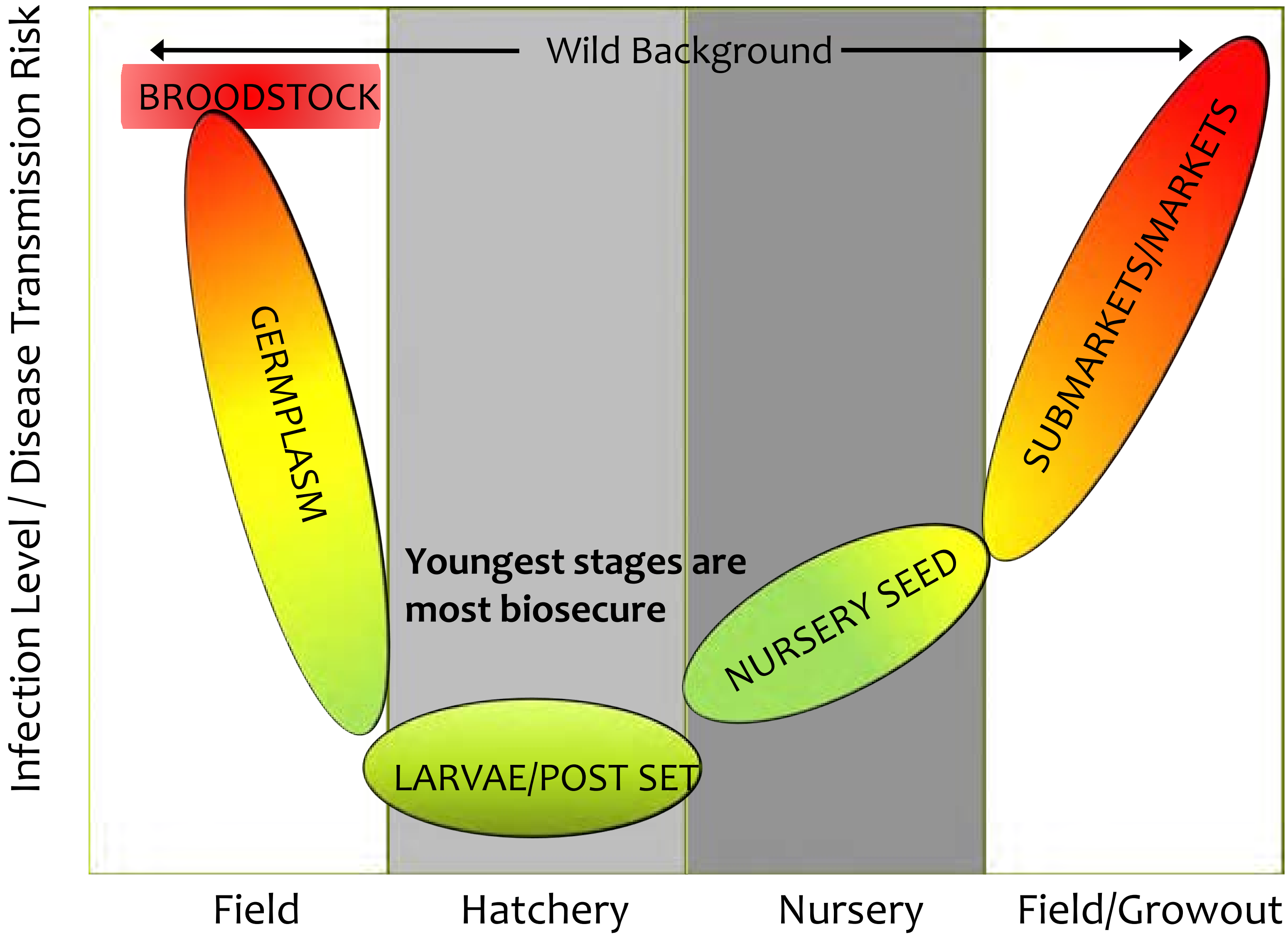
Tal Ben-Horin[1,2,*], Colleen A. Burge[3], David Bushek[4], Maya L. Groner[5,6], Dina A. Proestou[2], Lauren I. Huey[7], Gorka Bidegain[8], Ryan B. Carnegie[7]

Independent data sets demonstrate pathogen absence in larvae and small seed

Seed Certification History
Haskin Shellfish Research Laboratory

Period of record 2004-2019		**Size range of detection**
C. virginica	82	
Positive for MSX	5	> 5 mm
Positive for Dermo	7	> 10 mm
M. mercenaria	108	
Positive for Dermo	4	> 2 mm
Positive for QPX	1	> 17 mm
Positive for neoplasia	1	> 17 mm

What do we actually know?



- Collective results provide empirical support for the presumed high biosecurity of larvae and small (<4 mm) seed from hatcheries

- Low infection of smaller *nursery* seed suggests that the Hatchery Certification paradigm could justifiably be extended, as a next step, to nurseries

- Efforts could be better focused on environmental surveillance to assess risk and changes in pathogen distributions

Summary

RSSBP

Regional Shellfish Seed Biosecurity Program

The **RSSBP** is a voluntary program collaboratively developed by shellfish growers, scientists, extension specialists and State resource managers to foster a common goal of minimizing risks associated with interstate transfers of bivalve shellfish.

Core Elements

- Regional Shellfish Health Advisory Council
- Regional network of shellfish pathologists
- Interactive Shellfish Disease Database Mapping Tool
- Best Management Practices for minimizing shellfish disease risks
- Hatchery Certification Program

Next Steps – Questions – Discussion

RSSBP
Regional Shellfish Seed Biosecurity Program

- Continue Hatchery Compliance Program, adding Gulf hatcheries
- Conduct surveillance to fill in gaps, particularly across GoM
- Conduct an extension training workshop to facilitate outreach
- Pursue state by state outreach to regulators

Nurturing the Successful Growth and Maturation of a Domestic Seaweed Aquaculture Industry: Identifying and Removing Barriers and Promoting Opportunities-CTSG

A. Concepcion, J. Robidoux, M. Good, S. Otts, S. De Guise

National Seaweed Hub

Anoushka Concepcion
Connecticut Sea Grant
University of Connecticut
anoushka.concepcion@uconn.edu

Driver:

Need for a collective generation and sharing of science-based information:

National Seaweed Hub

www.SeaweedHub.org

Sea Grant

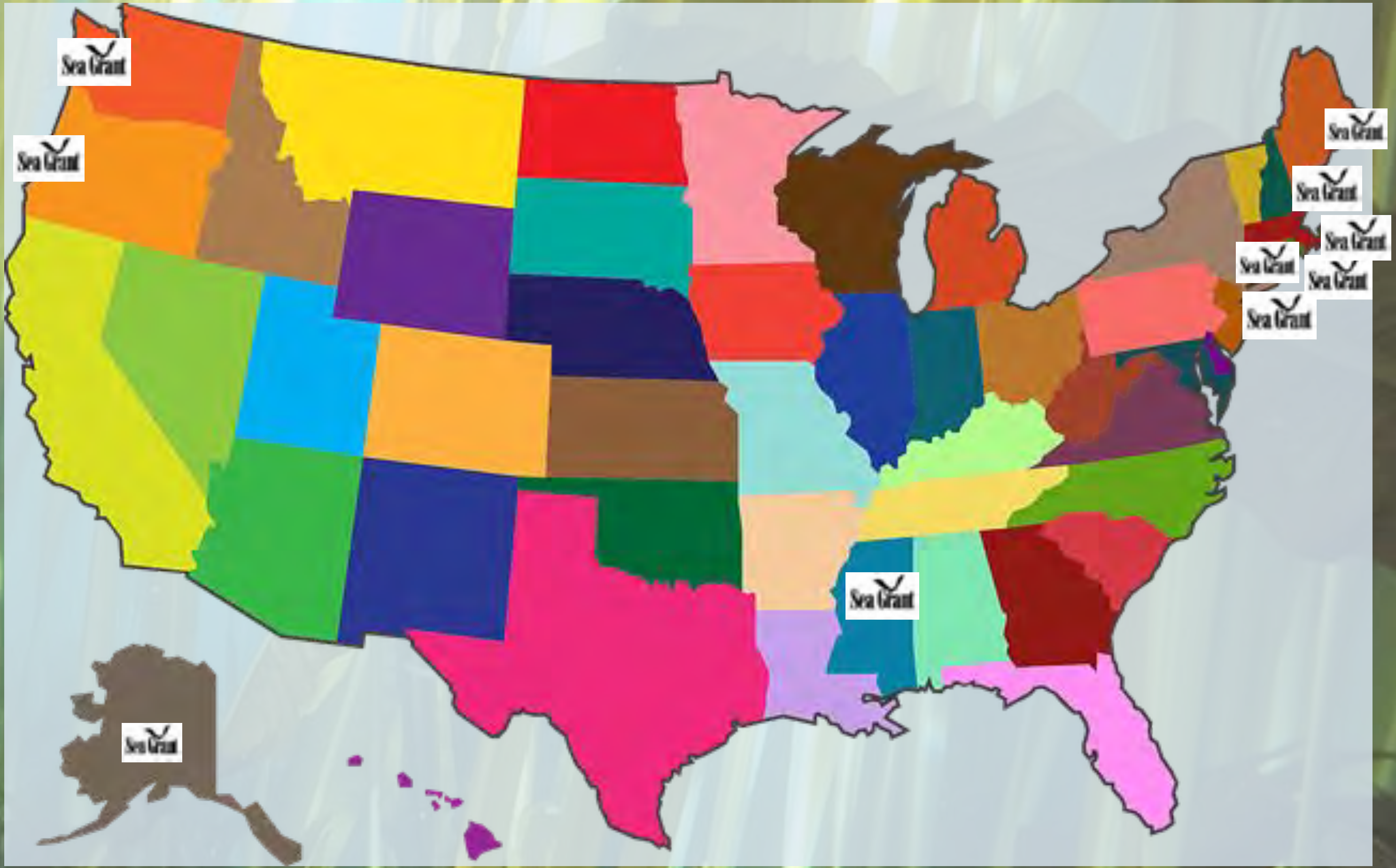
Background

- 12+ Sea Grant states
  - Actively cultivating or investigating cultivation
- 2018 "State of the States of Seaweed"
  - Similar challenges
  - Common goals

Sea Grant

Opportunity

- NOAA collaborative grant opportunity
- Establish a National Seaweed Hub
- Better understanding
  - Current status of the seaweed industry
  - Needs identified by various sectors
- Active participation
  - Collaborate
  - Strategize
  - Path forward



Sea Grant

Steering Committee

- Guidance
- Meet goals/objectives of the project

- **Caird Rexroad**, USDA
- **LaDon Swann**, MS-AL Sea Grant and Sea Grant Aquaculture Liaison
- **Steven Bloodgood**, FDA
- **Kevin Madley**, NOAA NMFS
- **David Hansen**, OR Sea Grant
- **Michael O'Neil**, UConn Extension
- **Katherine Bunting-Howarth**, NY Sea Grant
- **Quentin Fong**, AK Sea Grant
- **David Hansen**, OR Sea Grant

Hub Objectives

NEEDS ASSESSMENT

SEAWEED SYMPOSIUM

STAKEHOLDER WORK GROUPS

PRODUCTS

OUTCOME

Needs Assessment

- 259 responses, 14+ states
- Stakeholder groups
  - Permitted/prospective farmers, regulators, culinary, nursery operators, processors, researchers, other (i.e. extension, non-profits)
- Challenges identified – established Work Groups
  - Market Opportunities
  - Post-harvest and Processing Infrastructure
  - Regulations
  - Production Systems
- Dawn Kotowicz (RISG)

Seaweed Symposium

- Day 1: Introductory presentations and break-out discussions
  - Global overview
  - State of the States
  - Needs Assessment
- Day 2: Break-out discussions, Farmers’ Forum, Seaweed Showcase
- Day 3: Wrap-up

Sea Grant

Work Groups Sessions

- Participants pre-assigned

Day 1

- Big ideas
- Identify pressing needs, challenges, opportunities

Day 2

- Refine by achievable goals or objectives
- Identify outcomes or products for Work Group

Day 3

- Present Work Group Strategies

Evaluation

- 33% responded
  - 91% strongly agreed/agreed – good use of my time
    - 0% disagreed
  - 71% - increased knowledge of seaweed industry (a great deal/a lot)
  - 85% - can apply knowledge to their work (a great deal/a lot)
  - 97% - want a follow-up meeting
    - Willing to pay a nominal registration fee

Sea Grant

Virtual Work Groups

- Diverse, meet regularly
  - Rules of Engagement
- Strategy or work plan
  - Polling, MIRO
- Applied project funds
- Summaries and products available on web

Sea Grant

Refining Work Group Recommendations

- Production Systems
  - 30+ challenges/opportunities
- Regulations
  - 60+ challenges/opportunities
- Post-harvest and Processing Infrastructure
  - 30+ challenges/opportunities
- Market Opportunities
  - 60+ challenges/opportunities

Image: JP Vellotti, East Coast Kelp Farms

Production Systems Work Group

- Meg Chadsey* (WASG) and Joshua Reitsma (WHOI SG)
- Focus: Improve seed-stock supply
- Obj 1: Develop a national nursery list
  - Resource for growers (also regulators, end-users, etc)
  - Refining nursery survey questions
  - Use applied project funds to hire UConn students
  - Plan for long-term maintenance
- Obj 2: Increase nursery capacity

Regulations Work Group

- Stephanie Otts and Catherine Janasie* (NSGLC)
- Develop resources providing an overview of:
  - Food safety of seaweed-related food and food products (i.e. Preventive Controls)
  - Permitting concerns of seaweed farms

Post-harvest and Processing Work Group

- Antoinette Clemetson (NYSG) and Melissa Good* (AKSG)
- Feasibility study for a model regional processing facility
- Identify and assess processing technology to assist with product innovation

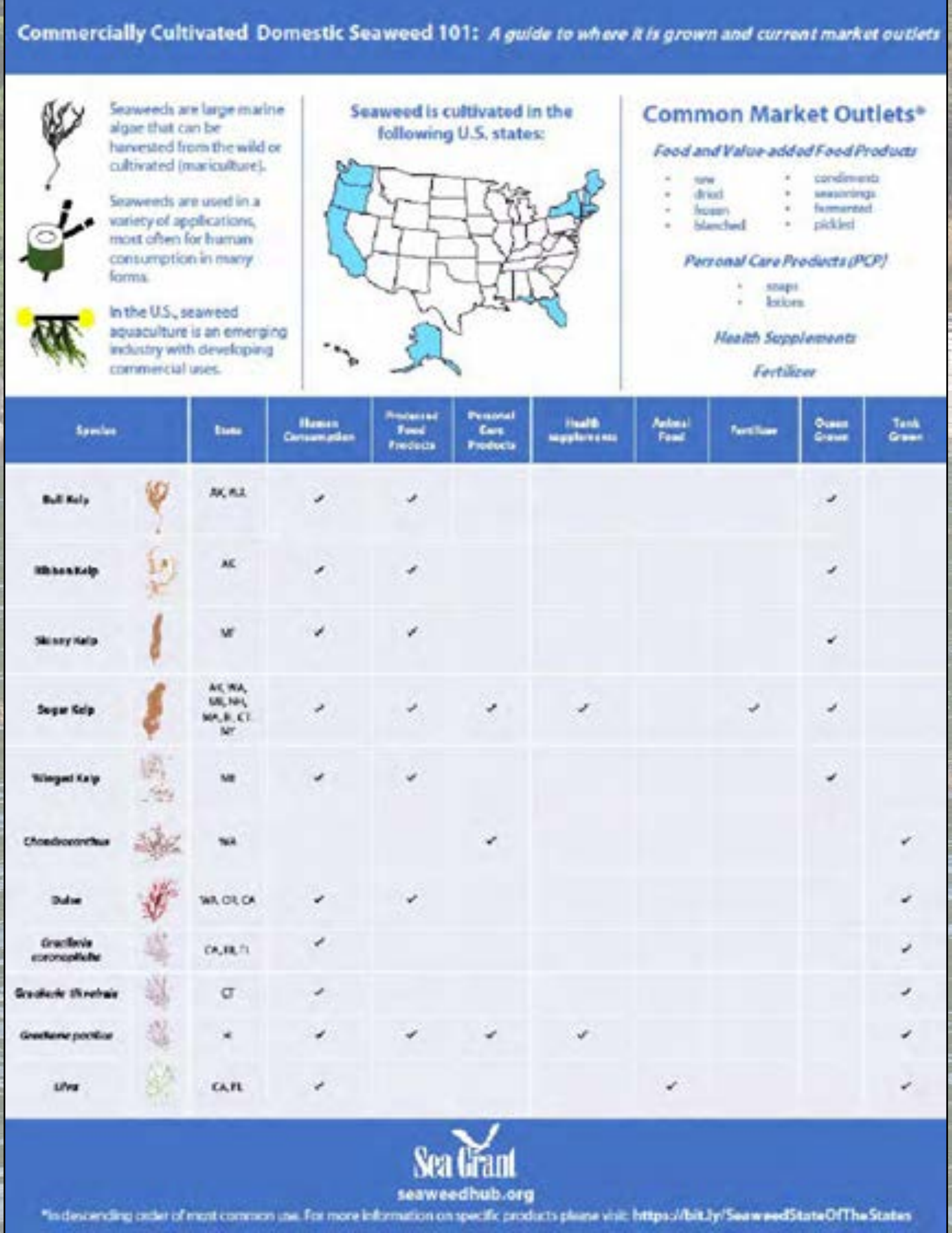
Market Opportunities Work Group

- Gabriela Bradt* (NHSG) and Jaclyn Robidoux (MESG)
- 3 subgroups formed to address work group priorities:
  - **Consumer education** and outreach opportunities to build markets, which can be accomplished relatively short-term
  - **Product development** needs, including standards and grading, scale and supply, nutritional profiles and labeling
  - **Industry representation** to tap into long-term marketing efforts, including pros/cons of industry associations, science-industry institutes, etc.

Outcomes

- Compilation of practical resources
- Transparent, accessible information
- Fostering long-term relationships
- Path forward for commercial seaweed aquaculture
- More informed audiences

Sea Grant



Economics of production systems and stabilization processes

Next Steps

- Seaweed Symposium 2.0 or biennial seaweed meeting
- Continuation of work group discussions
- More ways for specific stakeholder groups to connect (i.e. farmers with farmers, regulators with regulators)

Thank you!

Anoushka Concepcion
Gabriela Bradt
Meg Chadsey
Antoinette Clemetson
Melissa Good
David Hansen
Dawn Kotowicz
Stephanie Otts
Joshua Reitsma
Jaclyn Robidoux

Advancing Southern New England Shellfish Aquaculture Through an Engaged Public and Next Generation Decision Support Tools-CTSG

T. Getchis, A. Cygler, A. Franklin Archer, R. Porter, S. De Guise

Advancing Southern New England Shellfish Aquaculture Through an Engaged Public and Next Generation Support Tools

Abigail Archer[1*], Judy Benson[2], Azure Cygler[3*], Dana Bauer[6], Catherine Dwyer[3], Giulio Farolfi[6], Tessa L. Getchis[2,4*], Brooke Hodge[5*], Robert J. Johnston[6*], Kristen Jabanoski[7*], Sue Kennedy[3], Stephanie Murphy[1], Tom Ndebele[6], Diana Payne[2], Read Porter[8], Catherine Schulter[8*], Grace Simpkins[1], Julia Wyman[8] (*denotes speaker)

[1] Woods Hole Oceanographic Institution Sea Grant, [2] Connecticut Sea Grant, [3] Rhode Island Sea Grant, [4] UConn Extension, [5] New England Aquarium, [6] Clark University, [7] NOAA NEFSC Milford Laboratory, [8] Rhode Island Sea Grant Legal Program

National Sea Grant Aquaculture Symposium, Nov 2, 2021

Project Overview

1. Shellfish aquaculture landscape in southern New England
    1.1. What brings us together?
2. Research to inform extension programming
    2.1. Public concerns and tradeoffs for coastal aquaculture
    2.2. Role the media plays in aquaculture messaging
3. Engaging stakeholders with essential information and tools
    3.1. Public & media fact sheets, displays & interpretative signage
    3.2. Private sector training
    3.3. Law, policy & permitting initiatives
    3.4. Map & data viewers

Southern New England's shellfish aquaculture landscape

- Focus is bivalve shellfish aquaculture
- Hundreds of small businesses
- Farms located in near shore coastal areas
- Shellfish initiatives established to grow industry
- Expansion of submerged and floating gear
- Aquaculture has become increasingly visible
- Increased public attention, concern, scrutiny

Southern New England's shellfish aquaculture landscape

- Previous efforts focused mainly on producing information and tools for prospective farmers
- Now engaging public to increase knowledge of shellfish aquaculture and shared role of siting farms in coastal waters
- Opportunity to work together regionally to:
    - Listen to public & media perspectives
    - Develop targeted information and tools
    - Engage audiences across the region

Project Overview

1. Shellfish aquaculture landscape in southern New England
    1.1. What brings us together?
2. Research to inform extension programming
    2.1. Public concerns and tradeoffs for coastal aquaculture

Tradeoffs in Shellfish Aquaculture

- All shellfish aquaculture involves tradeoffs, e.g., economics, aesthetics, use of water resources, environmental impacts, etc.
- The public's initial impressions of shellfish aquaculture sometimes depend on misperceptions or lack of information.
- Existing research provides minimal information on what type of shellfish aquaculture development would maximize support.
- How does this support depend on the information provided on aquaculture characteristics and impacts?
- How and why does it differ across different population groups, areas of New England, etc?


FLOATING GEAR
AQUACULTURE
FLOATING GEAR
BOTTOM GEAR AREA
BOTTOM GEAR AREA
AQUACULTURE
BOTTOM GEAR

Discrete Choice Experiment to Quantify Preferences

- Develop and implement a stated preference discrete choice experiment (DCE) to quantify public preferences for different types of shellfish aquaculture
- Compare results across three New England states
- DCEs estimate preferences based on how different individuals would 'vote' for or against different types of hypothetical but realistic future scenarios.
- Statistical results demonstrate the public's value and preferences for different types of shellfish aquaculture in different areas.
- Can predict public voting support for different types of future development scenarios.

DCE Survey Design and Analysis

- Survey was designed over a two-year process with input from the literature, aquaculture experts and 6 focus groups with members of the public.
- Key attributes for scenario design include changes in (1) floating gear, (2) bottom gear, (3) jobs and income, (4) localized water clarity, (5) region where new aquaculture occurs, and (6) household taxes / fees.
- Scenarios grounded in actual (current) conditions in each state.
- Additional questions will allow preferences and values to be modeled as a function of household attributes, coastal recreation activities, experience with aquaculture, etc.
- Statistical analysis will enable public support to be predicted across sampled states, for different types of potential future aquaculture development strategies.
- What types of characteristics and impacts are most important to public support and why?

Next Steps

- Survey design is complete and coded on Qualtrics platform.
- Will be implemented via random internet panel in target states (CT, MA, RI), with sample quotas to match Census population.
- Anticipate N= ~1250 per state (3,750 total), conditional on quotes from survey implementation firms (e.g., Dynata).
- Expect implementation during fall 2021; initial results by early 2022.

Project Overview

1. Shellfish aquaculture landscape in southern New England
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    2.2. Role the media plays in aquaculture messaging

Public perception challenges

- Between 70 and 85% of the seafood Americans consume is imported
    - 50% of those products (finfish, shellfish, seaweed) are farmed
- Few Americans have firsthand experience with aquaculture
- Low awareness of benefits, risks, effects and practices associated with aquaculture industry (Murray et al. 2017)
- 47% of Americans have a negative view of farm raised seafood due to concerns for product quality, food safety and the environment (Bacher 2015)
- 1 in 4 respondents were aware of positive environmental contributions of shellfish aquaculture operations in a recent survey (Atlantic Corporation 2019)
- More general reporters covering science and the environment

Importance of understanding public discourse and perceptions

- Understanding how to educate and inform the public
- Foster support for public policy
- Design strategic risk communication
- Market local aquaculture products

Rickard & Feldpausch-Parker 2016 – "Of Sea Lice and Superfood"

- Content analysis study compared aquaculture coverage in 4 regional & 4 national newspapers
- Overall media coverage of aquaculture increased during study period, especially discussion of benefits and sustainability
- Most prevalent themes: economics and risk
- Finfish aquaculture discussed in 62.3% of articles, shellfish 51.5% & seaweed 5.3%
- More national coverage of risks, benefits and sustainability compared to regional
- 39% of Boston Globe articles mentioned benefits of aquaculture, ⅓ discussed sustainability

Objectives of Southern New England Content Analysis Study

- Analyze temporal and geographic trends and dominant themes in media coverage of shellfish aquaculture in southern New England,
- Determine whether and to what extent state shellfish initiative outreach efforts are informing or impacting media dialogue, and
- Explore which outreach activities (if any) are having a measurable effect on how aquaculture is covered by the media.

Project Overview

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    2.2. Role the media plays in aquaculture messaging
3. Engaging stakeholders with essential information and tools
    3.1. Public & media fact sheets, displays & interpretative signage

Public/Media Outreach Information

Aquaculture Interpretive Signage

- Pivot due to COVID
- 2 signs using community model

Media education

- Media forum
- Adopted/shared common language on events like HABs

Public Education

- Fact Sheets

Project Overview

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3. Engaging stakeholders with essential information and tools
    3.1. Public & media fact sheets, displays & interpretative signage
    3.2. Private sector training

Training

- Class has been taught in person for 30+ years (MA)
- Updated/adapted curriculum to 10-wk class via Zoom
- 50+ students (2021)
- Weekly Interactive assessments & discussion time
- Presentations from farmers, town managers & regulators

Evaluation Survey Feedback


padlet

What did you learn from either watching a video or reading an article in both the counting seed and nursery systems folders.

Homework for the Fundamentals of Shellfish Farming Class 2021 - Due Wednesday, 2/17 by Midnight.

Tidal upwelling system for clam seed grow out

Splitting

Corp Ext Team

Counting Seed

Size and Scale of Nursery Systems

Seed grade

Counting Seed

Counting Seed

Counting Seed

Successful Components of Class

- Weekly homework via Padlet
- Zoom class time of 75 minutes
- “Face-time” with regulators
- Level of technical content

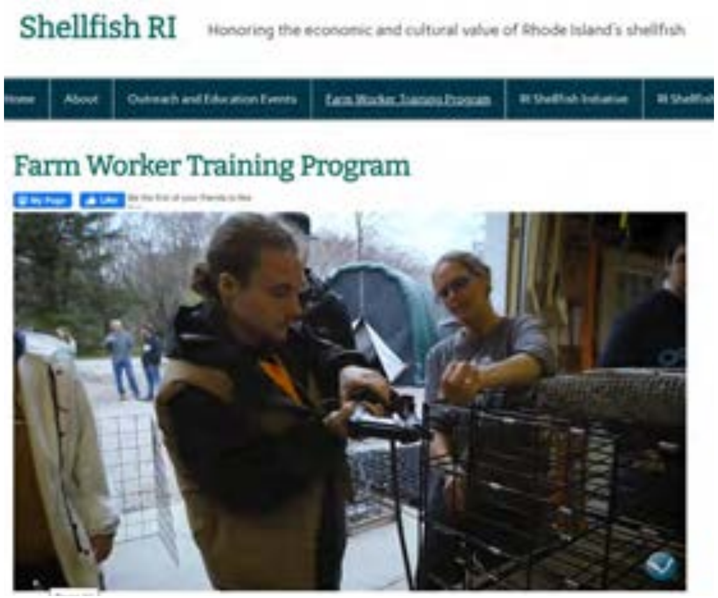
Things to work on in 2022

- If covid-safe to do so - hybrid approach
- Change format of weekly discussion groups
- Limit class size to allow time for more interaction

Training

Aquaculture Jobs Training Program

Building Skills for Entry-Level Workers



- Launch in December 2021
- Hosted through Teachables.com - FREE
- Modules will include emphasis on safety on the farm & skills to work with newer growing techniques & products such as kelp
- Will advertise through paid ads across the region
- Collaboration with Education Exchange, East Coast Shellfish Growers Association, Shedlight Productions

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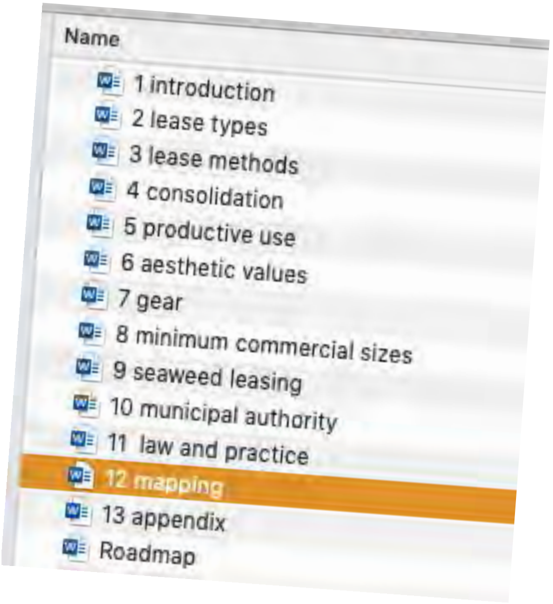
    3.3. Law, policy & permitting initiatives

Assessment of Connecticut Aquaculture Laws

- 2 major parts divided into 11 questions
  - Comparing Connecticut aquaculture laws to other eastern states (MA, RI, ME, NJ, VA, MD)
  - Reviewing Connecticut laws for inconsistencies or outdated sections



Examples of Questions

- What mechanisms do states use to allocate shellfishing grounds for aquaculture?
- How do Connecticut's regulations governing the minimum commercial size of wild-harvested shellfish and aquaculture-reared shellfish compare to competitor states?

Fact Sheet

- “The Relationship Between Aquaculture and the Public Trust in Connecticut, Massachusetts, and Rhode Island” - written by Andrew Spaulding, Law Fellow
- To improve the public’s understanding of the public trust doctrine and the use of public waters for shellfish aquaculture in Connecticut, Massachusetts, and Rhode Island


The Relationship Between Aquaculture and the Public Trust in Connecticut, Massachusetts, and Rhode Island

United States Supreme Court's Interpretation

Permitting Portals

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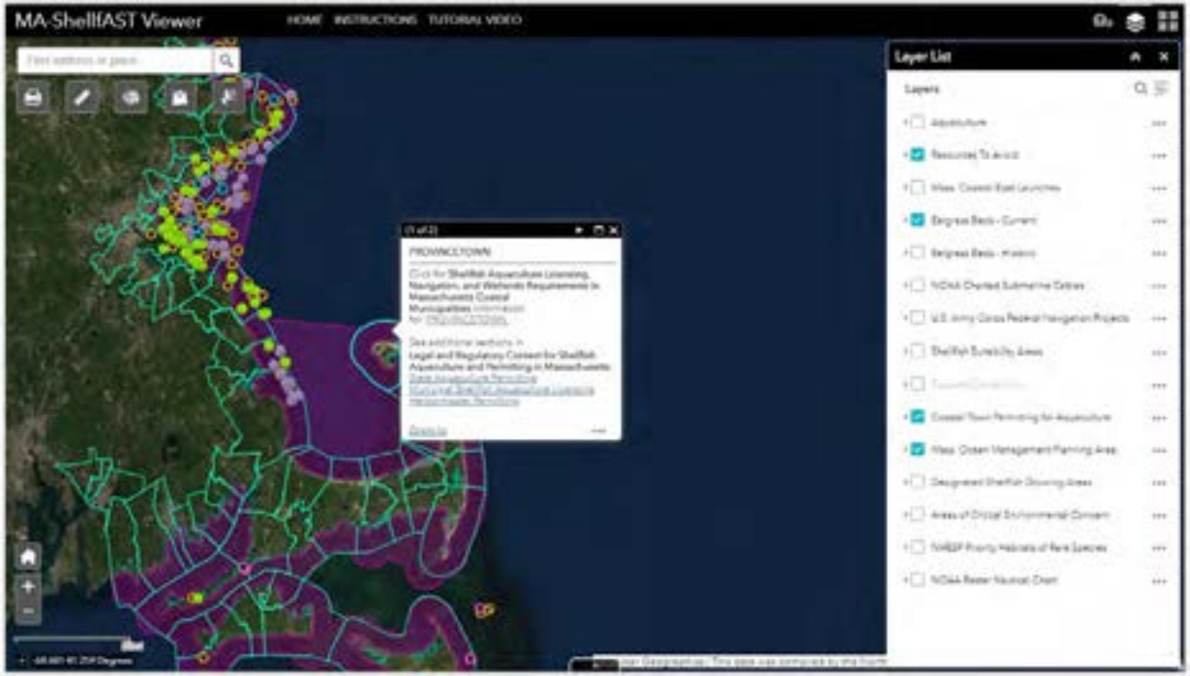
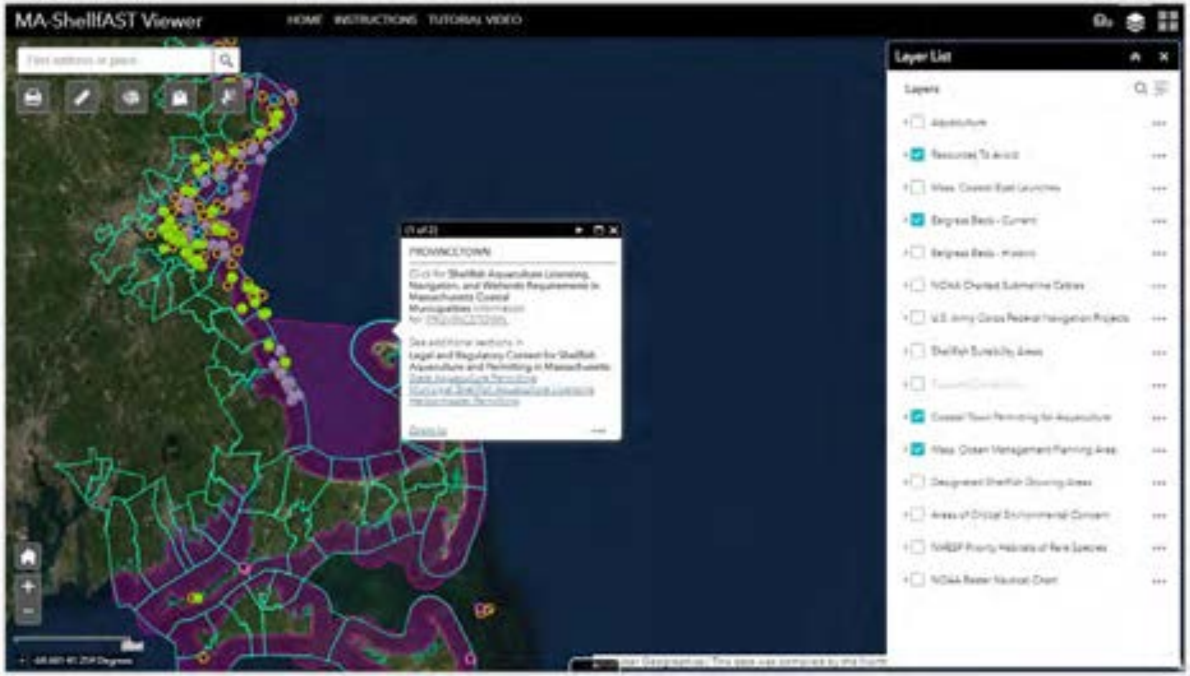
Rhode Island Shellfish Aquaculture Siting Tool (ShellfAST-RI)

- Beta version built and sent out for review by advisory board
- In the process of collecting feedback
- Plan to launch publicly in early 2022



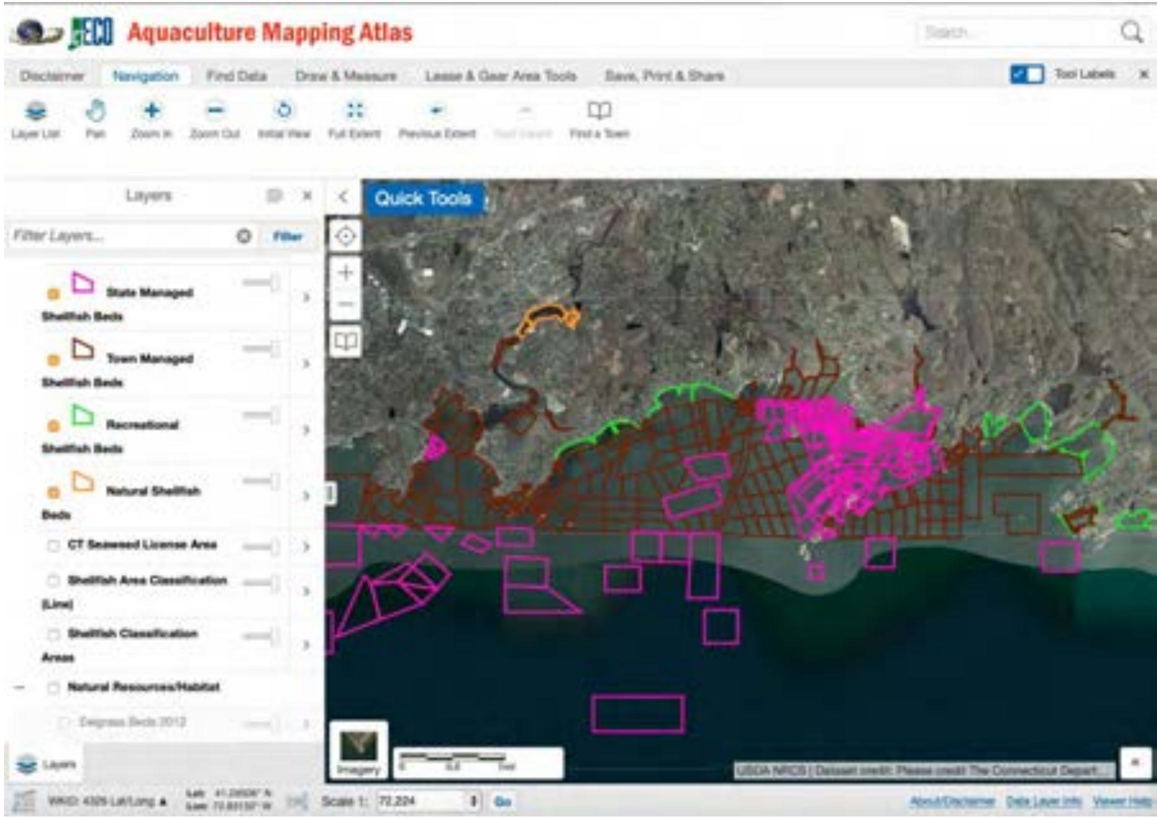
Massachusetts Shellfish Aquaculture Siting Tool (ShellfAST-MA)

- Launched in 2018
- Update slated for late 2021/early 2022



Connecticut Aquaculture Mapping Atlas

- Fourth iteration
- Update slated for 2022
- Will expand upon number of datasets, tools and query options



Summary

- Expansion of shellfish aquaculture in Southern New England faces common challenges
- Developing targeted outreach information and tools that are informed by social science research
- Sea Grant Aquaculture Collaborative has allowed us to:
    - Better understand public and private sector concerns
    - Improve upon and develop new shared information and tools
    - Expand our reach beyond traditional audiences

Acknowledgments

We are grateful for funding through DOC/OAR/National Sea Grant Program: Advanced Aquaculture Collaborative Programs NA18OAR4170081, and matching funds through partner organizations.

Much of the work presented here includes collaboration with industry, researchers and state and federal regulatory agencies.

Establishing a Hawai'i-Pacific Aquaculture Consortium: A Revitalization and Expansion of the Aquaculture Development Program-HISG

D. Lerner, M. Haws, D. Okimoto, A. Seale, S. Ellis,
K. Anderson Tagarino, M. Sudnovsky

Establishing A Hawai‘i-Pacific Aquaculture Consortium: A Revitalization and Expansion of an Aquaculture Development Program

Darren T. Lerner, Darren K. Okimoto, Kelly Anderson Tagarino, Max Sudnovsky, Andre P. Seale, Maria Haws, and Simon Ellis
w/Bradley "Kai" Fox, Cherie Kauahi, Katy Hintzen, and David Crisostomo

NOAA, Sea Grant Advanced Aquaculture Opportunities (Hubs) Symposium
November 1, 2021 (Virtual)

University of Hawaiʻi Sea Grant College Program

- Founded in 1968 at UH Mānoa and designated a Sea Grant College Program in 1972
- Organized research unit in the School of Ocean and Earth Sciences and Technology
- State-wide and Pacific region presence

Mission

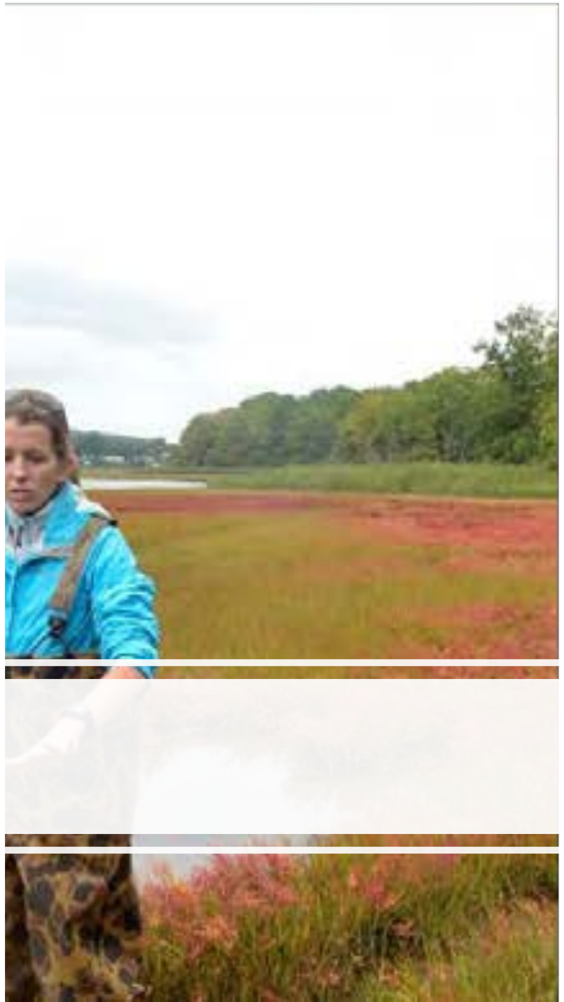
To provide integrated research, extension and education activities that promote sustainable coastal and marine resources and resilient communities across Hawaiʻi and the Pacific region.

