Food From the Sea:
Projects, Technology and Constraints
From an Engineering Perspective

Gary Loverich

European Mid-water Trawler
NET Systems Doors

Food From the Sea:

Projects, Technology and Constraints From an Engineering Perspective

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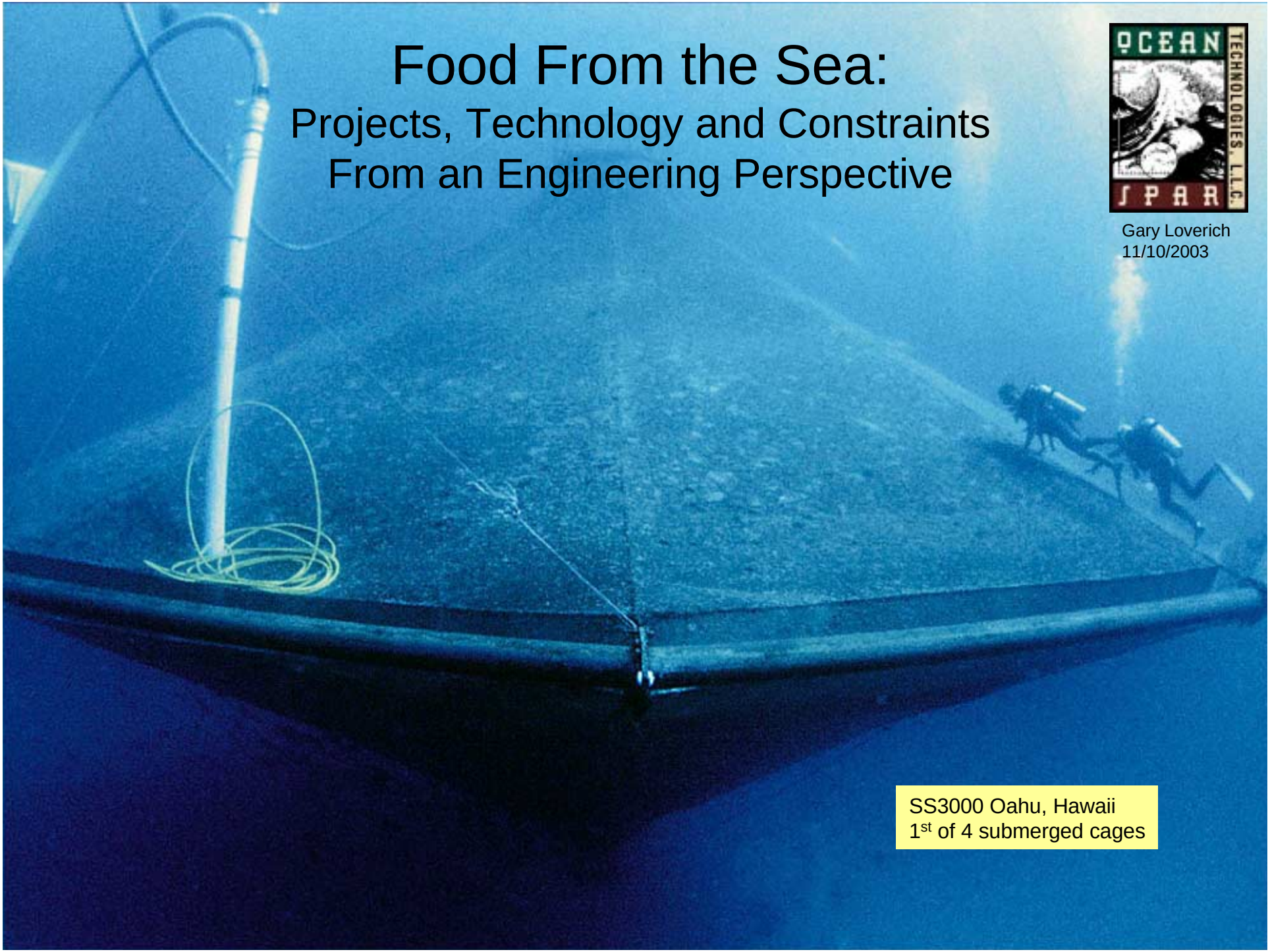

SS3000 Oahu, Hawaii
1st of 4 submerged cages

The Mission: FOOD FROM THE SEA
New Technology Brings

- Promise
- Conflict
- Resistance to change

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Sea Farming is going to occur where The conditions are right. And the Global economy means it will affect US fish markets.

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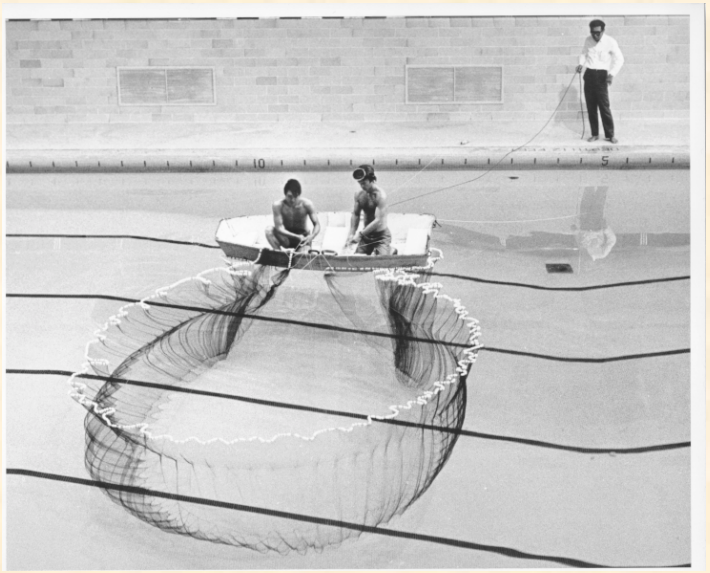
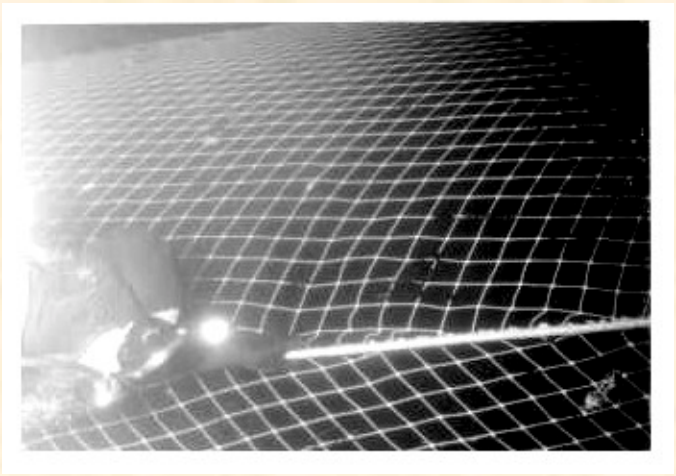
A few Professional Experiences

