Site selection and carrying capacity of aquaculture in the Mediterranean:

the SHoCMed project approach

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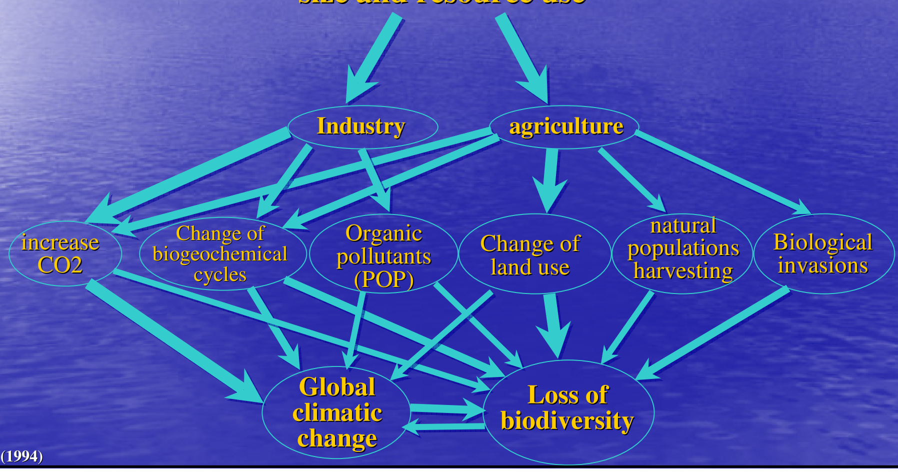
AZA Workshop Seville October 2010

21st: the century of Biology



Πηγή: Vitousek (1994)

The problem of water

- Water resources are alreary under overexploitation, while human population increases exponentially
- In 2050 the human population will reach 9.2 billions (50% increase over today)

water usage in food production

Think that today we need in water:

- 70 lt for 1 apple
- 140 lt for 1 cup of coffee
- 200 lt for 1 egg
- 3 400 lt for 1 kg rice
- 5 000 lt for 1 kg cheese
- 6 100 lt for 1 kg lamb
- 15 500 lt for 1 kg beef

Can we go on like that?

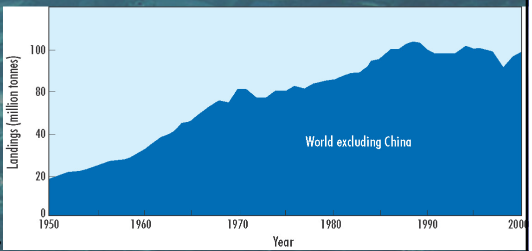
source: UNESCO 2007

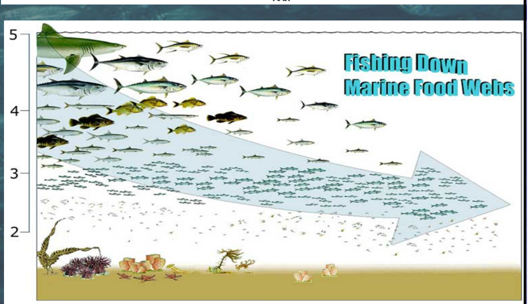
If things are like that…

- Perhaps the main source of animal protein will be the sea because it is the only ecosystem which does not depend on freshwater supply.

However …

- Global fisheries production is stagnant or decreasing during the last 20 years
- And fish decrease in size and trophic level with time






Aquaculture could be a solution …


If we do not overdo it
Photo from FAO Fish Tech Pap 498

Will the Oceans Help Feed Humanity?

December 2009 / Vol. 59 No. 11 • BioScience 967

CARLOS M. DUARTE, MARIANNE HOLMER, YNGVAR OLSEN, DORIS SOTO, NÚRIA MARBÀ, JOANA GUIU, KENNY BLACK, AND IOANNIS KARAKASSIS

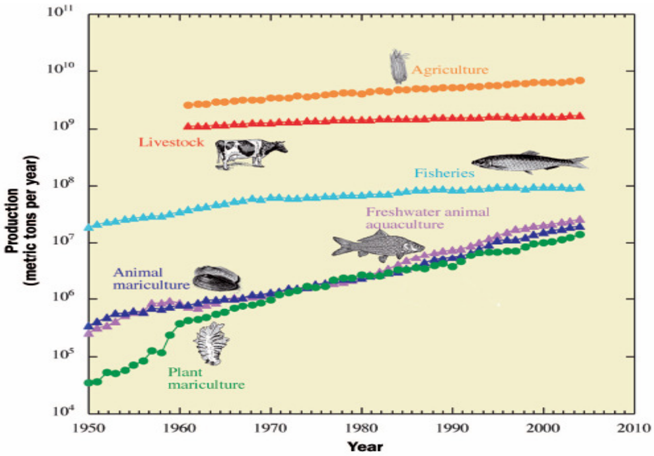


Figure 1. Trends in the global production of agriculture (nonfood items

Articles

Will the Oceans Help Feed Humanity?

