Global Conference on Aquaculture 2010

Farming the waters for People and Food

22-25 September 2010, Phuket, Thailand

Disclaimer

Citations

Please use the following citation sequence with citing this document:

1. Author.
2. Title.
3. Presented at the Global Conference on Aquaculture 22-25 September 2010, Phuket, Thailand.

Global Conference on Aquaculture 2010

Plenary Lecture I :

Resources, technologies and services for future aquaculture: a needs assessment for sustainable development

Patrick Sorgeloos (Ghent University, Belgium)

22–25 September 2010, Phuket, Thailand

from *Kyoto 1976*,

over *Venice 1981*,

and *Bangkok 2000*,

to *Phuket 2010*

Global Conference on Aquaculture 2010

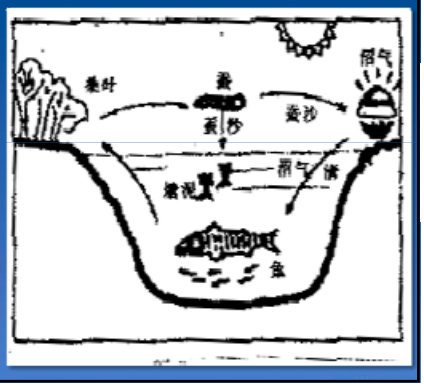
Overview of this presentation

1. History of aquaculture
2. Challenges, threats and opportunities for future aquaculture
3. Priorities for future aquaculture
4. The way forward



1. History of aquaculture

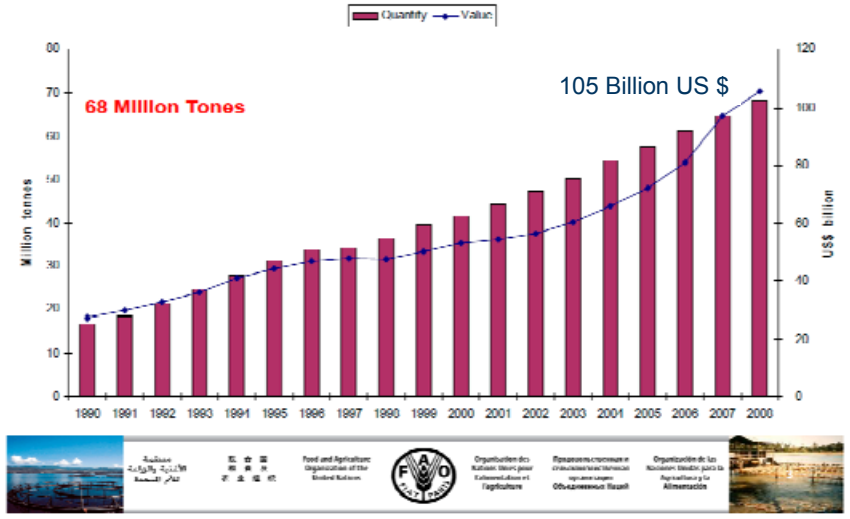
1. Facts and figures
2. Food versus business aquaculture
3. Systems and species
4. Success stories



1. History of aquaculture

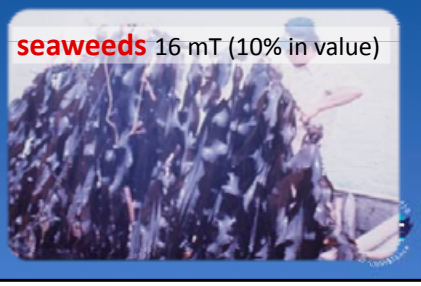
1. Facts & Figures

Quantity and value of world aquaculture production of aquatic animals and plants



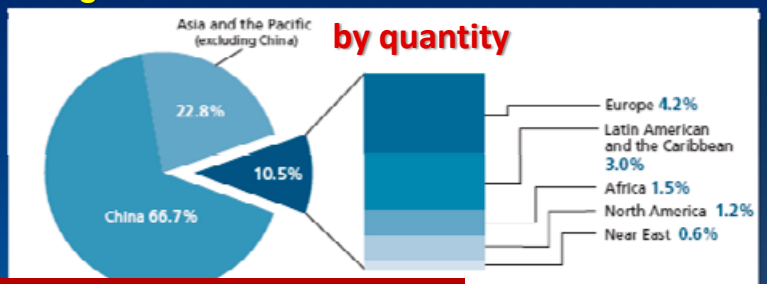
1. History of aquaculture

1. Facts & Figures

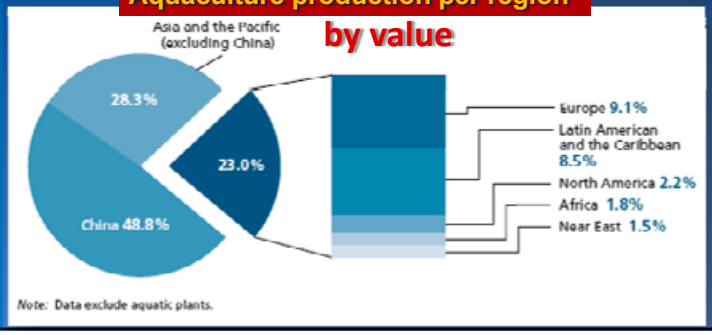


1. History of aquaculture

1. Facts & Figures



Aquaculture production per region



FAO, 2009

1. History of aquaculture

2. FOOD versus BUSINESS aquaculture

FOOD aquaculture

Asia, esp. China
- long history
- large production
- integrated farming

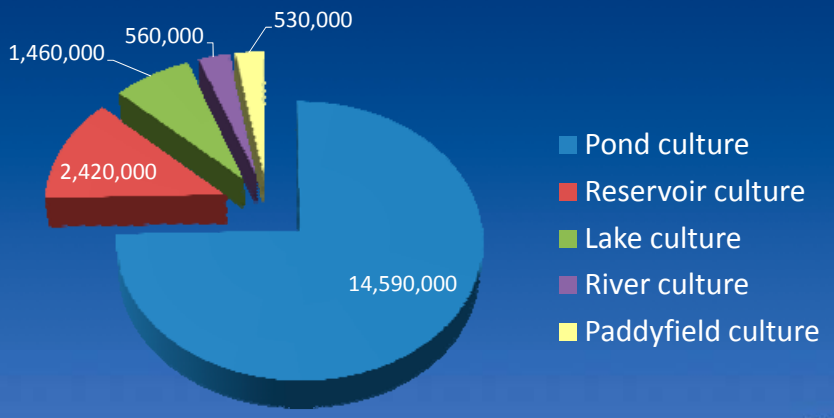
BUSINESS aquaculture

Recent developments (since 1960s)
- Japan, later Europe, America's, etc
- successful new industry
- monoculture

1. History of aquaculture

2. FOOD versus BUSINESS aquaculture

5 types of freshwater aquaculture in China (in tonnes)



Courtesy: Pan Yingjie, Shanghai Ocean University, 2010

1. History of aquaculture

2. FOOD versus BUSINESS aquaculture

1. History of aquaculture

2. FOOD versus BUSINESS aquaculture

1. History of aquaculture

2. FOOD versus BUSINESS aquaculture

FOOD aquaculture

Asia, esp. China
- long history
- large production
- integrated farming

BUSINESS aquaculture

Recent developments (since 1960s)
- Japan, later Europe, America's, etc
- successful new industry
- monoculture