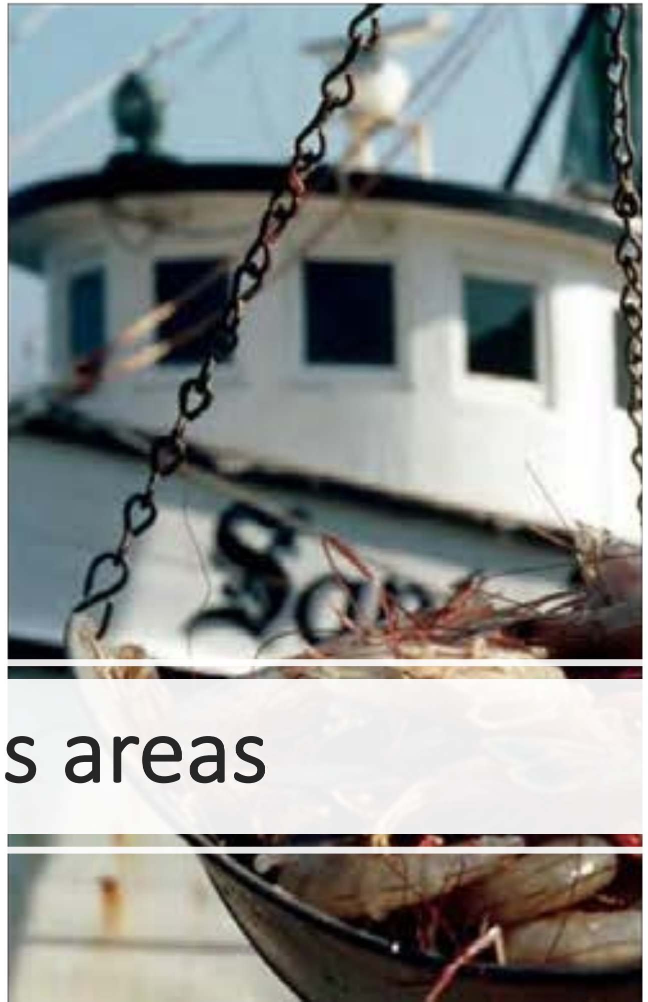
Healthy Coastal Ecosystems

Resilient Communities and Economies

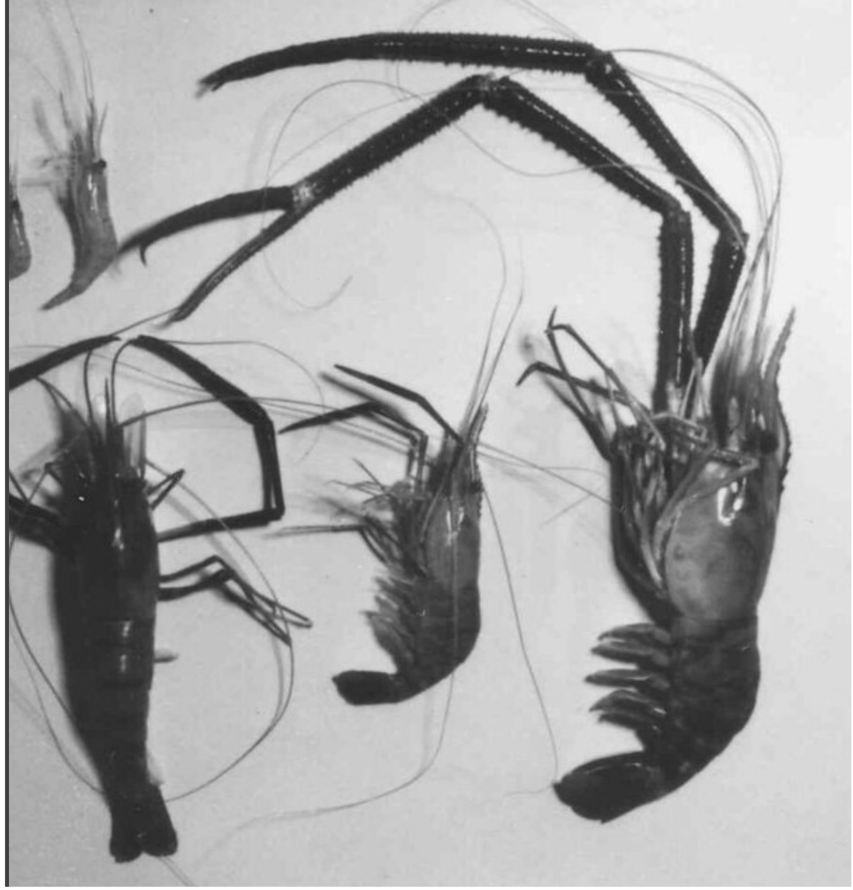
Sustainable Fisheries and Aquaculture

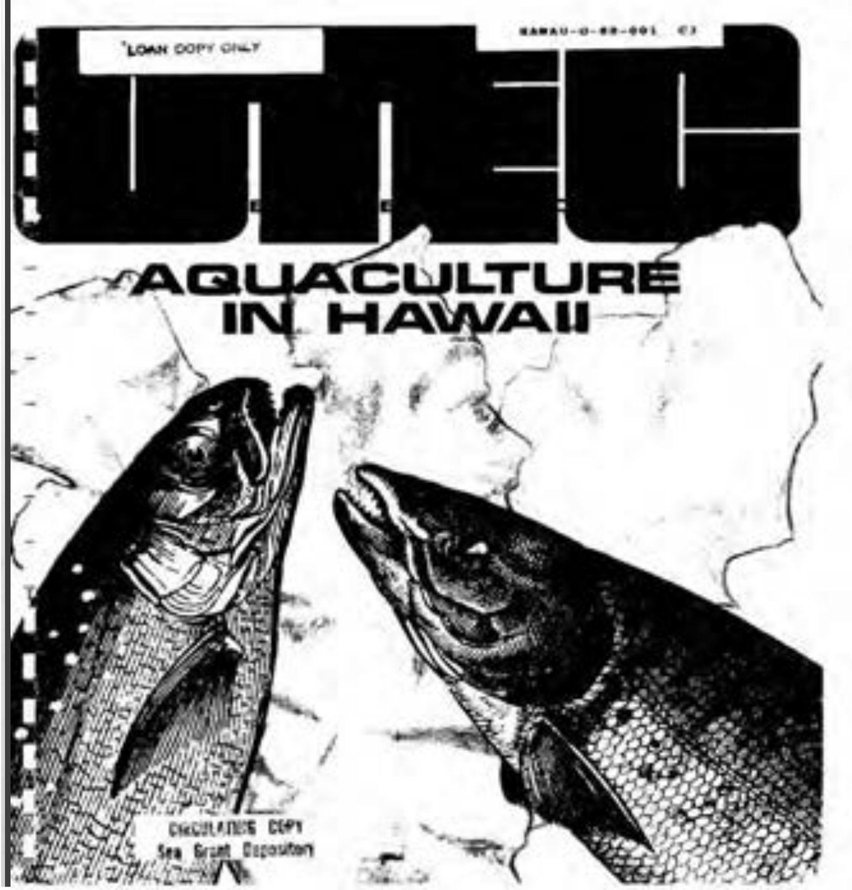
Environmental Literacy and Workforce Development





Focus areas





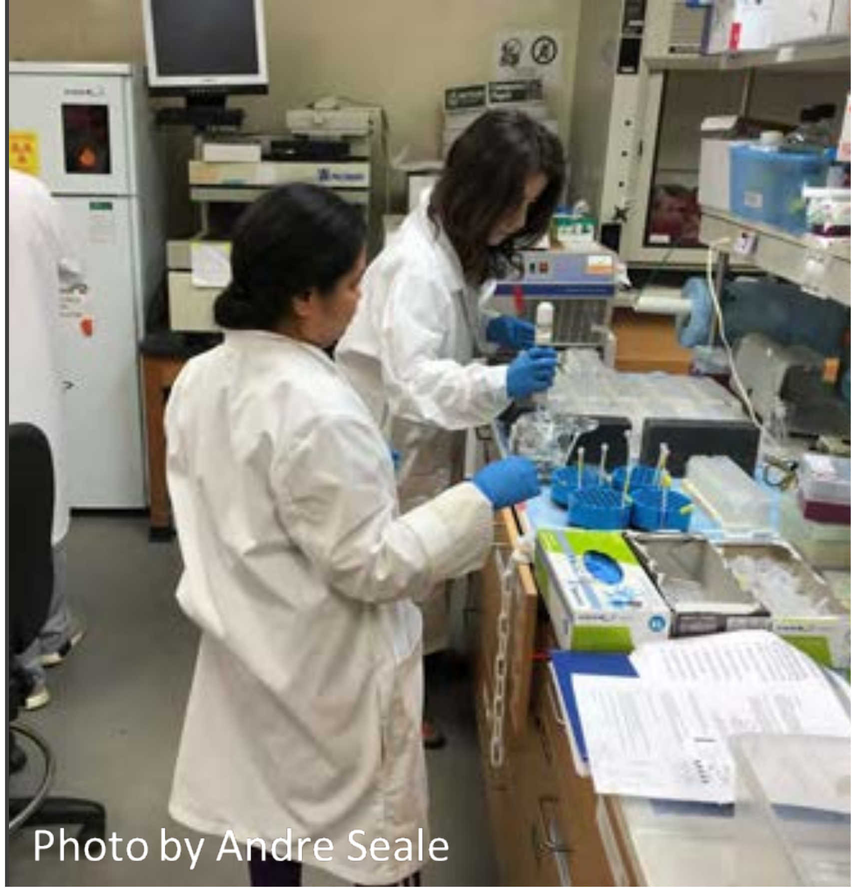
Seaweed Farming
1968-1986

Prawn Program
1973-1987

Cold Deep Ocean Water Aquaculture
1982-1983

Aquaculture Research

Sea Grant
University of Hawai'i



Marine Shrimp Program
1985-1990

Shrimp Virus Research
1984-2000

Feeds Technology Research
1985-2001

Aquaculture Research

Open Ocean Aquaculture

1995-2002

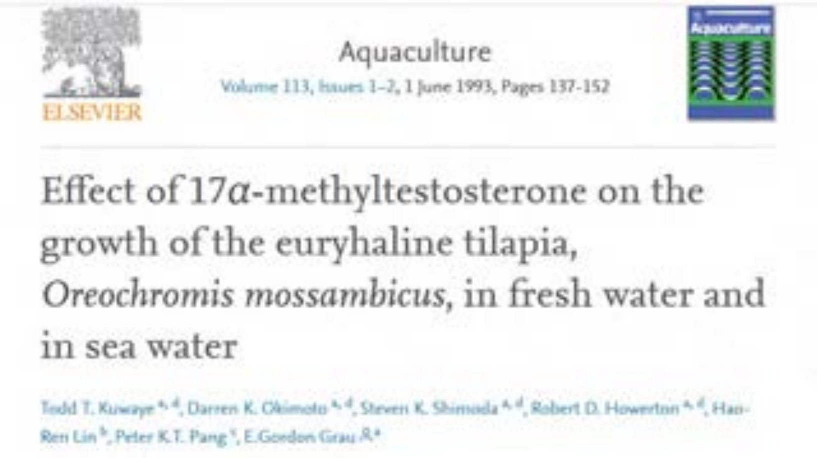
Hawaiian Fishpond Research

2007-present

Aquaculture Research

Aquaculture Research

- 95 newsletters
- Over 100 peer-reviewed publications
- 34 conference, symposium, or workshop papers
- 20 brochures
- 14 books authored/edited
- 12 book chapters authored
- 10 technical reports
- 19 dissertations/theses


ELSEVIER

Aquaculture

Volume 113, Issues 1–2, 1 June 1993, Pages 137-152

Effect of 17α-methyltestosterone on the growth of the euryhaline tilapia, *Oreochromis mossambicus*, in fresh water and in sea water

Todd T. Kuwaye [a, d], Darren K. Okimoto [a, d], Steven K. Shimoda [a, d], Robert D. Howerton [a, d], Han-Ren Lin [b], Peter K.T. Pang [c], E.Gordon Grau [a, *]


Maturation, Hatchery, and Nursery Techniques for Chinese Catfish, *Clarias fuscus*, in Hawaii

Introduction and Background

Past extension faculty for Hawaiʻi

Mary Brooks
1982-1986
Oʻahu

Bob Howerton
1994-2015
Maui

Clyde Tamaru
1995-2009
Oʻahu

Jim Szyper
1999-2009
Hawaiʻi Island

Kathleen McGovern-Hopkins
2000-2009
Oʻahu

Maria Haws
1999-2008
Hawaiʻi Island

Photo by M. Haws

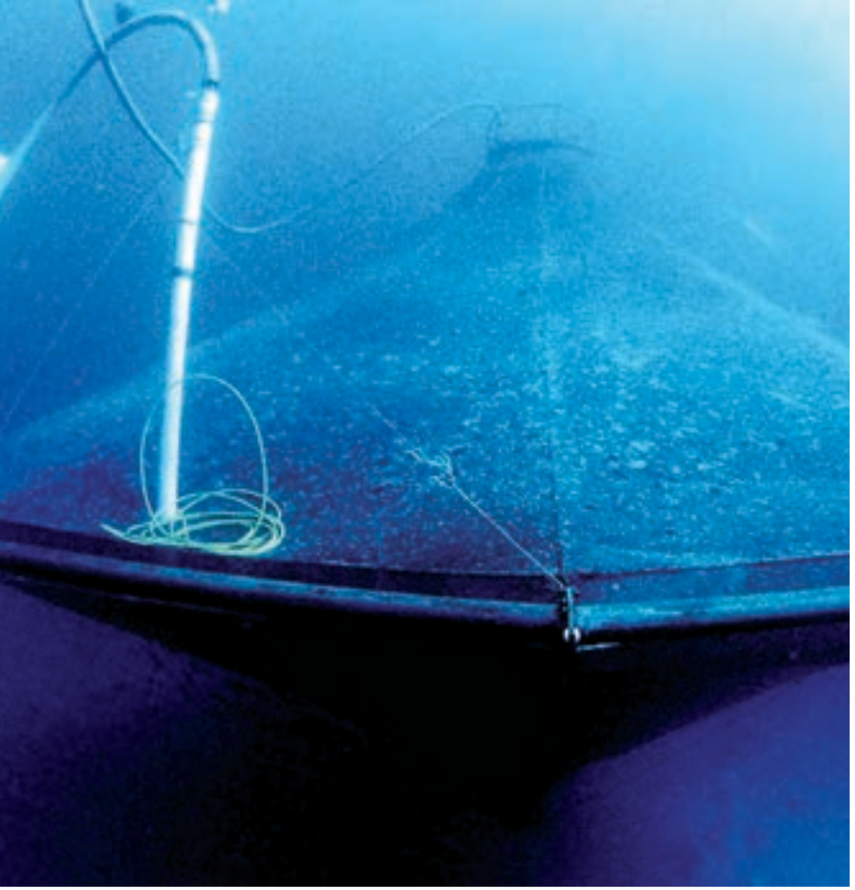
Photo by C.S. Tamaru

Freshwater & marine ornamentals

Commercialization of Hawai‘i bivalve industry

Industry diversification

Aquaculture Extension



Open ocean
cage culture

Hawaiian
fishponds

Aquaculture
as education

Aquaculture Extension

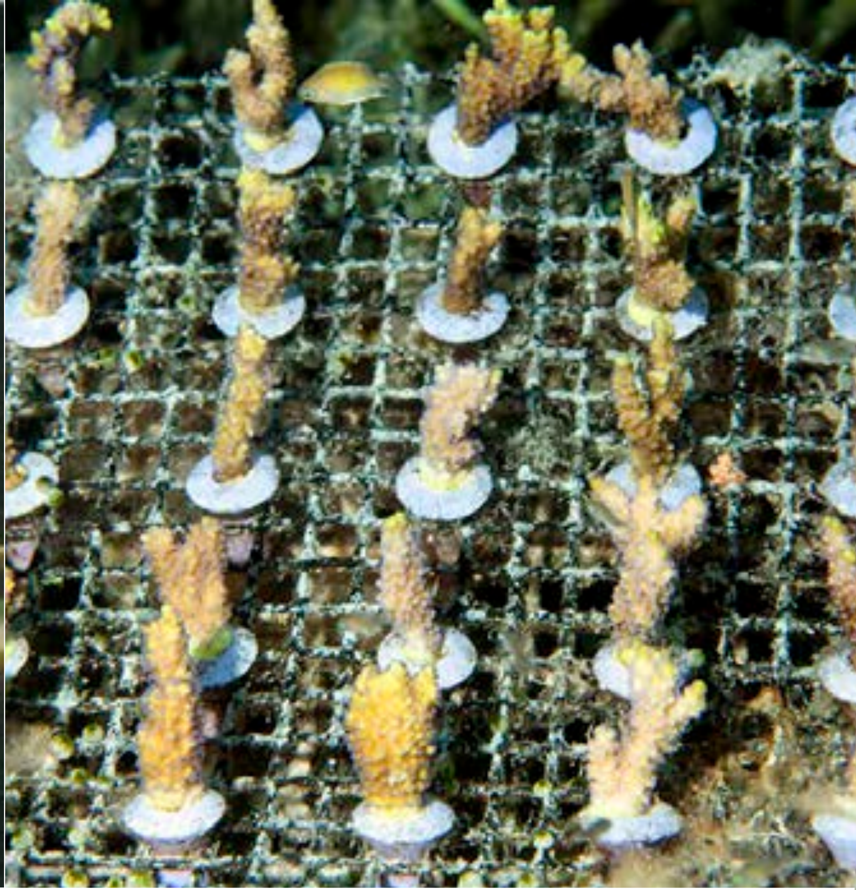
Sea Grant
University of Hawai'i

Pacific Regional Aquaculture Extension Service

- Est 1987
- Support aquaculture development in the US-affiliated Pacific Islands and US territories
- Partners: UH, US Dept. of Interior, CTSA, Land Grant Programs in Palau, RMI, American Samoa, CNMI, FSM, and Guam.

Aquaponics & feeds production

Black Pearl culture



Marine ornamentals

Aquaculture Extension US Pacific

Sea Grant
University of Hawai'i

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Posted on: Friday, September 19, 2008

Hawaii slipping into recession, report says

By Greg Wiles
Advertiser Staff Writer

A forecast being released today shows Hawai'i is tipping into a recession as job losses and a decline in personal income shrink the state's economy.

The report, by the University of Hawai'i Economic Research Organization, shows there will be a decline in jobs this year and next, while personal income on an inflation-adjusted basis will turn negative in the fourth quarter and continue that way during the first half of 2009.

"Hawai'i's economy is not growing at all. It's shrinking," said Carl Bonham, the research organization's executive director. "That's a recession."

The organization updates its economic projections quarterly, with the current report lowering projections of visitor arrivals. The group's economists almost doubled the projections they made June — now forecasting a 9.1 percent decline in visitor arr the biggest decline in arrivals since 2001 as vacation Mainland and Japan diminish.

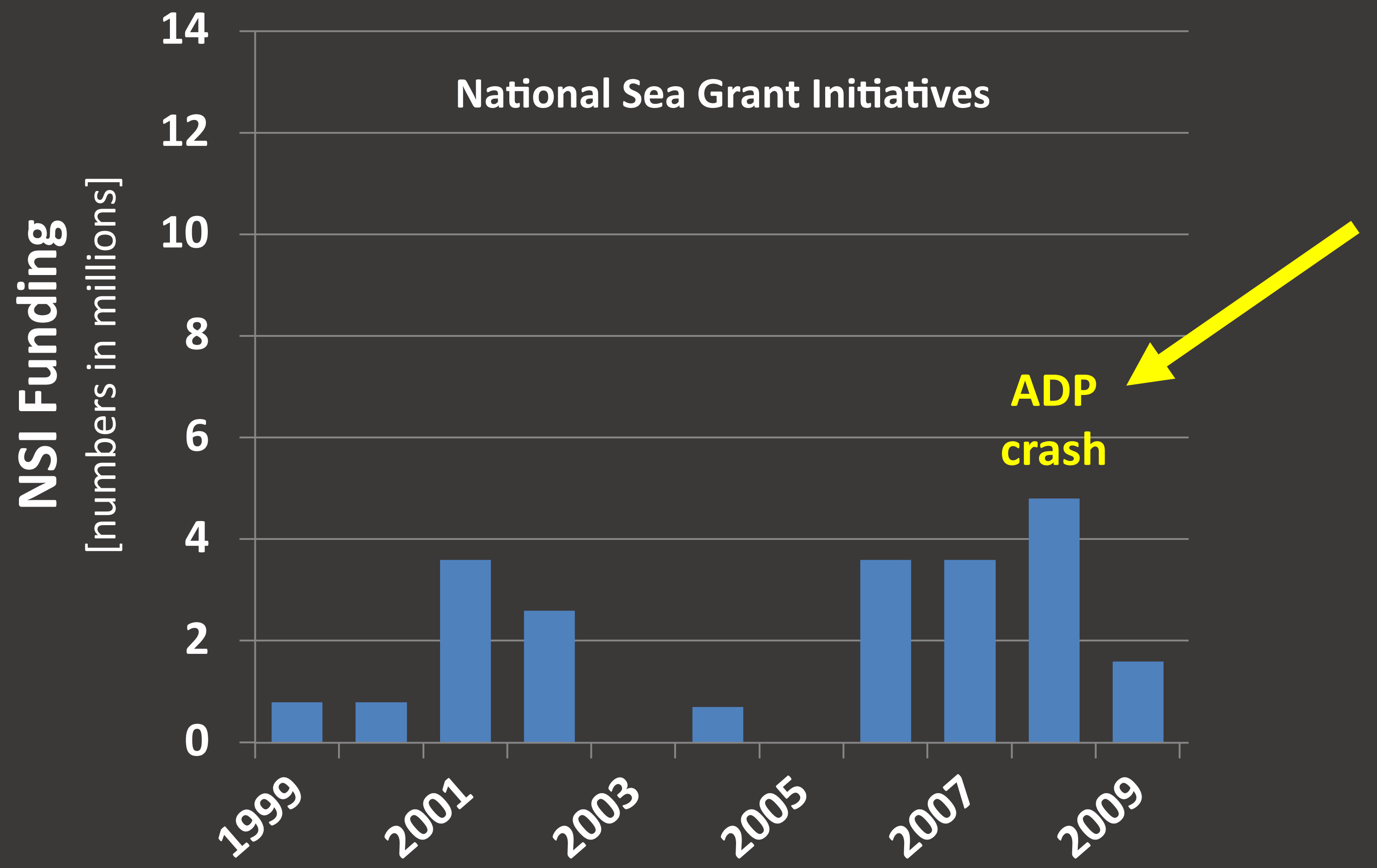
GRIM FORECAST

The University of Hawai'i Eco- nomic Research Organiza- tion's latest quarterly forec projects a bigger decline visitor arrivals than its Ju port. Here are the econ indicators, and what r age changes the gr casts.

CATEGORY
Visitor arrivals
U.S. arrivals
Japan arr
Other

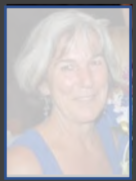
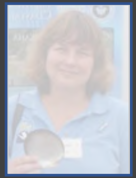
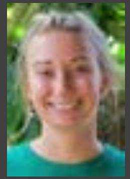
Economic Recession in 2008

Sea Grant Aquaculture NSI



Post economic recession extension capacity

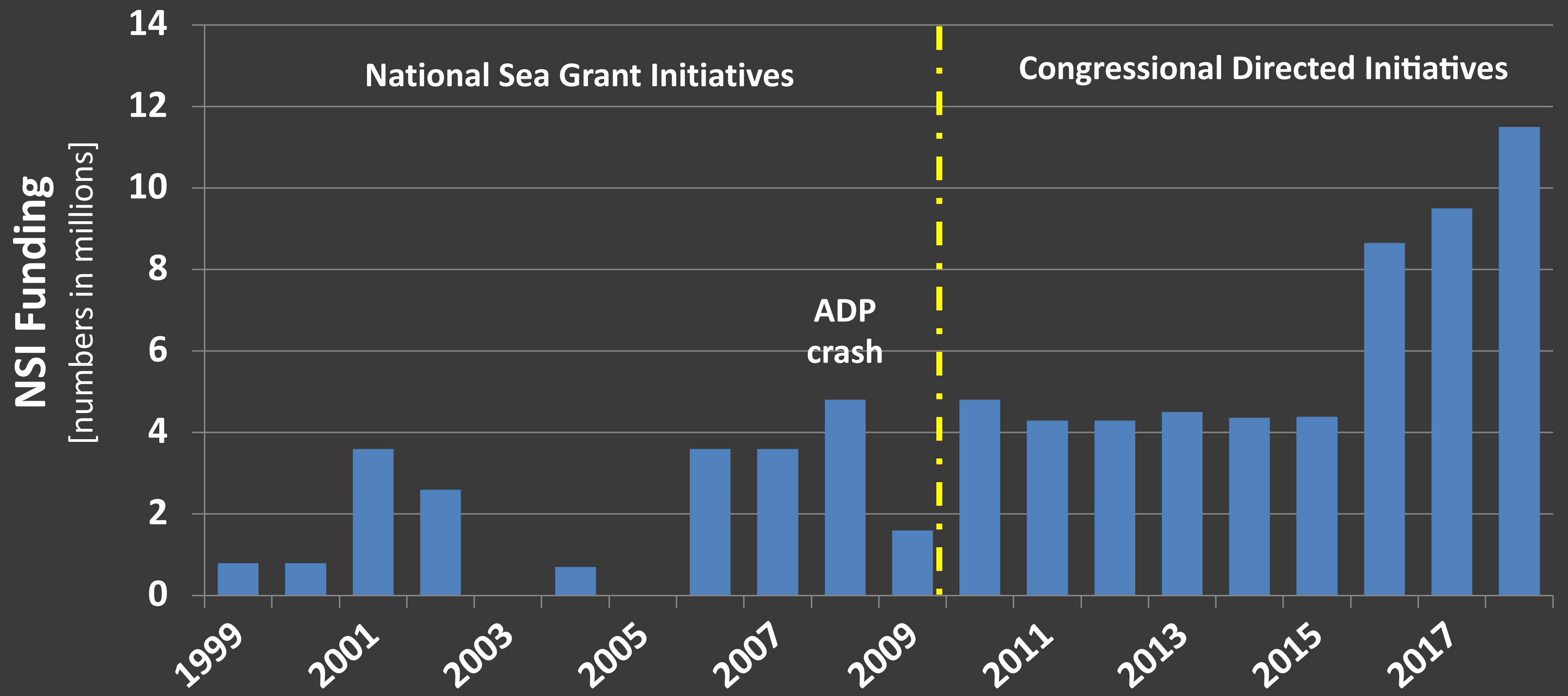


ROBERT DEAN HOWERTON

ROBERT DEAN HOWERTON June 16, 2016 Robert Dean "Bob" Howerton, PhD., age 59 passed away unexpectedly at his home in Makawao, Maui, Hawai'i on June 16, 2016. A kind and gentle soul, he was well-known by the aquaculture community locally and abroad and his passing is a huge loss for Bob's family, colleagues and friends. Born November 14, 1957 in Las Vegas, NV, to the late James M. Howerton and Mona (Brennecke) Howerton, he was the husband of the late Cynthia Lynn "Cindi" (Taylor) Howerton. He leaves behind his two beloved daughters Lauren Howerton of Wailuku, Maui and Jaime Howerton of Portland, OR, He also leaves behind brothers Jim (Robin Kuo) of Des Peres, MO, David of Sydney, Australia, and nieces Izzy and Mia. He was an alumnus of Punahou School, the University of Hawai'i at Manoa, and Auburn University, AL. and worked with the UH Sea Grant

Sea Grant Aquaculture NSI



Integrating Land and Sea Grant Aquaculture Research, Extension and Education at the University of Hawai‘i.

PI: Andre P. Seale, UHM, CTAHR
Co-PI: Darren Lerner and Darren Okimoto, Hawai‘i Sea Grant; and Rajesh Jha, UHM, CTAHR

2018
$750k

Establish an aquaculture program at UHM that leverages and integrates Land Grant and Sea Grant research, extension and education resources, including a state-of-the-art recirculating aquaculture demonstration center called the Tuahine Aquaculture Research and Education Center (TAREC)

Sea Grant
University of Hawai‘i

Establishing a Hawaiʻi-Pacific Aquaculture Consortium:
A Revitalization and Expansion of an Aquaculture Development Program

PI: Darren T. Lerner, Hawaiʻi Sea Grant
Co-PIs: Darren K. Okimoto, Kelly Anderson-Tagarino, and Max Sudnovsky, Hawaiʻi Sea Grant; Maria Haws, UH Hilo PACRC; Andre P. Seale, UH Mānoa CTAHR; and Simon Ellis, Marine and Environmental Research Institute of Pohnpei

2019
$1.2M

Revitalize, solidify, and expand an aquaculture development program through the establishment of an aquaculture-focused, collaborative hub which fully integrates research, extension, and education services directed towards supporting the continued development and enhancement of indigenous practices and the aquaculture industry in Hawaiʻi and the Pacific.

Objective 1. **Formalize current and new collaborative alliances to create integrated and synergistic research, education, and outreach efforts that foster the development, expansion, and promotion of local, regional, and indigenous sustainable aquaculture.**

Objective 2. **Support and conduct collaborative, applied research that addresses production barriers and bottlenecks related to feed availability, hatchery seed stock, production, disease, engineering limitations, and/or traditional practices.**

Objective 3. **Support critical extension/technology transfer capacity in Hawai‘i and the Pacific region in support of past research and the development of next generation efforts.**

Sea Grant
University of Hawai‘i

***Objective 4*. Explore the development of a regional aquaculture education program that leverages curricula, training courses, and extension materials for aquaculture audiences and work towards improved delivery of instruction.**

***Objective 5*. Develop adaptation strategies and practices that enhances the resilience of traditional aquaculture practices and the aquaculture industry to climate change.**

Co-Investigators and Current Extension, Specialist, and Research Faculty

Dr. Bradley "Kai" Fox
Aquaculture
Extension Specialist

Cherie Kauahi
Aquaculture
Extension Specialist

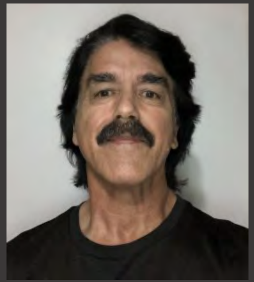
Kelley Anderson Tagarino
American Samoa
Extension Specialist

Max Sudnovsky
Republic of Marshall
Islands Extension
Specialist

Dr. Kanesa Seraphin
Prof & Asst. Director of
Education

Dr. Beth Lenz
Asst. Director for Diversity &
Community Engagement

Dr. Rosie Alegado
Assoc. Prof of
Oceanography, Director,
Center for Integrated
Knowledge Systems



David Crisostomo
Guam Aquaculture
Extension Specialist

Simon Ellis
Pohnpei Aquaculture and
Marine Resource
Management Specialist

Dr. Maria Haws
Professor of Aquaculture

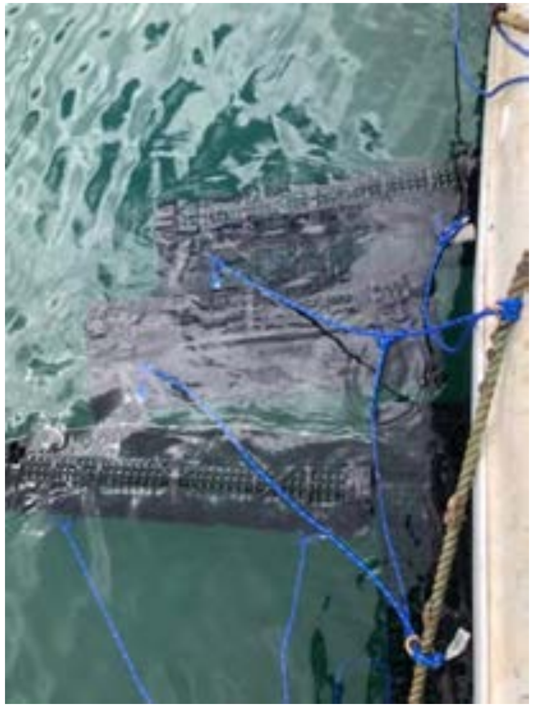
Dr. Andre Seale
Assoc Professor of
Animal Sciences

Katy Hintzen
Coastal Resilience
Specialist

Sea Grant
University of Hawai'i

Cherie Kauahi
Aquaculture Extension Specialist


FISHPOND
RESTORATION
KEEP CALM
IN THE LOKO I'A
#ALOHAHONOKEA



Dr. Bradley "Kai" Fox
Aquaculture Extension Specialist



GOFISH
HAWAIʻI
UNIVERSITY OF HAWAIʻI

Sea Grant
University of Hawaiʻi

CTAHR


Check
Check
Flush Bead
Filter
Other ?
Sun
Mon
Tue
Wed
Thurs
Fri
Sat
Dwight
Tran
Jon W.
John C.
ANN
X
X
EXPO






Katy Hintzen
Coastal Resilience Specialist

Future & History of Loko Iʻa Adaptation

Photo Credit: Kanda

Holistic approach that includes needs directly related to climate adaptation and the systemic social, political, and economic conditions that facilitate or hinder the perpetuation of loko iʻa

Photo Credits: Kanda

Nā ʻOno o ka ʻĀina

Strengthening Indigenous Food Systems and Supporting Restaurant Workers During COVID-19

Samoan Crab Ramen by Dilyuns Michael

Gorilla Ogo Salad by Alicia Nunez

Barracuda McNuggets by Alicia Yamachika

Papio Ceviche by Alicia Nunez

Gorilla Ogo Sourdough Crackers by Roxanne Begin

Indigenous Aquaculture Hub Gathering on Oʻahu

Dr. Andre Seale
Assoc Professor of
Animal Sciences

Tuahine Aquaculture Research & Education Center

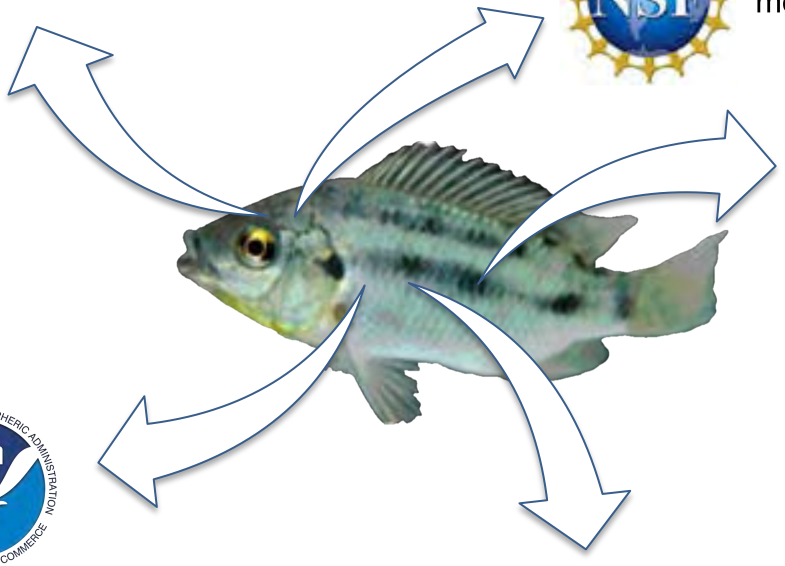
TAREC

Research

An adaptable fish model that allows for interdisciplinarity: from aquaculture to biomedical research

NIH: Integrating Osmosensitivity and Autocrine Signaling in a Model for Osmoregulation

NSF: Identifying osmosensitive molecular targets using a unique vertebrate model



Sea Grant: The development of acclimation salinity-based rearing strategies to maximize growth in Mozambique tilapia, *Oreochromis mossambicus*

The use of a euryhaline tilapia to assess the endocrine disrupting effects of anthropogenic chemicals on growth and osmoregulation

NOAA: Establishing an aquaculture program at the University of Hawai'i that leverages and integrates Land Grant and Sea Grant research, extension and education resources

USDA: Physiological effects of environmental stressors in a key finfish for aquaculture

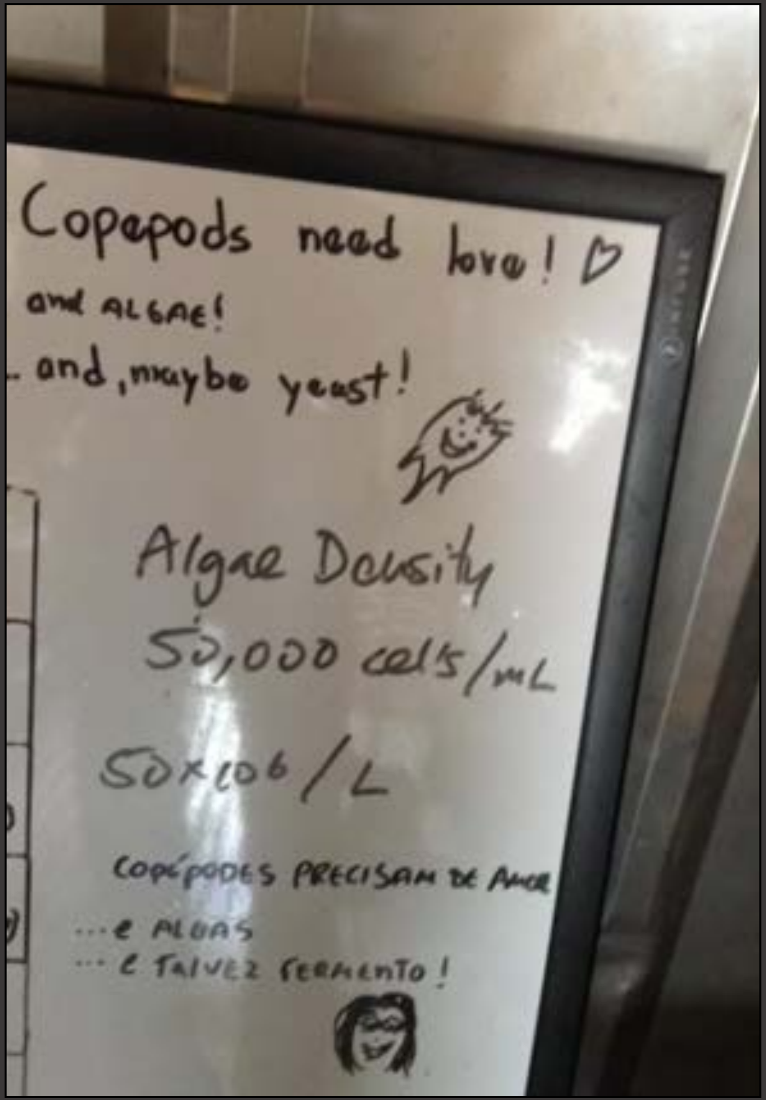
Pacific Aquaculture & Coastal Resource Center

Dr. Maria Haws
Professor of Aquaculture

Academic Contributions

- Aquaculture specialization part of Bachelor' degree in agriculture
- This is the only 4-year degree program in aquaculture in Hawai'i
- TCBES Masters degree students may choose aquaculture research topics
- Pursuing partnerships with community colleges
- Wildlife/Fisheries/Aquaculture degree program in planning stages

Aquaculture Student Workforce Training Program



PACRC's Fish Research, Development, and Extension Program

- Two fish hatcheries at PACRC
  - Marine food fish
  - Marine ornamental fish
- Also supported by NSGO and NOAA SK grants

Development of native food-fish species

Nenue (*Kyphosus* spp.)

Mullet *(Mugil cephalis)*

Nabeta (*Pavo iniistus*)

Moi (Polydactyus sexifilis)

Āholehole (*Kuhlia sandvicensis)*

Achilles Tang *(Ancanthuras achilles)*

Ornamental fish research program

Developing captive breeding methods for coral reef fish is an opportunity to elucidate life history traits to aid in fisheries management and conservation.

Hawaiian Flame Wrasse (*Cirrhilabrus jordani*), one of 10 ornamental species used for R&D at the PACRC

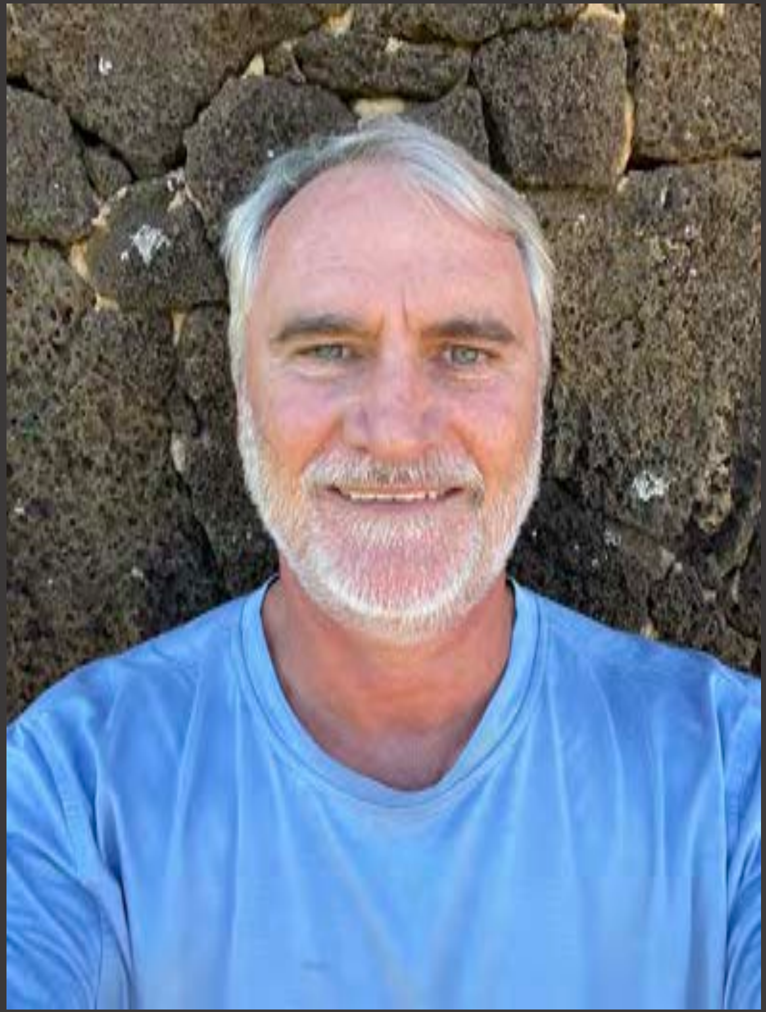
Embryos just prior to hatch

Just hatched (0 dph)

Shellfish research, training, and extension program

- ❖ Seed and technical training for fishponds and other producers
- ❖ Hawai'i's hatcheries supply 50-80% of NW seed
- ❖ Polyploid oyster research
  - ❖ Climate adapted polyploids (w/molluscan Broodstock Program, OSU)

Development of native bivalve species for production and restorative aquaculture



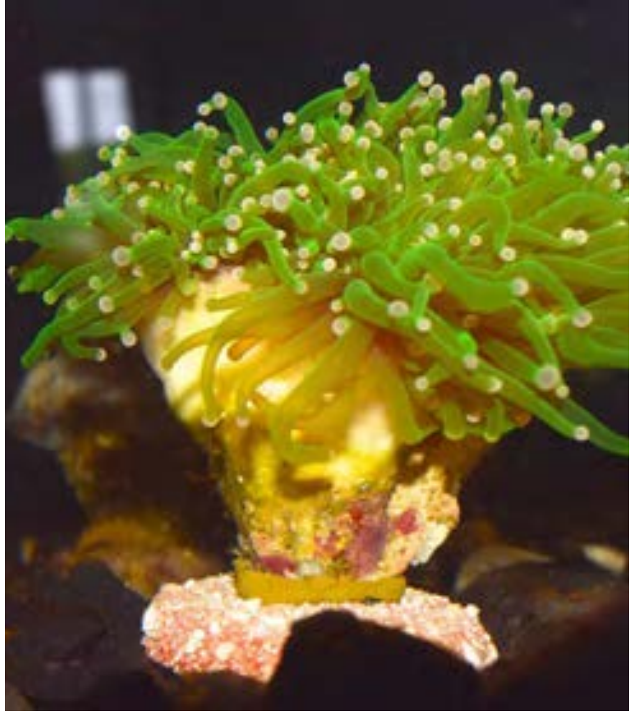
Simon Ellis
Pohnpei Aquaculture and Marine Resource Management Specialist

Marine and Environmental Research Institute of Pohnpei, Micronesia (MERIP)

MARINE AND ENVIRONMENTAL RESEARCH INSTITUTE OF POHNPEI

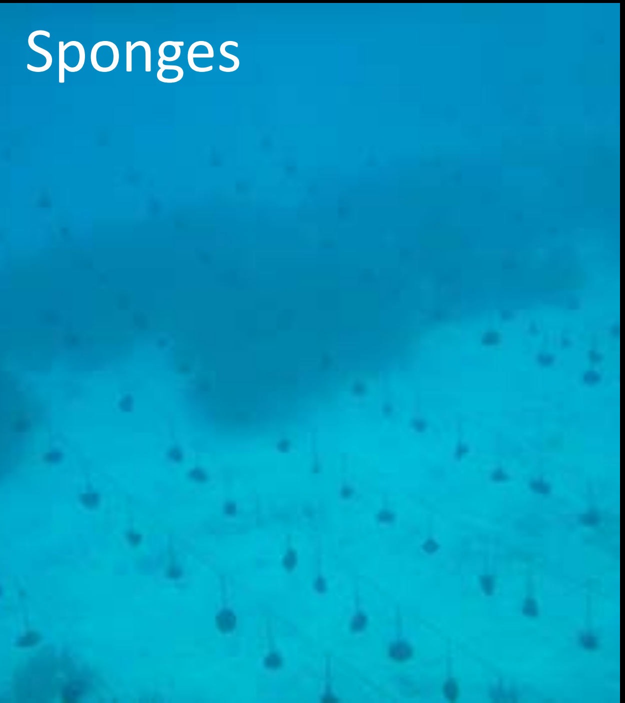
- Three tier, fully integrated development approach to sustainable development:
  - Product development
  - Community technology transfer/training
  - Marketing and market development





Products and Activities

- Farmed corals and giant clams for the marine ornamental trade
- Natural Sponges
- Capture-based farming of Rabbitifishes
- Giant clam Hippopus for food security
- Partnering with more than 60 farmers across Pohnpei and Kosrae



Aqua-Farming

- **Simple Design**
- **Lagoon & Community-based**
- **Easy to establish & run**

Kelley Anderson-Tagarino
American Samoa Extension Specialist

American Samoa's only aquaculture program

- A Sea Grant – Land Grant partnership based at the American Samoa Community College providing extension services and aquaculture education for the Territory.