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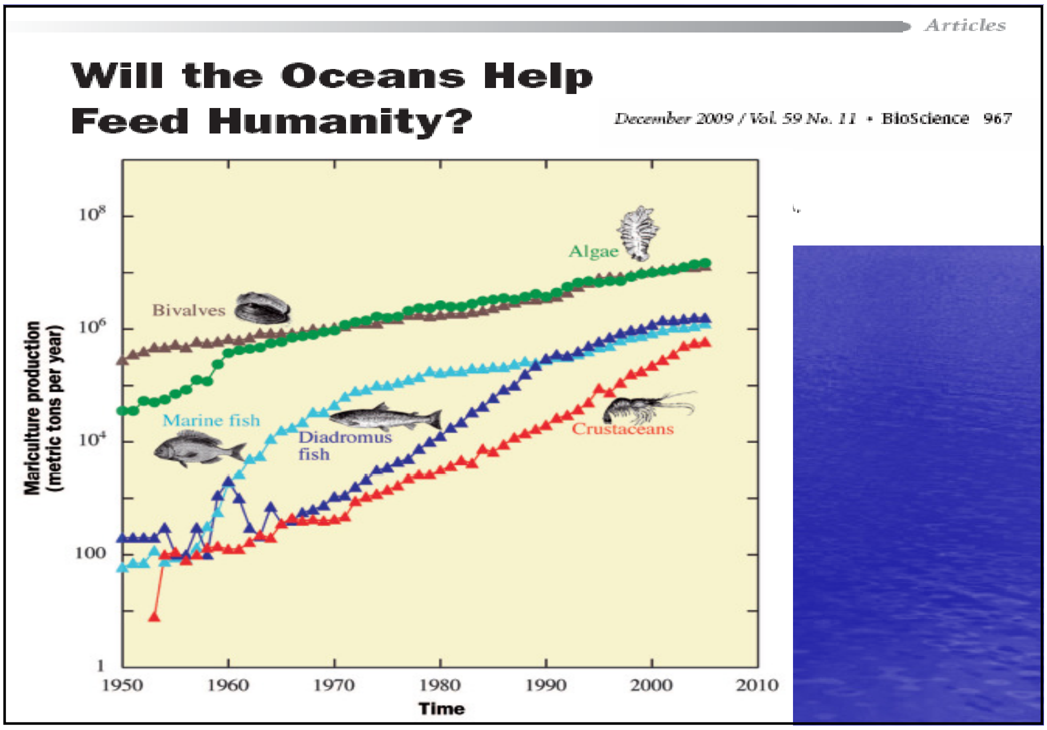
Table 2. Number of species accounting for 50%, 90%, and 100% of global food production in agriculture, livestock, marine fisheries, and mariculture, and percentage change of species diversification during this period.

	Number of species in 1994			Number of species in 2004			Percentage change from 1994 to 2004		
Group	50%	90%	100%	50%	90%	100%	50%	90%	100%
Agriculture	5	29	150	5	30	150	0.0	3.4	0.0
Livestock	1	4	16	1	5	16	0.0	25.0	0.0
Marine fisheries	13	134	987	17	145	1324	30.8	8.2	34.1
Mariculture	3	14	146	5	20	180	66.7	42.9	23.2

Note: A few of the items in FAO food production reports do not correspond to individual species, but rather to aggregates of an undefined number of species. Therefore, the actual number of species contributing 50% and 90% of food production should be slightly above the number that appears in this table.

Source: FAO 2006a, 2006b, 2006c, 2006d.


Articles
Will the Oceans Help Feed Humanity?
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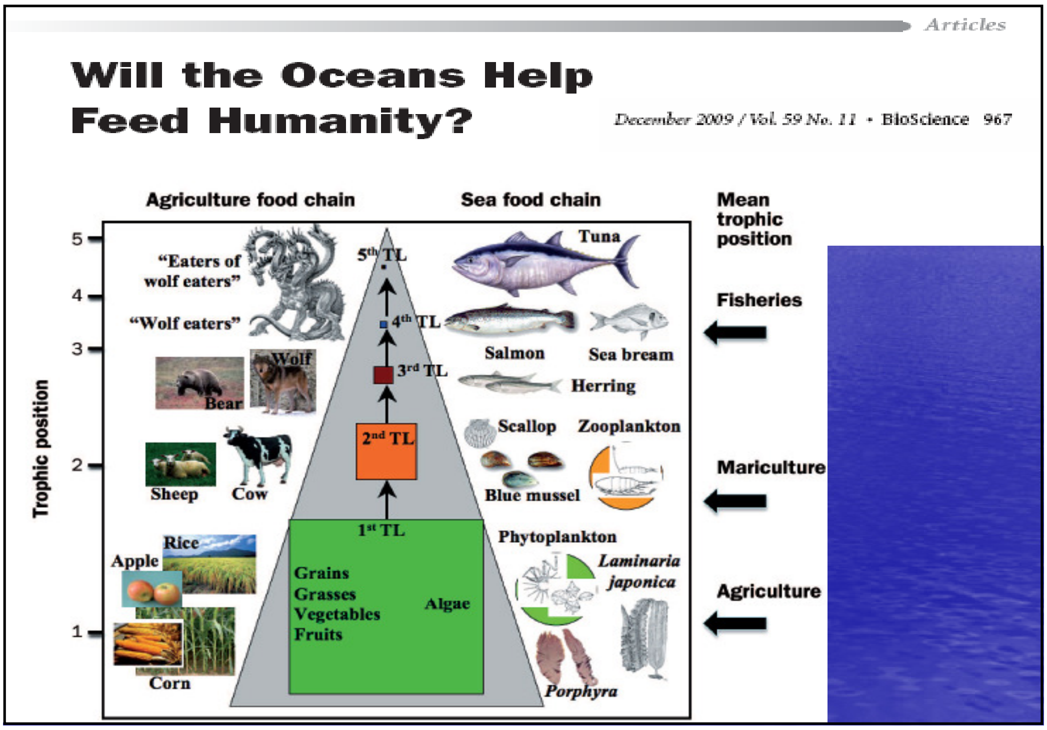
Mariculture production (metric tons per year)
Time
Algae
Bivalves
Marine fish
Diadromus fish
Crustaceans
1
100
10⁴
10⁶
10⁸
1950
1960
1970
1980
1990
2000
2010


