Global Conference on Aquaculture 2010

Farming the waters for People and Food

22-25 September 2010, Phuket, Thailand

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A centre with: SEI Stockholm Environment Institute, The Beijer Institute of Ecological Economics, Stockholm University

Global Conference on Aquaculture 2010, Farming the Waters for Food and People,
22–25 September 2010 Phuket, Thailand

Session III: Aquaculture and the environment

Expert Panel Presentation III.1:
Promoting responsible use and conservation of aquatic biodiversity for sustainable aquaculture development – Dr John Benzie (Ireland)

Expert Panel Presentation III.2:
Addressing aquaculture-fisheries interactions through the implementation of the ecosystem approach to aquaculture (EAA) – Dr Doris Soto (FAO)

Expert Panel Presentation III.3:
Improving biosecurity: a necessity for aquaculture sustainability – Dr Mike Hine (New Zealand)

Outline

- whats at stake
- ongoing processes - environmental integrity issues and criteria
- tools/frameworks
- possible generic traits
- challenges
- prospects

Environmental integrity

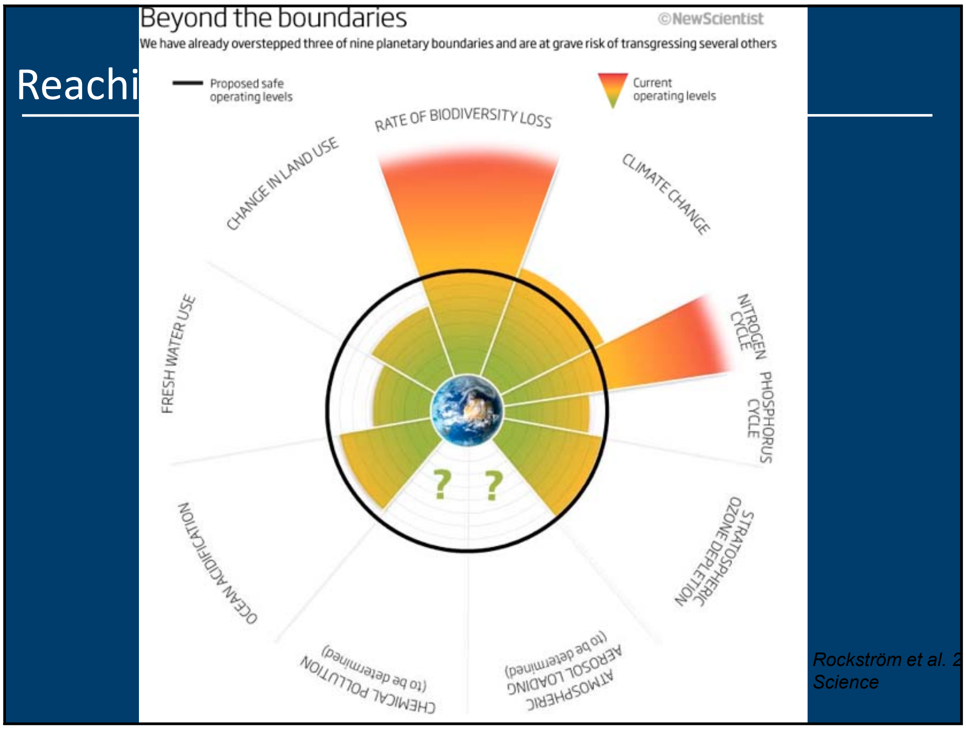
Millennium Ecosystem Assessment

Ecosystem Services

- Provisioning services e.g. food, fibers, freshwater
- Regulating services e.g. climate regulation, water regulation nutrient cycling
- Cultural services e.g. recreation and aesthetic experiences inspiration
- Supporting services necessary for production of all other ecosystem services

