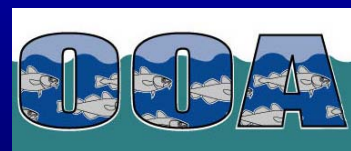
UNH Open Ocean Aquaculture Project

Richard Langan, CINEMAR, University of New Hampshire

The Cooperative Institute for New England Mariculture and Fisheries

"Solutions for Responsible Seafood Production"



Presentation Outline

- *Project overview and recent accomplishments*
  - *Engineering*
  - *Finfish Culture*
  - *Shellfish Culture*
  - *Economics*
  - *Technology Transfer and Commercialization*
- *Environmental Assessment*
- *Looking Ahead*

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Vision

Economically viable, socially compatible and environmentally responsible offshore aquaculture industry in New England

Mission

Provide regional and national leadership in research, technology development and technology transfer

Goal

To demonstrate the biological, engineering, operational,and economic feasibility of culturing fish and shellfish in unprotected, oceanic environments

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Approach

- *Select suitable and representative site*
- *Engage local and regional stakeholders*
- *Obtain state and federal permits*
- *Develop partnerships with industry*
- *Design and test offshore systems*
- *Establish an offshore platform and shoreside infrastructure*
- *Select appropriate native species of fish and shellfish*
- *Develop hatchery,nursery and growout technologies*
- *Evaluate Environmental Effects*
- *Demonstrate feasibility*
- *Evaluate production economics*
- *Transfer Technology*

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Project Characteristics

- *Interdisciplinary*

  Biologists, Oceanographers, Engineers, Economists, Social Scientists, Outreach Professionals, Mechanical Trades, Maritime skills

- *Regional Effort*

  MIT, WHOI, URI, U Mass, U Maine

- *Industry Partnerships- Ocean Spar,GBA, Heritage Salmon, E-Paint*

- *Research Grants Awarded Competitively*

- *Sharing of information and experience with other offshore initiatives in U.S. and abroad*

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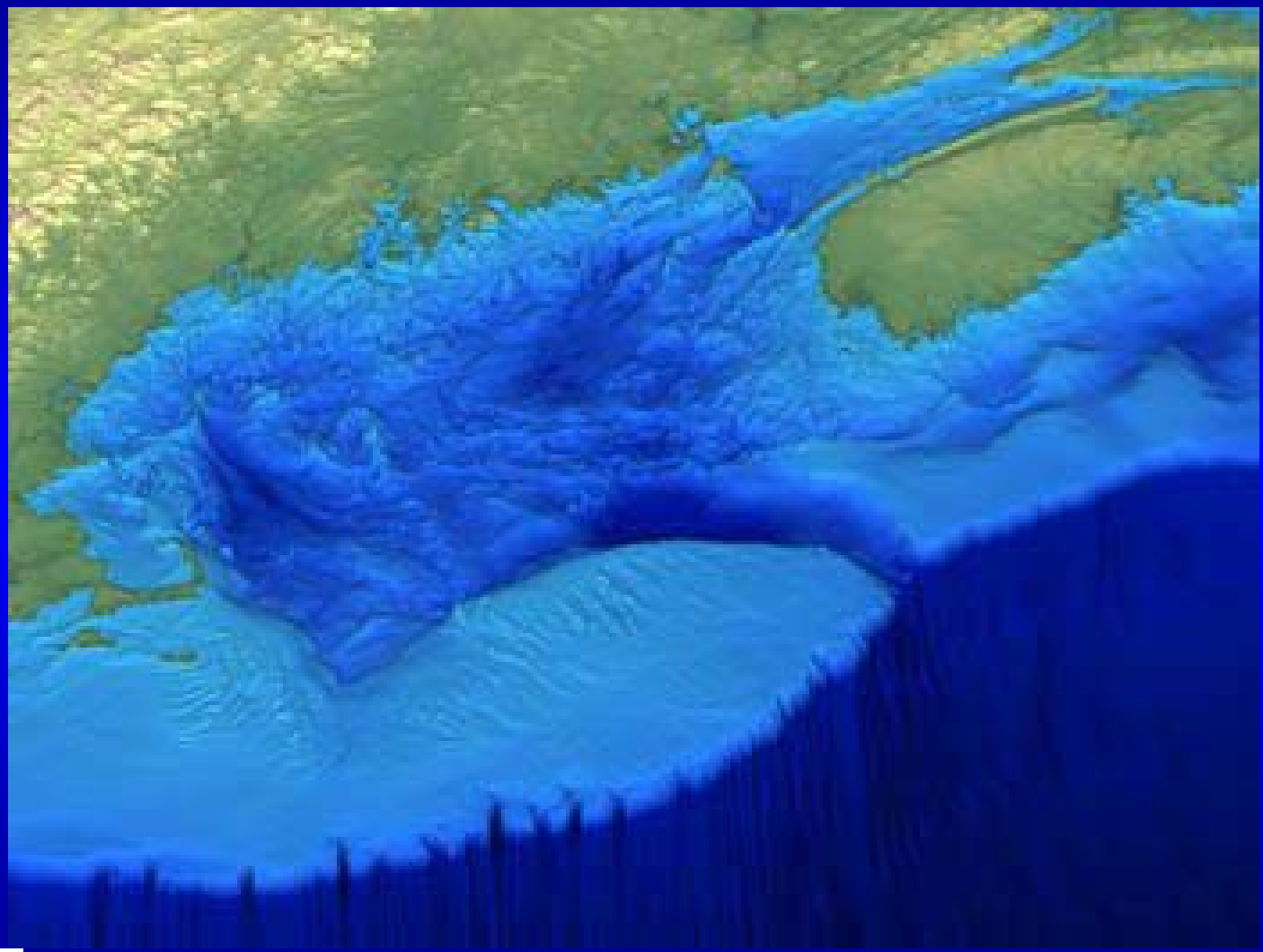
Project Location…. Gulf of Maine



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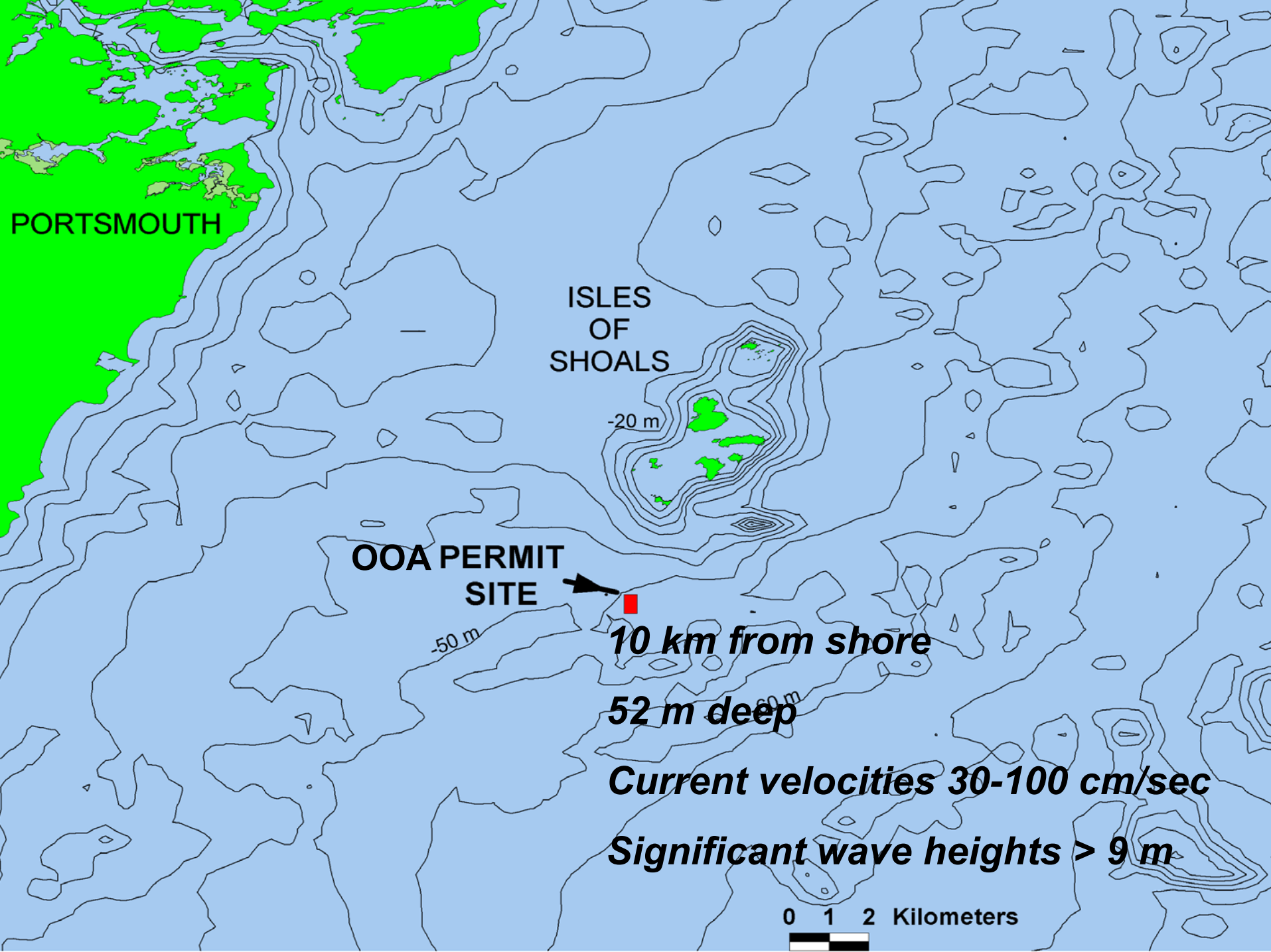
PORTSMOUTH
ISLES
OF
SHOALS
-20 m
OOA PERMIT
SITE
-50 m
-60 m
10 km from shore
52 m deep
Current velocities 30-100 cm/sec
Significant wave heights > 9 m
0 1 2 Kilometers

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Engineering Approach

Developing…

- ***Mooring Designs***
- ***Automated Feeders***
- ***Technology for Remote Operations***

Employing…

- ***Programming***
- ***Computer Modeling***
- ***Scale Model Testing***
- ***Field Evaluation and Verification***

