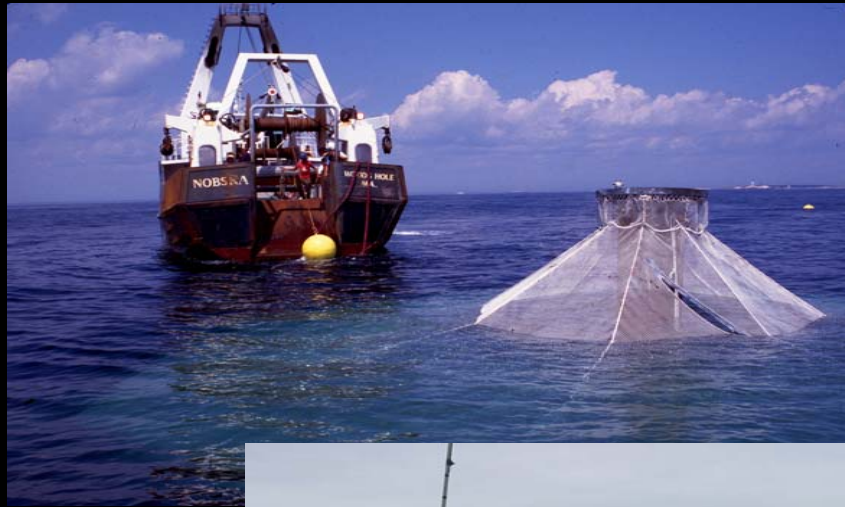


# Operations of an Open Ocean, Submerged Farm

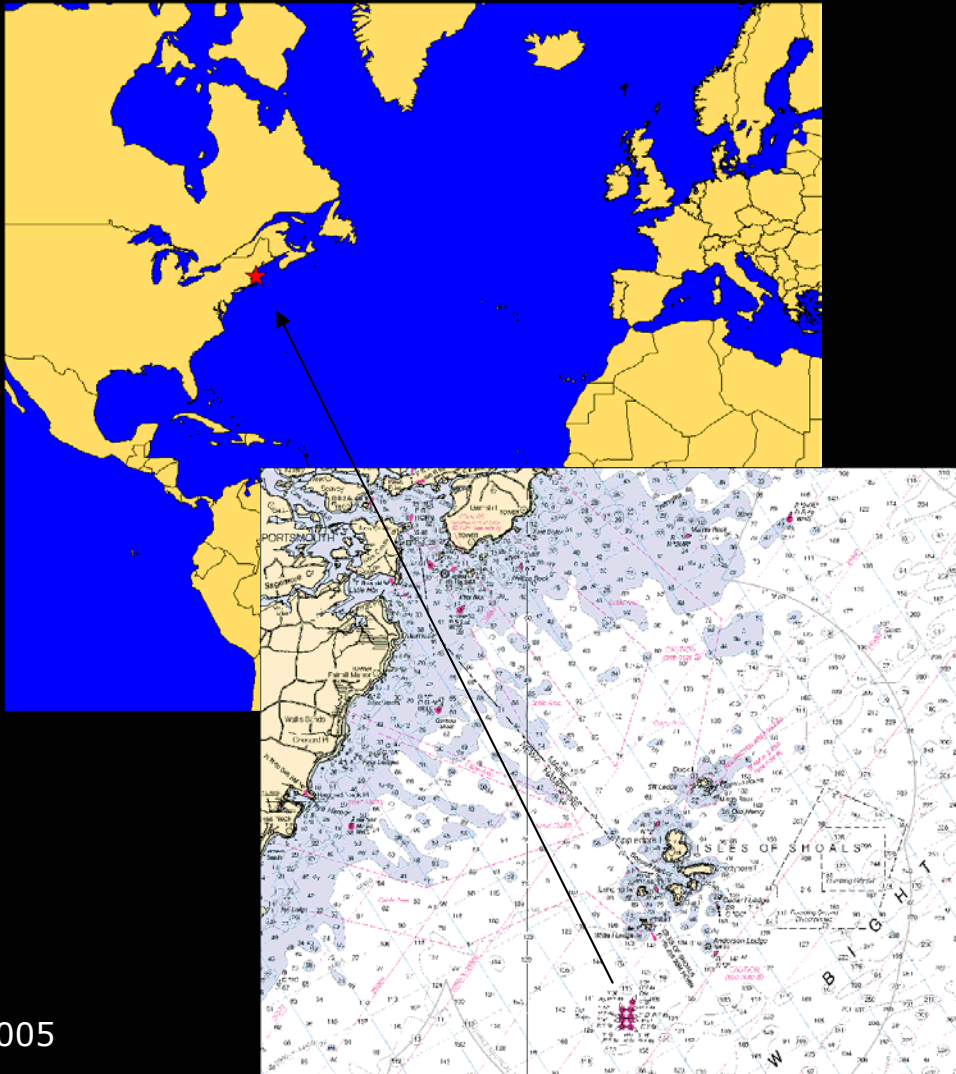


**OOA is a component of NOAA/UNH CINEMar**

**Solutions for Responsible Aquaculture**



# Open Ocean Challenges in New England



- UNH has a permitted site 10 km offshore of New Hampshire
- Three Ocean Spar Sea Stations
- Auto feed buoys
- Submerged grid mooring system
- Two submerged mussel longlines
- In 52 m of sea water
- Energetic Conditions