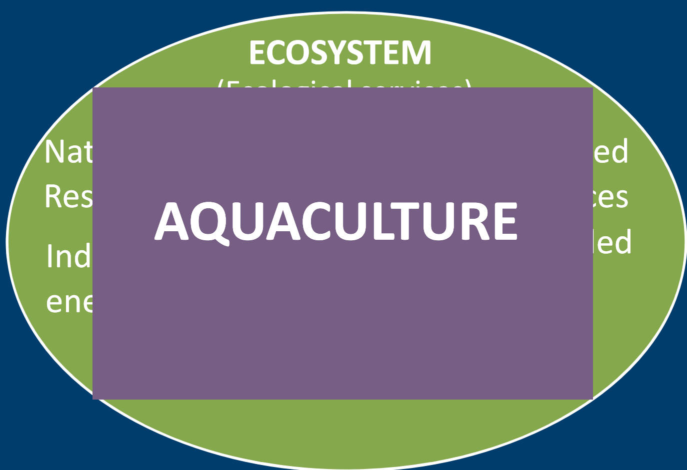
Biological diversity


Reaching
Limits

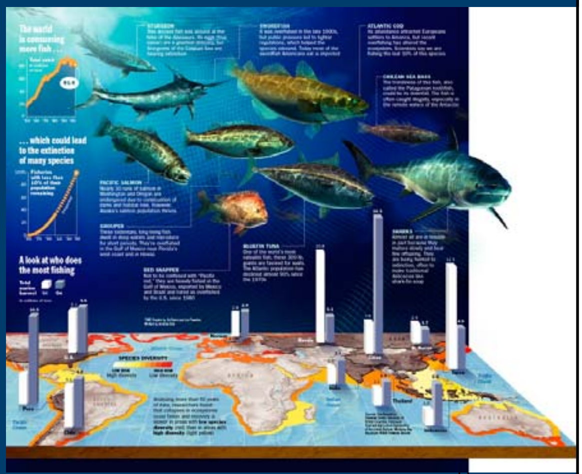

Reachi
Beyond the boundaries
©NewScientist
We have already overstepped three of nine planetary boundaries and are at grave risk of transgressing several others
Proposed safe operating levels
Current operating levels
RATE OF BIODIVERSITY LOSS
CLIMATE CHANGE
NITROGEN CYCLE
PHOSPHORUS CYCLE
STRATOSPHERIC OZONE DEPLETION
ATMOSPHERIC AEROSOL LOADING (to be determined)
CHEMICAL POLLUTION (to be determined)
OCEAN ACIDIFICATION
FRESH WATER USE
CHANGE IN LAND USE
? ?
Rockström et al. 2
Science

Global boundaries - Aquaculture

Limits to Growth - Aquaculture

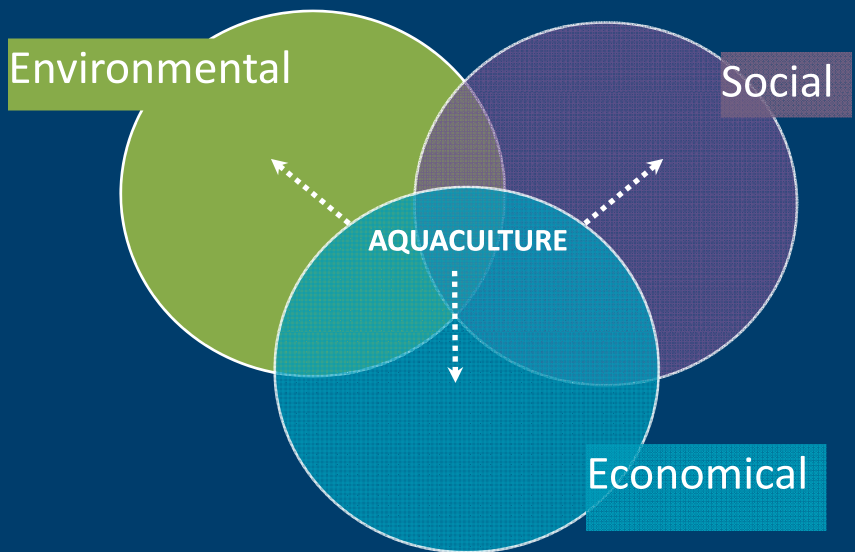


Increasing Capture Fisheries - not an option!!