Enhancing resilience

David Crisostomo
Guam Aquaculture Extension Specialist

Sea Grant University of Guam

Sea Grant University of Hawai'i

Building a Better Aquaculture Industry

Major Focus Areas

* Public awareness
* Public/private partnerships
* Applied research
* Community Training

PUBLIC AWARENESS

SOCIAL MEDIA :

- VIRTUAL “TALK AND TOUR” OF AQUACULTURE ACTIVITIES
  - *HAWAII AQUAPONI
- *PAYLESS MARKET LOCAL FOOD PROGRAMMING “CHAGI”*

- CONFERENCE ON ISLAND SUSTAINABILITY

- -TILAPIA TASTING EVENT

Public/Private Partnership

Community Level
Backyard Recirculating Aquaculture Systems

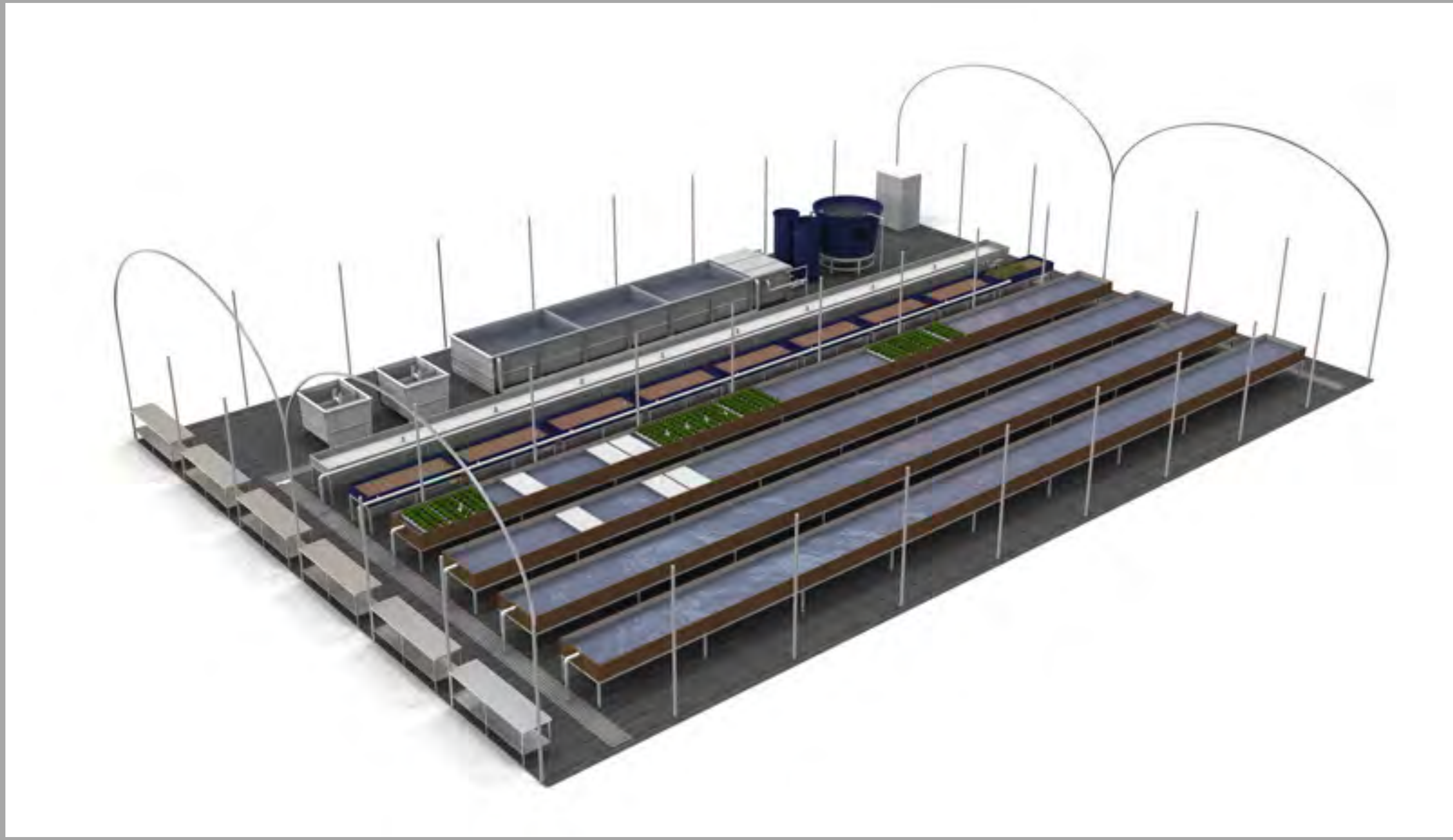
- 3 local non-profits organizations
  - GUAHAN SUSTAINABLE CULTURE
  - ISLAND GIRL POWER
  - HARVEST OF GRACE INTERNATIONAL, INC
- 2 Mayor's Offices
  - PITI MAYOR
  - SINAJANA MAYOR

Stakeholder Group (advisory)

Guam Aquaculture Stakeholder Group
* New group working to register as non-profit.

APPLIED RESEARCH

Production and Economic Analysis of Commercial scale aquaponic system in Guam



- Construct small commercial scale aquaponics system
- Compare production and economics between “coupled” and “de-coupled” aquaponics system.

Community Training

* G3 Conservation Corp.
* Guahan Sustainable Culture
* Island Girl Power
* Harvest of Grace International, Inc
* Piti Mayors Office
* Sinajana Mayors Office
* GSC-Americorps

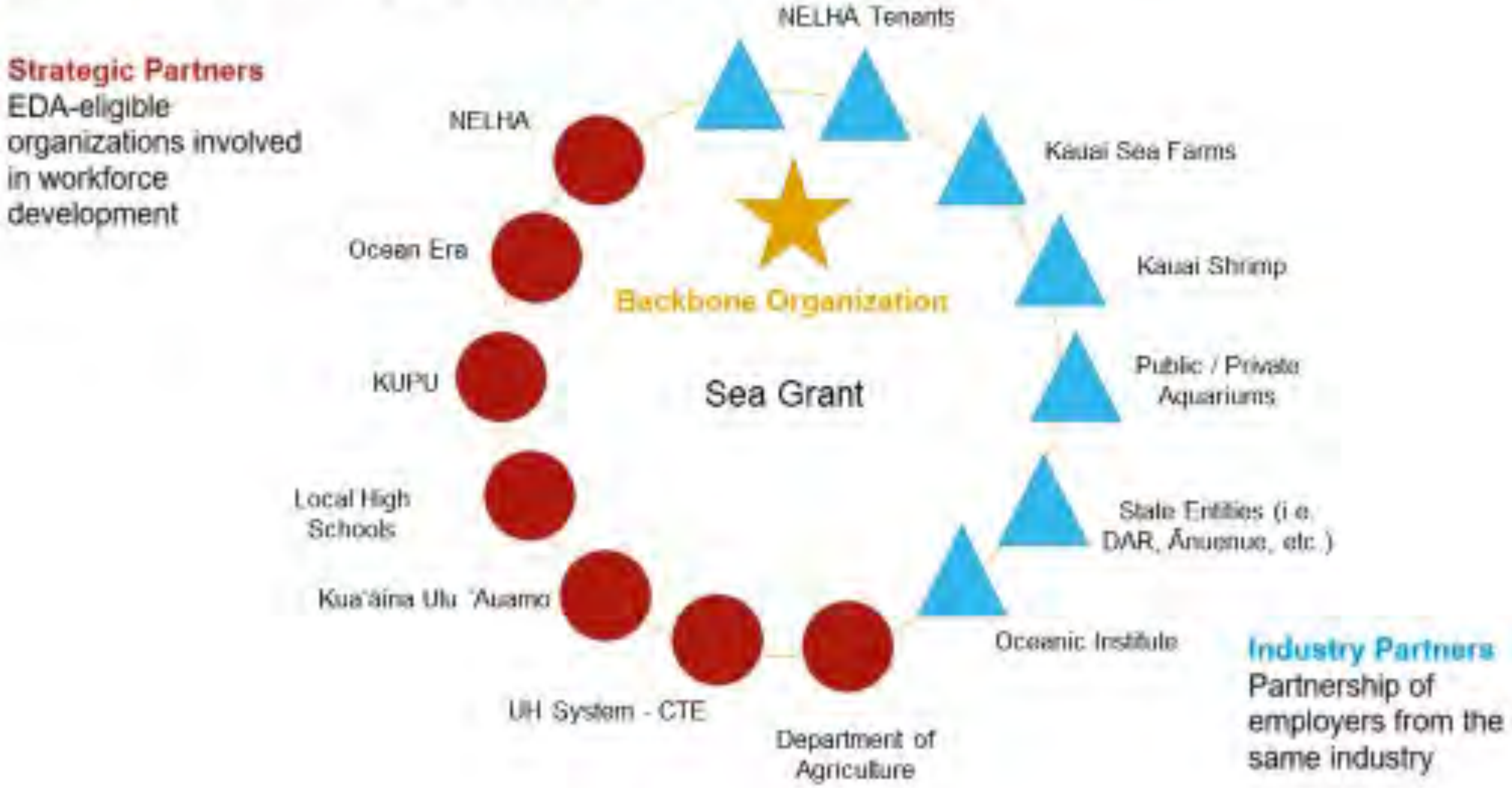

Future Directions

Core Partners

- Agriculture, Community, and Natural Resources Division, American Samoa Community College
- Aquaculture and Livestock Support Services, Hawai‘i Dept of Agriculture
- College of the Marshall Islands-Cooperative Research and Extension
- College of Tropical Agriculture and Human Resources, UH Mānoa
- Guam Sea Grant
- HATCH Accelerator
- Hawai‘i Aquaculture and Aquaponics Association
- Hawai‘i Strategic Development Corporation
- Kua‘āina Ulu ‘Auamo
- Natural Energy Laboratory of Hawai‘i Authority
- Oceanic Scientific, LLC
- Pacific Aquaculture and Coastal Resources Center, UHH
- Pacific Islands Regional Office, National Oceanic and Atmospheric Administration
- The Marine and Environmental Research Institute of Pohnpei
- University of Hawai‘i System
- Waterkeepers Hawaiian Islands
- Washington Sea Grant
- Windward Community College, University of Hawai‘i

EDA Good Jobs Challenge NOFO

Figure 1 – Visualization of a Sectoral Partnership



NSF Engineering Research Centers Opportunity (TBA)

Establish an Engineering Research Center on Sustainable Offshore Integrated Multi-tropic Aquaculture

$50 Million over 10 years

Mahalo!

- Photo by Andre Seale

West Coast Aquaculture Collaborative-WASG

N. Naar, R. Callender, D. Hansen, T. Talley

West Coast Aquaculture Hub

Nicole Naar
Washington Sea Grant

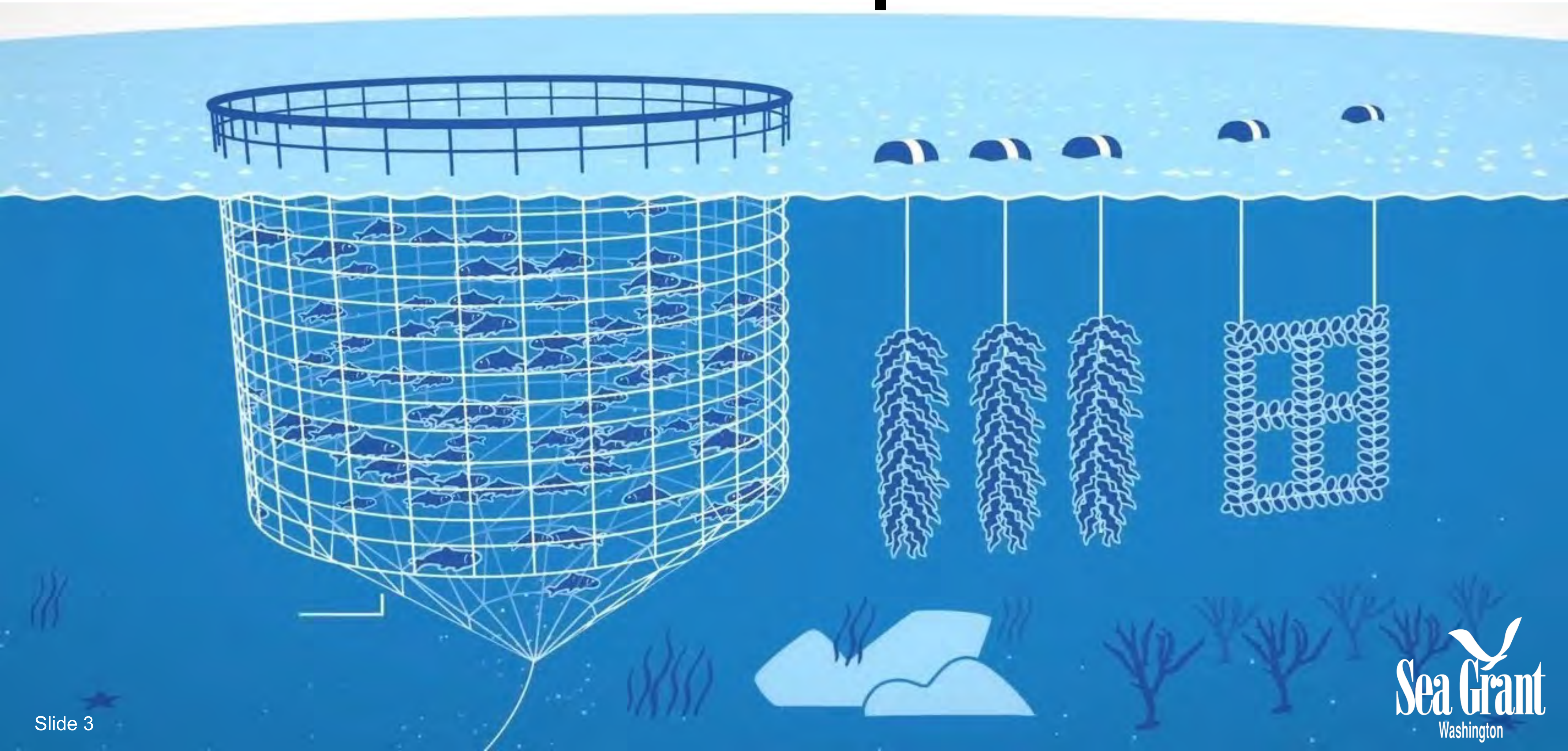
Sea Grant California
Sea Grant Oregon
Sea Grant Washington
Sea Grant Alaska

Sea Grant Aquaculture Research Symposium
November 3, 2021

West Coast Region

- Similar habitats and species
- Existing market connectivity
- Overlapping social license concerns
- Political and institutional diversity

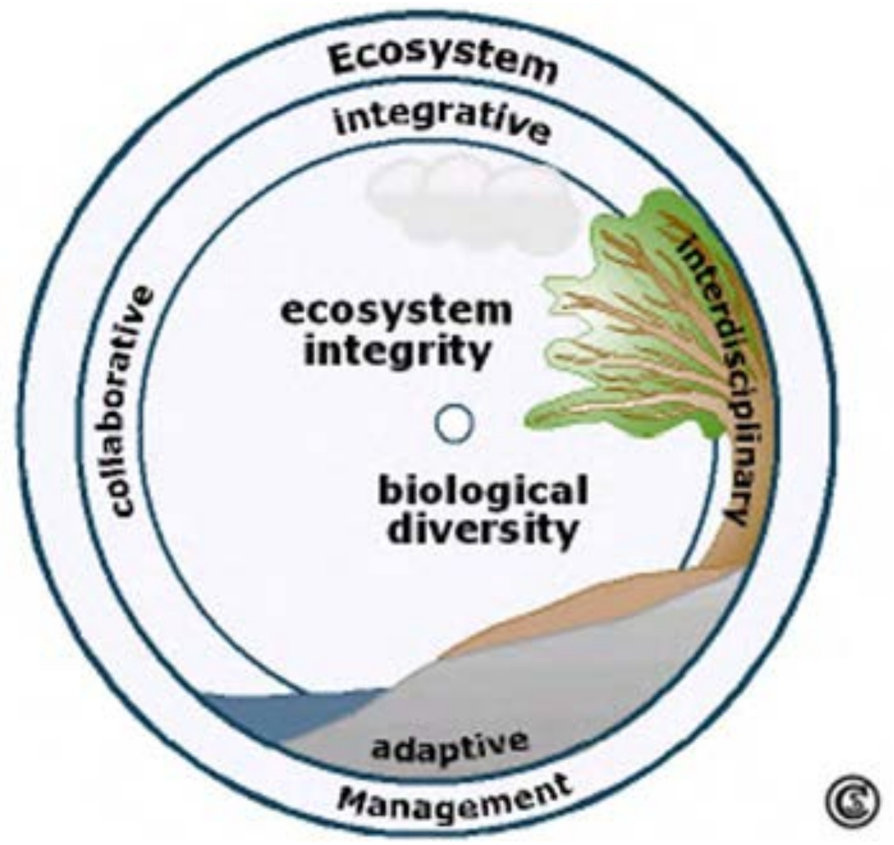
Sustainable Aquaculture



Sea Grant
Washington

Ecosystem-based Management

- Landscape-scale
- Collaborative
- Interdisciplinary
- Adaptive management



Hub Objectives

1. Establish a collaborative structure
2. Test the approach through a pilot study
3. Report outcomes and identify future opportunities

Hub Participants & Structure

Theresa Talley

Amy Ehrhart

Angee Doerr

Nicole Naar

Joe Tyburczy

Gina Contolini

Dave Hansen

Sean Macduff

Melissa Good

Pilot Study: WCSAS

- WA Coast Shellfish Aquaculture Study
  1. EBM approach for stakeholder engagement
  2. Field protocols for assessing aquaculture

https://bit.ly/wsg-wcsas

Sea Grant Washington

WCSAS Overview

- 3-year state-funded project
- Goals:
  - Sustain shellfish farming
  - Ecosystem-based management

MARK NOWLIN / THE SEATTLE TIMES

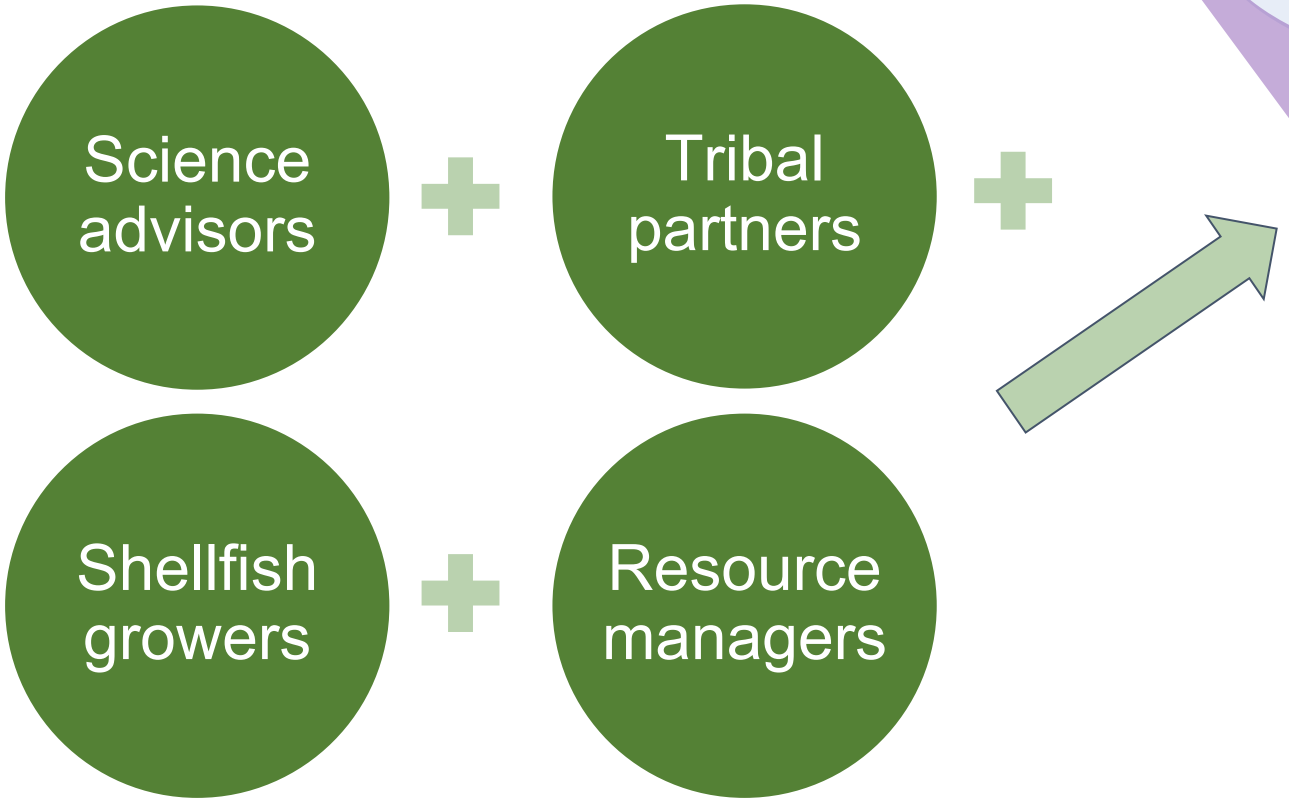
Sea Grant Washington

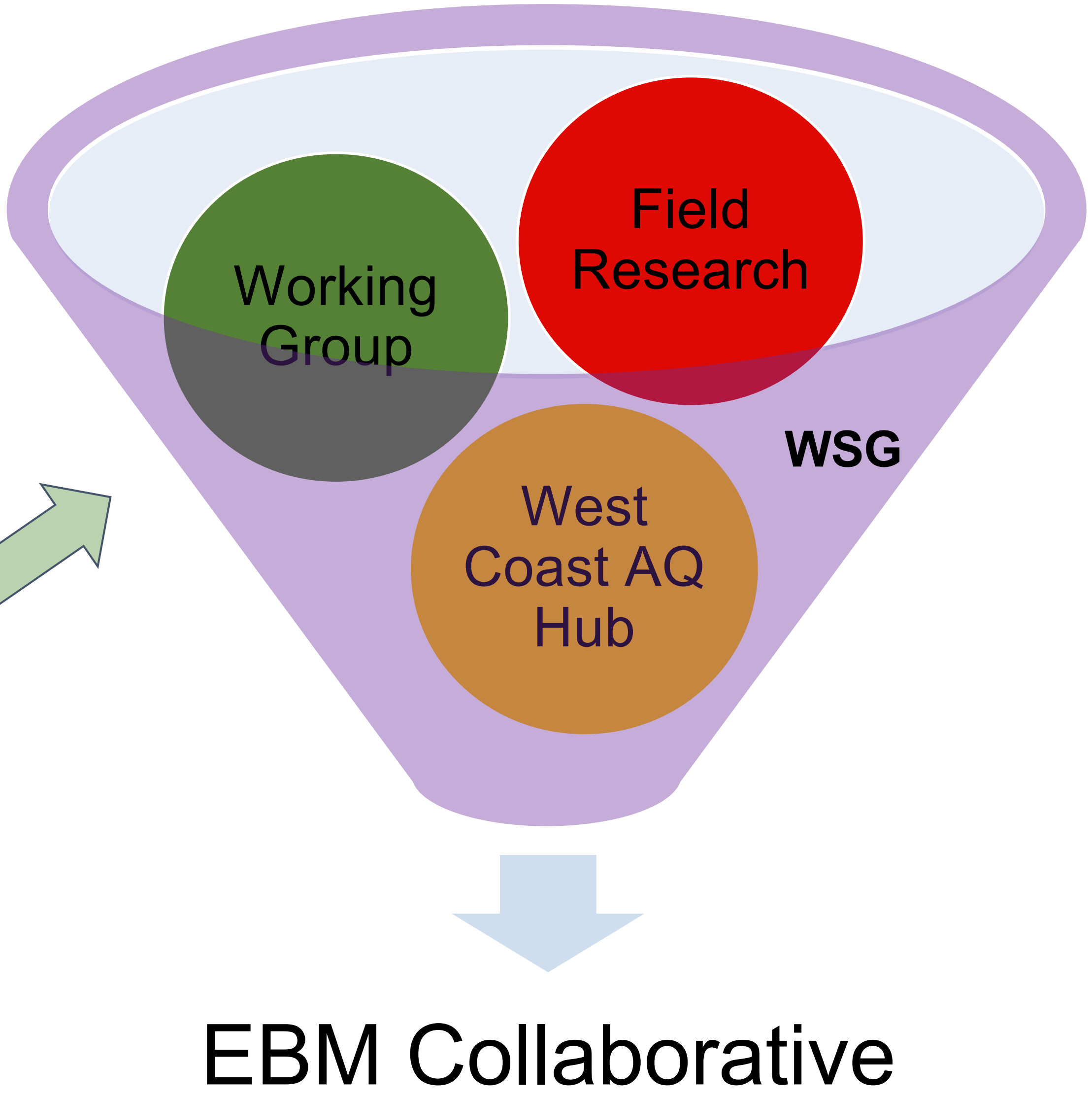
WCSAS Overview

- 2 key challenges:
  - Shellfish farming and eelgrass interactions
  - Burrowing shrimp management

Sea Grant Washington

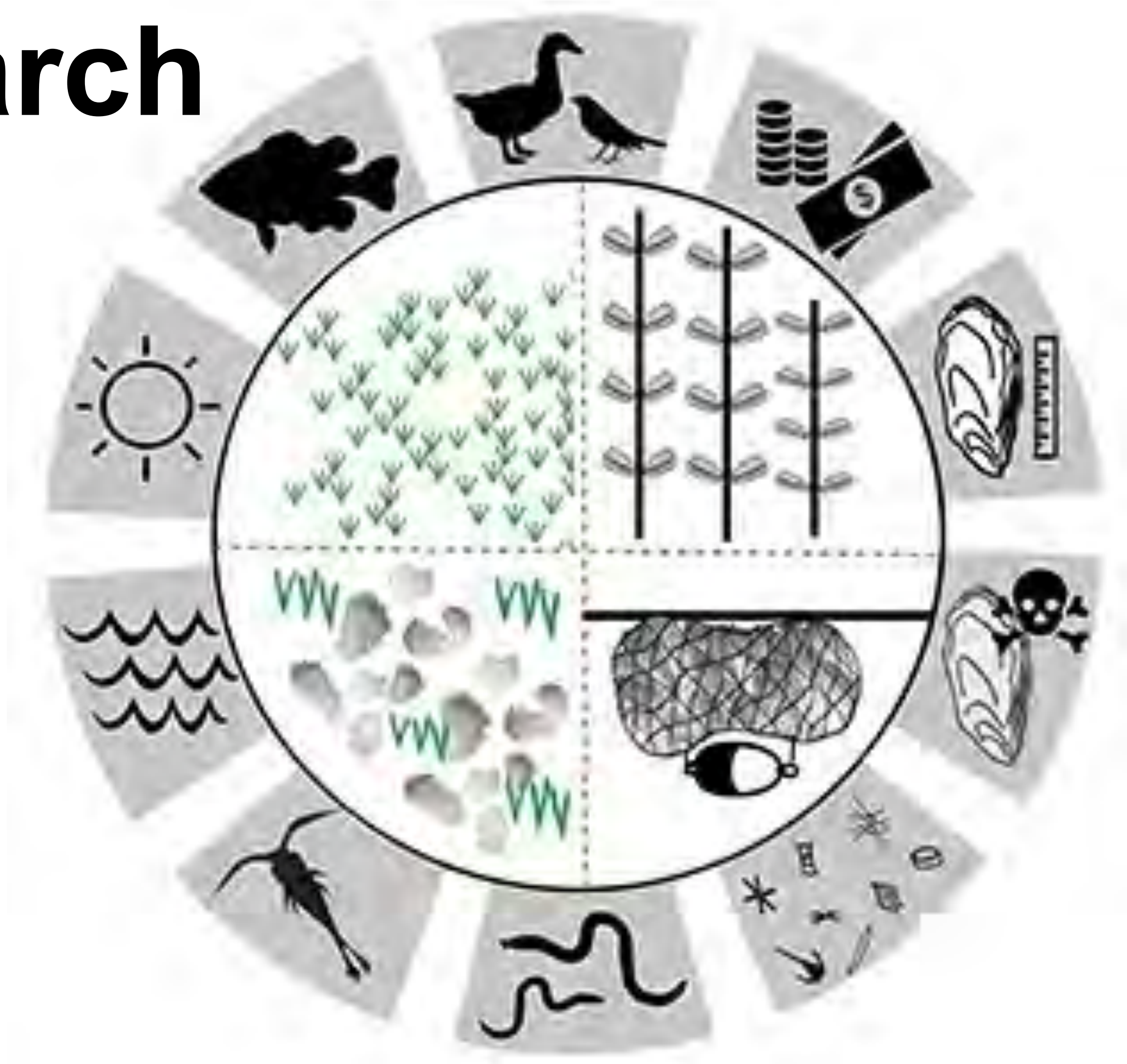
WCSAS Approach





WCSAS Field Research

- Comparing habitat conditions
- Monitoring and assessment tools
- BMPs



(Revised) Working Group Process

State of the Science & System

Outside Perspectives & Local Challenges

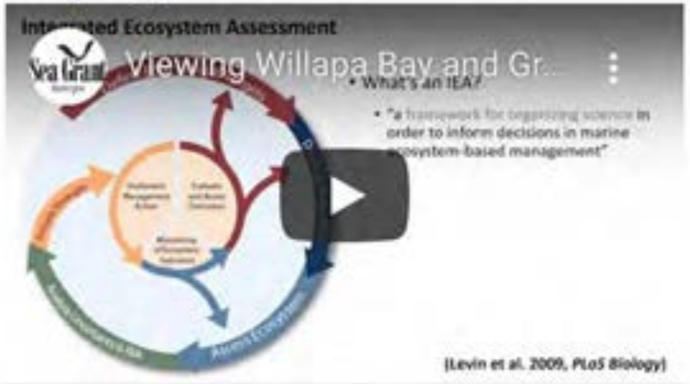
System-wide Understandings

Recommendations

Workshop 1

- 2 days, in-person
- State-of-the-science
- Priority information needs

Viewing Willapa Bay and Grays Harbor as social-ecological systems



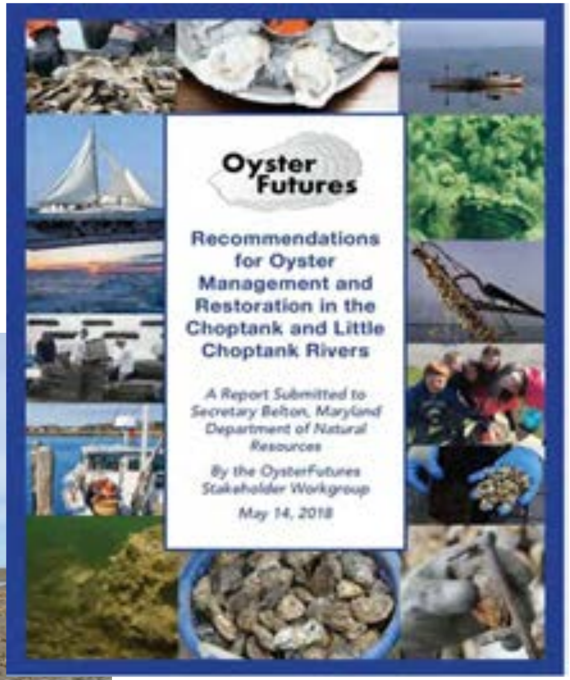
Chris Harvey

Spartina in Willapa Bay

Kim Patten

Workshops 2 & 3

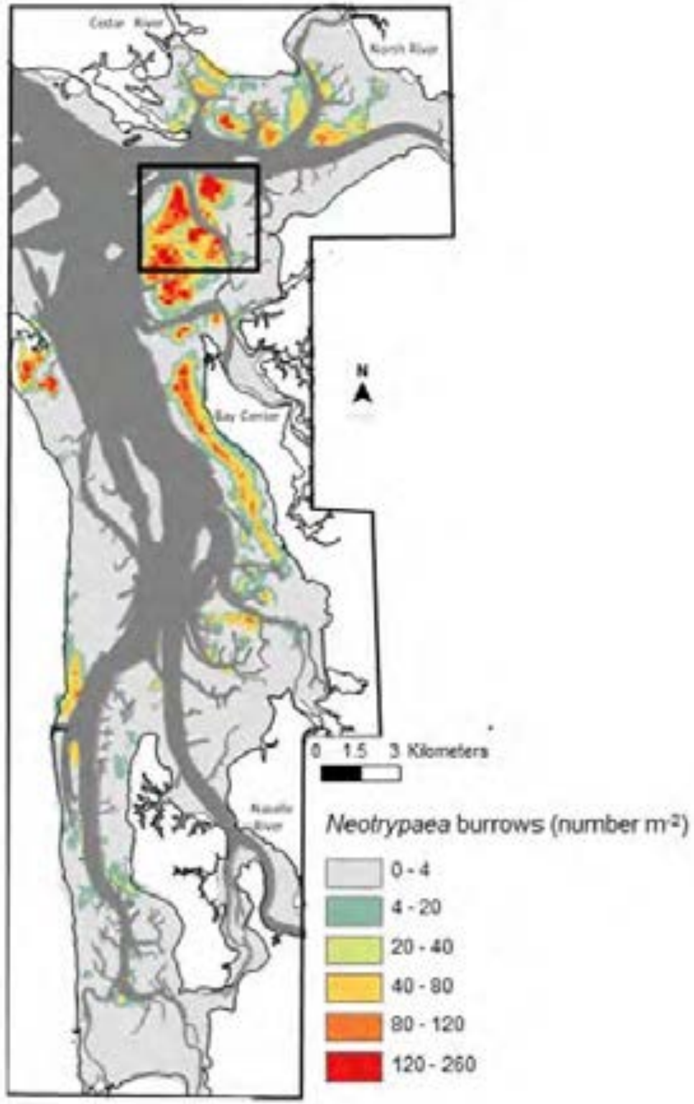
- EBM case studies
- Science/management
- Farming methods
- IPM



Sea Grant Washington

Workshop 4

- 2 days, hybrid
- Science synthesis
- Shrimp impacts
- Social-ecological system



Sea Grant Washington

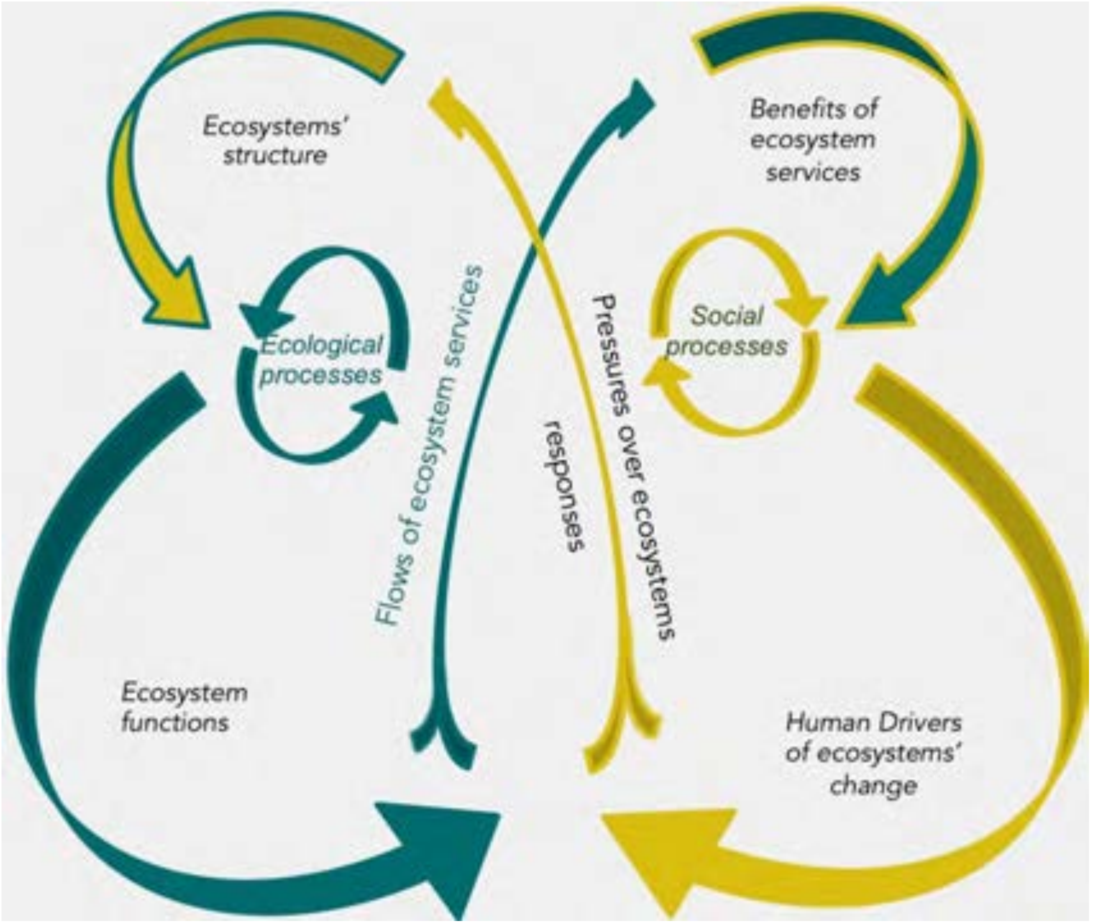
Workshop 5

- Remote sessions
- Draft charter for EBM collaborative
- Recommendations

Sea Grant Washington

WCSAS Products

1. Science synthesis report



WCSAS Products

1. Science synthesis report
2. Online outreach materials
   - Aquaculture timeline https://bit.ly/AQtimeline
   - Prioritized information needs https://bit.ly/wcsas-pin

1929

SHELLFISH AND CULTIVATION

Baypoint Oyster Farms and three other growers plant *Crassostrea gigas* in Willapa (Kincaid 1968).

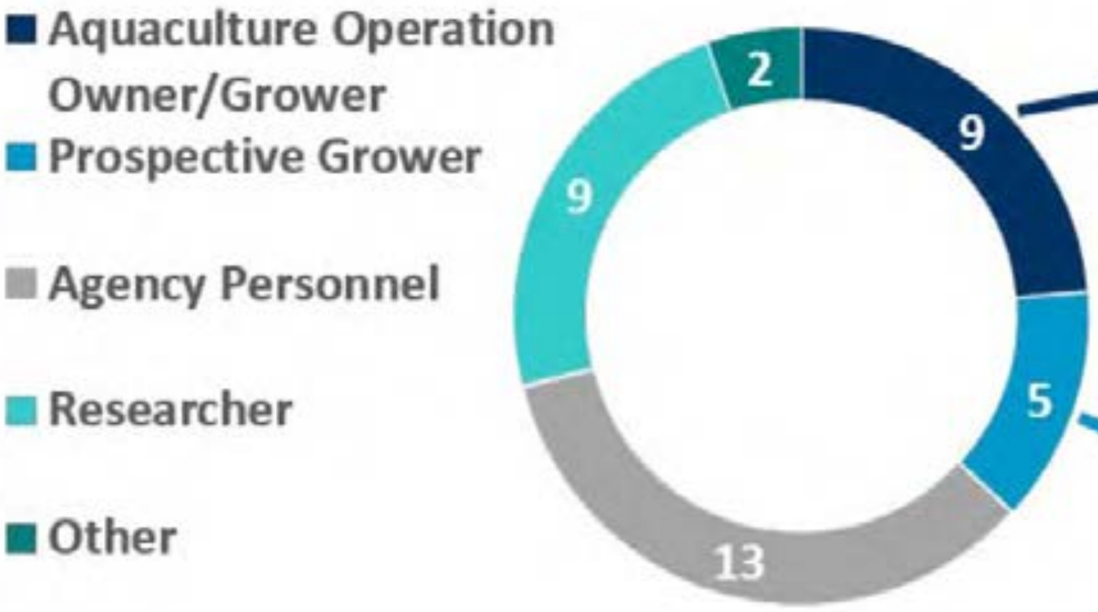
Sea Grant Washington

WCSAS Products

1. Science synthesis report
2. Online outreach materials
   - Aquaculture timeline
   - Prioritized information needs
3. Recommendations
   - Draft EBM collaborative charter

Assessing Opportunities

Oregon Aquaculture Needs Assessment



Current Grower Species

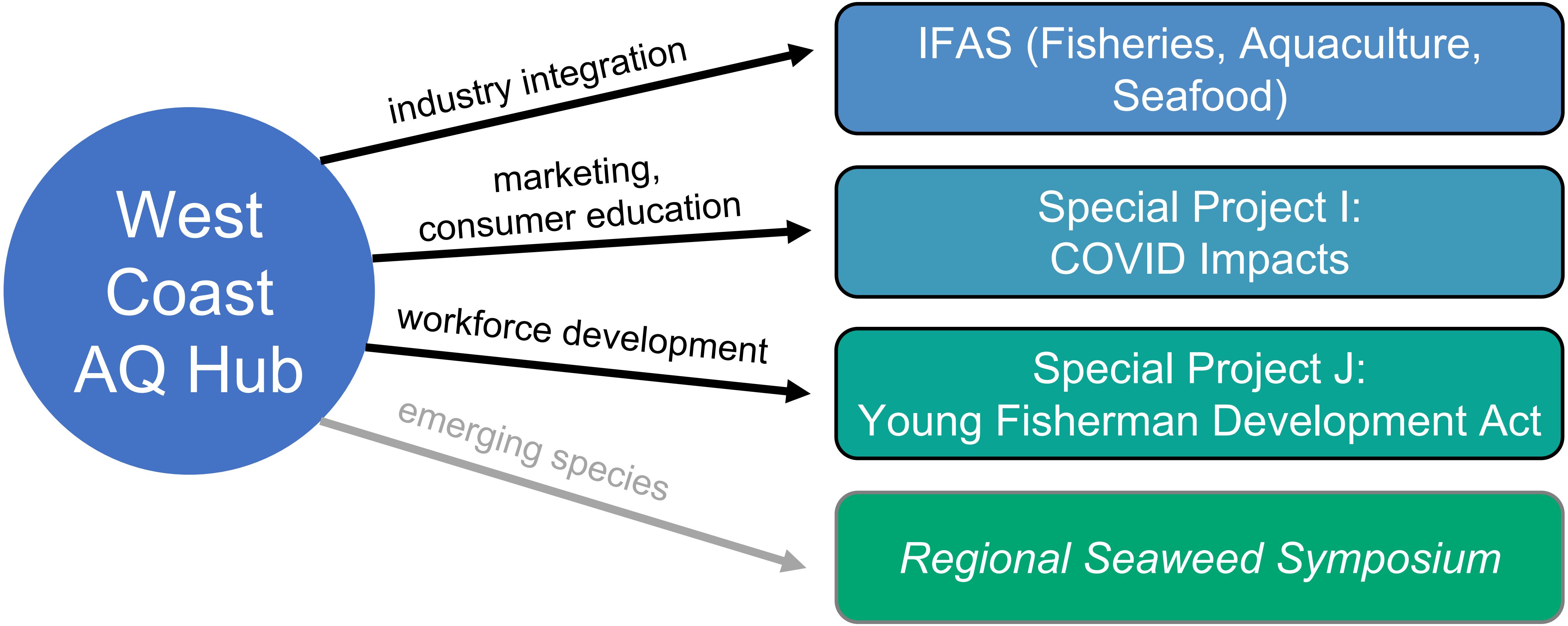
Pacific oysters	58%
Kumamoto oysters	17%
Olympia oysters	8%
Shrimp	8%
Dulse seaweed	8%

Prospective Grower Species of Interest

Pacific oysters	30%
Kelp	30%
Dulse seaweed	20%
Mussels	10%
Sea urchins	10%

https://bit.ly/orsg-aqneeds

Ongoing & Future Collaborations



THANK YOU!