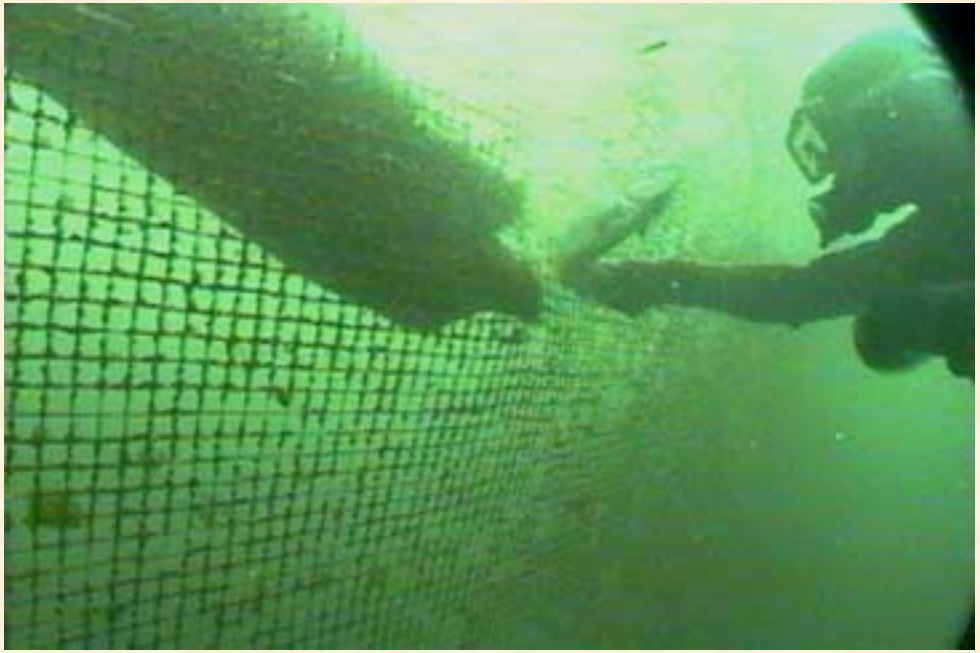


TUNA SEINE 1971-1973



TRAWL DIVING 1969-1978

BOTTOM TRAWL MODELS 1982-Present



SEA LION PREDATION Investigation-1995

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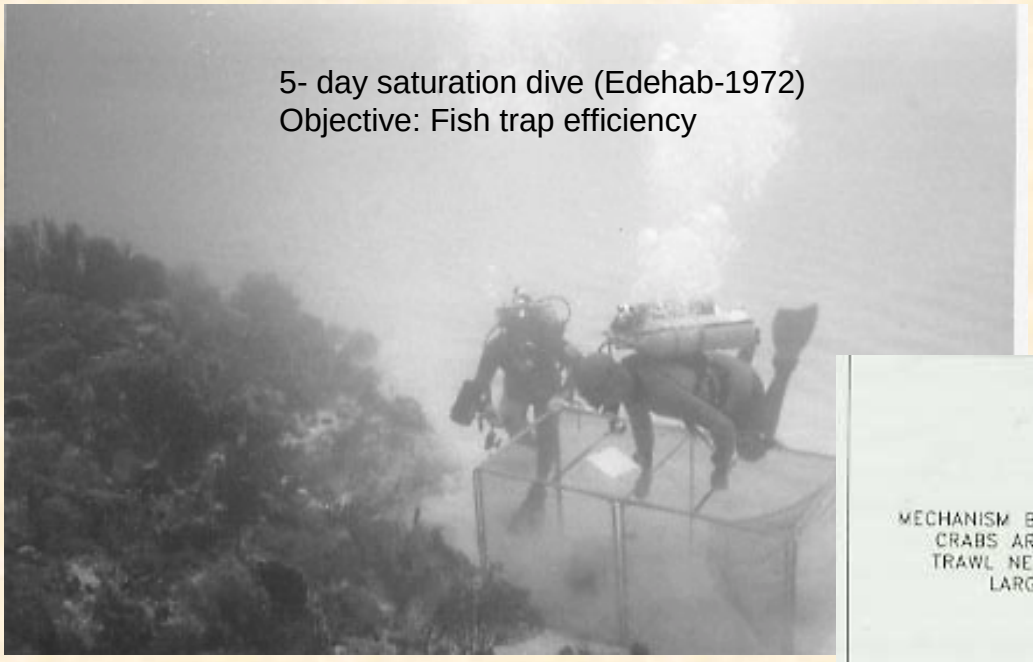
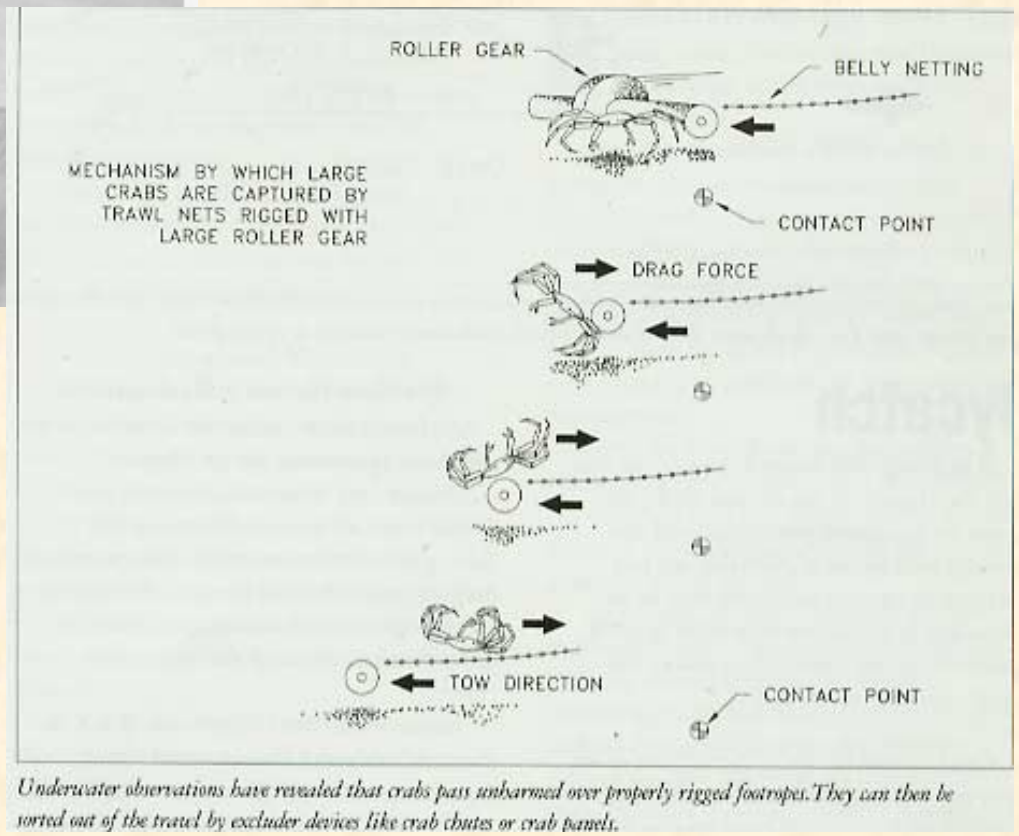


5- day saturation dive (Edehab-1972)
Objective: Fish trap efficiency

1986-1987
Found large king crab
enter trawls by hydro-dynamics
rather than by crushing impact



Underwater observations have revealed that crabs pass unharmed over properly rigged footropes. They can then be sorted out of the trawl by excluder devices like crab chutes or crab panels.

And so on!

Familiar aquaculture- Gravity Cages sheltered water-low energy sites

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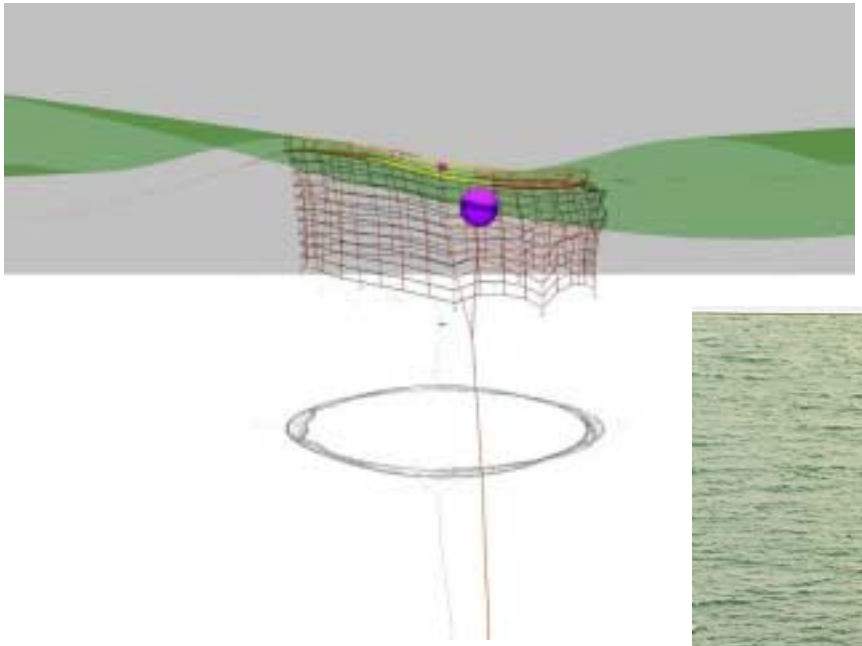

Sea Bream Cages on Spanish Mediterranean Coast

This cage class makes up 99% of all aquaculture Equipment. Reasonable For Sheltered waters

These cages do not represent the future Of coastal or offshore sea farming

Since 1989 our major emphasis has been developing
Sea cage systems that will overcome one of the major
Constraints to offshore development

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This is a broken gravity cage manufactured
In New Zealand and purported to be for offshore.
It and two others broke up in Puget Sound before
The nets were even installed.

