University of New Hampshire
Center for Sustainable Seafood Systems

Dauphin Island Sea Lab
Alabama Center for Marine Education and Research

Gulf States Marine Fisheries Commission

The University of Southern Mississippi

Sea Grant Mississippi-Alabama

Community-Scale Integrated Multi-Trophic Aquaculture in New Hampshire

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University of New Hampshire

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Kittery, ME

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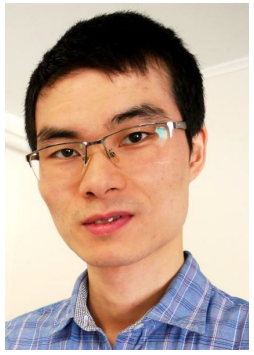
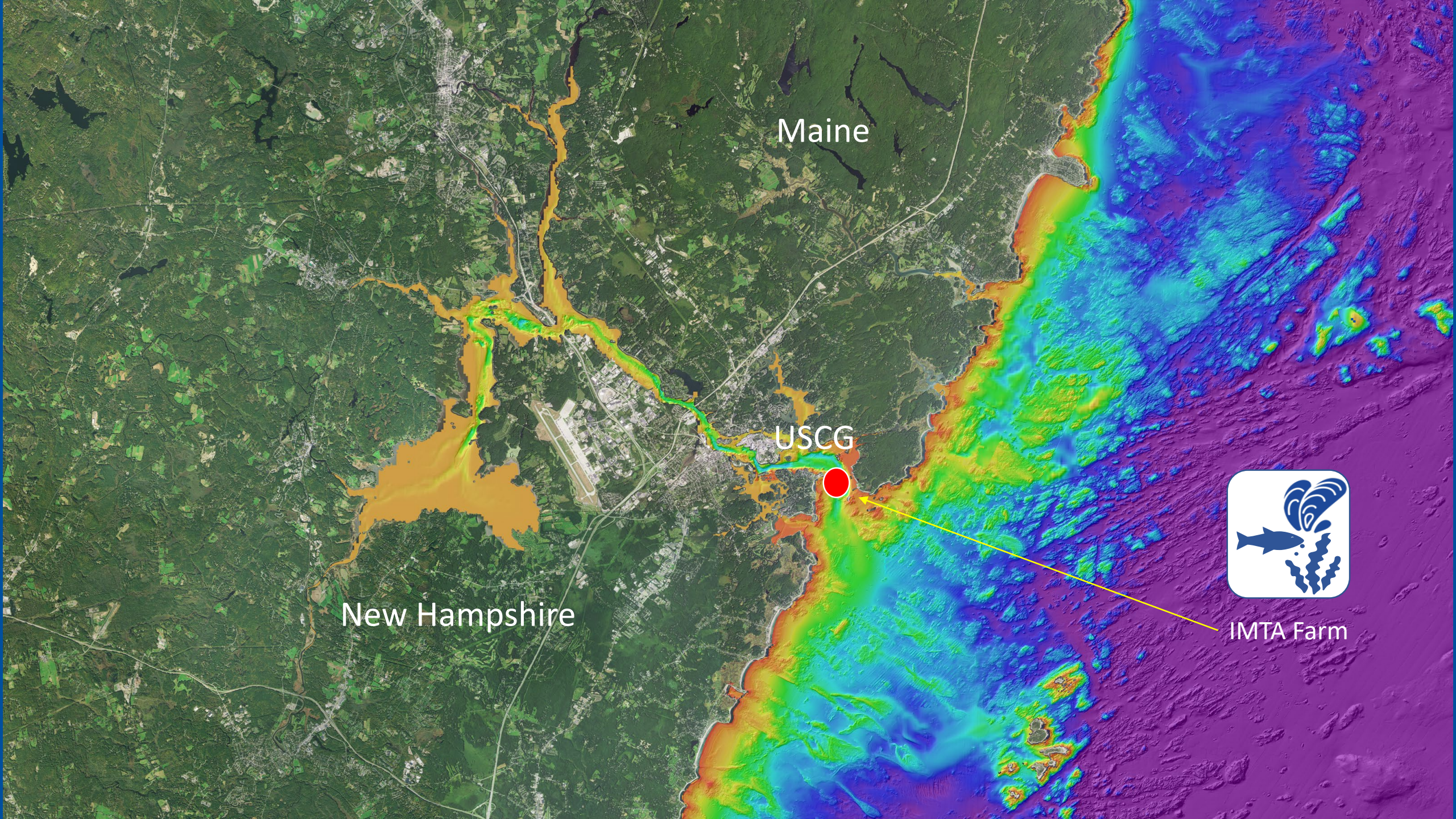
Research Project Engineer
Sustainable Seafood Systems



Longhuan Zhu
Research Scientist
Sustainable Seafood Systems

Ward Byne
F/V Sugar Daddy
Portsmouth, NH

Stephen Jones
Research Associate Professor
NH Sea Grant, Seafood Safety


Maine
USCG
New Hampshire
IMTA Farm

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Operations

School of Marine Science and Ocean Engineering
Judd Gregg – Marine Research Complex
New Castle, NH

R/V Tego (Abenaki for “wave”)

- Vessel built by Lyman-Morse in ME.
- 33’ length
- Twin 250hp outboard motors
- 1 ton capacity
- Capacity up to 10 passengers

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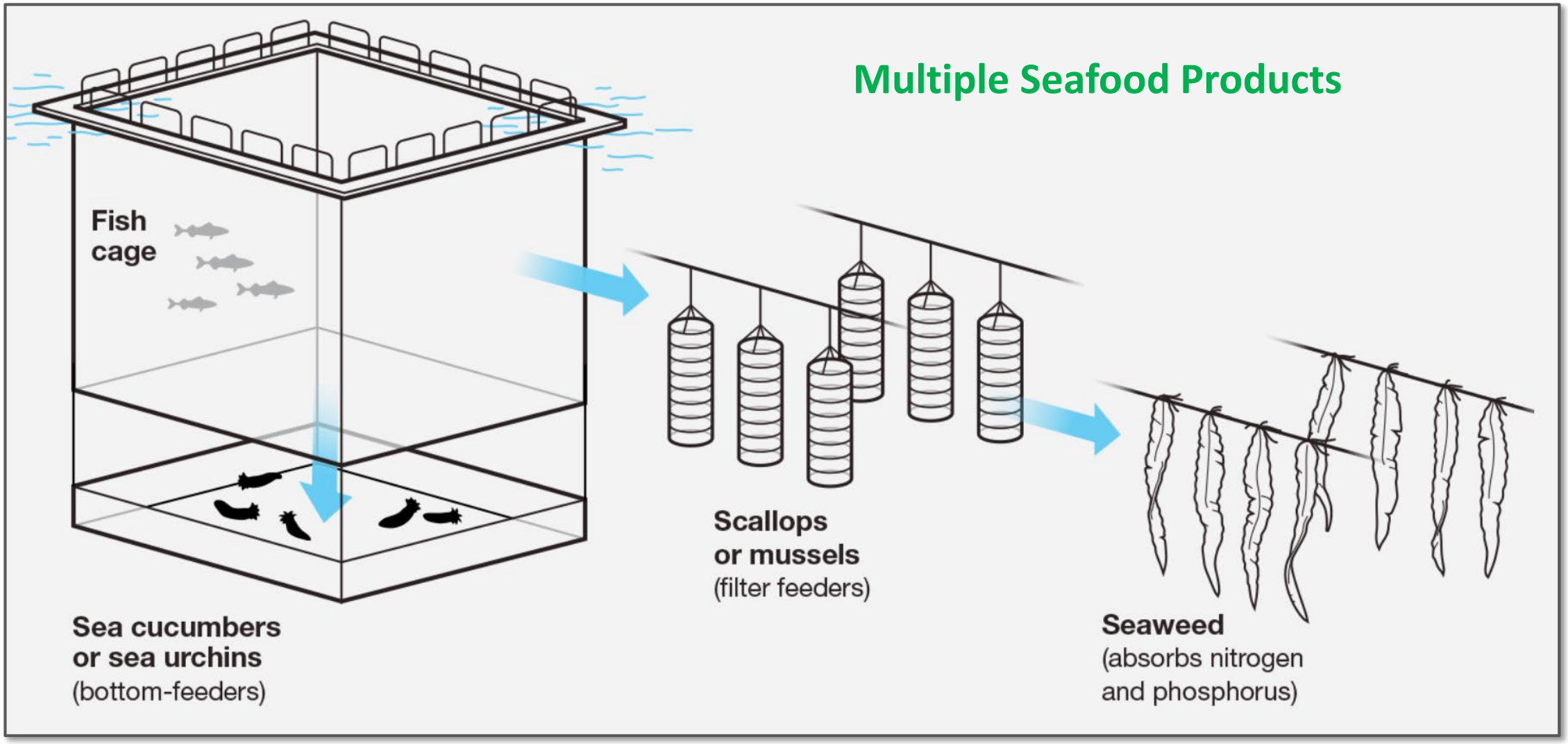
What is Integrated Multi-Trophic Aquaculture