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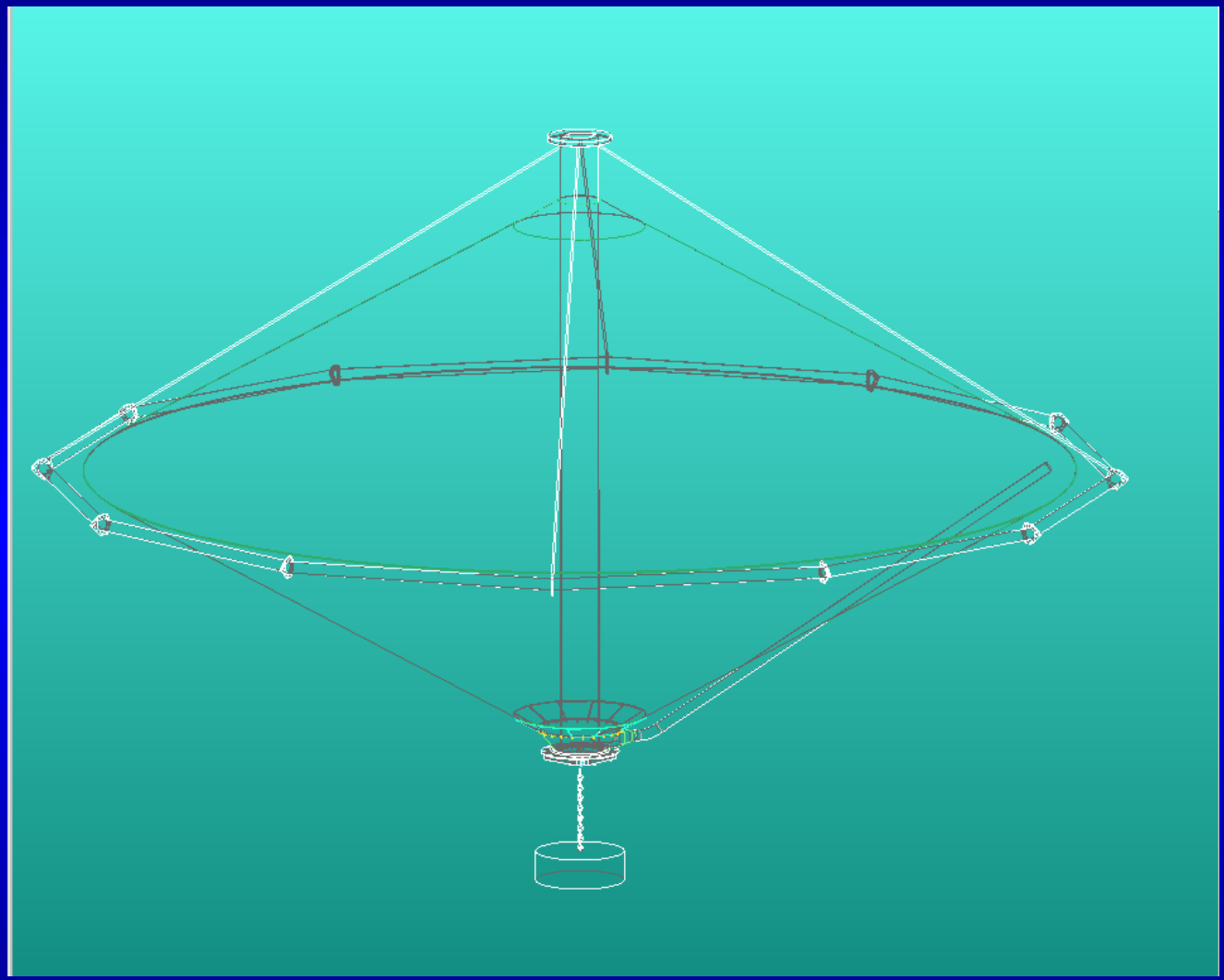
Sea Station Submersible Cage



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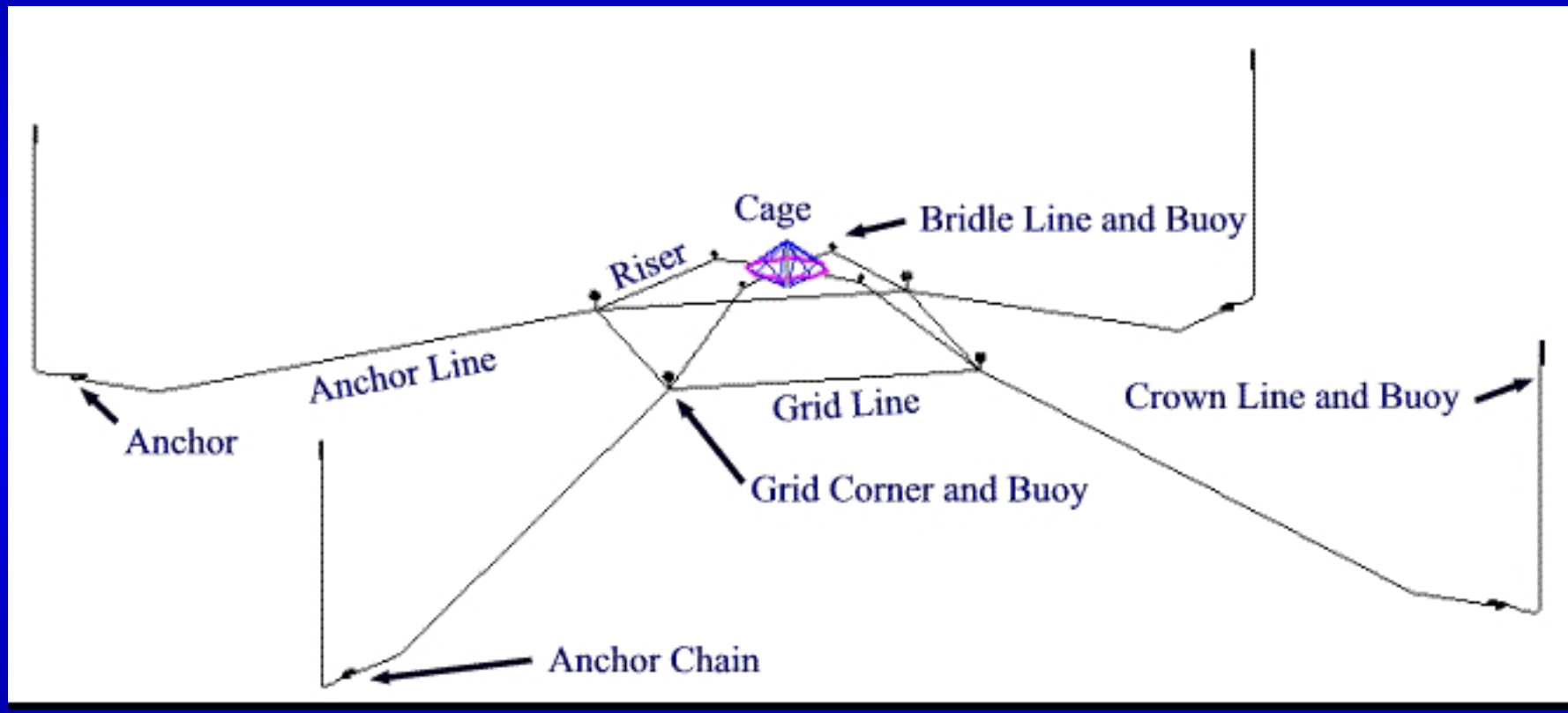
Initial Cage Installation



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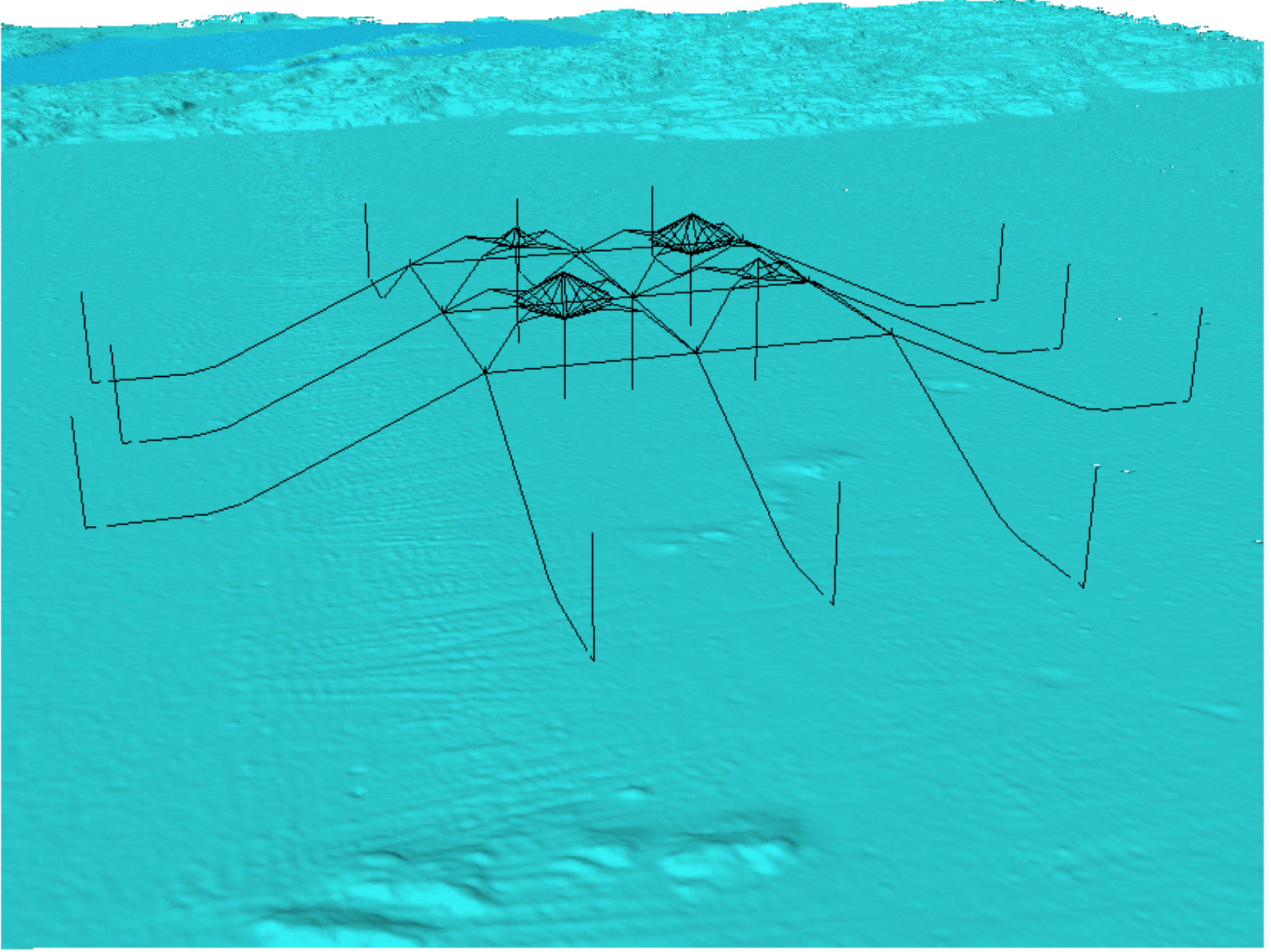
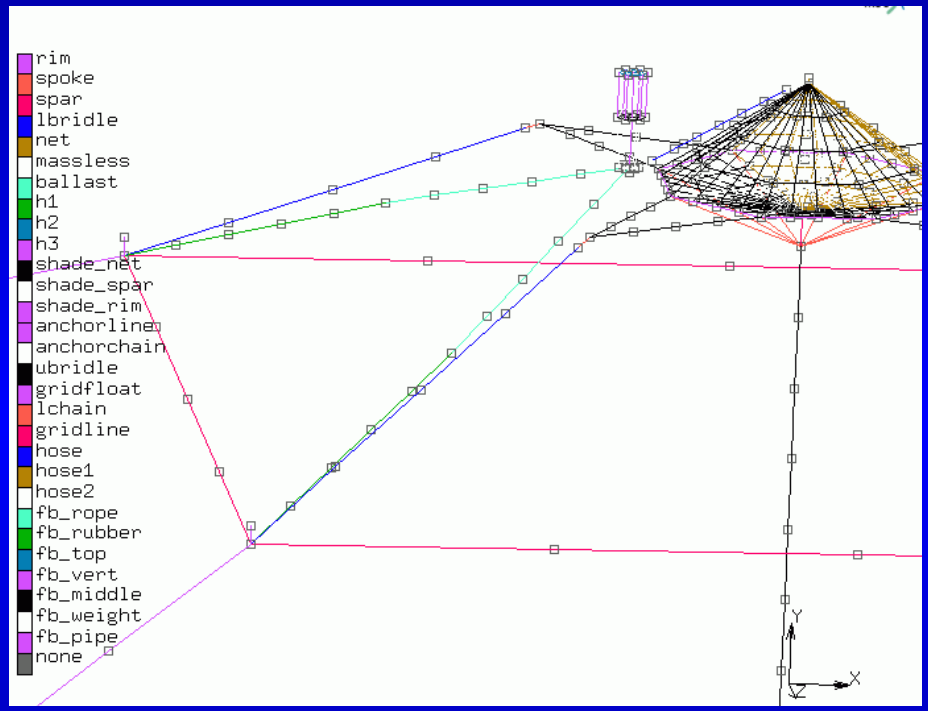


