Establishing and Operating Open-Sea Fish Farm Facilities: REFA MED Technological Competence.

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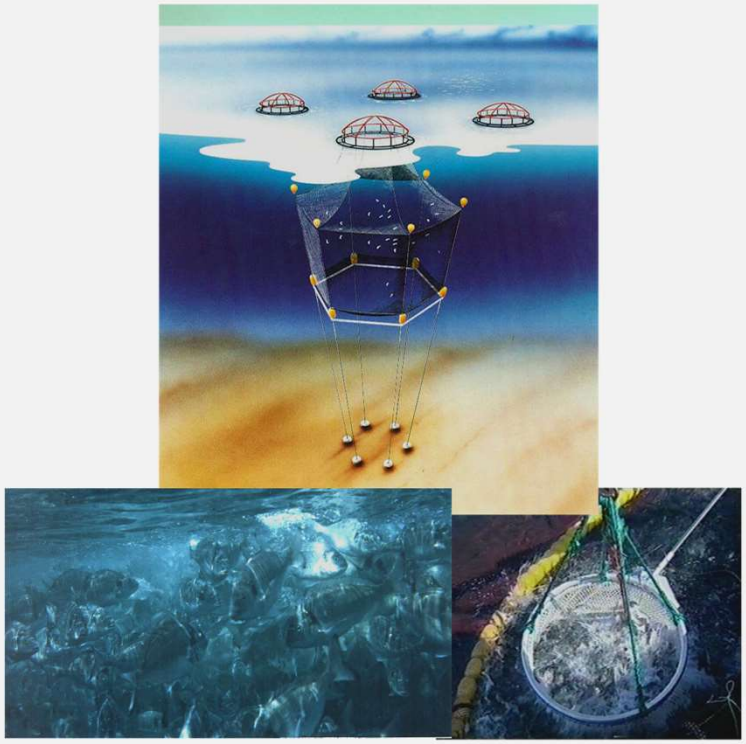
www.refamed.com

Main Frame Study:
Sea Cage Culture Development in Iran



Refa Holding AS

Finnsnes, Norway.

2001 – Spring 2002

CONDITIONS in IRAN (2002 Refa study)

Floating Cage systems are applicable mainly in the Persian Gulf.

In the Caspian and Oman Sea waves over 10 m can occur: Open Sea conditions prevail.

Here surface cages can't be safely used in the long term.

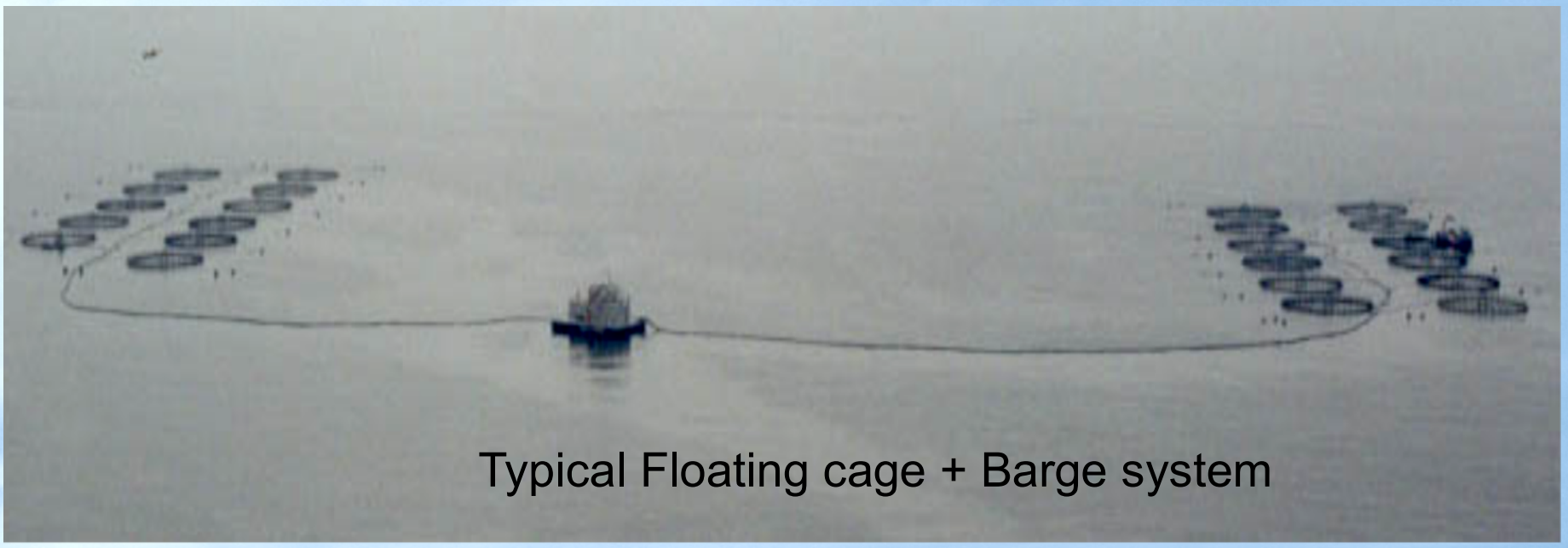
> 15 years have passed,
but our conclusion is still valid today.

Max. wave height return period (example):

01 year = 6 m

10 year = 10 m

50 year = 13 m



Typical Floating cage + Barge system

The effect of a freak storm event, on PE cage farm:

Failure in grid mooring system can lead to the "domino-effect".