Articles
Will the Oceans Help Feed Humanity?
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Agriculture food chain
Sea food chain
Mean trophic position
Trophic position
"Eaters of wolf eaters"
"Wolf eaters"
Wolf
Bear
Sheep
Cow
Rice
Apple
Corn
5th TL
4th TL
3rd TL
2nd TL
1st TL
Grains
Grasses
Vegetables
Fruits
Algae
Tuna
Salmon
Sea bream
Herring
Scallop
Zooplankton
Blue mussel
Phytoplankton
Laminaria japonica
Porphyra
Fisheries
Mariculture
Agriculture

Effects of aquaculture on marine biotic communities

Source of pressure	Potential effect on biota	Level sci document	Communities affected	spatial scale	type of impact	Estimated recovery of the community
physical structure	Direct mortality through entanglement	poor	Vertebrates	local	neg	medium
	Behavioral changes in coastal pelagic fish	medium	Vertebrates (Fish)	local	unid	unidentified
	Behavioral changes in coastal birds and marine mammals (e.g., avoidance)	poor	Vertebrates	loc/int	neg	unidentified
predator control systems	Direct mortality	poor	Vertebrates	loc/int	neg	unidentified
	Behavioral changes of wild fauna	medium	Vertebrates	loc/int	neg	unidentified
fish escapement	Disease transmission to other species	poor	various (probably fish)	int/lar	neg	unidentified
	Genetic interactions with wild fish	High	Vertebrates (Fish)	int/lar	neg	slow
	Displacement of wild fish from natural habitat (e.g., through competition, predation)	poor	Vertebrates (Fish)	int/lar	neg	unidentified
release of uneaten food and feces	Suffocation and displacement of benthic organisms	High	Macrofauna	local	neg	slow
	Loss of foraging, spawning and /or nursery habitat for wild species	High	various	local	neg	slow
	Loss of biodiversity	High	Macrofauna	local	neg	slow
	Fragmentation of benthic habitat	poor	various	loc/int	neg	slow
release of nutrients	Change in water quality	poor	various	loc/int	nrg/pos	rapid
	Mortality of plankton (including fish and invertebrate egg and larvae)	poor	various	local	neg	rapid
	Increased primary productivity	poor	various	loc/int	nrg/pos	rapid
	Shift in plankton community composition	poor	Phytoplankton	loc/int	unid	rapid
	Increase in harmful algal blooms	poor	various	loc/int	neg	rapid
	Decline of seagrass meadows	poor-medium	marine plants & various indirectly	loc/int	neg	slow
antibiotics	Tainting of wild species	poor	various	local	neg	rapid
	Changes in benthic bacterial community	poor	microbes	local	neg	unidentified
	Resistant microbial strains	poor	various indirectly	unknown	neg	unidentified
pesticides	Direct mortality and sublethal effects	poor	invertebrates	local	neg	unidentified
	Tainting of wild species	poor	various	local	neg	unidentified
disinfectants and antifoulants	Direct mortality and sublethal effects	poor	invertebrates	local	neg	unidentified
	Tainting of wild species	poor	invertebrates	loc/int	neg	unidentified
	Changes in physiology	poor	invertebrates	loc/int	neg	unidentified

(modified after Milowski 2001)

However...

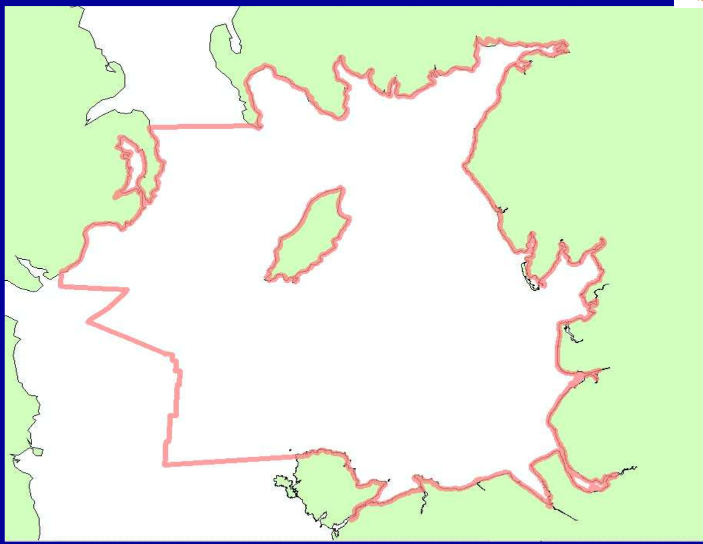
- Conflicts with other users of the coastal zone and mainly with the well-established tourism industry
- Decreasing profitability (market saturation)
- Concerns for the environment and biodiversity issues
- EIA reliability?

An almost pristine coastal area

defra

Are you convinced about ICZM?

Perhaps there is room for more

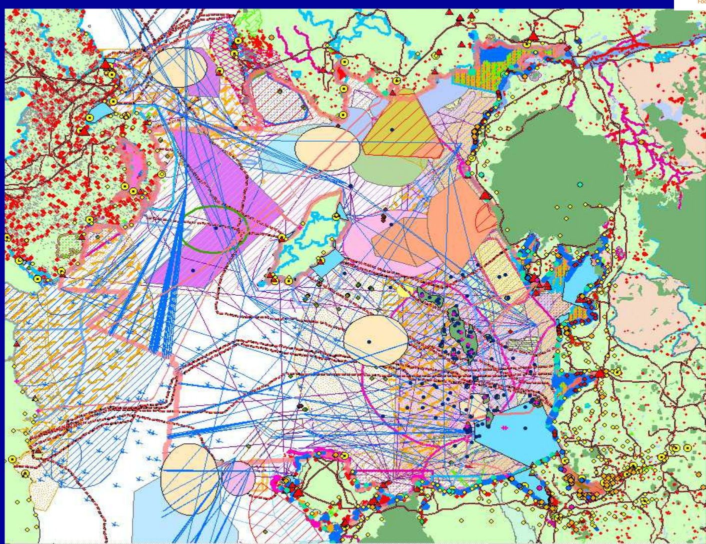


- Kindly offered by Dr. Waddah Saab
- Fisheries & Maritime Affairs European Commission