Finite Element Modeling



Material and Geometric Properties

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

Dynamic Simulation

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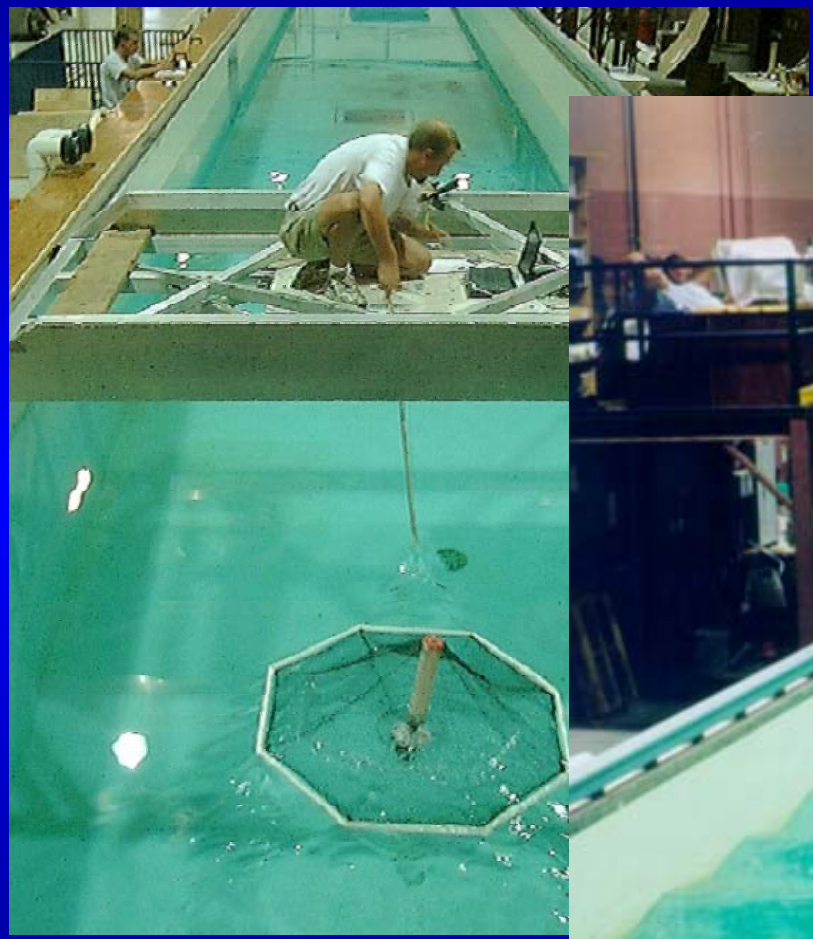
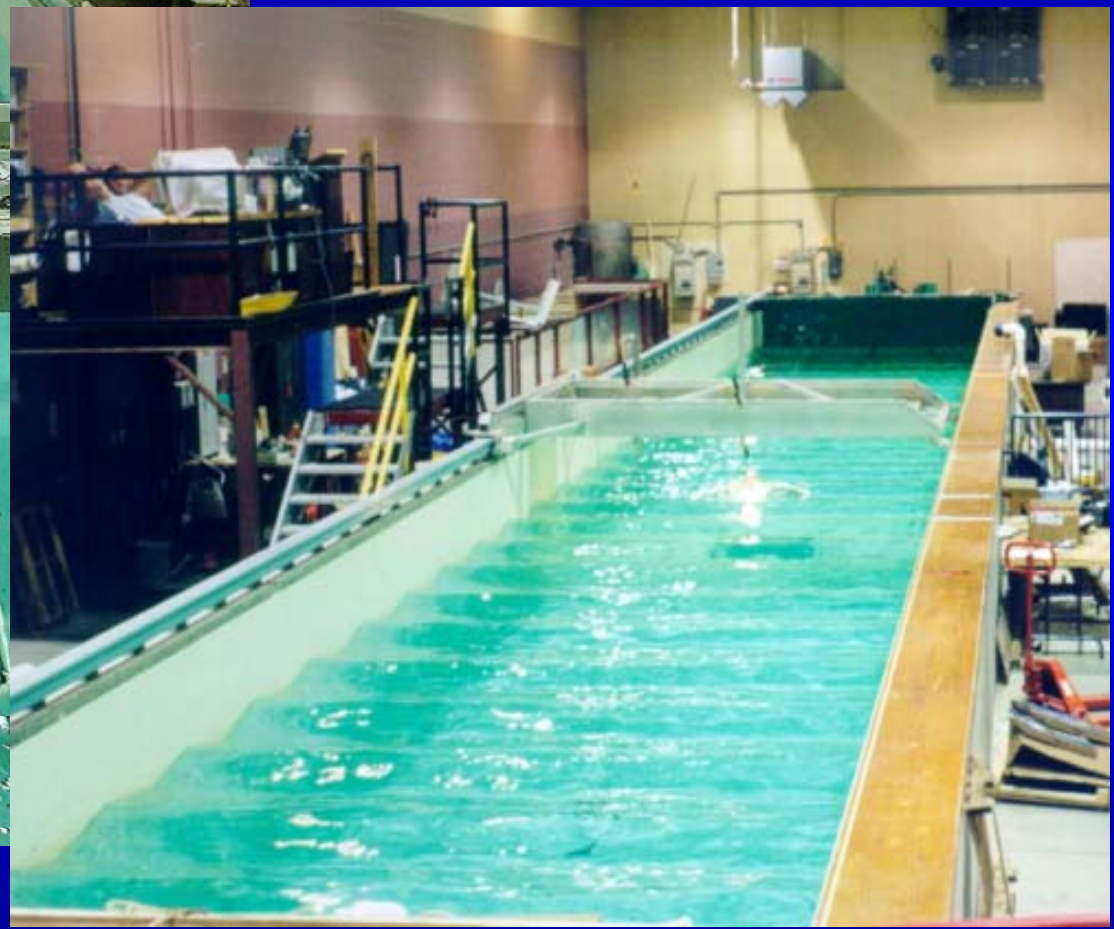
Scale Model Testing





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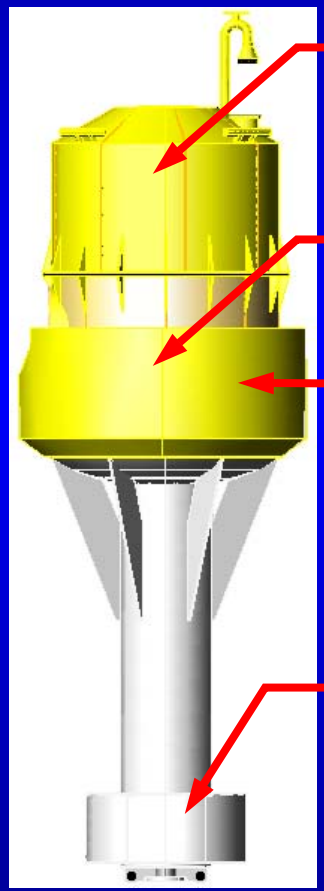
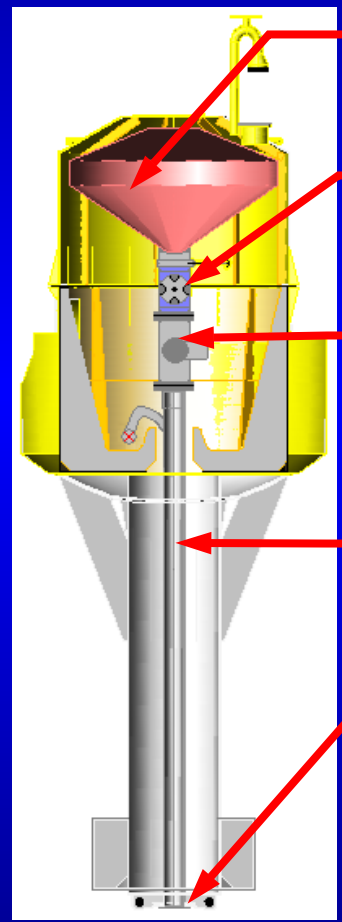
Automated feeding systems