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The effect of a freak storm event, on PE cage farm:

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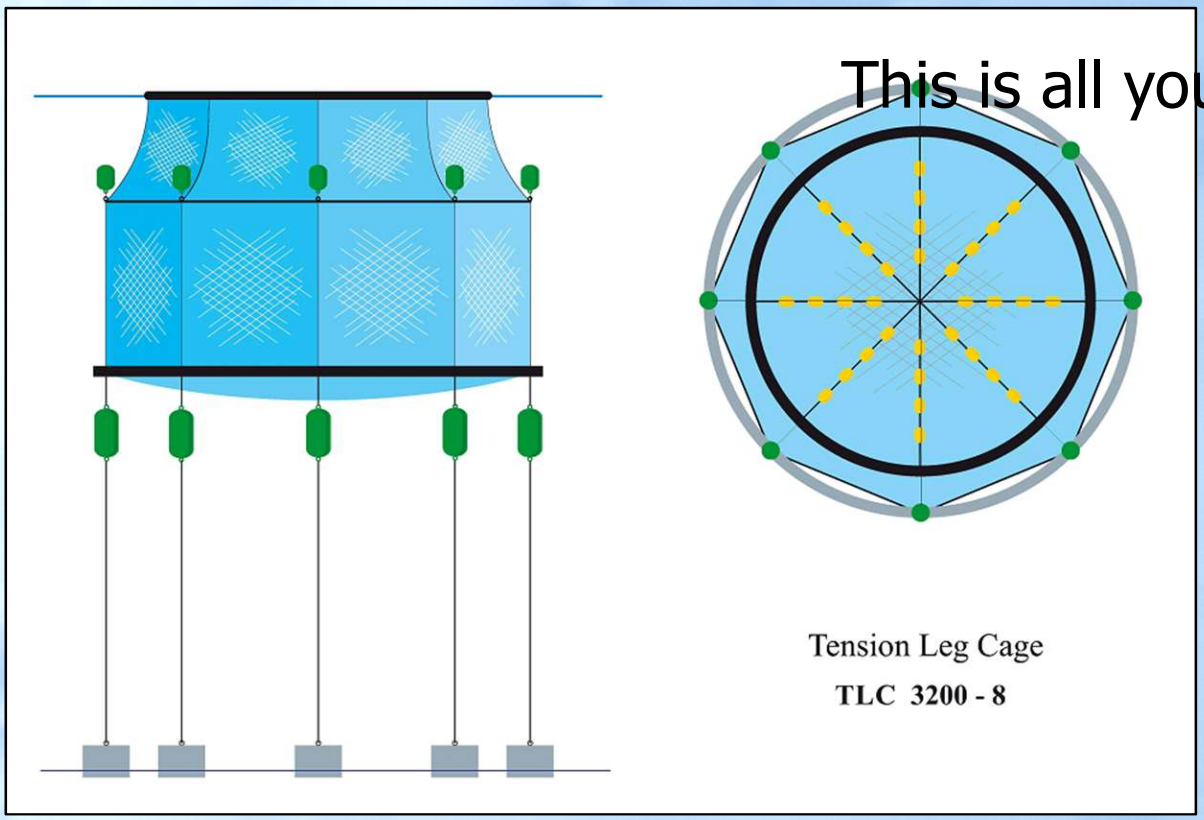
In contrast, each Tension Leg Cage (TLC) is an independent, stand-alone fish rearing unit.

No links to neighbouring cages.



This is all you see from the surface.

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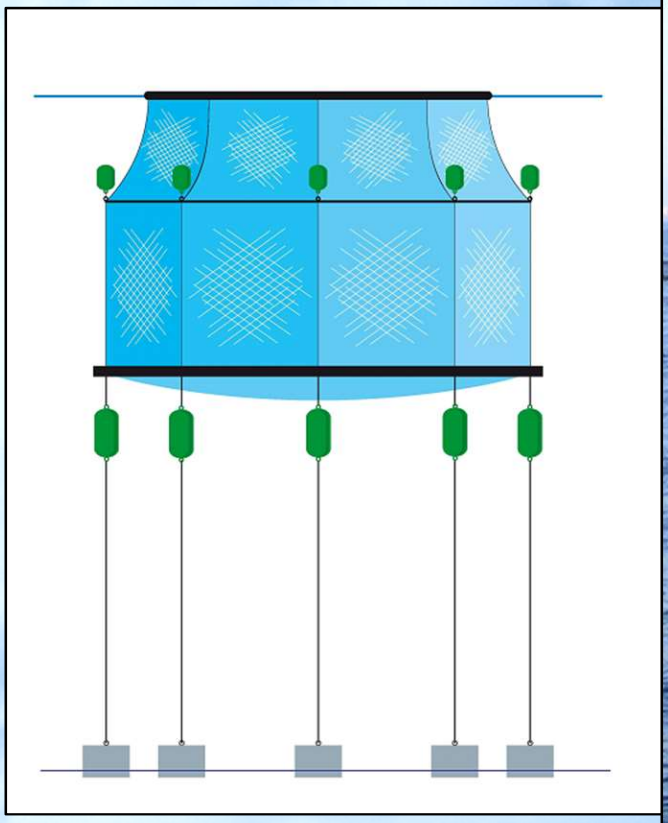
No links to neighbouring cages.



In 1995 we installed the first commercial Tension Leg Cages, installed on a site with 2000 km open-sea fetch to the West.

CAGES IN FARMING

Sea farm off Sicily installs Refa Tension Leg system

With a central position in the Mediterranean, Italy has 8000 km of coastline but lacks sheltered areas suitable for traditional cage farms. The first floating cages were installed in semi-exposed sites in 1992 followed by open-sea installations from 1994 onwards. A recent project to install Norwegian Refa Tension Leg cages at a sea bass and sea bream farm in Sicily is described by DARKO LISAC of Maraqua Ltd.

THE EOLIAN Archipelago comprises seven scattered volcanic islands off NE Sicily, 20-70 nautical miles from the port of Milazzo.

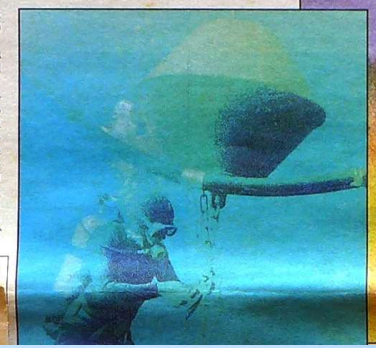
They rise up high from a seabead over 1000 meters deep, bathed in crystal clear waters at all times. Fisheries and tourism have long been the main earners. But decline in natural stocks and recent EU legislation are limiting traditional fishing of large pelagics like swordfish, tuna and yellowtail.