Questions?

nanaar@uw.edu

Co-Principle Investigators

Russell Callender (WA Sea Grant)
Dave Hansen (OR Sea Grant)
Theresa Talley (CA Sea Grant)
Bobbi Hudson (PSI)
Daniel Cheney (PSI)
Brett Dumbauld (USDA-ARS)
Jennifer Ruesink (UW Biology)

Sea Grant Washington

Catalyzing a Cross-Pacific Regional Collaborative Hub to Advance Indigenous Aquaculture Practices and Enhance Marine Food Production for Cultural-Ecological Benefits-WASG

M. Poe, R. Alegado, J. Barber, C. Greiner , K. Hintzen, R. Callender, D. Lerner, G. Eckert

Catalyzing a Cross-Pacific Regional Collaborative Hub to Advance Indigenous Aquaculture Practices and Enhance Marine Food Production for Cultural-Ecological Benefits

November 2, 2021

Sea Grant Aquaculture Research Symposia

Presenters: Melissa Poe, Rosie Alegado, Brenda Asuncion, Lindsey Pierce, Joe Williams, Courtney Greiner, Jodie Toft, and Ginny Eckert

The Indigenous Aquaculture Collaborative

https://indigenousaquaculture.org/

We think of ***Indigenous Aquaculture*** *as:*

Cultivated biocultural ecosystems based on Indigenous knowledge and observations of land and water, developed over generations in reciprocal relationships with places. These cultural-ecosystems strengthen community access to customary foods and increase local seafood production.


Clam garden, credit: Lepofsky


Lummi Nation *sxwole* (reef net) fishing, source: NW Treaty Tribes

Herring spawn on kelp ponds

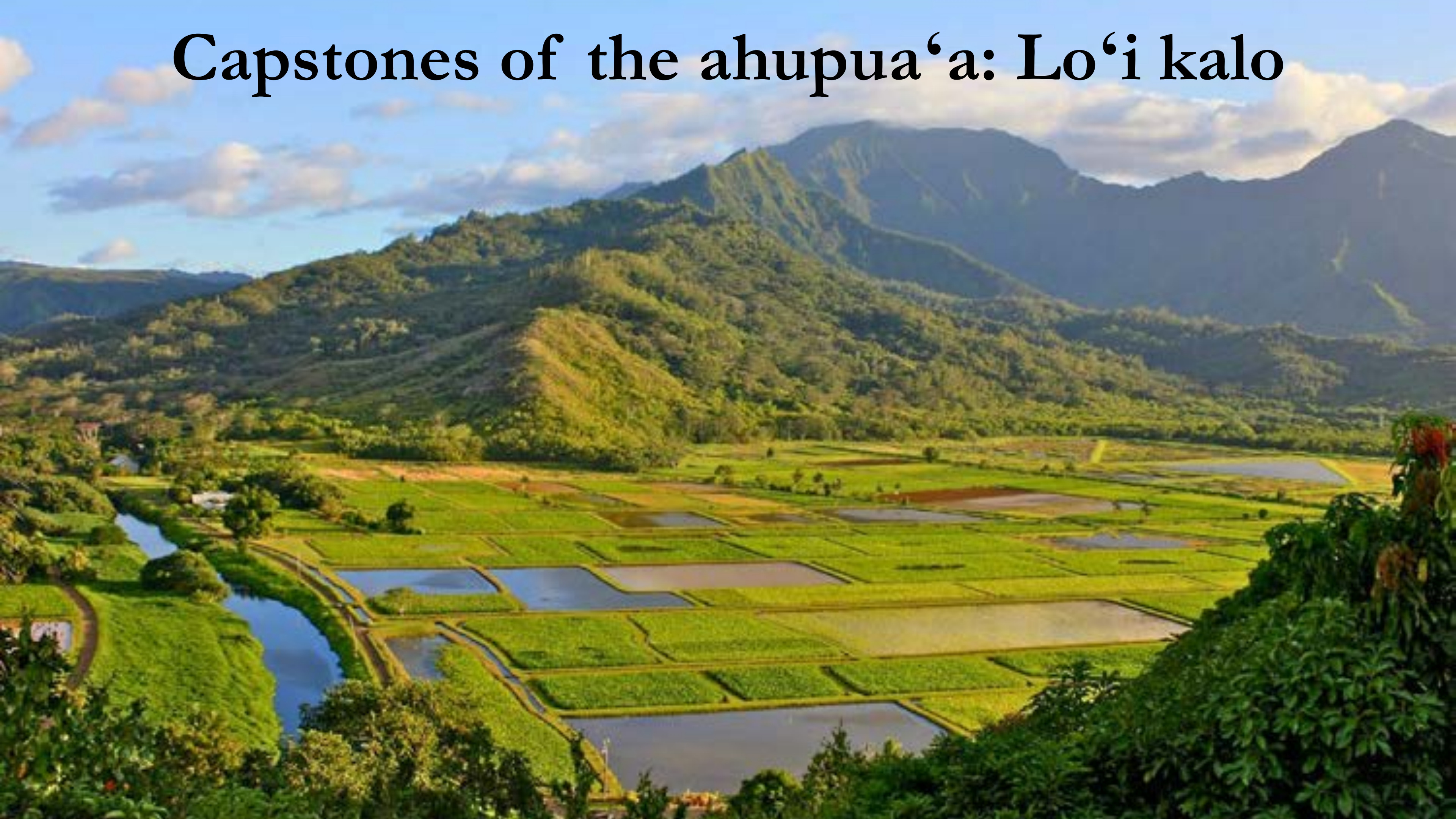
Intertidal management features in a Heiltsuk location, Mathews & Turner 2017

Ka moʻolelo o Lehoʻula: the 1st fishpond

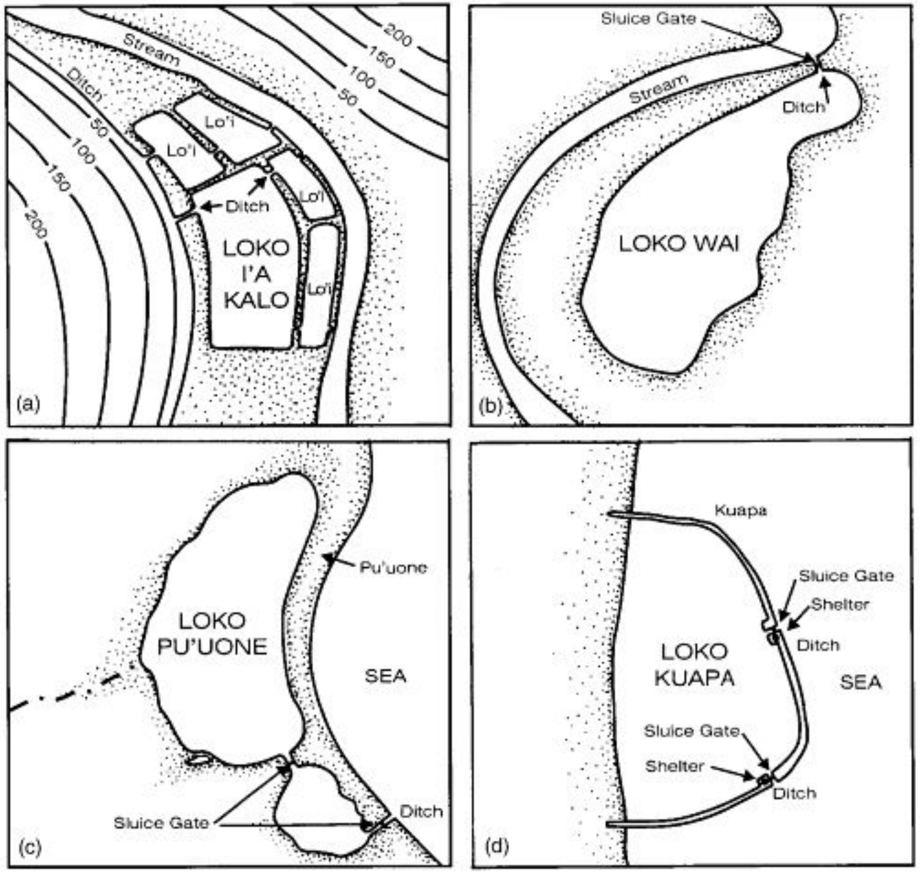
- **Kūʻula**: "supernatural" understanding of fish
- Head fisherman during a time of famine
- Built the 1st fishpond at the confluence of the stream and ocean
- Enabled cultivation of fish all year round
- Fishponds: an innovation of necessity

Historical Perspective – Ahupuaʻa

Capstones of the ahupuaʻa: Loʻi kalo



Capstones of the ahupuaʻa: Loko iʻa



Costa-Price. Ecological Aquaculture: Evolution of the Blue Revolution (1987)

BIOCULTURAL RESTORATION

"The science* and practice of restoring not only ecosystems, but human and cultural relationships to place, so that cultures are strengthened and revitalized along with the lands to which they are inextricably linked."

~ *Center for Native Peoples and the Environment*

(*from plural knowledge systems)

Photo credit: Ikaika Rogerson

Key Features:

- Revitalization and restoration of ancestral mariculture and coastal stewardship
- Food systems and food sovereignty
- Cultural and spiritual connections to the land and ocean
- Intergenerational knowledge and ethics
- Self-determination in resource management
- Just pathways for climate adaptation
- Rooted in Indigenous knowledge, values, and practices

Loko I’a fish survey during 2020 Gathering in Oahu, credit: Lindsey Pierce

The Indigenous Aquaculture Collaborative is currently made up of about 75 members (elders, knowledge holders, restoration practitioners, researchers, students, and outreach and communications folks)

Representatives from WA, BC, AK, Hawaii elsewhere in the Pacific basin

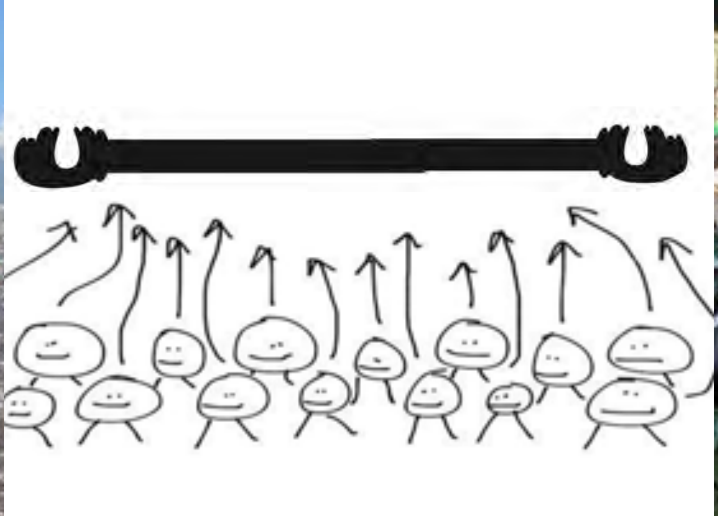
We are active in:

- sharing experiences
- learning from one another
- supporting community efforts
- engaging students
- participating in hands-on restoration

kua

KUA'ĀINA ULU 'AUAMO

http://kuahawaii.org/


Photos by Scott Kanda

Central Council of the Tlingit and Haida Indian Tribes of Alaska, and the Alaska Delegation

Types of clams that SE AK tribes send into SEATOR

SEATOR
Culture
Science
Community
Southeast Alaska Tribal Ocean Research

www.seator.org

Swinomish Indian Tribal Community

Swinomish Clam Garden Project

Swinomish Indian Tribal Community

Swinomish Clam Garden Project

density
biomass
growth rates
biodiversity

Swinomish Clam Garden Project

Socio-ecological site selection process:

- Technical Advisory Board
- Spatial exclusion map
- Intertidal surveys
- Community intercept surveys
- Fish Commission and Tribal Senate approval

Swinomish Clam Garden Project

Addresses socio-cultural and ecological concerns

Ancient technology resilient to environmental change

Monitoring response to climate change impacts

Knowledge transferable to other communities

JODIE TOFT

PUGET SOUND
RESTORATION FUND

PUGET SOUND
RESTORATION FUND

We design, test and spearhead in-water actions to restore Puget Sound's marine habitats, species, and waters – for people and place.

THE SUQUAMISH TRIBE
Jamestown S'Klallam Tribe
SWINOMISH INDIAN TRIBAL COMMUNITY
SKOKOMISH INDIAN TRIBE
NISQUALLY INDIAN TRIBE
SAMISH INDIAN NATION
LUMMI NATION TREATY OF 1855

DEPARTMENT OF ECOLOGY State of Washington
Natural Resources
USDA
Washington State Department of Health

Northwest Straits Commission
Northwest Straits Foundation
Jefferson County Marine Resources Committee
CLALLAM COUNTY MARINE RESOURCES COMMITTEE
MRC Whatcom County
evergreen

PACIFIC SHELLFI INSTITU
The SeaDoc Society
The Nature Conservancy
Port of Seattle
Sea Grant Washington
Washington Conservation Corps
WASHINGTON STATE UNIVERSITY

THE PAUL G. ALLEN FAMILY FOUNDATION
CHARLOTTE MARTIN FOUNDATION
BENJAMIN & MARGARET HALL FOUNDATION
The Burning Foundation
TAYLOR SHELLFISH Farms
ELLIOTT'S
BAYWATER Sweet Oysters

KENNETH K. CHEW CENTER

For Shellfish Research and Restoration

THE SUQUAMISH TRIBE

Developing aquaculture techniques for basket cockles, *Clinocardium nuttallii*

1. Develop capacity within the Chew Center to accommodate additional production
2. Produce cockle seed for research and experimental outplants
3. Assess impacts of ocean acidification and elevated temperature

Developing aquaculture techniques for basket cockles, *Clinocardium nuttallii*






A new take on restoration aquaculture?

Cockle reconveyance to meet multiple objectives

NOAA

THE SUQUAMISH TRIBE

Jamestown S'Klallam Tribe

Sweet Oysters BAYWATER

Next stop, Kelp

Credits: The Seattle Times - Steve Ringman, Emily Engman

For more info, please see https://indigenousaquaculture.org
or email Dr. Melissa Poe mpoe@uw.edu

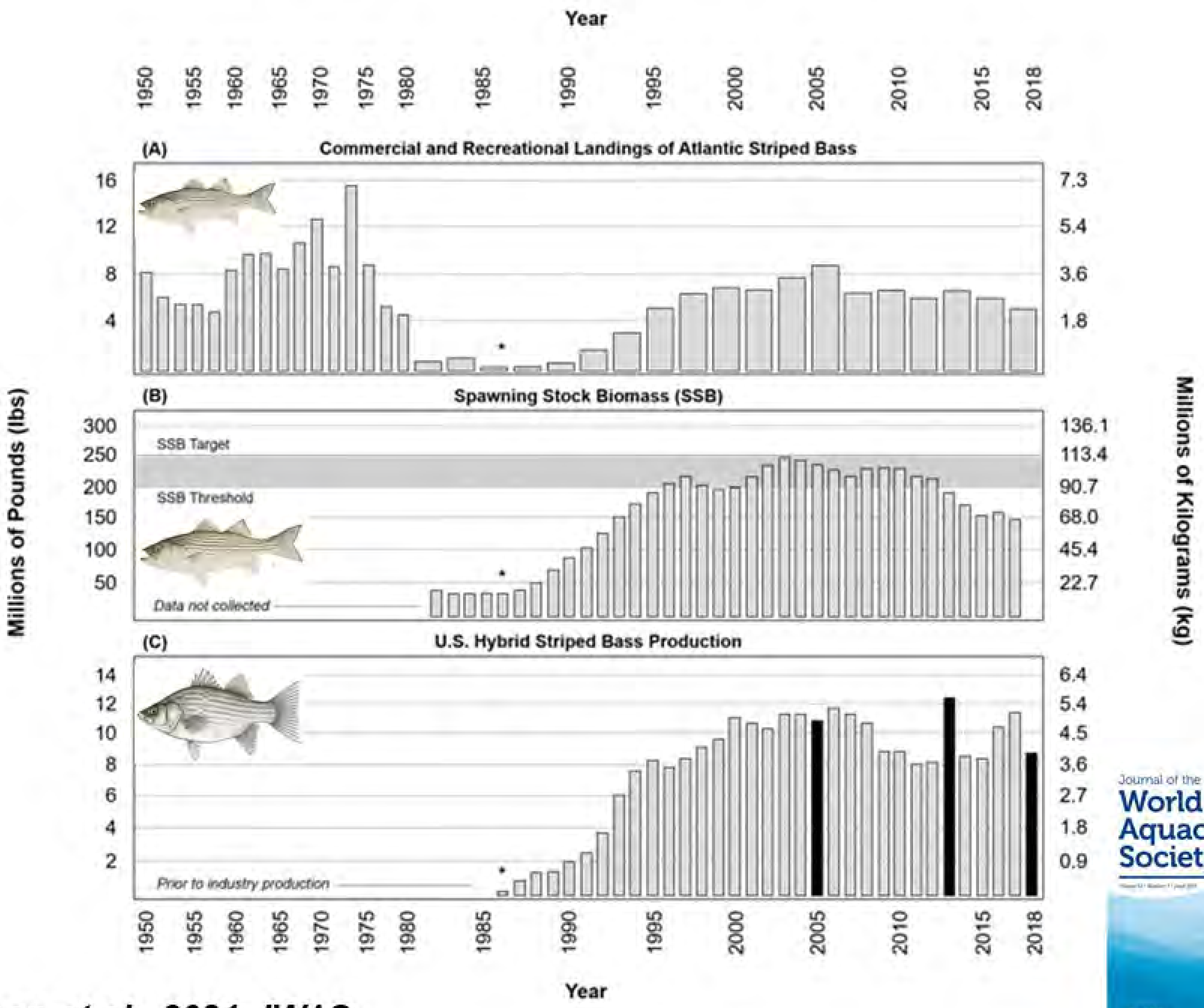
Establishing the Sea Grant Striped Bass Aquaculture Hub (StriperHub): Commercialization, Economics, and Marketing-NCSG

B. Reading, R. Borski, D. Berlinsky, M. Ciaramella,
M. Parker, F. Lopez, B. Nash, D. Cerino, E. Herbst, B. Snyder, S. White

"Farm Raised Domestic Striped Bass"

Benjamin J. Reading bjreadin@ncsu.edu

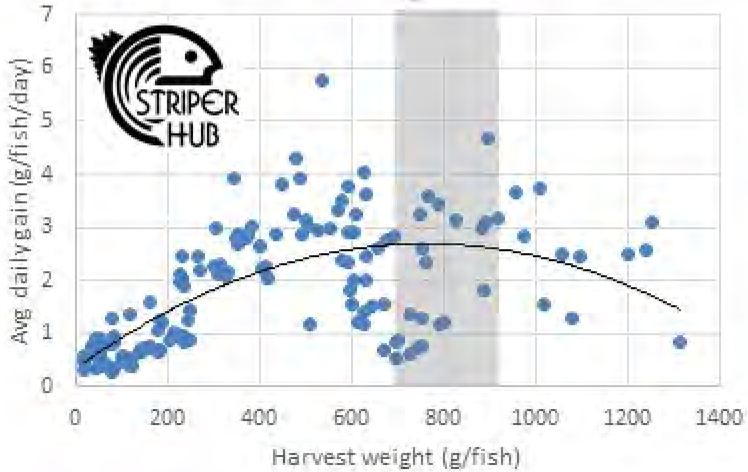
R. Borski, B. Nash, F. Lopez, E. Herbst, D. Cerino, D. Berlinsky,
M. Ciaramella, M. Parker, B. Snyder, and S. White



Andersen et al., 2021 JWAS

Hybrid striped bass

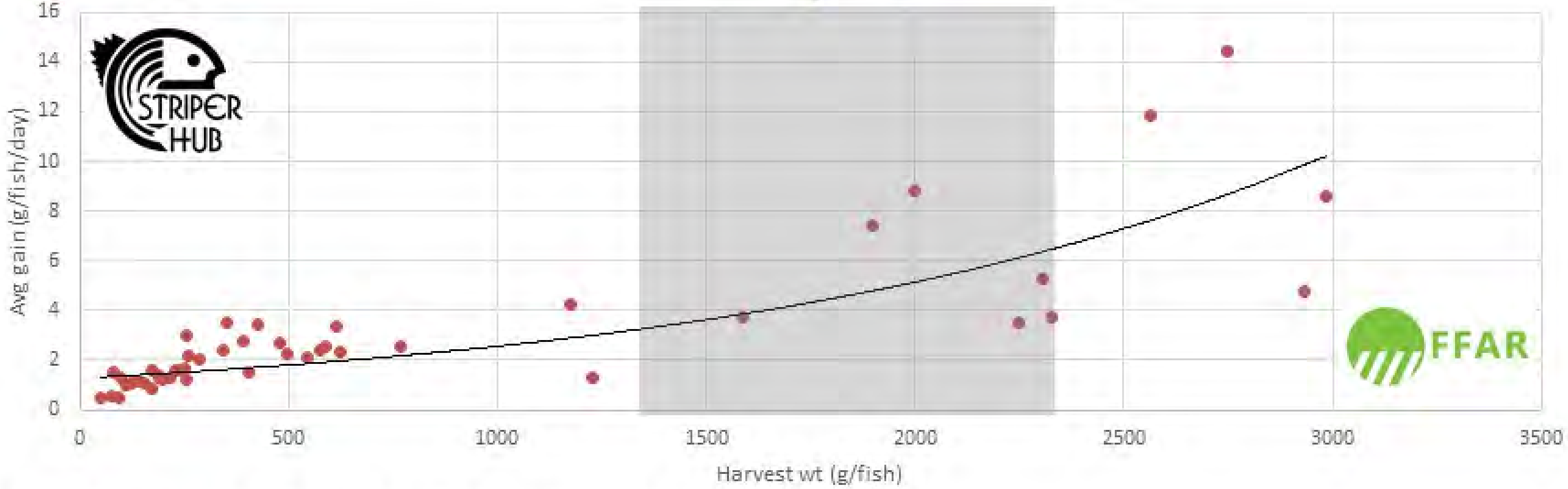
Daily Growth Rates & Harvest Sizes



Hybrid striped bass: Rapid growth rate up until about 2 lbs/fish, then *slows*. Target harvest size = 1.5 to 2.0 lbs/fish

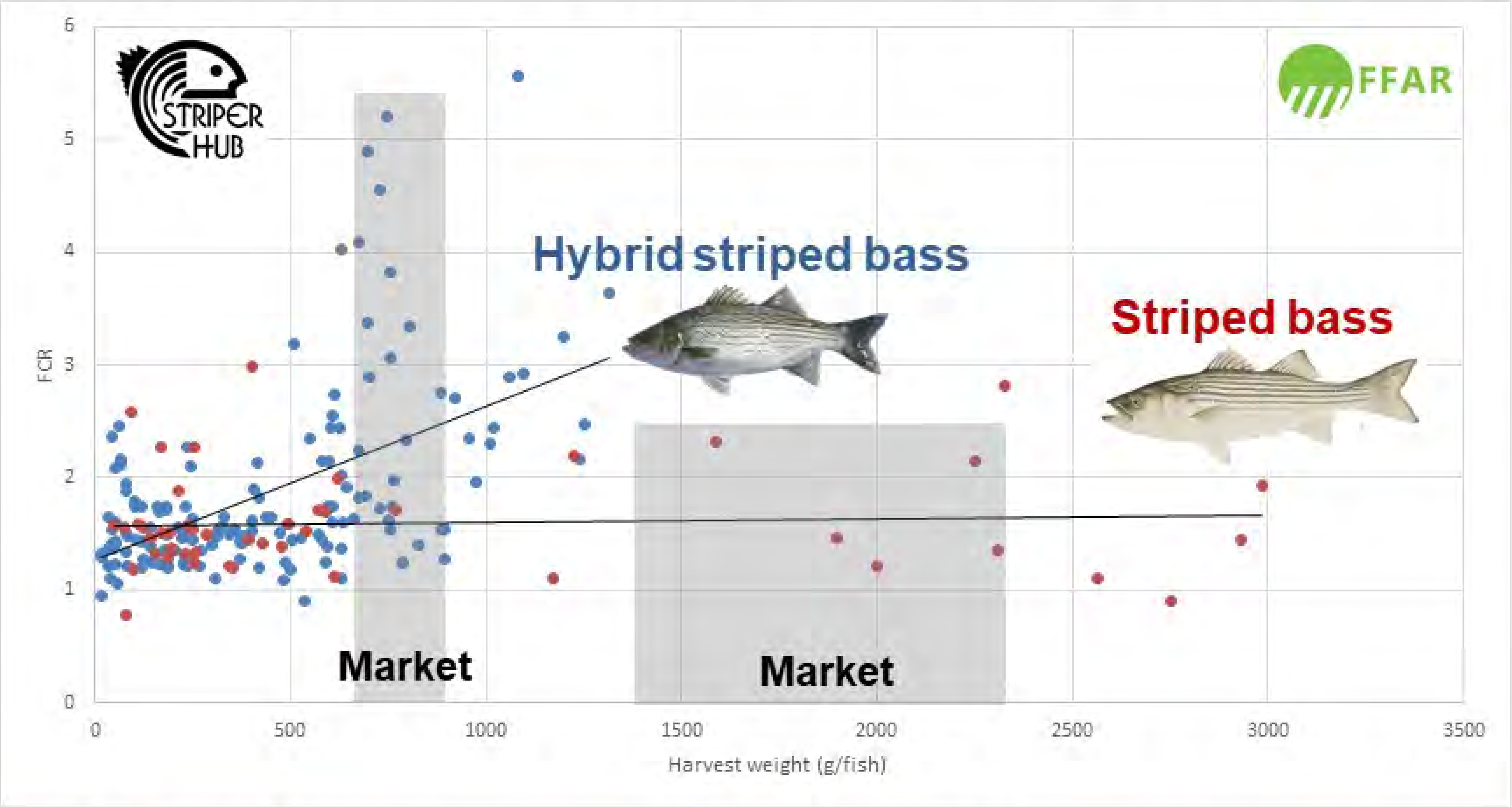
Striped bass: Slower growth rate up to 2 lbs/fish then *accelerates*. Target harvest size = 3.0 to 5.0 lbs/fish

Striped bass



Data from historical NC State PAFL production (over many years)

Feed Conversion Ratio (FCR) and Growth



Hybrid striped bass: Superior FCR when small; FCR increases as fish reach (or exceed) typical market size. Harvest size = 1.5 to 2.0 lbs/fish (680 to 900 g)

Striped bass: Slightly higher FCR when small; FCR remains consistent throughout production. Harvest size = 3.0 to 5.0 lbs/fish (1360 to 2268 g)

"The aim of the proposed work is to establish a *Sea Grant hub* for striped bass aquaculture (*StriperHub*) that will overcome barriers to industry development and expansion through demonstration and promotion of commercial-level culture, economics, and marketing of striped bass in the U.S. *StriperHub* is guided by a diverse community of interdisciplinary stakeholders coordinated by North Carolina Sea Grant."

Objective 1. Establish a Sea Grant Aquaculture Hub: A nexis to commercialize striped bass as a major aquaculture industry (The Sea Grant *StriperHub*);

Objective 2. Demonstrate seed stock production, distribution, growout, and production economics of domestic striped bass aquaculture;

Objective 3. Develop marketing strategies, market economics, permitting clarity, and business models for domestic striped bass aquaculture; and

Objective 4. Establish communication, outreach, extension, and training to support domestic striped bass aquaculture development.

StriperHub
North Carolina (Lead)

Sea Grant
North Carolina **Frank Lopez, Barry Nash**
New Hampshire **Michael Chambers**
New York **Mike Ciaramella**
Maryland **Matt Parker**

Striped Bass Aquaculture

University of New Hampshire
David Berlinsky
Applied Ecology

Cornell University
Eugene Won
Animal Science

University of Maryland
Matt Parker
Extension

NC STATE UNIVERSITY
Benjamin Reading
Applied Ecology
Russell Borski
Biological Sciences
Matt Booker
History
Stacey Pigg
English
Andy McGinty
Pamlico Aquaculture Laboratory
Mike Frinsko
Steve Gabel
NC Cooperative Extension

USDA Agricultural Research Service
Carl Webster, Jason Abernathy, Adam Fuller, Steve Rawles

NOAA

Carteret
David Cerino

Travis Brown
Brunswick Community College

STRIPER HUB
Frank Lopez
Director
Sea Grant North Carolina
Eric Herbst
Asst. Coordinator
Ben Reading
Coordinator and Asst. Director
NC STATE UNIVERSITY
NC STATE UNIVERSITY
Russell Borski
SE Regional Coordinator
Growth & Production
University of New Hampshire
David Berlinsky ("Czar")
NE Regional Coordinator
Harvest, Processing, & Marketing
Greg Bolton
Barry Nash
Mike Ciaramella
Feeds & Nutrition
Steve Rawles
Marc Turano
Business Economics
Matt Parker
Workforce Training
David Cerino
Travis Brown
Breeding & Hatchery
Adam Fuller
Jason Abernathy
Communications & Outreach
Stacey Pigg
Matt Booker
Eugene Won
Michael Chambers

Vote for the Best Logo

(Circle Choice)

1 STRIPER HUB

2 STRIPER HUB

3 Striper Hub

4 Striper Hub


8th Annual
NC Catch Summit
Monday, March 2, 2020
Transfer Co. Food Hall - Raleigh, NC
TRUST LOCAL.
LOCALS SEAFOOD
EAT FRESH.
200+ Person Event!
TRANSFER CO.
FOOD HALL
LOGO #1
LOGO #2
LOGO #3
LOGO #4
SEAFOOD

STRIPER
HUB

35th Annual NC Seafood Festival
Morehead City, NC

Accomplishments and Future Directives: To Dos…

-Monthly Planning Meetings (Eric Herbst)
-Annual Workshops (2020 in person, 2021 virtual, 2022?)

-StriperHub Seminar
Aquaculture America 2023
-Striped Bass Culture Manual
Planning session 2022
-Commercial Ventures
In person, starting soon…

"The aim of the proposed work is to establish a *Sea Grant hub* for striped bass aquaculture (*StriperHub*) that will overcome barriers to industry development and expansion through demonstration and promotion of commercial-level culture, economics, and marketing of striped bass in the U.S. *StriperHub* is guided by a diverse community of interdisciplinary stakeholders coordinated by North Carolina Sea Grant."

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Objective 4. Establish communication, outreach, extension, and training to support domestic striped bass aquaculture development.

National Breeding Program for the US Hybrid Striped Bass Industry

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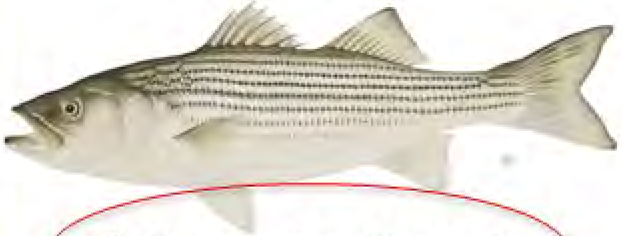
USDA-ARS
Harry K. Dupree SNARC
adam.fuller@ars.usda.gov

Striped Bass

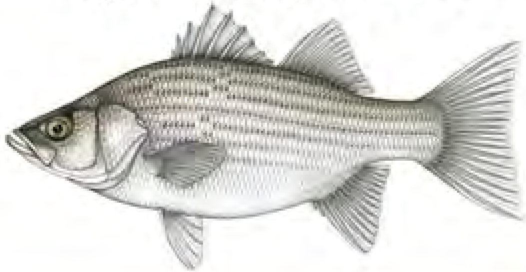


7th Generation Domestic

White Bass

12th Generation Domestic

Hybrid Striped Bass



National Breeding Program for the US Hybrid Striped Bass Industry

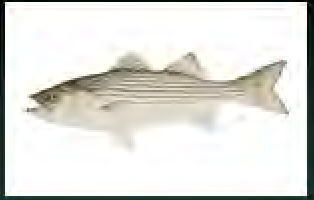
Benjamin J. Reading
Fish reproduction and aquaculture
North Carolina State University
Department of Applied Ecology
bjreadin@ncsu.edu

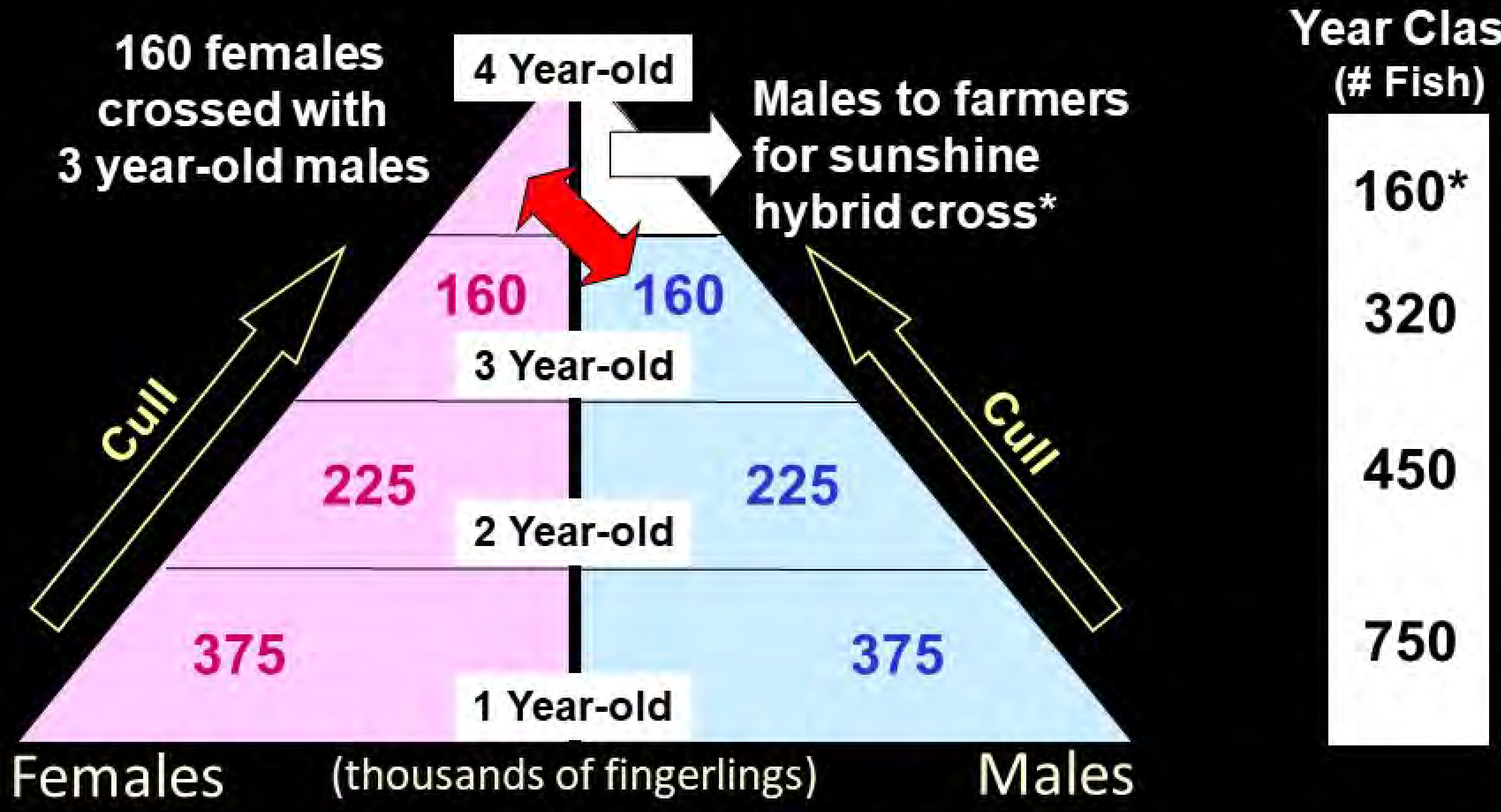
Michael S. Hopper
Superintendent
North Carolina State University
Pamlico Aquaculture Field Laboratory
mshopper@ncsu.edu

S. Adam Fuller
Geneticist
USDA-ARS
Harry K. Dupree SNARC
adam.fuller@ars.usda.gov

**Come visit us in Aurora, NC
April-May to see us spawning striped bass!**

National Striped Bass Breeding Program
Pamlico Aquaculture Field Laboratory



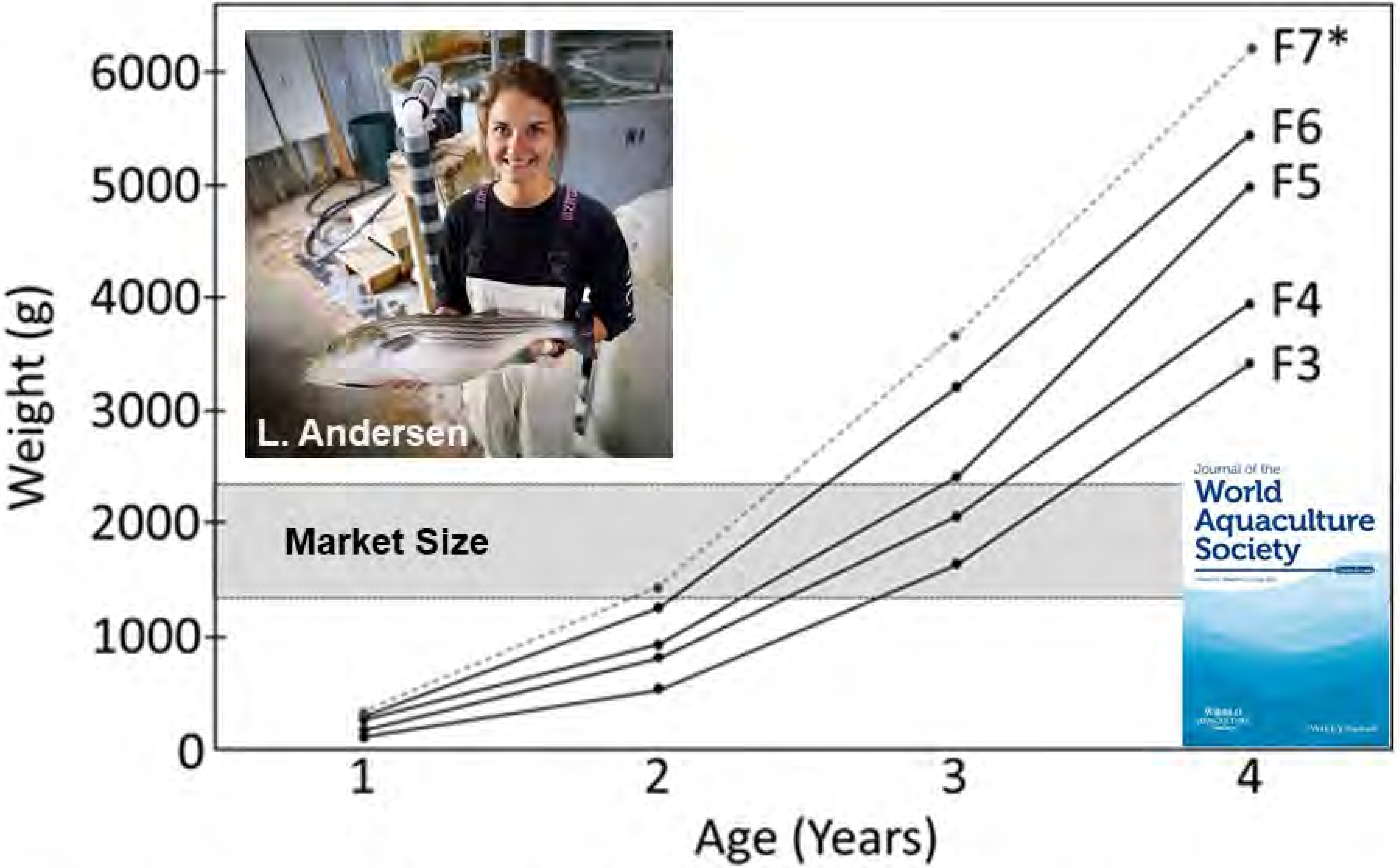


140 striped bass families created in 2019
100 striped bass families created in 2020
108 striped bass families created in 2021

NRSP-8

USDA ARS Agricultural Research Service

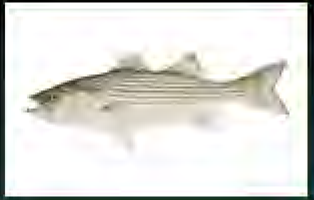
"Aquaculture breeders can tap a rich trove of genetic material; most fish and shellfish have seen little systematic genetic improvement for farming, compared with the selective breeding that chickens, cattle, and other domesticated animals have undergone."



Domestic striped bass growth performance for different age classes and generations during the springs and early summers (March-June) of each year (2005-2020): Year 1 (45-60 weeks of age), Year 2 (80-104 weeks of age), Year 3 (136-154 weeks of age), and Year 4 (197-209 weeks of age). The filial generation of captive breeding is indicated for the periods of 2004-2007 (F3), 2008-2011 (F4), 2012-2015 (F5), and 2016-2019 (F6). The gray shading indicates the target striped bass market size at between 1.36 and 2.27 kg (3.0 and 5.0 lbs.).