1. Length: 5 m
2. Diameter: 1.7 m
3. Overall Weight: 2000 kg



0.25-ton Design



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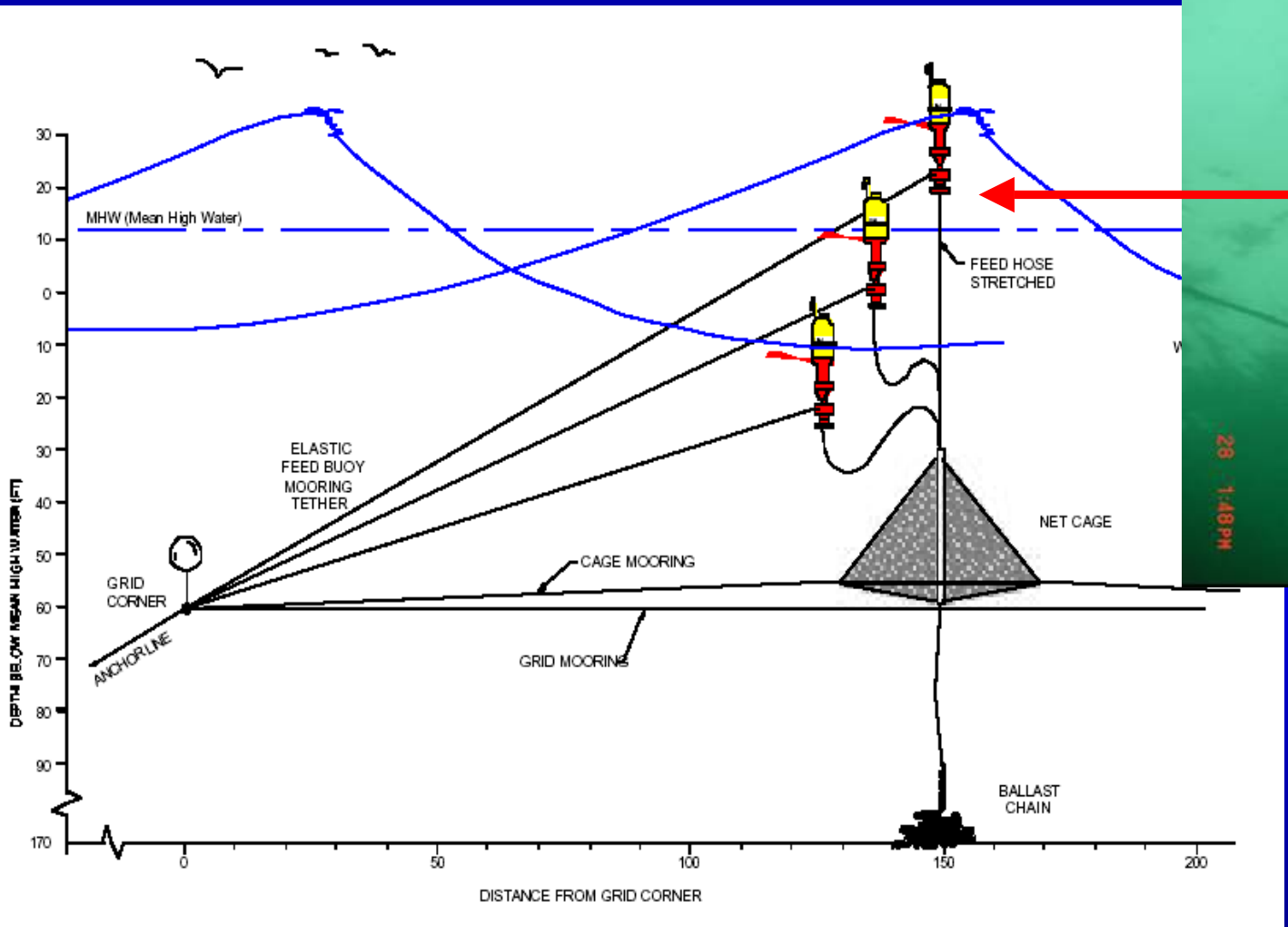
Mooring Configuration



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Physical Model Testing

Moored Response Amplitude Operators

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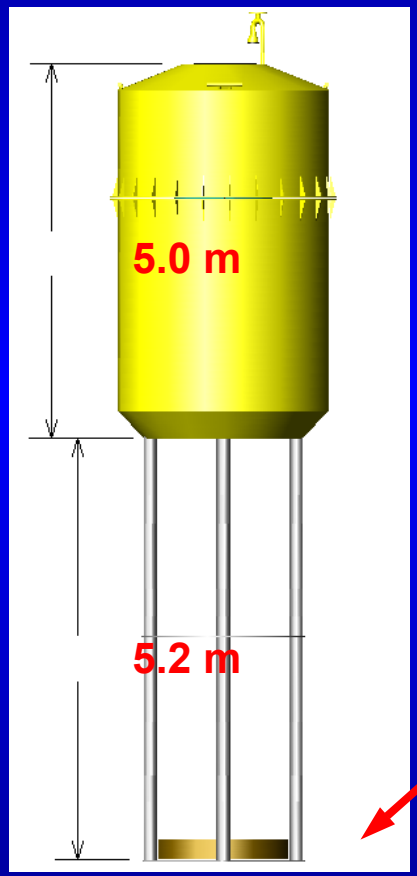
One-ton Design Configuration

1. Length: 11 m
2. Overall Weight: 7,800 kg (8.6 ton)



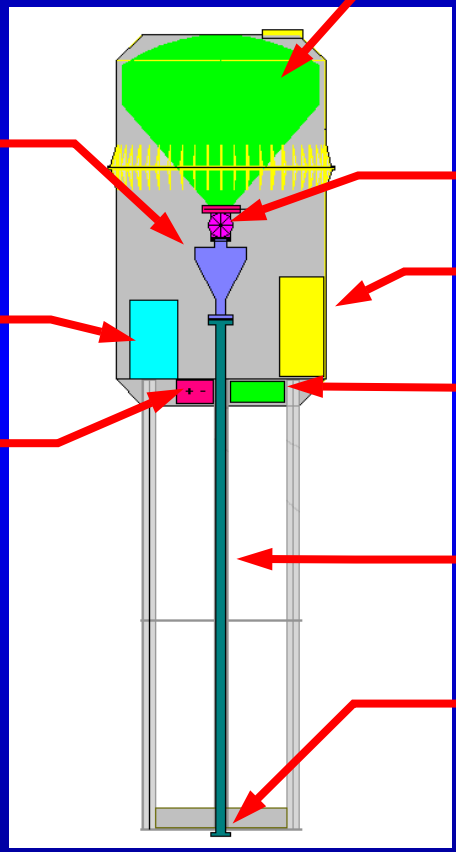
Ø 2.5 m

Mixing Chamber

Generator

Battery Bank

2040 kg Ballast



1-ton capacity Feed Hopper

Rotary Airlock

Diesel Tank

Feed Slurry Pumps

Feed Pipe

Flexible Hose Connection

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One ton feeder is
diesel powered

Storm Conditions Simulation

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

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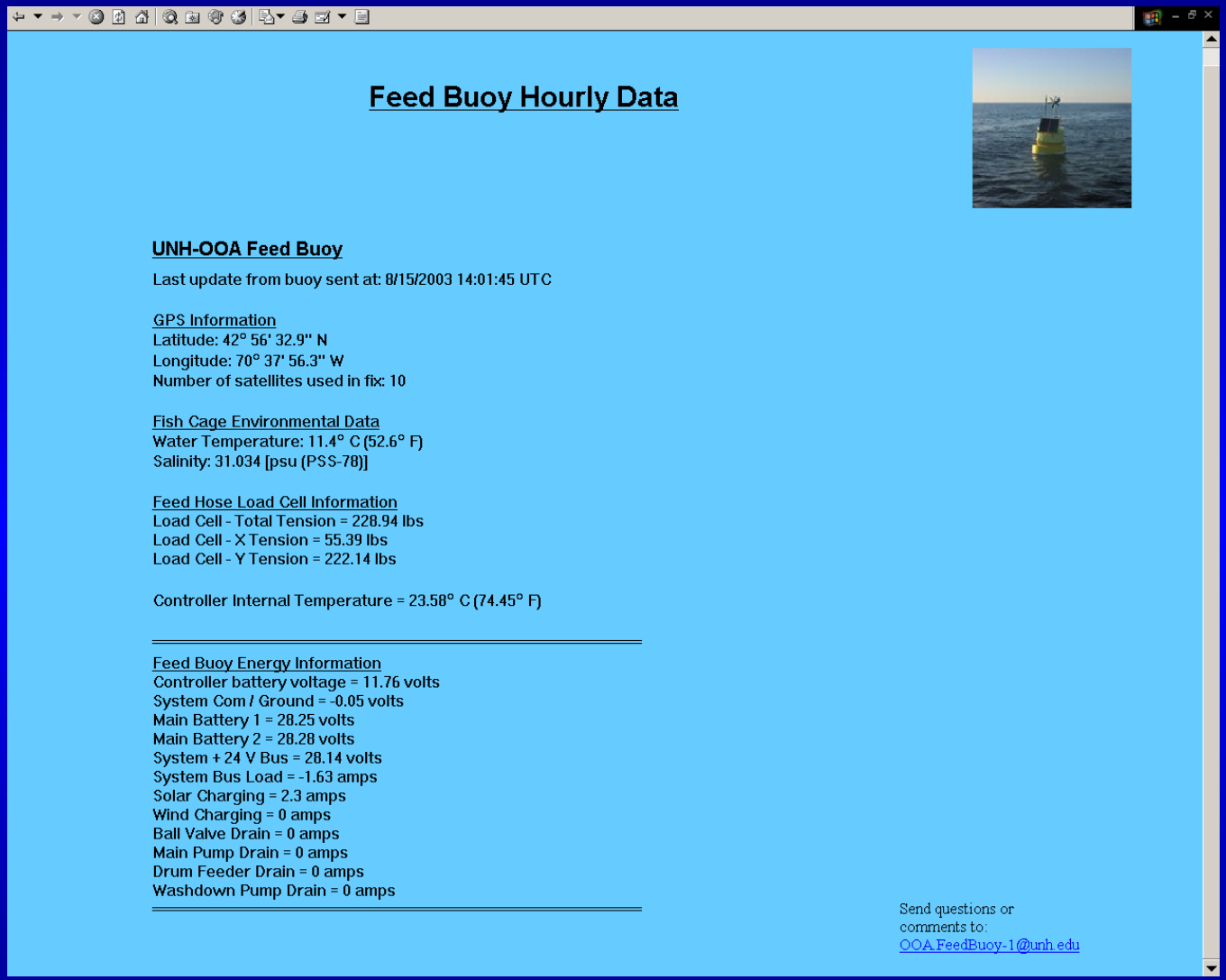
Communication and Automated Reporting



Feed Buoy Hourly Data

UNH-OOA Feed Buoy

Last update from buoy sent at: 8/15/2003 14:01:45 UTC

GPS Information
Latitude: 42° 56' 32.9" N
Longitude: 70° 37' 56.3" W
Number of satellites used in fix: 10

Fish Cage Environmental Data
Water Temperature: 11.4° C (52.6° F)
Salinity: 31.034 [psu (PSS-78)]

Feed Hose Load Cell Information
Load Cell - Total Tension = 228.94 lbs
Load Cell - X Tension = 55.39 lbs
Load Cell - Y Tension = 222.14 lbs

Controller Internal Temperature = 23.58° C (74.45° F)

Feed Buoy Energy Information
Controller battery voltage = 11.76 volts
System Com / Ground = -0.05 volts
Main Battery 1 = 28.25 volts
Main Battery 2 = 28.28 volts
System + 24 V Bus = 28.14 volts
System Bus Load = -1.63 amps
Solar Charging = 2.3 amps
Wind Charging = 0 amps
Ball Valve Drain = 0 amps
Main Pump Drain = 0 amps
Drum Feeder Drain = 0 amps
Washdown Pump Drain = 0 amps

Send questions or comments to:
OOA.FeedBuoy-1@unh.edu

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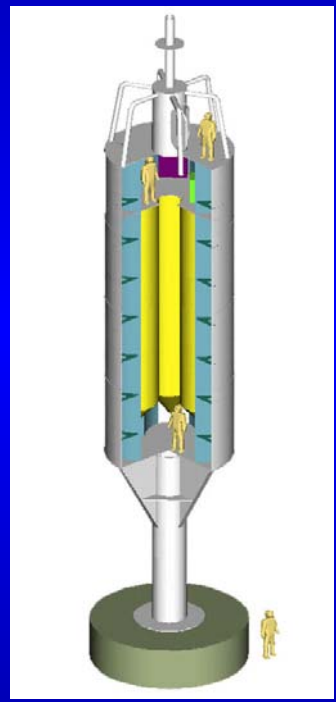
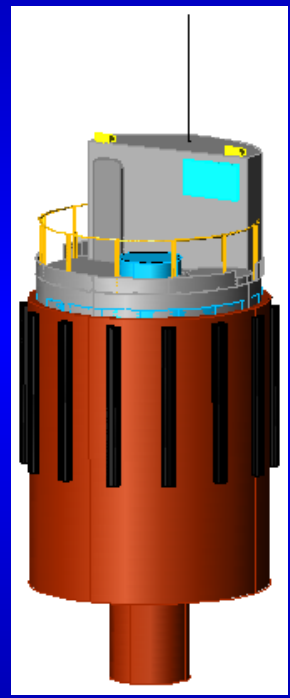
Future Work on Feeding Systems

1. *Maintain and improve the existing feeders*
2. *Make improvements to remote operations systems*
3. *Develop and deploy a 20-ton Feed Buoy that will feed up to four submerged cages*

* *In conjunction with Ocean Spar Technologies*





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Finfish Culture

Summer Flounder	1999 and 2000
Atlantic halibut	2001-2004
Haddock	2002-2004
Atlantic Cod	2001
	2003-2005
Steelhead trout (exp)	2004
Bluefin tuna penning (exp)	2005?

