

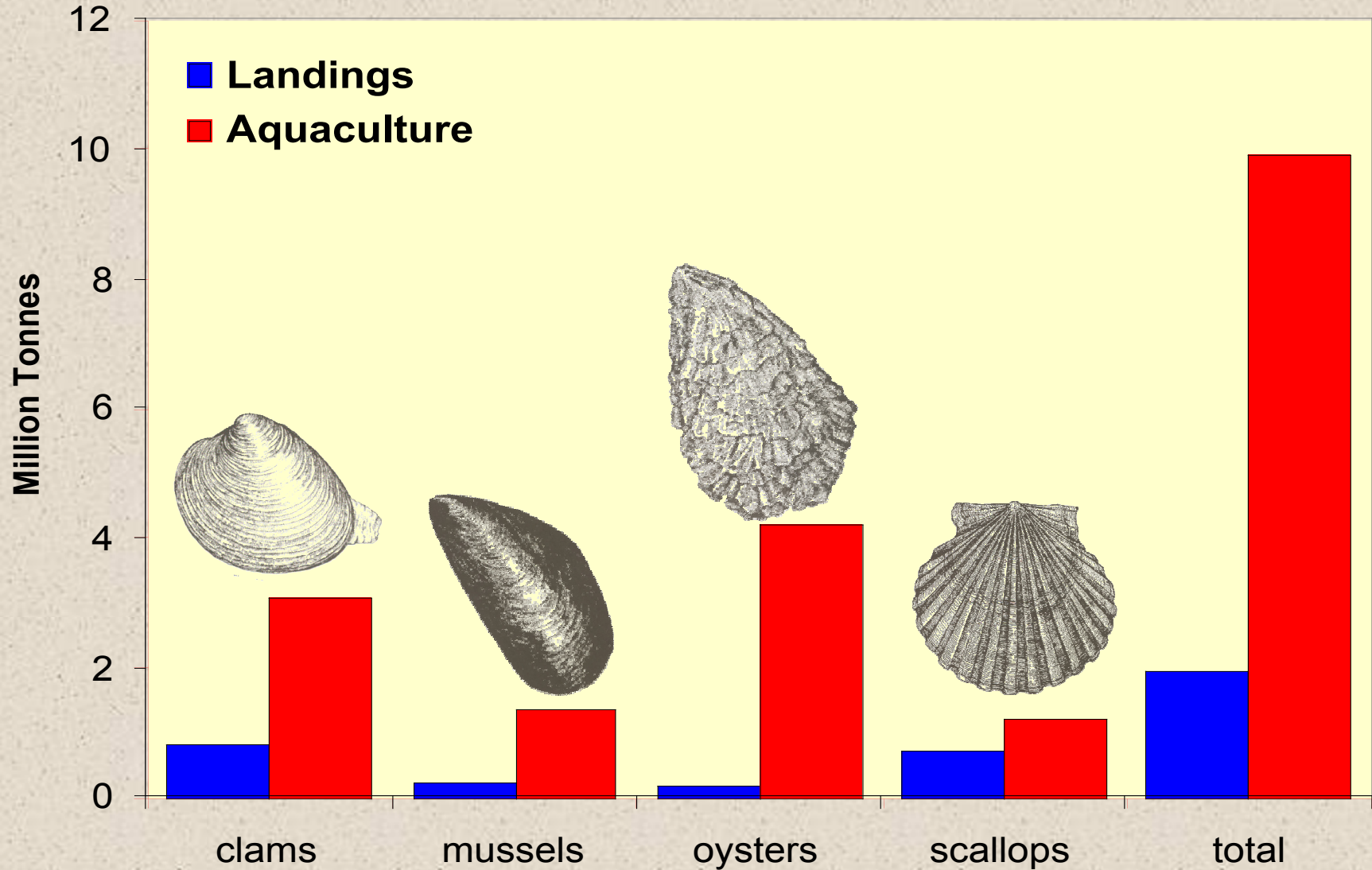
# Environmental Impact and Ecosystem Services Provided by Oyster Aquaculture