The need for a robust, reliable, economical offshore
Sea Farming "**SYSTEM**" operating in high energy coastal sites

Ocean Spar Cage-Exposed site
Higher Currents/Moderate Waves

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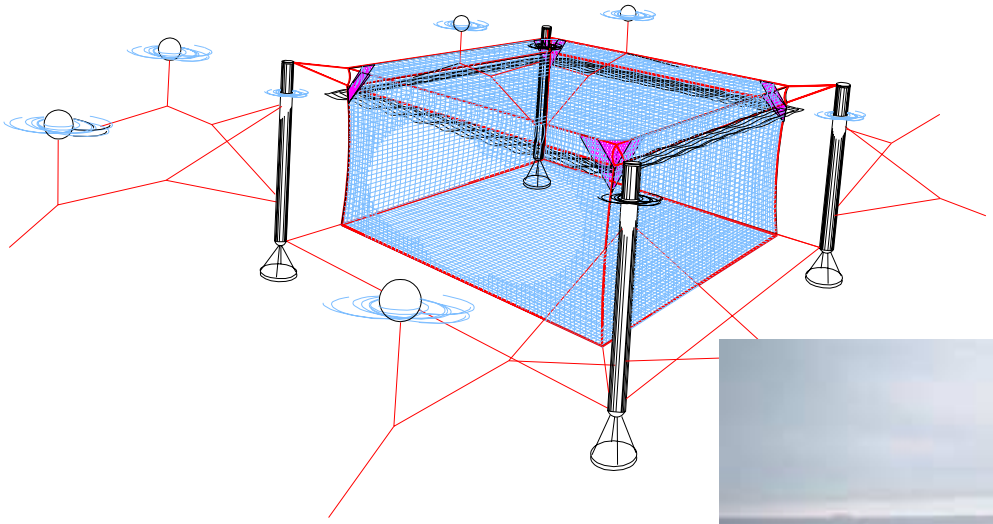

Straits of Juan De Fuca

First offshore install---------1990
Total # installs--------
Cage Capacity (salmon)---750 T
Status------------------Operational
Efficiency----------------Very High
Initial cost-------------Competitive

Sea Station Cage-Exposed site Moderate Currents/High Waves

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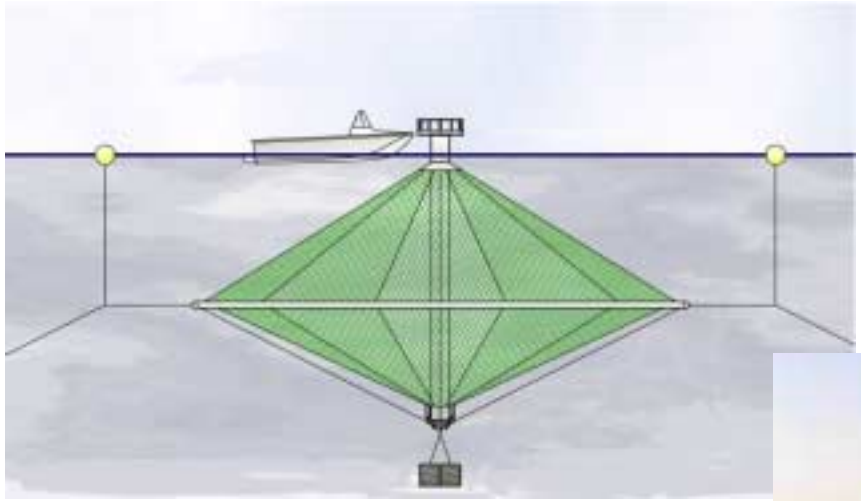
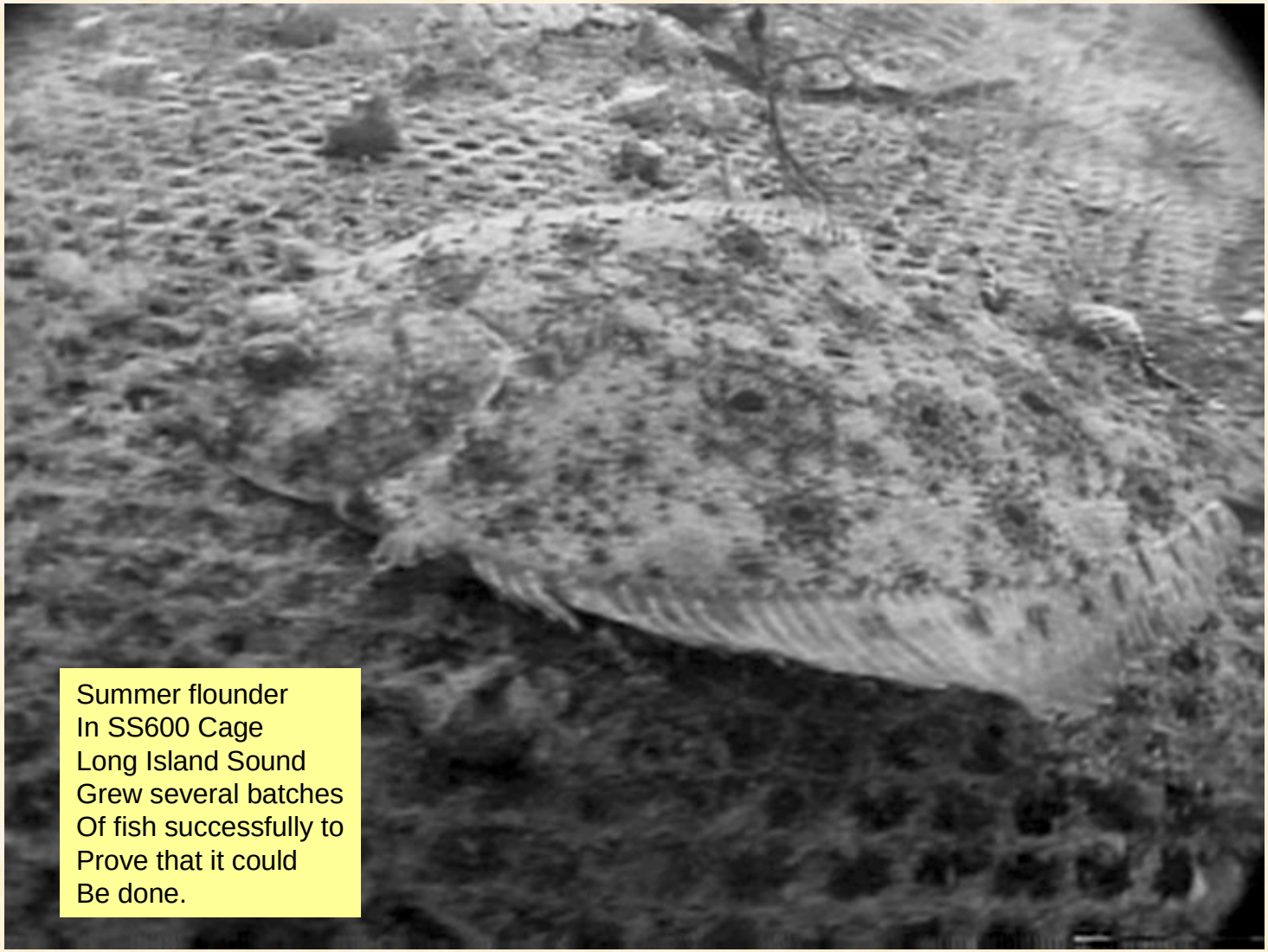


SS3000-Paphos, Cyprus
Mediterranean
Automatically sinks in storms

First offshore install---------1996
Total # installs--------
Cage Capacity (salmon)-----90 T
Status----------Operational
Operating Efficiency----------high
Initial Cost---------considered high

Long Island Sound
Single SS600-exposed site



Summer flounder
In SS600 Cage
Long Island Sound
Grew several batches
Of fish successfully to
Prove that it could
Be done.