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Summer flounder- seasonal trials 1999 and 2000

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Atlantic halibut 100 gm- December 2001

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Atlantic Halibut
April 2004- 4 kg
3 2:36 PM

Haddock 70 gms in fall 2002

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Approx 1 kg in April 2004
Inches in 1/10 ths
Aquatic Eco-Systems, Inc.
1767 Benbow Court
Apopka, Florida 32703
21 10:12AM

35,000 Cod stocked at 30 gm fall 2003

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250 gm April 2004
18 12:11 PM

Acoustic Tracking- Transmitter Implant

Fish were ~24 cm long and 100 grams: tag = ~ 1% W.

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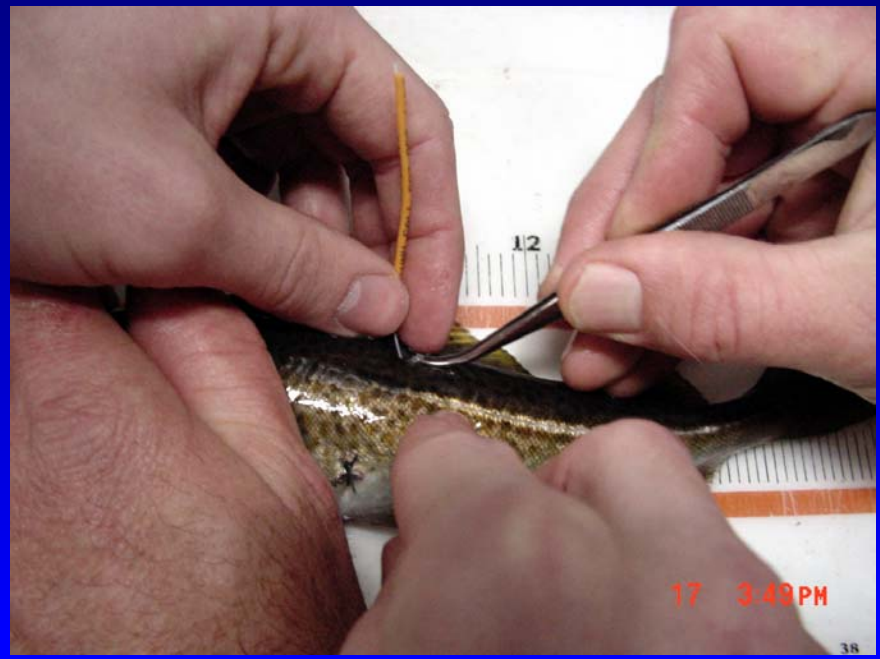
Suture and Recovery



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Sorenson Video decompressor
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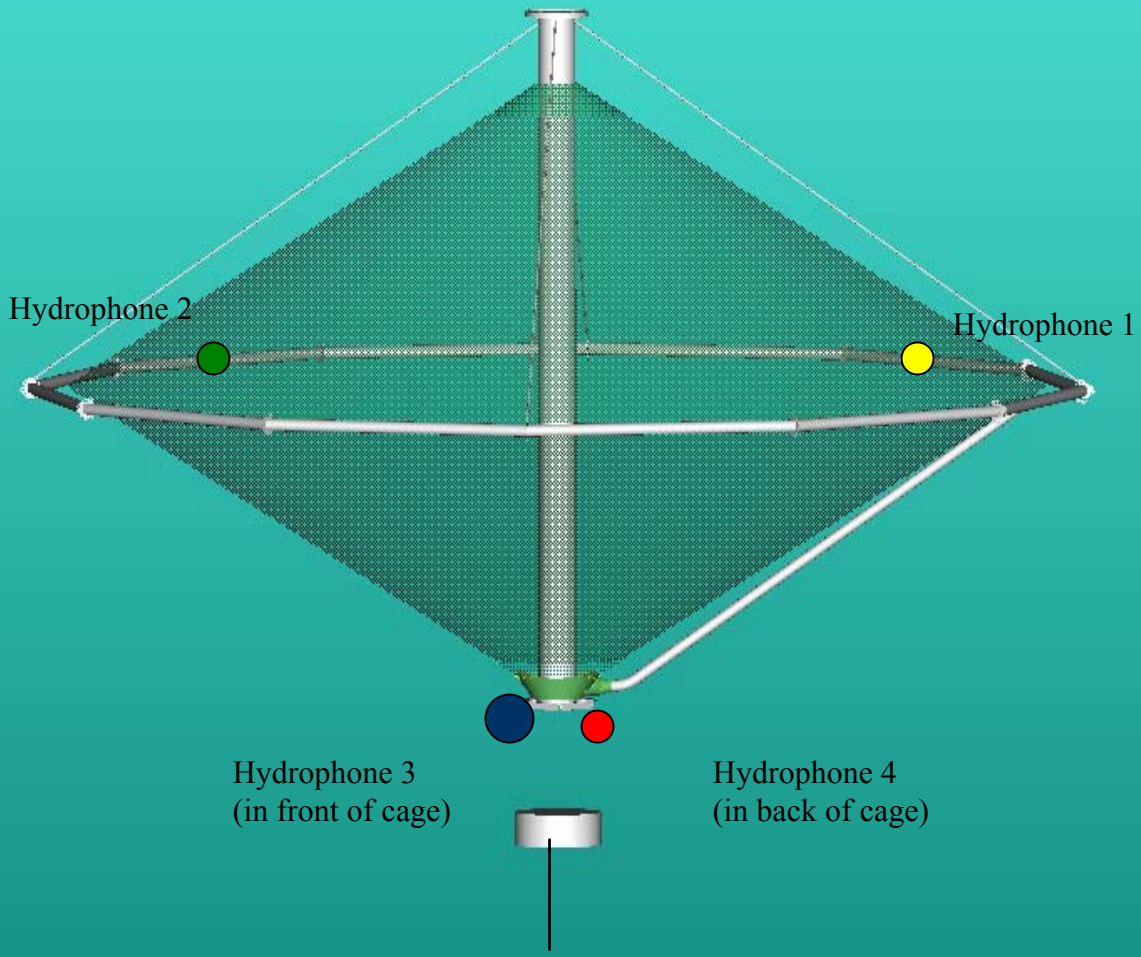
Arrangement of Hydrophones



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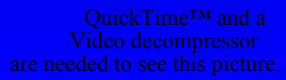
Cod tracks



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QuickTime™ and a
decompressor
are needed to see this picture.

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Economics of Atlantic halibut culture in offshore cages

Assumptions

4 cages with 20,000 fish

stocking 2 cages in yr 1, 2 in yr 2

harvest size 3 kg

Annual Operating costs	***$550,800***
Annual amortized capital costs	***$138,533***
Total Annual costs	***$775,499***
Total annual production	***120,000 kg***
Production costs per kg	***$6.46 USD***