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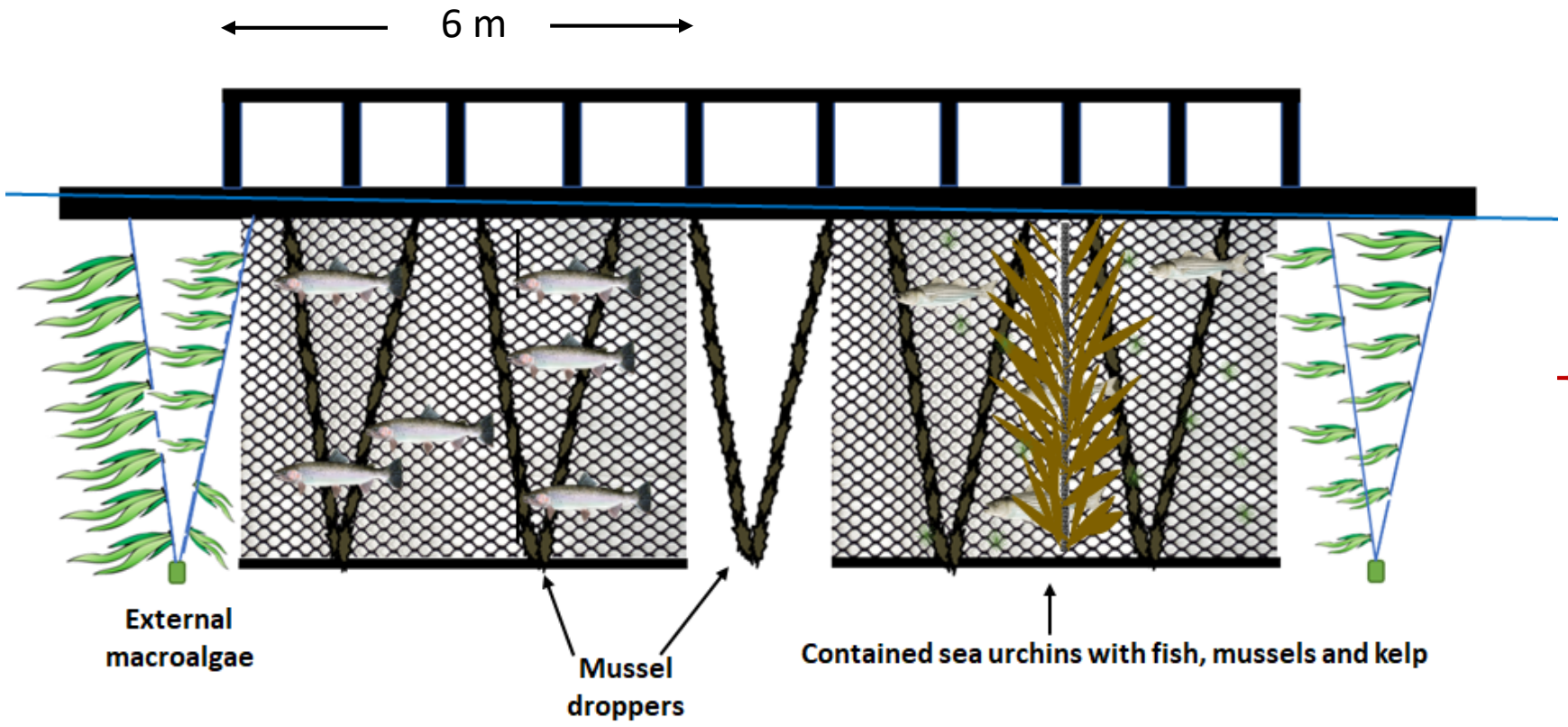
New Hampshire IMTA: Steelhead Trout, Blue Mussels and Sugar Kelp



Steelhead trout (Oncorhynchus mykiss)

4000 trout

Blue mussels (Mytilus edulis)

72 m of mussel droppers

Sugar kelp (Saccharina latissima)

28+ m of kelp line

Potential IMTA species

Fed

Finfish
- Steelhead trout (colder)
- Striped bass (warmer)

Extractive

Echinoderms
- Green urchin
- Sea cucumber

Shellfish
- Mussels
- Scallops
- Oysters
- Clams

Macroalgae
- Brown
- Red
- Green

Mass Balance

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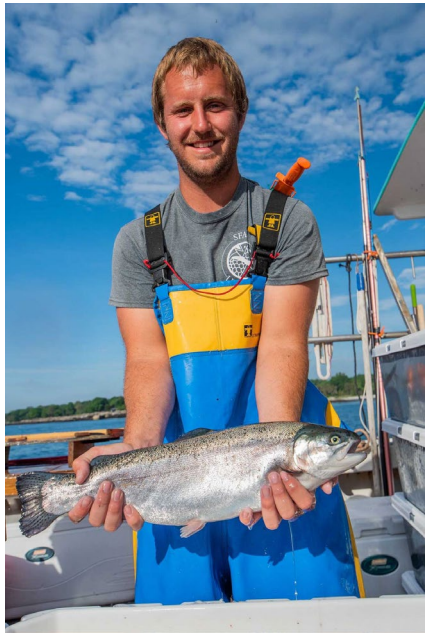
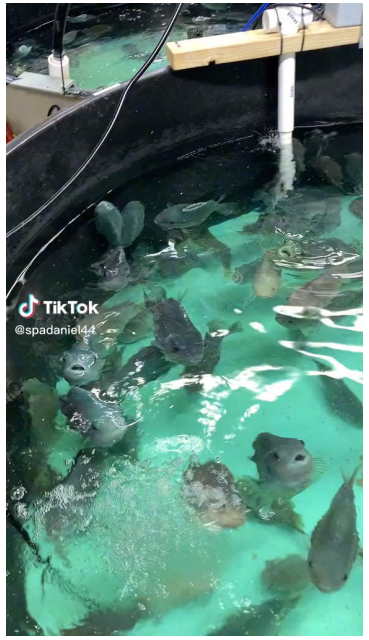
Species we are Permitted to Culture