Worm et al. 2006, Science

Limits to Growth - Aquaculture

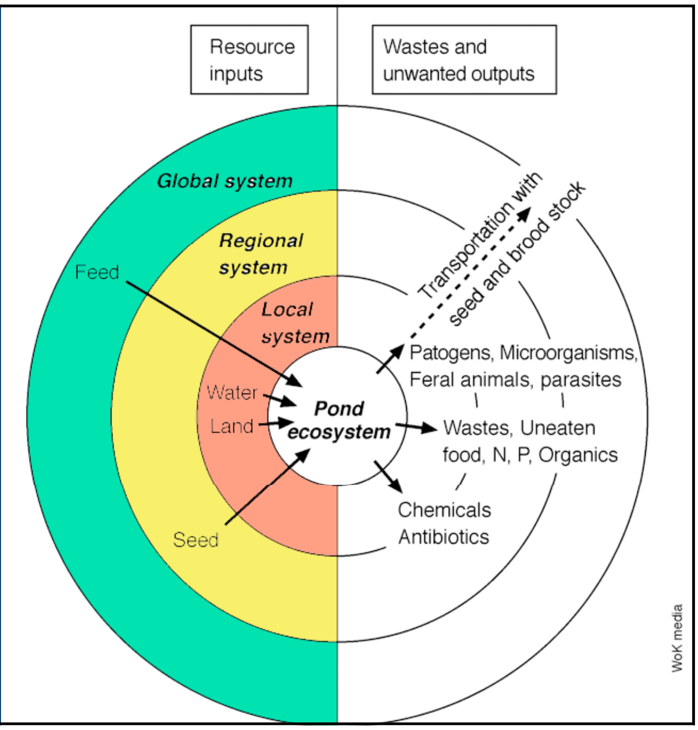


Environmental Integrity

Some Key environmental issues

- Farm design - space allocation
- Water use/pollution
- Feed management
- Broodstock/Seed
- Pathogens/Chemicals
- (Socio-economic issues)

Multi-scale and cross-scale dynamics



Aquaculture Dialogue

WWF

Standards aiming at minimizing key negative environmental and social impacts.

12 species/groups: shrimp, salmon, abalone, clams, mussels, scallops, oysters, Pangasius, tilapia, trout, Seriola and cobia.

Aquaculture Dialogue

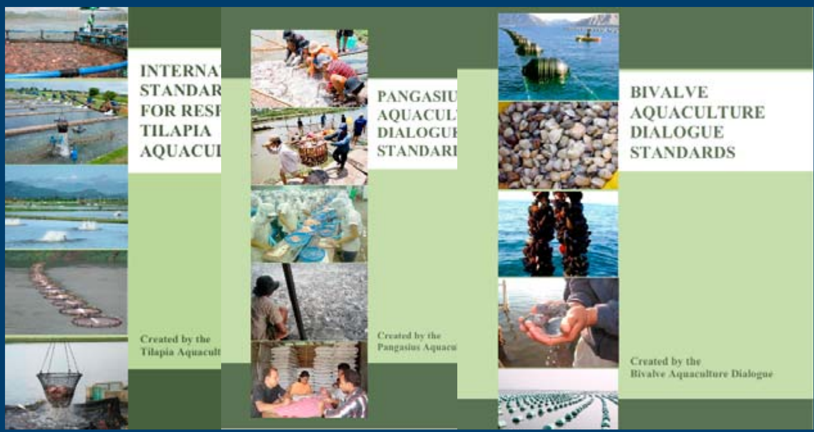
WWF

Standards

- Based on consensus
- Created by a broad and diverse set of stakeholders
- Developed through a transparent process
- Science-based
- External Stakeholders
- Measurable and performance-based

Aquaculture Dialogue

3 Standards Published



Aquaculture Dialogue

Shrimp Standards

Principle 2: Site farms in environmentally suitable locations while conserving biodiversity and important natural habitats

↓

Criterion 2.1 - 2.3:
Land/water allocation, wastes, salinisation, soil erosion

Principle 2

Guided by international conventions - for example CBD

"conserving biodiversity and ecosystem functions at all spatial scales"

"Planning should be based on an ecosystem approach"

Aquaculture Dialogue

Shrimp Standards

Principle 5: Manage shrimp health in a responsible manner

Criterion 5.1 - 5.3:
Disease management and predator control

Aquaculture Dialogue

Shrimp Standards

Principle 6: Manage broodstock origin, stock selection and effects of stock management

Criterion 6.1 - 6.4

Post larvae origin, escapees, transgenic shrimps

Aquaculture Dialogue

Shrimp Standards

Principle 7: Use resources in an environmentally efficient and responsible manner