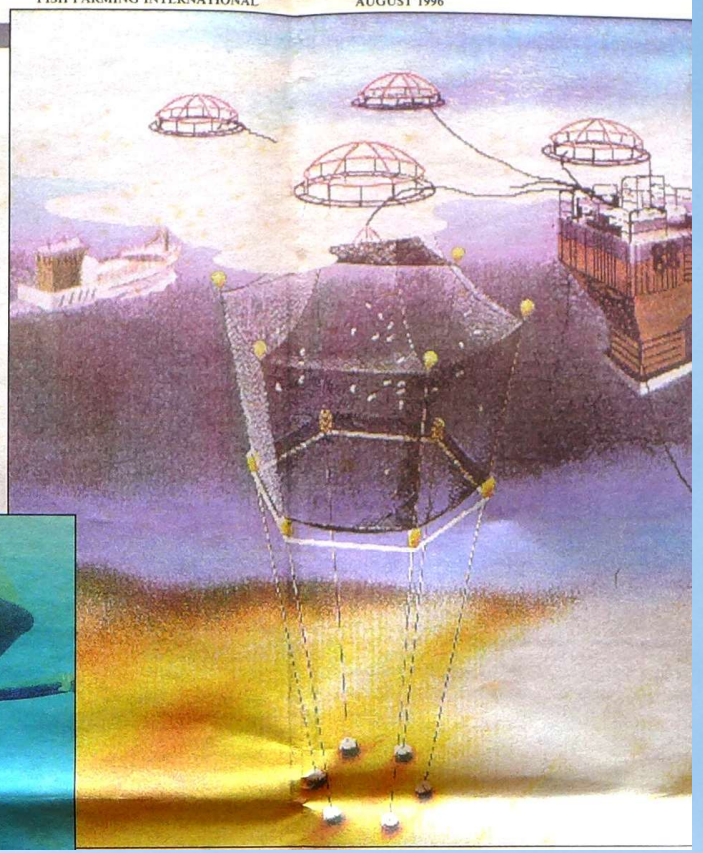
The local community is therefore looking into ways to develop a viable local marine farming industry as a substitute for fisheries.

A group of private investors led by Nando Rossini, planning to set-up a small farm, applied for a site on the Island of Filicudi. They commissioned Maraqua to analyse the technical options for developing the project with an initial production capacity of 100 metric tons of bass, bream and yellowtail.

Filicudi has an area of nine sq. km; it is 770 metres high, and the surrounding seabed slopes downwards at a 40 degree angle.

The area available for the farm was initially described as sheltered, not subject to strong currents, and with a large extension of relatively flat seabed. Unfortunately no detailed maps with depth soundings were available. From the first field visit it became clear that the best site availabe was exposed and subject to an open-sea fetch of almost 2000 km in the west direction. There is a limited area 25-38 m deep with a slope of 20 per cent, the seabed being a mixture of coarse sand, rocks and algae.





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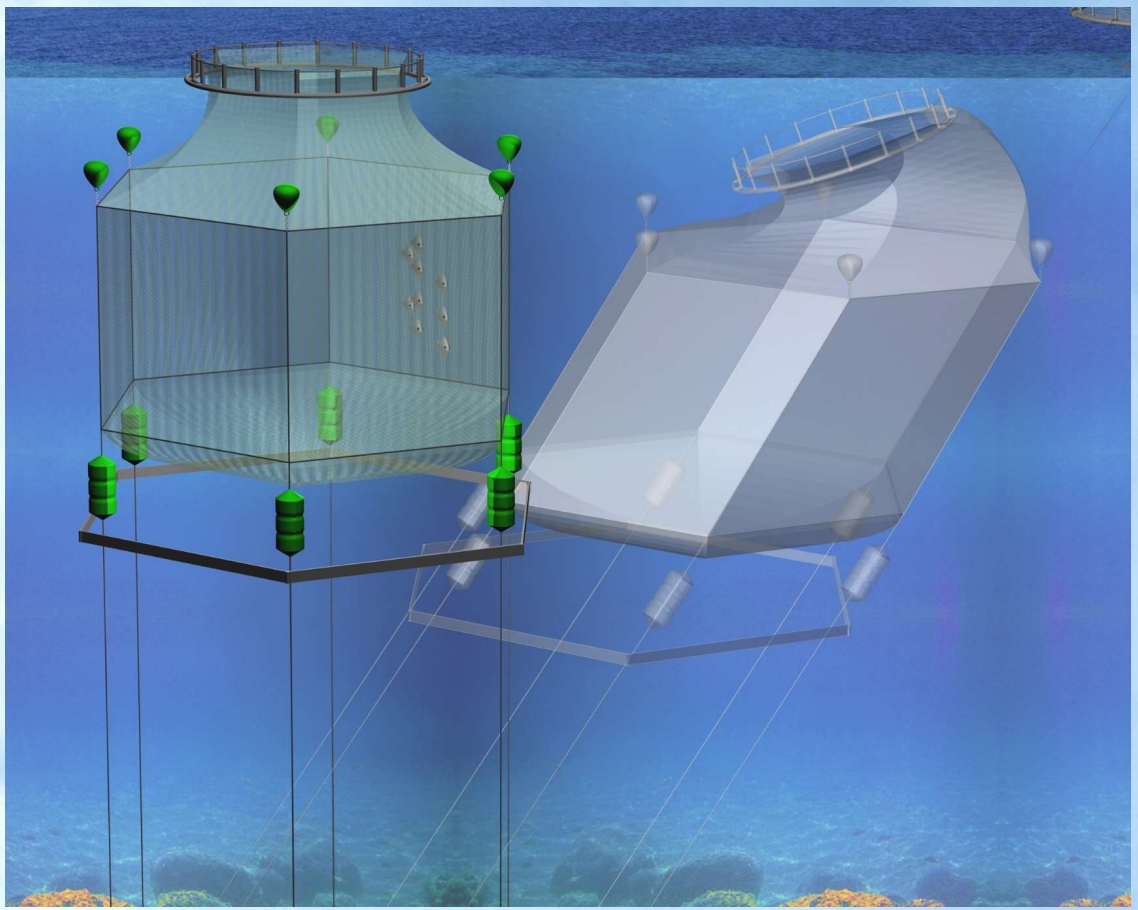
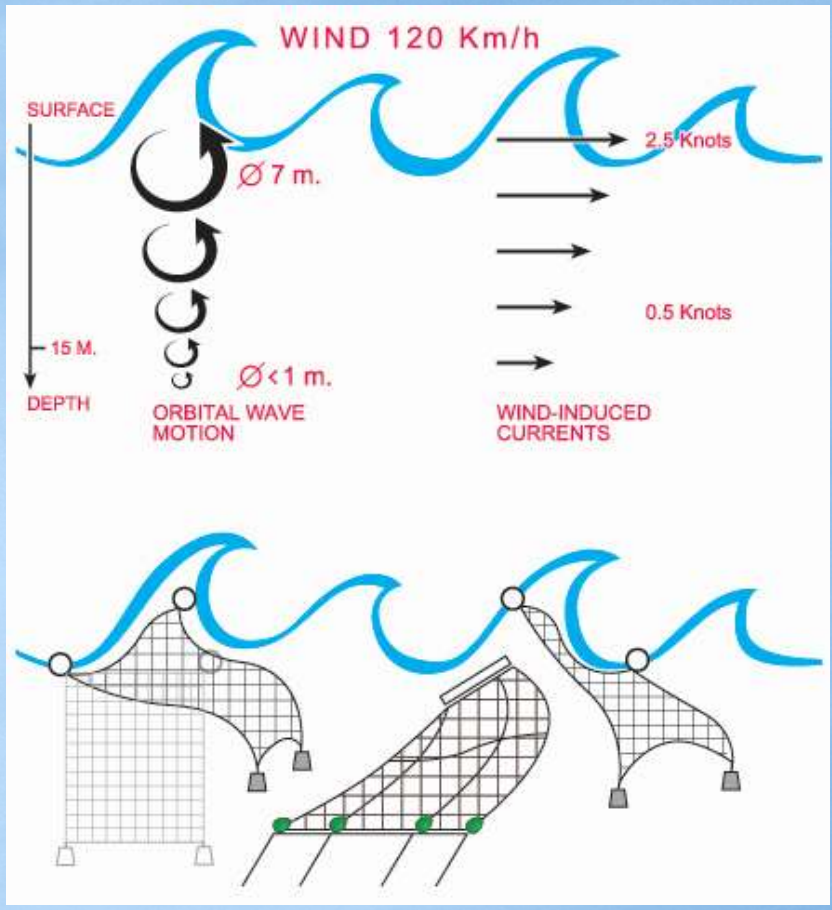
The unique design of the Tension Leg Cages exploits the marine forces to submerge during storms, rather than to fight against the sea motion.