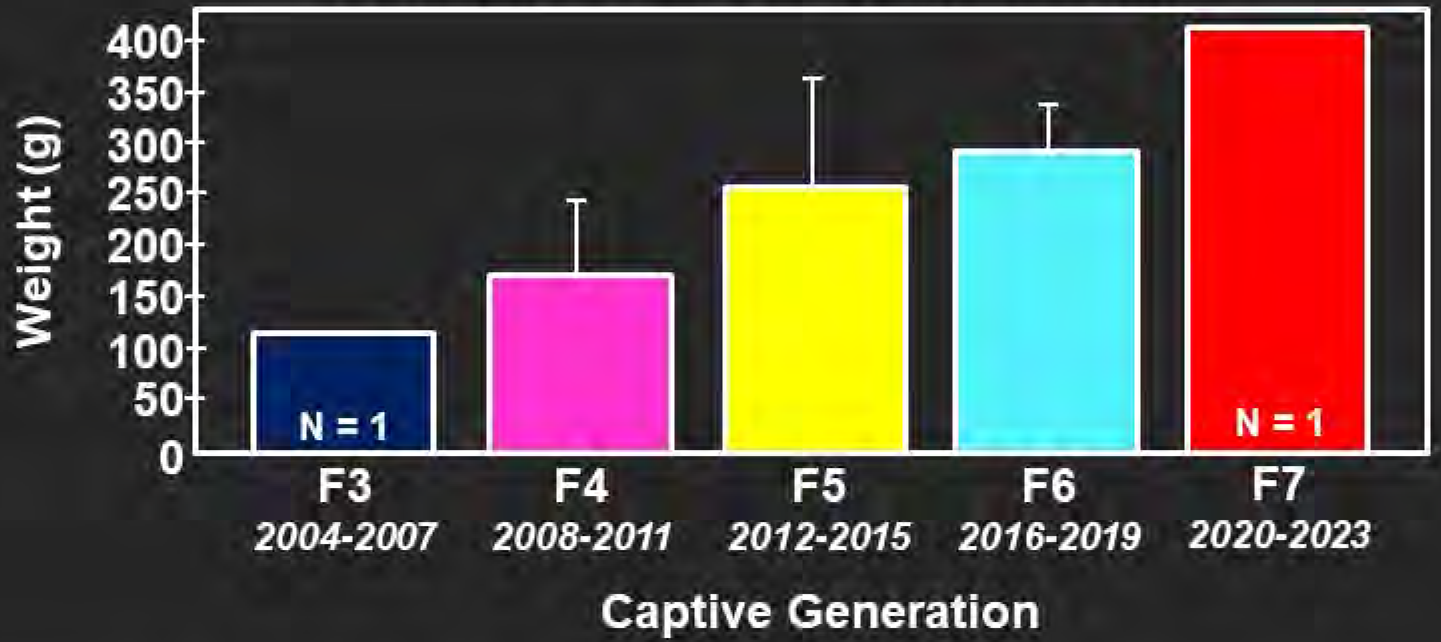
National Striped Bass Breeding Program

Growth Gains Through Domestication



Size of Domestic Striped Bass at Age 1 Year

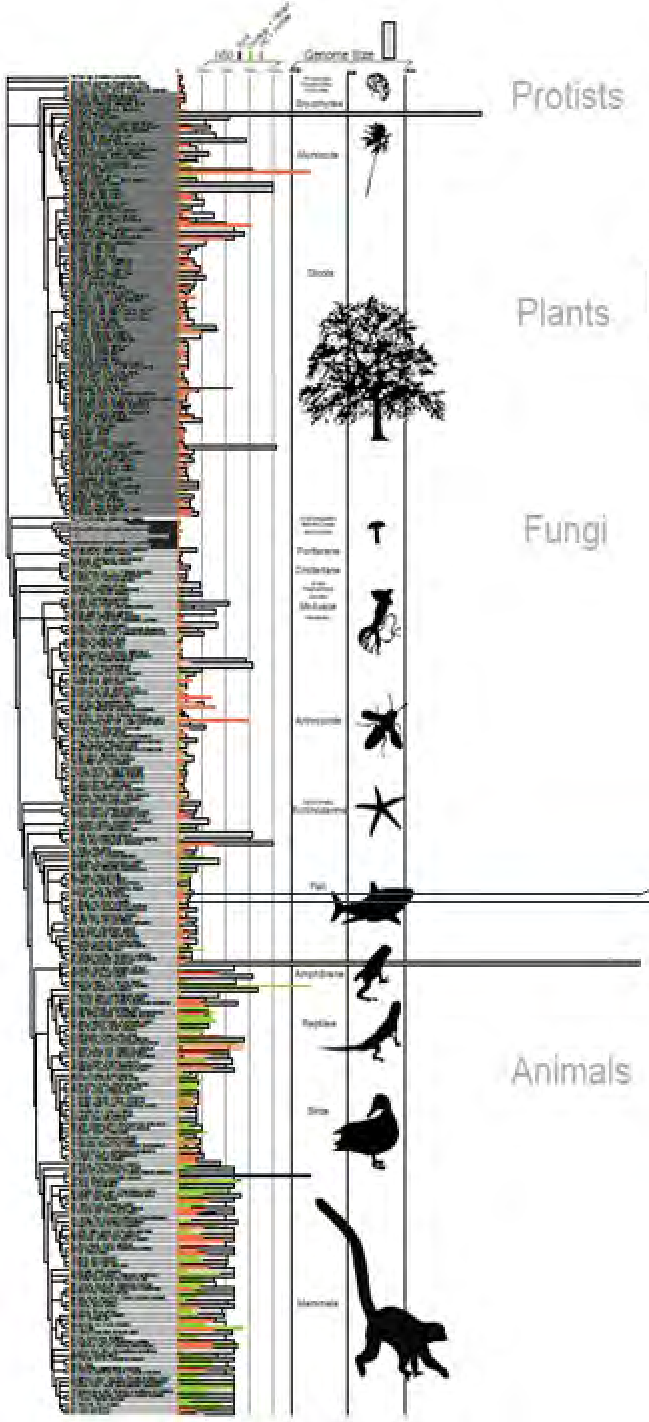
(February-April; 10-12 months old)



Age 1 data for F7 fish were available in February 2021

F7 fish were 415 g (almost 25% larger than the F6 fish of previous years!)

Striped bass and white bass genomes are part of the Dovetail Genomics Tree of Life



Jason Abernathy

Linnea Andersen

USDA

National Aquaculture Genome Project

Striped bass &
white bass genomes
About 685 Mb
24 linkage group resolution

Dovetail GENOMICS

Aquaculture 532 (2021) 735967

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aquaculture

Volitional tank spawning of domestic striped bass (*Morone saxatilis*) using human chorionic gonadotropin (hCG) and gonadotropin releasing hormone analogue (GnRHa)- induced 'pace-setting' females

L.K. Andersen[a], R.W. Clark[b], A.S. McGinty[b], M.S. Hopper[b], L.W. Kenter[d], S.A. Salger[a], J. Schilling[a], R.G. Hodson[a], A.I. Kovach[c], D.L. Berlinsky[d], B.J. Reading[a,b,*]

[a] North Carolina State University, Department of Applied Ecology Raleigh, NC, USA
[b] North Carolina State University, Pamlico Aquaculture Field Laboratory, Aurora, NC, USA
[c] University of New Hampshire, Department of Natural Resources and the Environment, Durham, NH, USA
[d] University of New Hampshire, Department of Agriculture, Nutrition and Food Systems, Durham, NH, USA

Aquaculture 533 (2021) 736025

Contents lists available at ScienceDirect

Aquaculture

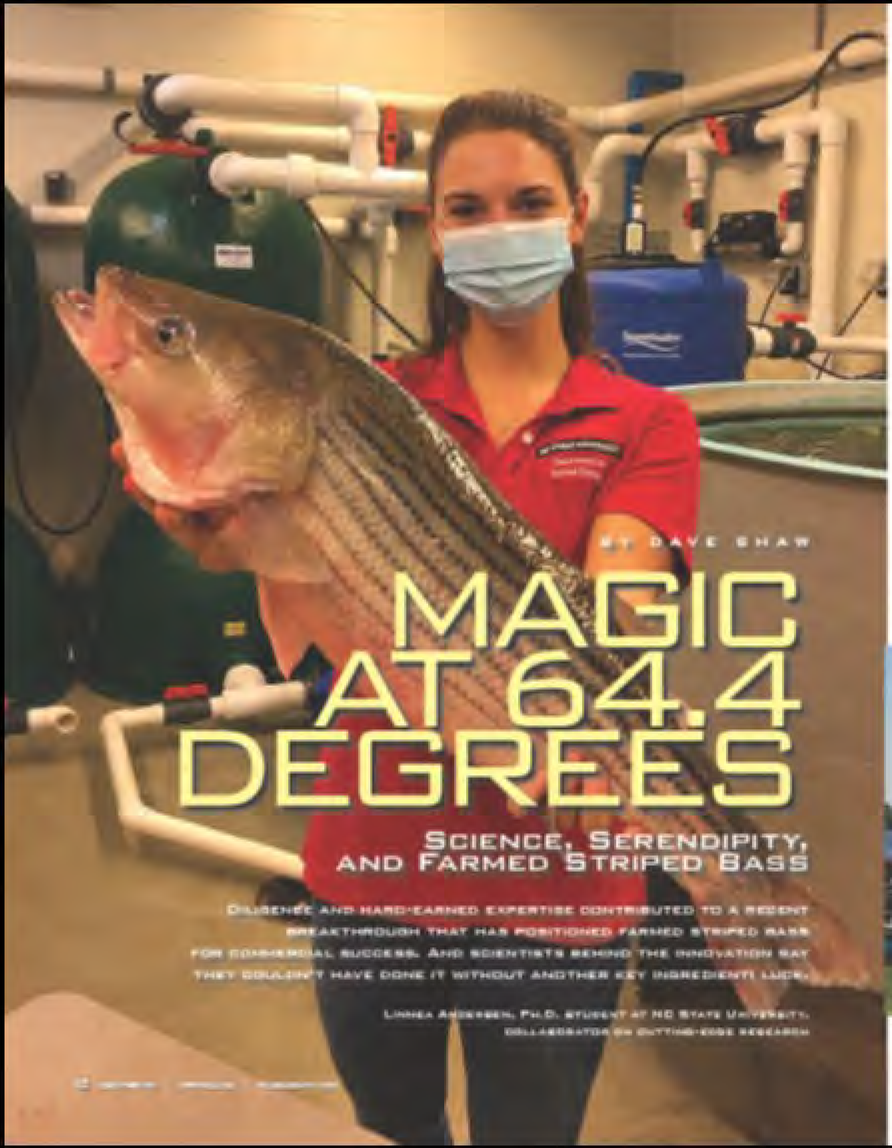
journal homepage: www.elsevier.com/locate/aquaculture

Methods of domestic striped bass (*Morone saxatilis*) spawning that do not require the use of any hormone induction

L.K. Andersen [a], R.W. Clark [b], M.S. Hopper [b], R.G. Hodson [a], J. Schilling [a], H.V. Daniels [a], L. C. Woods III [c], A.I. Kovach [d], D.L. Berlinsky [e], L.W. Kenter [e], A.S. McGinty [b], B.J. Reading [a,b,*]

[a] North Carolina State University, Department of Applied Ecology, 100 Eugene Brooks Avenue, Raleigh, North Carolina 27695, USA
[b] North Carolina State University, Pamlico Aquaculture Field Laboratory, 2002 Hickory Point Road, Aurora, North Carolina 27806, USA
[c] University of Maryland, Crane Aquaculture Facility, 8705 Greenmead Drive, College Park, MD 20742, USA
[d] University of New Hampshire, Department of Natural Resources and the Environment, Durham, NH, USA
[e] University of New Hampshire, M.S.Agriculture, Nutrition, and Food Systems, Durham, NH, USA

NC Sea Grant Coastwatch Spring 2021



By Dave Shaw

MAGIC AT 64.4 DEGREES

Science, Serendipity, and Farmed Striped Bass

Diligence and hard-earned expertise contributed to a recent breakthrough that has positioned farmed striped bass for commercial success. And scientists behind the innovation say they couldn't have done it without another key ingredient: luck.

Linnea Andersen, Ph.D. student at NC State University, collaborator on cutting-edge research

When he was 34, the Swiss engineer George de Mestral set off with his dog into the Alpine countryside on a hunting trip. After crossing flowering fields in the crisp, glacial air on his return, he discovered that burdock burs thoroughly covered his dog's coat. At home, he picked the persistent clingers from his pet's fur, one by one, marveling at their tenacity, so much so that he had to examine them under a microscope.

The Prize

Continued

Since the 1980s, scientists have been domesticating hybrid striped bass and striped bass at the Pamlico Aquaculture Field Laboratory in Aurora, North Carolina.

Group spawning

Harvest large quantities (20 to 30 L) of eggs at a time

Limited handling of broodstock and hormone use

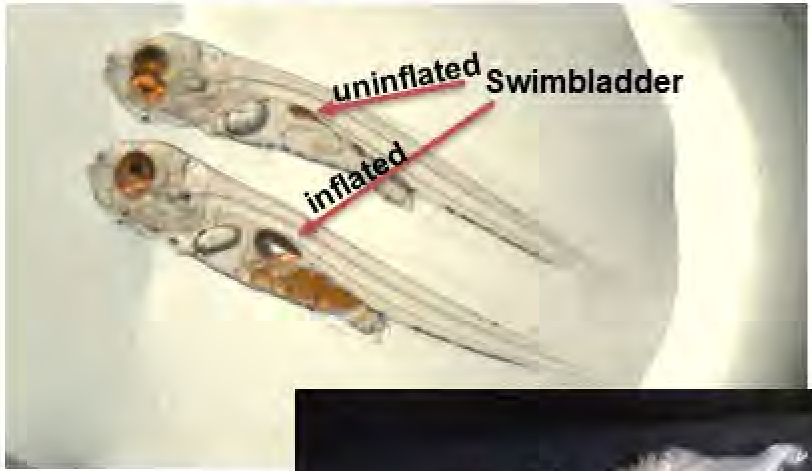
Consistent production with good fertility (30-50% of eggs producing larvae or *fry*)

Commercially scalable and less labor intensive compared to strip spawning

Advancing Fish Larviculture: Innovations in Production, Feeds and Feeding Systems

1) Technical improvements in swim bladder inflation and deformities
2) Developing microdiets to replace *Artemia*
3) Evaluating feeding behavior/ feed acceptance among commercial microdiets
4) Evaluating larval rearing success using commercial probiotics/prebiotics
5) Examining GI physiological changes
6) Evaluating microbiome / bacterial colonization
7) Developing automated *Artemia* and microdiet feeding systems

<u>FUTURE</u>: Commercial Scaling…

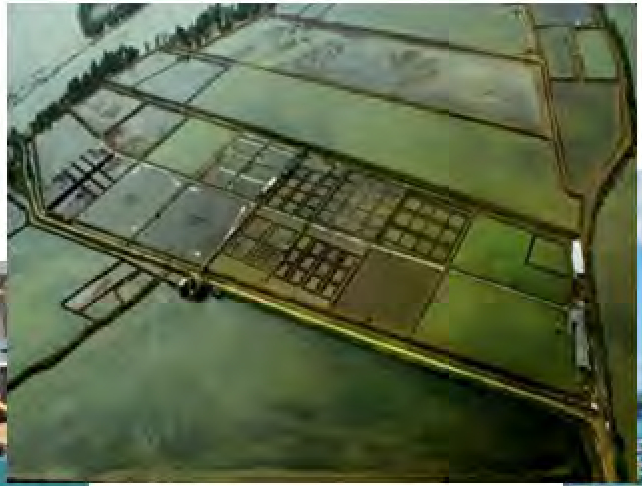


Mike Frinsko – NC Extension
Ben Reading – NC State
Steve Hall – NC State
Kim Livingston – ELANCO/CVM
Michael Joseph – NC State
Lou D'Abramo – UAB

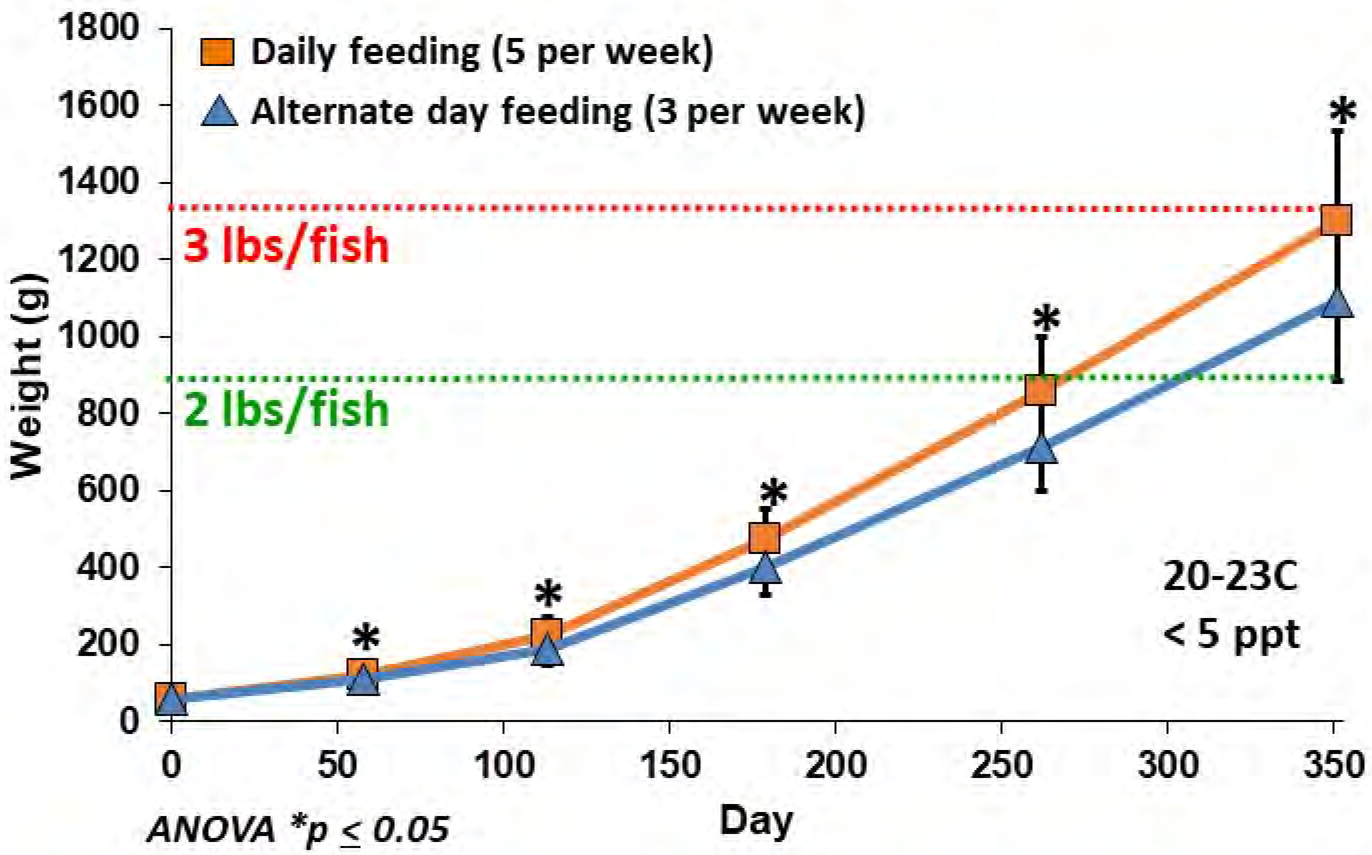
Scoliosis deformities

Demonstrate production of market-sized Striped Bass (3-5 lb fish) in different aquaculture systems

- Freshwater Recirculating Aquaculture Systems – RAS (< 5.0 ppt)
- Flow-through Aquaculture System (fresh water)
- Seawater RAS simulated cage-culture (David Berlinsky, UNH)
- Pond – RAS/Flow-through combined (fresh water)



Growth curve for domestic striped bass in RAS at NCSU fed daily and on alternate days



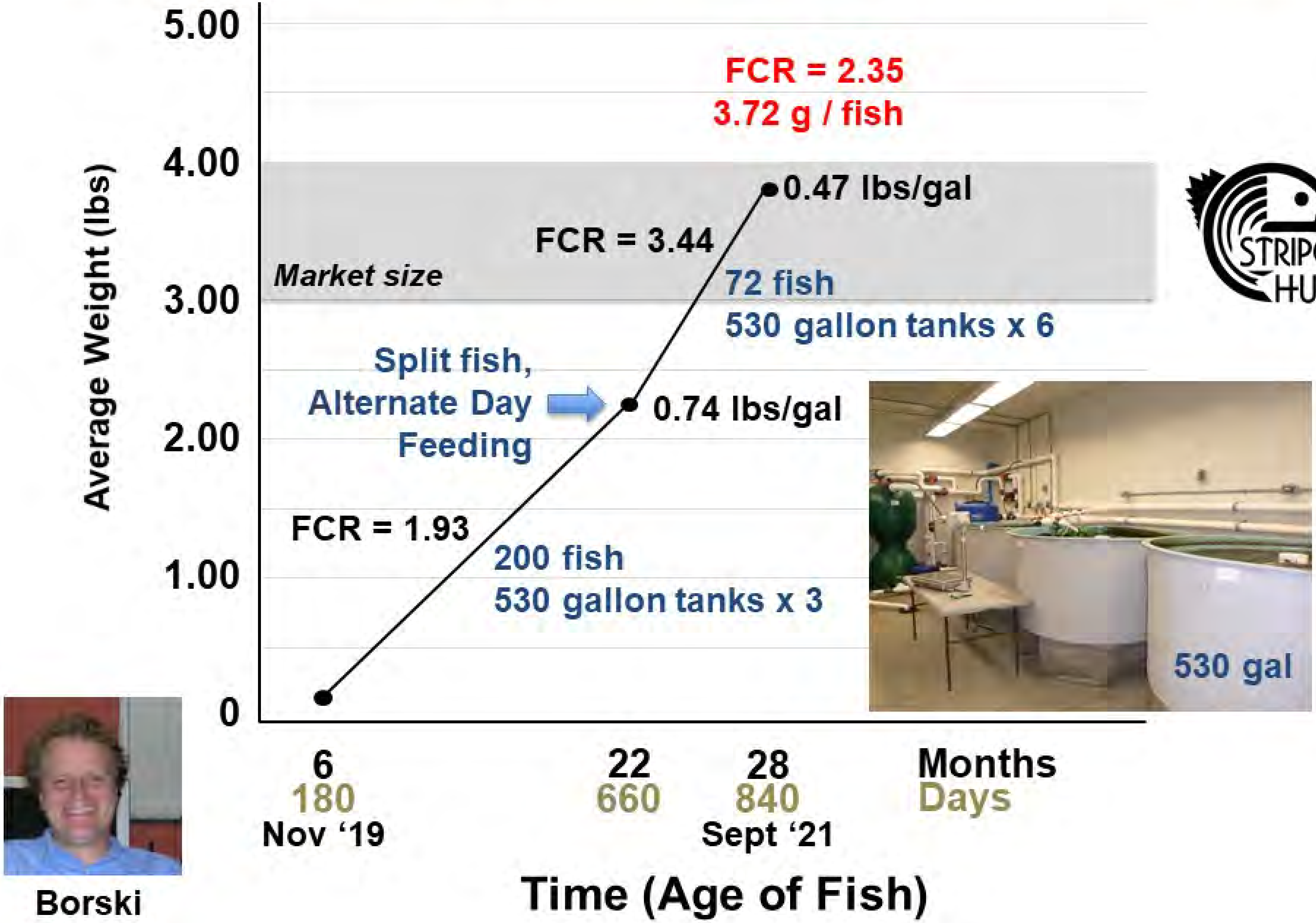
Juvenile fish require more frequent feedings, however less frequent feedings may improve feed conversion efficiency (FCR) in larger fish and reduce labor costs on farms.

Striped bass were fed 3 or 5 days per week and weighed every 2 months for 1 year.

Fish fed 5 days per week grew to a larger size overall and FCR was marginally better by 2.7% (FCR 1.485 versus 1.525), however the FCR changes as the fish age...

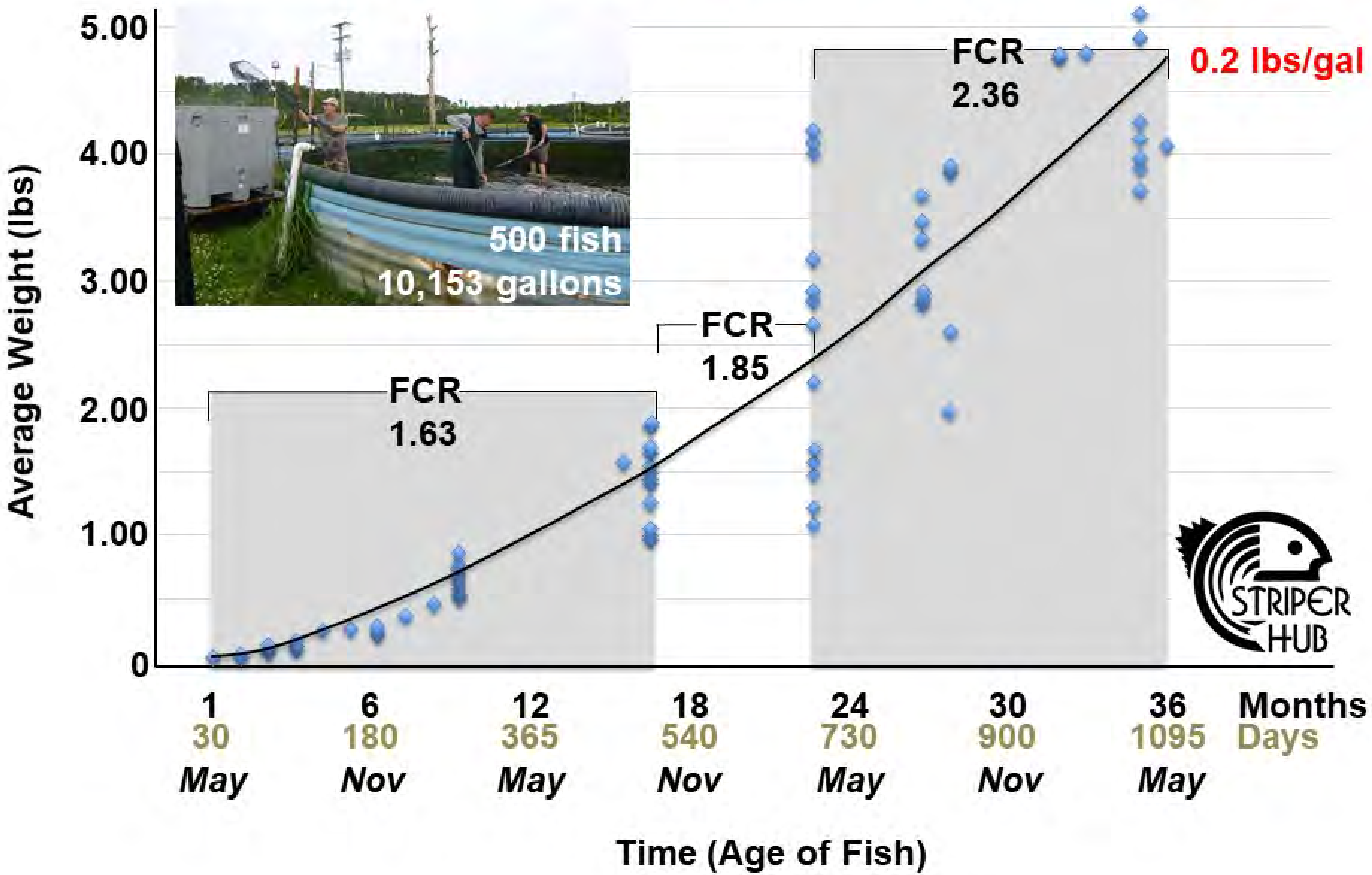
Salger et al. unpublished

Grow Out in RAS at Grinnells (< 5 ppt salinity) 2019–2021



Borski

Grow Out in Flow-Through at PAFL (< 5 ppt salinity) 2018–2021 (Multiple Replicate Growout Tanks)



AQUACULTURE FIRM TO GROW STRIPED BASS IN OFFSHORE CAGES

MARCH 22, 2018

Taking the Plunge into a New Way of Farming: A Fish Farm Grows Off the East End of Long Island

Considerations

1. What are the populations (strains) of striped bass migrating in the northeast area?

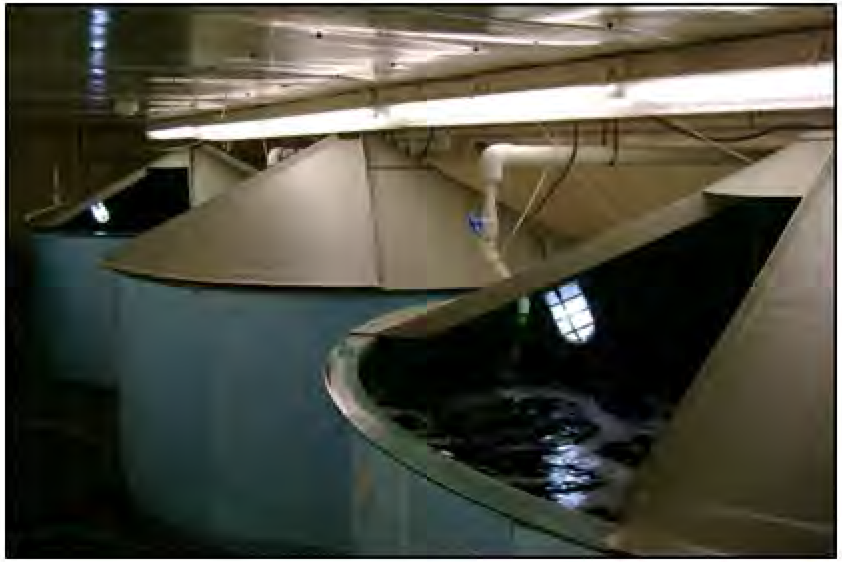
2. What are growth rates of striped bass in offshore net pens in the northeast?

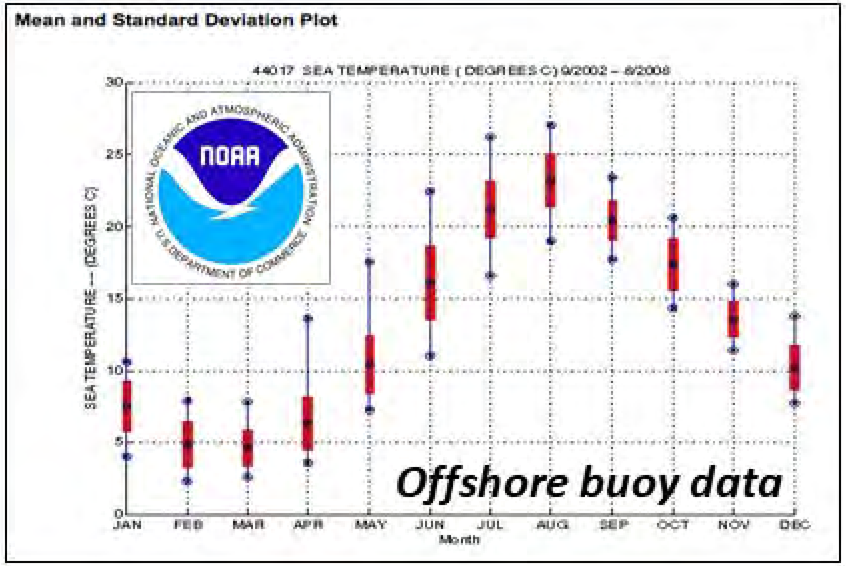
Berlinsky

Kenter

University of New Hampshire

Simulated Net Pen Growout at UNH (marine salinity ambient temperature and photoperiod) 2020–2021

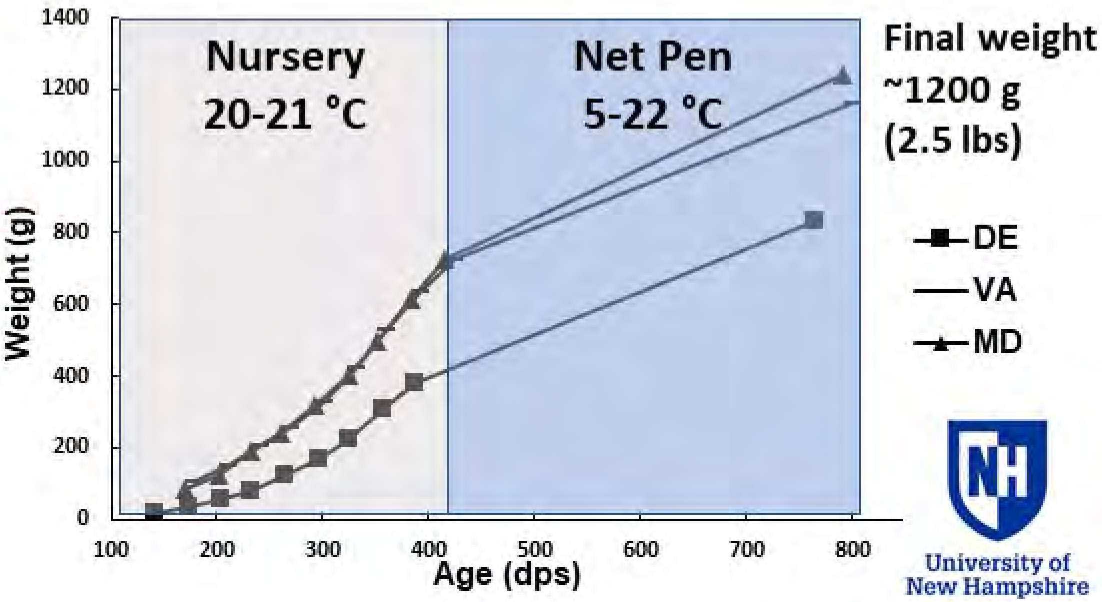




Native migratory strains

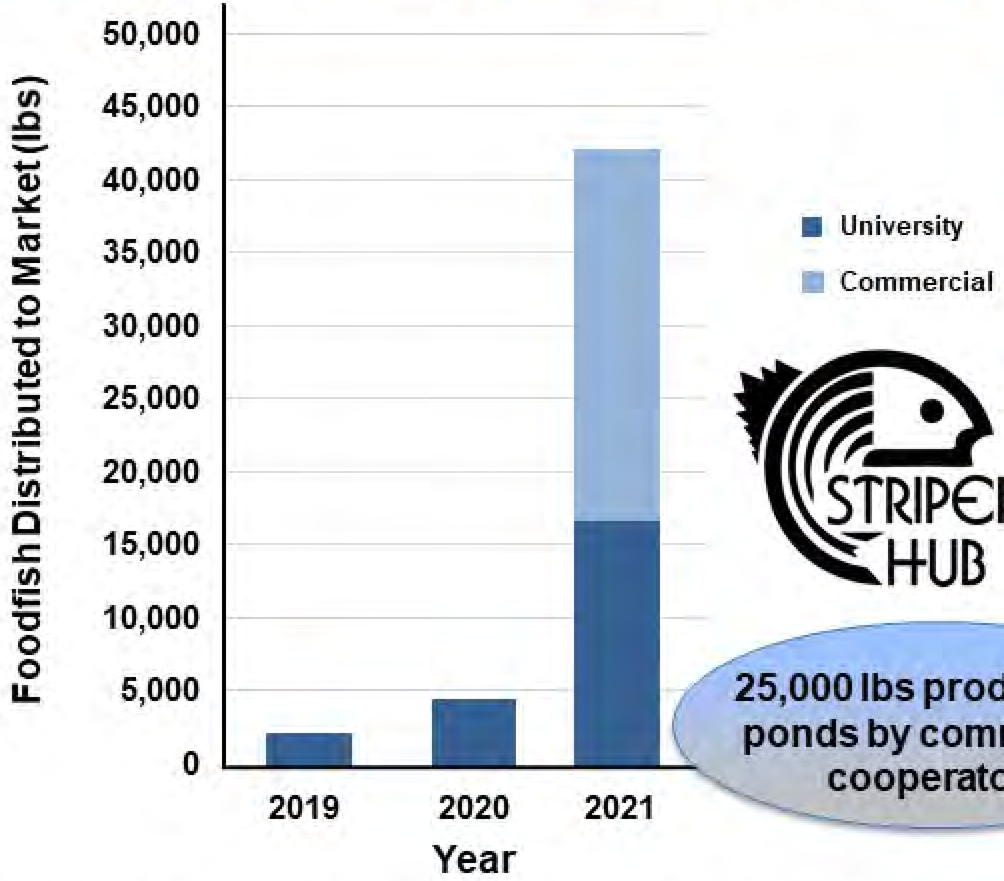
2-year growth trials

- Nursery phase (~1yr)
- Net pen phase (~1yr)



University of New Hampshire

StriperHub Striped Bass Foodfish Distributions by Funding Year



STRIPER HUB

25,000 lbs produced in ponds by commercial cooperators

Striped Bass Distributions	Fry/Larvae #	Fingerlings #	Foodfish lbs.
2019 (*university*)	3,000,000	92,000	2,070
2020 (*university*)	2,750,000	150,000	4,130
2021 (*university*)	5,000,000	31,800	17,135
2021 (*commercial*)	0	300,000	25,000
TOTAL	10,750,000	573,800	48,335
Project Proposal	“millions”	100,000	140,000

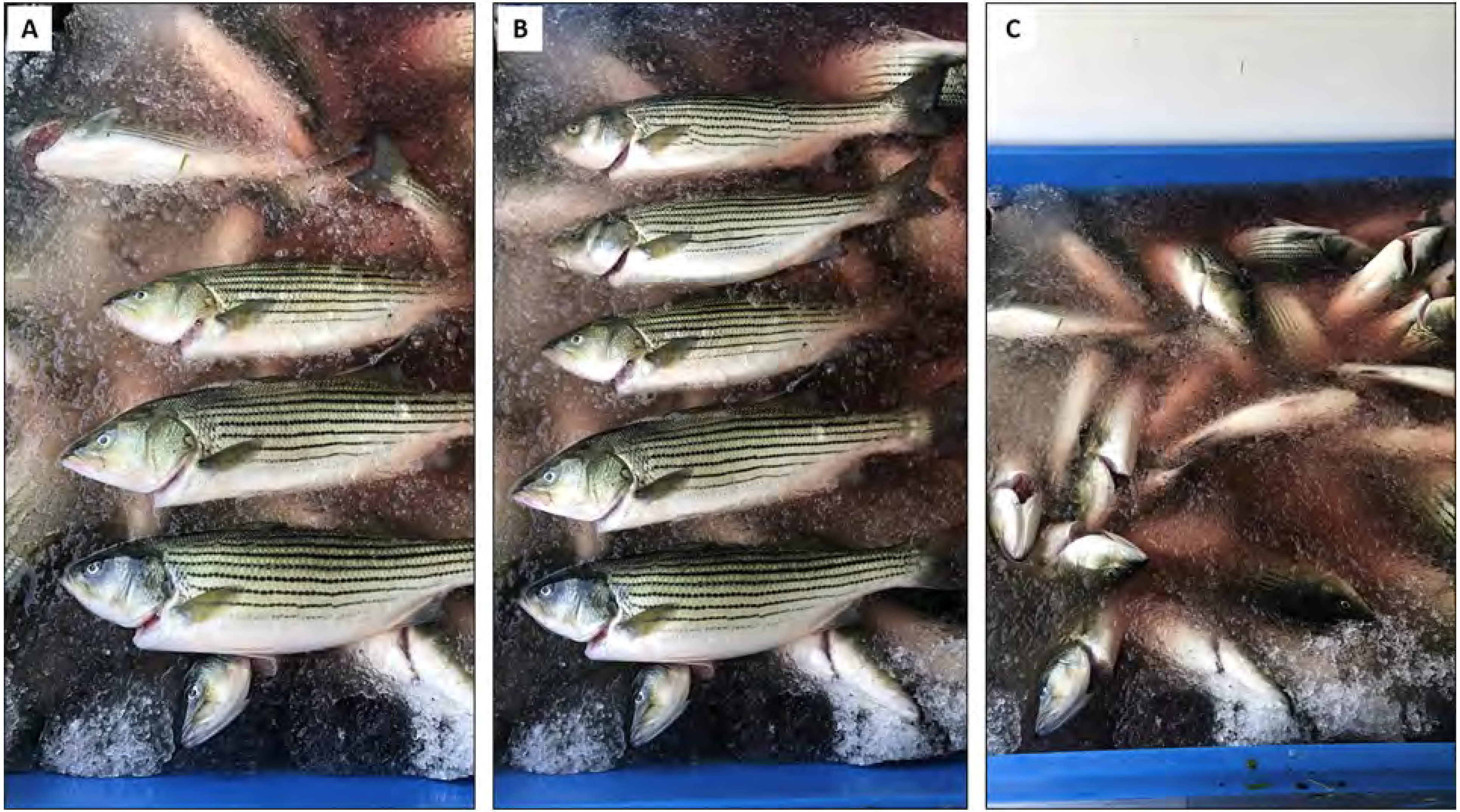
Locals Seafood
Raleigh Farmer's Market


Striped bass on ice post-harvest

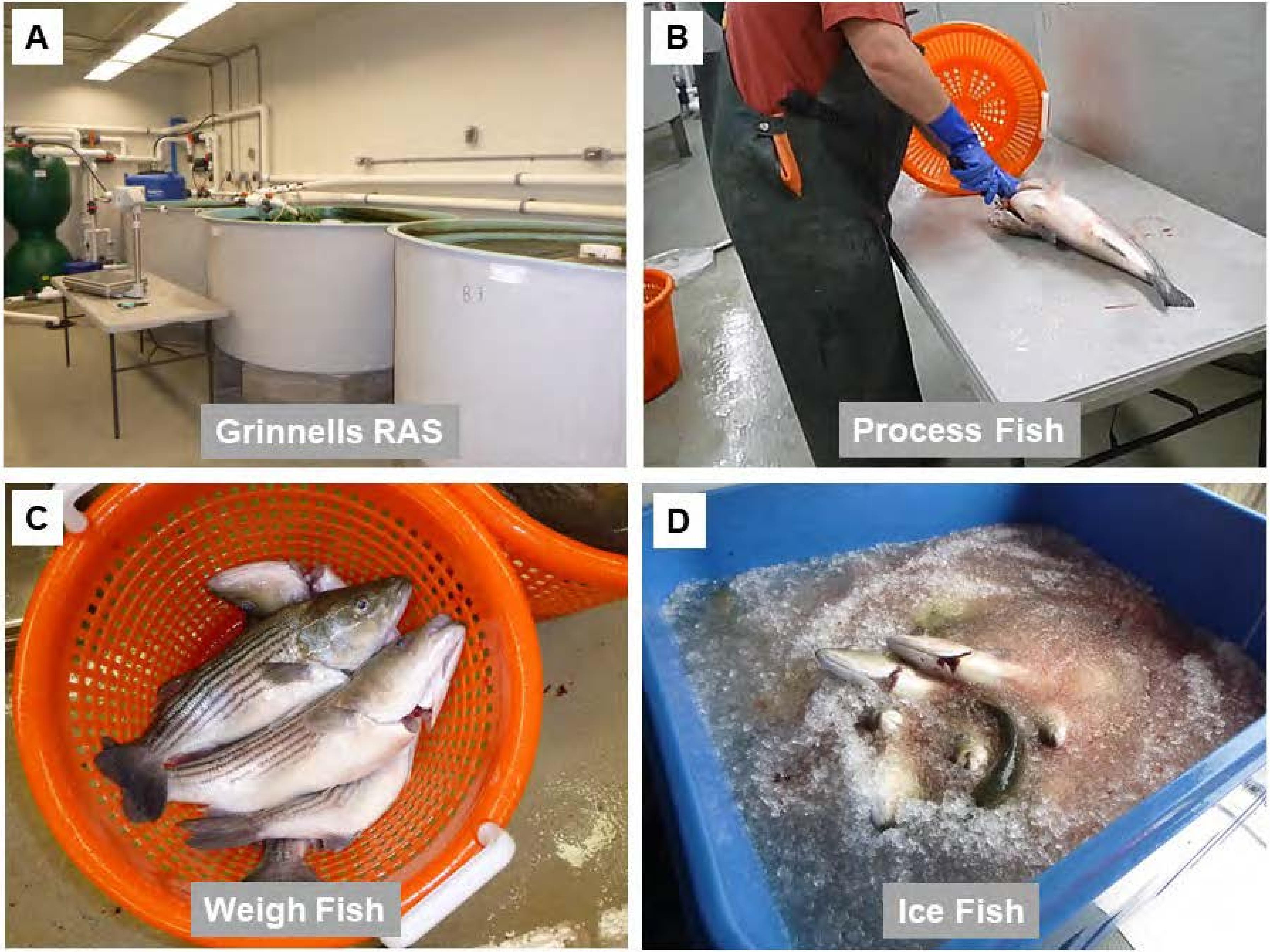
Harvesting striped bass
Pamlico Aquaculture Field Laboratory


Processed fillet

Striped Bass Processing



Cut isthmus and bleed out in ice slurry


A
Grinnells RAS
B
Process Fish
C
Weigh Fish
D
Ice Fish


A
CAP 6000
Yale
Place Ice Chests
B
Harvest Fish
C
Chill Kill Fish
D
Load Hauler

STRIPER HUB

MURRAY L. NIXON FISHERY INC.