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Oahu, Hawaii 4-SS3000 Operating Sea Farm

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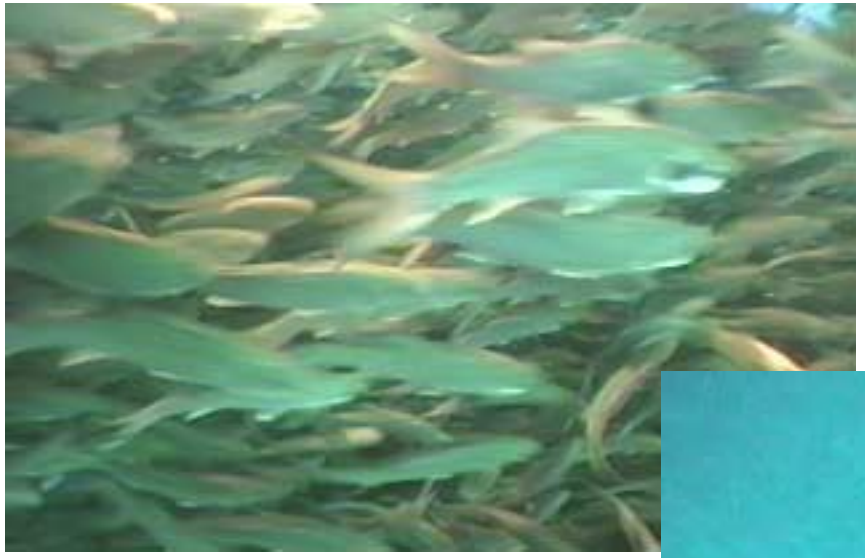

Moi-Pacific Threadfin
Always submerged
Innovative & Successful operation
Submarine tours starting in Spring

OST Can do certificate

Eleuthera, Bermuda-1 SS3000
A teaching/demonstration site

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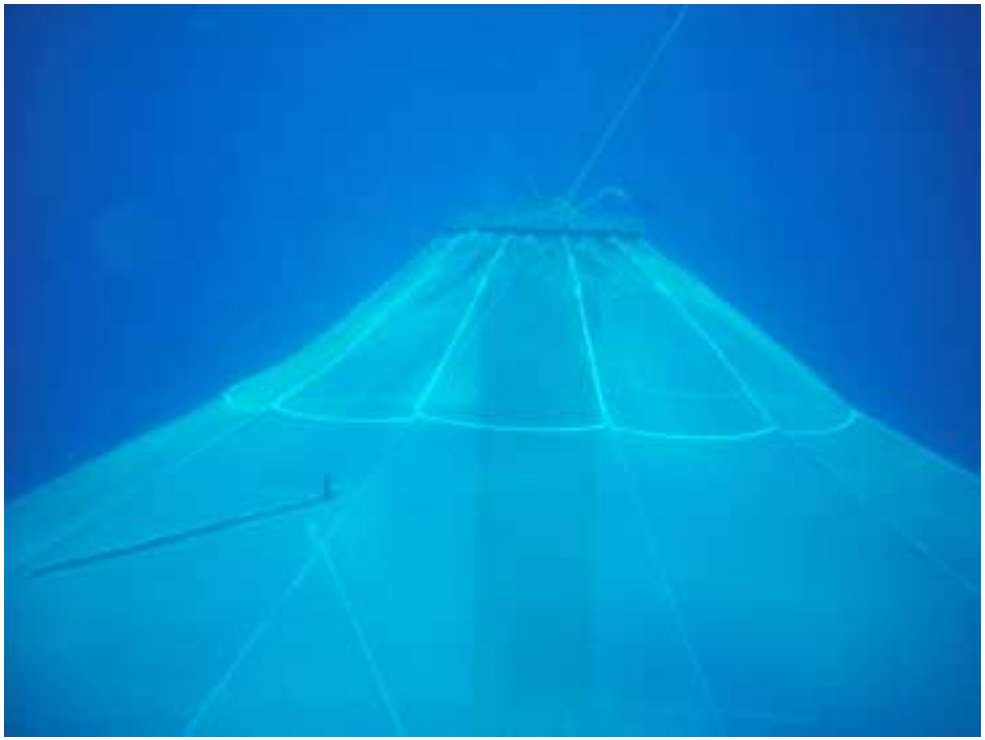

Cobia and Snapper

Ocean Spar Cages
New Brunswick

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Head Harbor
360 t Atlantic Salmon
Special Anchor system to
Avoid Scallop trawl area

Tinker Island
600 t Atlantic Salmon
High Current Site

Calabria,Puerto Rico-2 SS3000
Sea Farms, Inc.

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Now harvesting fish for market
That wants more

Cobia-10-15 lbs in one year

Atlantic Coast-Development Sites:
1- Spanish & 1- Portugeuse-SS3000

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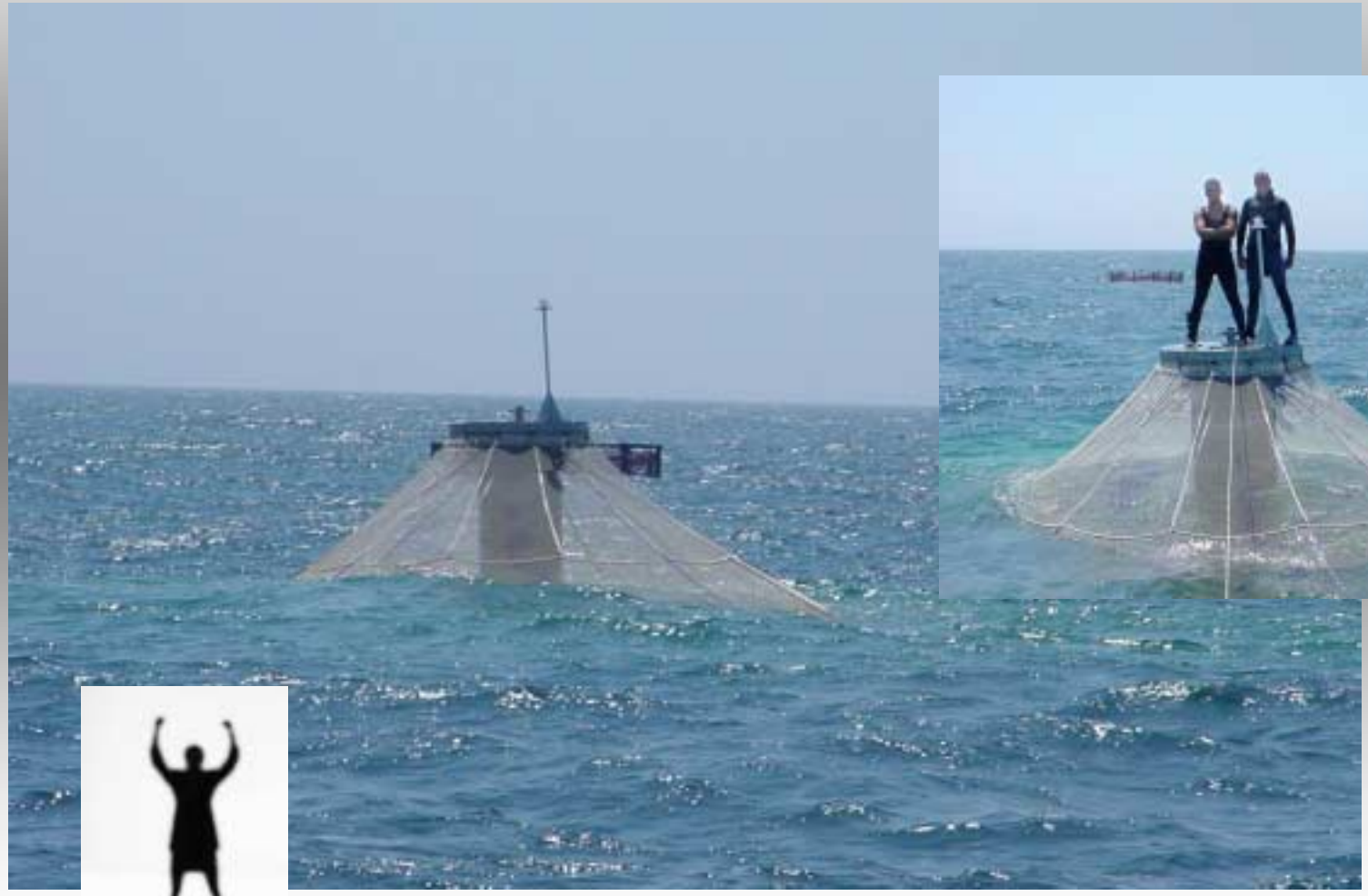