No human intervention is required.





Examples from Tension Leg Cage farms

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TLC Farm in East Mediterranean, Hadera

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TLC Farm in East Mediterranean, Hadera

In January 2013 the TLC farm here has sailed smoothly through an extreme storm with 13 m high waves.

TLC OPERATIONAL ASPECTS

Feeding the fish

Manually,

Or with portable cannon blower

TLC OPERATIONAL ASPECTS

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Feeding the fish

With Cone-shape Barge

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TLC OPERATIONAL ASPECTS

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Feeding the fish

With small "Feed Buoy"

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TLC OPERATIONAL ASPECTS

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Feeding the fish

With Offshore Feed Boat

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TLC OPERATIONAL ASPECTS

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Feeding the fish

With Offshore Feed Boat

TLC OPERATIONAL ASPECTS

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Inspection and Maintenance

Strict Protocols need to be implemented in all open-sea farm installations to control the integrity of all system components.

We provide Inspection protocols customised for the equipment used and site specifics.

The constructive simplicity and quality of all components used in TLC cages results in 5 x lower maintenance costs in comparison to floating cage systems.

TLC OPERATIONAL ASPECTS

Fish Harvest Strategies

Batch harvest of one whole cage in 1 to a few days is the easiest.

This is standard in the Salmonid sector, while with other fish species the market often demands to supply fresh fish 2 x /week.

With TLC cages, various solutions can be adopted in function of the market demand and farmers preference.

TLC OPERATIONAL ASPECTS

Fish Harvesting Strategies

Direct harvest from the TLC grow cage may be used for small quantities.

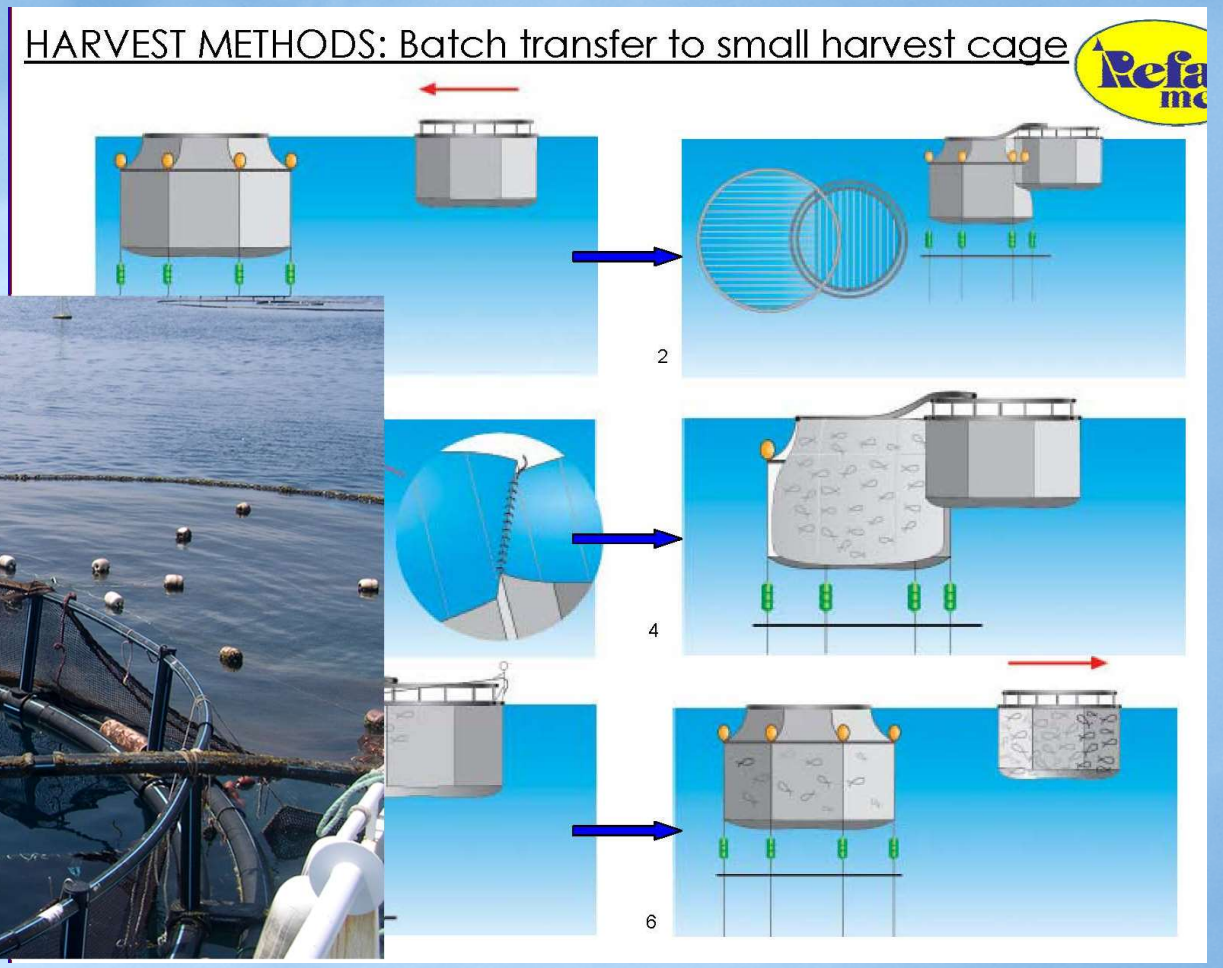
For big harvests:

- Bring a standard PE floating frame over the TLC,
- Attach net along perimeter,
- Remove the top-cover net (there is zipper all around),
- Harvest as in any floating cage.

TLC OPERATIONAL ASPECTS

Other Fish Harvest Methods

Transfer lots of about 15 tons fish from grow cage to a small, 10-m, harvest cage.



TLC OPERATIONAL ASPECTS

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TLC OPERATIONAL ASPECTS

Other Fish Harvest Methods

Transfer lots of about 15 tons fish from grow cage to small, 10-m, harvest cage.

Advantages:

Remaining >50 t fish continue to grow.

Ease of harvest, even with rough sea.

TLC DIVERSIFICATION

The TLC cage system can be adapted for a range of different requirements.

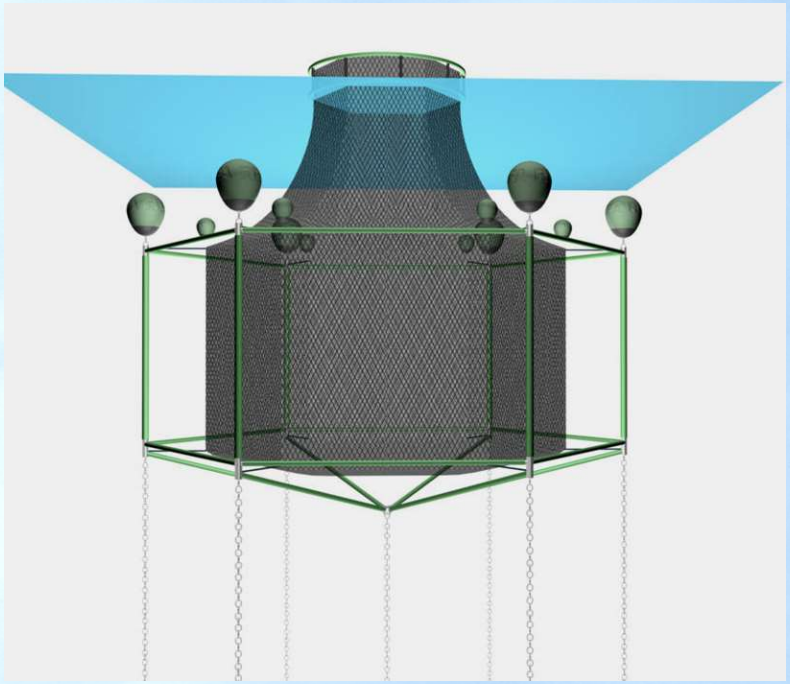
Some users appreciate the ability to pull it down a few meters by simply shortening the vertical moorings below the Sub Buoys.

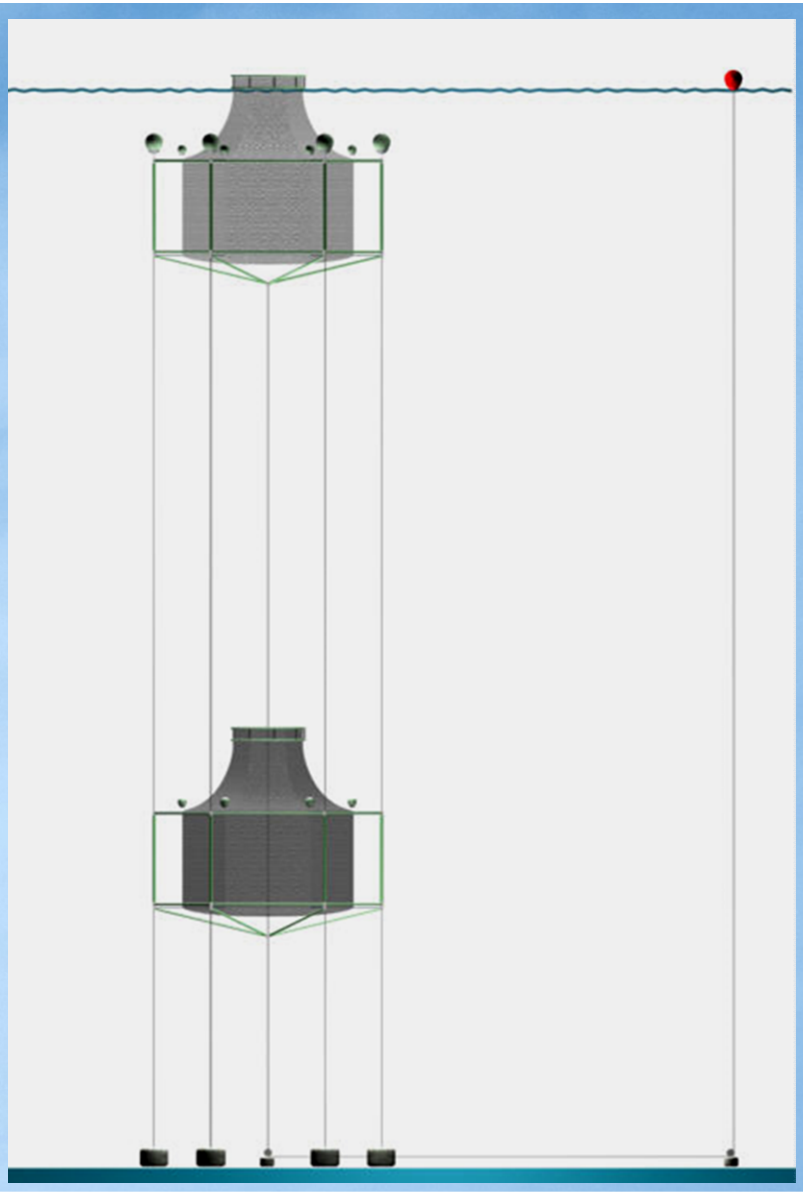
→ Easy transformation into a Submerged cage.