Edenton, NC

L.D. AMORY Seafood Co

Hampton, VA

Nationwide Distribution

TRUST LOCAL. LOCALS SEAFOOD EAT FRESH.

Raleigh, NC

NC Distribution

got to be NC SEAFOOD Freshness From NC Waters

Locations (78 total) of cultured striped bass marketed and distributed in NC

Apex
The Provincial

Carrboro
Weaver Street Market
Glasshalfful
Oakleaf

Cary
Whole Foods Market
Maximillians
Postmaster
Verandah at Mayton Inn

Chapel Hill
Chapel Hill Farmer's Market
Weaver Street Market
Whole Foods Market
Al's Burger
Franklin St.
Southern Village Kitchen
Lantern
Stoney River Steakhouse & Grill

Durham
Bulldega
Durham Co-Op
Copa
Dashi
Foster's Market
Gocciolina
Guglhupf

Durham (*continued*)
JuJu
Littler
Lucky's Deli
Luna Rotisserie
Piedmont
Pizzeria Toro
Pompieri Pizza
Refectory
Rose's Meat Market
Saltbox
Saltbox Rockwood
St. James Seafood
The Durham
The Lakewood
The Pit
Washington Duke Inn

Hillsborough
Weaver Street Market
La Place
Panciuto

Morrisville
Western Wake Farmers Market

Oxford
Farm to Home Market

Raleigh
State Farmers Market
Transfer Co. Food Hall
Weaver Street Market

Raleigh (*continued*)
Whole Foods Markets (2 locations)
18 Seaboard
42nd Street Oyster Bar
Beasley's Chicken + Honey
Bella Monica
Bida Manda
Brewery Bhavana
Death & Taxes*
Garland
Hummingbird
Locals Oyster Bar
Mandolin
Midtown Grille
Nofo at the Pig
Poole's*
Raleigh Times
Saint Jacques
Sitti
St. Roch
Stanbury
The Cortez
The Pit
Vinnie's Steakhouse
Wakefield Tavern
Whiskey Kitchen

Saxapawhaw
Left Bank Butchery

Southern Shores
Coastal Provisions

Production Economics

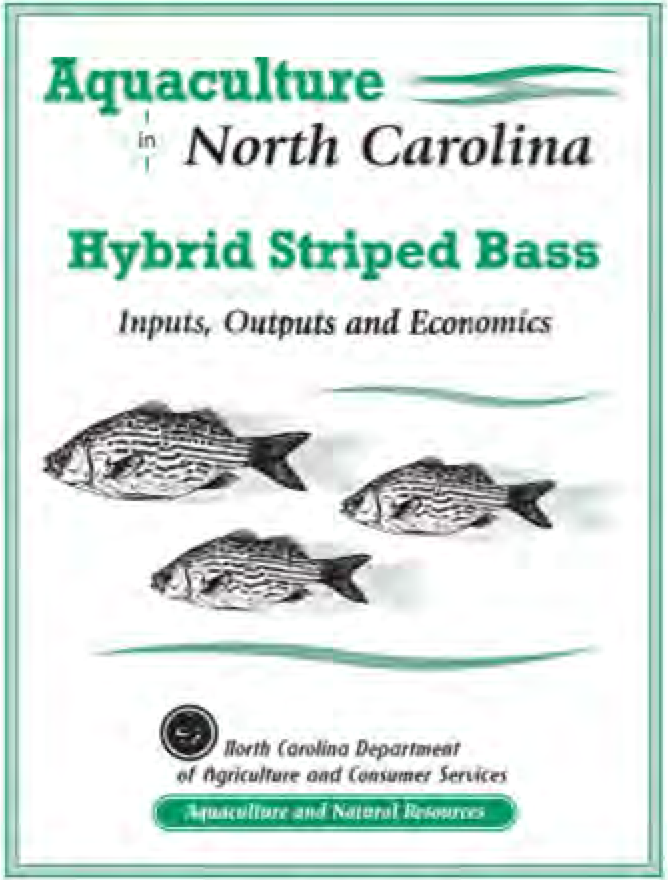

Matt Parker

We are developing enterprise budgets for farming striped bass.

Pond Culture: *Pond culture budget analysis is underway*. Designing a production plan for cash flow each year the farm is in operation based on a feeding program compiled for striped bass from the NC State PAFL. Split stocking strategy where half of the ponds are stocked in year 1 and then the other half stocked the following year. This would give an annual crop rotation for yearly cash flow.

Once the enterprise budget is complete, we will use data from growers for inputs and complete a Monte Carlo Analysis to determine the probability of a successful operation at different production scales and break-even pricing. <u>We are looking to obtain information from growers</u>.

Recirculating Aquaculture Systems (RAS): The system at NC State University Grinnells will be used as a baseline.



NC DA&CS

"The aim of the proposed work is to establish a *Sea Grant hub* for striped bass aquaculture (*StriperHub*) that will overcome barriers to industry development and expansion through demonstration and promotion of commercial-level culture, economics, and marketing of striped bass in the U.S. *StriperHub* is guided by a diverse community of interdisciplinary stakeholders coordinated by North Carolina Sea Grant."

Objective 1. Establish a Sea Grant Aquaculture Hub: A nexis to commercialize striped bass as a major aquaculture industry (The Sea Grant *StriperHub*);

Objective 2. Demonstrate seed stock production, distribution, growout, and production economics of domestic striped bass aquaculture;

Objective 3. Develop marketing strategies, market economics, permitting clarity, and business models for domestic striped bass aquaculture; and

Objective 4. Establish communication, outreach, extension, and training to support domestic striped bass aquaculture development.

Eat North Carolina Striped Bass!

Nutrition Facts

Serving Size 4 oz (113g)
Servings Per Container 1

Amount Per Serving

Calories 170	Calories from Fat 70
	% Daily Value*
Total Fat 8g	**12%**
Saturated Fat 2g	**10%**
Trans Fat 0g	
Cholesterol 65mg	**22%**
Sodium 65mg	**3%**
Total Carbohydrate 0g	**0%**
Dietary Fiber 0g	**0%**
Sugars 0g	
Protein 25g	

Vitamin A 0% • Vitamin C 0%
Calcium 8% • Iron 4%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300 mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

TRUST LOCAL.
LOCALS SEAFOOD
EAT FRESH.

got to be
NC
SEAFOOD

PACIFICO
AQUACULTURE

"Wolfpack" Striper: Farm Raised striped bass at the Raleigh Farmers Market. Fillet skin-on Price: $16.00/lb (2015), $18.00/lb (current). Whole: $8.00-$10.00/lb (current).

35TH ANNUAL NC SEAFOOD FESTIVAL

COOKING WITH THE CHEFS

Saturday, October 2, 2021
10:00 am - 5:30 pm

Sunday, October 3, 2021
11:00 am - 4:00 pm

In the Chefs Tent at Katherine Davis Park

SEAFOOD got to be NC

AGRICULTURE got to be NC

Sea Grant North Carolina

NC STATE UNIVERSITY

35TH ANNUAL NC SEAFOOD FESTIVAL

COOKING WITH THE CHEFS

SEAFOOD got to be NC

AGRICULTURE got to be NC

Saturday, October 2, 2021

10:00: Basnight's Lone Cedar Cafe *Sauteed Shrimp and Stone Ground Grits*
11:00: Chef Clarke Merrell *Smoked Wahoo Salad*
12:00: Chef Ana Shellem *Wildly Sustainable North Carolina Mussels*
1:00: Chef Caroline Dominguez* *Sauteed Garlic-Basil Butter Striped Bass*
2:30: Chef Dawn Freeman *Blackbeard's Blackened Snapper with Tropical Fruit Slaw*
3:30: Chefs Marshall Beatty and Jimmy Reale *Outer Banks Scallops*
4:30: Chef Jeremiah Tryon *Pan Seared Flounder Tacos*

Sunday, October 3, 2021

11:00: PBS North Carolina presents *The Key Ingredient* with Sheri Castle *Oyster Stew with Toasted Benne Seeds*
12:00: Chef Chad Blackwelder *Seafood Charcuterie with Speckled Trout*
1:00: Chef Keith Rhodes *Crab Cakes*
2:00: Chef Caroline Dominguez* *Sauteed Garlic-Basil Butter Striped Bass*
3:00: Chef Dawn Freeman *Ole' Salt Shrimp, Crab, and Corn Chowder*

Special event: NC Sea Grant will host a taste test and survey following the cooking demonstration.

In the Chefs Tent at Katherine Davis Park

Chef Caroline Dominguez

Aubrey Onley, Striped Bass Farmer

The North Carolina Seafood Festival
Where Seafood and Sea-Fun Meet!

STRIPER HUB

Sensory Panel Analysis: Farm Raised Domestic Striped Bass (2021)

The North Carolina Seafood Festival
Where Seafood and Sea-Fun Meet!

STRIPER HUB

Barry Nash

Sea Grant
North Carolina

Sensory Evaluation: Farm Raised Domestic Striped Bass (2021)

NC Agrotourism Networking Association (baked)		*NC Seafood Festival Day 1 (sauteed)*		*NC Seafood Festival Day 2 (sauteed)*	
N = 39 Persons		**N = 46 Persons**		**N = 33 Persons**	
Flavor:	5.64	Flavor:	6.17	Flavor:	6.15
Texture:	5.59	Texture:	5.61	Texture:	5.88
Aroma:	5.64	Aroma:	6.22	Aroma:	6.06
Appearance:	5.54	Appearance:	6.59	Appearance:	6.55

Scale: 1 unacceptable, 2 very poor, 3 poor, 4 fair, **5 good, 6 very good**, 7 excellent

Striped Bass Similarity (votes):

Sea bass:	7	19	13	= **39**
Cod:	8	11	7	= **26**
Grouper:	7	10	8	= **25**
Snapper:	3	3	5	= **11**
Haddock:	6	3	1	= **10**
Flounder:	2	7	1	= **10**
Triggerfish:	2	0	0	= **2**
Tilefish:	0	1	1	= **2**
Hogfish:	0	1	0	= **1**
Largemouth Bass:	0	1	0	= **1**

Sea Grant North Carolina

Mariner's Menu

About Contributors Resources Archives

https://ncseagrant.ncsu.edu/mariners-menu/

Striped bass recipes

Seafood Specialist
Barry Nash

Joyce Taylor

Vanda Lewis

Baked Striped Bass with Garlic-Basil Butter

1 ½ pounds striped bass fillets, skinless, cut into serving-size pieces

2 tablespoons butter, melted

salt

black pepper, freshly ground

Garlic-Basil Butter

½ cup butter or margarine, softened

1 teaspoon garlic, pressed

1 teaspoon fresh basil, finely chopped

1 teaspoon fresh lemon juice

⅛ teaspoon salt

Sea Grant North Carolina

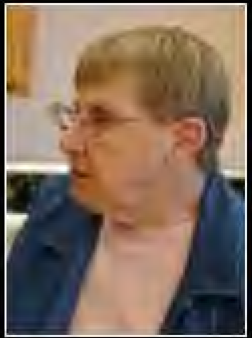
Prepare Garlic-Basil Butter and set aside. Preheat the oven to 350° F.

Place fish on a parchment-lined baking sheet. Brush with butter. Sprinkle lightly with salt and pepper.

Bake for 15-20 minutes, until fish flakes easily with a fork. Serve with Garlic-Basil Butter.

In a small bowl, combine butter, garlic, basil, lemon juice and salt. Spread over warm fish.

*Recipe contributed by Joyce Taylor (**6/10/2021**).*



Sautéed Striped Bass with Garlic-Basil Butter

1 ½ pounds striped bass fillets, skinless, cut into serving-size pieces
1 tablespoon butter, melted
1 tablespoon oil
salt
black pepper, freshly ground

Garlic-Basil Butter
½ cup butter or margarine, softened
1 teaspoon garlic, pressed
1 teaspoon fresh basil, finely chopped
1 teaspoon fresh lemon juice
⅛ teaspoon salt

Prepare Garlic-Basil Butter and set aside.

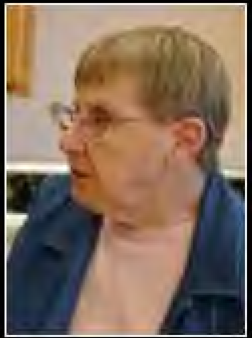
Pat fish dry with paper towels. Season with salt and pepper.

In a large nonstick skillet, melt the butter with oil over medium-high heat.

Place the fish in the skillet and cook about 6 minutes. Gently turn the fish over and cook about 1-2 minutes longer or until done. Serve with Garlic-Basil Butter.

*Recipe contributed by Joyce Taylor (**6/10/2021**).*

Sea Grant
North Carolina



NC State Extension Homegrown Series

Video December 16, 2020

Ginger-Crusted Bass Over Vinegar Rice

https://homegrown.extension.ncsu.edu/2020/12/ginger-crusted-bass-over-vinegar-rice/

https://homegrown.extension.ncsu.edu/

Farm Raised Domestic Striped Bass Recipe Development

Recipes Developed	Hot Eats | *Cool Science*	NC Sea Grant
2019	6	0
2020	1 (*video*)	3
2021	0	9
TOTAL	7	12

Vivian Howard Deep Run, NC

Ashley Christensen Raleigh, NC
2019 James Beard "Outstanding Chef"

15 states total

Sea Grant
Law Center

Stephanie Showalter-Otts
Director Law Center

Terra Bowling
Senior Counsel

Commercial sales of striped bass PROHIBITED
New Jersey, New Hampshire

Possession or commercial retail of striped bass requires special permitting/procedures
Maine, Massachusetts, Rhode Island, Connecticut, New York, Delaware, Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida

Aquaculture operational permitting
Inshore states

****Commercial fishing for striped bass is prohibited Maine, New Hampshire, Connecticut, New Jersey, Pennsylvania, and South Carolina.***

National Sea Grant Law Center helped finalize *Striped Bass Regulations of Atlantic States*

- Regulatory provisions for Atlantic striped bass in each state
- Identifying Atlantic striped bass culture or production regulations in each state (*excluding hybrid striped bass*)

Virginia

- A permit is required for a striped bass aquaculture facility, which will authorize the purchase, possession, sale, giving, receiving, and transportation of striped bass or hybrid striped bass.
- Striped bass or hybrid striped bass fingerlings, fry, or eggs, may be obtained only from state permitted fish dealers and must be certified by the seller as having a disease-free status.
- All striped bass or hybrid striped bass except fingerlings, fry, and eggs from an aquaculture facility must be packaged with a printed label with the name, address, and permit number of the facility.
- Labeled, aquacultured bass may be transported and sold at retail or at wholesale for commercial distribution (receipts required). Striped bass or hybrid striped bass which are the product of an approved and state permitted aquaculture facility in another state may be imported into Virginia for the consumer market. **4 Va. Admin. Code 20-252-170 through 4 Va. Admin. Code 20-252-230**.

Example of commercial striped bass dealer tag for North Carolina. From ASMFC (Addendum III to Amendment 6: The Atlantic Striped Bass Interstate Fishery Management Plan, 2012).

NATIONAL Aquaculture ASSOCIATION

Examples of striped bass with dealer (sales) tags for North Carolina. From Locals Seafood (Raleigh, NC; http://localsseafood.com/).

FARM BUREAU NORTH CAROLINA

N.C. DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES · FOUNDED 1877 ·

NORTH CAROLINA MARINE FISHERIES

North Carolina Aquaculture Association
NCAA
"Farming Fresh Alternatives"

Striped Bass Commercial Fishing: Availability in Seafood Markets and Gear Types

State	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
MA							hl	hl	hl*			
RI					ft	ft,hl	ft,hl	ft,hl	ft,hl	ft*,hl	hl	hl
NY					hl	hl	hl	hl	hl	hl	hl	hl
DE		gn	gn	gn,hl	gn,hl	hl	hl	hl	hl	hl	gn,hl	gn,hl
MD BAY	gn	gn				pn,hs	pn,hs	pn,hs	pn,hs	pn,hs	pn,hs	gn
"						hl	hl	hl	hl	hl	hl	
MD AO	hl	hl	hl	hl							hl	hl
PRFC	hl	pn,hl	pn,hl			pn,hl	pn,hl	pn,hl	pn,hl	pn,hl	pn,hl	pn,hl
"	gn	mg,gn	mg,gn			mg	mg	mg	mg	mg	mg,gn	mg,gn
VA	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg*
NC	gn,pn	gn,pn	gn,pn	gn,pn						gn,pn	gn,pn	gn*,pn*

gn = gill net, hl = hook and line, ft = floating trap, pn = pound net, hs = haul seine, mg = miscellaneous gear (including Fyke net, trot line, haul seine, and fish pot), * = or until quota is fulfilled.

"The aim of the proposed work is to establish a *Sea Grant hub* for striped bass aquaculture (*StriperHub*) that will overcome barriers to industry development and expansion through demonstration and promotion of commercial-level culture, economics, and marketing of striped bass in the U.S. *StriperHub* is guided by a diverse community of interdisciplinary stakeholders coordinated by North Carolina Sea Grant."

Objective 1. Establish a Sea Grant Aquaculture Hub: A nexis to commercialize striped bass as a major aquaculture industry (The Sea Grant *StriperHub*);

Objective 2. Demonstrate seed stock production, distribution, growout, and production economics of domestic striped bass aquaculture;

Objective 3. Develop marketing strategies, market economics, permitting clarity, and business models for domestic striped bass aquaculture; and

Objective 4. Establish communication, outreach, extension, and training to support domestic striped bass aquaculture development.

Lake Wheeler Field Laboratory Tours 2019

AS SEEN IN
DECEMBER 2019/
JANUARY 2020

RALEIGH

A Fishy Business

NC State's aquaculture program raises fish for local restaurants. By Lauren Kruchten

NOT ALL FISH COMES from the ocean. For Raleigh's Locals Seafood and Locals Oyster Bar, some fish, including striped bass and hybrid striped bass, are grown in tanks at NC State's Fish Barn and Pamlico Aquaculture Field Laboratory in Aurora, NC. Aquaculture is a burgeoning industry in North Carolina, one of the fastest-growing segments of agriculture in the state, and it helps take pressure off of the wild stock in our oceans while yielding more consistent and reliable-sized fish. This is hugely beneficial to people like Lin Peterson, the co-founder of Locals Seafood and an alum of NC State's Fisheries, Wildlife and Conservation Biology program. Peterson buys NC State's pure stripers at market size and then sells them to chefs at various local restaurants, including Locals Oyster Bar. "Chefs love [these fish]; our retail has been great," Peterson says.

Hatchery Manager Robert Clark with a farmed striped bass.

The ideal size of the fish is achieved through selective breeding, Peterson explains, not genetic modification. Commercial farmers raise hybrid striped bass at their own facilities on the coast that are spawned with adult fish from the university to produce the crop. Pure striped bass are produced at the Pamlico Field Laboratory, where the adults are held in indoor, temperature-controlled tanks with optimal water quality, diet and other factors until they spawn in the spring. The larvae that hatch from the eggs are then raised in farm ponds and, once the fish get large enough, they are moved into tanks where they live in water from the Castle Hayne aquifer and from the Pamlico Sound.

Additionally, through a partnership with Raleigh-based Infinity Hundred Farms, three of the tanks holding hybrid striped bass at the Fish Barn are part of a greenhouse-based aquaponic gardening system. In the system, fish waste is oxygenated with water and run to a 9,000-gallon deep-bed hydroponics tank which grows lettuce, herbs and other produce sold to more than 20 restaurants around town. "Infinity Hundred is all about trying to do more with less—growing more food for more people using less resources," says founder and principal farmer David McConnell.

Ben Reading, facility director at both aquaculture sites and an assistant professor in NC State's ecology department, says that, while some people are wary of farm-raised seafood at first, the taste is indistinguishable from wild-caught seafood. You won't be able to tell the difference in Locals Oyster Bar's crudo, grilled fish sandwich or seared fish filet, because, whether farmed or wild, striped bass maintain the same mild, clean flavor. "There are lots of concerns about global aquaculture and there are lots of questions," Peterson says. "But there are tons of regulations in place that produce great products in North Carolina. We're going to educate people on why local aquaculture is good when it's done right."

Fish tanks at Pamlico Aquaculture Field Laboratory

Bust the Oyster Myth

There's a persistent adage that you should only eat oysters in months with the letter "r" in the name—September through April. Locals Oyster Bar chef Eric Montagne and Locals Seafood owner Lin Peterson insist that it's not true—at least, not anymore—thanks to modern oyster farming methods. Today's oyster farmers have found a way to produce triploid oysters, which, unlike diploid oysters, don't spawn in the summer months. This means they can be enjoyed all year long. Peterson explains that when an oyster spawns, its quality suffers; it becomes soft and watery as it expends all of its energy reproducing rather than getting nice and fat for consumption. Oyster farmers grow triploid oysters in the same natural habitat of wild diploid oysters, in North Carolina's coastal sounds. The triploid oysters are grown either in floating bags on the surface of the water or in cages along the bottom of the sound. Locals Oyster Bar offers a rotating variety of raw oysters sourced from five different oyster farmers on the coast.

December 2019

Carolyn Dunn
Department Head
Agricultural & Human Sciences

Derek Aday
Department Head
Applied Ecology

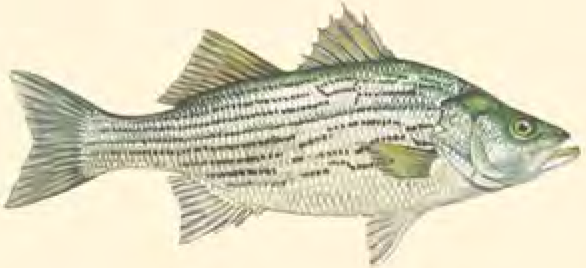
Ben Chapman
Professor
Agricultural & Human Sciences

HOT EATS
COOL SCIENCE

is a collaborative dinner hosted by

Department of Agriculture & Human Sciences
https://cals.ncsu.edu/agricultural-and-human-sciences/

Department of Applied Ecology
https://cals.ncsu.edu/applied-ecology



Join our next evening of decadent striped bass dishes expertly paired with wines and science, at the Dinah E. Gore Teaching & Research Kitchen!

Contact: Michelle Jewell
majewell@ncsu.edu | 919-515-3766

NC STATE UNIVERSITY

Thai Bass Cakes

Ingredients

16 oz. striped bass fillet, bones & skin removed

1 Thai chili

1 shallot, peeled

4 inch piece of ginger, peeled

2 inch piece of galangal, peeled

5 kaffir lime leaves

2 lemongrass stalks, bottom 4 inches only

1 tsp. salt

2 tsp. fish sauce

1/2 cup Chinese long beans, sliced into paper-thin rounds

Non-stick cooking spray

Directions

1. Combine the chili, shallot, ginger, galangal, lime leaves, lemongrass, and salt in the bowl of a food processor. Process to a paste. Remove from bowl & set aside.
2. Add fish to the food processor bowl and process to form a coarse paste.
3. Combine the spice paste, fish paste, fish sauce, and sliced Chinese long beans in a medium bowl. Stir until well combined, mixture will be slightly sticky.
4. Shape into 12 round, flat cakes.
5. Refrigerate until ready to cook.
6. Heat a large non-stick pan over medium heat. Spray with non-stick cooking spray. Sear cakes until golden brown, turn, and continue cooking until the internal temperature is 145-150°F.

Hot Eats | *Cool Science* 2020

NC State University College of Agriculture and Life Sciences

2 Events in 2019, 1 Event in 2020

Over 300 attendees tried Thai Striped Bass Fish Cakes with Kimchi and heard about striped bass aquaculture!

CARTERET
COMMUNITY COLLEGE

Aquaculture Technology

David Cerino
Professor & Coordinator

Workforce Training

2019: 19 students
2020: 31 students (2 financially supported)
2021: 18 students (2 financially supported)

Shuck, Rattle, & Roll **is an annual event showcasing seafood harvested and served by current and former Carteret CC Aquaculture students**

Striped Bass Dissection and Q&A in 2021!

https://www.youtube.com/watch?v=S85IwuOyzbE

Michelle Jewell

This is a recording of striped bass dissection that was first streamed on February 16th, 2021. Hosted by Ph.D. candidate, Linnea Andersen, Prof. Ben Reading, and Michelle Jewell of NC State's Department of Applied Ecology.

Follow the StriperHub & Striped Bass Genome Project with **780 others** on Facebook: **https://www.facebook.com/stripedbassgenome**

NH-Grown Striped Bass Aquaculture

174 views • Oct 12, 2021 9 0 SHARE SAVE ...

Sea Grant New Hampshire | NH Extension

YouTube

Aquaculture is a Growing Part of North Carolina's Agriculture Industry

By Capital Tonight Staff North Carolina

PUBLISHED 7:00 PM ET Apr. 09, 2021

NC COOPERATIVE EXTENSION

N.C. DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES · FOUNDED 1877 ·

Aquaculture is fast becoming a big agriculture product in North Carolina. We talk with **Michael Frinkso** of N.C. Cooperative Extension and **Pete Anderson** of the N.C. Department of Agriculture & Consumer Services about this growing sector.

SPECTRUM NEWS 1

"Fish Farms", a WRAL Documentary, explores one of North Carolina's best-kept secrets: Aquaculture, or the farming of fish and seafood, is a thriving industry that brings over $60 million in revenue to the state each year. Broadcast July 2021.

Aquaculture
North America

Pure-strain striped bass: An opportunity waiting to be tapped

October 13, 2021

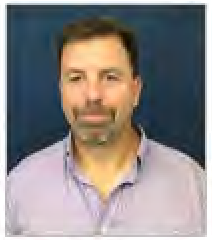
By Liza Mayer

"The market opportunity for striped bass exists, is strong and largely untapped — <u>and it is for the taking</u>."

STRIPER HUB

Frank Lopez
Director

Sea Grant North Carolina



Eric Herbst
Asst. Coordinator

Ben Reading
Coordinator and Asst. Director

NC STATE UNIVERSITY

NC STATE UNIVERSITY

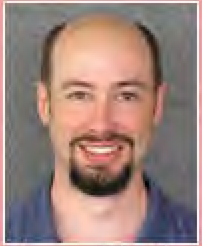
Russell Borski
SE Regional Coordinator

Growth & Production

University of New Hampshire

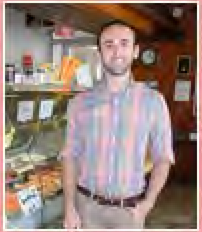
David Berlinsky ("Czar")
NE Regional Coordinator

Harvest, Processing, & Marketing



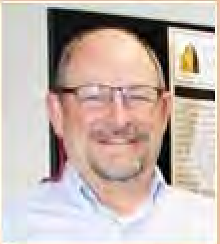
Greg Bolton

Barry Nash



Mike Ciaramella

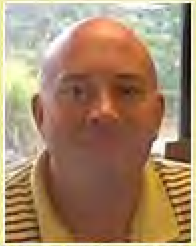
Feeds & Nutrition



Steve Rawles

Marc Turano

Business Economics



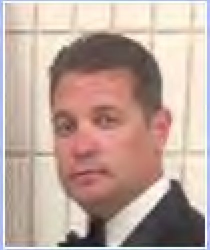
Matt Parker

Workforce Training

David Cerino

Travis Brown

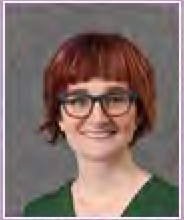
Breeding & Hatchery



Adam Fuller

Jason Abernathy

Communications & Outreach



Stacey Pigg

Matt Booker

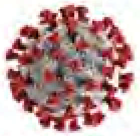
Eugene Won

Michael Chambers

StriperHub: Milestones / Timeline

STRIPER HUB

Project Funding Began February 2020



"Pandemic Closures"

Here

*No Cost Extension:
- Symposium (WAS/AA)
- Culture Manual
- Economics
- Business Model
- Finish Growout Trials

Project Activities	*A priori*	Year 1:2019-2020				Year 2:2020-2021				Year 3: 2021-2022			
	Apr-Aug	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug
Objective 1			START										
Formation of Advisory Panel		✓											
StriperHub workshops/meetings *		✓		NCADC				NCADC			??	NCADC	
Information networks/newsletter		✓						✓		✓			
Objective 2			START										
Seed stock production/distribution	✓			✓	✓			✓	✓				
Growout - flow-through	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Growout - pond/RAS					✓	✓	✓	✓	✓	✓			
Growout - RAS					✓	✓	✓	✓	✓	✓			
Growout - marine net pens										---------AMENDMENT -----------			
Production economics								✓	✓	✓			
Objective 3			START										
Marketing/consumer assessment							✓			✓			
Permitting clarity					✓			✓	✓	✓			
Business model development *									✓	Delay			
Objective 4			START										
Outreach and extension	✓	✓	✓				✓	✓	✓	✓			
Training/workforce development			✓	✓	✓		✓	✓	✓				
Striped bass aqua. manual *								Delay	Delay	Delay	Delay		
Commercial ventures *								Delay	Delay	Delay	Delay		
Final Reports													

Striper Hub Future Directives 2022 Onward

-Continue chef survey distributions with striped bass foodfish (NC State University, NC Sea Grant, and University of New Hampshire)

-Distribute 25,000 lbs of striped bass foodfish to markets and distribute fry and fingerlings to producers for growout (NC State University)

-Complete striped bass growth trials (NC State University and University of New Hampshire)

-Carteret Community College continue to raise striped bass for *Shuck Rattle and Roll* (2022) and student training

-Continue analysis of striped bass production cycle and culture economics (University of Maryland and NC State University

-White bass genome assembly annotation and release for public use (NC State University and USDA ARS)

-Monthly *StriperHub* planning meetings, online resources, and annual workshop to define and outline writing objectives for the revised striped bass culture manual (NC Sea Grant)

-Re-initiate outreach events, sensory panel analysis, and videography (All)

Funding & Stakeholder Support

Foundation for Food and Agriculture Research

NRSP-8 National Animal Genome Project
J. Liu
Syracuse Univ., VP Research
Aquaculture Director

Stuttgart National Aquaculture Research Center
C.E. Rexroad III
National Program Leader
Aquaculture

S.A. Fuller
Geneticist
Breeding Program

D. Thompson
Director Research Partnerships

C. Sandy
Proposal Development

B. Boston
Asst. Director CALS

N. Hummel
NCARS University Field Labs

Linton & Lommel
Dean's Office
William White Endowment

L. Peterson
Owner

R. Speckman
Owner

M. Lanahan
VP Commercialization

N. Wert
Raystown Striper Club

R. Gray
President

J. Avery
Director

NUTRIENDO POSIBILIDADES, JUNTOS
Colombia

P. Barngrover
Development and Innovation

P. Anderson
NC DACS Aquaculture

R. Reich
Asst. Commissioner
Agricultural Services

M. Denson
Marine Resources
Research Institute

R.L. Lane
VP Animal Nutrition

P.W. Zajicek
Executive Director

L. Brothers
Owner

B. Brothers
Owner

Clay Chappell (Southland Fisheries)
Gary Sawyer (Artesian Aquafarms)
Aubrey Onley (Onley the Best)
Brad Todd (Lucky Clays Fresh)
Keith Hairr (Carolina Flounder)
Craig Perry (Pungo Fisheries)
Scott Deal (Castle Hayne Fisheries)

J. Evans
Watha Hatchery

A. Onley
Edenton Hatchery

J. Botinovch
Project Coordinator

T. Mathes
Fishery Biologist


8th Annual
NC Catch Summit
Monday, March 2, 2020
Transfer Co. Food Hall - Raleigh, NC
Russell Borski
Ron Hodson
Ben Reading

New Innovators in Food & Agriculture Research 2017

2019 State of the Union Address

NOAA
USDA

THE WHITE HOUSE
WASHINGTON

Executive Order: Promoting American Seafood Competitiveness and Economic Growth
EO 13921 Issued on: May 7, 2020

2021 PUBLIC-PRIVATE ANALYTIC EXCHANGE PROGRAM

Homeland Security

"The U.S. government needs to promote domestic aquaculture for food security"

Feed the Future…

Maine Aquaculture Hub: Building capacity for industry-driven innovation, diversification, and workforce development-MESG

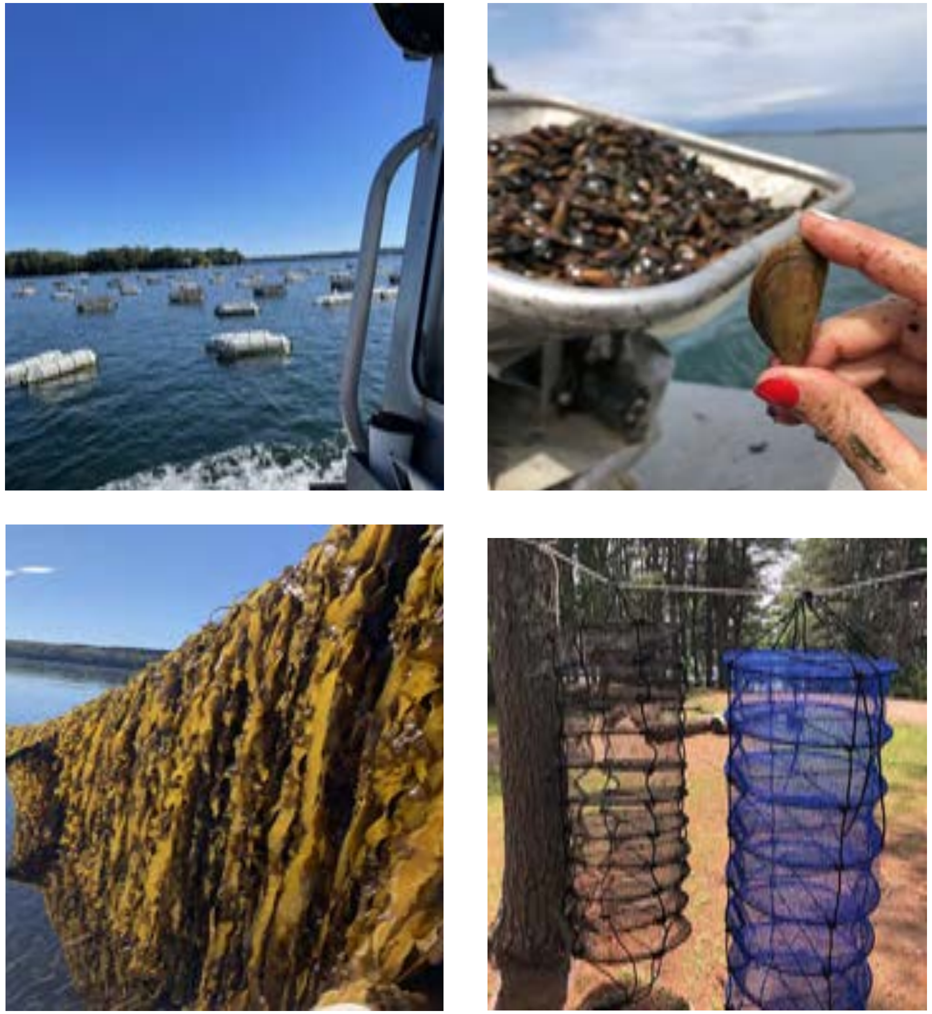
G. Zydlewski, H. Sadusky, D. Bouchard, S. Belle, H. Cowperthwaite, C. Davis

MAINE AQUACULTURE HUB

Building capacity for industry-driven innovation, diversification, and workforce development

AQUACULTURE IN MAINE

- Gulf of Maine is highly productive yet quickly changing
  - Coastal development pressures, climate change, decline in wild harvests
- Aquaculture is a growing industry in the state:
  - Salmon, oysters, mussels, seaweed, scallops
- Supports coastal communities, contributes to state's economy, new area for job growth, maintains working waterfronts, produces healthy sustainable domestic seafood
- Valued at $88.4 million in 2019, $71.75 million in 2018
  - Economic impact study currently underway



FOUNDING THE HUB

- AQSW training program
  - Recipient of two NSI grants
  - Awarded 2019-2020 Sea Grant Extension Assembly Superior Outreach Programming Award
- Partners convened to identify barriers to the industry and activities to address them
- Starting point for the proposal for the Maine Aquaculture Hub

- The Maine Aquaculture Hub is a network for strengthening aquaculture in Maine, connecting organizations and individuals across the state.

- It was formed to help the aquaculture industry in Maine overcome barriers to growth.

- The Maine Aquaculture Hub is supported by six organizations that make up the Steering Committee

3 PRIMARY ACTIVITIES

- Expand AQuaculture in Shared Waters training program
- Responsive call for proposals to fund industry-led projects
- Develop 10-year Roadmap for aquaculture in Maine

MAINE
AQUACULTURE
HUB
Orono
Eastport
Machias
Ellsworth
Corea
North Haven Island
Thomaston
Walpole
Brunswick
Bath
Harpswell
Portland
Moshier Island
Scarborough
Saco
Aquaculture in Shared Waters trainings
Roadmap focus group meetings
Projects funded by the Hub

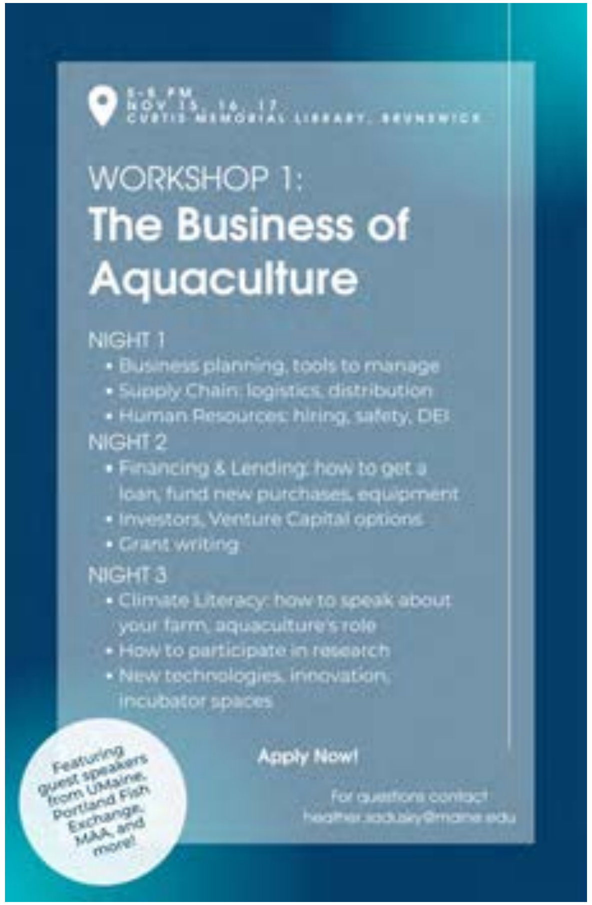
AQUACULTURE IN SHARED WATERS

- Since 2013, Aquaculture in Shared Waters has provided training, technical support, and networking opportunities to over 300 individuals.
  - >30 new aquaculture businesses established
  - >100 jobs established, expanded, or retained as program participants began working in the aquaculture field, added new species to their existing businesses, or expanded their harvest seasons (not including newest class)

- 2020 students: 33 Brunswick, 19 Belfast
- 2021 students (so far): 36 (virtual)

AQSW 2.0

- 2021 pilot
  - Followed format of original course
  - 29 students; held virtually March-May
- 2021-22 Winter Workshop offering
  - Four workshops in total
  - 3-night series taking place during one week
  - Targets existing sea farmers
  - Features numerous guest speakers
  - In person! With remote option

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Aquaculture in Shared Waters trainings
Roadmap focus group meetings
Projects funded by the Hub

MAINE AQUACULTURE ECONOMIC ROADMAP

- Goal: develop a shared vision for the future of aquaculture in the state; plan for the next 10 years; building off of 2010 Aquaculture Economic Development Plan
- Approach:
  - 10 Focus Group meetings with variety of stakeholders
  - Which goals from 2010 plan still relevant? New goals?
  - Specific action items needed to achieve goals, and identification of organizations that could work toward these
  - 1-on-1 calls to those who could not attend focus group
- In total, 140 individuals and 92 organizations provided input to the Roadmap
- Coming end of 2021!