  - Wave Heights: 9+ meters
  - Wave Periods: 4- 12 sec
  - Ocean Currents: Up to 60+ cm/s

# Project Components

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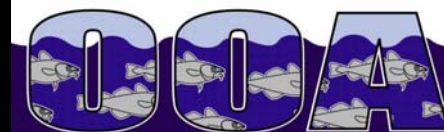
- *Site Selection and Permitting*
- *Engineering*
- *Biology-finfish, shellfish*
- *Environmental Monitoring*
- *Education and Outreach*
- *Economics*
- *Technology Transfer*
- *Operations and support for above*



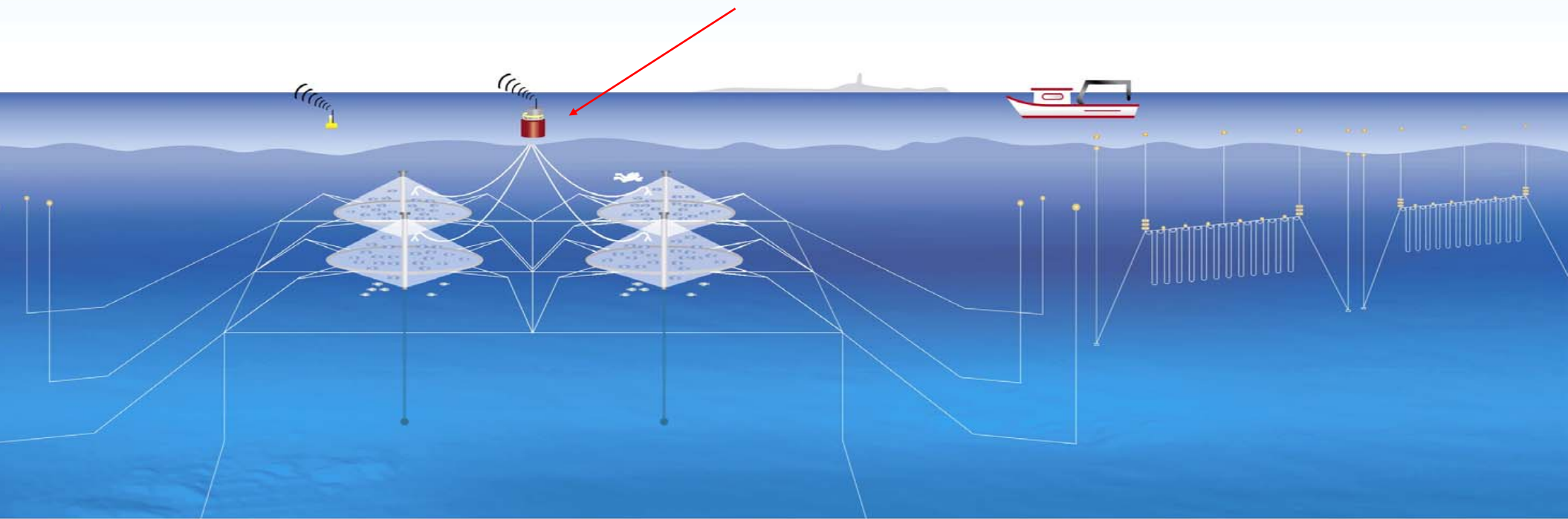
# Why submerged Culture?