Steelhead trout



Lumpfish



Blue mussels

Sugar kelp (brown)

Dulse (red)

Nori (red)

Sea lettuce (green)

Oysters

Sea Scallops

Green sea urchins

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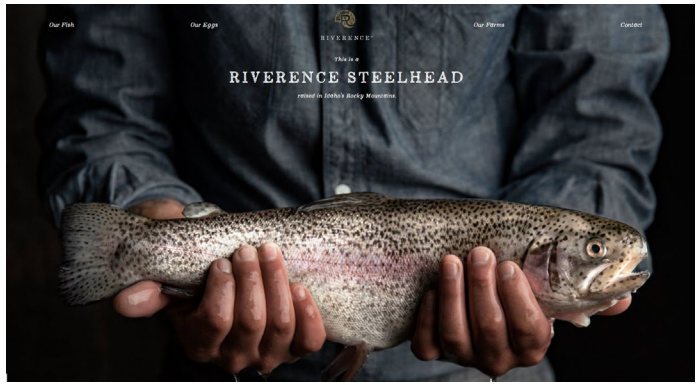
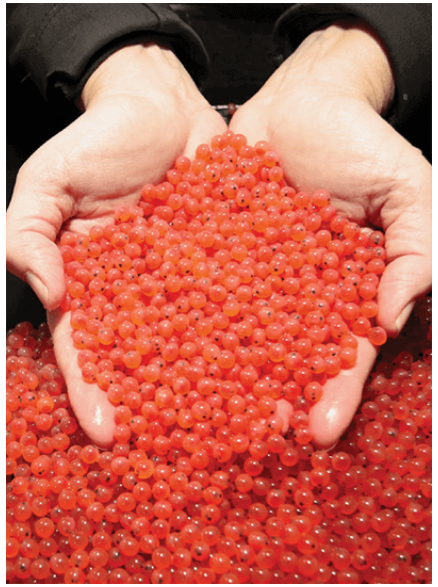
The steelhead trout process

Riverence Steelhead
Washington State, USA





Sumner Brook Fish Farm
Ossipee NH, USA

University of New Hampshire
New Castle NH, USA

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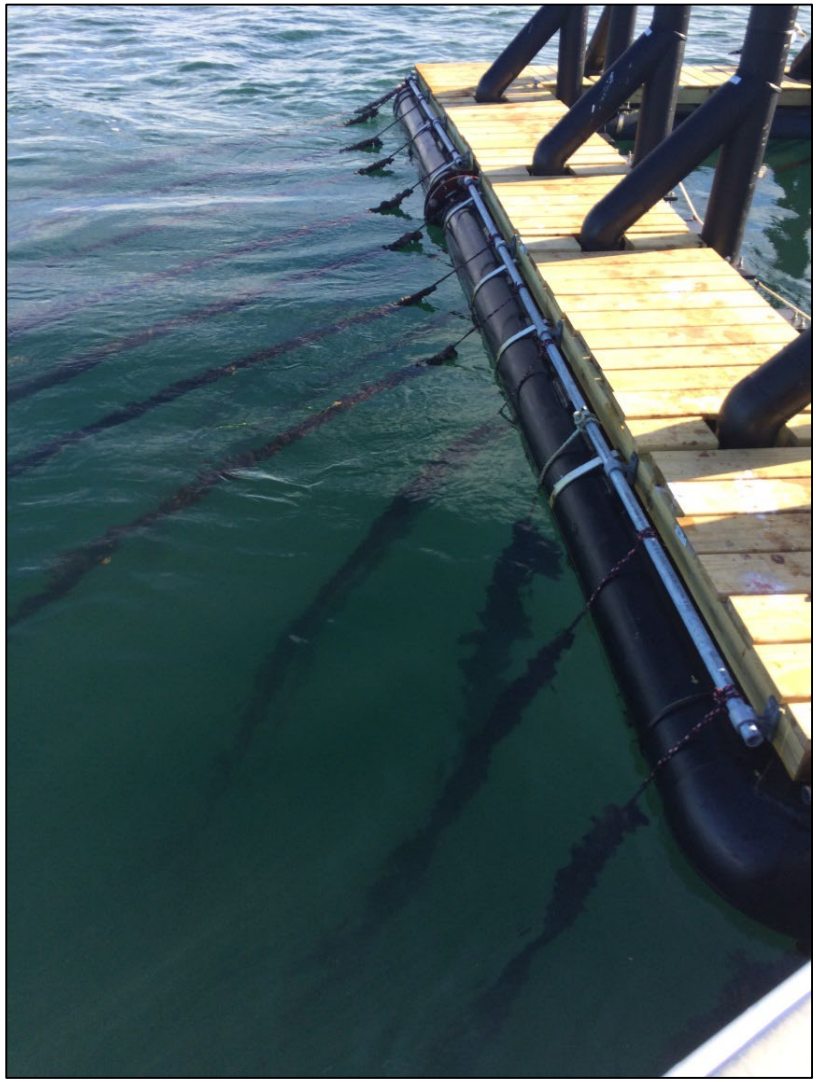
Mussel Settlement and Growout

- *Mytilus edulis* spawn twice /year
- Seed naturally settles onto substrate - dropper lines suspended around the cage platform.
- Fuzzy rope acquired from NZ
- Approximately 75, 000 seed collected/m of line.



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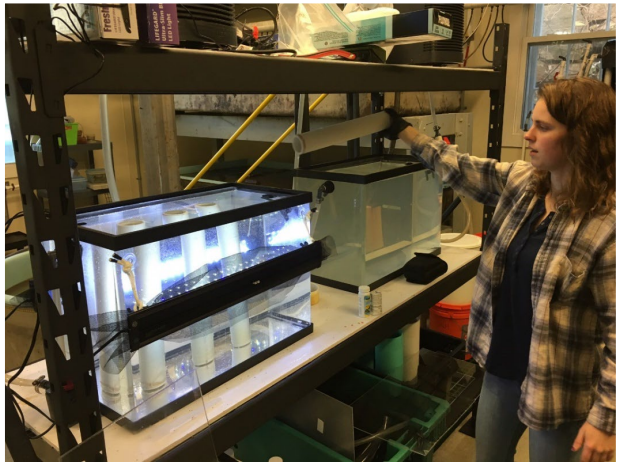
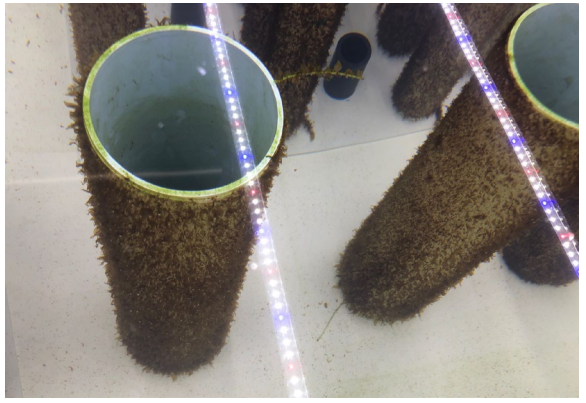
Seaweed Settlement and Growout





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Environmental Monitoring Protocol

1. Sampling of the farm site three times throughout the trout production cycle.
2. Sampling occurred before fish transfer, mid point of production cycle and at initial harvest.
3. Water quality :
    - Temperature
    - DO
    - pH
    - Current speed
    - Salinity
    - Ammonia
    - Nitrite
    - Nitrate
    - Current direction
4. Benthic sampling
5. Video sampling
6. Annual reporting to EPA, NH Fish & Game, NH Dept. of Environmental Services.