MAINE
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Aquaculture in Shared Waters trainings
Roadmap focus group meetings
Projects funded by the Hub

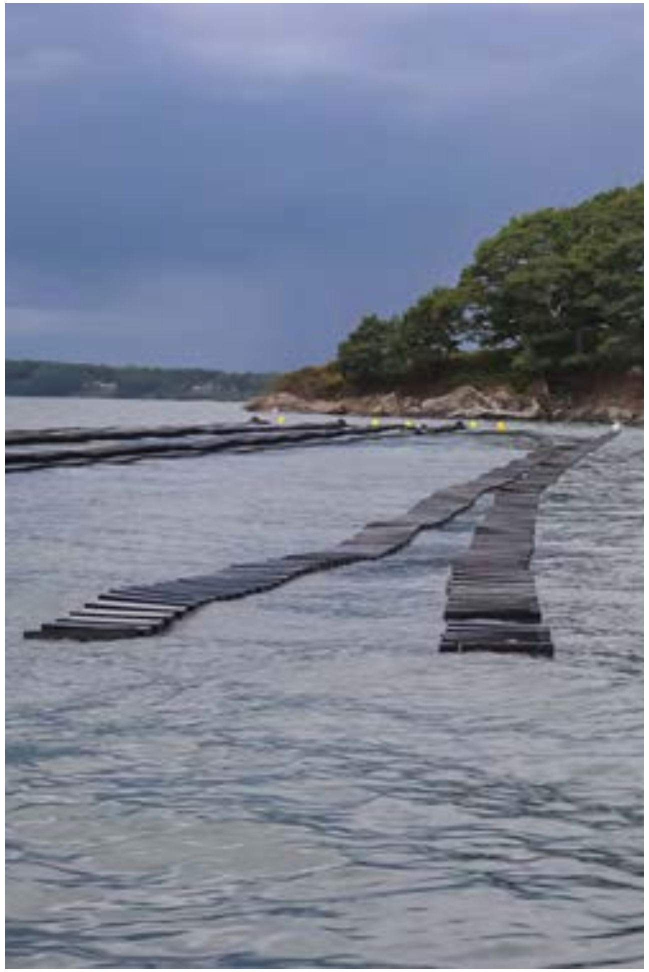
MAINE AQUACULTURE HUB RFP

- 2020: Building capacity for industry-driven innovation, diversification, and workforce development
  - 5 projects awarded funds, from Saco to Eastport
- 2021: Strengthening the sector through research, community engagement, and addressing farm challenges
  - Areas of Focus developed from needs/action items identified in the Roadmap
  - Steering Committee making recommendations to NSGO
- Possible third call for proposals

"Mussel farming trials in Downeast Maine: testing new opportunities to expand Maine's mussel aquaculture industry"

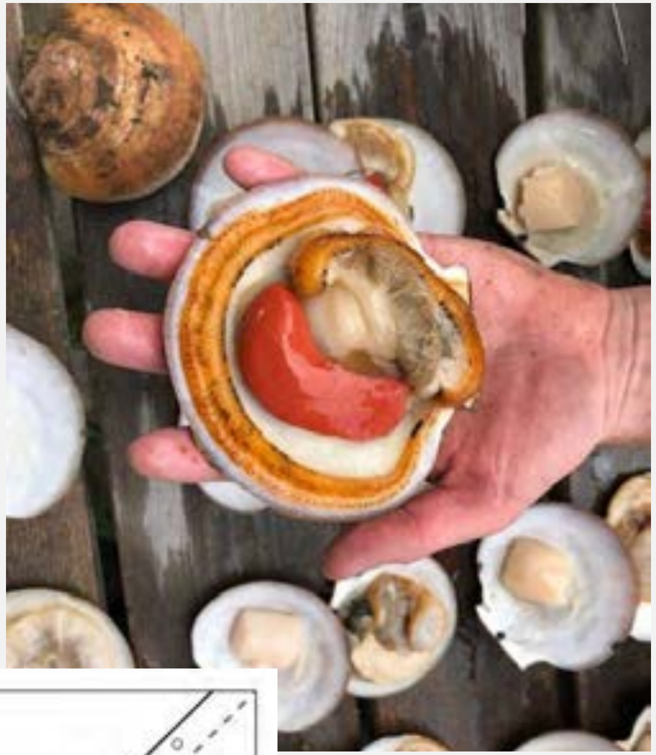
“Testing the efficiency of a net washing machine for intermediate culture of the Atlantic sea scallop”

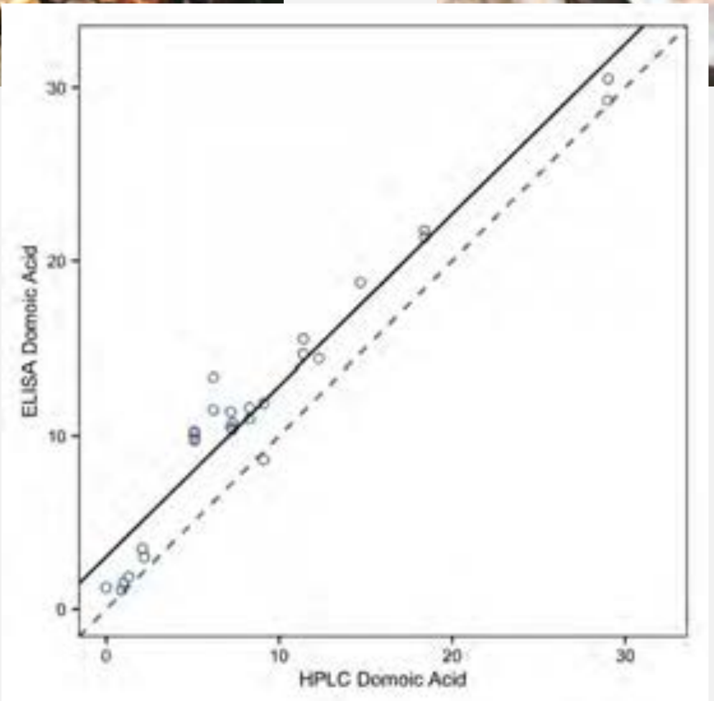
Credit: Karen Butterfield



"Ocean Smart Farm: Mechanizing Biofouling Control in Oyster Farming"

"Reducing the Cost of Biotoxin Testing in Scallop Aquaculture"





Credit: Tom Kiffney

“Atlantic Sea Farms: Kelp Blancher” – retrofitting a vegetable blancher for seaweed

WHAT'S NEXT?

Social scientists at UMaine have been evaluating the Maine Aquaculture Hub throughout its life

Now working to identify strategy, future directions

- What is the Hub's competitive advantage, its mission, its strengths;
- Where to best operate in the aquaculture landscape moving forward?
- What is the funding mechanism?

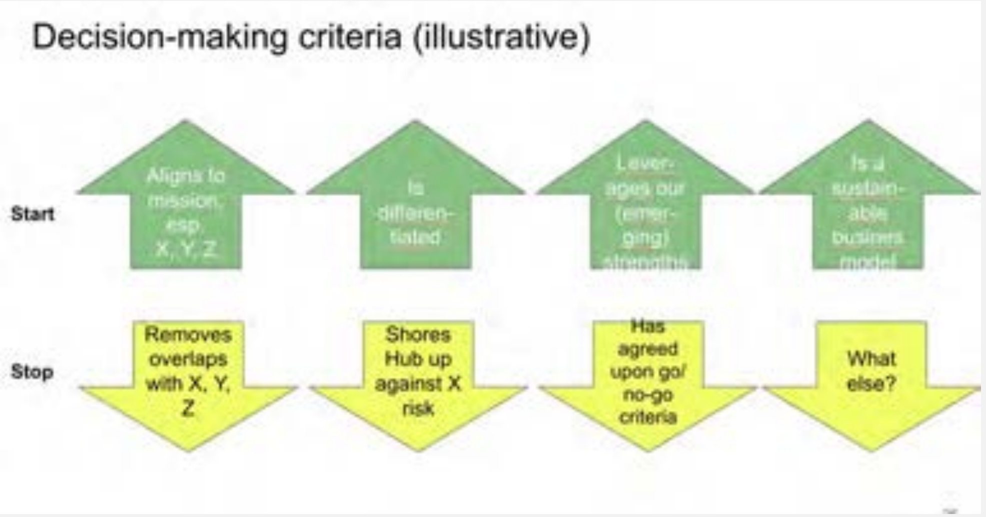
Potential Strategies

“Aquaculture Academy Collective”

Building on the longstanding AQSW program, this model builds content, courses, coaching, and standards as needed to strengthen the aquaculture sector across the state.

“Aquaculture Market & Brand Maker”

Brings together producers, tourism and hospitality sector, the greater food system and seafood industry to build a community that includes aquaculture and tells its story.



Thank you!

Questions?

heather.sadusky@maine.edu

Great Lakes Sea Grant Aquaculture Collaborative-MNSG

A. Schrank, L. Jescovitch, E. Nelson, A. Shambach, Nicole Wright, M. Ciaramella, D. Schneider, K. Quagrainie, E. Wiermaa, T. Seilheimer, S. Moen, E. Forbes, T. Malone, R. “Max” Melstrom, S. Carlton, J. Downing

Great Lakes Aquaculture Collaborative (GLAC) | 2019-2022

Sea Grant Minnesota

NOAA

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF COMMERCE

Great Lakes
AQUACULTURE
Collaborative

NY Sea Grant

Emma Forbes

PA Sea Grant

Sean Rafferty

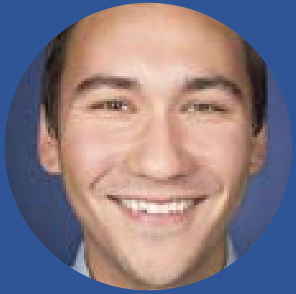
MN Sea Grant

John Downing

Marie Thoms

Don Schreiner

Great Lakes **AQUACULTURE** Collaborative



Elliot Nelson

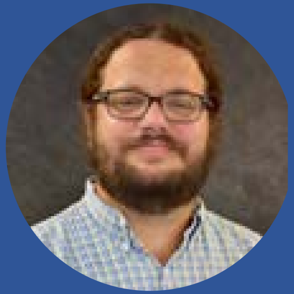
MI Sea Grant

Lauren Jescovitch

Chiara Zuccarino-Crowe

IL-IN Sea Grant

Amy Shambach



Stuart Carlton

Kwamena Quagrainie

OH Sea Grant

Nicole Wright

Tory Gabriel

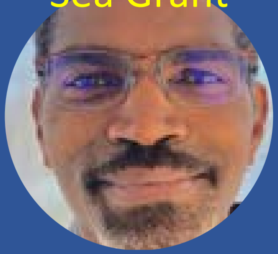
Michigan State University

Trey Malone

Loyola University

Max Melstrom

Lake Champlain Sea Grant



Theo Willis

WI Sea Grant

Titus Seilheimer

Emma Wiermaa

NADF

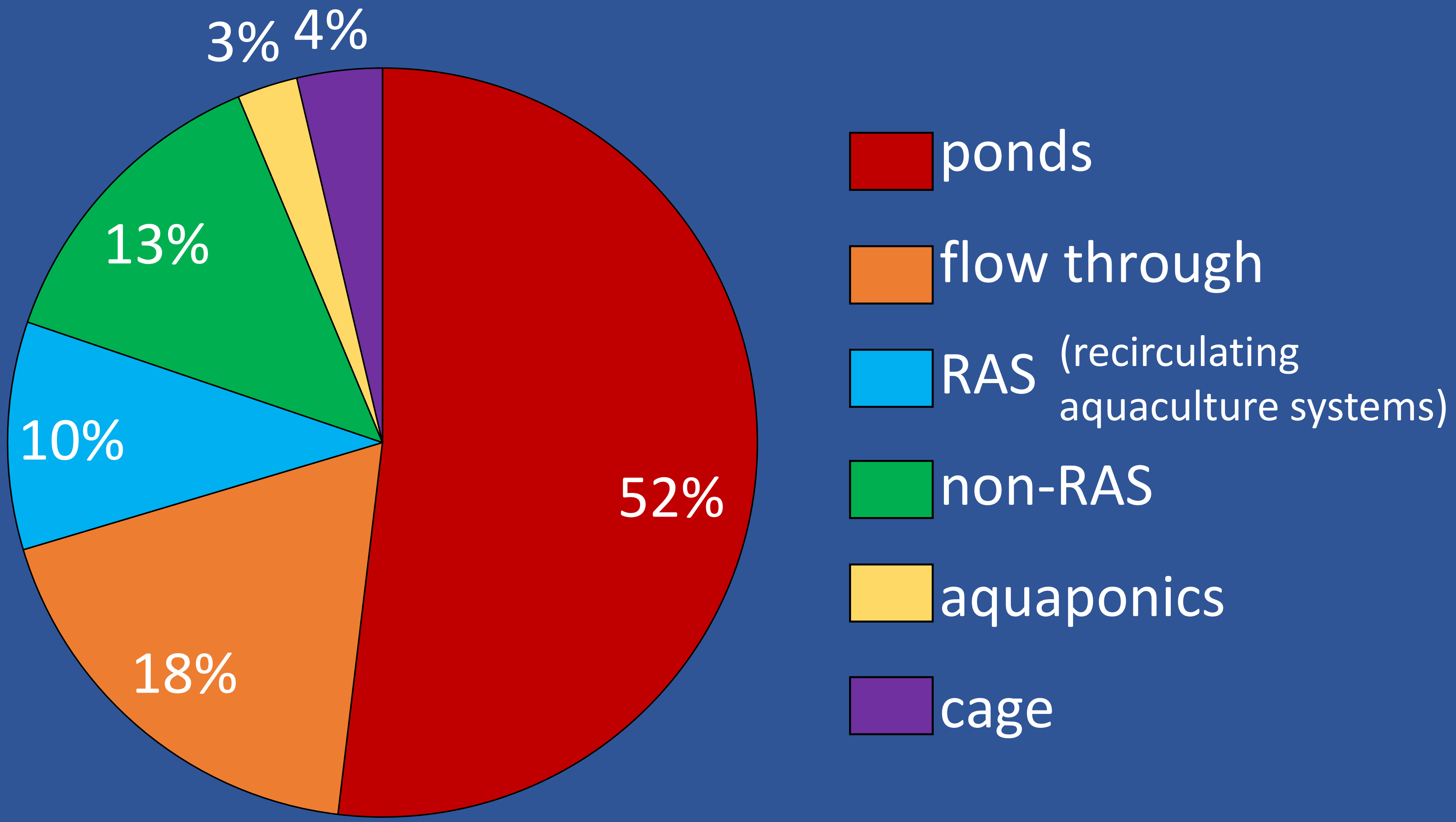
Greg Fischer

Sea Grant
Great Lakes Network

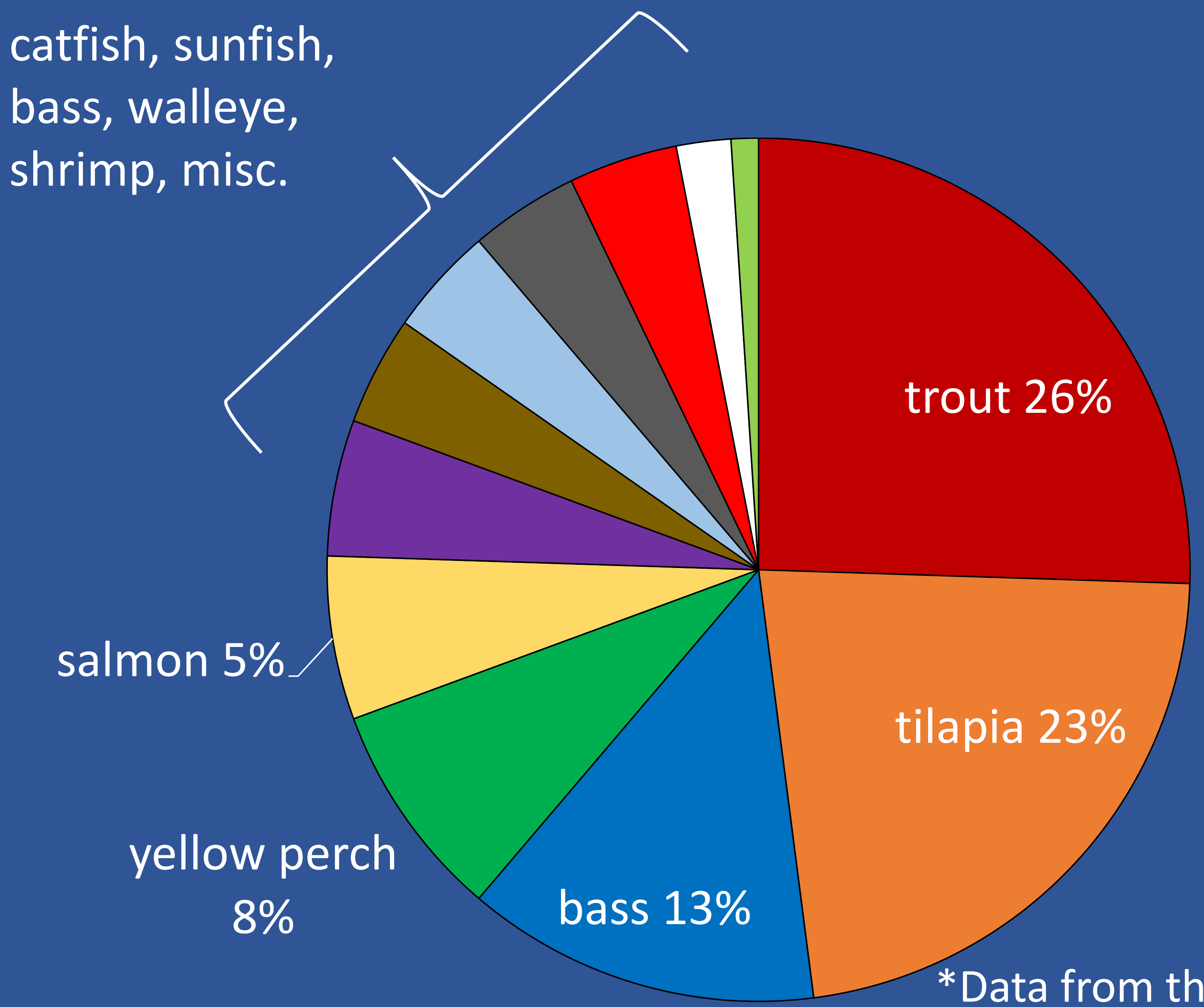
Great Lakes
AQUACULTURE
Collaborative

21%

Aquaculture systems in the Midwest region



*Data from the 2018 Aquaculture census



Species raised in the Midwest region (308 farms)

*Data from the 2018 Aquaculture Census

Aquaculture vs Recreational Fishery Value

State	Total Aquaculture * bait, stocking, food	Food-fish Aquaculture *	Recreational Fishery **
MI	$1.53 Million	$1.18 Million	$2.4 Billion
MN	$5.62 Million	$1.72 Million	$2.4 Billion
WI	$5.30 Million	$2.41 Million	$1.4 Billion

*2012 Aquaculture Census
**2011 National Survey of Fishing, Hunting, and Wildlife related Activities, USFWS

US Dept. of Interior

T. Vang – Happy Fish Aquaponics

A. Schrank

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Goal: provide science-based information and activities that support an environmentally responsible, competitive, and sustainable aquaculture industry in the Great Lakes region.

UWSP NADF/Narayan Mahon

GLAC phases

Phase 1:
State Sea Grant Program and Industry Focus

Phase 2:
Research/Academic Focus

Michigan Sea Grant

Wisconsin Sea Grant

UWSP NADF/Emma Wiermaa

Illinois-Indiana Sea Grant

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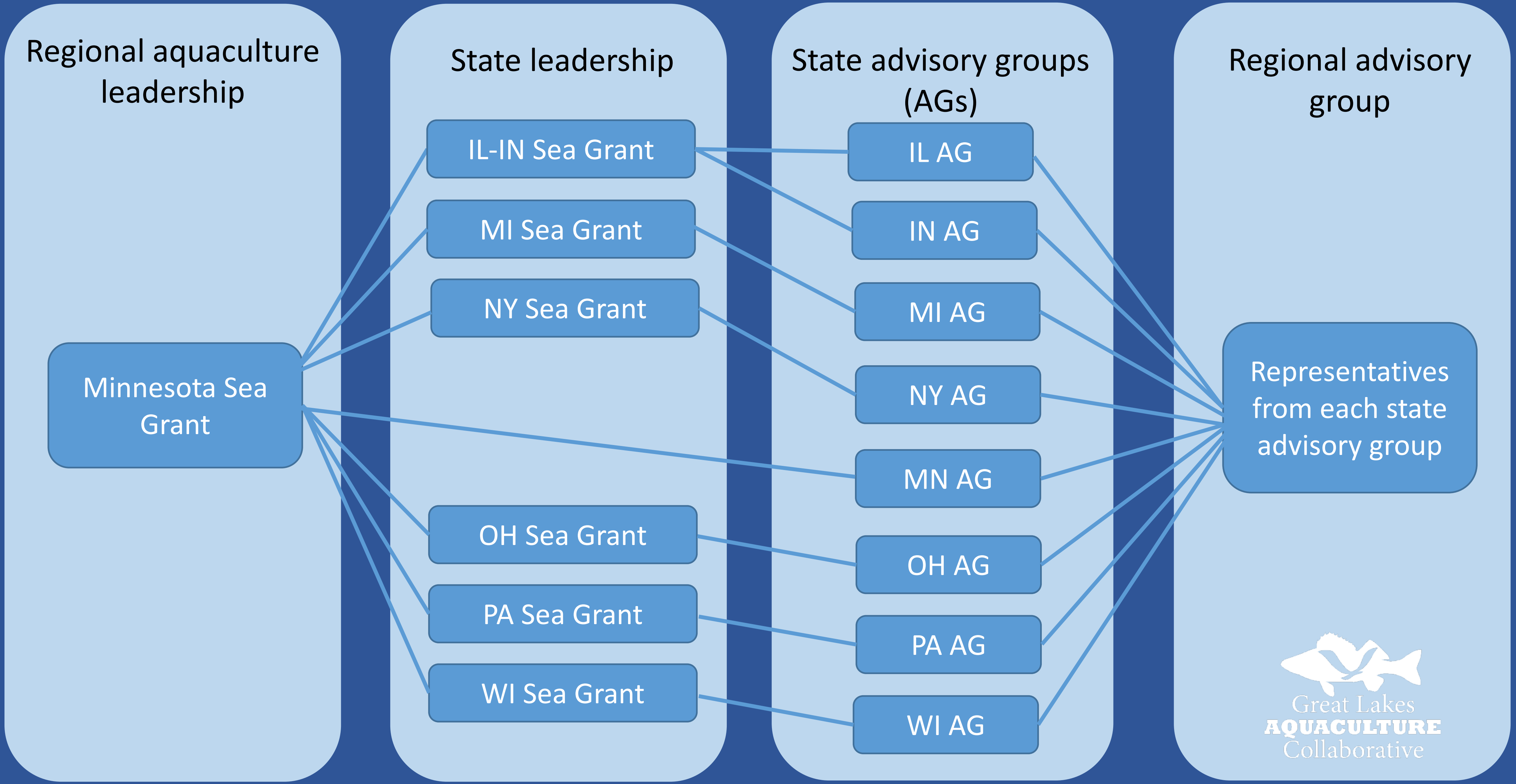
GLAC Phase 1 - Sea Grant Program/Industry Focus

1. Establish GLAC within a formal structure
2. Develop and convene advisory groups
3. Develop process for annual event and webinar series idea
4. Develop GLAC website
5. Host webinar series (2-3 webinars per year) and annual aquaculture events (1 per year) to share and disseminate information

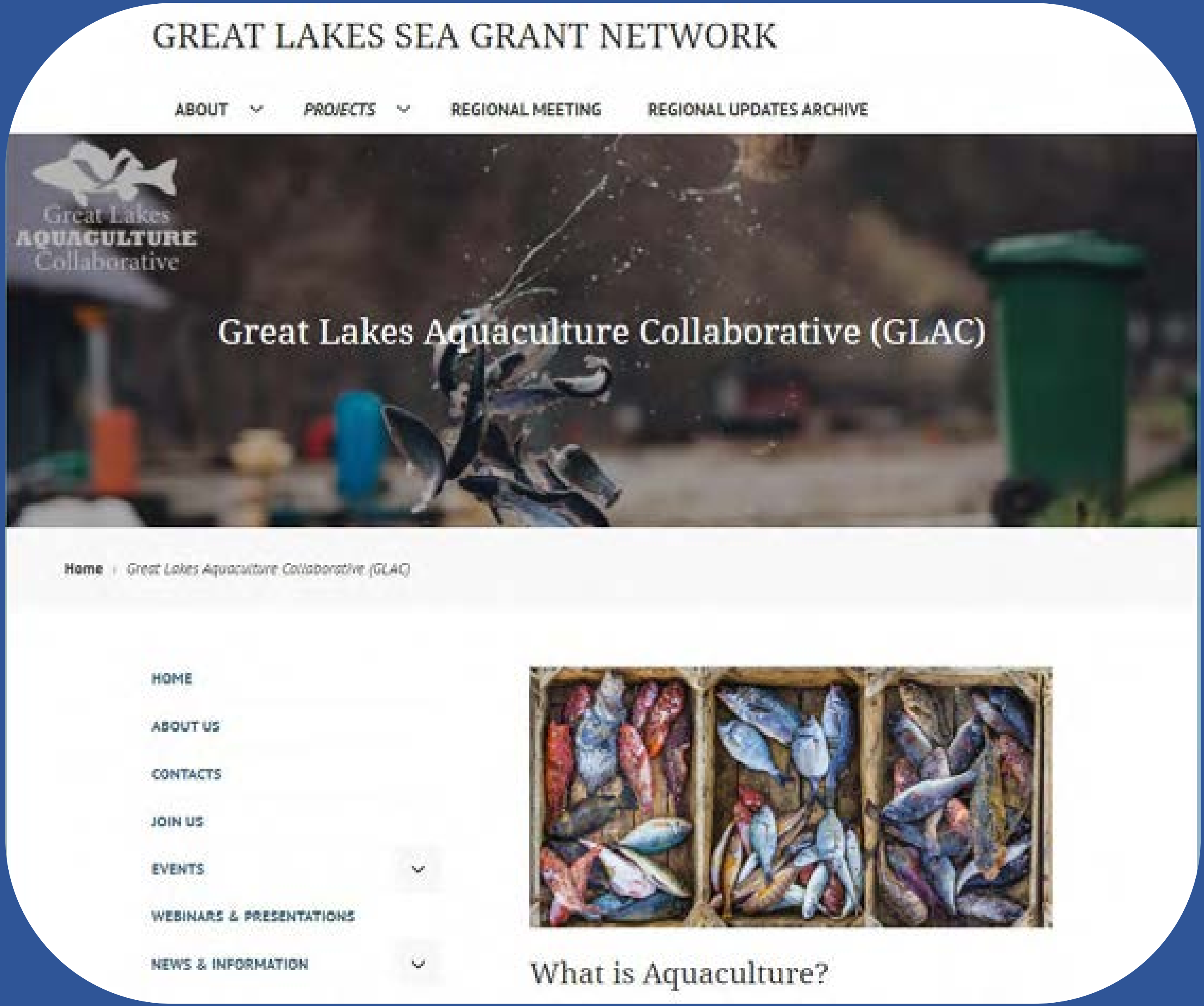
Great Lakes
AQUACULTURE
Collaborative

GLAC Organizational Structure



GLAC website:

https://greatlakesseagrant.com/aquaculture/



Great Lakes AQUACULTURE Collaborative

Great Lakes
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Collaborative

Webinars

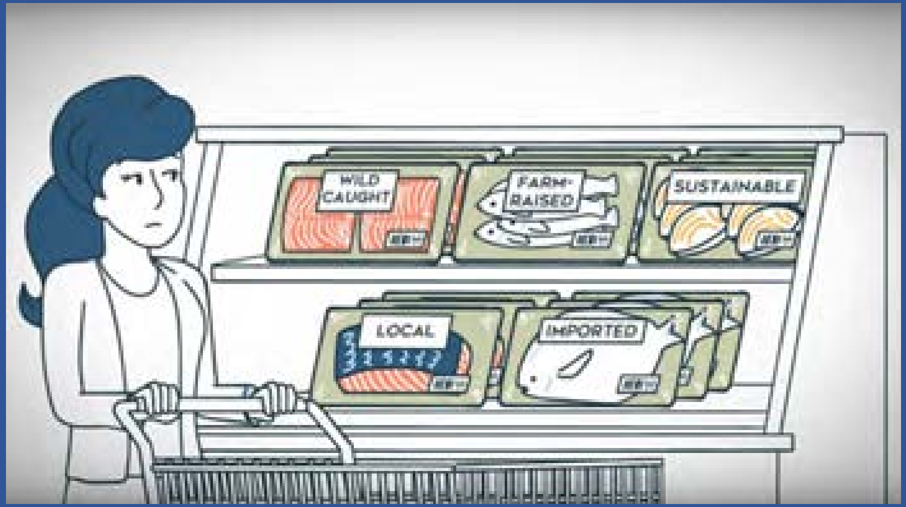
Events: Great Lakes Aquaculture Day 2020 and 2021

Great Lakes
AQUACULTURE
Collaborative

GLAC Research

1. What are consumers willing to pay for Great Lakes aquaculture products?

   Richard Melstrom (Loyola), Kerri Smetana (Loyola), Jillian Hyink (Loyola), Eric Abaidoo (MSU), Trey Malone (MSU)



https://conservationfilmfest.org/what-is-land-based-fish-farming/

Little to no GL data!

But other studies suggest consumers

1. will pay a premium for locally produced fish
2. are concerned with quality, freshness, food safety, animal welfare and will pay more for this
3. prefer fresh over frozen

GLAC Research

Great Lakes
AQUACULTURE
Collaborative

1. What are consumers willing to pay for Great Lakes aquaculture products?

   Richard Melstrom (Loyola), Kerri Smetana (Loyola), Jillian Hyink (Loyola), Eric Abaidoo (MSU), Trey Malone (MSU)

Qualitative and quantitative meta-analysis based on lit review of WTP studies:

136 studies
- **Database search for relevant studies**

44 studies
- **Pass title and abstract check**

32 studies
- **Final group of papers**

GLAC Research

Great Lakes
AQUACULTURE
Collaborative

1. What are consumers willing to pay for Great Lakes aquaculture products?

   Richard Melstrom (Loyola), Kerri Smetana (Loyola), Jillian Hyink (Loyola), Eric Abaidoo (MSU), Trey Malone (MSU)

Conduct discrete choice experiment measuring WTP for several product types:

Whitefish vs trout vs salmon
Fresh vs Frozen
Farmed in state vs U.S. vs import

GLAC Research

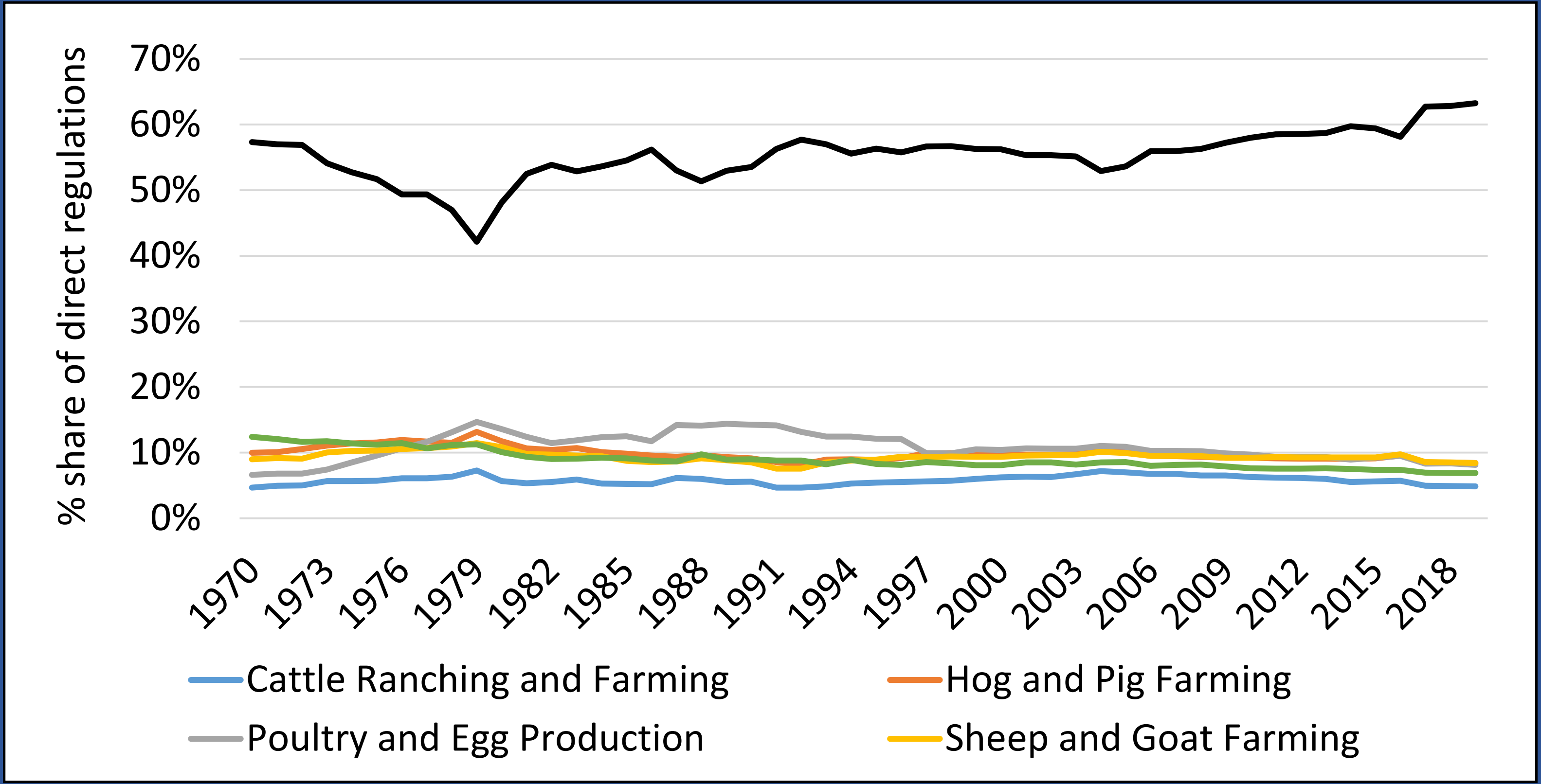
Great Lakes
AQUACULTURE
Collaborative

2. What policy challenges and opportunities exist?

Trey Malone (MSU), Aaron Staples (MSU), Richard Melstrom (Loyola), Stuart Carlton (Purdue)

Regulations at top of self-reported challenges

Content analysis of CFR partially validates this concern



GLAC Research

Great Lakes
AQUACULTURE
Collaborative

2. What policy challenges and opportunities exist?

Richard Melstrom (Loyola), Stuart Carlton (Purdue), Trey Malone (MSU)

$

Pricing is challenging

Producers generally sell on farm and in restaurants

GLAC Research

Great Lakes
AQUACULTURE
Collaborative

3. What are farmer attitudes towards business expansion?

Stuart Carlton, Haley Hartenstine (Purdue)

GLAC Research

Great Lakes
AQUACULTURE
Collaborative

3. What are farmer attitudes towards business expansion?

Out of 30 interviews, 23 farmers were trying to expand production

Producers are generally optimistic about business expansion

GLAC Research

Great Lakes
AQUACULTURE
Collaborative

- Aaron J. Staples, Dustin Chambers, Richard T. Melstrom, and Trey Malone. Regulatory Restrictions Across U.S. Protein Supply Chains. *Journal of Agricultural and Applied Economics.*
- Special issue in *Choices*:
  - Eric Abaidoo, Max Melstrom, and Trey Malone. The Growth of Imports in U.S. Seafood Markets.
  - J. Stuart Carlton, Amy Shambach, and Haley A. Hartenstine. Voices from the Industry: Aquaculture Producers in the Midwestern United States.
  - Titus S. Seilheimer, Emma Wiermaa, and Lauren N. Jescovitch. Fisheries, Hatcheries, and Aquaculture—What's the Difference?
  - Simone Valle de Souza, Kwamena Quagrainie, William Knudson, and April Athnos. Go FISH: U.S. Seafood Consumers Seek Freshness, Information, Safety, and Health Benefits.
  - Kwamena K. Quagrainie and Amy M. Shambach. Aquaculture Markets in the Twenty-First Century.
  - Aaron J. Staples, Eric Abaidoo, Lauren N. Jescovitch, Dustin Chambers, Richard T. Melstrom, and Trey Malone. Regulatory Landscape of the U.S. Aquaculture Supply Chain.
- Kerri Smetana, Richard T. Melstrom and Trey Malone. What Do We Really Know about Consumer Preferences for Aquaculture Products? AAEA presentation.
- Four graduate researchers (Staples, Smetana, Abaidoo, Hartenstine)
- Three UG researchers (Jillian Hyink, Joanna Szremeta, Jessie Marshall)

Other outcomes from GLAC

Connect fish producers directly with consumers

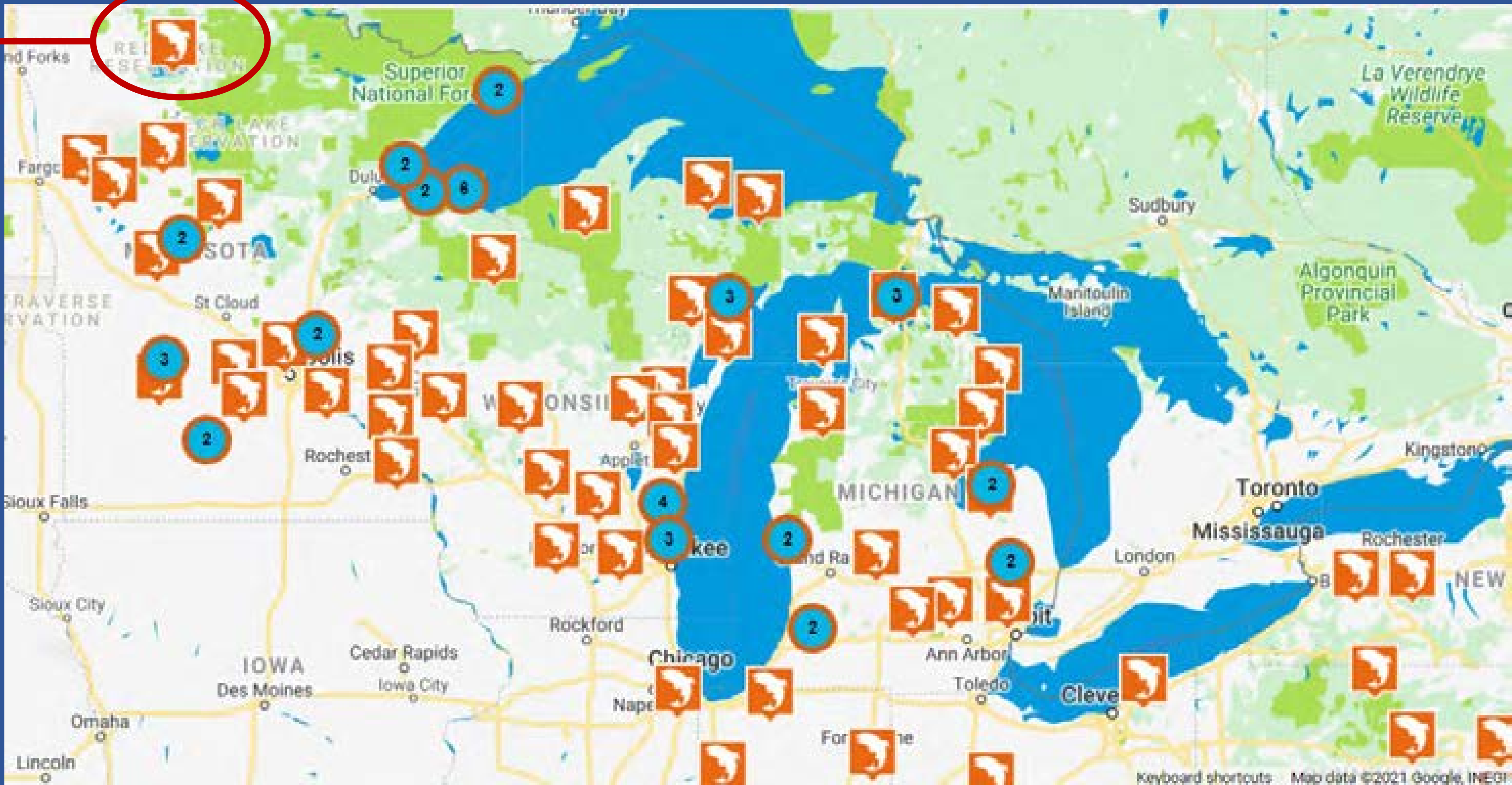
RED LAKE NATION FISHERY

Redby, MN

Food fish

Business Website

Expanded Listing



freshfishfinder.org

Other outcomes from GLAC

Great Lakes AQUACULTURE Collaborative

- GLAD 2020: WAS publication
- GLAD 2020: 2 films were presented
- Survey advisory groups about potential regulatory barriers
- Compare USDA census data to direct producer contact across the region

WORLD AQUACULTURE

Vol. 52 No. 1 March 2021

INTRODUCING THE GREAT LAKES AQUACULTURE COLLABORATIVE: FOSTERING AN AQUACULTURE EVENT DURING COVID-19

LAUREN N. JESCOVITCH, ELLIOT NELSON, TITUS SEILHEIMER, EMMA WIERMAA AND AMY J. SCHRANK

Other outcomes from GLAC

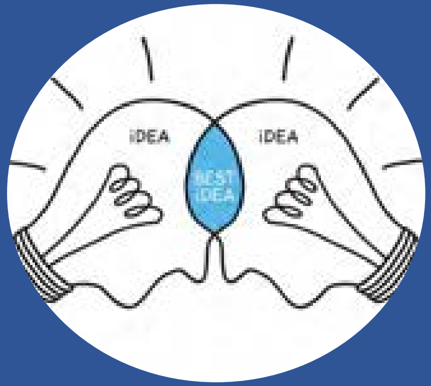
Great Lakes
AQUACULTURE
Collaborative

- Hosted an aquaculture symposium at the Midwest Fish and Wildlife Conference
- Sponsoring a fish health workshop at the WIAA/MNAA joint conference

2021 VIRTUAL
MIDWEST
FISH & WILDLIFE
CONFERENCE

MINNESOTA AQUACULTURE ASSOCIATION
MNAA

WAA
WISCONSIN AQUACULTURE ASSOCIATION



- North Central Regional Aquaculture Center (NCRAC)
- NOAA/NSG

GLAC 2.0

Great Lakes
AQUACULTURE
Collaborative

Continue to develop from GLAC 1.0:

1. Advisory groups

2. Improve GLAC web presence

3. Maintain/expand GLAC community of practice
   - NCRAC
   - AFS Fish Culture section
   - Others

NCRAC North Central Regional Aquaculture Center

FISH CULTURE SECTION OF THE AMERICAN FISHERIES SOCIETY

UWSP NADF/Emma Wiermaa

GLAC 2.0: new ideas

1. Focus on building networks:
   - Support producer focused sessions at state aquaculture conferences

2. Focus on workforce development
   - Potential to create an apprenticeship program

3. Develop synergy between wild-caught fisheries and aquaculture
   - Processing, distribution, etc.

4. Research: Consumer and network focus


J. Grenn


A Schrank

Great Lakes
AQUACULTURE
Collaborative

From GLAC advisory group members:

- *"Love this group!"*
- *"I truly appreciate the good work Sea Grant is doing! I see it of vital importance."*
- *"I value what you are doing."*

GLAC events:

- *"Thanks so much for bringing this symposium to us, the industry needs more of these."*
- *"This was so incredibly well put together. I learned so much and I appreciated all the panels."*

Questions?

Building capacity of land-based Atlantic salmon aquaculture in the US-MDSG

Y. Zohar, C. Frederick, J. Stubblefield, S. Knoche, G. Fischer, E. Wiermaa, A. Place, K. Sowers, K. Saito, T-T. Wong, B. Vinci, C. Good, W. Hubbard, J.A. Frederick, R. Jagus, C. Hartleb, D. Bouchard, B. Peterson, C. Bartlett, S. Summerfelt, B Gottsacker, J. Mitchell, J. Fortier, C. Hlubb, B. Keleher, J. Trushenski, J. LaChance, K. Ritchie, F. Moser

Recirculating Aquaculture Salmon Network (RAS-N)

Building Capacity of Atlantic Salmon Production in the U.S.