Criterion 7.1 - 7.8

Origin of Feeds (aquatic/terrestric), GMO, By-products, wild fish (meal and oil) as feed, effeluents, energy

Aquaculture Stewardship Council

Aquaculture Stewardship Council

"Responsible for working with independent, third party entities to certify farms that are in compliance with the standards"

Aquaculture Dialogue

WWF

Shrimp Standards

Local

Protect and maintain ecosystem function and ecosystem services

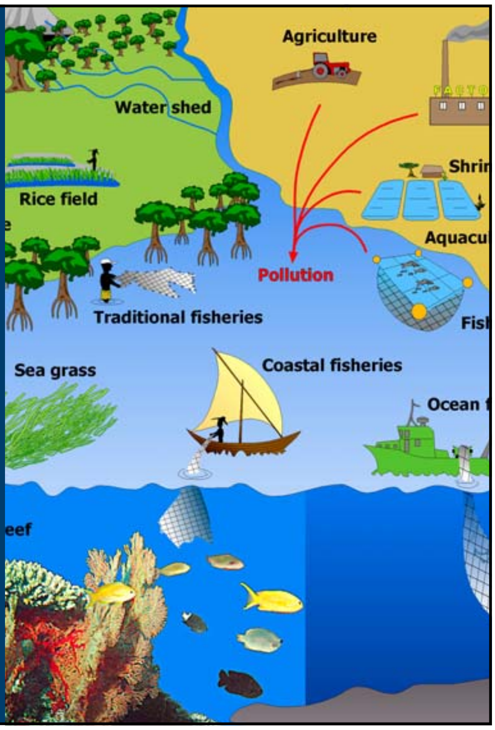
".........with the recognition that aquaculture operations are not solely responsible for total ecosystem health."

"An **Ecosystem Approach for Aquaculture** is a strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development and resilience of interlinked social-ecological systems" (FAO, 2006)

Ex. EAA principles:

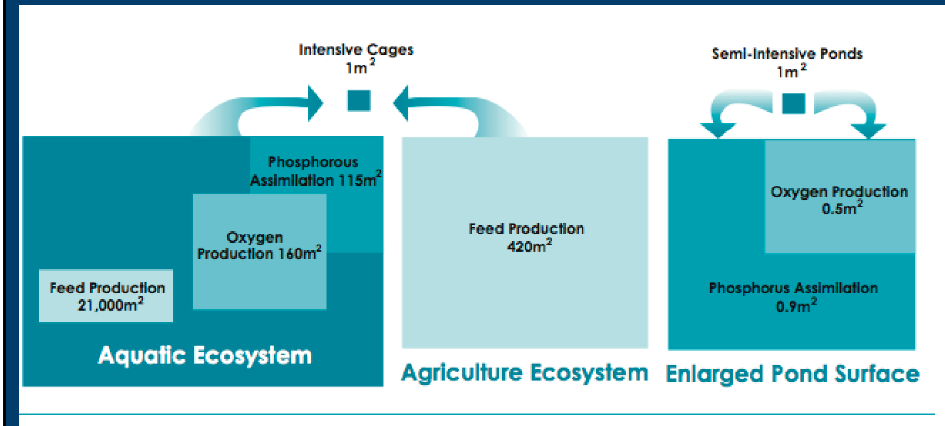
Aquaculture should improve human well-being and equity for all relevant stakeholders.

Aquaculture should be developed in the context of other sectors, policies and goals.



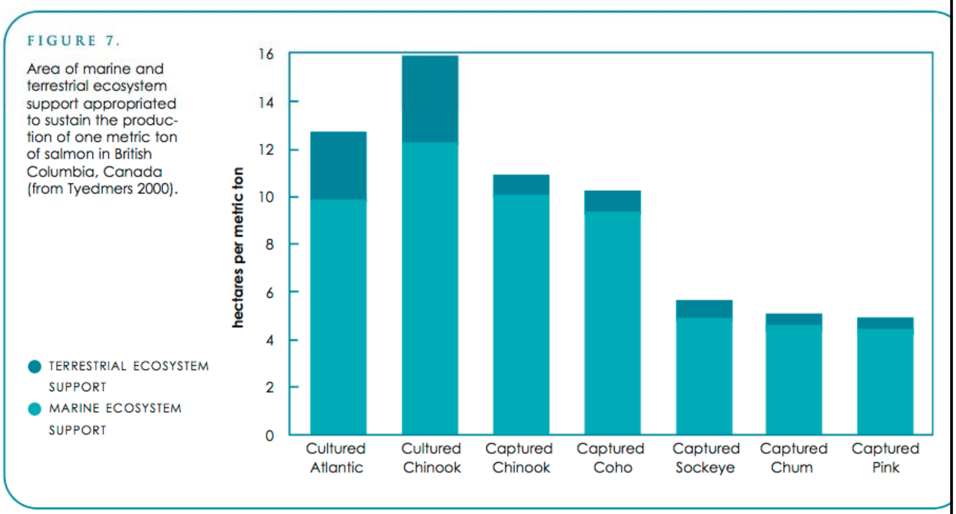
Analytical techniques for quantitatively assess biophysical performance in aquaculture