1. History of aquaculture

2. FOOD versus BUSINESS aquaculture

BUSINESS aquaculture

biology
technology
profitability

monoculture approach

1. History of aquaculture

3. Aquaculture sytems and species

1. History of aquaculture

3. Aquaculture sytems and species

Courtesy Harache

1. History of aquaculture

3. Aquaculture sytems and species

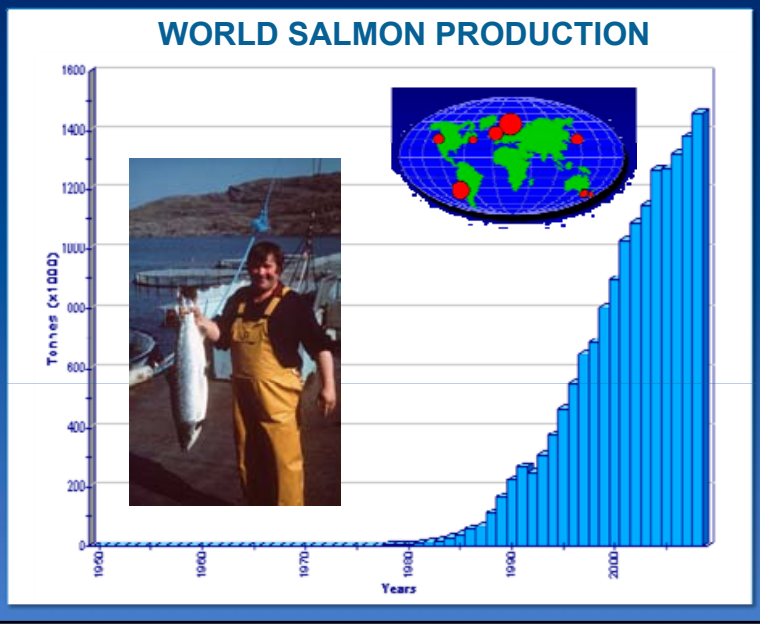
Courtesy Harache

1. History of aquaculture

3. Aquaculture sytems and species

1. History of aquaculture

4. Success stories



1. History of aquaculture

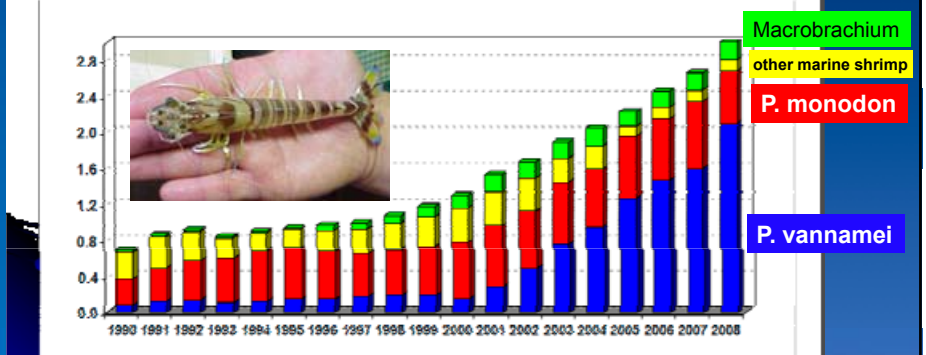
4. Success stories

12,000 ton/yr salmon farm in Norway operated by <10 people

1. History of aquaculture

4. Success stories

World shrimp production by species



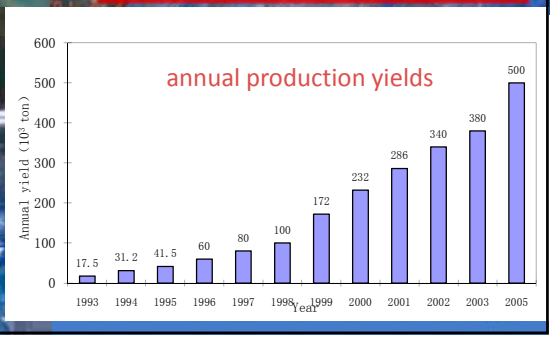

1. History of aquaculture
4. Success stories
PANGASIUS CATFISH FARMING IN VIETNAM
> 1,000,000 TONS/YEAR


1. History of aquaculture
4. Success stories
in 1,000 ha (surface area)
Production (in 1000 tons
0
1
2
3
4
5
6
7
8
9
10
0
100
200
300
400
500
600
700
800
900
1000
1997
1999
2001
2003
2004
2005
2006

1. History of aquaculture

4. Success stories

CHINESE MITTEN CRAB
Eriocheir sinensis



1. History of aquaculture

4. Success stories

scallop farming

mollusc farming: 14 million ton / year

1. History of aquaculture

4. Success stories

red and brown
algae farming in China

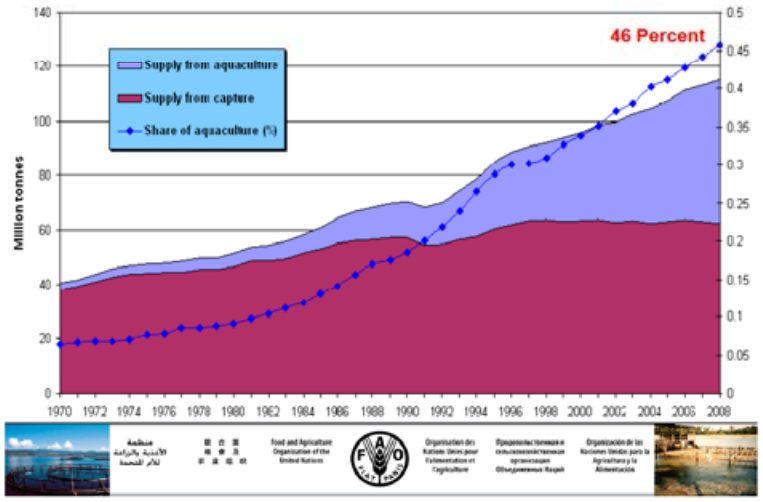
seaweed farming: 16 million ton / year

2. Challenges, threats & opportunities for future aquaculture

- Increased market demands, limited fisheries, population increase, health benefits
- Freshwater versus seawater
- Long term human food supply
- Sustainability issues

2. Challenges, threats & opportunities

Contribution of aquaculture to world fish consumption during 1970-2008

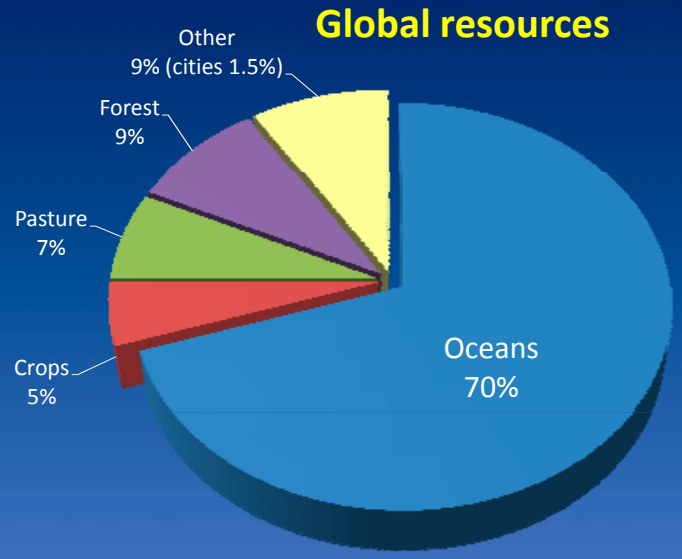


2. Challenges, threats & opportunities

2. Challenges, threats & opportunities

- In 2007, the world consumed 113.7 million tonnes of fish, 50.3 million tonnes originated from aquaculture
- Ten years from now, aquaculture will need to produce 28.8 million tonnes more per year than current annual production