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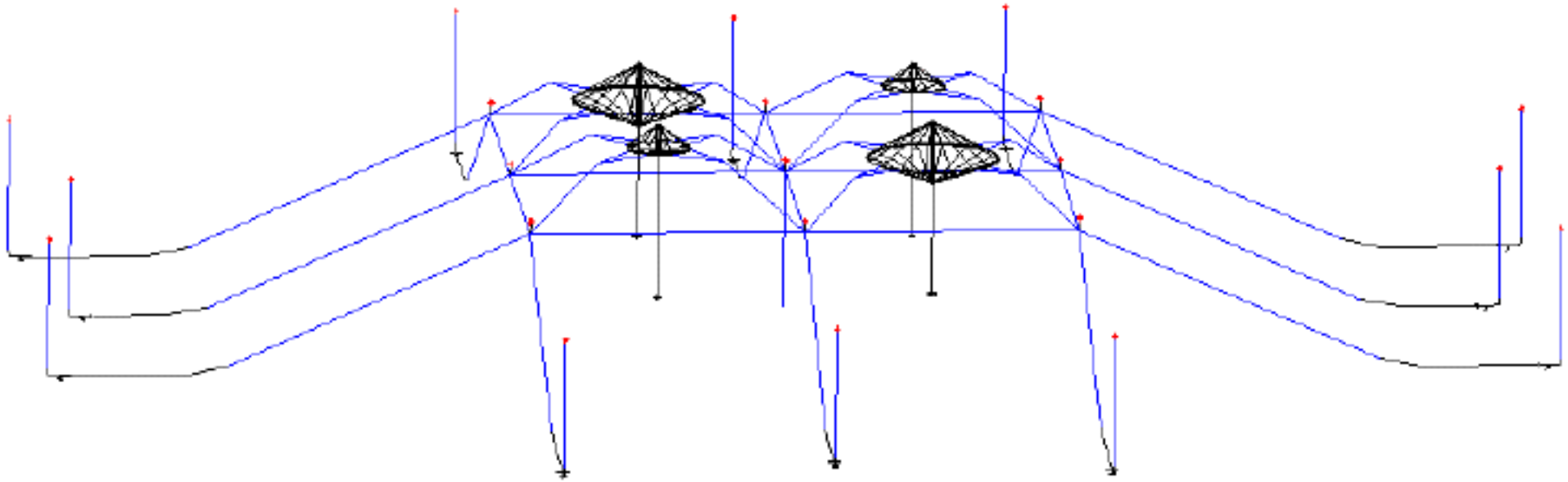
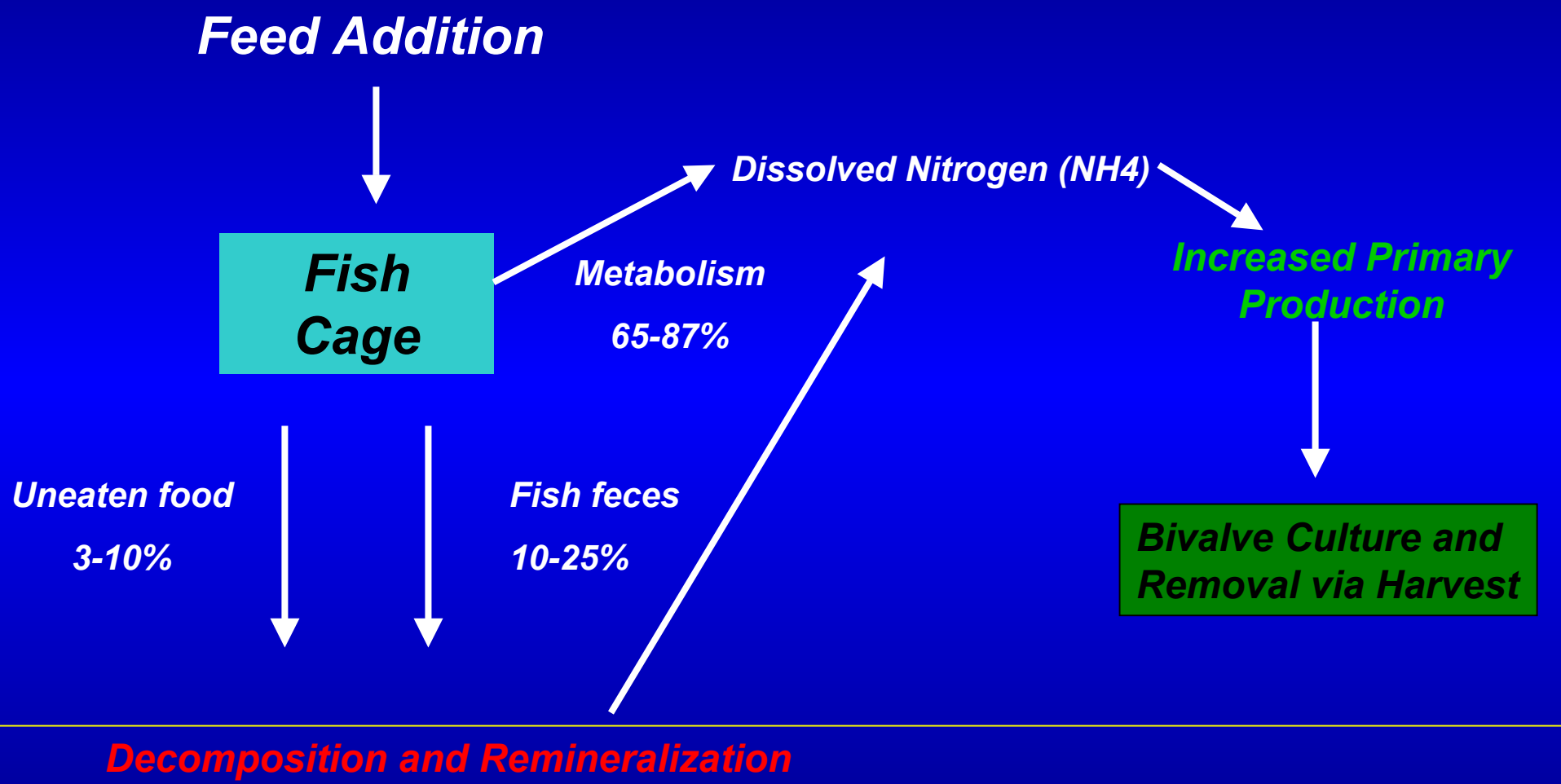
Fish + Bivalves = Integrated Aquaculture



Fate of Nitrogen when Extractive Aquaculture is Added



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Why Culture Mussels?

cultured *vs* *wild caught*

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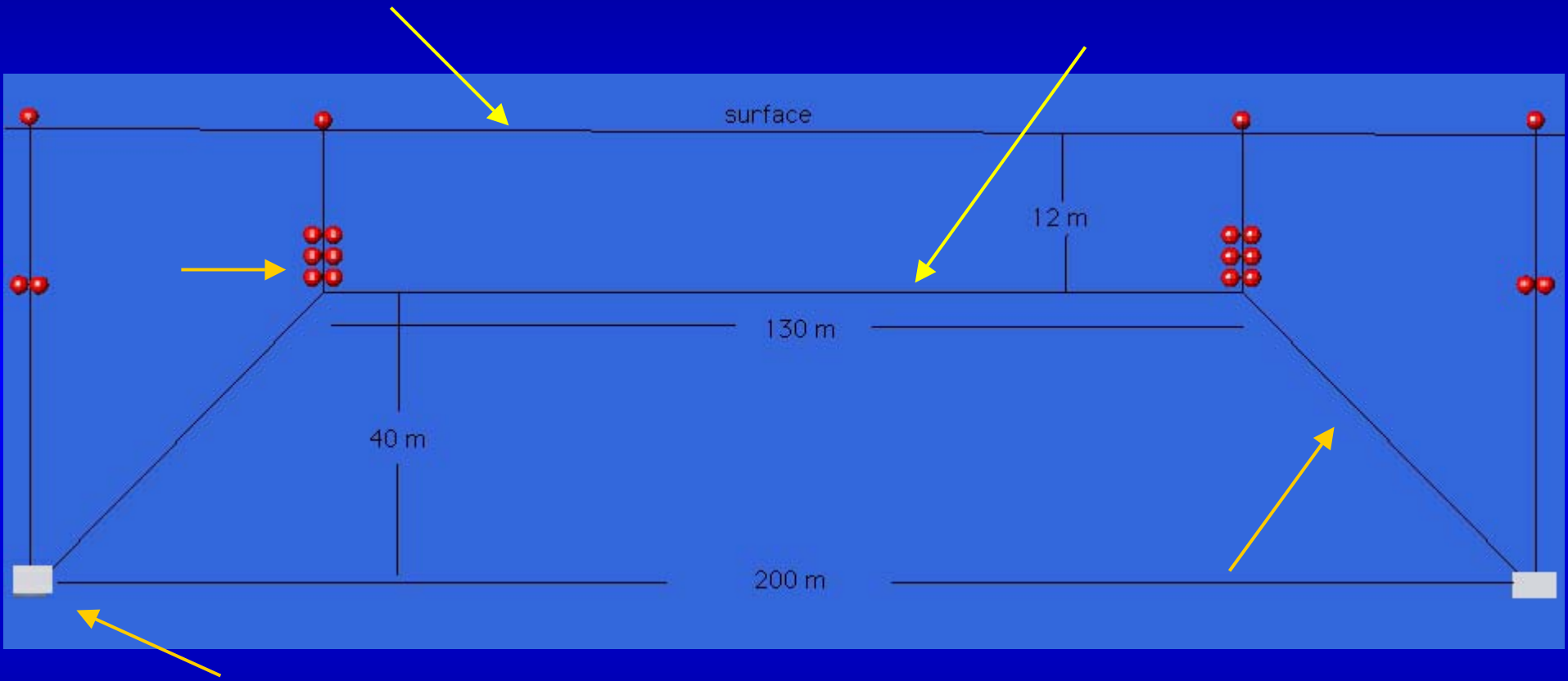
Surface Referenced Longlines-PEI

Submerged Longlines



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MUSSEL CULTURE

- **Seed Collection**

  Wild caught seed; issues are timing, location, materials and fouling; settlement density 3,500 to 25,000 per meter

- **Nursery Culture**

  On seed lines; 4-6 months

- **Growout**

  Suspension from submerged longline

  Discrete lengths of mesh socking

  Continuous with mesh socking

  Continuous with rope core and biodegradable cotton sleeve

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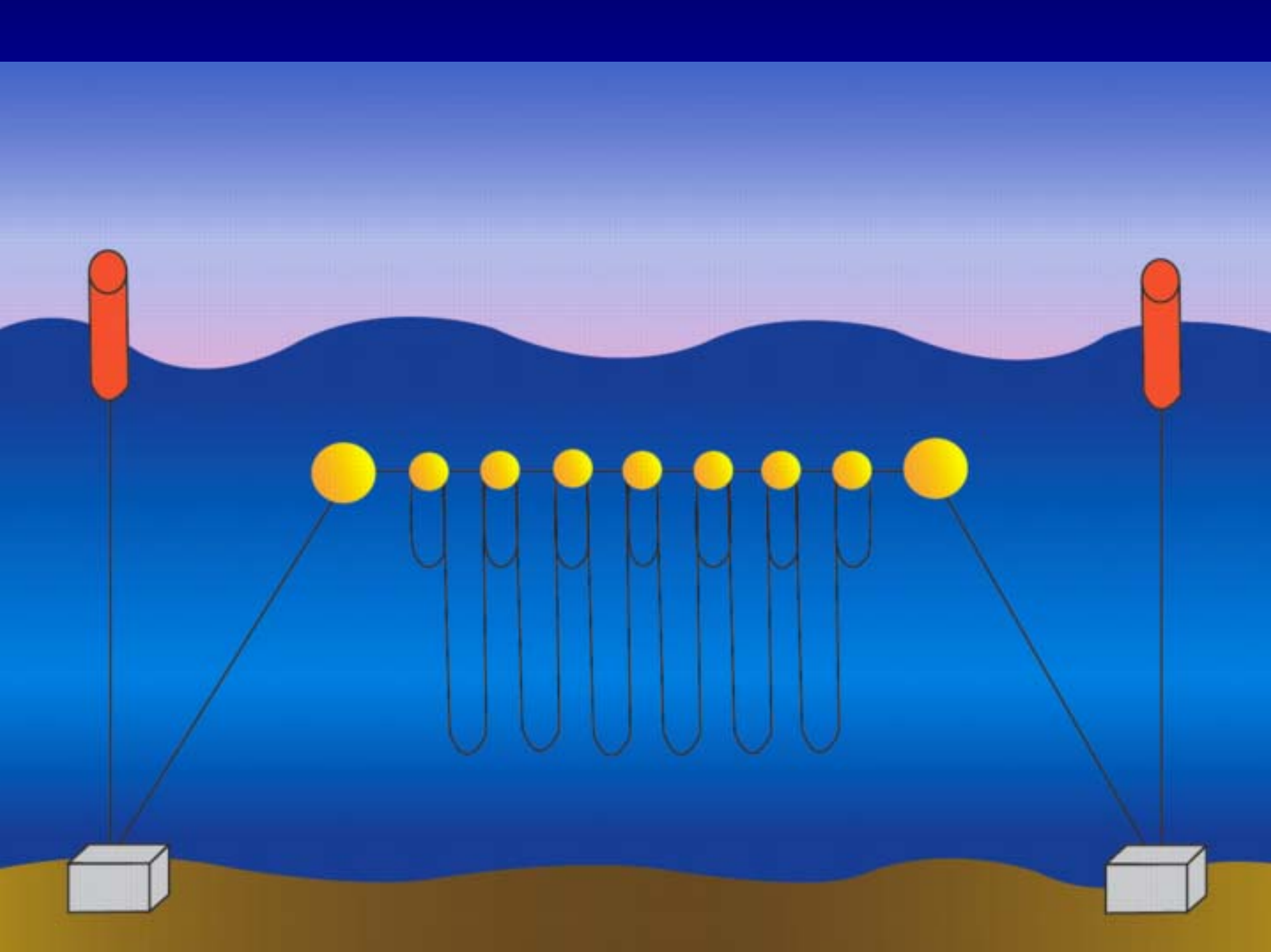