TLC DIVERSIFICATION

Installation and operation of a submersible cage at 55 m depth in Crete for rearing of *Pagrus pagrus*

Controlled Submersion
T L C Cage





TLC DIVERSIFICATION

Controlled Submersion
T L C Cage

operation

The cage is submerged to 40 m at the installation site.

The hauling up of the cage is done with an electric winch, maintaining a controlled velocity below 1m/min not to stress the fish

The operation of the cage is supported by a floating platform

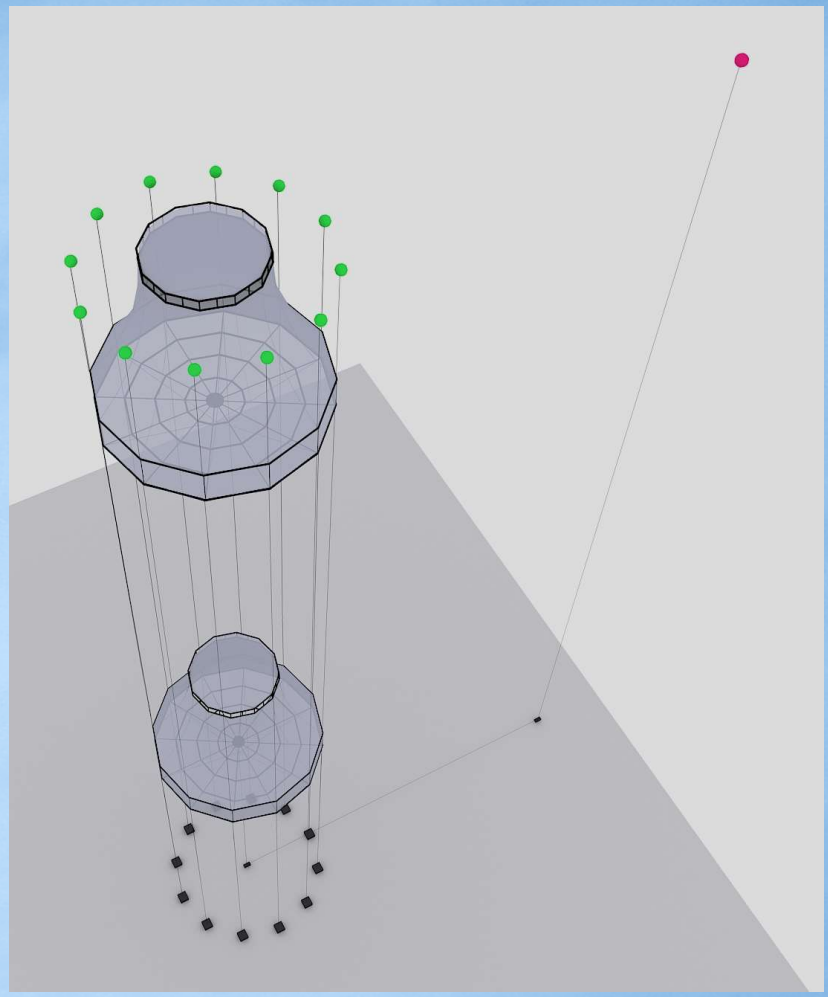
TLC DIVERSIFICATION

REFAMED

Controlled Submersion
T L C Cage System

Can be conveniently applied to those Caspian Sea projects requiring great depths of submersion and a highly controllable speed.

It requires sufficient depth on site, and an increase in the cost of investment.