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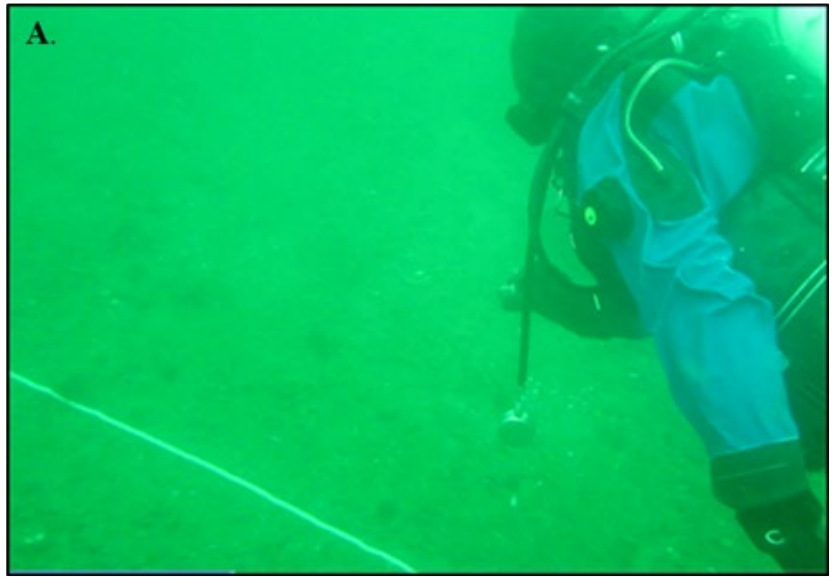
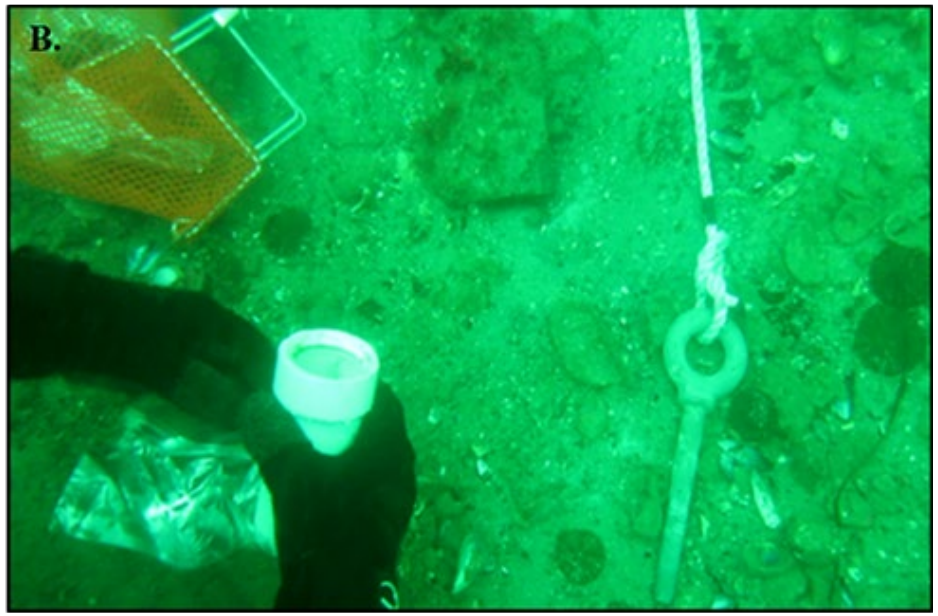
Video and Benthic Sampling



Diver with a Go Pro™ underwater camera

- 30 m bottom transect
- Video taken along the entire transect
- Sediment samples taken:
  - underneath the cage
  - 15 m up current
  - 15 m down current



Sediment samples are Frozen for 1 year and used for further analysis if desired by NHFG

Sediment sampling with a PVC pipe and cap (5 cm x 10 cm)

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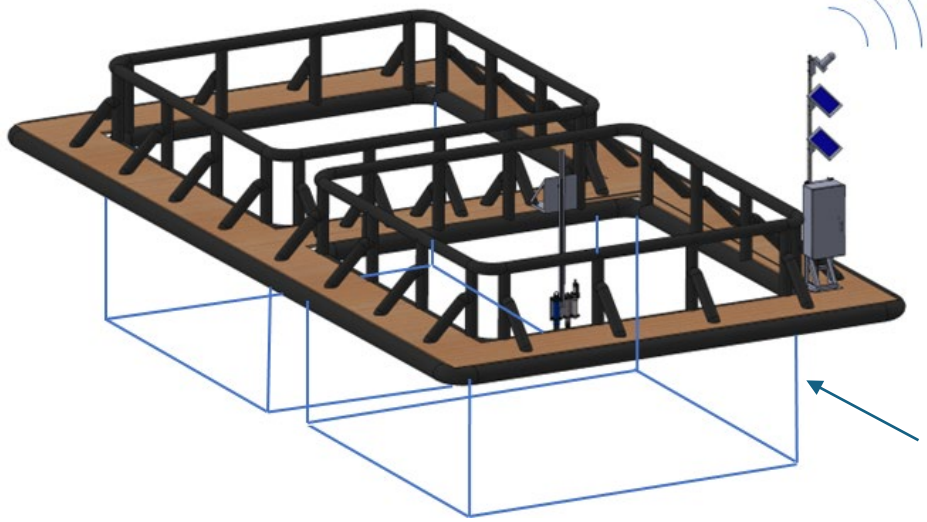
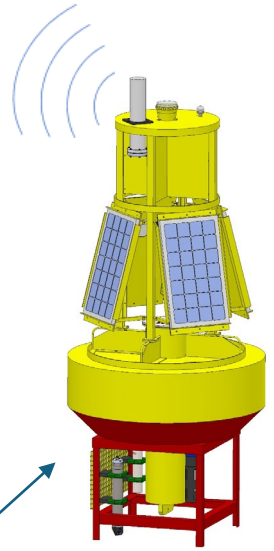
Quantify environmental interactions