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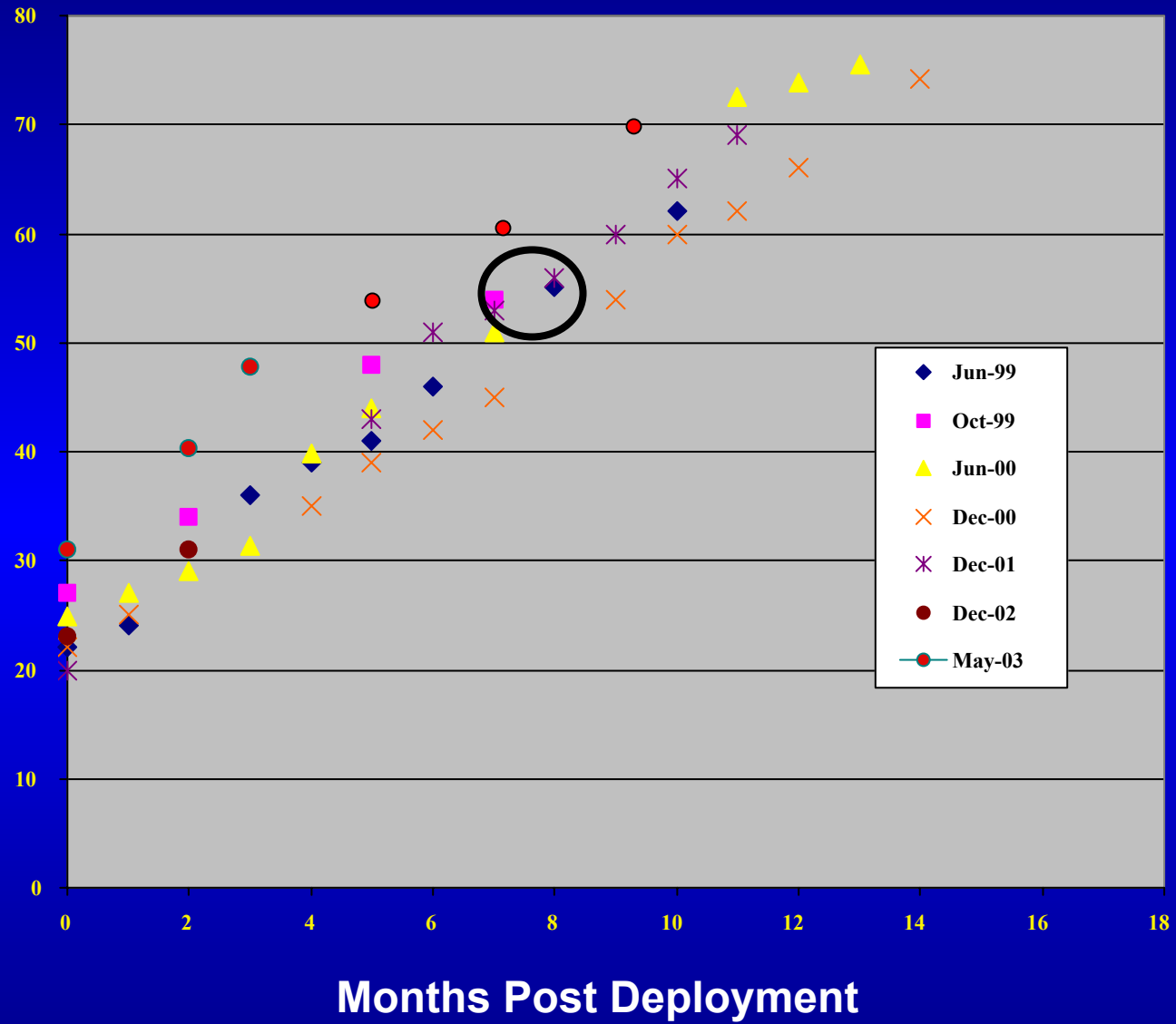
Mussel Growout on Submerged Longlines



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Wholesale price $1.25 USD/ lb. ($2.75/kg)

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"A Superior Mussel"

ISLES OF SHOALS SUPREMES™

Rope cultured mussels from the pristine waters of the Gulf of Maine

rope cultured mussels

rope cultured mussels

"A Superior Mussel"

ISLES OF SHOALS SUPREMES™

Isles of Shoals Supremes are farm-raised mussels grown in the pristine offshore waters of the Gulf of Maine, far removed from any pollution sources. Our mussels are grown on ropes suspended from submerged longlines, so they are free of any grit, sand or pearls. They feed on naturally occurring microscopic plants, free of artificial additives, and are a healthy, nutritious, tasty, and environmentally friendly source of protein.

The technology for growing Isles of Shoals Supremes was developed by the Cooperative Institute for New England Mariculture and Fisheries' Open Ocean Aquaculture project at the University of New Hampshire. The project was funded by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

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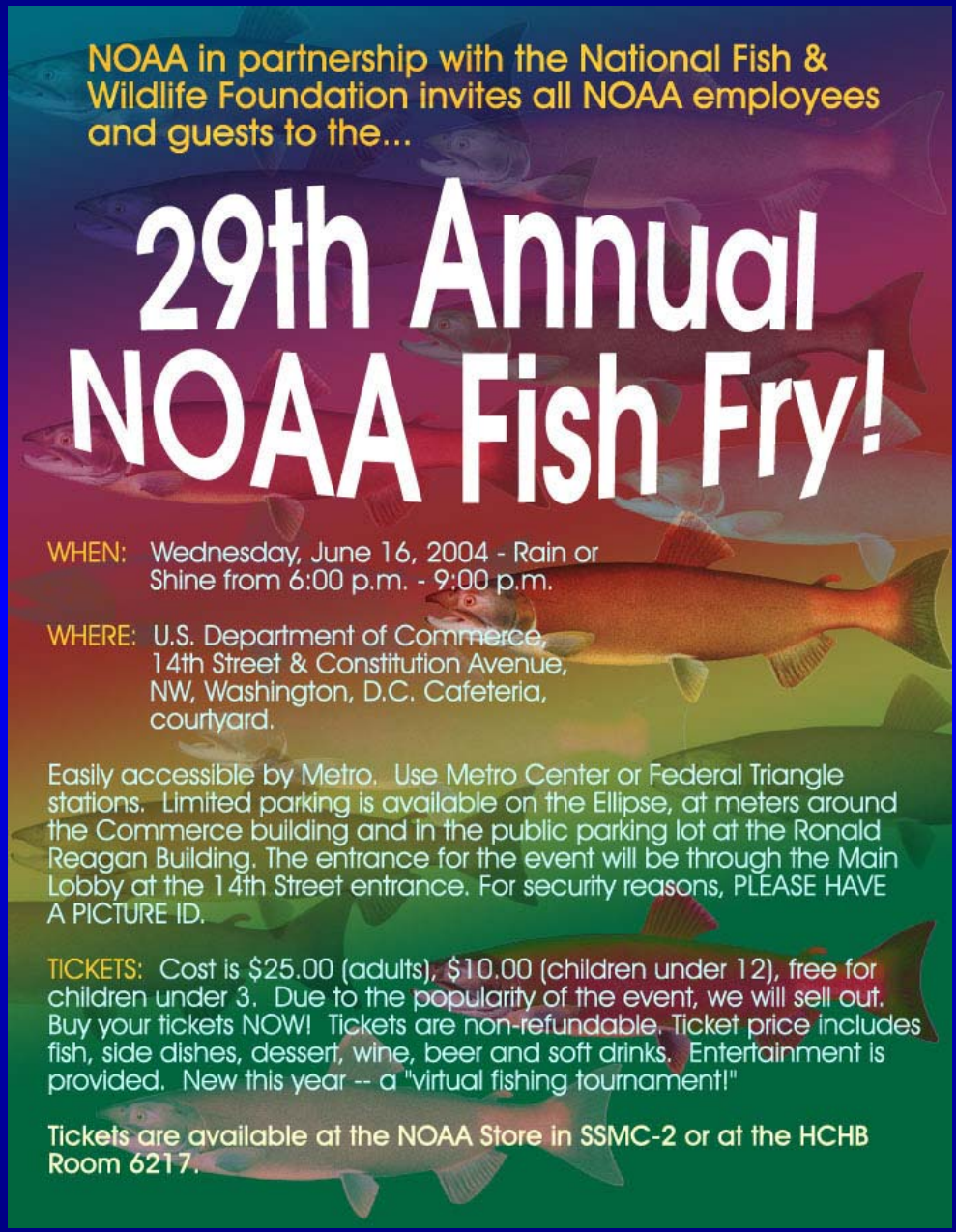

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$ Economics $

Assumptions:

- 120 Longline farm (longevity 5 yrs)
- Equipment amortized over 5 years
- Conversion Vessel (s)
- Ex-vessel price (estimated) $.99/kg ($0.45/lb)

Annualized Costs $389,600

- Annual production 6,000 kg/line, total annual production 720,000 kg (1,544,000 lbs)
- Annual Production Costs $0.52/kg ($0.24/lb)
- Gross Proceeds (with 10% loss) $712,000