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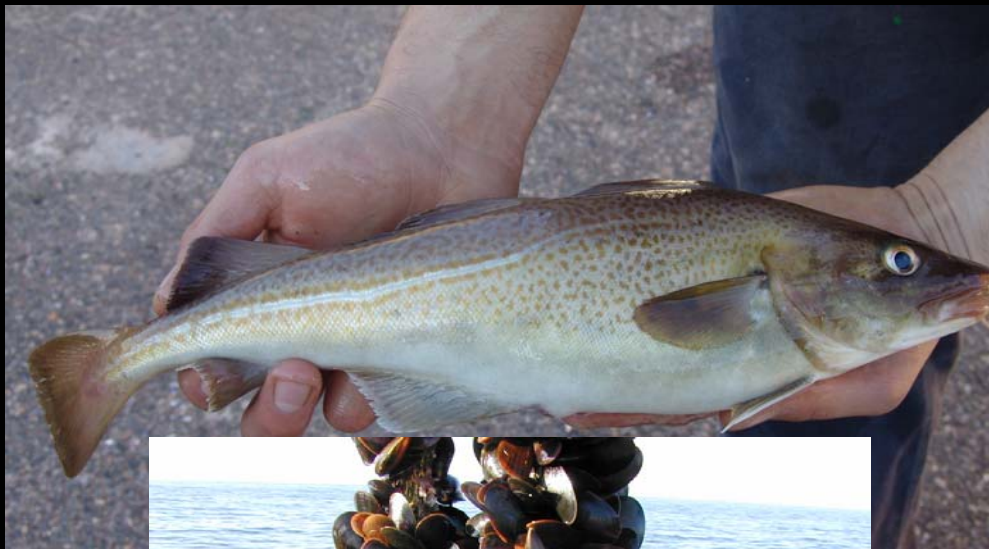
- Less seasonal variation in temperature (max. 13°C vs. 20°C at surface)
- More conducive environment for fish
- Less energetic environment
- Minimizes wear on gear and cages
- Less bio-fouling at depth
- Fewer visual impacts



20 ton centralized feed buoy

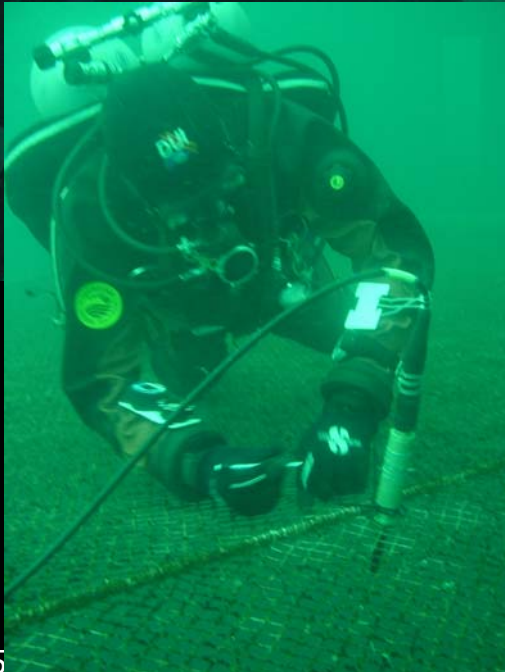


# Cold Water Marine Species



# Operations are Diving Intensive

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# Fin Fish Needs (think like a fish)