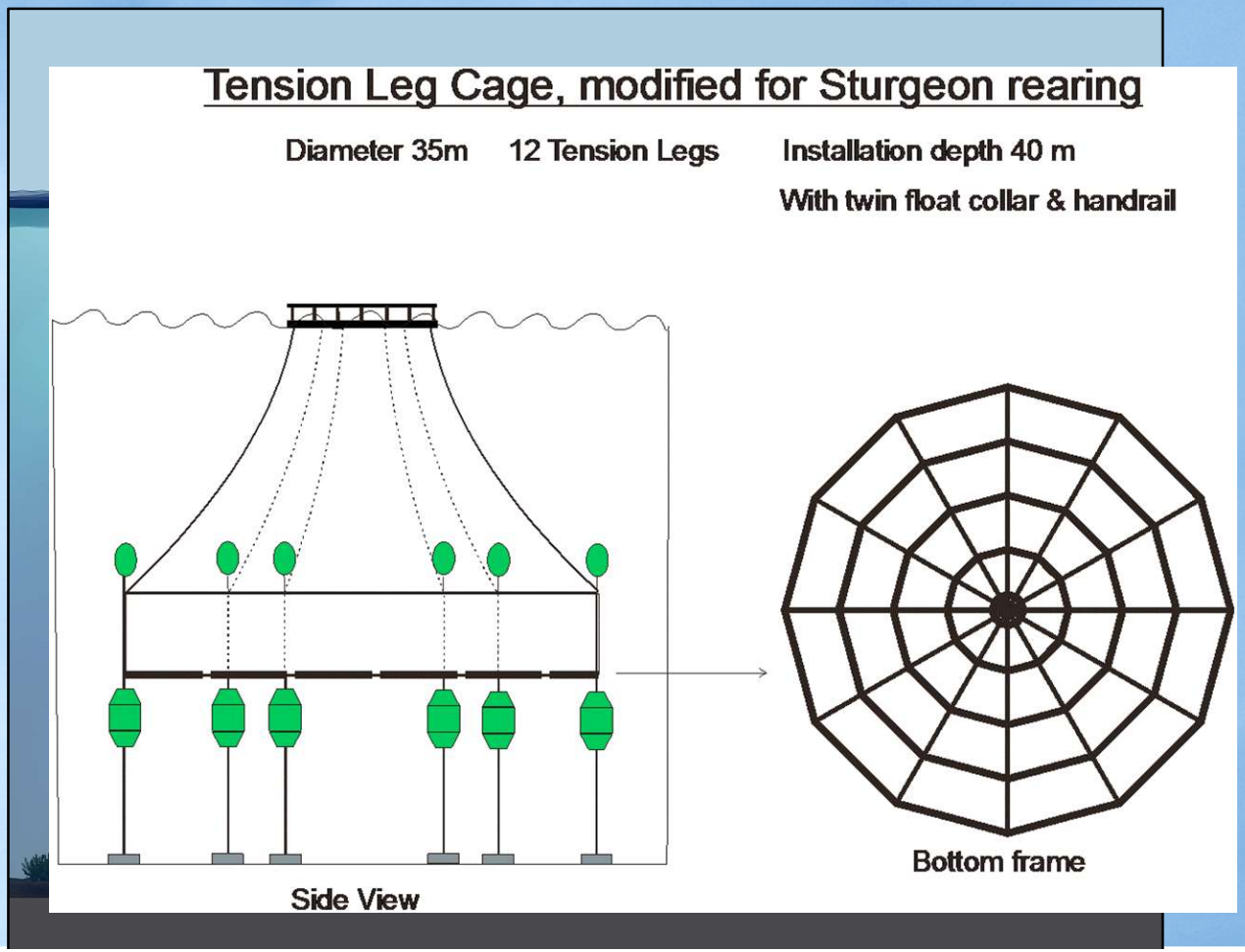


TLC DIVERSIFICATION

Sturgeon TLC cage Development

Based on experience with the REFA Flatfish Cage, we can integrate a solid base frame for bottom dwelling fish such as the Sturgeon.

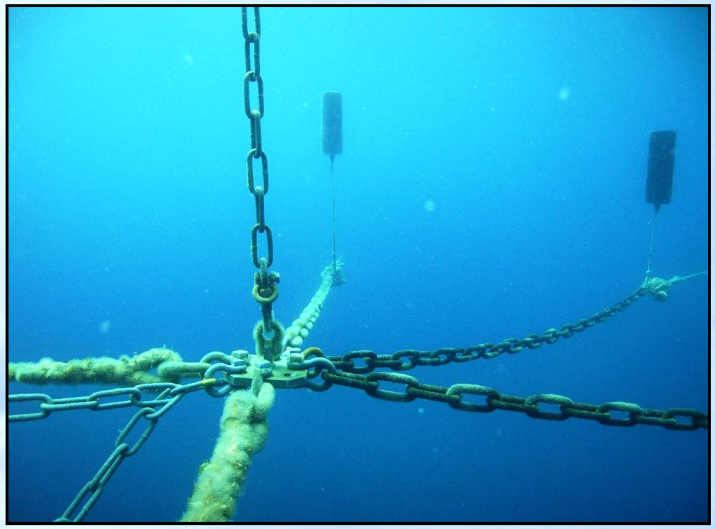
With its carrying elements at depth rather than at surface, the TLC construction ensures an extremely stable cage floor for the fish, unaffected by surface wave action.



FUTUR Cage Brackets - **NEW SERIES**

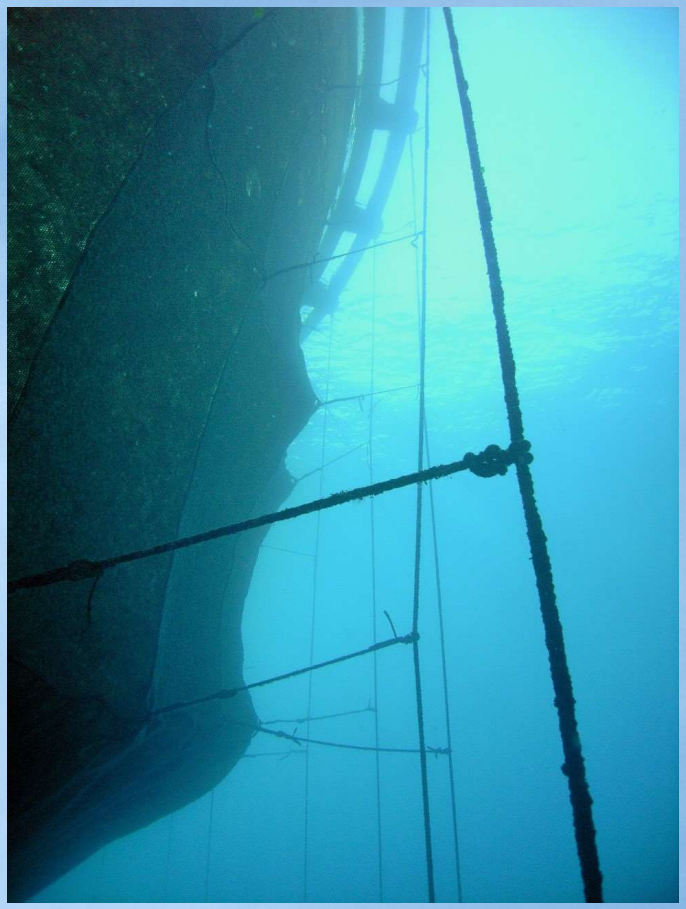
REFAMED

Over the years we have greatly increased the ability of our PE cage systems to withstand very exposed marine sites.



The configuration and optimal balancing of the mooring system, combined with specific net-pen design have played a crucial role.

They are still not able to sail 10 m waves though.