Annual profit (with 10% product loss) $322,400

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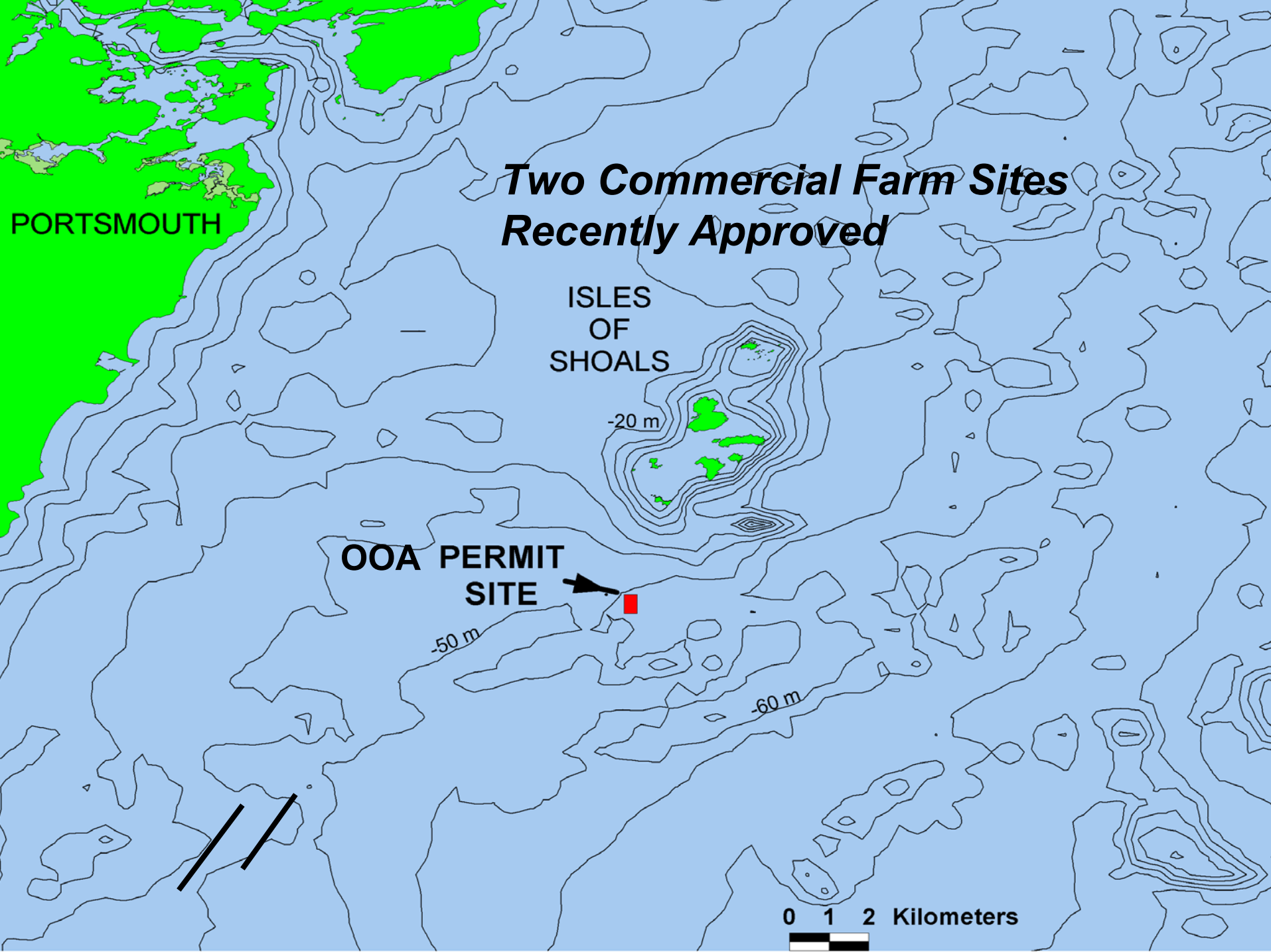
Two Commercial Farm Sites
Recently Approved
PORTSMOUTH
ISLES
OF
SHOALS
-20 m
OOA PERMIT
SITE
-50 m
-60 m
0 1 2 Kilometers

$ Economics $

Annualized Investment (based on 5 lines over 5 years)

• Longline: assembled and installed	$ 4,500
• Labor (based on 26 days /year)	$10,400
• Vessel Conversion (equipment)	$ 1,000
• Vessel Operations	$15,600
• Seed Costs	$ 4,000
• Expendable supplies	$ 3,000
• Processing, packaging, shipping	$10,000
Total	$48,500

Production

• Yield per line:12,000 lbs	60,000 lbs
• Wholesale price (processed product)	$1.25/lb
• Gross Revenue	$75,000

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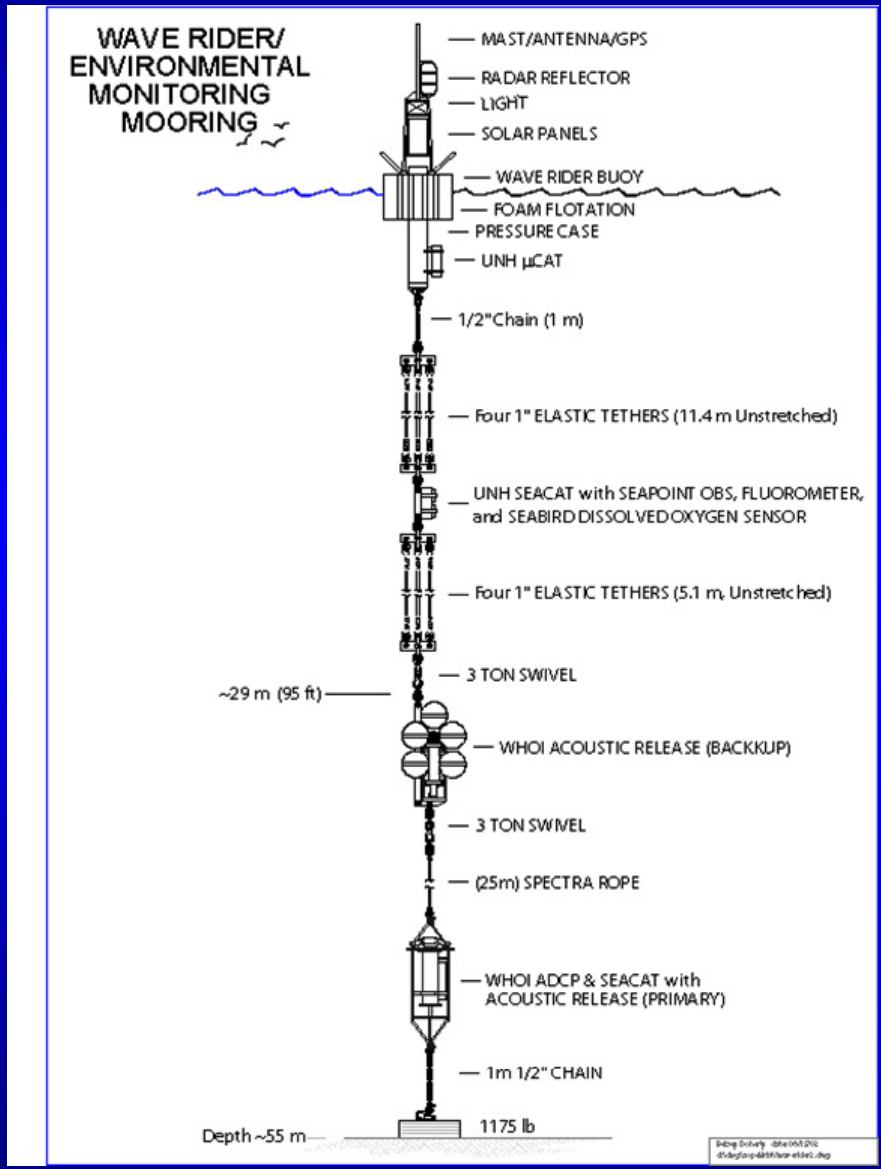
Environmental Assessment

Instrumentation Buoy

In-situ Instrumentation



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Benthic Fauna

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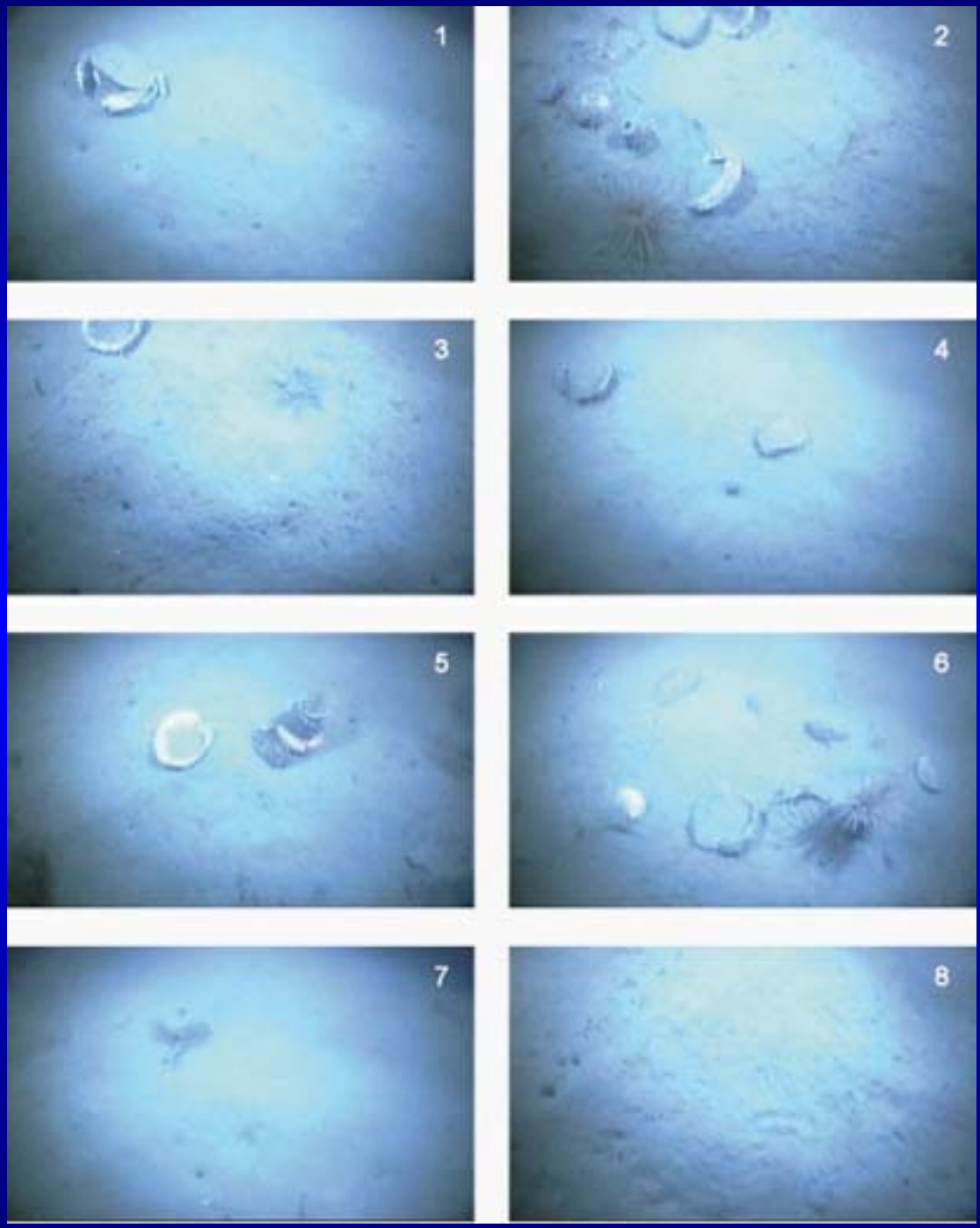

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Sampling and Analysis

Indicators

Sediment

Benthic community

Still &Video

Water Quality (O2,N, P, Chl, TSS)

No Measurable Changes

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Looking Ahead

Engineering

- *Twenty ton feeder*
- *Improve real time video transmission*
- *New cage and Mooring Designs*

Finfish

- *Cod physiology and behavior*
- *Juvenile production and nursery strategies*
- *Live marketing of 0.75 kg fish*
- *Additional species*

Shellfish

- *Expand Commercialization Efforts*
- *Develop local processing capacity*
- *Product Branding and marketing*
- *Continue Technology Transfer*

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Thank You!
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Questions?