

THE NEW CHALLENGE OF KOREAN AQUACULTURE **OFFSHORE AQUACULTURE**



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BACKGROUNDS

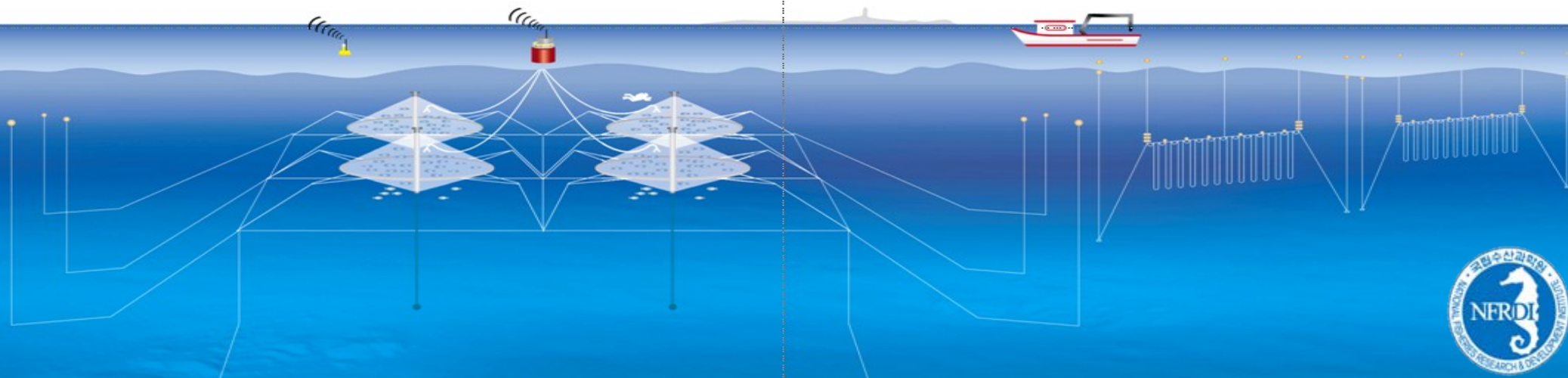
Recent Paradigm of World Aquaculture?

❖ Trends:

- Sustainable (지속적 양식)
- Responsible (책임 있는 양식)
- Environment-friendly (환경친화적 양식)
- Ecosystem-based (생태계기반 양식)
- Food-safety (식품안전 양식)

❖ Site: Inshore ⇒ Offshore

❖ Scale: Family-oriented/Small-scale ⇒ Industrial/Large-scale





Difficulties of Korean Aquaculture?

- Over-cultured in the South Sea where storms can be protected
 - ✓ Low growth rate and pollution-driving disease outbreaks
 - ✓ Losing consumer' trust as valuable fish foods
- Traditionally small scale and family-oriented traditional system
 - ✓ High cost and low efficient business
- Quantity-oriented, few investment for aquaculture engineering
 - ✓ Damaged annually by typhoons and red tides
- Domestic and overseas circumstances
 - ✓ Internally: demanding environment-friendly, food-safety aquaculture
 - ✓ Externally: importing low-cost fishery products



How to Solve?

1. To change the current aquaculture system

◆ *Modification of culture methods*

- ❖ Structure: Quantity-oriented ⇒ Environment-sustainable and/or friendly aquaculture
- ❖ Culture site: Inshore ⇒ Offshore aquaculture
- ❖ Scale: Family-managed, small scale ⇒ Industrialized business, large-scale industry
 - Small-scale ⇒ Large-scale industry

◆ *Up-grading of aquaculture business*

- ❖ Enhancement of internal and external competitiveness by
 - Developing genetic engineering and breeding technology
 - Minimizing disease's caused damages by quarantine and prevention from epidemics
 - Diminishing production cost by automatic culture systems
- ❖ Restoration of consumer's trust by
 - Performing ecosystem-based aquaculture
 - Reducing aquaculture-pollution loads by overall application of formulated feeds
 - Minimizing medicine usage and vaccination



2. To shift the current aquaculture's paradigm

◆ *Relocation of aquaculture grounds*

❖ *Inshore*

- *Finfish aquaculture within the carrying capacity*
- *Ecosystem-based management such as polyculture*
- *Improvement of culture grounds by seaweed culture*
- *Leisure/tourism-oriented coastal management*

❖ *Offshore*

- *Large industrialized cage aquaculture*

Offshore Aquaculture



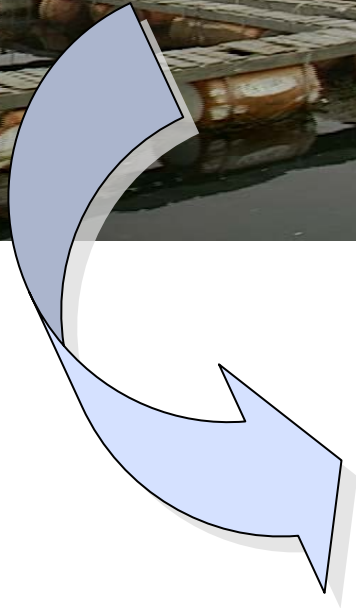


Why Offshore Aquaculture?

- Correspond to international standard for aquaculture activities
 - ✓ Sustainable and responsible
 - ✓ Ecosystem-based and environment-friendly
 - ✓ HACCP principle: Food- safety
- Utilize the ocean three-dimensionally
 - ✓ Inshore: Integrated coastal management, marine leisure zone, extractive aquaculture
 - ✓ Offshore: High-value fed aquaculture
- Strengthen the international competitiveness for aquaculture
- High initial investment for cage installation, autofeeder, workboat, and other facilities
- Risky activities for managing fish cultivation under the deep sea



OFFSHORE AQUACULTURE



Snapperfarm, Inc.
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Outline...

♣ *Name of project: Development of Fundamental Technology for Offshore Aquaculture in KOREA*

❖ **Period: Three years (year 2005~2007)**

❖ **Team formation and major roles:**

- ✓ Jeju Fisheries Institute: Culture techniques, future target fish, feed development, etc.
- ✓ Engineering department: Net-cage development suitable for Korean environments
- ✓ Environment department: Environmental assessment
- ✓ Noah Offshore Farm: Culture and business

❖ **Annual fund:**

- ✓ For research: R&D fund from NFRDI of \$650 thousand
- ✓ For business: Several million dollars from Noah Offshore Farm

❖ **Offshore cage system:**

- ✓ Ocean Spar of Net Systems co. developed by NOAA, U.S.A.