COMPETING CLAIMS

defra

- Landuse
- Tourism
- Oil &Gas
- Mariculture
- Coastal Defence
- Ports & Navigation
- Military Activities
- Culture
- Conservation
- Dredging & Disposal
- Submarine Cables



- Fishing
- Renewable Energy
- Marine Recreation
- Mineral Extraction

- Kindly offered by Dr. Waddah Saab
- Fisheries & Maritime Affairs European Commission

LEGALISATION OF NEW MARICULTURE ZONES

New Mariculture Zone in Mugla City -Turkey

The new mariculture zones entered into force as part of the overall coastal zone plans and management in 2008

Effects of and on Aquacuture

Table 3: Modified version of the table provided by HOTO in 2001. As in the original table, numbers "3", "2", "1" denote increasing importance

VARIABLES	SEAFOOD	Finfish	Shellfish	Fish culture	Shellfish culture	WASTE DISPOSSAL	Municipal	Industrial	Agroforestry	TOURISM	MARITIME OPERATIONS	FISHING	OIL/GAS EXTRACTION PRODUCTION	MINERAL EXTRACTION	COASTAL AREA DEVELOPMENT	HYDROLOGICAL CYCLE ALTERATIONS	RECREATION WATER
Algal toxins		↑1	↑1	↑1	↑1					↑1							↑2
Artificial radionuclides		↑3	↑3	↑3	↑3			←1			←3						
Dissolved oxygen		↑1	↑1	←3 ↑1	←3 ↑1		←1	←1	←2	←3 ↑3	←3		←3		←2	←3	
Herbicides/Pesticides/Biocides		↑2	↑2	←3 ↑2	←3 ↑2		←2	←3	←1	←2	←3				←2		
Human pathogens		↑1	↑1	←3 ↑1	←3 ↑1		←1	←3		←2 ↑1	←3				←2		↑1
Litter/plastics		↑3	↑3	←3	←3		←1	←1	←3	←2 ↑1	←2	←3			←2		↑2
Metals and organometals		↑2	↑1	←3 ↑3	↑3		←2	←1	←2		←3			←1	←2		
Nutrients				←2 ↑3	←3 ↑3		←1	←1	←1	←2 ↑3	←3				←3	←1	
PAHs		↑3	↑2	↑3	↑2		←2	←2	←3		←3		←1		←3		
Petroleum Hydrocarbon/ Oil		↑3	↑1	↑3	↑1		←1	←2	←3	↑1	←1		←1				↑2
Phytoplankton abundance/diversity		↑1	↑1	↑2	←3 ↑1		←2	←2	←1	←2 ↑3					←3	←1	
Pharmaceuticals		↑3	↑3	←2 ↑3	←3 ↑3		←3	←2	←3								
Suspended particulate matter			↑2	↑2	←3 ↑2		←1	←2	←1	←3 ↑2	←1	←3	←3	←2	←2	←1	↑3
Synthetic Organics/POPs		↑3	↑2	↑3	↑2		←3	←1	←2		←3				←3		
Exotic species		↑2	↑2	←2 ↑3	←2 ↑3						←1						
Habitat destruction				←2	←2		←3	←3	←3	←2	←3	←1	←1	←1	←1	←1	
Predators		↑2	↑2	←3 ↑1	←3 ↑1					←2	←1	←1	←1		←2		
wind				↑1	↑1						↑3	↑3					
light conditions		↑3	↑3	↑3	↑3												
water temperature		↑2	↑2	↑2	↑2			←1								←3	
salinity		↑3	↑3	↑3	↑3			←2								←1	
turbidity		↑2	↑2	←3 ↑2	←3 ↑2		←1	←2	←1	←3	←1	←3	←3	←2	←2	←1	
pH		↑3	↑3	←2 ↑3	←2 ↑3		←2	←2	←2								
benthic effects				←2	←2							←1	←1	←1		←3	
Genetic pollution				←3	←3												

Variables and analytes affecting aquaculture activities (strength of impact)

- algal toxins (1)
- dissolved oxygen (1)
- human pathogens (1)
- predators (1)
- wind (1)
- phytoplankton abundance (1-2)
- petroleum, hydrocarbon, oil (1-3)
- artificial radionucleotides (2)
- herbicides, pesticides, biocides (2)
- suspended particulate matter (2)
- water temperature (2)
- turbidity (2)
- PAHs (2-3)
- synthetic organics, POPs (2-3)
- metals and organometals (3)
- nutrients (3)
- pharmaceuticals (3)
- exotic species (3)
- light conditions (3)
- salinity (3)
- pH (3)

Some uses of the coastal zone are more sensitive than others

Relationship between different human activities/coastal uses.

Numbers “3”, “2”, “1” denote increasing impact strength of the activities of the first column on the activities of the first row.