Instruments both internal and external to the IMTA system

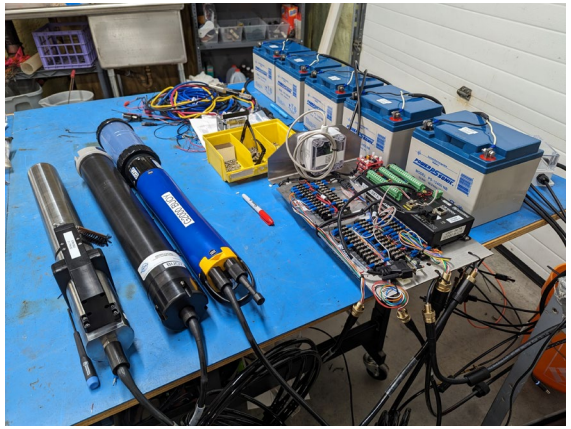


Telemetry to shore

Solar Power



Measured Parameters

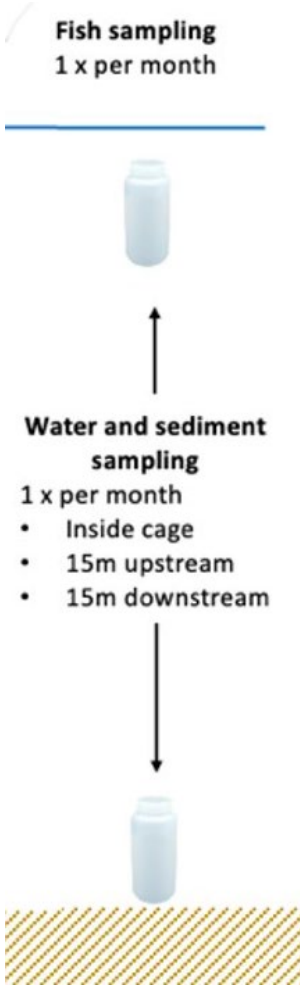


YSI Exo2 Sonde
Chlorophyl$_a$
fDOM
Turbidity
Dissolved oxygen
Temperature
Salinity

Seabird SUNA
Nitrates

Nortek Aquadopp
Currents, Waves

Environmental parameters and eDNA



The *AquaFort*, an Integrated Multi-trophic Aquaculture System

- ✓ Small scale system eases permitting and is user friendly for fishers and family farmers
- ✓ Allows farmers to learn aquaculture husbandry and develop local markets before expanding capacity
- ✓ Excellent for aquaculture education, training and research

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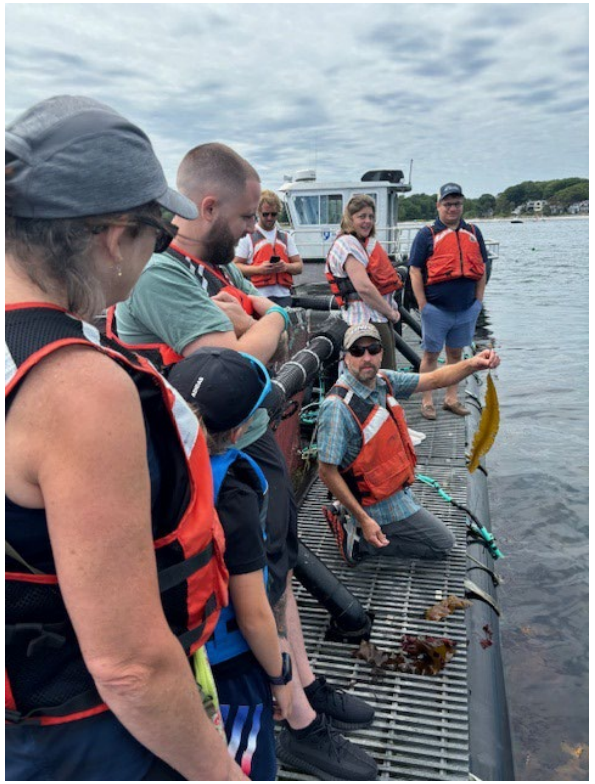
Aquaculture Education, Training and Outreach

1. Outreach – Over to 250 visitors/year ranging from UNH classes, city members, researchers, regulators, NGO's, investors and friends.
2. Developed an online, asynchronous IMTA course – 2 weeks
3. This fall, a new graduate 3 credit – "hands on" IMTA course

Local chefs and Youtubers

Potential donors



UNH classes

Gulf IMTA team


https://seagrant.unh.edu/person/tim-briggs

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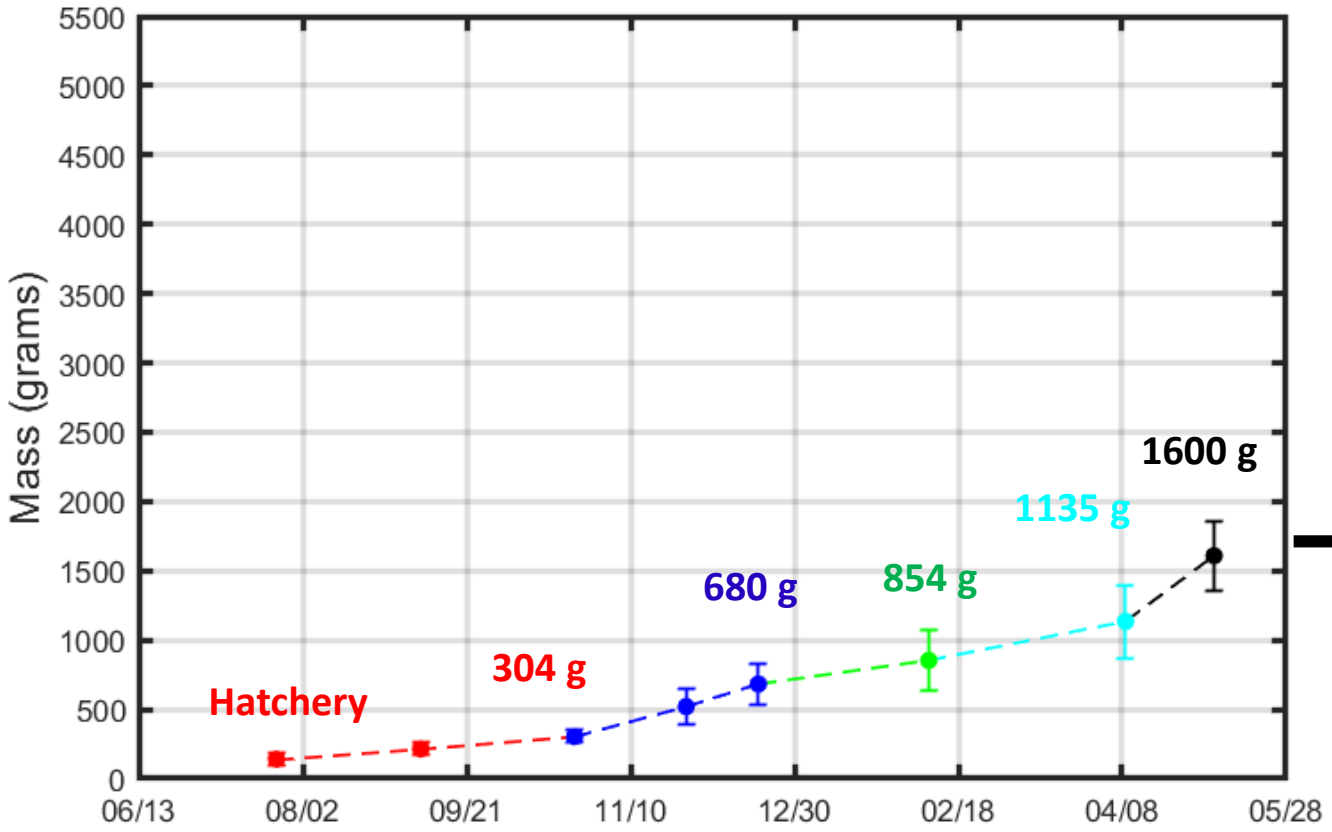
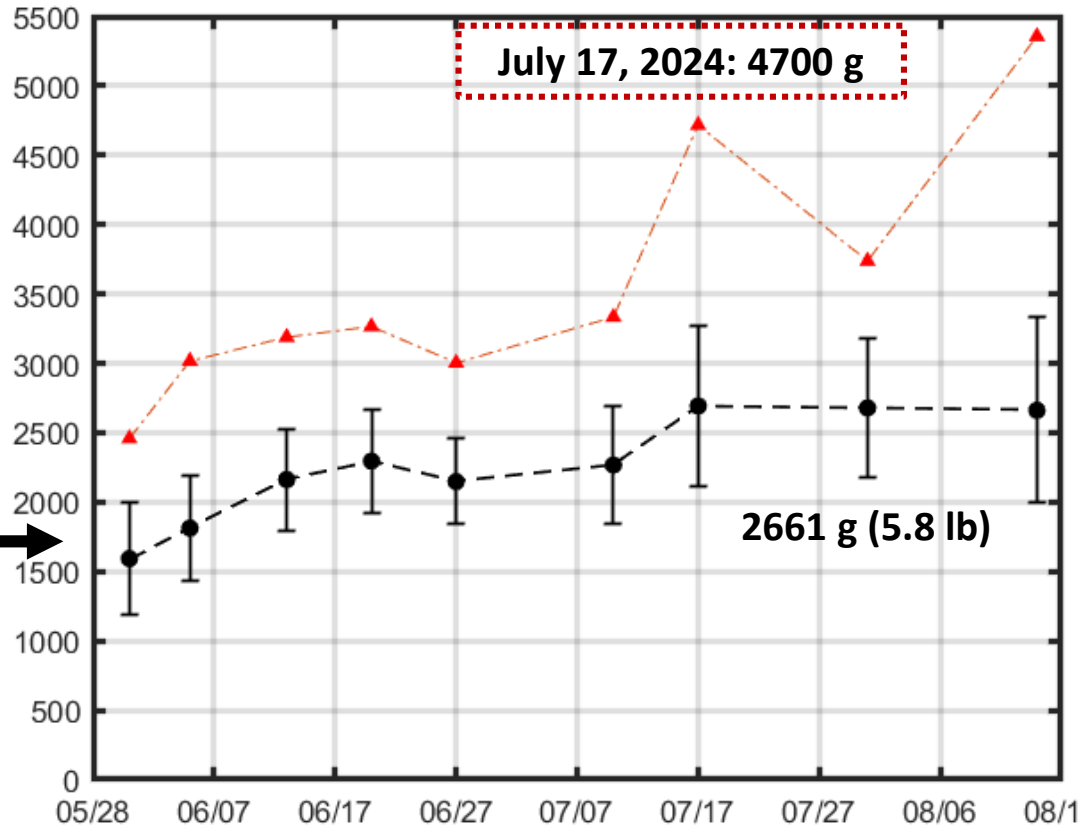
Increase of biomass in Pen #1