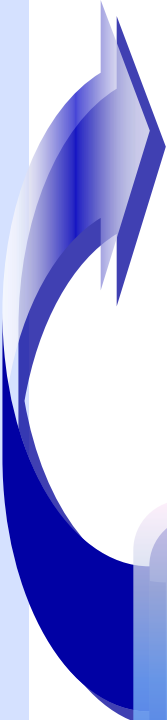
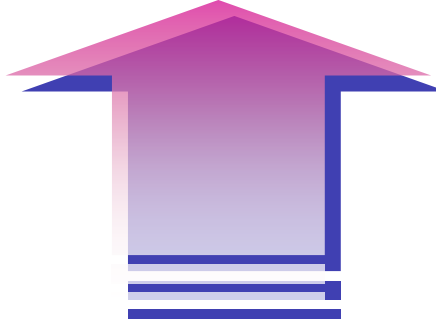




MISSION AND GOALS...



Paradigm Shift of Korean Aquaculture Industry



Increase aquaculture potentials utilizing open sea
Produce environment-friendly and food-safety culture products
Develop offshore cage fit for Korean oceanic conditions



METHODOLOGY AND RESULTS

Crucial Factors for Successful Offshore Aquaculture!!!

- ❖ Where to settle? < *A. Culture site* >
 - Environmentally: W.T., currents, depth, substrates, etc.
 - Safety of net-cages against strong waves
 - Other facilities: seedlings, port, transportation, etc
- ❖ Which systems to choose? < *B. Cage system* >
- ❖ What kinds of species to culture? < *C. Target fish* >
- ❖ How about manpower?
- ❖ Other considerations: law and regulation, residents, etc.





1. Culture Site...

❖ Criteria for site selection

➤ For cage safety:

- ✓ Amiable water currents (around 1 knot), typhoons, storms, etc.
- ✓ Appropriate water depth and substrate components

➤ For culture animal:

- ✓ Suitable water temperature ranges and duration
- ✓ Seasonal variation of salinity, D.O., and water quality
- ✓ Red tide, pollution, storm, etc.

➤ Other factors:

- ✓ Distance from markets and relative facilities (port, hatchery, etc)



JEJU-DO

Seongsan

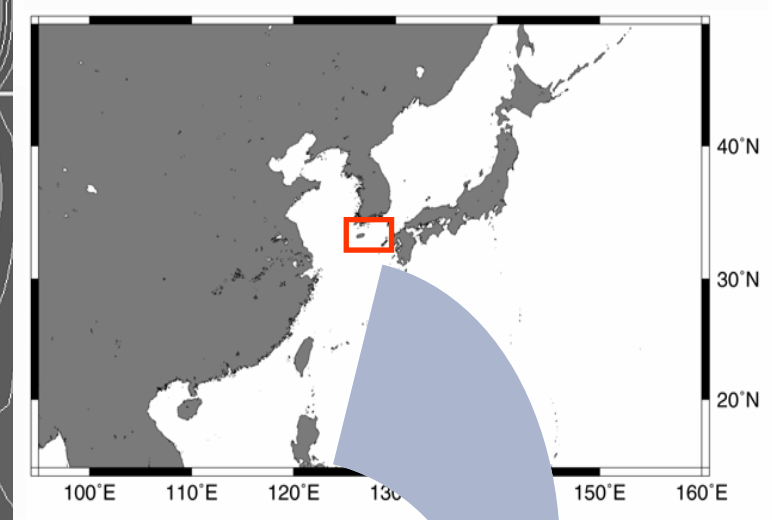
Onpyeong

Pyoseon

Culture site

- ✓ Location: Pyosun-ri, Namjeju-gun/ Southeastern side of Jeju island
- ✓ Distance from nearest land: 4.5 km
- ✓ Water depth and temp.: 40~50 m, 13~26°C
- ✓ Current velocity: 0.6~2.knots, east to west

Model domain





2. Cage Installation...

❖ Which cage systems?

➤ First consideration:

- ✓ Cage safety against strong water currents and storms?

➤ Second considerations:

- ✓ Price?
- ✓ Managing conveniences for cage and culture animals?
- ✓ Systematic combination of cage and other structures?
- ✓ Disturbance to navigation and other fishery?
- ✓ Technological cooperation and assistance?
- ✓ A/S and technical transfer?

➤ Others:

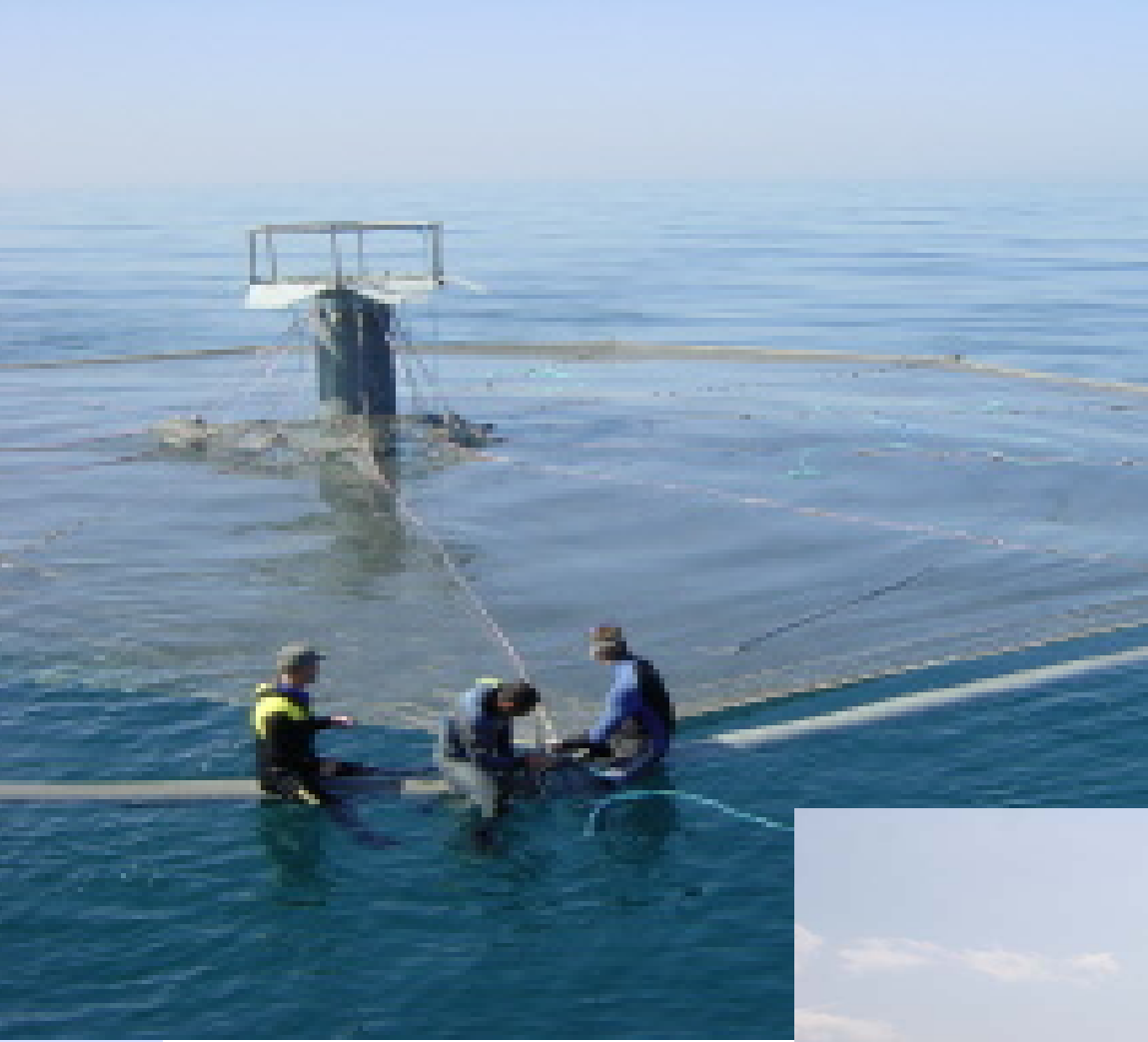
- ✓ Sociologically consents?