Ecological footprint analysis



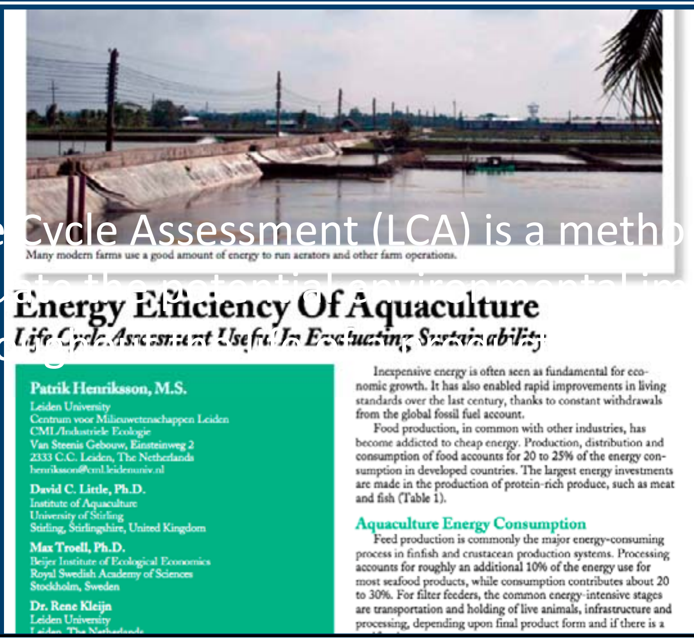
Tyedmers et al 2007, Data Berg et al. 2006

Ecological footprint analysis



Tyedmers et al 2007

Life cycle assessment


Many modern farms use a good amount of energy to run aerators and other farm operations.

Energy Efficiency Of Aquaculture

Life Cycle Assessment Useful In Evaluating Sustainability

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Inexpensive energy is often seen as fundamental for economic growth. It has also enabled rapid improvements in living standards over the last century, thanks to constant withdrawals from the global fossil fuel account.

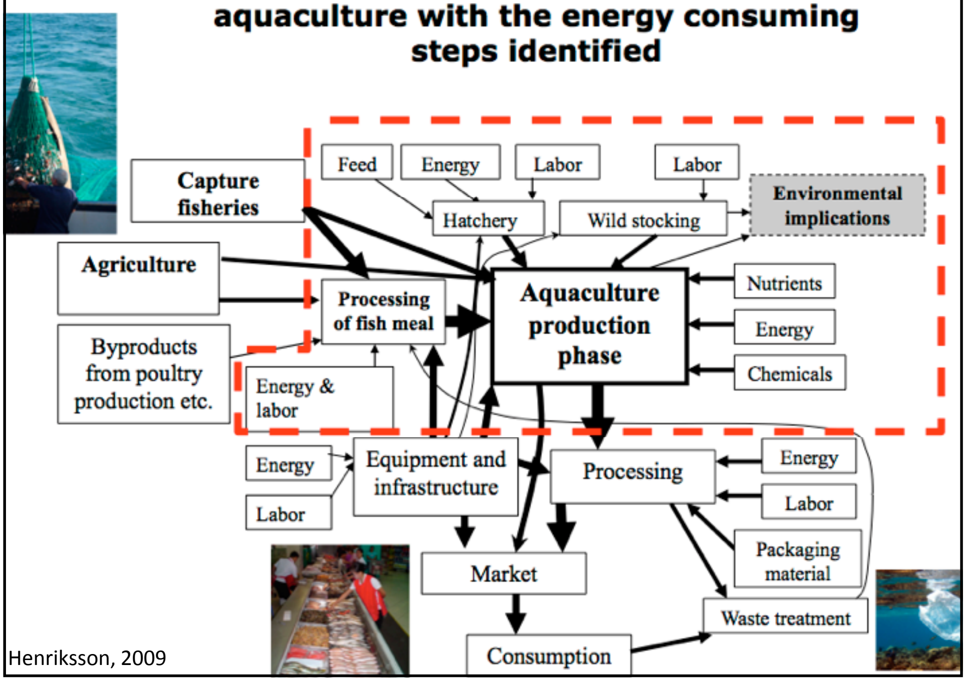
Food production, in common with other industries, has become addicted to cheap energy. Production, distribution and consumption of food accounts for 20 to 25% of the energy consumption in developed countries. The largest energy investments are made in the production of protein-rich produce, such as meat and fish (Table 1).