HUMAN ACTIVITIES	AQUACULTURE	FISHING	TOURISM	WASTE DISPOSAL			MARITIME OPERATIONS	OIL/GAS EXTRACTION/ PRODUCTION	MINERAL EXTRACTION	COASTAL AREA DEVELOPEMENT
				MUNICIPAL	INDUSTRIAL	AGROFORESTRY				
AQUACULTURE	*	3	2	—	—	—	—	—	—	—
FISHING	3	**	—	—	—	—	—	—	—	—
TOURISM	2	2	**	*	—	—	—	—	—	—
MUNICIPAL	1	1	1	—	—	—	—	—	—	—
INDUSTRIAL	1	1	1	—	—	—	—	—	—	—
AGROFORESTRY	1	2	2	—	—	—	—	—	—	—
MARITIME OPERATIONS	2	2	2	—	—	—	—	—	—	—
OIL/GAS EXTRACTION/PRODUCTION	2	2	2	—	—	—	—	—	—	—
MINERAL EXTRACTION	2	2	2	—	—	—	—	—	—	—
COASTAL AREA DEVELOPEMENT	2	2	**	*	—	—	—	—	—	—

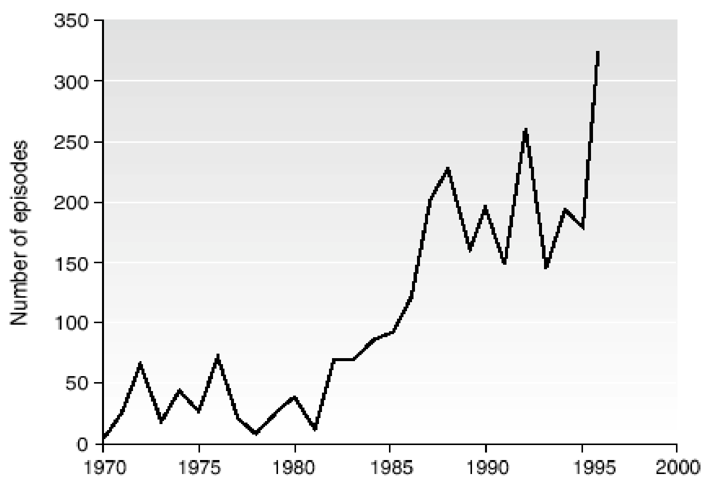
* uknown strength of impact
** negative impact above a certain degree of intensity
— no impact

Global human health burden and associated economic cost of selected diseases in relation to exposures to marine waters and shellfish contaminated with enteric micro-organisms

Disease or cause	Disability adjusted life-years DALY	Corresponding economic losses (rounded) in US million dollars
Disease		
Tuberculosis	38 000 000	115 000
Malaria	31 000 000	95 000
Diabetes	11 000 000	35 000
Trachea, Brachia and Lung cancer	8 800 000	26 000
Stomach cancer	7 700 000	23 000
Intestinal nematodes	5 000 000	15 000
Upper respiratory tract infections	1 300 000	4 000
Trachoma	1 000 000	3 000
Onchocherciasls	900 000	2 700
Dengue fever	750 000	2 200
Japanese encephalitis	740 000	2 200
Chagas disease	660 000	2 000
Leprosy	380 000	1 100
Diphtheria	360 000	1 100
Marine exposures		
Contaminated bathing water	400 000 - 800 000	1 200 - 2 400
Contaminated shellfish	3 500 000 - 7 000 000	10 000 - 20 000

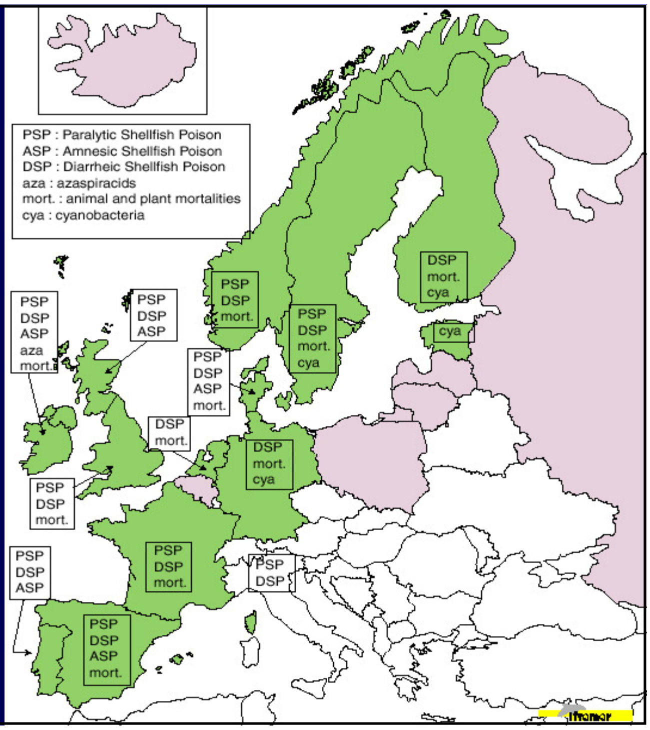
Source: Shuval, H.I. 1999. Scientific, economic and social aspects of the impact of pollution in the marine environment on human health - a preliminary quantitative estimate of the global disease burden. Unpublished report prepared for the Division on the Protection of the Human Environment, World Health Organization and GESAMP, 28 pp. (14 August 1999).

HABS in West central Atlantic



Source: Safeguarding the Health of the Oceans (Worldwatch).