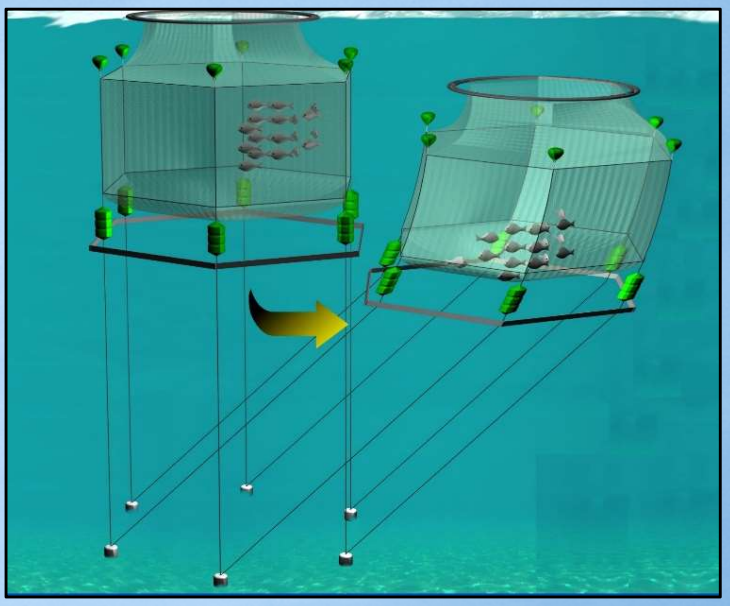
WHY TLC ?

For Open Sea and extreme sea states the TLC provides a safe haven for your fish, which continue to grow undisturbed.

The TLC can be operated and managed very easy, mostly like a surface cage, but with minimal maintenance requirements.

It can be actively submerged if required.

The REFA MED TLC cage system safeguards your investment, providing the optimum economic returns for your open sea farms.



REFA MED ?

Extensive knowledge of the conditions in Iran.

We are not a company applying the same product to all.

We are a specialist Cage Technology Provider,
with customised solutions in function of site conditions
and company exploitation strategy.

In Iran we have teamed with AFTM to offer you an
extensive range of support services for your project.

Thanking you for your patience and attention!

Darko Lisac

www.refamed.com

2. SITE STUDY

Essential to assess the prevailing and extreme conditions in terms of:

- Winds
- Waves
- Currents

Analysis of Marine Conditions						Candidate Site No 1.				
Wind direction from	Frequency in Percentage				Fetch (km)	Frequency in Percentage				
	Total frequency	Wind strength in Beauforts				Maximum wave height (m)				
		1 - 3	4 - 6	7+		< 1	1 - 2	2 - 4	4 - 6	> 6
000	3,7					3,7				
N	12,3	11,8	0,5	0,0	10	11,8	0,0			
NNE	8,8	8,7	0,1	0,0	4	8,8	0,0			
NE	14,4	14,4	0,0	0,0	3	14,4	0,0			
E	4,0	4,0	0,0	0,0	2	4,0				
SE	6,1	5,1	1,0	0,0	2	6,1				
S	6,4	5,9	0,5	0,0	1300	4,8	1,1	0,3	0,2	
SW	5,9	5,5	0,3	0,1	1600	4,6	0,9	0,2	0,1	0,1
W	18,6	15,5	2,9	0,2	1100	15,5	1,5	0,6	0,3	0,4
NW	20,4	17,4	3,0	0,0	350	17,4	1,7	0,8	0,5	
Sum of conditions		Number of days /year				334	19	7	4	2

CONCLUSIONS

For	353	days /yr the farm is fully operative
For	7	days /yr is difficult to reach the farm, & feeding is reduced
For	4	days /yr it is not possible to feed the fish nor reach the farm
For	2	days /yr there may be danger of damages to the farm facilities

Magnitude Vs. Frequency

2. SITE STUDY

Less extreme Wave height, but 25% of the time farm not fully operational.

Preliminary Analysis of Marine Conditions						Site No 2.					
Wind direction from	Frequency in Percentage					Fetch (km)	Frequency in Percentage				
	Total frequency	Wind strength in Beauforts					Maximum wave height (m)				
		1 - 2	3 - 4	5 - 6	7+		< 1	1 - 2	2 - 4	4 - 6	above 6
000	1,7						1,7				
N	4,9	3,5	1,2	0,2	0,0	170	3,5	1,2	1,0		
NNE	44,7	13,0	17,0	14,4	0,3	550	10,7	12,0	15,9	5,1	0,0
NE	16,0	5,5	6,0	4,5	0,0	15	12,0	4,0			
E	1,5	1,5	0,0	0,0	0,0	2	1,5				
SE	4,3	2,8	1,0	0,5	0,0	3	4,3				
S	13,1	6,6	5,0	1,5	0,0	5	13,1				
SW	5,1	2,5	2,3	0,3	0,0	1600	1,5	0.7	2,0	1,3	
W	4,0	2,7	1,2	0,1	0,0	310	2,7	1,2	0,1		
NW	4,9	2,6	2,0	0,3	0,0	90	3,6	1,0	0,3		
Sum of conditions		Number of days /year					199	71	70	23	0

CONCLUSIONS

For	270	days /yr the farm is fully operative
For	70	days /yr is difficult to reach the farm, & feeding is reduced
For	23	days /yr it is not possible to feed the fish nor reach the farm
For	0	days /yr there may be danger of damages to the farm facilities

Magnitude Vs. Frequency

SITE STUDY

Other Major Factors to Assess:

- Seabed topography & composition
- Infrastructure / availability of skilled seamen / service
- Proximity to harbour / site accessibility & sailing time
- Risks such as Typhoons / Plankton Blooms
- Marine Predators

Feeding:

- Can automated feeding systems be installed ?
- Feed Barges / Feed Buoys / Feed Boats

Fish Harvest:

- Regularity of Market supply ?
- Dedicated harvest cages / harvest site.

Cage systems in Korea: TLC

In 2016 they came back and ordered our TLC cages.

We delivered last month and are presently completing the installation.

IntraFish | AQUACULTURE

- The Global Leader In Aquaculture And Fish Farming News -

30,000 tons of farmed bluefin tuna hitting South Korean market this year

Hongjin Fishing Associationsucceeded in growing bluefin tuna over the last 22 months.

Sushi lovers in South Korea will be able to taste a new breed of tuna in local restaurants and gourmet shops because farm-bred bluefin tuna is