Aquaculture Energy Consumption

Feed production is commonly the major energy-consuming process in finfish and crustacean production systems. Processing accounts for roughly an additional 10% of the energy use for most seafood products, while consumption contributes about 20 to 30%. For filter feeders, the common energy-intensive stages are transportation and holding of live animals, infrastructure and processing, depending upon final product form and if there is a

Life Cycle Assessment (LCA) is a method to evaluate the potential environmental impacts thro… ice.

Flow chart of the production process in aquaculture with the energy consuming steps identified



Henriksson, 2009

Life cycle assessment

Table 1. Energy use in food production systems to farm gate.

Edible Produce	MJ kg-1
Beef	43-64
Farmed salmon	26-48
Pangasius	12-56
Global fisheries	24
Tilapia, intensive	18-27
Broiler chickens, U.S.	15
Milkfish	7-16
Wheat	4
Soybeans	2-3
Oysters	< 1

Tyedmers et al 2007

Food Type (technology, environment, locale)	Protein Energy Output/ Industrial Energy Input (%)
Carp (extensive freshwater pond culture, various)	**100 – 11**[a]
Herring (purse seining, North Atlantic)	50-33[b]
Seaweed (marine culture, West Indies)	**50-25**[a]
Chicken (intensive, U.S.A.)	25[c]
Salmon (purse seine, gillnet, troll, NE Pacific)	15 - 7[b]
Tilapia (extensive freshwater pond culture, Indonesia)	**13**[a]
Rainbow Trout (intensive net pen culture, Finland, Ireland)	**13 - 4.2**[a]
Cod (trawl and longline, North Atlantic)	10 - 8[b]
Mussel (marine longline culture, Scandinavia)	**10 - 5**[a]
Turkey (intensive, U.S.A.)	10[c]
Carp (unspecified culture system, Israel)	**8.4**[a]
Wild-caught seafood (all gears, marine waters, global average)	8.0[d]
Milk (U.S.A.)	7.1[c]
Swine (U.S.A.)	7.1[c]
Tilapia (unspecified freshwater culture system, Israel)	**6.6**[a]
Tilapia (freshwater pond culture, Zimbabwe)	**6.0**[a]
Shrimp (trawl, North Atlantic and Pacific)	6.0 – 1.9[b]
Beef (pasture-based, U.S.A.)	5.0[c]
Catfish (intensive freshwater pond culture, U.S.A.)	**3.0**[a]
Eggs (U.S.A.)	2.5[c]
Beef (feedlot, U.S.A.)	2.5[c]
Tilapia (intensive freshwater cage culture, Zimbabwe)	**2.5**[a]
Atlantic salmon (intensive marine net pen culture, Canada)	**2.5**[a]
Shrimp (semi-intensive culture, Colombia)	**2.0**[a]
Chinook salmon (intensive marine net pen culture, Canada)	**2.0**[a]
Lamb (U.S.A.)	1.8[c]
Seabass (intensive marine cage culture, Thailand)	**1.5**[a]
Shrimp (intensive culture, Thailand)	**1.4**[a]