Toxic algal blooms



source: ICES/IOC (IFREMER)

Mediterranean initiatives regarding aquaculture interactions and sustainability

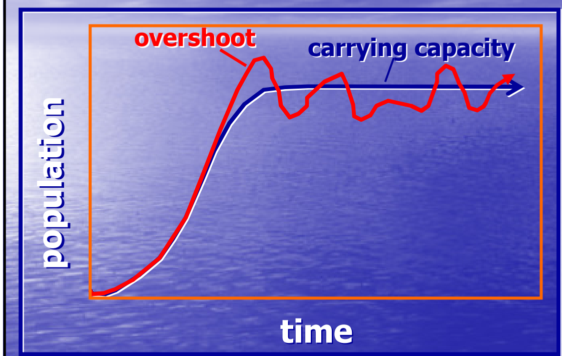
Mediterranean is a miniature of the world, if a plan becomes successful here it is likely that it may become a good example for other parts of the world also

- **GFCM** initiatives:
  - "Use of Indicators for the Sustainable Development of Aquaculture" (**InDAM**)
  - "Developing and Implementing Siting and Carrying Capacity Guidelines for Mediterranean Aquaculture" (**SHOCMED**)
- **IUCN-FEAP** guidelines for site selection and site management (published Oct 2009)

GFCM/SHOCMED
Carrying capacity

- The use of the term in relation to aquaculture has some positive aspects (i.e. people understand that there may be some limits to the growth of any economic activity)
- But there are also problems as to what scientific advice is expected

In Ecology c/c has a precise meaning



- i.e. the maximum population size a certain environment can support for an extended period of time, for a population of a particular species

- In fact this concept can be easily applied to e.g. mussel farming where the farmed species depends on natural resources (phytoplankton)

However in fish farming there are some problems

- Carrying capacity of the system depends less on the ecosystem properties and more on
  - ✓ the technology used
  - ✓ the amount of (allochthonous) food supplied
  - ✓ the effects on the environment (externally defined)
- Therefore defining a "standard" carrying capacity for fish farming sites is not straightforward

For bivalve farming McKindsey *et al.* 2006* have defined:

- *physical carrying capacity* — the total area of marine farms that can be accommodated in the available physical space,
- *production carrying capacity* — the stocking density of bivalves at which harvests are maximized,
- *ecological carrying capacity* — the stocking or farm density which causes unacceptable ecological impacts,
- *social carrying capacity* — the level of farm development that causes unacceptable social impacts.

* Aquaculture 262:451-62

Unacceptable?

- It needs to be defined by policy makers rather than by scientists, therefore some arbitrarity is expected
- The only way is to achieve consensus between parties and countries in order to ensure harmonization across the Mediterranean

Criteria/variables to be used for estimating C/H capacity

A. exclusion criteria such as:

- Protected habitats or species
  - ✓ *Posidonia oceanica* meadows (distance >800m)
  - ✓ Maelr beds
- Activities that could be harmful for aquaculture:
  - ✓ E.g. occurrence of HABs, polluted sites,

Criteria/variables to be used for estimating C/H capacity

B. variables related to the characteristics of the receiving environment, e.g.

- **Depth**, (minimal effect on fragile costal ecosystems)
- **Openness/exposure** (maximal water renewal and removal of wastes)
- **Distance** from the shore (minimal conflict with other users of the coastal zone)

And finally:

… *ecological carrying capacity* – the stocking or farm density which causes unacceptable ecological impacts

- Potential … unacceptabilities:
  - ✓Low **oxygen** in the water column
  - ✓High **Chla**, or **POC** (eutrophication)
  - ✓Effect on important **habitats** or spp
  - ✓Exceeding **EQS** set by the regulators

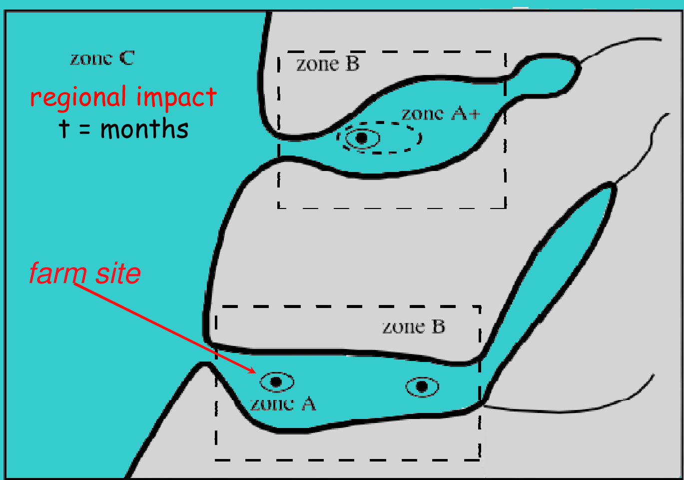
… alternatively

Instead of waiting to encounter unacceptable ecological impacts

- Standards could be adopted to promote good practice by adapting farm size to the environmental characteristics of the receiving environment
- Size=f (depth, distance, exposure)

Scales: spatial extent and timescale

(scale of ecosystem considered must be relevant to scale of industry and impact)



10 km

zone B scale
water body;
eutrophication
t = days

zone A scale
local to farm; benthic impact
t = hours

Paul Tett

Some ECASA models

Model name	Scale	Brief description	Partner
MERAMOD DEPOMOD	A	Particle tracking models used for predicting the impact of particulate waste material	1 SAMS
CSTT	B	A box model that predicts the maximum phytoplankton chlorophyll that can result from nutrient enrichment.	3 Napier U
LESV	B	Loch (fjord) ecosystem state vector model (from CSTT) including O2 and phytoplankton. Able to simulate seasonal change	3 Napier U
ShellSIM	Ib	Dynamic model for feeding, biodeposition, metabolism, excretion, and growth among bivalve shellfish (oysters, mussels, clams, scallops) as a function of temperature, salinity, and seston availability and composition.	9 PML

Some ECASA models

Model name	Scale	Brief description	Partner
EcoWin 2000	B, C	A model using a spatial (1D, 2D or 3D) framework of boxes, within each of which the relevant biogeochemistry and population dynamics can be resolved for particular locations and problems	10-IMAR
Longlines	B	Combined ecophysiology and box model for simulating growth of mussels reared in long lines	12-IFREMER
TRIMODENA	A B	Includes a 3D finite element hydrodynamical model for the numerical simulation of dispersive processes, and a 3D Lagrangian Particle Tracking model to simulate particle dispersion; both have been applied to maricultural pollution	13-AZTI

ECASA Toolbox

Toolbox Introduction and Main Menu v.3

boîte à outils - caja de herramientas - caixa de ferramentas - strumenti - Weskzeugkasten - orodiarna - εργαλειοθηκη - others

The ECASA project was co-funded by contract 006540 from EC's DG Fish, and by EU member and associated states, to develop an **ecosystem approach to sustainable aquaculture**. It operated from December 2004 until November 2007.