	SeaStation3000	SeaStation5400
No. installed	Three cages	Three cages
Date installed	May 5 – July 13, 2005	May 4 – 25, 2006
Height	15 m	22.5 m
Diameter	Φ25 m	Φ33 m
Total area	3,000m ³	5,400m ³
Anchor weight	25 ton, Four	37 ton, Four

- ❖ SeaStation™ (OceanSparLLC. USA)
- ❖ Maintenance of the structure: A central spar and 12 circular rims
- ❖ Volume: 3,000/ 4,500/ 6,000 m³
- ❖ Why the cage?
 - Practically using in Hawaii, Puerto Rico, New Hampshire, etc.
 - Highly protective against strong currents and storms
 - Not affect boat and ship passage
 - Easy towing for harvest or escaping unfavorable conditions
 - Available to rear fingerlings at a nursery cage in the mother cage

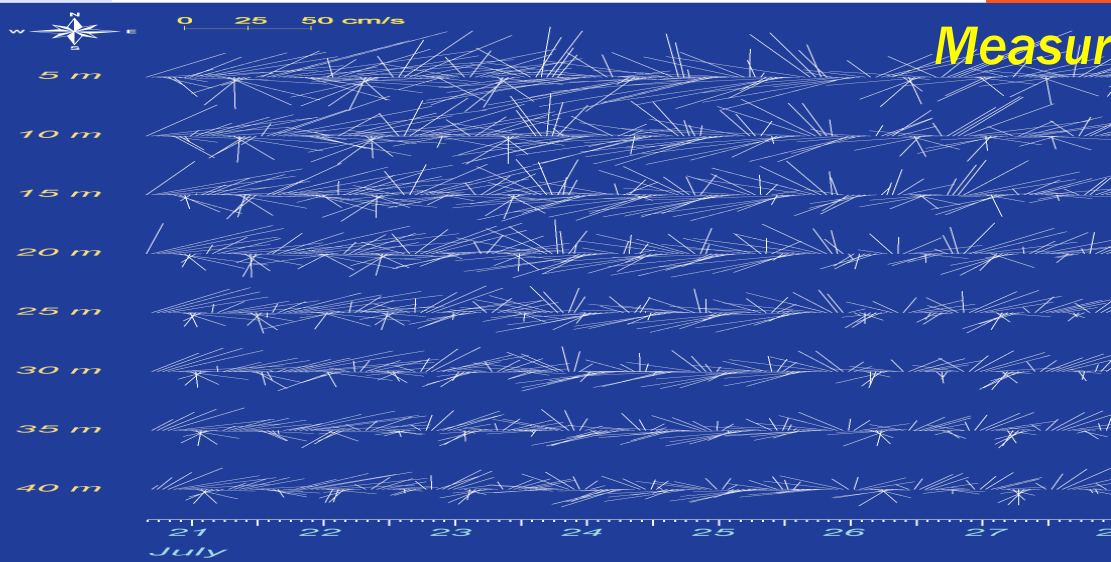
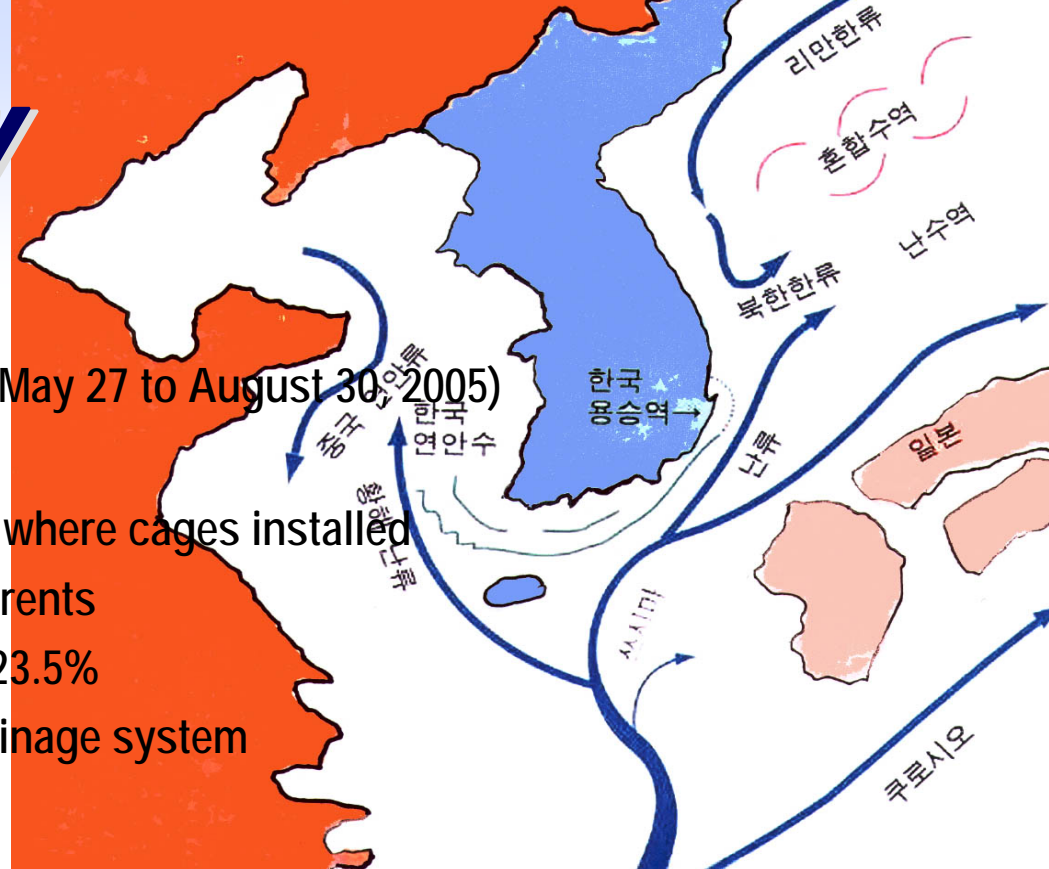