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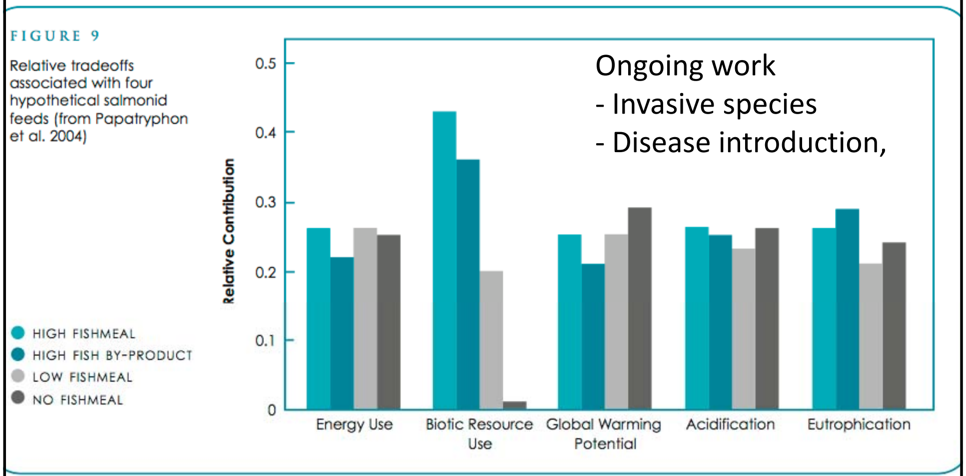
Sources: a. Troell et al. 2004, b. Tyedmers 2004, c. Pimentel 2004, and d. Tyedmers et al. 2005

Life cycle assessment



Ongoing work
- Invasive species
- Disease introduction,

Tyedmers et al 2007

Diversity and variability of Aquaculture Systems

Aquaculture Systems

Different Species
Different trophic levels
Extensive to Intensive
Small scale to Large scale
Simple to complex
Family - Int. Companies
Low - High Fossil Fuel
Monoculture-Polyculture
Integrated multitrophic
Local to International market
etc..................
....

Generic general models (traits) for responsible aquaculture?

Aquaculture Systems

1. Species low in the food chain
2. Extensive/Traditional forms of aquaculture - usually identified as having less environmental impacts compared to intensive systems.
3. Integrated approaches - being more sustainable than monocultures
4. Off-shore farming

1. Farming of species low in the food chain

Tilapia, Photos: Brummet/Beveridge

Mussel farming, Chile. Photo: A. Buschmann

Seaweed farming - responsible?

Photo: jumhullot/Creative Commons

Seaweeds - Scale matters!

1. Extensive/Traditional Farming

Prawns/fish India

Intensive

Photo: Henriksson

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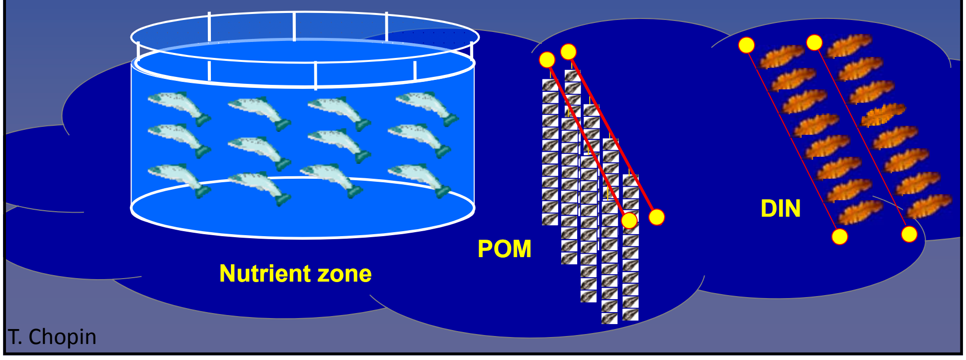
Rice and Shrimps

Photo: Joffre Olivier

Integrated Multi-Trophic Aquaculture (IMTA)