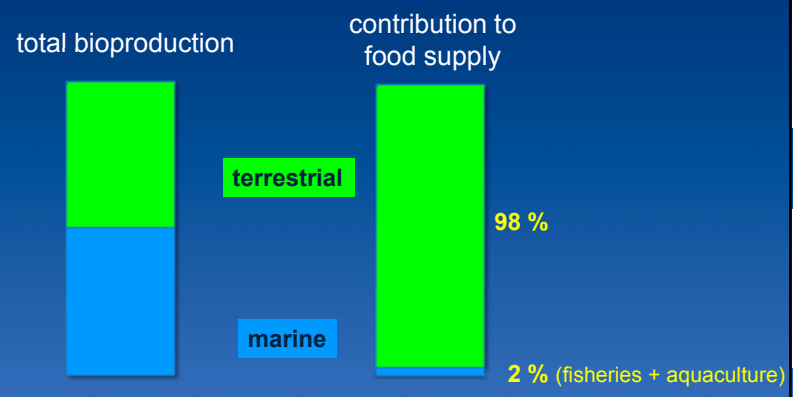
2. Challenges, threats & opportunities



from Cunningham, **"Knowledge Based Bio-Economy towards 2020"**
Brussels, September 14, 2010

2. Challenges, threats & opportunities

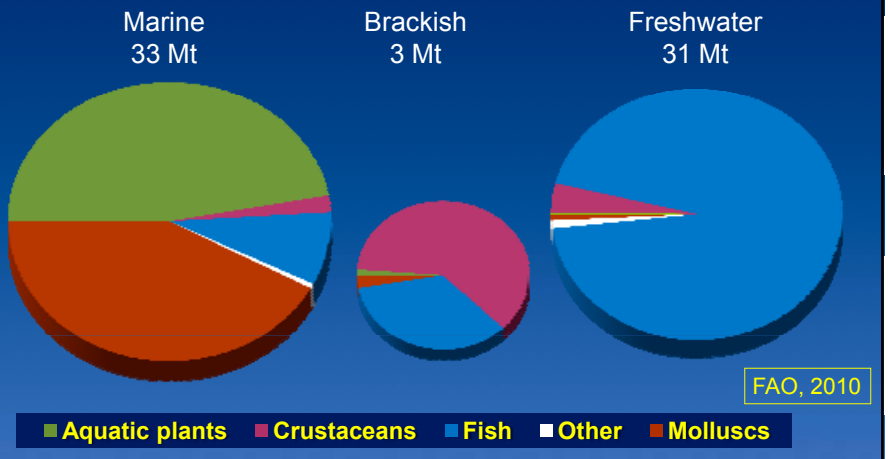
Global primary production and food supply



from Field et al. (1998) and Duarte et al. (2009)

2. Challenges, threats & opportunities

AQUACULTURE PRODUCTION BY SPECIES GROUP & ENVIRONMENT



2. Challenges, threats & opportunities

STAGNANT CAPTURE FISHERIES

environmental problems?
human health risks?
sustainable?

INCREASED MARKET DEMAND

more responsible farming !

INCREASED AQUACULTURE PRODUCTION

3. Priorities for future aquaculture

from empiricial farming

towards

a knowledge-based bio-industry

AQUACULTURE :
BLUE BIOTECHNOLOGY OF THE FUTURE ?

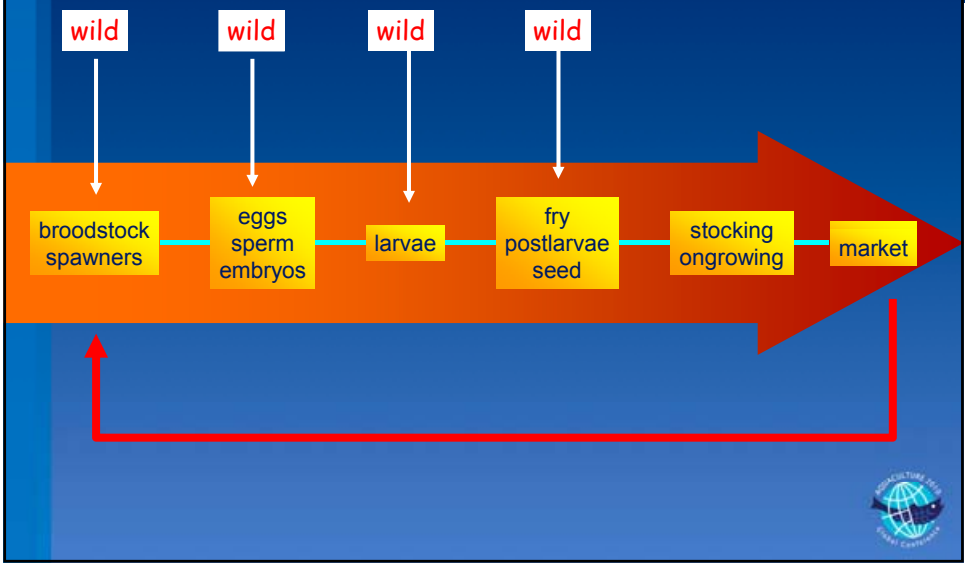
resulting in new concepts & products for
a sustainable aquaculture

3. Priorities for future aquaculture

1. Complete independence from natural stocks through **DOMESTICATION**
2. Improved / more cost-effective **SEED PRODUCTION**
3. Better targeted **SPECIES SELECTION**
4. Development of more efficient stocks through **SELECTIVE BREEDING**
5. More **MICROBIAL MANAGEMENT** for more sustainable production
6. Better understanding of **IMMUNE SYSTEMS** in vertebrates and invertebrates
7. More **INTEGRATED PRODUCTION SYSTEMS** for plant and animal farming
8. **COASTAL AND OFF-SHORE FARMS** of food and energy
9. Full independence from fisheries stocks for **LIPID AND PROTEIN INGREDIENTS** in aquatic feeds
10. More attention for **INTEGRATION** of restocking activities with **FISHERIES** management
11. **SOCIETAL LEVERAGE:**
    - multi-stakeholder interaction
    - International cooperation on a win-win basis

3. Priorities for future aquaculture

1. Complete independence from natural stocks through **DOMESTICATION**




3. Priorities for future aquaculture
2. Improved / more cost-effective SEED PRODUCTION


3. Priorities for future aquaculture
2. Improved / more cost-effective SEED PRODUCTION

3. Priorities for future aquaculture

2. Improved / more cost-effective **SEED PRODUCTION**

example:

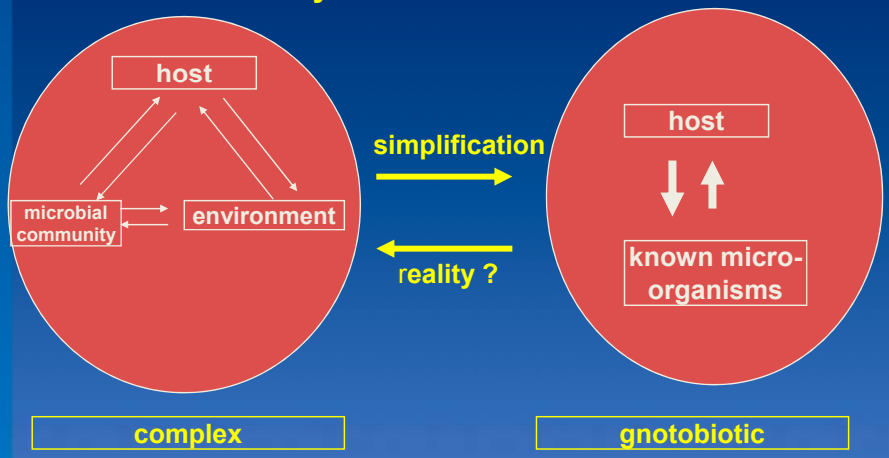
Sea bass/bream larviculture in the Mediterranean

- annual production of 1 billion fry
- market value of 15 Euro cents a piece
- average survival 20 % by day 60
- low survival = critical bottleneck for future cost efficiency and sustainability of the industry
- microbial interference considered to be the main culprit
- no selected breeds available yet