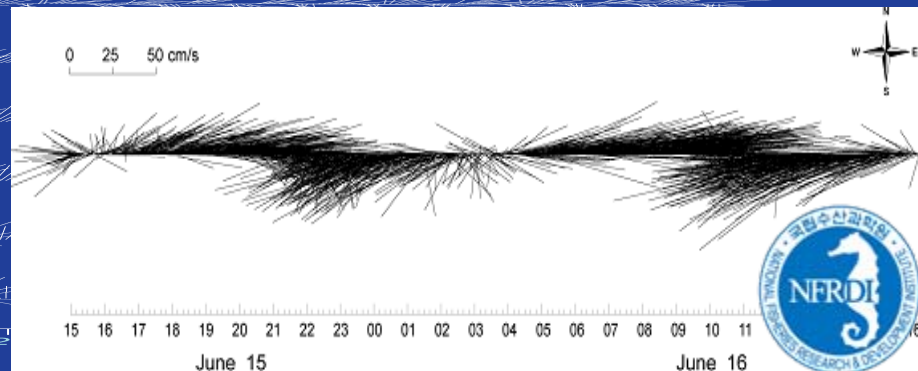
3. Cage Security

By water currents

- Monitored cage's safety for three months (May 27 to August 30, 2005)
- Maximally 120 cm/sec on surface
- Slower than 50 cm/sec at 20 to 30 m depth where cages installed
- Affected by tidal currents than oceanic currents
- Extended anchor lines of 85 m to 95 m by 23.5%
 - ⇒ Added supplemental anchor lines/ dual linage system

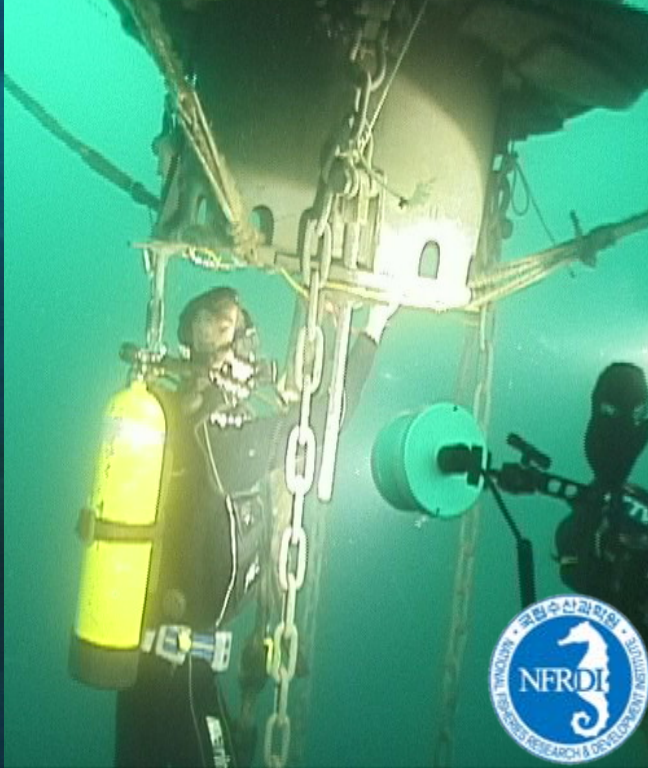


Measured by RCM and ADCP hydrometer



By storms

- Observed on Typhoon NAVI (Sep. 2 to 6, 2005) and EWINIA (Jul. 8-13, 2006)
- Waves maintained 6 to 8 meters high for a week
- Destructed all buoys on water surface
- No damaged on the cage systems and culture fish





4. *Target fish*

❖ Criteria for choosing culture fishes

➤ Economic considerations

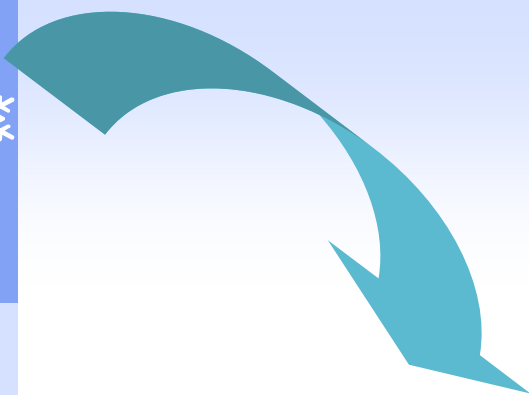
- ✓ Domestic and oversea market value?
- ✓ Competitiveness over other culture species?

➤ Cultural considerations

- ✓ Ecological and physiological stability to offshore aquaculture?
- ✓ Obtainable mass seedlings production technology?
- ✓ Growth rate and disease resistance?
- ✓ Adaptability for formulated feed?

➤ Social considerations

- ✓ Adverse influence to current culture business?
- ✓ Social restriction?



Parrot fish (*Oplegnathus fasciatus*)