Yonathan Zohar and Catherine Frederick
University of Maryland and
Institute of Marine and Environmental Technology (IMET)
and many others…

RAS-N

Recirculating
Aquaculture
Salmon Network

Sustainable • Innovative

Recirculating Aquaculture Salmon Network (RAS-N)

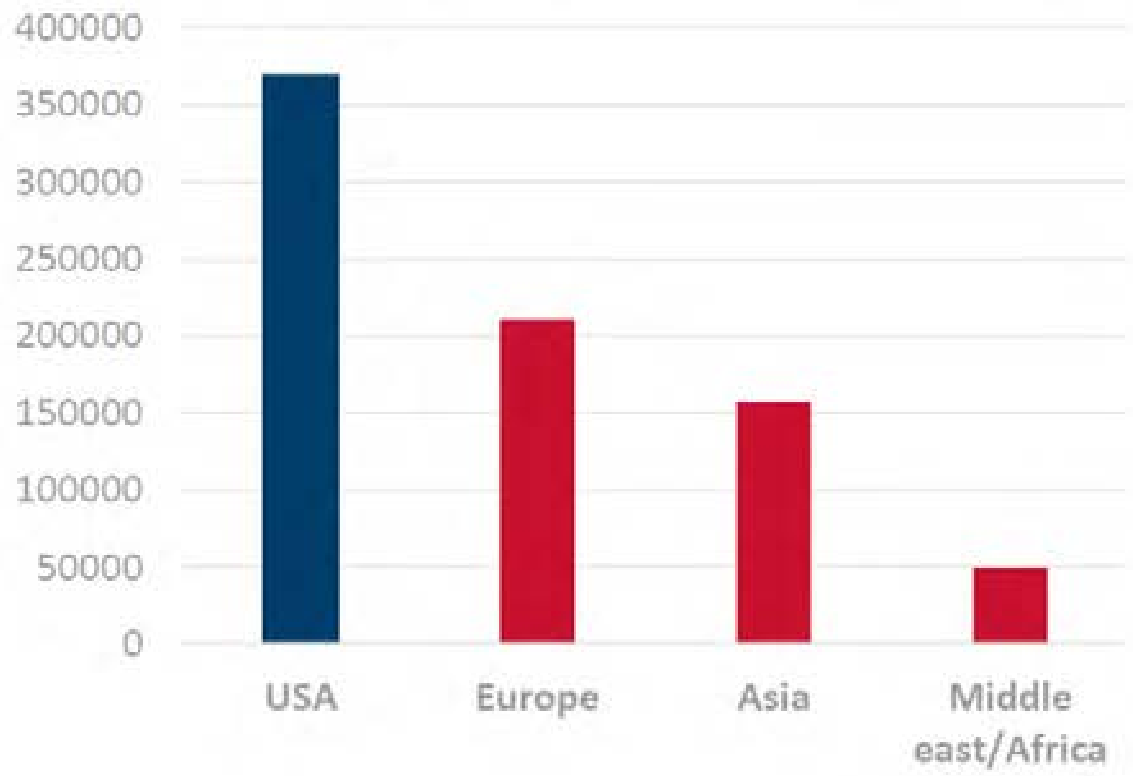
Background

- >90% of salmon consumed in the US (~500,000 tons) come from overseas, at a value of ~$3.2 B (20% of seafood trade deficit)
- >$ 3 billion investment in land-based Atlantic salmon production in the US
- Covid accelerated interest in local, safe, land-based production
- Maine, Florida, Virginia, Wisconsin, Indiana, Ohio, Texas, New-York, Washington, California, Maryland, Nevada

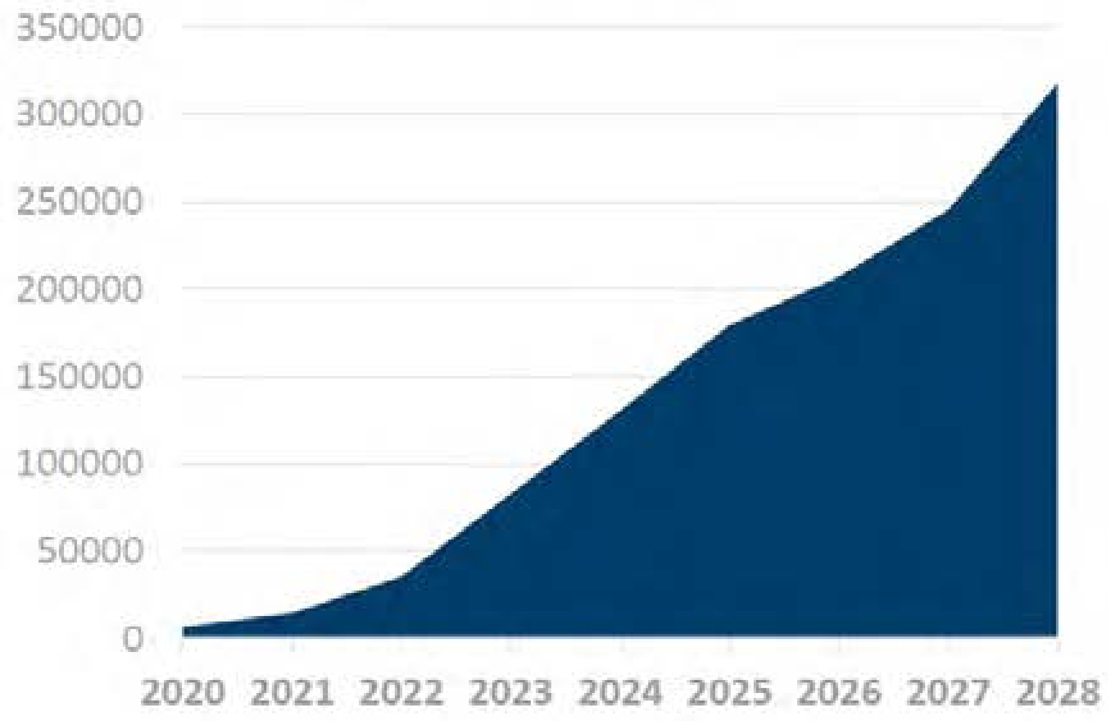
RAS-N

Projected Land Based Salmon Production

Global Proposed Volume, MT



USA Production Trend, MT



SKRETTING
a Nutreco company

Overall Goal of RAS-N

- Establish a national, public-private holistic and collaborative hub of knowledge

- Build capacity for the land-based Atlantic salmon sector towards successful
  - Growth
  - Stability
  - Environmental compatibility
  - Economic feasibility

Recirculating Aquaculture Salmon Network (RAS-N)

Specific Objectives

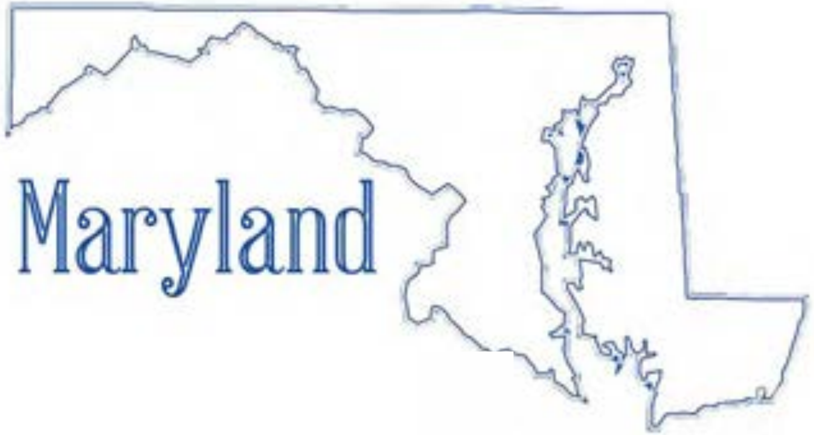
1. Engage stakeholders, solicit input
2. Identify gaps and barriers, prioritize R&D and other areas to address them
3. Develop a White/Concept Paper
4. Economic analysis and feasibility
5. Education, Career & Workforce Development (ECWFD)
6. Extension and technology transfer
7. Demonstrate technology (R&D) and hands-on training projects

RAS-N

Building Capacity of Atlantic Salmon Production in the U.S.:

A national Public-Private-Federal Partnership

IMET
Institute of Marine and Environmental Technology
UMBC
University of Maryland Extension
Sea Grant
The Conservation Fund
Freshwater Institute
Sea Grant Maryland
RAS-N
Morgan State University
Salmo

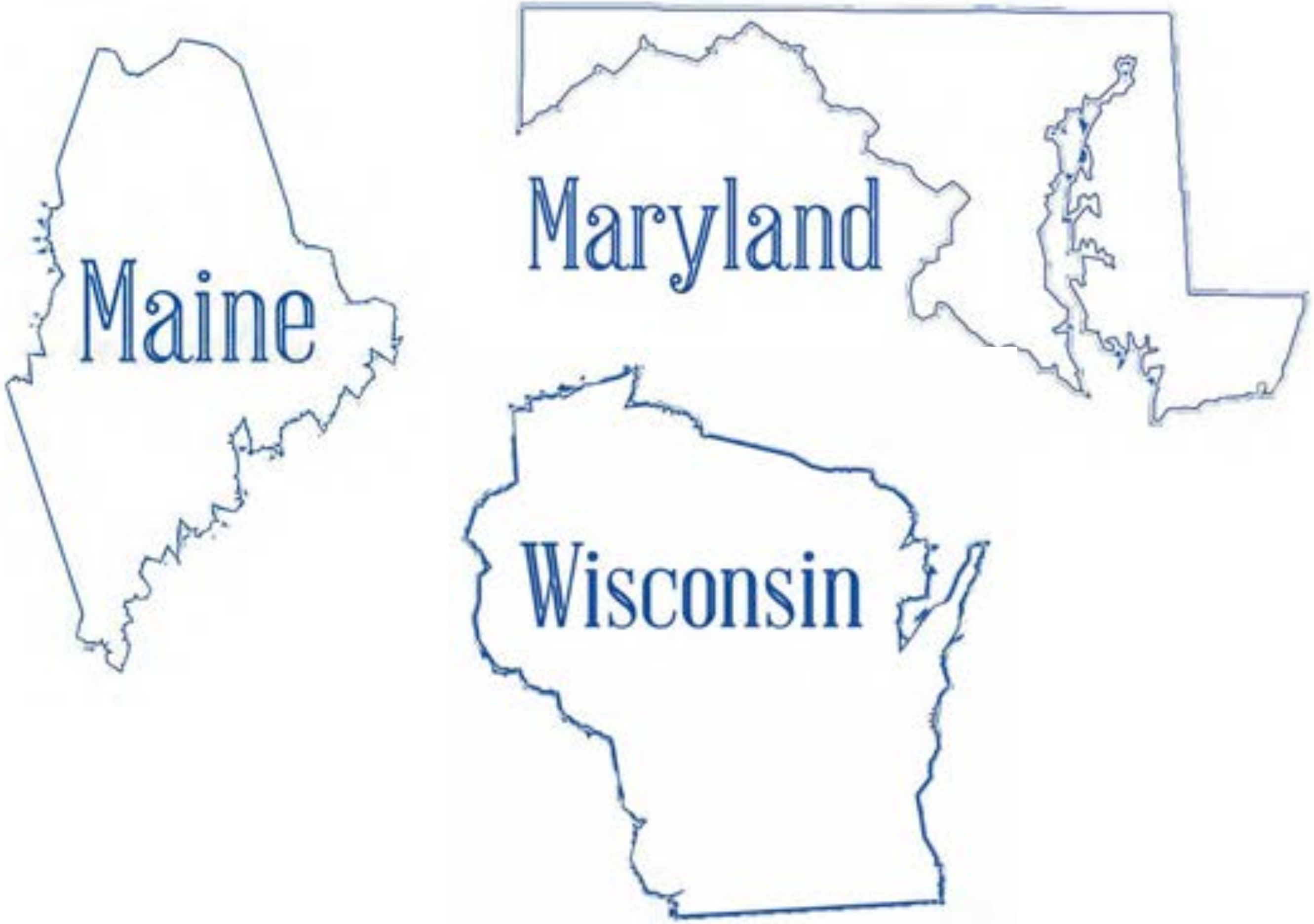


Building Capacity of Atlantic Salmon Production in the U.S.:

A national Public-Private-Federal Partnership

Building Capacity of Atlantic Salmon Production in the U.S.:

A national Public-Private-Federal Partnership



Building Capacity of Atlantic Salmon Production in the U.S.:
A national Public-Private-Federal Partnership

We've Added Partners

INNOVASEA

AquaCon™

Benchmark Genetics

SKRETTING
a Nutreco company

Our Supporters

NORDIC AQUAFARMS
SUSTAINABLE AQUACULTURE

Exciton Clean
WATER TREATMENT

BioMar

ATLANTIC SAPPHIRE®

RAS-N to enable/'spawn' future projects

RAS-N

RECIRCULATING AQUACULTURE SALMON NETWORK

Sustainable • Innovative

Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS^2)

RAS-N

RECIRCULATING
AQUACULTURE
SALMON NETWORK

Sustainable • Innovative

SAS^2

Sustainable Aquaculture Systems
Supporting Atlantic Salmon

$10M, 5-year funding from USDA/NIFA for national program

RAS-N Mantra: Engage with Industry Stakeholders

Research and Industry Updates

Stakeholder Sessions, Panels and Surveys

Panels on Areas of Priority

Education Needs and Programming

Also: WAS and other meetings

2nd Annual RAS-N Workshop (October 8-9, 2020*)

Hosted by the Institute of Marine and Environmental Technology (IMET) and Maryland Sea Grant

Workshop Registration: https://bit.ly/RASNWorkshop2020

**All times are Eastern Standard Time (EST)*

Wednesday October 7th

6:30PM – 7:30PM: Virtual Social Hour (Register for Social Hour: https://bit.ly/RAS-NSocialHour)

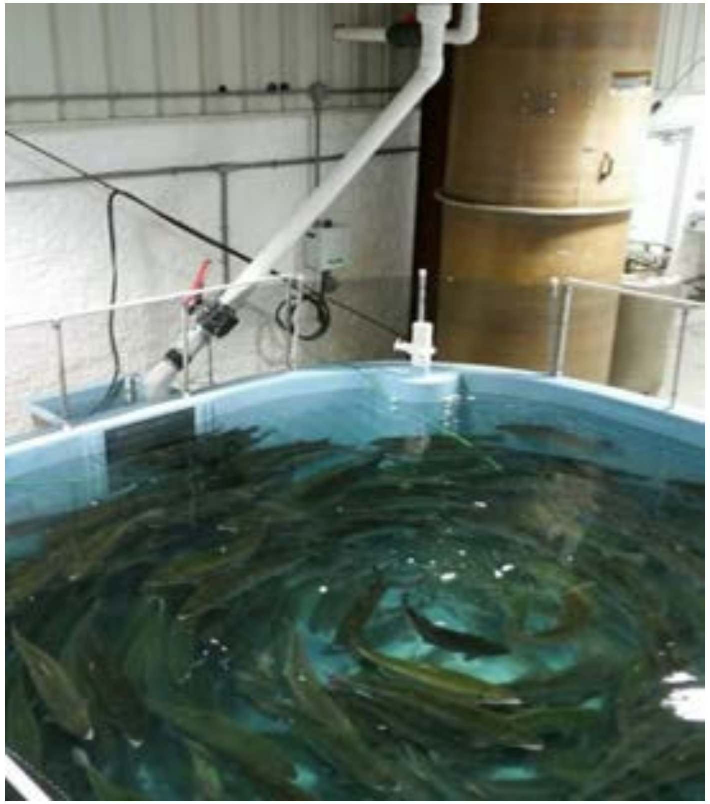
Thursday October 8th

10:00AM – 10:01AM: Call to Order – Yoni Zohar (IMET, MD)

10:01AM – 10:05AM: Welcome – Russell Hill (IMET - University of Maryland, MD)

Off-flavor Research at the Freshwater Institute

- **Develop and refine SOPs to optimize depuration**
- **Two peer-reviewed articles (2020-21) and trade press publications resulted from Sea Grant-funded work**
- **Freshwater Institute and IMET have also developed research (USDA-NIFA) to help the salmon RAS industry tackle this important challenge**



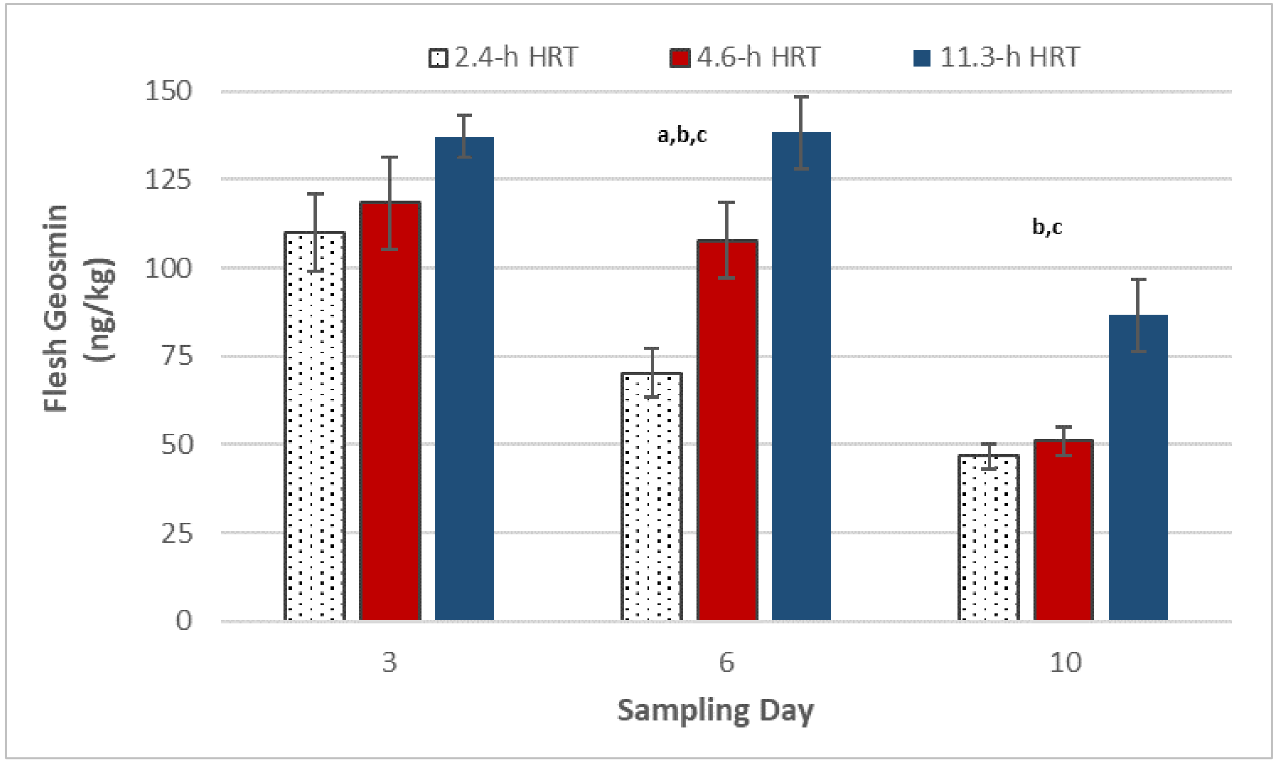


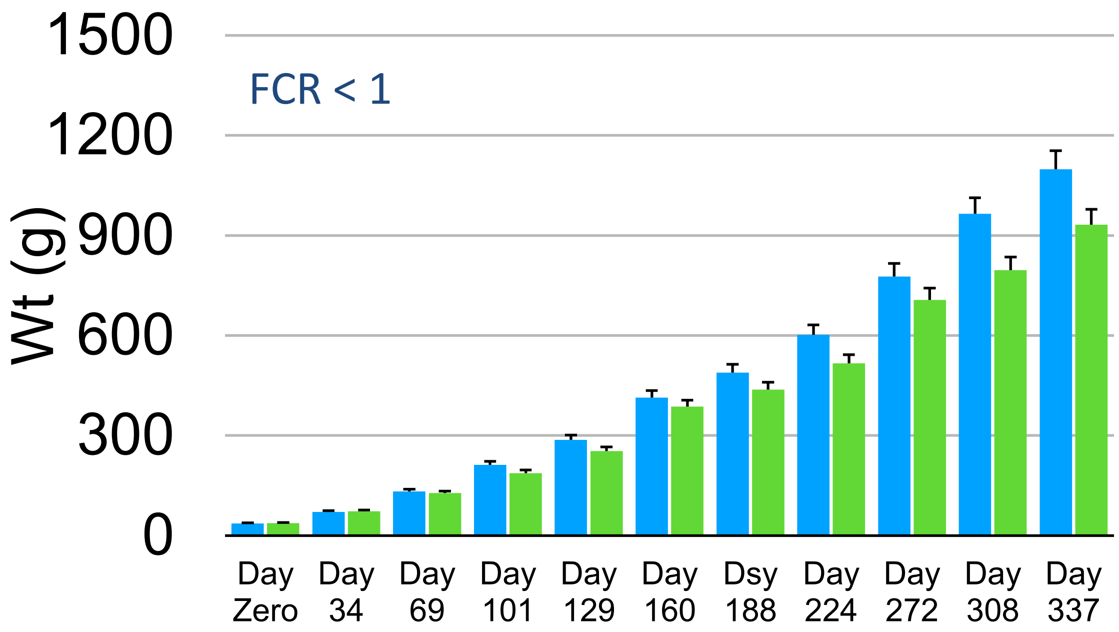
Figure courtesy Davidson et al. (2020). Aquacult. Eng. 90, 102104

John Davidson, CFFI

Atlantic Salmon Alternative RAS Feeds

Insect Digestibility:

Protein 89% ± 3.84
Lipids 92% ± 3.84



Superworms: *Zophobas morio*

Allen Place, IMET, in collaboration with Skretting

Converting RAS Organic Waste to Fuel Grade Methane (Biogas)

Kevin Sowers and Keiko Saito, IMET

Converting RAS Organic Waste to Fuel Grade Methane (Biogas)

Kevin Sowers and Keiko Saito, IMET

Stochastic Economic Simulation Model

Exploring the economics of RAS Atlantic salmon production from egg to market in the U.S.

- **Key Model Inputs:** Operating and capital costs for hypothetical 5,000MT facility (based on an industry survey)
- **Accounting for Uncertainty:** in key production parameters (e.g., feed; mortality) and market parameters (e.g., head-on gutted price)
- **Key Deliverable:** Obtain ten-year Net Present Value (NPV) for hypothetical 5,000MT facility

Scott Knoche and Kaitlynn Ritchie, MSU

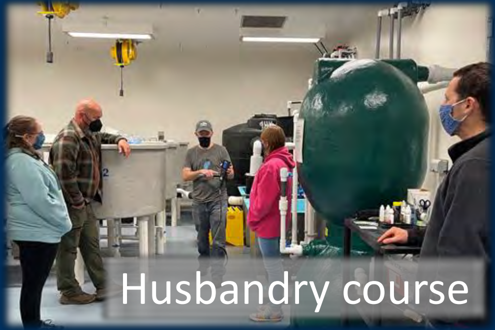
The University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility

Outreach, Education and Workforce Development Program Includes:

- K-12 education initiatives – incorporate aquaculture into the classroom
- Virtual tours and presentations showcasing facility, species, systems, and projects
- Interactive technical or educational demonstration tours for all audiences
- UWSP Aquaculture Minor and Aquaponics Certificate Program
- Intensive apprenticeships & internship training programs with nearly 100% job placement rating into the industry.

Emma Wiermaa, UW-SP NADF

1. Experiential Courses for All Learners



2. Industry Partnered Internship Program

Interns work within a wide diversity of aquaculture organizations learning skills sets desired by the industry

AQUACULTURE RESEARCH INSTITUTE

3. UMaine Aquaculture Micro-Credentials

Prepare

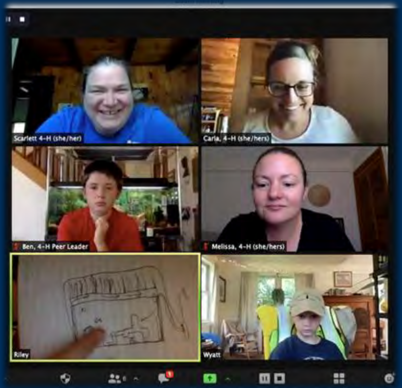
Train

Apply

Earn

4. 4-H Aquaponics Program

Virtual program that allows youth to design, build and maintain their own aquaponics system at home



Scarlett Tudor, UMaine

THE UNIVERSITY OF MAINE Cooperative Extension

Maryland Sea Grant and University of Maryland Extension

Aquaculture in Action

TOOLS FOR TEACHING SCIENCE

- Uses aquaculture to provide K-12 learning opportunities meeting science education standards
- Student-Driven Science

Aquaculture in the classroom
(Biology, Chemistry, Physics)

Teacher Professional Development Workshops

Sea Grant Maryland

IMET

Adam Frederick, MDSG

RAS-N Extension: Develop a White Paper (now Concept Paper)

Building Capacity of Land-based Atlantic Salmon (*Salmo salar*) Aquaculture in the United States

Prepared by

The Recirculating Aquaculture Salmon Network (RAS-N)
A National Sea Grant-funded Private-Public Network

October 2021

RAS-N

RECIRCULATING AQUACULTURE SALMON NETWORK

Sustainable • Innovative

Recirculating Aquaculture Salmon Network (RAS-N)

Delivering on objectives- Targeted Working Groups

Research and Development

Brian Peterson
(USDA-ARS)

Economics

Scott Knoche
(Morgan State)

ECWFD

Adam Frederick
(MDSG) and M.S.
Tudor (UMaine)

Extension

Bill Hubbard
(UMD)

Communications

Jennifer Smith
(WISG)

Website Development

PMT and WISG

Recirculating Aquaculture Salmon Network (RAS-N)

Delivering on objectives- Targeted Working Groups

Research and Development

Brian Peterson
(USDA-ARS)

Ecor mics

ECWFD

and M.S.
r (UMaine)

<u>34 Individuals from:</u>
6 Industry Partners
2 USDA Agencies
NOAA
3 Sea Grant Programs
1 non-profit
5 Universities

Extensi

ions

Website Development

Bill Hubbard
(UMD)

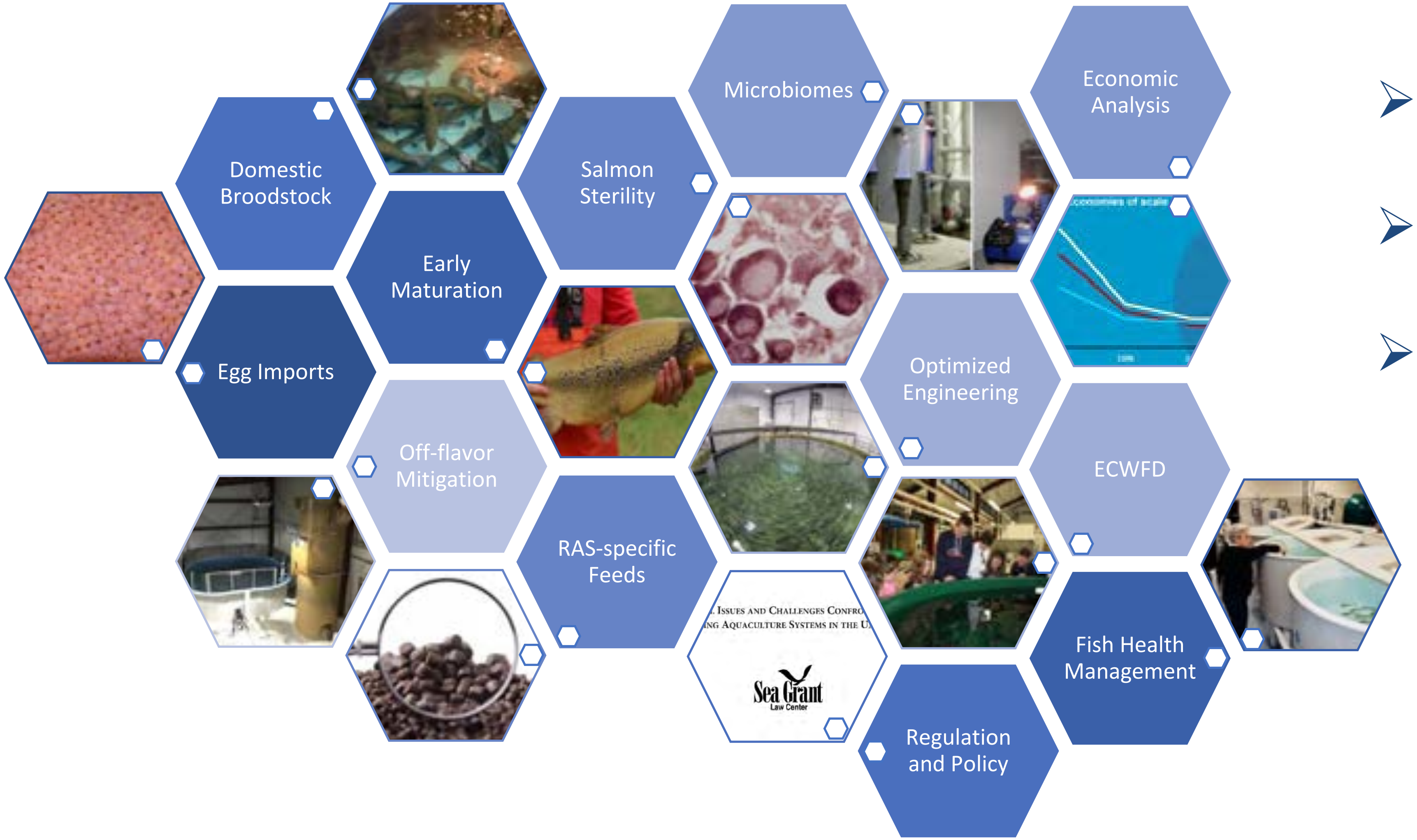
Jennifer Smith
(WISG)

PMT and WISG

RAS-N

RAS-N Extension: Develop a White Paper (now Concept Paper)

Involved Work Groups: R&D, ECWFD, Extension, and Economic



- **28 Contributors**
- **15 Organizations/Companies**
- **20 Pages**
  - **State of Supply and Production Practices**
  - **Needs/Barriers**
    - ✓ **Challenges**
    - ✓ **Potential Solutions**

RAS-N Extension: Concept Paper Status

Winter 2019
Stakeholder Workshop to Outline Topics

Spring 2020
Form Working Groups Around Topics

Summer 2020
Generating Content for Concept Paper

Fall & Winter 2020
Compiling Concept Paper and Meetings

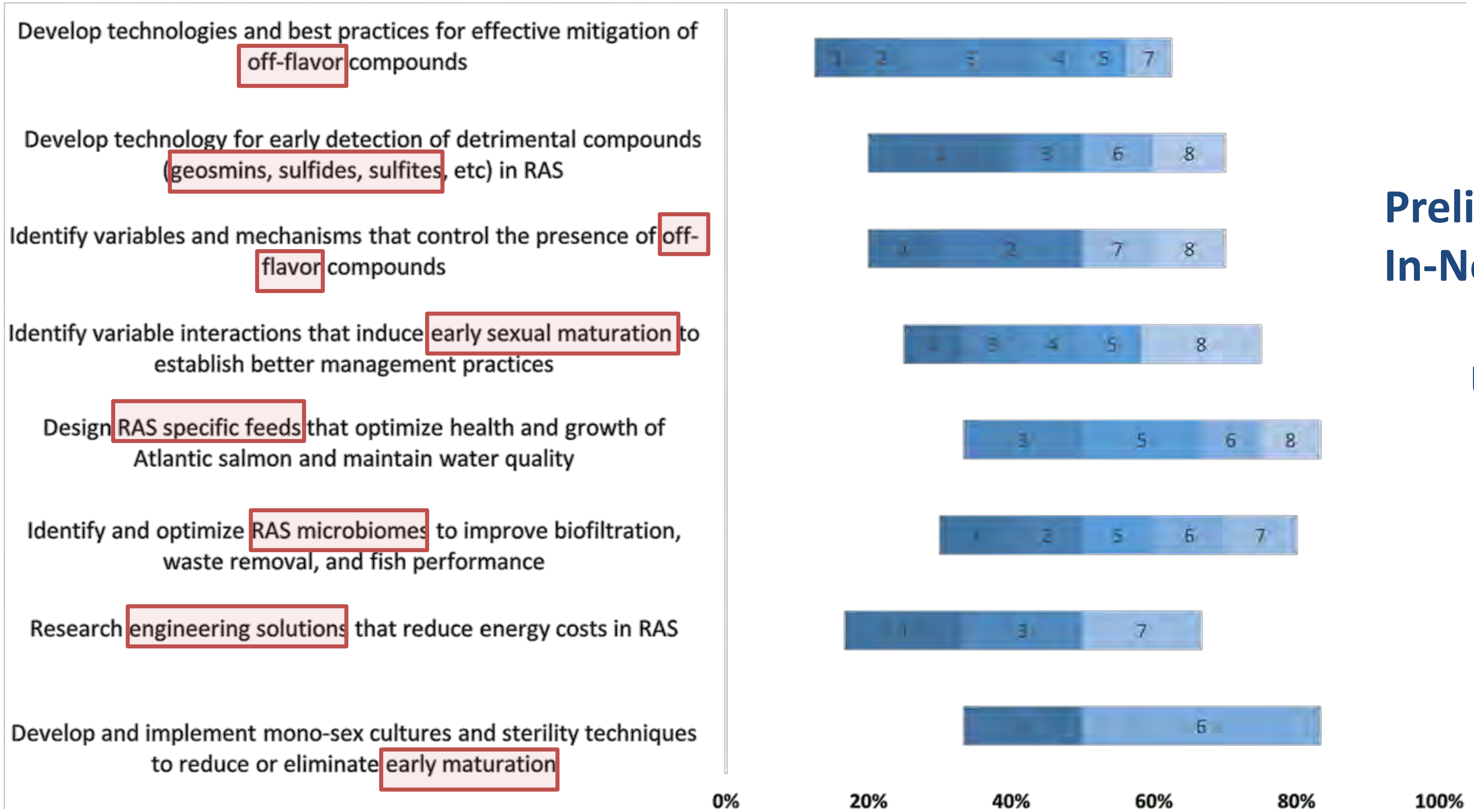
Spring & Summer 2021
Editing and 1st Round of Sharing w/ Chairs of Working Groups

Summer & Fall 2021
Editing and 2nd Round of Sharing w/ Sea Grant Leadership

In Progress
Editing and Final Round of Sharing w/ External Advisory Panel

RAS-N Extension: Survey of Salmon RAS Priorities

Involved Work Groups: Extension and Research



Preliminary Results of 12 In-Network Respondents

Updated Results coming soon

RAS-N Extension: Website for Outreach and Information Sharing

Involved Work Groups: Web Development w/ PMT and Communications

Institute of Marine and Environmental Technology

John Stubblefield

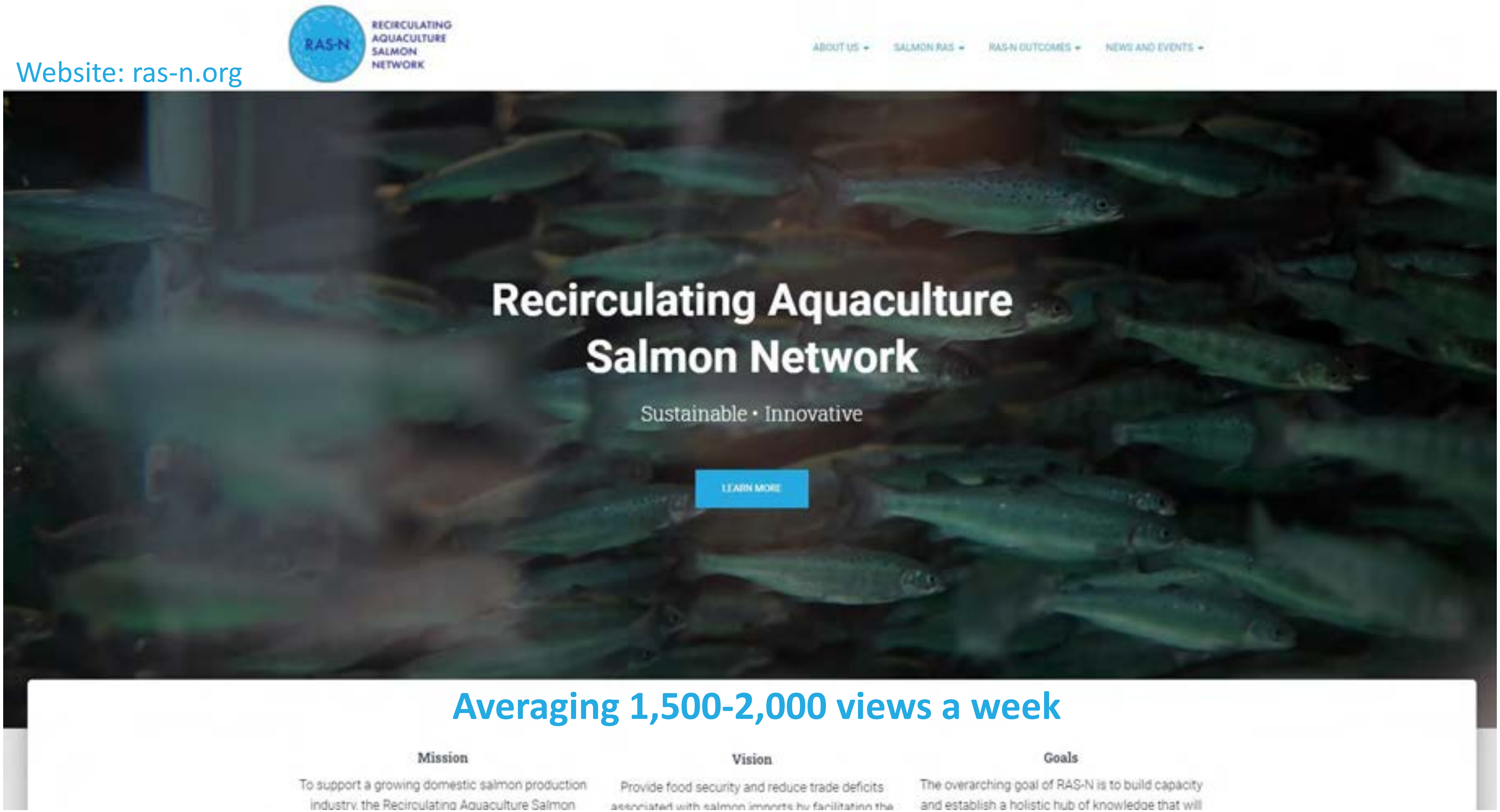
Emma Wiermaa

Jennifer Smith
Tom Xiong (not pictured)

Lisa Tossey

RAS-N Extension: Website for Outreach and Information Sharing

Website: ras-n.org



Averaging 1,500-2,000 views a week

RAS-N Extension: Communicating Information with Targeted Audiences

RAS-N

RECIRCULATING AQUACULTURE SALMON NETWORK
Building Capacity for Land Based Salmon Aquaculture in the US

Summary of RAS-N land-based salmon stakeholder priorities

Background and Rationale

The US faces a significant and growing seafood trade deficit ($16.8B in 2018; NOAA Current Fisheries Statistics, 2019) with nearly 90% of consumed seafood originating from abroad and over 50% of products coming from foreign aquaculture (NOAA Office of Aquaculture, 2020). Furthermore, many importing countries do not possess regulatory frameworks that meet US standards. Atlantic salmon consumption has risen in the US over the last decade at about 7-10% per year and currently is at a level of 493,000 tons annually. To meet consumer demands, Atlantic salmon imports to the US have grown in parallel to a record of 470,000 tons in 2018 valued at $3.4 billion (US-DOC, 2018). Domestic production of Atlantic salmon accounts for only ~ 4% of US consumption (NOAA-NMFS, 2017) and is confined to a relatively small industry off the coasts of Maine and Washington; however Atlantic salmon production in ocean cages in Washington has been banned by state legislation after their current permits expire. These staggering statistics mean that ~ 96% of consumed Atlantic salmon is imported, contributing over 20% to the $16.8 billion US trade deficit in edible seafood. Thus, there is an urgent need and opportunity to promote domestic aquaculture development and increase Atlantic salmon production in the US.

Benefits of the emerging land-based salmon industry to US seafood production, national food security and local economic development

The current strategy for supporting the future growth of US aquaculture production relies on the

Maryland-led Land-based Salmon Aquaculture Advancement

The Recirculating Aquaculture Salmon Network (RAS-N), funded by the National Sea Grant College Program, co-led by the University of Maryland Baltimore County and Maryland Sea Grant, and in collaboration with Maine and Wisconsin Sea Grants, supports the growing domestic Atlantic salmon production industry.

This national network of scientists, economists, educators, and industry experts are working together to advance land-based salmon aquaculture technology and create a clear, national action plan to meet economic, environmental, and community goals. In the first year of work this network has:

- Identified industry barriers and research needs for expanding successful land-based salmon aquaculture
- Completed first steps in creating an economic model to predict RAS economic feasibility
- Expanded our network to include several more domestic and international industry partners.
- Defined levels of public engagement and avenues for recruitment of skilled personnel.
- Drafted a policy paper "*Building Capacity of Land-based Atlantic Salmon Aquaculture in the United States.*"

Building Maryland Capacity in Land Based Aquaculture

Land-based farming is considered a more sustainable way to produce Atlantic salmon and is identified by Monterey Bay Aquarium's Seafood Watch as a Best Choice (green). A land-based salmon aquaculture farm

Reuses 90-99.9% of water. In Maryland, we will reuse over 99.9% of water.

Moves production close to markets, which lowers costs, reduces footprint, and provides product transparency.

Brings jobs and career opportunities to rural Maryland

Reduces pollution discharge and recovers nutrients by controlling and treating fish waste.

Creates opportunity to convert aqua-

Grows fish in fully contained rearing

October 8-9, 2020: Second Annual RAS-N Workshop (virtual meeting)

Institute of Marine and Environmental Technology (IMET), Baltimore, Maryland

+ Program and Welcome

+ Plenary presentations

– Off-flavor and Mitigation updates

Off-Flavor & Mitigation: Industry Perspective - Steve Summerfelt, Superior Fresh

Exciton Technology for Removing Geosmin- Jack Holland, Exciton Clean

RAS-N Extension: Collaboration Efforts for Traditional Extension Products

THE CONSERVATION FUND
FRESHWATER INSTITUTE

1865 THE UNIVERSITY OF MAINE

UNIVERSITY OF MARYLAND EXTENSION

Kata Sharrer (not pictured)

Laura Rickard

(including SAS2 efforts)

Allen Patillo

Recirculating Aquaculture Salmon Network (RAS-N)
A Final Deliverable: Road Map/Strategic Plan

An extensive analysis of the status of the industry, projected growth, biological and technological gaps, R&D priorities, mechanisms to promote public-private partnerships.

Help policymakers, federal and state agencies and industry identify and responsibly allocate resources to promote an economically feasible and environmentally sustainable land-based Atlantic salmon industry in the US.

RAS-N

RAS-N Hub Aquaculture Roadmap:
Addressing NSGO, NOAA and U.S. Goals & Policies

- NSGO
    - Stakeholder partners: academia, industry, government, consumers
    - Sea Grant partners (MD, ME, WI)
    - Integrate Sea Grant extension, communications and education networks
- NOAA- national marine and economic policy goals
    - Increasing sustainable marine aquaculture
    - Workforce development
    - Increasing diversity in marine science
- U.S. federal policy goals:
    - Sustainable seafood production
    - Reducing pressure on wild fisheries
    - Climate change mitigation and adaptation
- Congress's goal: Increase U.S. aquaculture production

RAS-N

RECIRCULATING AQUACULTURE SALMON NETWORK

Sustainable • Innovative

Fredrika Moser, MDSG, co-Lead PI

Our Network Welcomes Questions and Insights

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