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- Transport to site
- Containment
- Feed
- Observe
  - Acoustic
  - Visual
  - Instrumentation
- Harvest



# Operations (think like a human)

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- Maintenance
- Access
- Safety
- Ergonomics
- Communications
- Procedures

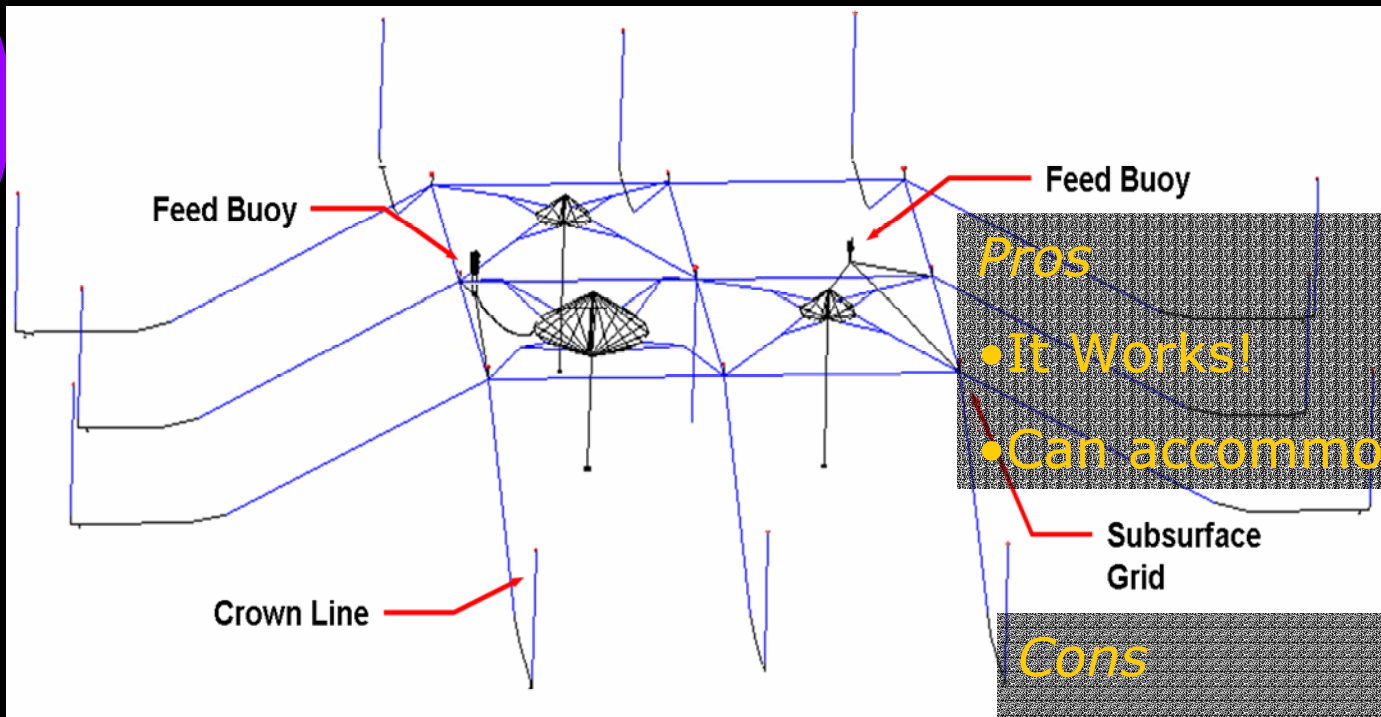


# Open Ocean Farm Support



Need the right tools for the job!