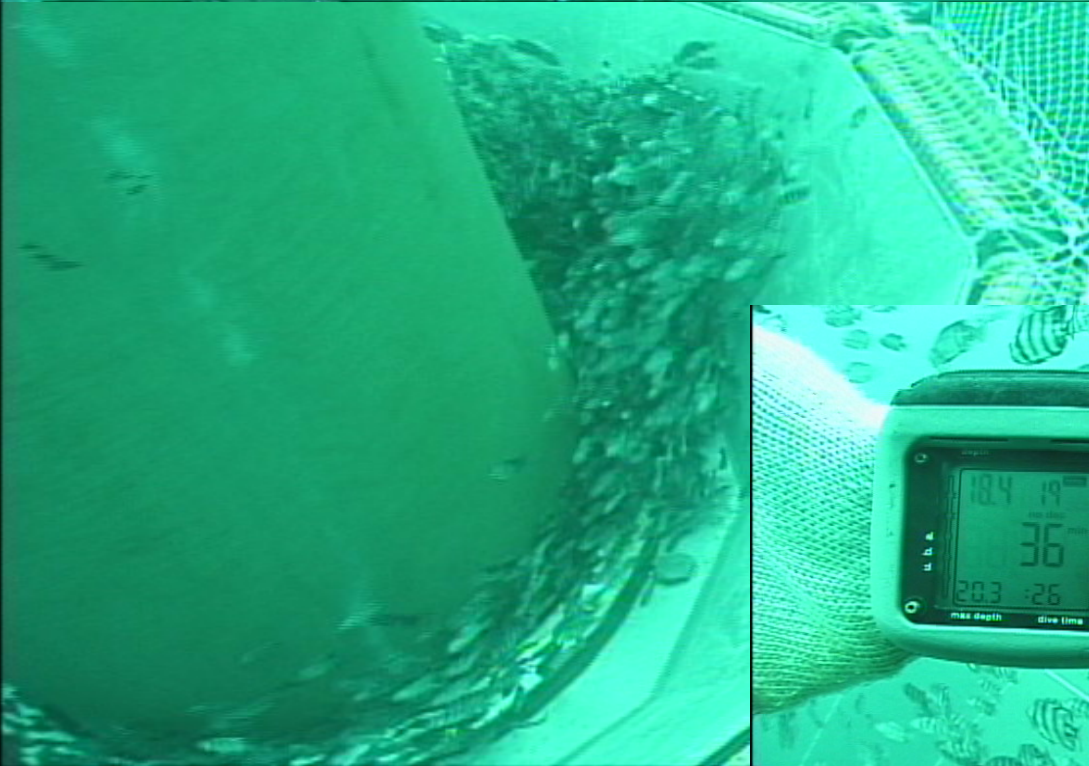
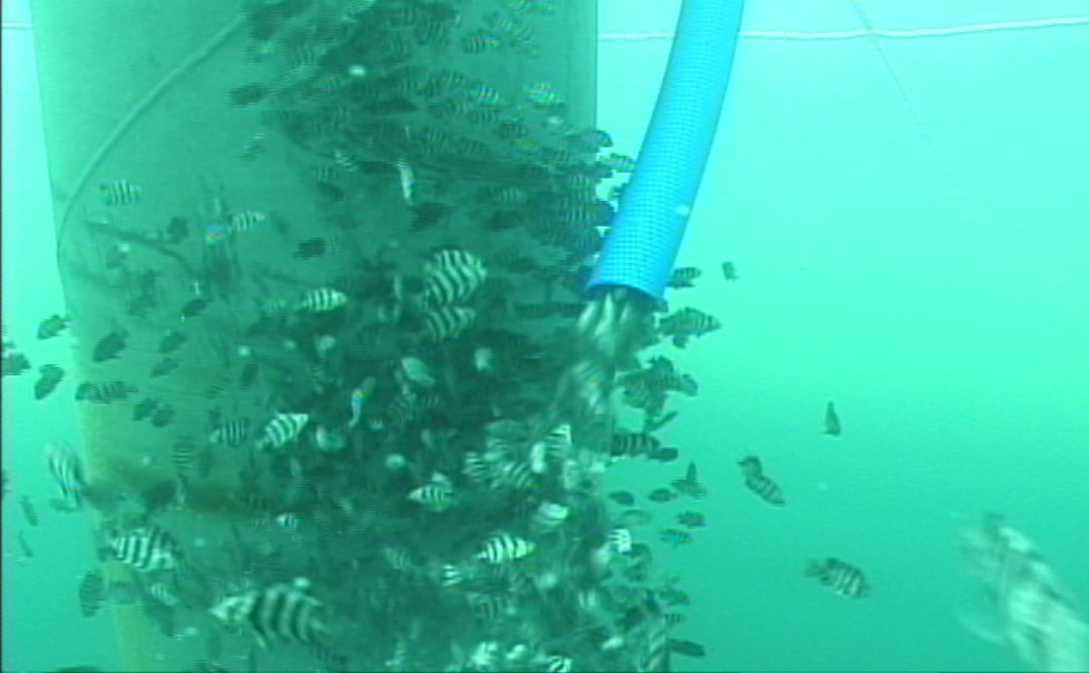
- ✓ Relatively expensive (larger fish size, higher market price)
- ✓ Suitable for raw fish (taste, texture, etc.)
- ✓ Artificial mass seedling production possible
- ✓ Optimal temperature range in Jeju sea where cages are installed
- ✓ Competition with inshore aquaculture fish species
- ✓ Mass production in offshore aquaculture might be restricted by MOMAF