Winter-Spring growth



Summer Harvest



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Produce up to 20,000 lbs. of Steelhead Trout

April 9, 2024
1600 g
(3.5 lb)

May 8, 2024
2400 g
(5.2 lb)

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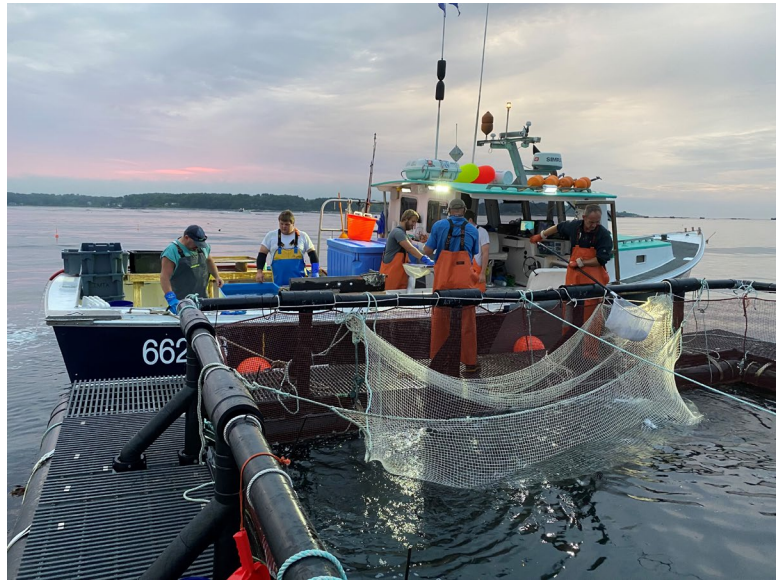
Harvest and Processing Steelhead Trout at Sea



Seine fish

Place in ice bath

Ikejime

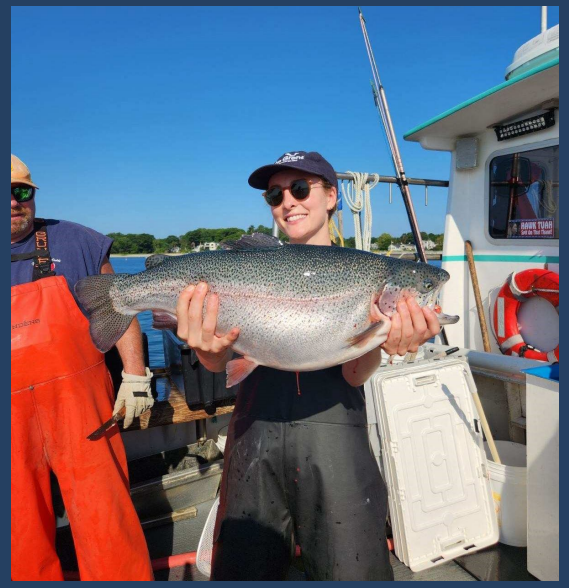
Bleed gills

Gut and rinse

Pack in ice slurry and transfer to shore

Count, weigh, label and transfer to market

Seafood Products Sold from the UNH Farm



Steelhead trout

Fillets in local markets

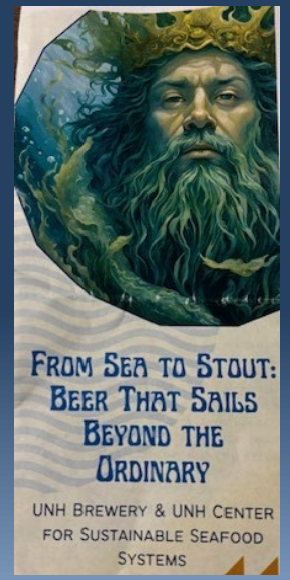
Smoked trout

Send kelp beer

Trout row

Fresh mussels

Selkie kelp beer



UNH kelp beer

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Community Economics: Seafood Markets