3. Priorities for future aquaculture

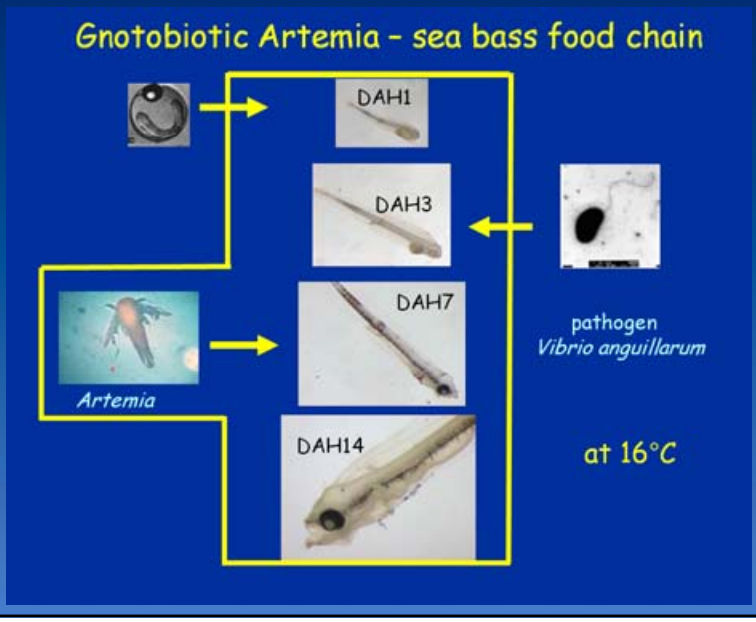
2. Improved / more cost-effective **SEED PRODUCTION**

How to study host-microbial interactions?



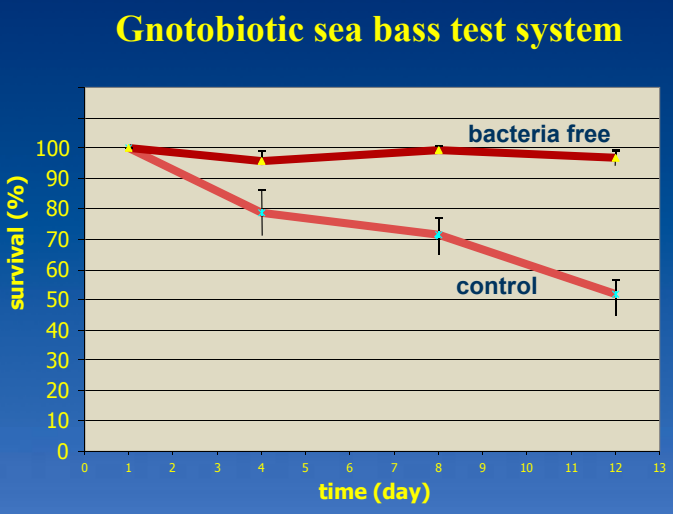
3. Priorities for future aquaculture

2. Improved / more cost-effective **SEED PRODUCTION**



3. Priorities for future aquaculture

2. Improved / more cost-effective **SEED PRODUCTION**

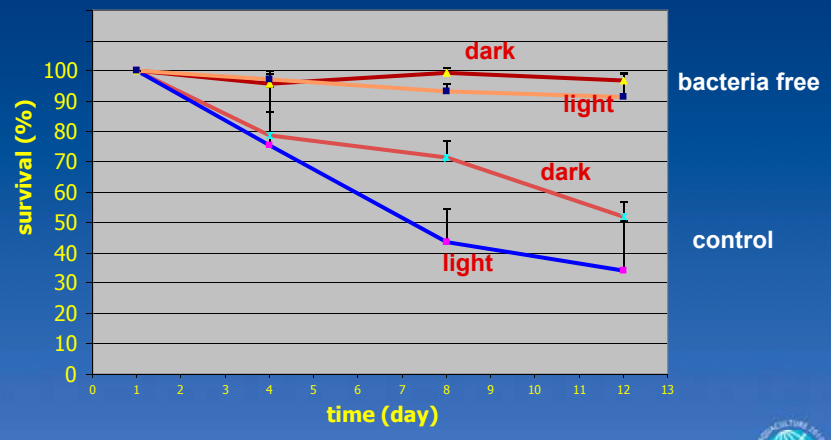


3. Priorities for future aquaculture

2. Improved / more cost-effective **SEED PRODUCTION**

Gnotobiotic sea bass test system

Effect of light stress on survival of xenic sea bass larvae

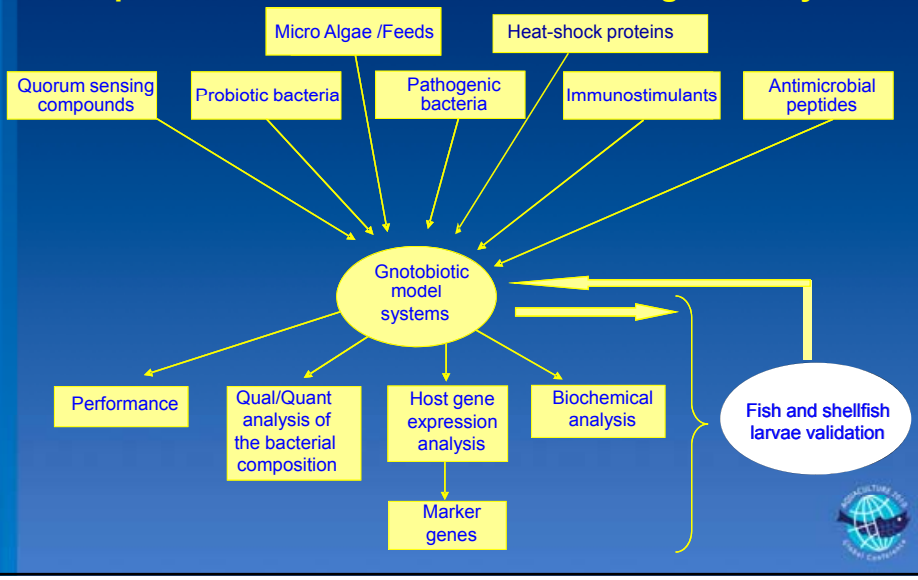


Axenic sea bass larvae are not sensitive to light stress

3. Priorities for future aquaculture

2. Improved / more cost-effective **SEED PRODUCTION**

Development of innovative microbial management systems



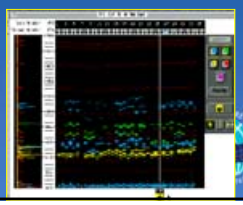
3. Priorities for future aquaculture

2. Improved / more cost-effective **SEED PRODUCTION**

disease free

certified seed

disease resistant



3. Priorities for future aquaculture

3. Better targeted **SPECIES SELECTION** for bulk & niche markets

3. Priorities for future aquaculture

4. Development of more efficient stocks through **SELECTIVE BREEDING**

wild stock → genetic variation

- disease resistance
- growth rate
- size / quality
- feed conversion
- fecundity
- ease of domestication

domesticated stock

genetic improvement

breeding objectives

breeding program

3. Priorities for future aquaculture

4. Development of more efficient stocks through **SELECTIVE BREEDING**

Genomic breeding

(Xu et al, Nature 2006)

- High throughput **genotyping** of germplasms
- Coupled with high throughput **phenotyping**
- Valorized by high throughput **bioinformatics**
- Organise large **worldwide networks** within public research