Cadiz

In the distance is New York

China-2 SS3000
Status Unknown

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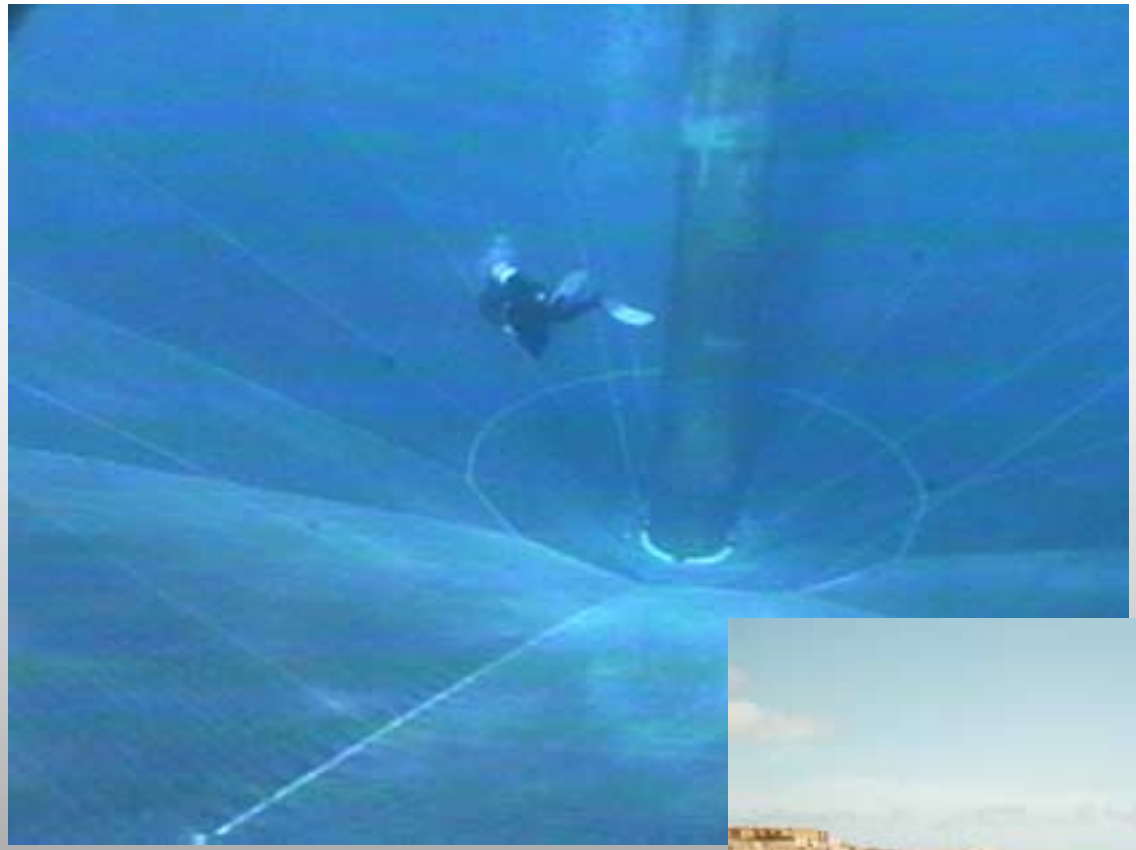
10 t OST concrete anchors
Water very Murky/shallow
Working climate---adversarial
Infrastructure-------poor
Lots to learn

Philippines-2 SS3000
Great Potential-No infrastructure

The guard & shelter in Philippines
Milk fish-4 crops/year/cage-240T
Local infrastructure and adversarial culture
was/is problematic.

Experiment growing shrimp in the
Bottom of the milk fish cage was
Interesting and shows there should
Be some potential for cage
shrimp culture



Sea Station Cage in Paphos, Cyprus
60T Sea Bream every harvest cycle

2-Ocean Spar cages in Canary Islands 400T of Sea Bass

Gulf of Mexico Sea Station 12T capacity
US Gov't funded research

Two Ocean Spar Sea Cages
Nova Scotia-250 T salmon
High current area without a
Salmon industry

UNH 3 yr experience submerged
12 mile in Atlantic, Isle of Shoals
2-SS600 & 1-SS3000
1500 Halibut,
Haddock
30,000 cod fish
Developed 2 auto feeders

Ocean Spar Sea Cage-Faroe Islands
750T of Atlantic Salmon each growing Cycle

Ocean Spar Sea Cage-Killary, Ireland
750T of Atlantic Salmon each growing Cycle

Efficient Harvest with these
Bottom moves upward and
Remains taut. Fish move out
30 ft x 8 ft opening to a smaller
Harvest cage

Sea Farming will be applied- - - - - - - - well where ever!

Steelhead farm on the Columbia River-1000T-entirely submersible
location 10 mi down river from Grand Coolee Dam-7 cage total

Other Washington State Applications

Ocean Spar Sea Cage- Straits of Juan de Fuca 100T capacity- Was a developmental site to prove the concept. The straits have great Potential, long coast, clean water

Ocean Spar------Coho salmon enhancement cages-Elliot Bay & Agate Pass, Washington.

1 million smolts released every year for the past 7 years & up to 15% return

How will sea farming equipment develop?

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It will develop similar to the Commercial Fishing Industry

- Specialized vessels/cages
- Faster Gear Handling times
- Specialized equipment
- Ocean compliant equipment
  1. Flexible
  2. Smaller/Lighter
  3. Modular
     - Replace units at sea
     - Repair units on shore
- Volume pricing for equipment

Caution---If this was easy it would have been done years ago!

Sea Farming Equipment
Ready for Application

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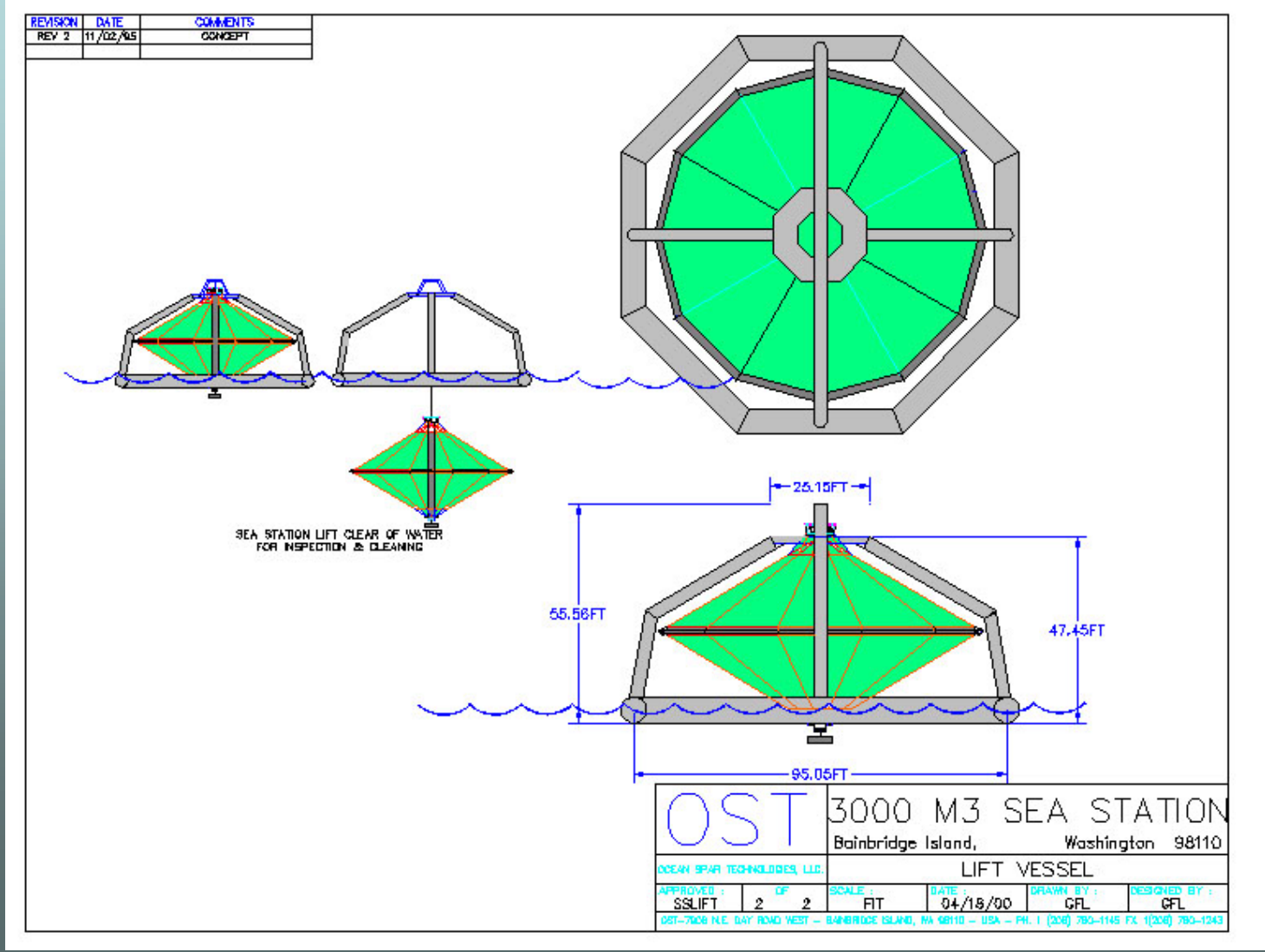
The only needs are:

- Market
- Vision
- Capital
- Location
- Spirit
- Realism

These combinations exist somewhere and really just wait for the proper organizing entity

Possible Hardware Heavy Lift Vessel



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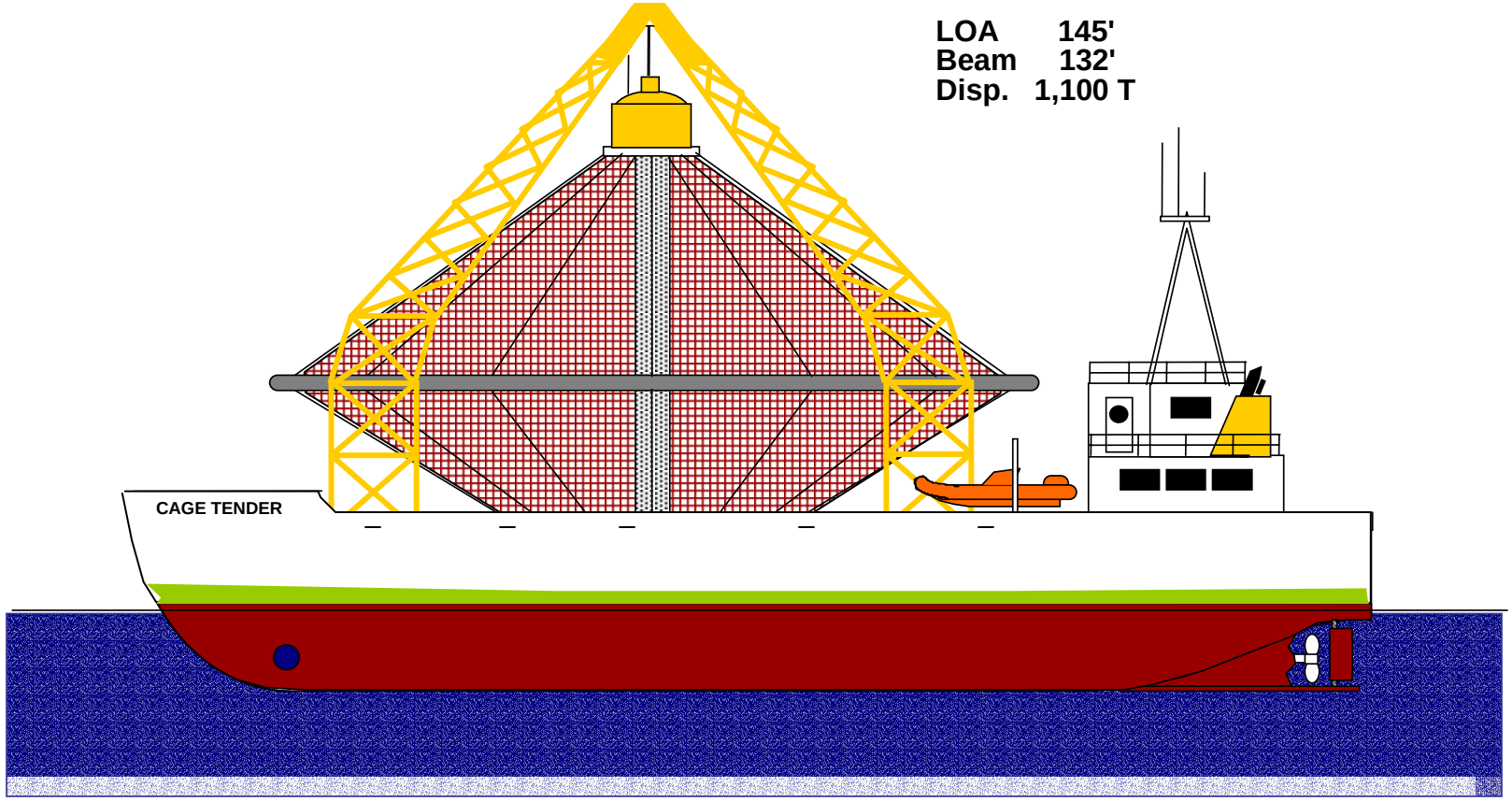
Install
Harvest-human time
Clean
Service
Mort removal
Remove

M/V Cage Tender

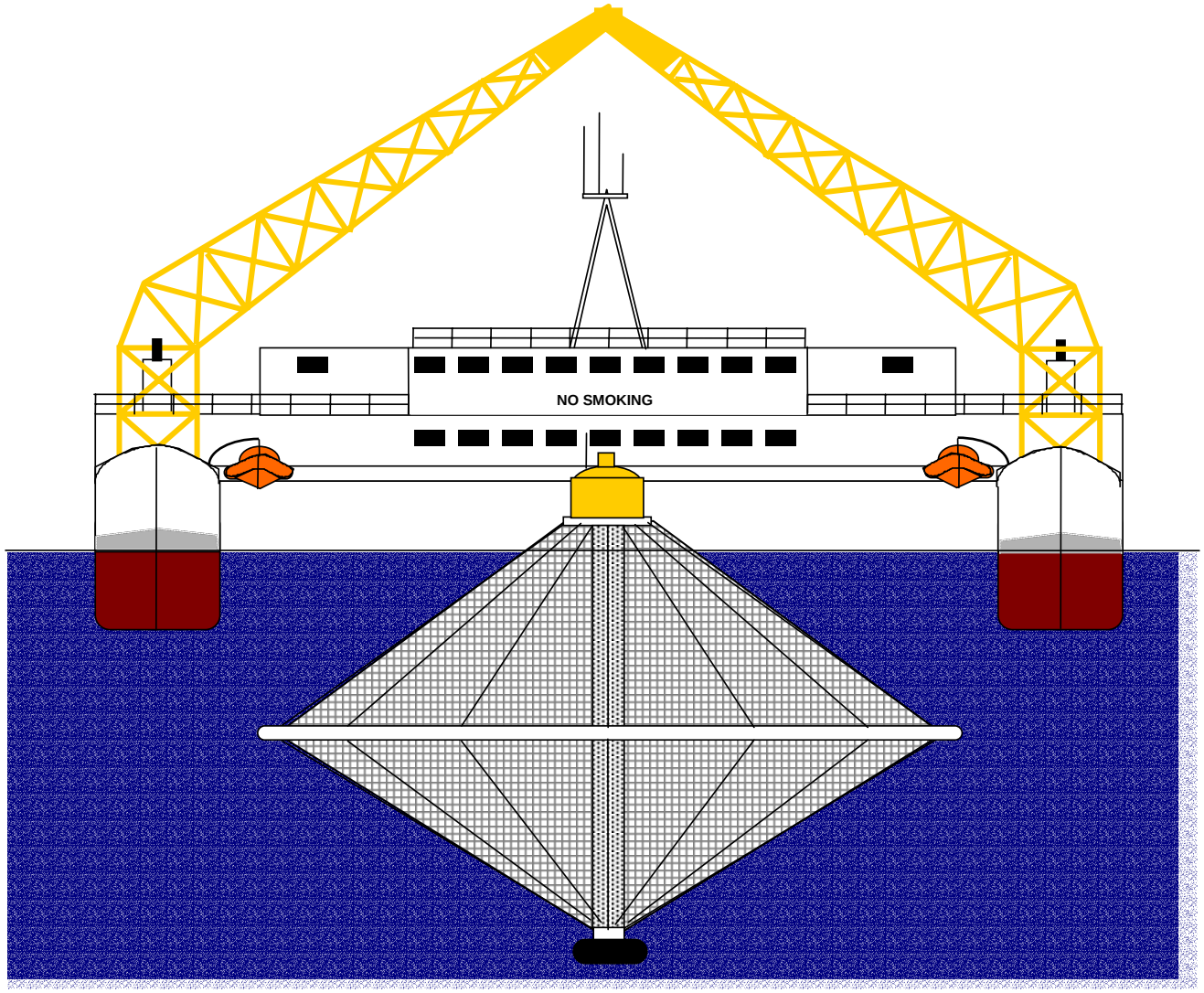
Designed for installing, stocking, maintaining, and harvesting ocean cages up to 100’ (30.5 m) in diameter and live fish transport.