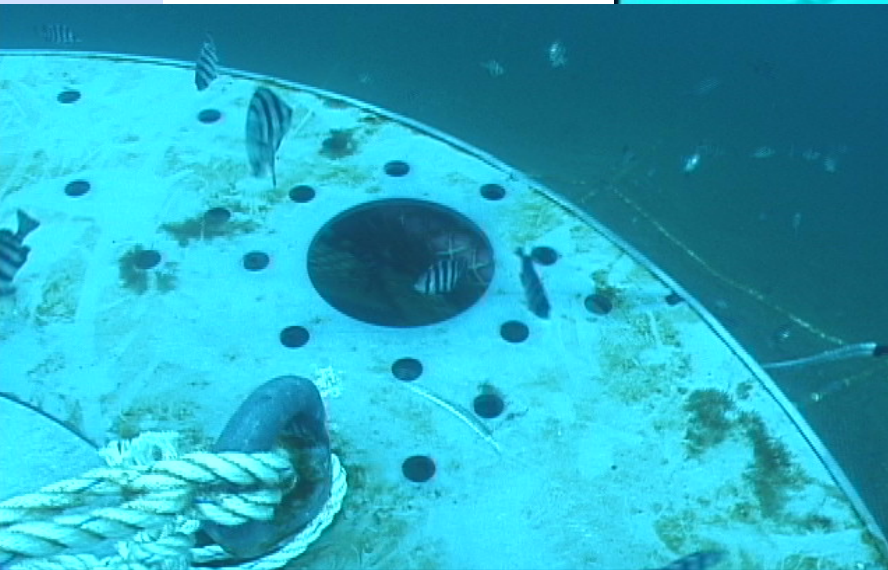
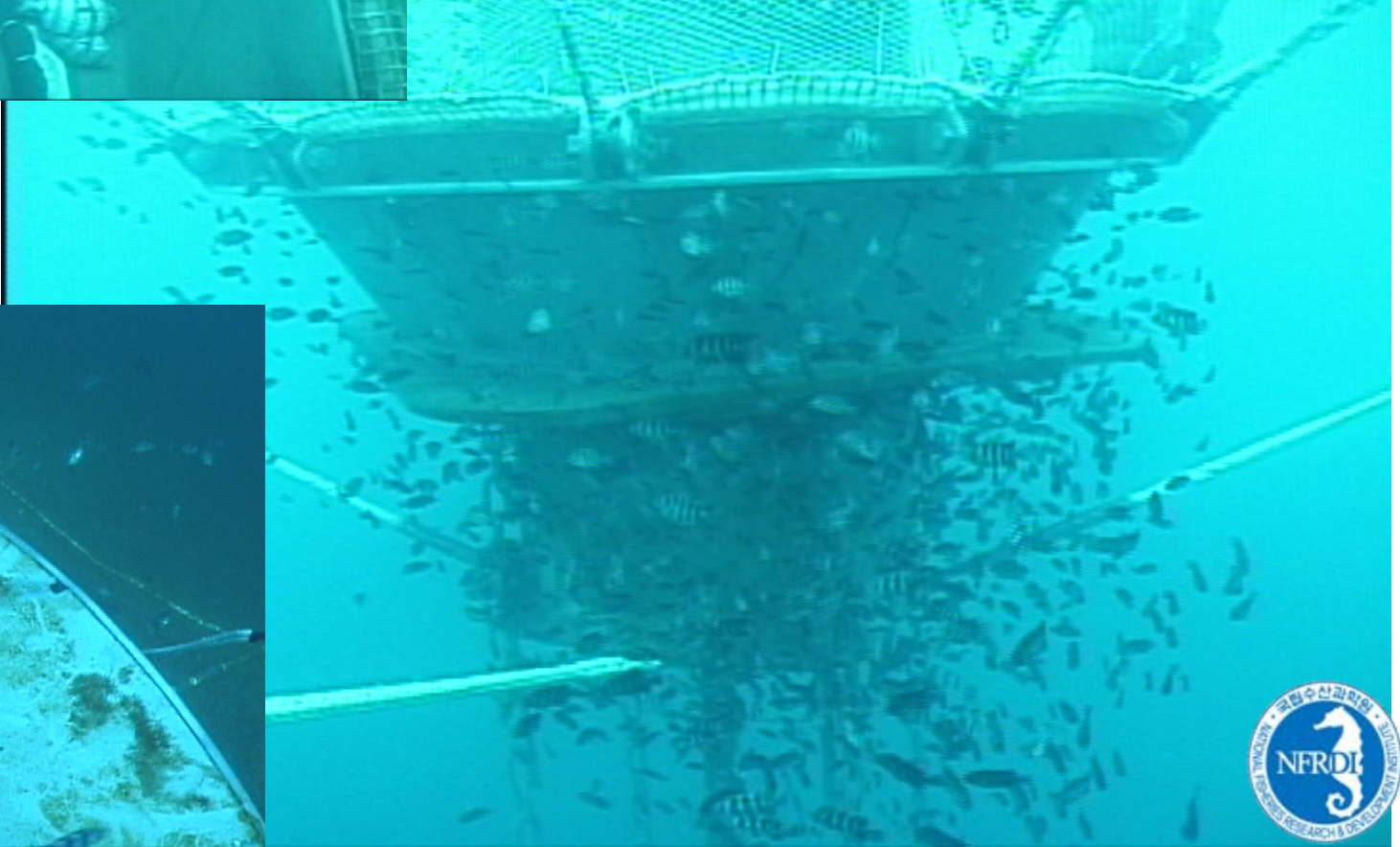
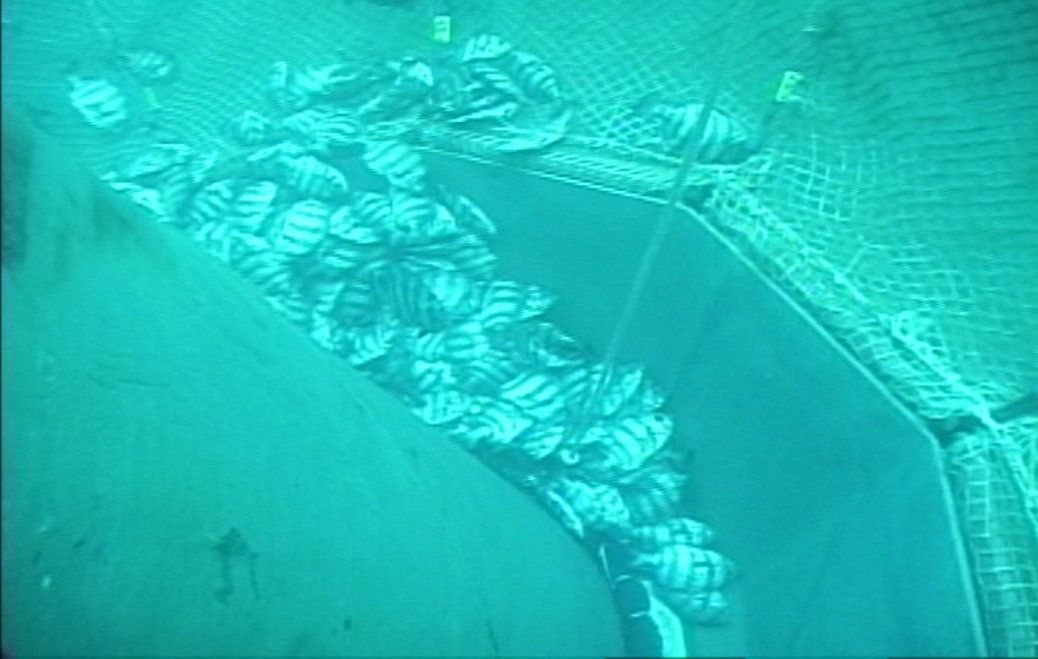