# Submerged Mooring Platform



## Pros

- It Works!
- Can accommodate different cages

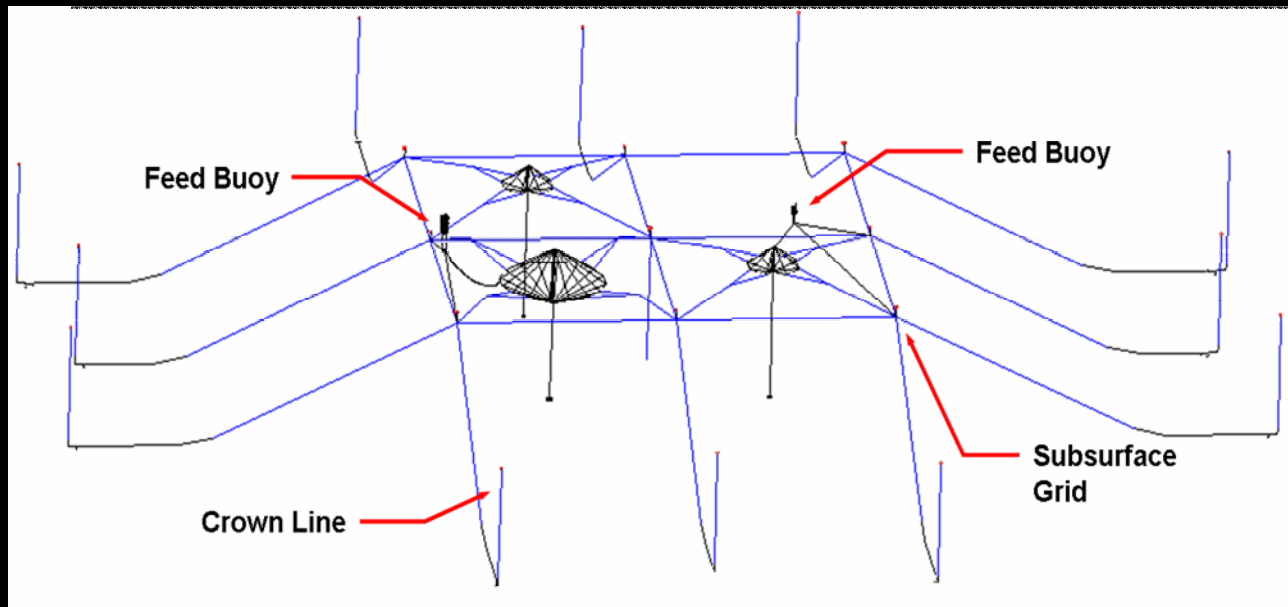
## Cons

- Divers required
- Large foot print
- Complicated deployment

# Submerged Mooring Platform

## Mooring Design For the Future

- Optimized for a cage
- Small foot print for used area
- Minimize diving
- Submerged