Its key deliverable is this virtual **toolbox**, which contains 'tools' to aid fish farm managers and regulators in selecting farm sites, and operating farms, so as to minimize environmental impact and ensure the sustainability of sites and water bodies for aquaculture. Use the links below to find out more.

Operational

Finfish farming	Seeking a site	EIA	Optimizing a farm	Expanding a farm
Shellfish farming	Seeking a site	EIA	Optimizing a farm	Expanding a farm
Regulation and local planning	Guidelines for site selection	Consenting a site and farm	Monitoring a site and water body	Consenting expansion
Regional/national planning	Regional guidelines	Rules for consenting	Regional/national monitoring	Rules for consenting

Categorical

Informative	Indicator groups	Model choice	Information by species	ECASA Site EIAs by country
Introduction Glossary How to get models Legislation Background theory ECASA's science the ECASA project	Pressure Benthic impact Pelagic impact Response Sustainability Socio-economic	DEPOMOD CSTT LESV etc Model list	salmon cod sea-bream tuna mussels clams salamanders mermaids	Norway Scotland France Portugal Italy Slovenia Croatia Greece etc

Fin-fish farming: finding a site

ECASA Toolbox

Indicative contents!

Finding a site for a **new fin-fish farm** involves the following environmental considerations. Farmed fish use oxygen and release ammonia. Where water movements are weak, the build-up of ammonia and the decrease in dissolved oxygen at a farm can harm fish. Uneaten fish food, and fish faeces, sink to the sea-bed and can harm the animals or seagrass here, as well as releasing gases harmful to fish and humans. The following models can be used [are recommended for use] to screen sites for these effects before incurring the large costs of an EIA. They will, typically, tell you the maximum mass of fish that can be stocked in order to avoid environmental problems on the farm scale.

Environment	Species	Scale	Model alphabetical order
Fjords, sea-lochs and voes	salmon cod	A:farm	DEPOMOD MOM
Mediterranean open coastal water	sea-bream sea-bass tuna	A:farm	MERAMOD TRIMODENA

In addition, you should seek an informal interview with persons responsible for consenting site development, who should be able to tell you if there are other environmental matters to be considered. Some states or provinces have national or regional plans that direct aquaculture to certain areas or prevent its development in others.

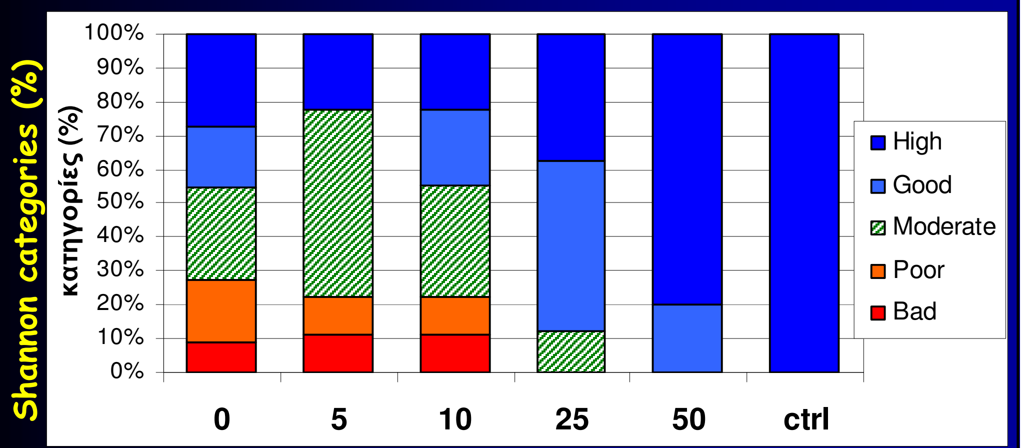
CAQ WG on site selection and Carrying Capacity

Objectives

- To produce criteria for enhancing the integration of aquaculture in CZM by improving site selection and holding capacity standards.
- To provide a basis for harmonization of standards across the Mediterranean as a means for ensuring equal terms of market competition and minimal environmental damage.
- To know what are the consequences on site selection and holding capacity under a shift in production scale in Aquaculture which is likely to occur in the near future.
- To explore the potential for using Allocated Zones for Aquaculture (AZA) as a means for improving management for aquaculture aiming at (a) increase in production, (b) reducing conflicts and (c) reducing environmental impacts.