Local workforce

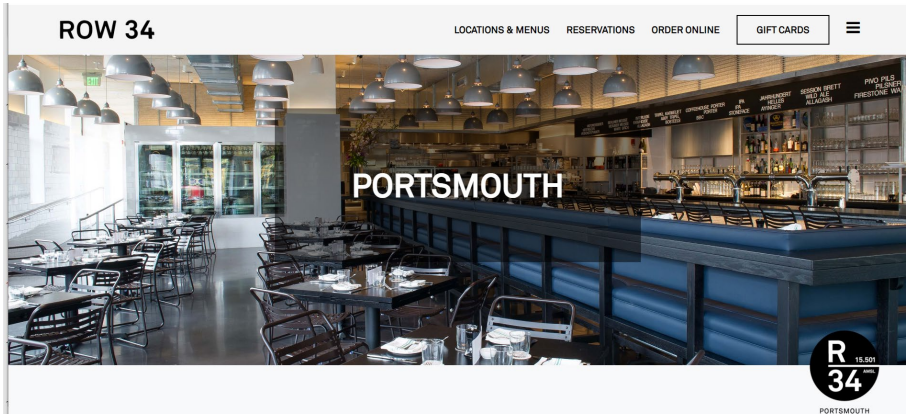
Carbon footprint

Local seafood markets

SANDERS FISH MARKET
PORTSMOUTH, NH

Seaport FISH

Local restaurants



Local food pantry

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Fresh Markets

- 2024 prices, tiered approach:
  - 1-50lb $9.00/lb.
  - 50-100lb $8.50/lb.
  - 100-200lb $8.00/lb.
  - Over 200lb $7.500/lb.
- Whole fish is filleted and deboned – $2-3/lb.
- Fillet yield of 60% from, head on, gutted fish
- Fillet is sold for $18-29/lb.
- Limited shelf life – 10 days on ice
- Product is sold to local seafood markets, restaurants and customers
- Seasonal product
- Markets control pricing and amount
- Can get a premium price for a fresh, local product

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Smoking your Fish

- Transportation (White Truck) - $0.50/lb.
- Filleting (Red's Best) - $1.90/lb.
- Deboning (Red's Best) - $0.25/lb.
- Smoking (Boston Smoked Fish) - $5.95/lb.
- Label design (TG Graphics) - $300
- Label printing (TG Graphics) - $0.16 each
- Shelf life – 1 year in freezer
- Removed from freezer – 1 month in the refrigerator
- Sell for $12/4oz and $16/6oz

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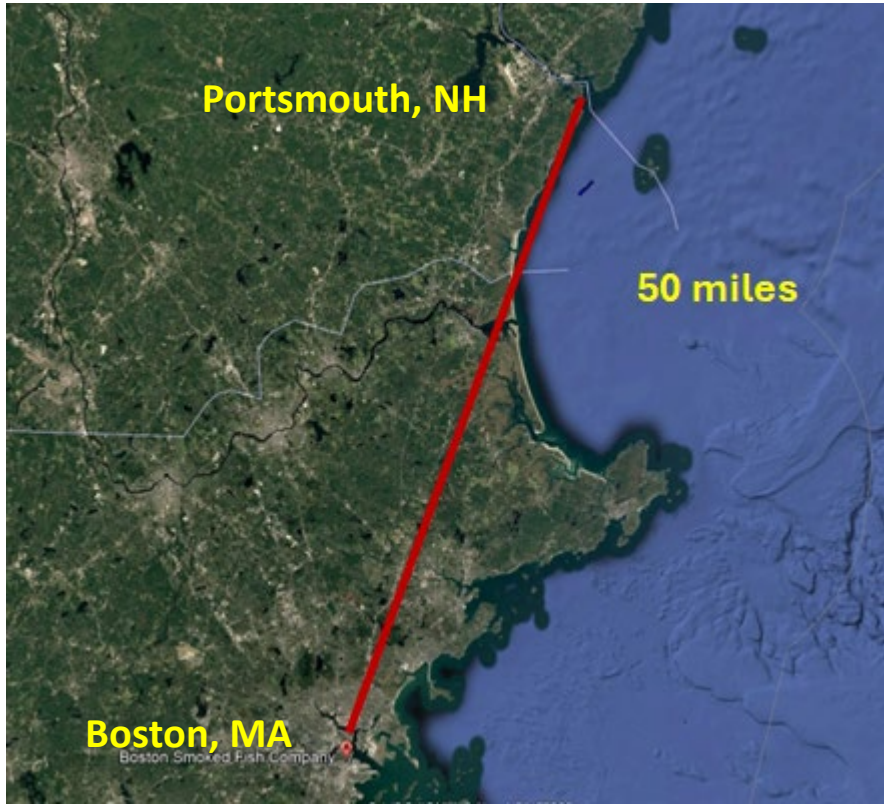
Community Economics: Value added

BOSTON SMOKED FISH CO.
SMALL BATCH HAND CRAFTED



Looking for delicious and locally-raised seafood? Help support our Center for Sustainable Seafood Systems by purchasing smoked Steelhead trout from our offshore aquaculture training platform! Our responsibly-grown trout are raised offshore with blue mussels and sugar kelp in UNH's multi-trophic AquaFort and smoked by Boston Smoked Fish Co. with a mouthwatering mixture of brown sugar, tamari, salt, and other spices.

Orders can be placed below and picked up at Jere A. Chase Ocean Engineering Lab in Durham, NH or the Judd Gregg Marine Research Complex in New Castle, NH. Thank you for your support!

ORDER HERE

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Tinning your Product

- Need fillets
- Transportation (White Truck) - $0.50/lb.
- Filleting (Red's Best) - $1.90/lb.
- Deboning (Red's Best) - $0.25/lb.
- Tinning - $2.00/can – 4ozLabel
- Label printing (TG Graphics) - $0.16 each
- Different flavors
- Materials and labels
- Shipping back to NH
- Shelf life – 5 years
- Easy storage and handling
- Sell for between $10-16/4oz can

Canning offers a great opportunity for farmers to yield more from their crops and bring their product to market in a more sustainable downstream supply chain through shelf stable tins, which eliminate food waste and reduce carbon footprints by avoiding refrigeration and excessive transportation.

Benefits to a Steppingstone Aquaculture System

- Lower initial investment.
- Small scale footprint eases the permitting process and coastal community concerns.
- Can be used for aquaculture education, training and research.
- Provides time to study the effects of a farm on the marine environment before expansion.
- Allows staff to be trained properly before larger scale culture systems are adopted.
- Allows markets to get established before large scale production occurs.
- Allows hatchery/nursery technology to develop and increase fingerling production for larger scale sea pens.
- Can eventually be used as a nursery system for a commercial farm.
- Perfect starter system for coastal communities that have not engaged in net pen aquaculture.