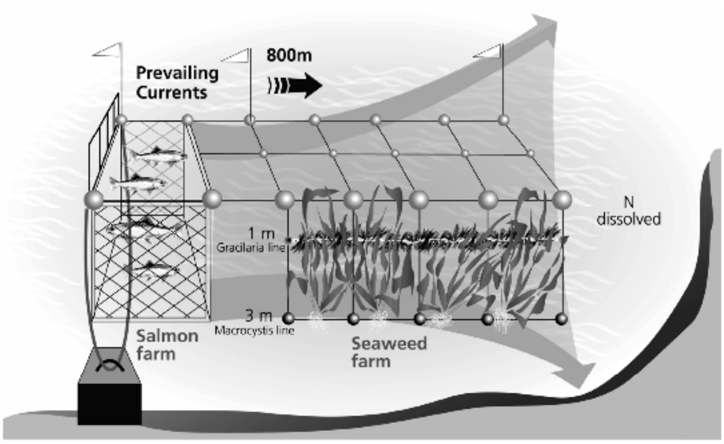
Fed Aquaculture + Extractive Aquaculture

(Finfish) | Organic (Shellfish) | Inorganic (Seaweed)



T. Chopin


s a l m o n
mussels
mussels
mussels
seaweeds
seaweeds
INTEGRATED MULTI-TROPHIC AQUACULTURE
Photo: T. Chopin


Prevailing Currents
800m
N dissolved
1 m
Gracilaria line
3 m
Macrocystis line
Salmon farm
Seaweed farm

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ABALONE
(Haloites midae)


Abalone - Seaweeds

Off-shore Aquaculture

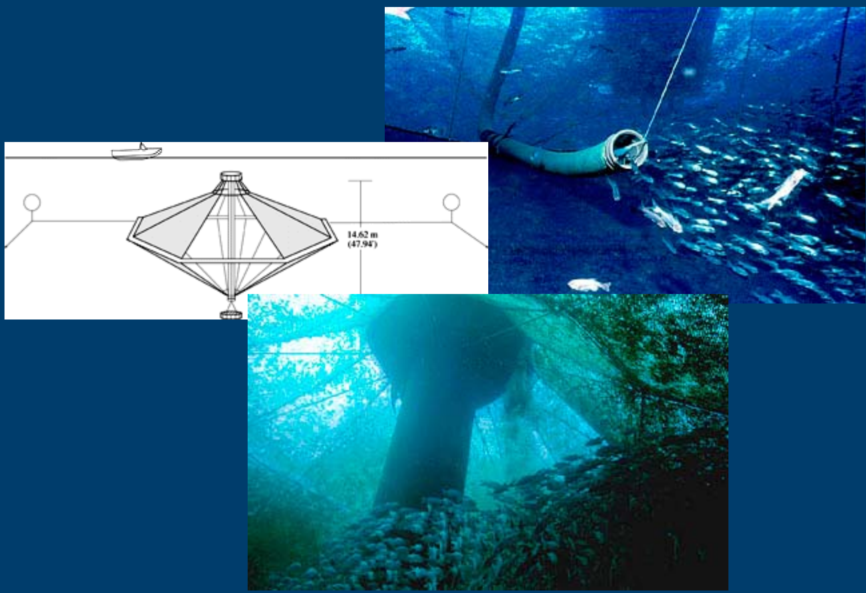

Photo: ?

Challenges

- To understand the complexity of aquaculture seascape/landscapes sufficiently, identifying multiple scale and cross scale interactions.

- Get all onboard with resect to labeling schemes

- Manage for multiple ecosystem services:

• Identifying the ecosystem services provided by seascape/landscape ecosystems
• Understanding the ecological basis for these services well enough to also understand the trade-offs and synergies provided by different management scenarios
(3) Valuing or otherwise ranking these services so they can be prioritized and linked to both policy and market mechanisms

Constraints

- Multiple demands on the environment! Space and quantity/quality of water for aquaculture may constitute a challenge in the future - for all type of aquaculture. Operating space is closing -increase in coastal populations, increased competition from other users and water quality degradation.

- The proposed next frontier may be the off-shore environment but still questions remain to be answered concerning environmental effects, resource use (will depend on what species that will be targeted) and energy dependencies.

- *Climate change effects!*

Opportunities

- The aquaculture dialogue is an important step towards maintaining the functioning of our life supporting system - i.e. ecosystems and their functions.

- Another opportunity is the introduction of a more holistic approach through the Ecosystem Approach to Aquaculture.

- Technological development with respect to feeds.

- Acknowledging Aquacultures role for building resilience and providing various services - creating economic incentives

Bridge scientific knowledge about degradation of the natural environment- and government action required to reverse the damaging trends

Science on biodiversity and ecosystem services