INRA

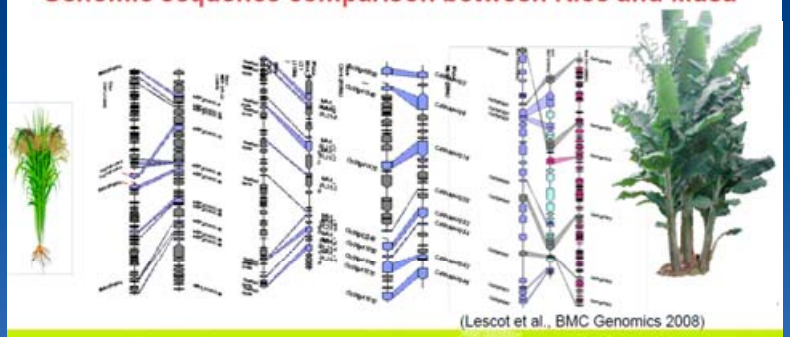
Marion Guillou, CEO
September 14th, 2010
Knowledge Based Bio-Economy towards 2020

3. Priorities for future aquaculture

4. Development of more efficient stocks through **SELECTIVE BREEDING**

New avenues, from model to (other) crops

Genomic sequence comparison between Rice and Musa

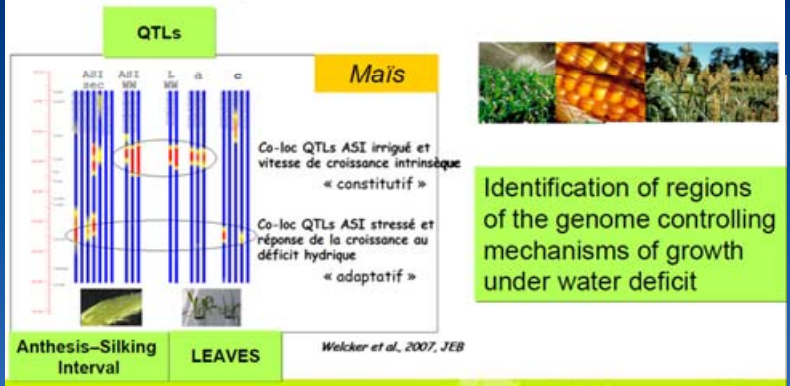


(Lescot et al., BMC Genomics 2008)

3. Priorities for future aquaculture

4. Development of more efficient stocks through **SELECTIVE BREEDING**

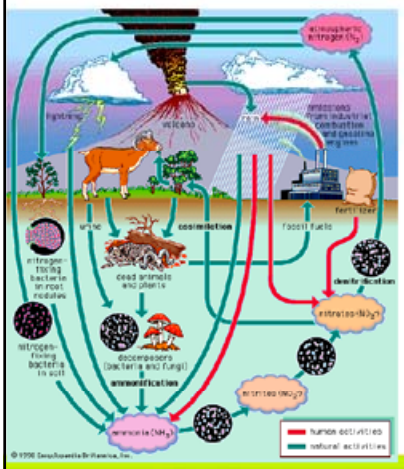
Design of new plants tolerant to environmental stresses



Identification of regions of the genome controlling mechanisms of growth under water deficit

Marion Guillou, CEO
September 14th, 2010
Knowledge Based Bio-Economy towards 2020

3. Priorities for future aquaculture



Microbes "run the world"

- Most microbes live in complex population, and as many as 99% of prokaryote taxa are not currently cultivable

- Universal implication
  - Food, health, environment, agriculture
  - Fundamental knowledge of genome and population functioning and evolution

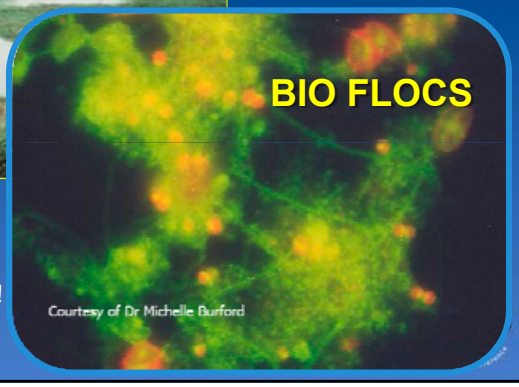
INRA

Marion Guillou, CEO
September 14th, 2010
Knowledge Based Bio-Economy towards 2020

3. Priorities for future aquaculture

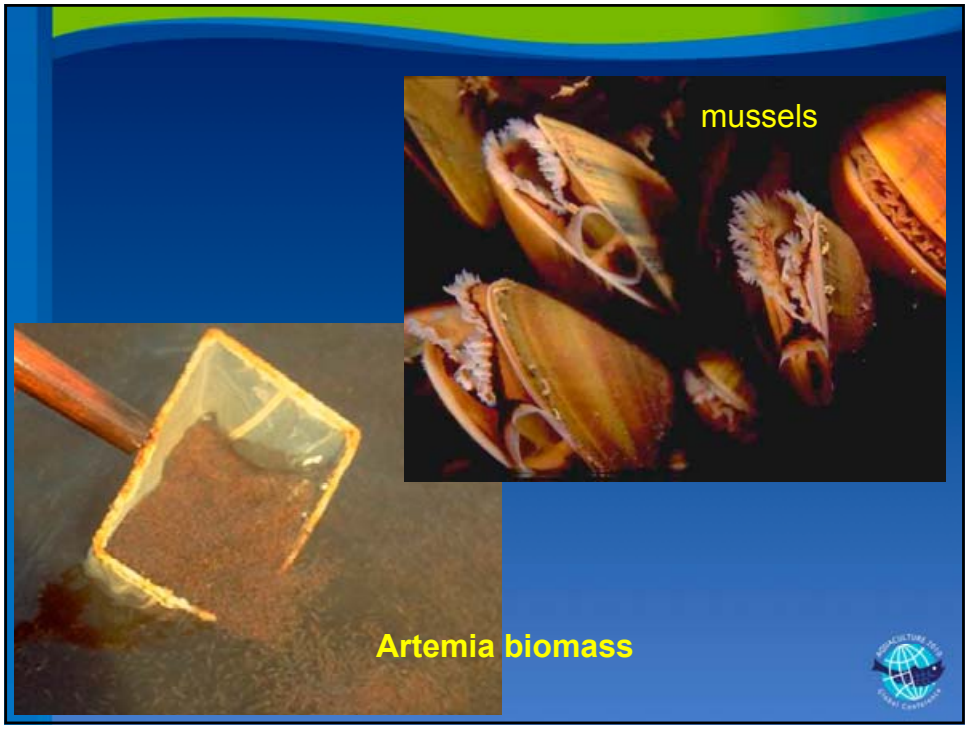
5. More **MICROBIAL MANAGEMENT** for more sustainable production

70 % of all farmed fish are produced in ponds



What is the role of the microflora ?

Recent documentation:
30 % N contribution from bio flocs !



3. Priorities for future aquaculture

5. More **MICROBIAL MANAGEMENT** for more sustainable production

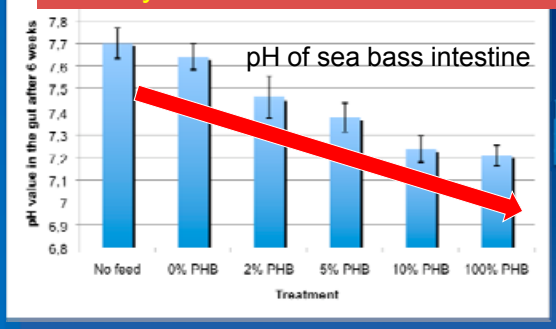
Examples of steering host-microbial interactions

- ***Stimulating the host's immune response***
  - yeast cell wall-bound components
  - heat shock proteins
- ***Influencing microbial numbers or activity***
  - intestinal pH modulation (polyhydroxybutyric acid)
  - quorum-sensing interference

3. Priorities for future aquaculture

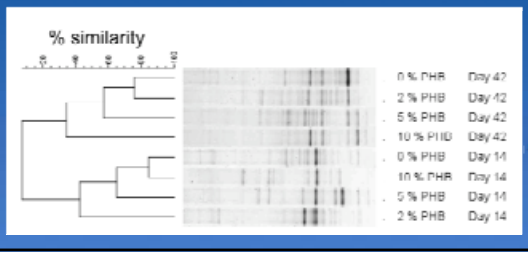
5. More **MICROBIAL MANAGEMENT** for more sustainable production

Dietary effect of PHB addition to the diet of sea bass larvae



higher uptake of PHB results in lower intestinal pH

production of 3-HB or other SCFA in the gut?