Goudey, 2001

M/V Cage Tender

A purpose-built aquaculture support vessel



Goudey, 2001

Possible Hardware In Sea Farming

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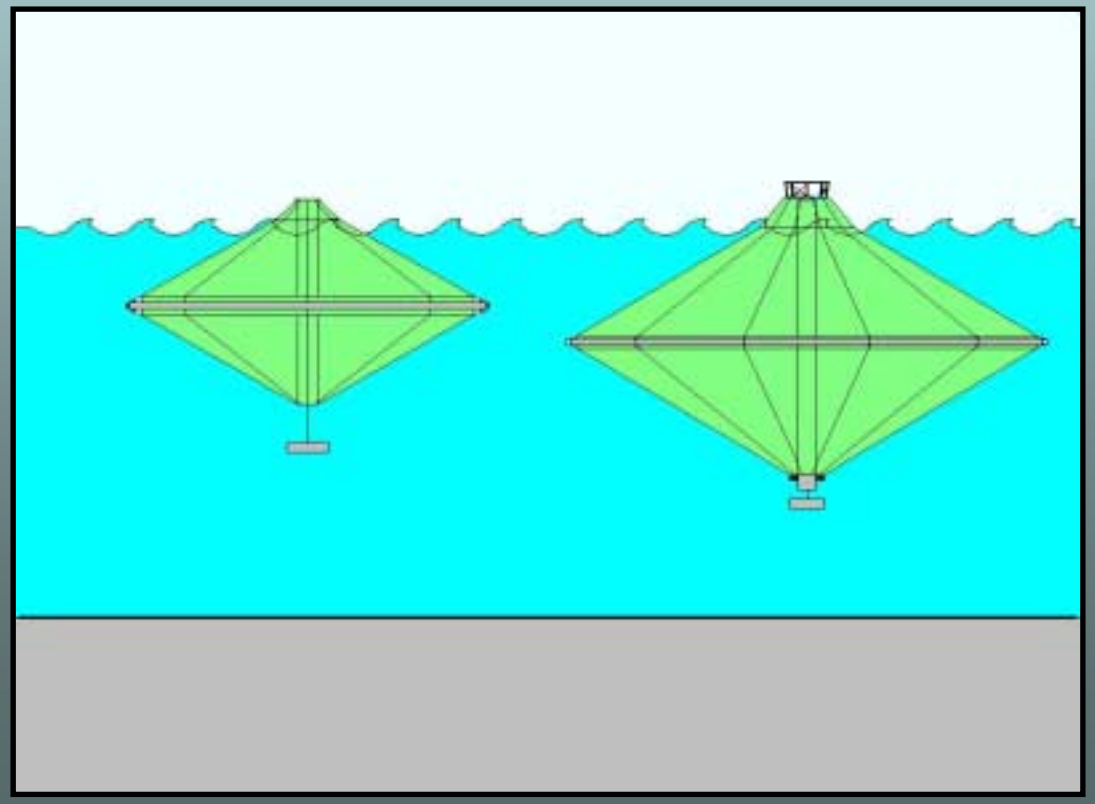
Rough sites—use smaller Sea Stations for easier handling
Develop equipment to handle them faster & more efficiently



As of today's date
SS600:
Drag----------1/3 SS3000
Rim--------8x stiffer SS3000
Volume----------1/5 SS3000
Life----------5x SS3000
Cost---------1/3-1/2 SS3000
Harvest-------12t vs 60t/unit
Surface----------1/3 area
Service Vessel---0.58 x size

Must be designed as System
Within these parameters we
Can design handling equipment
To make smaller units economical

Possible Hardware
50 ton Feed Spar

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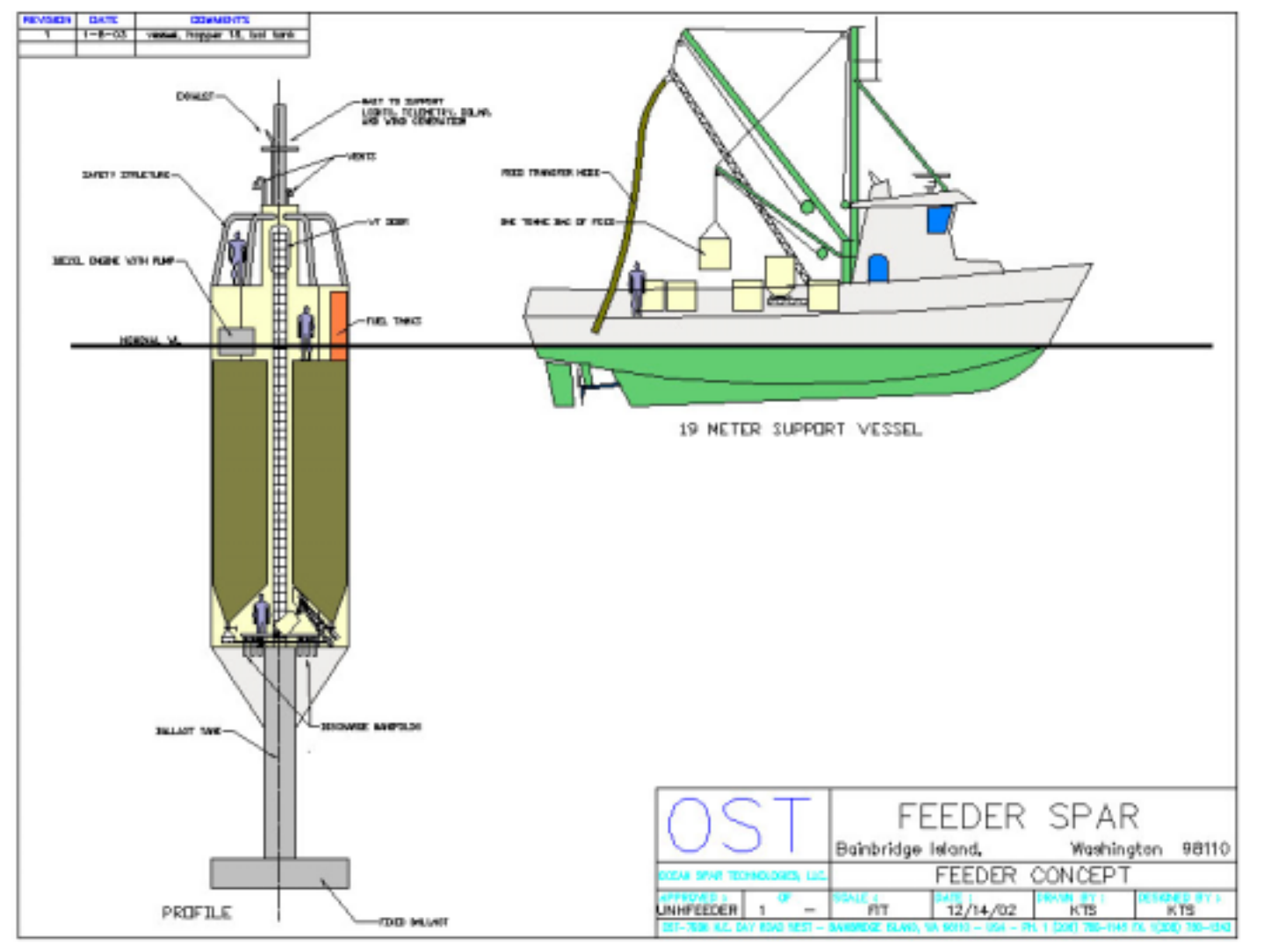