H' index, all samples & stations

(Δείκτης Shannon σε όλα τα δείγματα)



Distance (m) Απόσταση

Conclusions for WFD indices

- **All** the stations at **50m** and at the control are good or excellent in terms of sediment quality.
- The same is true for **75-87%** of the samples at **25 m**, whereas the remaining are medium
- At the stations beneath the cages and up to a distance of 10m a considerable amount (up to 27% with Shannon and up to 67% with AMBI) are of "poor" or "bad" quality although there are also farms where even these stations are of "good" or "very good" sediment quality.
- AZE with specific standards (e.g. num of spp)

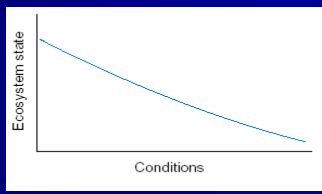
thresholds

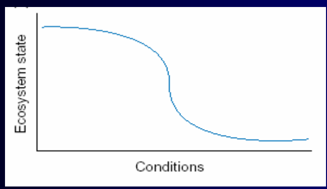
- Groffman et al (2006): An ecological threshold is the point at which there is an abrupt change in an ecosystem quality, property or phenomenon, or where small changes in an environmental driver produce large responses in the ecosystem.
- On the other hand thresholds may also be defined in a legal framework as the point beyond which pollution load becomes unacceptable. This threshold defines the legal boundary between acceptable contamination and unacceptable pollution (Hassan 2006).

Types of regime shifts

smooth regime shifts

χαρακτηρίζονται από φαινομενικά γραμμική σχέση ανάμεσα στην πίεση (αλιευτική προσπάθεια) και την απόκριση (αφθονία ειδών).



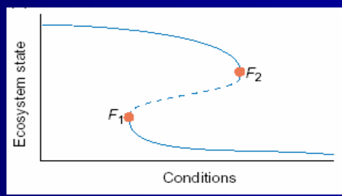


abrupt regime shifts

χαρακτηρίζονται από μη γραμμική σχέση ανάμεσα στην πίεση και την απόκριση.

discontinuous regime shifts.

Η πίεση υπερβαίνει ένα κρίσιμο «κατώφλι» με αποτέλεσμα η απόκριση να περνάει από μία κατάσταση σταθερής ισορροπίας σε μία άλλη μέσω μίας ασταθής ισορροπίας.



Collie *et al.* 2004, Scheffer & Carpenter 2003

thresholds

- Oxygen: One of the most obvious thresholds to be considered is the effect of aquaculture on dissolved oxygen levels. This is because the organic wastes discharged into the marine environment, as well as the OM produced *in situ* by phytoplankton exploiting nutrient wastes induce microbial metabolism thereby consuming oxygen. Gray et al. 2002 have described different thresholds related to O2 concentration in seawater:
- <0.5 mg l-1: catastrophic effect
- 2.0-0.5 mg l-1: mortality
- 4.0-2.0 mg l-1: metabolism affected
- 6.0-4.5 mg l-1: growth affected

thresholds

Values of benthic components for identifying cautionary and critical conditions of fish-farm environments (After Yokoyama et al 2004)

Benthic components	Cautionary condition	Critical condition
Sediment		
Total organic carbon (mg g^{-1} dry)	>20	>30
Total nitrogen (mg g^{-1} dry)	>2.5	>4
Total phosphorus (mg g^{-1} dry)	>4	>6
Chemical O2 demand (mg g^{-1} dry)	>30	>75
Acid-volatile sulfide (mg g^{-1} dry)	>0.5	>1.5
Macrobenthos		
Biomass[a] (g m^{-2})	<10	0
Density (individuals m^{-2})	<1500	0
Number of species (/0.04 m^2)	<20	0

[a] Wet weight of animals excluding the shell of mollusks.

Sediment quality criteria in Scotland: action levels within and outside the Allowable Zone of Effects (AZE), modified after Henderson & Davies (2000)

Component	Determinant	Action level within AZE	Action level outside AZE
Benthos	Number of taxa	<2 polychaete taxa present (sample replicates bulked)	Must be at least 50% of reference station value
Benthos	Number of taxa	Two or more replicate samples with no taxa present	
Benthos	Abundance	Organic enrichment polychaetes present in abnormally high densities	Organic enrichment polychaetes must not exceed 200% of reference station value
Benthos	Shannon index	N/A	at least 60% of ref. station value
Benthos	Infaunal trophic index (ITI)	N/A	at least 50% of ref station value
Sea bed	*Beggiatoa*	N/A	Mats present
Sea bed	Feed pellets	Accumulations of pellets	Pellets present
Sediment	Copper	289 mg kg^{-1} (dry wt)	
Sediment	Zinc	169 mg kg^{-1} (dry wt)	
Sediment	Free sulphide	4800 mg kg^{-1} (dry wt)	3200 mg kg^{-1} (dry wt)
Sediment	Organic carbon	9%	
Sediment	Redox potential	Values <-150mV (as a depth average profile OR < -125mV (in surface sediments 0-3 cm)	
Sediment	Loss on ignition	27%	

2 more thresholds

- Distance from Posidonia meadows : at least 400m
- The CSTT (1997) group has also suggested a critical value of 10 µg/L for Chlorophyll *a* in water samples assuming that above this level there is a high risk for phytoplankton sedimentation to cause sediment anoxia. These values are quite difficult to find in most typical Mediterranean mariculture sites, but still this EQS value is a useful stimulus for research

Expectation from this workshop

AZA workshop

- To explore the AZA concept as a management tool for aquaculture planning in the coastal zone
- To identify the advantages and disadvantages of AZAs it areas that have been used (particularly in a form of a SWOT analysis)
- To identify the attitudes of different stakeholders against AZAs
- To identify potential research needs that could shed light on questionable aspects of AZA
- To identify institutional/organizational complements needed to increase the positive aspects

AZA workshop

Specific questions from each case study-country

- How and why has this concept been introduced?
- For how long is it in operation?
- Has the introduction of AZA relaxed the conflicts with other users of the coastal zone?
- What is the effect on local management of farms within AZA?
- Is there a common monitoring of the AZA area?
- How is the "capacity" of the AZA determined?
- Has the efficiency of the AZA concept been evaluated by an independent study /environmental audit?
- What stakeholders think after the adoption of AZA?

Thank you