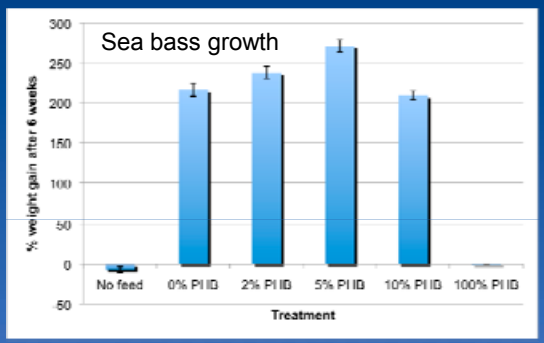


change in microbial community

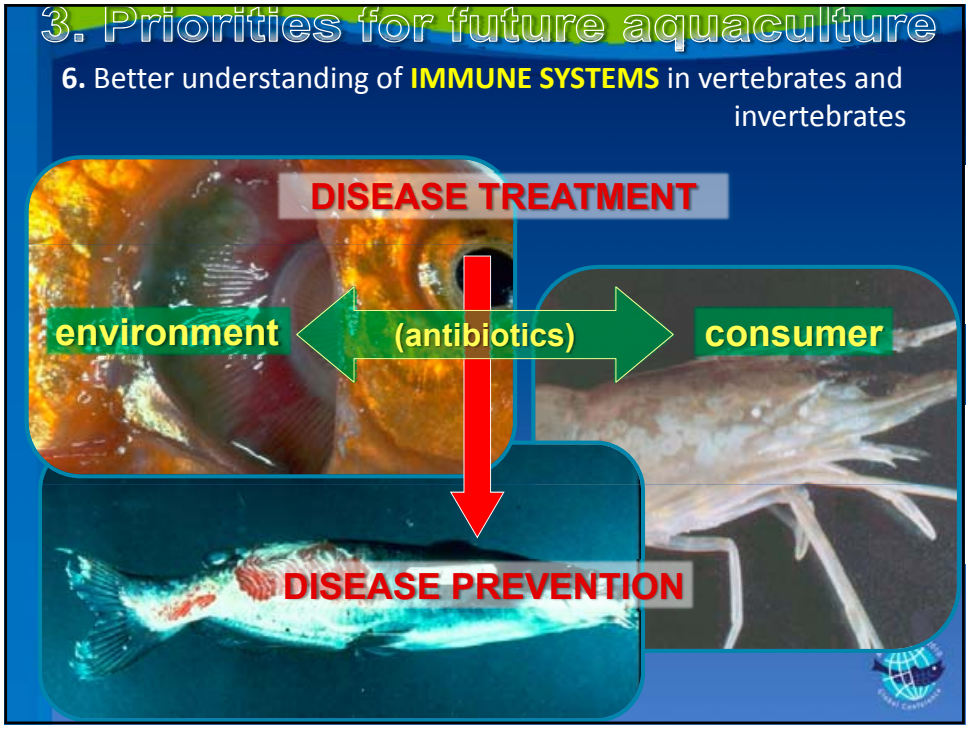
3. Priorities for future aquaculture

5. More **MICROBIAL MANAGEMENT** for more sustainable production

Dietary effect of PHB addition to the diet of sea bass larvae



2 – 5 % PHB induces significant weight increase


3. Priorities for future aquaculture
6. Better understanding of IMMUNE SYSTEMS in vertebrates and invertebrates
DISEASE TREATMENT
environment
(antibiotics)
consumer
DISEASE PREVENTION


3. Priorities for future aquaculture
6. Better understanding of IMMUNE SYSTEMS in vertebrates and invertebrates
diagnostics
immunology
vaccines
quarantine

3. Priorities for future aquaculture

6. Better understanding of **IMMUNE SYSTEMS** in vertebrates and invertebrates

Next breakthroughs in vaccine development

- DNA vaccines √
- Live vaccines √
- GMO's
- Parasite vaccines
- Non-oil adjuvanted vaccines
- Adjuvanted multivalent oral vaccines

Intervet Schering-Plough Animal Health Aquavision 2010 09/06/2010 29

3. Priorities for future aquaculture

6. Better understanding of **IMMUNE SYSTEMS** in vertebrates and invertebrates

Conclusions

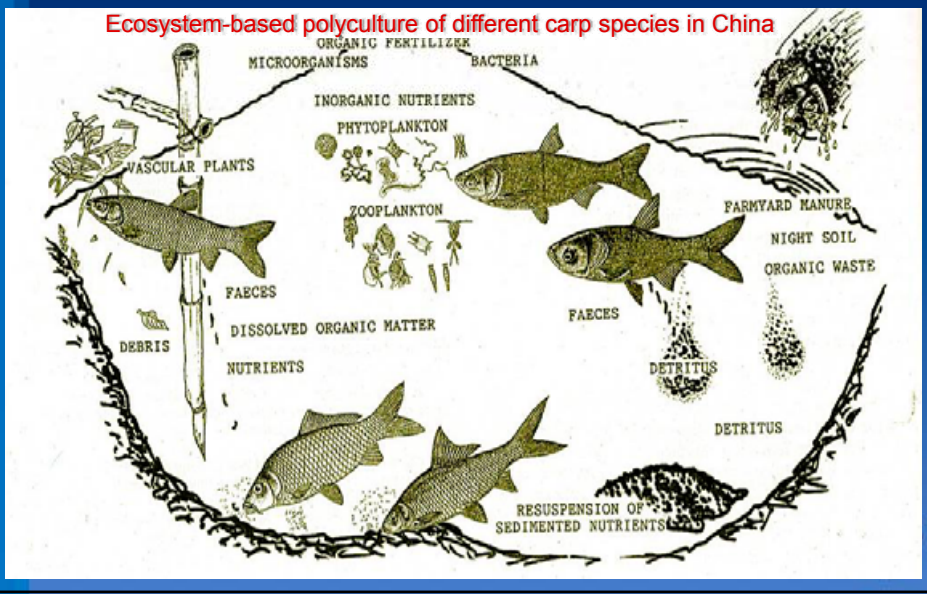
- Fish vaccinology is still a young and maturing science.
- All species go through the same processes – yet faster
- In a species' development attention shifts from late infections to early infections
- Vaccines are only part of an Integrated Health Plan making use of therapeutics and vaccines in a coherent sensible scheme
- Antigens and approaches developed for one species benefit others
- The next level in fish health will be reached through a collaboration of stakeholders and not just through the advancement of science alone