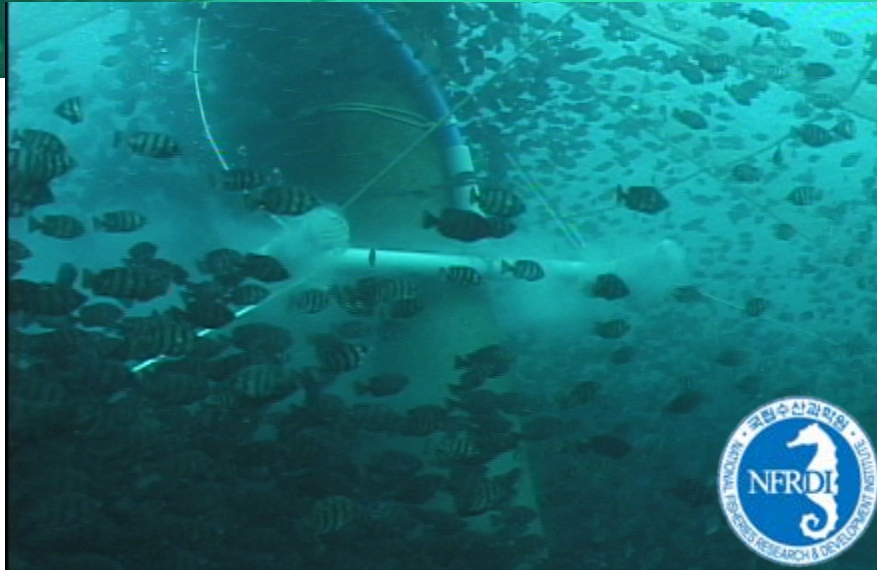
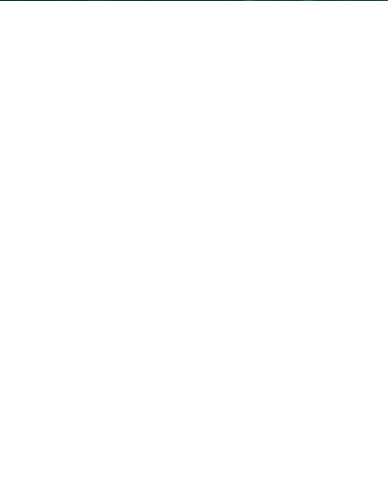
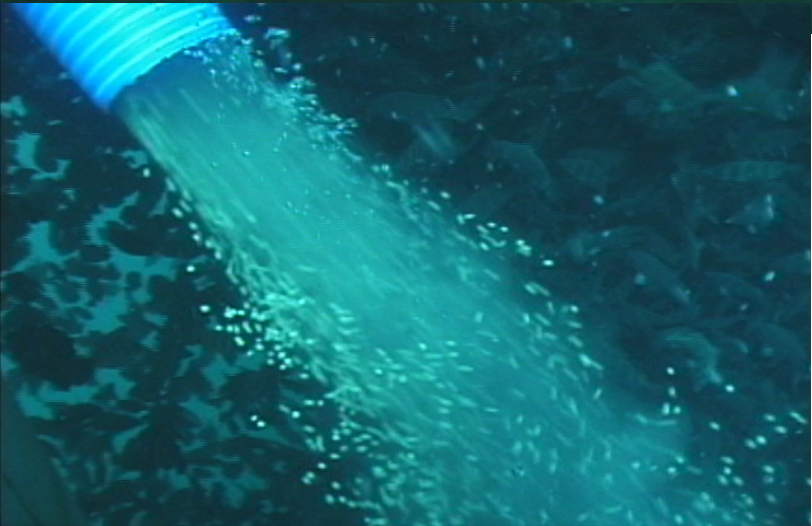
5. Fish Stocking and Feeding

- ❖ Fish species: Parrot fish (*Oplegnathus fasciatus*)
- ❖ Date: June 24~July 8, 2005 / June 5~10, 2006
- ❖ Feeding: commercial pellet feed, semi-auto feeding with water from boat
 - One or two times per day except stormy days (roughly 2 days per week)









6. Growth and Survival

Cage	Initial				Feb. 20, 2006	Aug 25, 2006	Jan. 20, 2007			
	Jun.24-Jul.8, 2005		Jun. 5-10, 2006							
	No. fish (10 ³)	B.W. (g)	No. fish (10 ³)	B.W. (g)	No. fish (10 ³)	B. W. (g)	No. fish (10 ³)	B.W. (g)	No. fish (10 ³)	B.W. (g)
1	550	5	-	-	460	131	300 ¹⁾	180	290 ¹⁾	290
2	75	10	-	-	60	164	160 ²⁾	225	150	322
3	80	123	-	-	64	357	150 ³⁾	5-24	120	25-123
4			400	12	-	-	360	85	0 ⁴⁾	0
5			400	9	-	-	370	80	350	178
6			150 ⁵⁾	20	-	-	145	75	140	250

- 1) Fish over 200 g has been marketed and around 100 thousand fish moved to No 2 cage (late July, 2006)
- 2) Around 100 thousand fish were stocked from No 1 cage (late July, 2006)
- 3) Other experimental target fishes are culturing: rock fish, yellow croaker, giant croaker, etc.
- 4) The cage was ruptured by accident (early October, 2006)
- 5) Red sea bream were stocked and cultured from late July, 2006

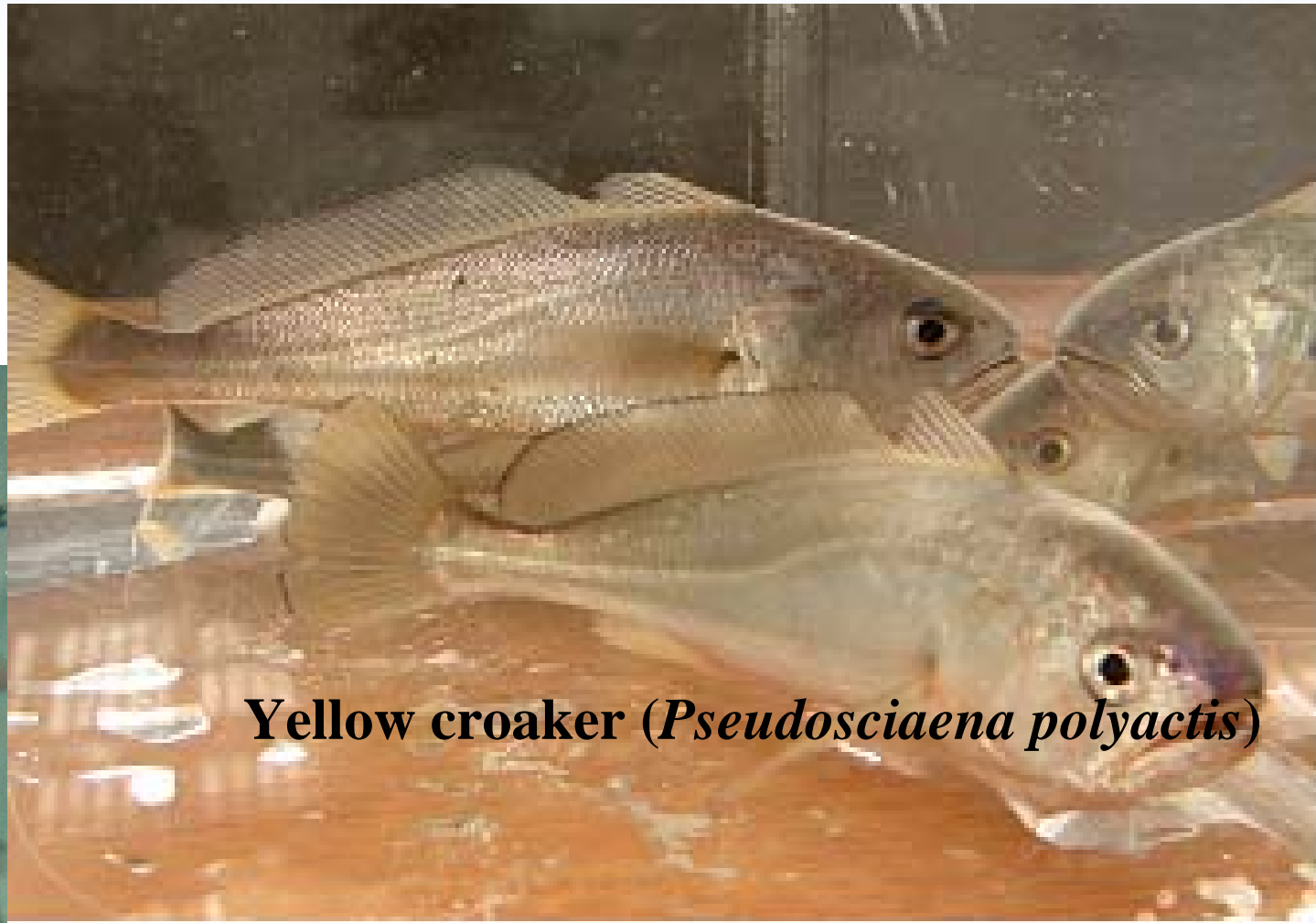




7. Other Culturing Fishes



Tiger fugu (*Fugu rubripes*)