# Sea Station 3000



## *Pros*

- Structurally sound
- Submersible



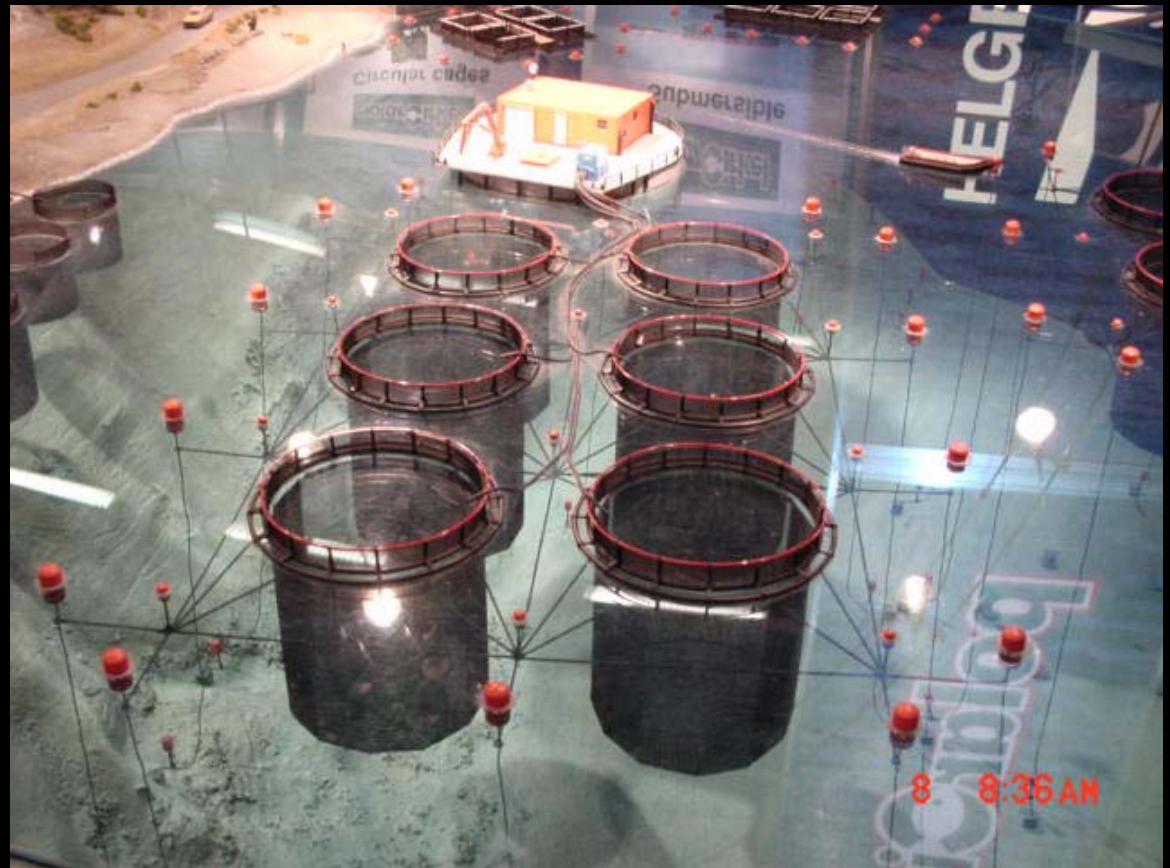
## *Cons*

- Holding vessel close to cage is difficult
- Harvesting requires divers
- Pendant weight problems
- Ascent is uncontrolled

# Development of New Submersible Cages

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- SBIR - NH
- GOMAC - ME
- ASA - China
- OWS - CA



# Development of New Submersible Cages

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Cage functions

Biofouling

Net repair

Structure repair/maintenance

Raise and Lower the cage

Interaction with support vessel



# Development of New Submersible Cages

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Fish work  
Mort removal  
Decompression (live harvest)  
Grading  
Harvest  
Sample  
Feed distribution



# Open Ocean Feed Buoys

- Began 5 yrs ago
- 1/4 ton deployed 4 yrs ago 1/4 ton
- 1 ton deployed 2 yrs ago
- Development of 20 ton



1 ton

# UNH Feed Buoy Design Criteria

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- Loading feed and fuel
- Biotelemetry / communication
- Serviceable platform
- Hydraulic feeding
- Feed multiple cage
- Compliant mooring



# Fish Transport, Stocking and Harvest



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# Video Monitoring Essential

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- **Monitor fish for:**
  - Behavior
  - Feed rates / patterns / satiation
  - Hierarchies
  - Mortality
  - Predators
  - Cage utilization
  - Feed loss to environment



# Real Time Biotelemetry

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- Video monitoring
- Communication and control of feed buoys
- Diagnostic testing of components
- Wave rider buoy – environmental data





What are the Next Challenges?