Intervet Schering-Plough Animal Health Aquavision 2010 09/06/2010 31

3. Priorities for future aquaculture

7. More **INTEGRATED PRODUCTION SYSTEMS** for plant and animal farming

Ecosystem-based polyculture of different carp species in China



3. Priorities for future aquaculture

7. More **INTEGRATED PRODUCTION SYSTEMS** for plant and animal farming

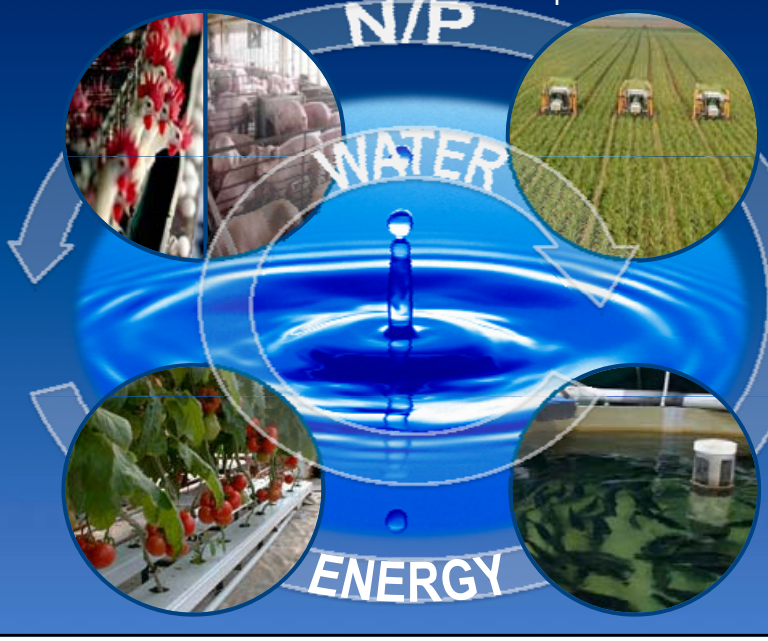
3. Priorities for future aquaculture

7. More **INTEGRATED PRODUCTION SYSTEMS** for plant and animal farming

HYDROPONICS / AQUACULTURE INTEGRATION

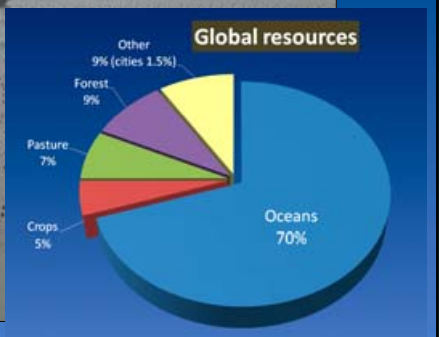
3. Priorities for future aquaculture

7. More **INTEGRATED PRODUCTION SYSTEMS** for plant and animal farming



3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy



3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy

EXTRACTIVE aquaculture

nutrient recycling

FED aquaculture

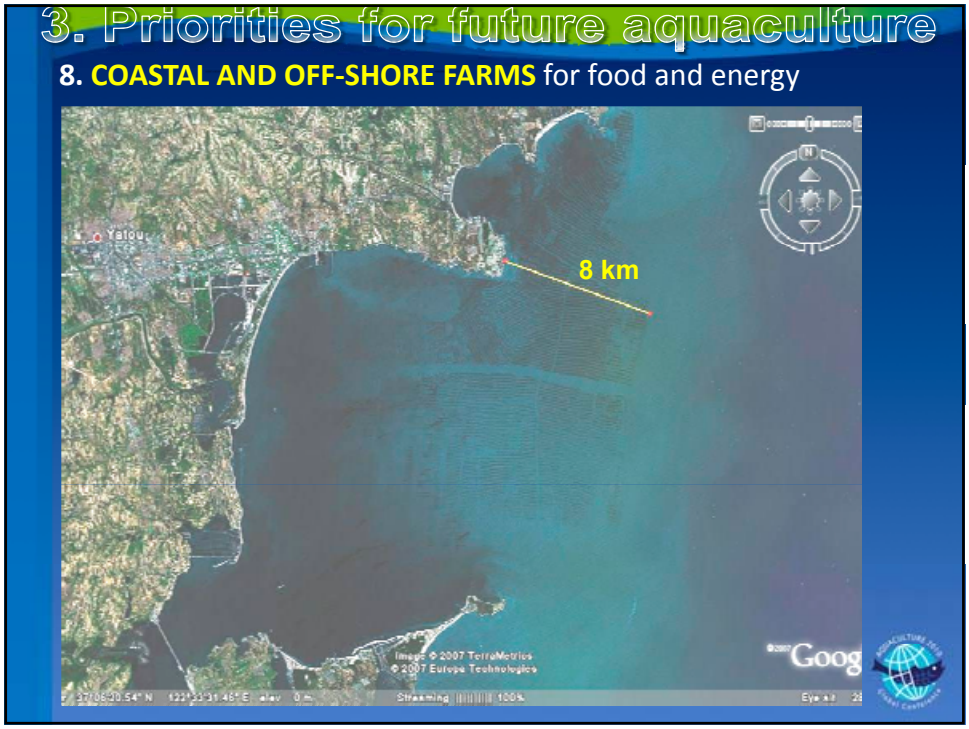
3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy

3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy


3. Priorities for future aquaculture
8. COASTAL AND OFF-SHORE FARMS for food and energy
Integration of culture of different trophic levels
MACROALGAE
MUSSELS
FINFISH

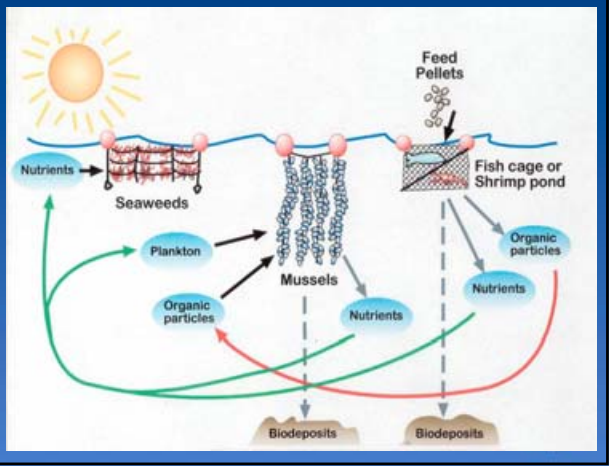

3. Priorities for future aquaculture
8. COASTAL AND OFF-SHORE FARMS for food and energy
8 km

3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy

Multi-trophic aquaculture integrating different niches of the ecosystem: fish, shellfish & seaweeds and maximizing nutrient recycling

- for food production
- for bioremediation



3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy

Sea ranching or sea bottom culture in subtidal zone in Zhangzidao Island, Dalian, Liaoning Province, China

3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy

Marie Curie Actions
Human resources and mobility

Status of sea ranching in ZZD

Species	Sea ranching area (ha)	Annual yield (ton)
Scallop *Patinopecten yessoensis*	40,000	20,000
Abalone *Haliotis discus hannai*	1,000	100
Sea Cucumber *Apostichopus japonicus*	1,000	400
Sea urchin *Strongylocentrotus mudus*	1,000	300
Ark shell *Scapharca broughtonii*	3,000	500

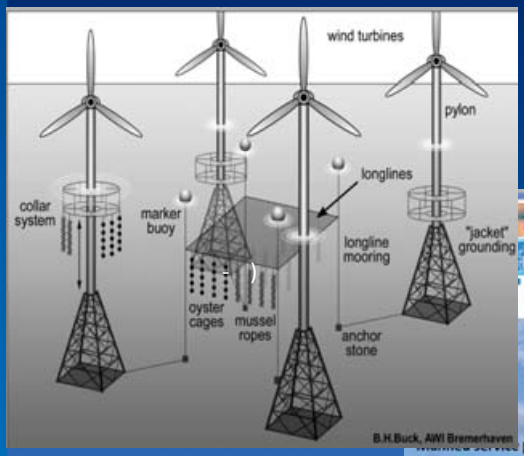
3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy

Role of aquaculture in environmental bioremediation & habitat rehabilitation

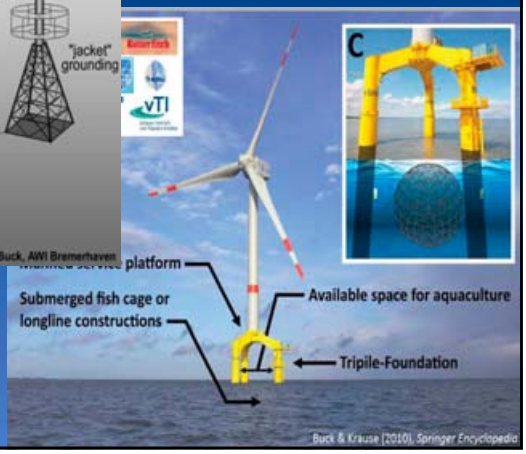
3. Priorities for future aquaculture

8. COASTAL AND OFF-SHORE FARMS for food and energy



Energy generation

(wind, wave, thermal)



3. Priorities for future aquaculture

9. Full independence from fisheries stocks for **LIPID AND PROTEIN INGREDIENTS** in aquaculture feeds

3. Priorities for future aquaculture

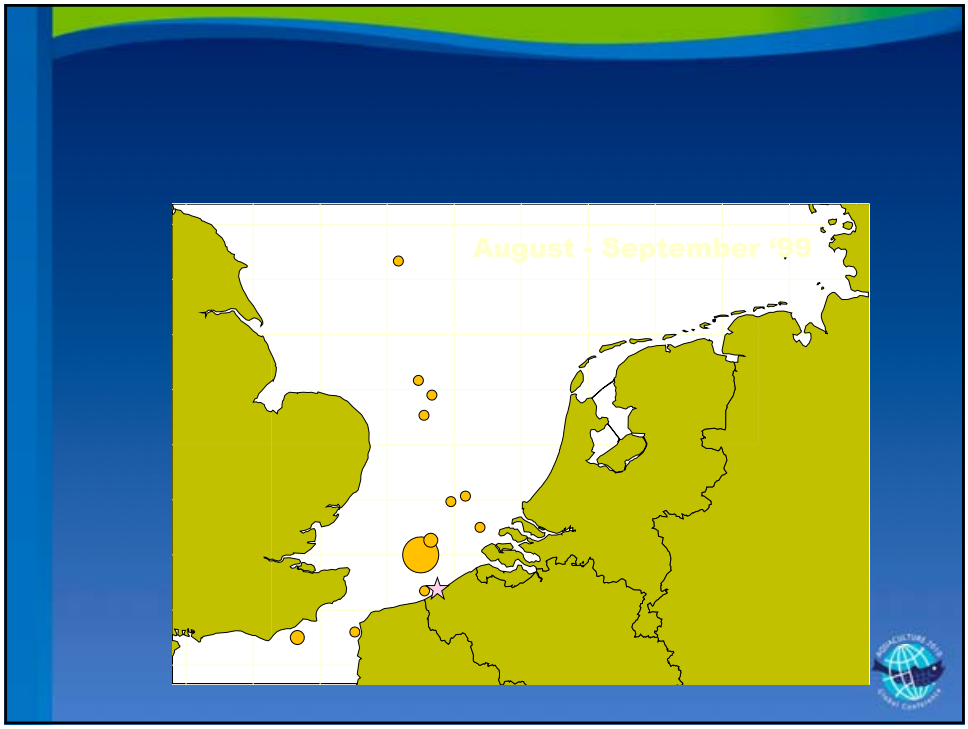
10. More attention for **INTEGRATION** of restocking activities with **FISHERIES** management

- more attention for integration of restocking activities with fisheries management through multidisciplinary cooperation: oceanography, marine biology, fisheries & aquaculture

- juvenile fitness
- releasing strategies
- impact on wild stocks

3. Priorities for future aquaculture

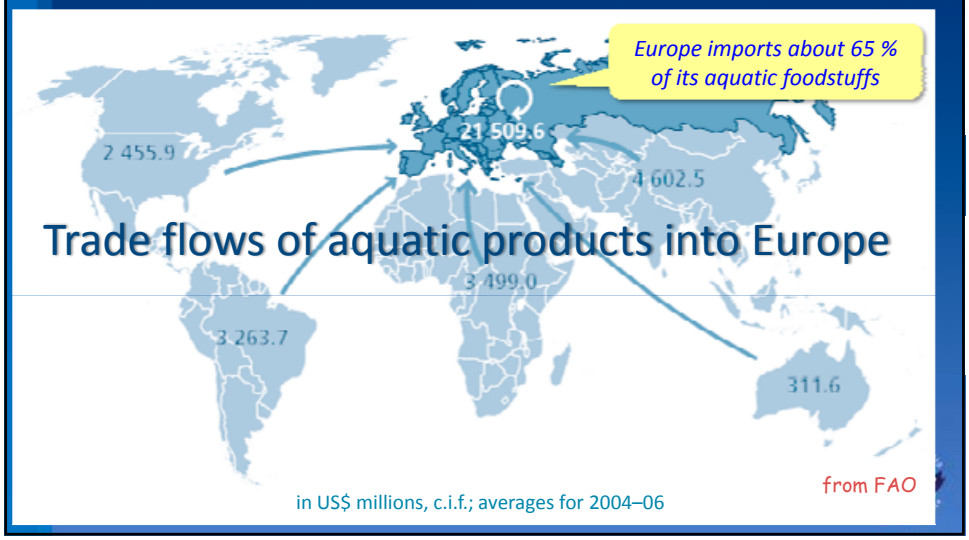
10. More attention for **INTEGRATION** of restocking activities with **FISHERIES** management



3. Priorities for future aquaculture

11. SOCIETAL LEVERAGE:

- multistakeholder interaction
- international cooperation on a win-win basis



4. The way forward

EATIP
European Aquaculture Technology & Innovation Platform

EATiP stakeholder groups:

- Producers (FEAP, Mollusc Assoc,...)
- Feed companies (FEFAC)
- Pharmaceutical companies
- Service / Hardware companies
- Scientific Organisations (education, training, research)
- International associations (EAS, NACEE, AquaTnet, …)
- Consumer organisations / Retailers
- Legislation / Policy makers

4. The way forward

Strategy, Structure, Processes

- Establishing a strong relationship between aquaculture and the consumer
- The assurance of a sustainable industry
- Consolidation of the role of aquaculture in society

Aquaculture and the Consumer | The Assurance of a Sustainable Industry | The Role of Aquaculture in Society

Thematic Areas

Product quality & human safety and health
Technology and systems (engineering)
Managing the biological lifecycle
Sustainable feed production
Interactions with the environment
Aquatic animal health and
Knowledge manag

New: Socio-economics and Management

Stakeholders Meeting
Board of Directors
Secretariat
Operative Council
Thematic Areas
Working Groups

EATIP


4. The way forward
marineharvest
XPLORA
Scottish Sea Farms
INVE
PESCANOVA
TECHNOSEA
TRES MARES
Marine Farms
nutreco
NIREUS S.A.
Adrien
AQUAMOR
TINAMENOR
AGROTICA TOSCANA
Valle a Zuliani
cermaq
AKVA GROUP
optimar
AZZURRO
IDEMA
UNIVERSITEIT GENT
AQUATT
APROMAR
EMEC
AquaVision
NASCO
EFARO
BluePlanet
Fisheries
azti tecnalia
CSIC
Ifremer
NTNU
SINTEF
fefac
TEKMAR
NACEE


4. The way forward
feap
AQUA-TNET
Network of Aquaculture Centres in Central-Eastern Europe
NACEE
EABA
EUROPEAN ALGAE BIOMASS ASSOCIATION
EATIP
ASEM Aquaculture Platform
China AquaFishNet
ViFINET
NACA
UNIVERSITEIT GENT
Asian Fisheries & Aquaculture Society


Thank you
www.aquaculture.ugent.be