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# World

## WILD CAPTURE vs AQUACULTURE 2001

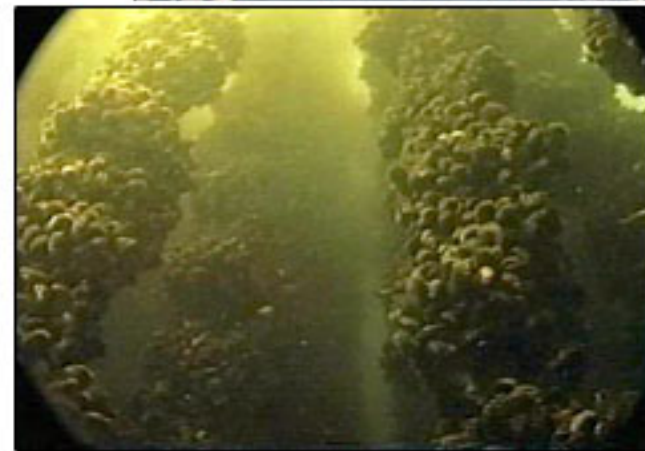


Source: FAO

**Shellfish Aquaculture**  
**(Like any Other Activity) has**  
**Environmental Impacts**  
**but it also provides**  
**Valuable Ecosystem Services**

# What are some of the impacts?

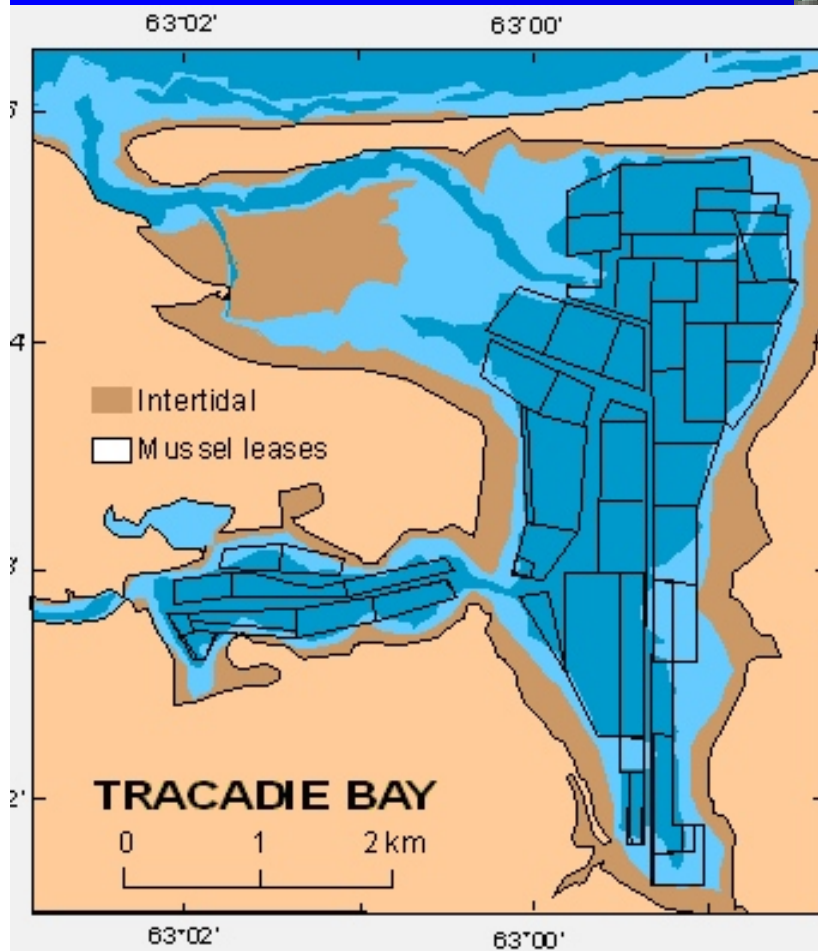
- Impacts depend on scale and intensity
- At very high stocking levels you start to see
  - Food depletion
  - Slower shellfish growth
  - Benthic impacts
    - Buildup of organic material
    - Shell waste
    - Diversity impacts?
- Dredge Harvest impacts
  - Similar to bullrakes





# Canadian Mussel Industry Findings (Crawford, Kaiser)

Impact depends on:  
scale / hydrodynamics  
and biomass per acre



# Too much of a good thing is almost always a bad thing

- Where is the line?
  - High flow can bring lots of food, but areas with restricted flow can be depleted quickly
  - Large vertical arrays allow for huge biomass loading
- Monitoring is the key
  - Depth of the sediment redox zone measures organic loading
  - Depletion of Chlorophyll easy to detect

# Other Impacts

- Introductions of Exotic Species
  - A problem historically that we have dealt with through regulations and procedures
- Spread of Disease
  - Biosecurity regulations ensure that seed are inspected prior to import
  - Seed are typically imported at a very small size
  - Growers highly motivated to minimize disease
- Regulations in place to minimize risk
- Risks similar to many other activities