This is now being Designed and Evaluated by OST And UNH For Coastal Sites

Possible Hardware Guided/Drifting Sea Farms

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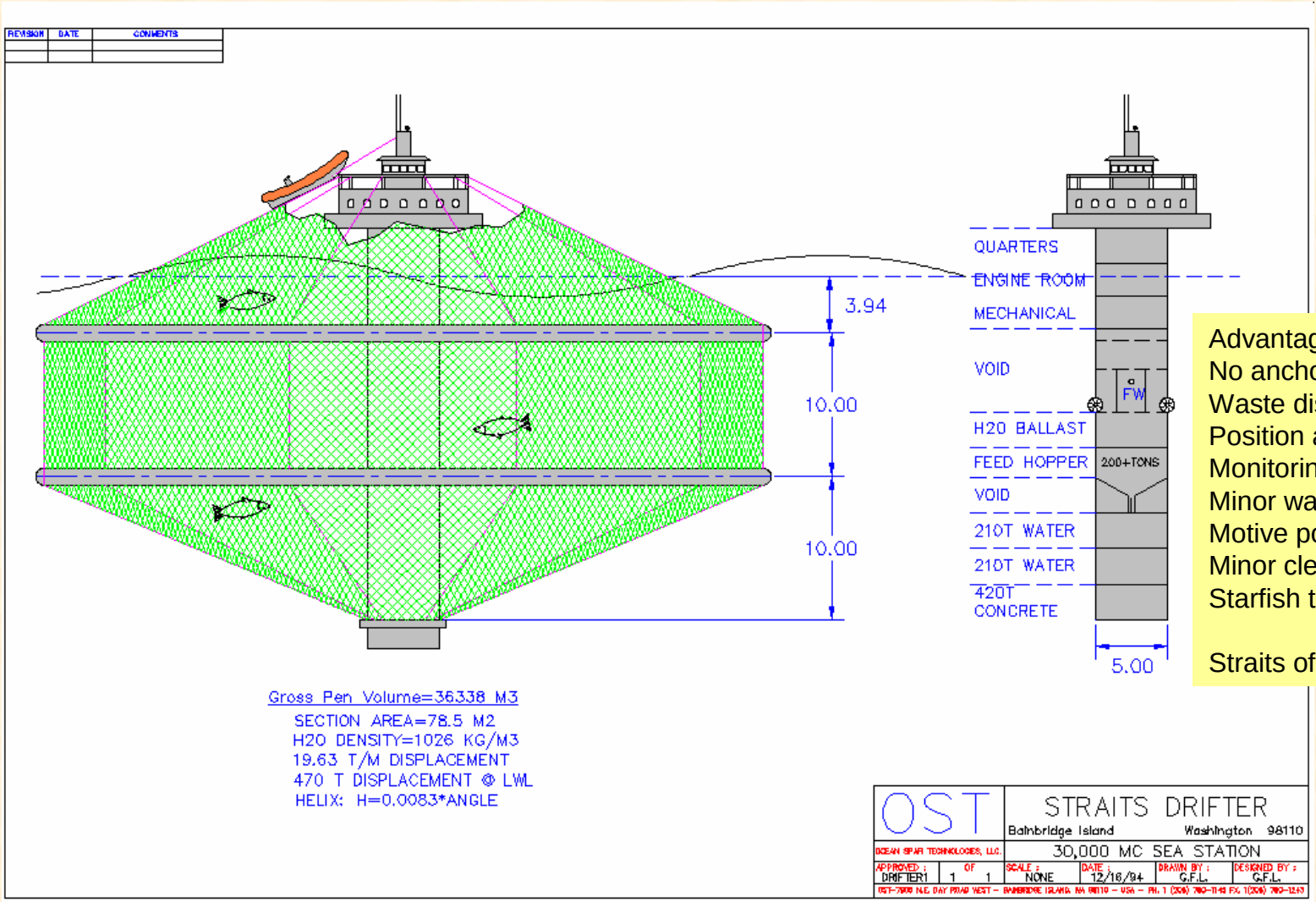

Advantages:
No anchor forces
Waste distribution
Position adjustments
Monitoring
Minor wave forces
Motive power
Minor cleaning need
Starfish to clean mussels

Straits of Juan De Fuca

Possible Hardware
The Fish Rocket

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Reel:
Stores
Deploys
Empties

Control:
Inner velocity

Cost:
Inexpensive

Application-
Tuna farming

5000 cubic meters-Moving 100 Tons live fish at 4.0 kts

Developments:
Cage based on High Seas Mobile Base for Defense Dept.

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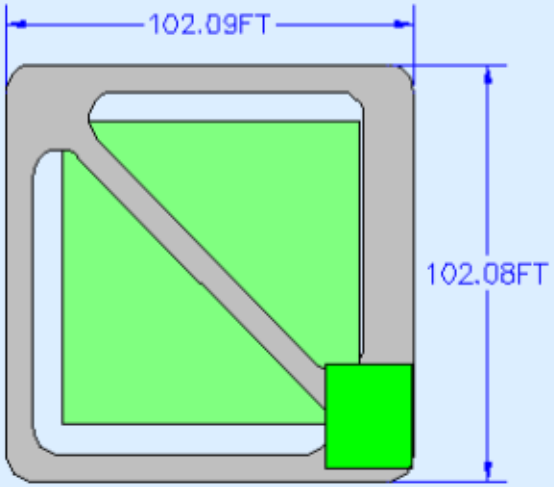
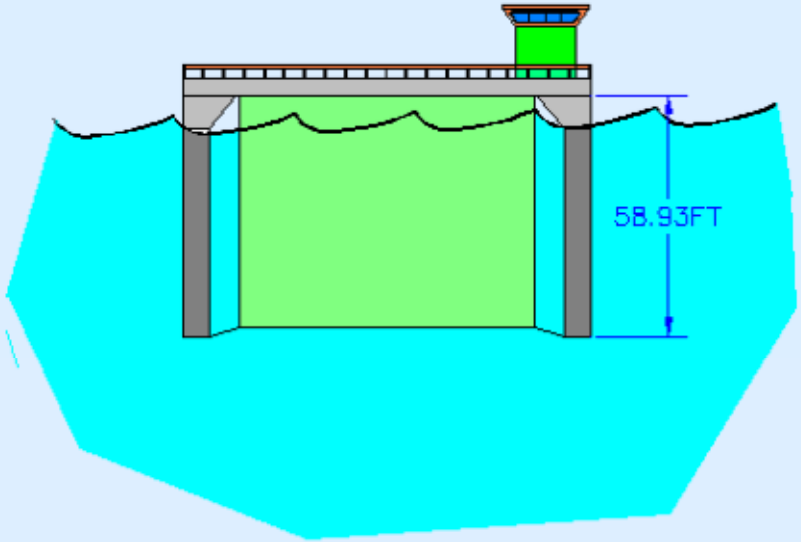
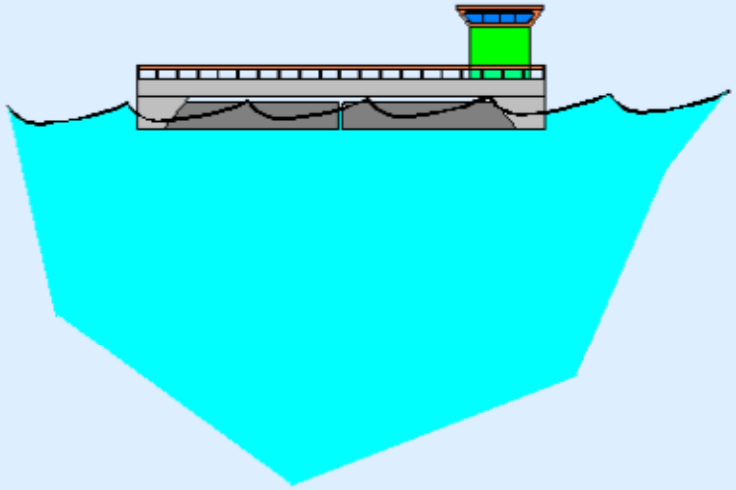


Rights & patent:-CDI Government Services:
Contact- John Buck

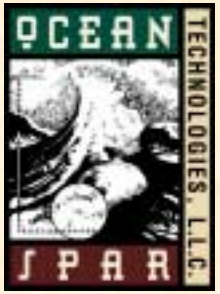




Proto type is being built under Defense Dept.
Contract and may be available for sea farming
Tests afterwards.

More complex version of Ocean Spar cages.
Capable of being moored, powered, or drifting.
Modules mechanically couple to make a large platform

Immediate Applications of Sea Farming Technology For Fishers



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Fish traps

- •Efficiency of operation (long history for salmon)
- •Control of by catch
- •Marine mammal interactions-(down side)

Enhancement cages

- •Mitigating habitat & resource loss
- •Enhancing resource levels for selected species

Holding cages for wild caught fish

- •Halibut and Blackcod-----the fish and cages are waiting
- •Tuna----------already been done & on going
- •Cod fish----------Norway, Canadian E. Coast

Immediate Applications of Sea Farming Technology For Fishers

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Contract "grow out"

- In remote locations
- In coastal sites requiring special skills

FADS-tropical waters

- Commercial fishers already use FADS in deep water for wild fish capture
- Sea Cages are much better fish attractors than buoys
- FADS are just a floating artificial reef

Immediate Applications of Sea Farming Technology For Fishers

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The Fish Feed Business already exists

- Its all caught by fisherman for-
  1. Bait used by commercial fishers to catch more "valuable" wild species or
  2. Fishmeal used by sea farmers to grow more "valuable" domesticated species.

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Food From The Sea: The Fisher and the Farmer

1st- Sea Station at install - Hawaii

2 months later-wild fish outside the cage

2 months later- Moi inside the cage

Here netting separates the domain of the fisher and the farmer.

My fish inside, Your fish outside

or

Your fish inside, My fish outside

Mission: Food From the Sea!

Sea Farming Happens!