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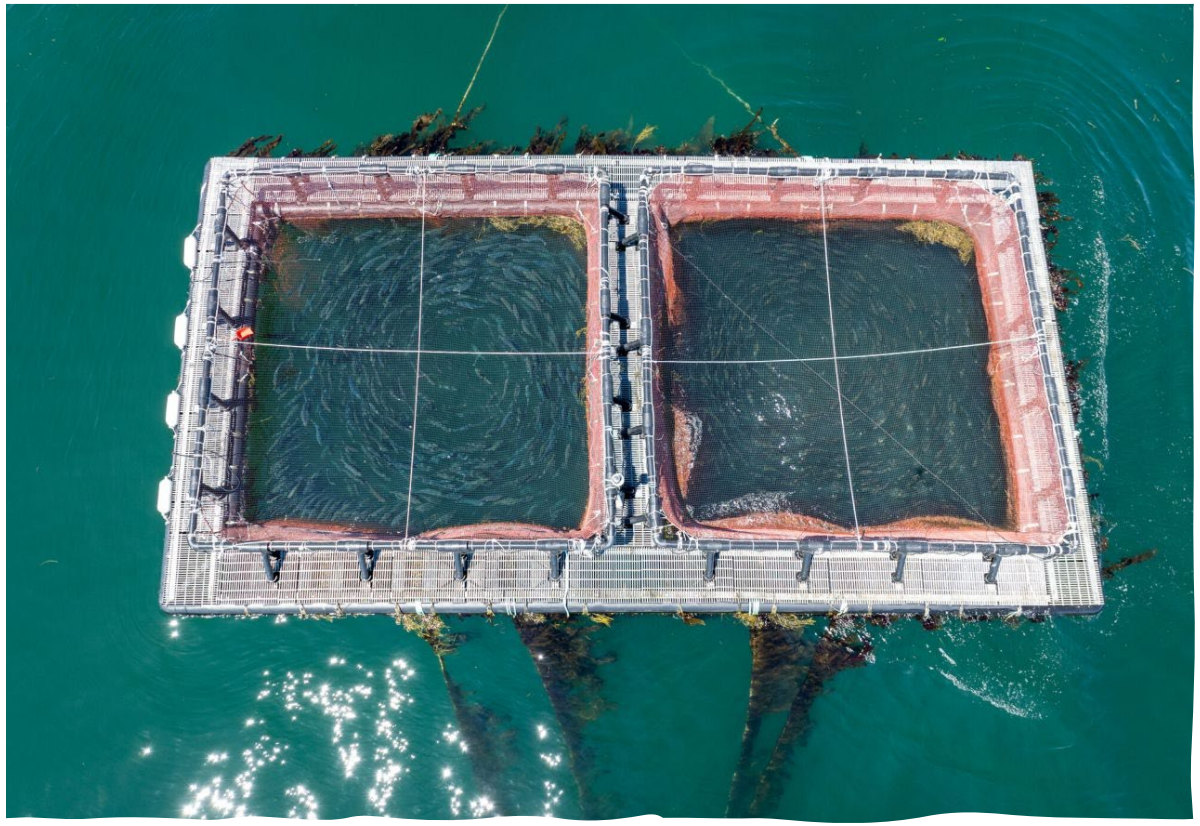
Moving Forward

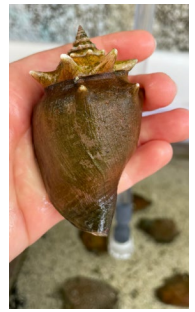
- Continue to explore novel seafood markets to increase revenue for the CSSS program.
- AF build out in the Gulf with DISL and USM.
- New IMTA project in Saipan with the NMC, HPU & UH with species below.
- Creating a Global Masters in Aquaculture Engineering program at UNH.
- Recently funded NOAA Sea Grant proposal to “Bring a Commercial Open Ocean. Aquaculture Farm to Puerto Rico”.
- Designing lower cost AquaFort systems to increase affordability in other countries.
- Continue to develop and assist IMTA projects in the US and abroad.



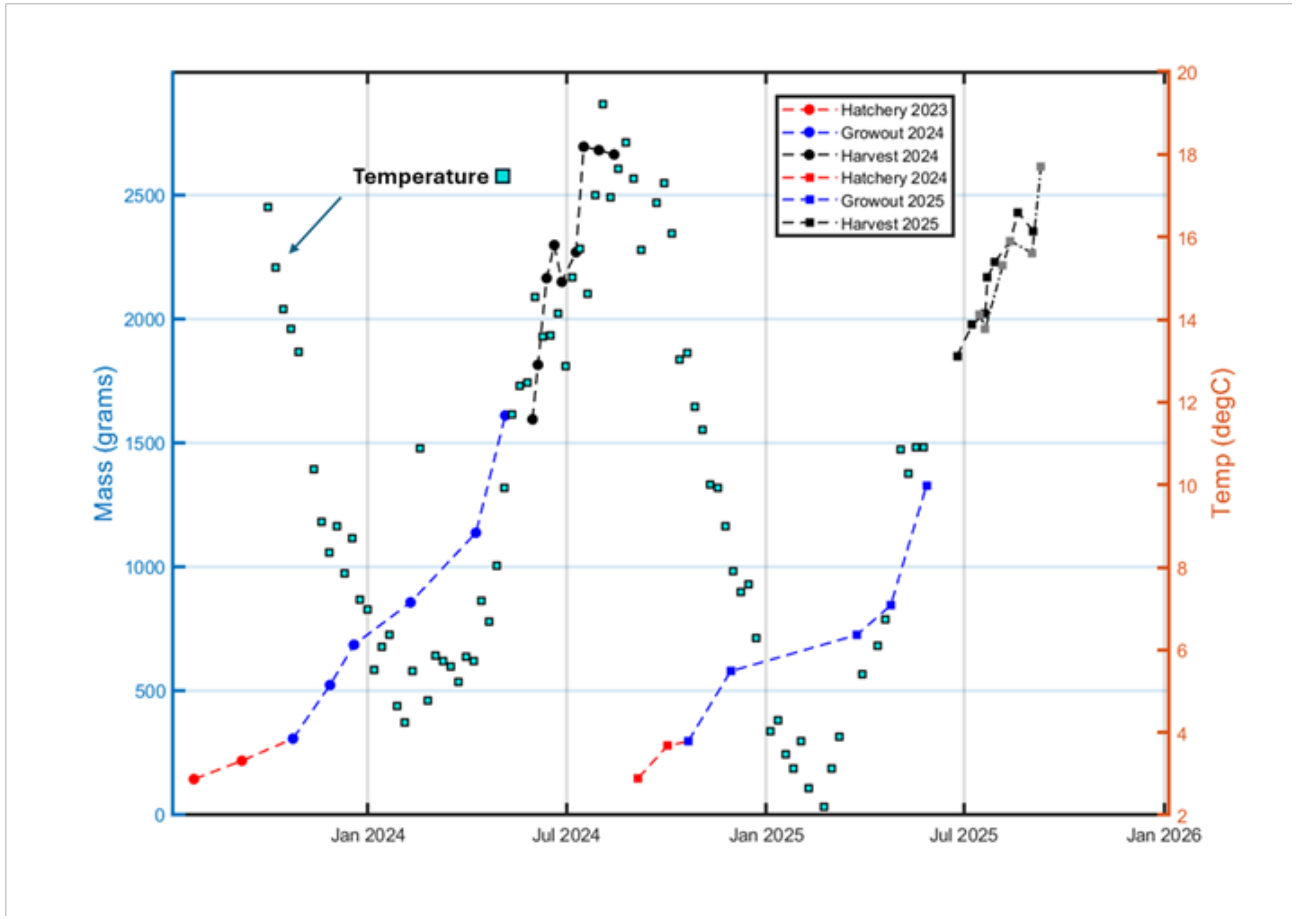







Thank you!
Questions?


Temperature
Hatchery 2023
Growout 2024
Harvest 2024
Hatchery 2024
Growout 2025
Harvest 2025
Mass (grams)
Temp (degC)
0
500
1000
1500
2000
2500
2
4
6
8
10
12
14
16
18
20
Jan 2024
Jul 2024
Jan 2025
Jul 2025
Jan 2026

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What is