# Ecosystem Services from Oyster Culture

- Nutrients are removed when oysters are harvested
- Oysters enhance bacterial denitrification
- Oysters enhance sedimentation rates and speed the sequestration of nutrients
- Carbon deposited in shell is sequestered for decades
- Filter feeding improves water clarity and increases light penetration which helps eelgrass
- Oysters and aquaculture gear provide habitat and support a diverse assemblage of juvenile fish
- Cultured oysters release larvae into the environment



# SHELLFISH

## VACUUM CLEANERS OF THE SEA

by K.T. Pirquet



# Shellfish Filtration


- **Reduces turbidity and bacterial counts**
- **Improves light penetration**
- **Stimulates bacterial denitrification and reduces anoxia**
- **Nitrogen contained in oyster tissue is removed from the system when shellfish are harvested.**
- **If the oysters are not harvested the nitrogen is released back into the water when the oysters decay.**



# EELGRASS

- **Essential Fish Habitat**
- **Growth is light limited**
- **Thallus is weakened by excess nitrogen**
- **Oyster populations can benefit eelgrass**





**AQUACULTURE STRUCTURES  
PROVIDE HABITAT AND PROTECTION  
FOR LARVAL AND JUVENILE  
FISH AND INVERTEBRATES**

**Improves the abundance and  
diversity of important marine species**

# Vertical Structure

- Firm substrate provides foundation for fouling which provides food and cover
- More than just a fish attracting or aggregating device
- Nooks and crannies provide refuge for juvenile fish
- Juvenile fish and crabs in turn provide food for larger predators
- Featureless mud is attractive to a limited number of species





# Aquaculture structures

- Kilpatrick et al. (2002) found more than 10X the abundance of fish and crustaceans in oyster gear vs. eelgrass beds
- Counted thousands of fish, lobster, crabs etc.
- Species diversity was similar
- Species richness was similar
- Evenness was lower in aquaculture gear because of hyperdominance of mudcrabs

# Cages provide quality habitat

- Tallman and Forrester (URI) – In press
- Found that oyster grow-out cages were similar to natural and constructed rocky reefs – both attract scup, cunner and tuatog
- Both provide good quality habitat for fishes typically associated with hard-bottom habitats.
- “Habitat restoration programs for these fishes should thus consider grow-out cages alongside other types of artificial reef.”



A 7.6cm market-size oyster contains  
0.52 g N and 0.16 g P

The combined effect of US eastern oyster  
aquaculture harvest directly removes  
**357 metric tons of nitrogen** and  
**110 metric tons of phosphorus**  
from the marine environment  
each year

**The harvest of about 3,750 rapidly growing oysters will compensate for the nitrogenous wastes from one person leaching into the watershed.**



Each female oyster releases  
as many as 3-30 million eggs  
annually

# Impacts of Eastern Oyster Farming

- 357 metric tons of nitrogen removed
- 110 metric tons of phosphate removed
- hundreds of tons more nutrients are removed by burial or denitrification
- 51,559 tons of carbon sequestered in shell
- $1.7 \times 10^{15}$  larvae released each year
- 94 million cubic meters of water filtered daily
- thousands of acres of bottom are turned into high quality habitat

# What does oyster culture do?

- Growers invest thousands in seed
- Water quality and light penetration improved
- Growout beds turned from barren silt to diverse habitat with vertical structure
- Habitat improved for juvenile fish and other critters
- Growers have great incentive to preserve water quality and monitor pollutants



# What else?

- Jobs on the water
  - Help maintain the working waterfront
- Revenues for the suppliers to industry
  - Foul weather gear, outboards, wire mesh, etc.
  - Growers invest heavily in gear and equipment
- Product for our local shellfish dealers
- High product quality elevates prices
- Reduces our dependence on foreign imports



# How much is too much?

- Conflicts with other users will limit the area available for aquaculture
  - Priority given to other users in Law
- Unlikely to permit large vertical arrays in low flow areas
- **User conflicts will be more important than carrying capacity issues**
- Speculation about potential impacts vs monitoring to observe real impacts

# If User Conflicts are the Issue...

- By law productive fishing areas and navigational lanes are protected from leasing
- Recreational fishing is not impacted by the vast majority of leases
  - Rod and reel fishermen are welcome on almost every lease
  - In fact, fishing may be improved because some gear acts to attract larger predators and fish stocks benefit from habitat
  - There may be some confusion about what is allowed where
- Boaters pass freely over most leases without danger
- Aesthetic concerns are an issue that we need to address

# User Conflicts....

- Conflicts with recreational and commercial shellfishing
  - Prohibited from digging in areas that have less than the average density - deemed not commercially productive
- 1% of the ponds
- Fraction of a percent of the bay
- Compensated for this sacrifice by the ecosystem services of the shellfish farms