Yellow croaker (*Pseudosciaena polyactis*)

Groupers



Red sea bream

8. Facilities

Workboat

Name	Tonnage	Size	Others
NORH (SGR-068944)	29 ton	Length: 18.16 m, width: 7.30 m, height: 2.20m	Two engines, crane for lifting





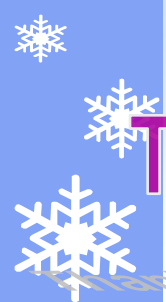
DONE AND TO BE DONE?

❖ What's done successfully???

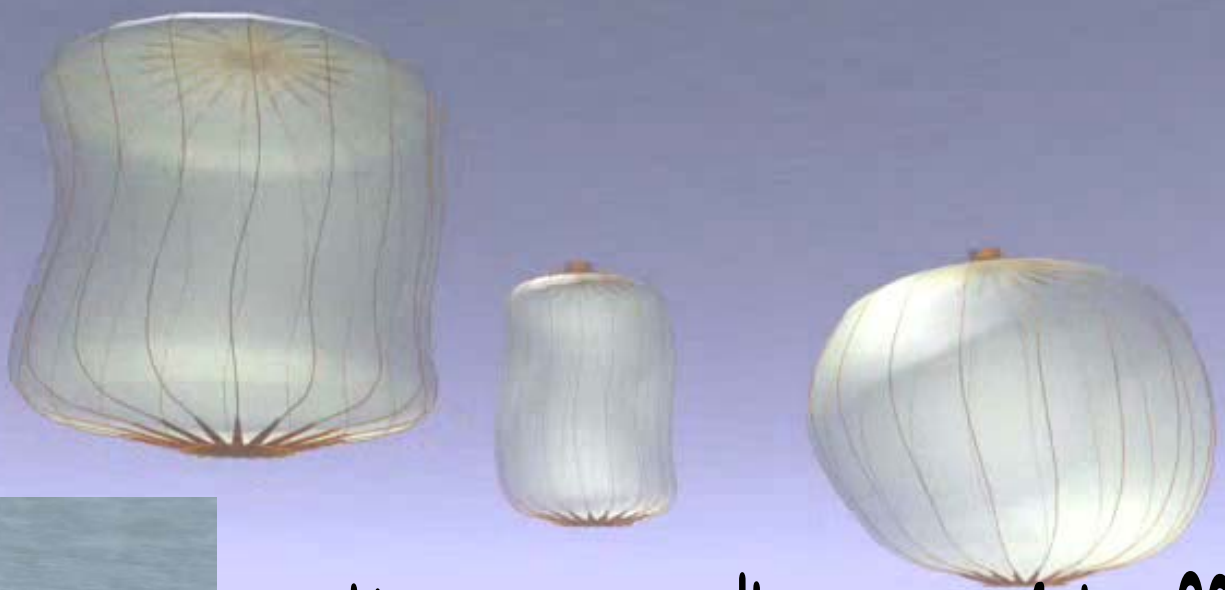
- Possible to successful offshore aquaculture business in Korea
- Confirm cage safety against seasonal storms, typhoons, and currents
- Know-how for offshore aquaculture management: stocking, feeding, harvesting, etc
- Hold the upper hand over foreign aquaculture products

❖ What's waiting to be developed???

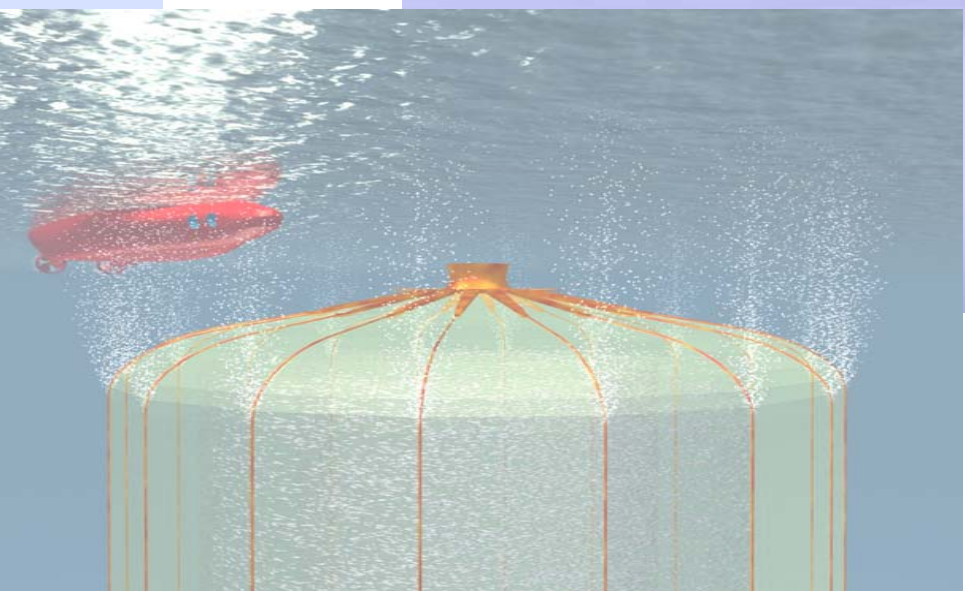
- Specialized offshore cages for southern coast
- Superhigh-value candidate fishes for offshore cages
- Automatic system of feeding, monitoring, swimming activity, etc.
- Sorting, thinning, net cleaning, harvesting
- Action dynamics of culture animal



Thanks for your attentions!!!
Any questions???



Korean aquaculture in the future???



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**West Sea
(Yellow Sea)**

- **Wide tidal mudflats and high tidal range**
 - ✓ Self-purification ability of water pollution
- **Relatively wide annual water temperature range**
 - ✓ Limiting factor for warm-water fish culture

South Sea

- **Complicated coastlines**
 - ✓ Fit for performing net-cage cultures
- **Relatively warm annual water temperature**
 - ✓ Suitable environments for warm-water fishes

- 
- **Monotonous coastlines, strong waves**
 - ✓ Limited aquaculture species

East Sea



