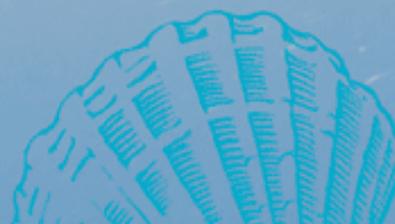


HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH





Aquaculture – the Norwegian focus on environmental challenges



Ole Torrissen



HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH

Sustainable development

”Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

Our Common Future

The World Commission on
Environment and Development, 1987
(Brundtland Commission)



Assumptions

- Humans are omnivorous
 - Animals and animal products are acceptable ingredients in human foods at levels determined by culture and individual preferences.



”needs of the present” include needs for meat



Definitions (ICES Study Group, EIM 1987)

Carrying capacity: maximum potential production of a species or population in a defined area in relation to available food resources

Sea Ranching (Lobster, scallop), mussels

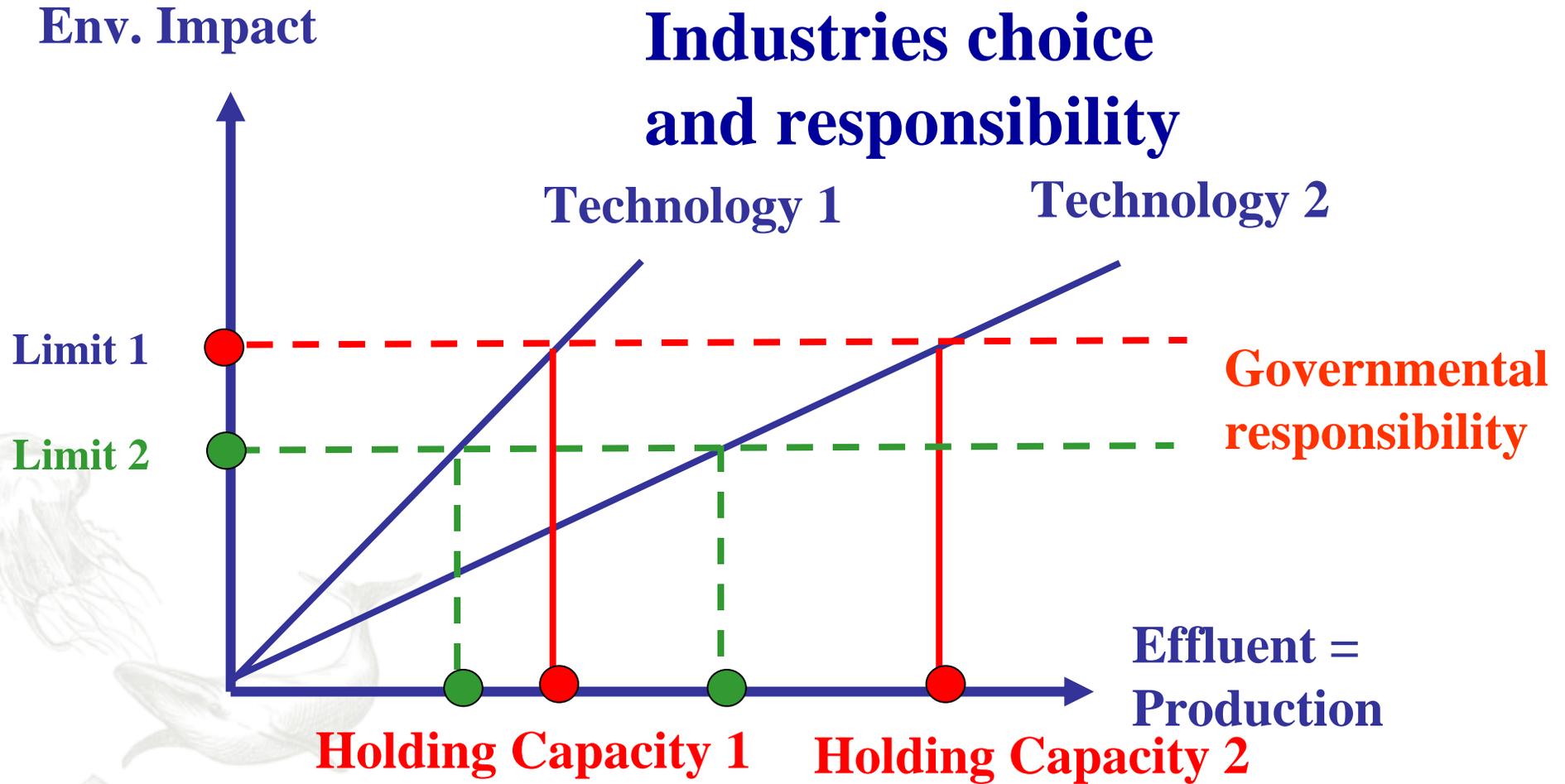
Holding capacity: maximum potential production of a defined area limited by a non-trophic resource

Intensive farming, several factors, incl. Animal welfare



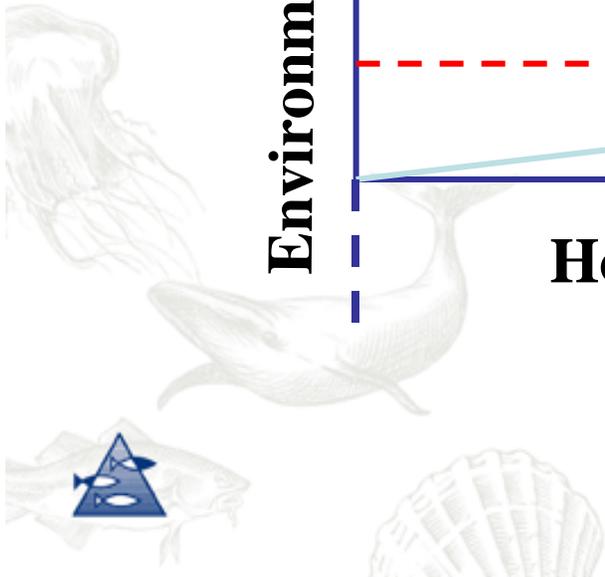
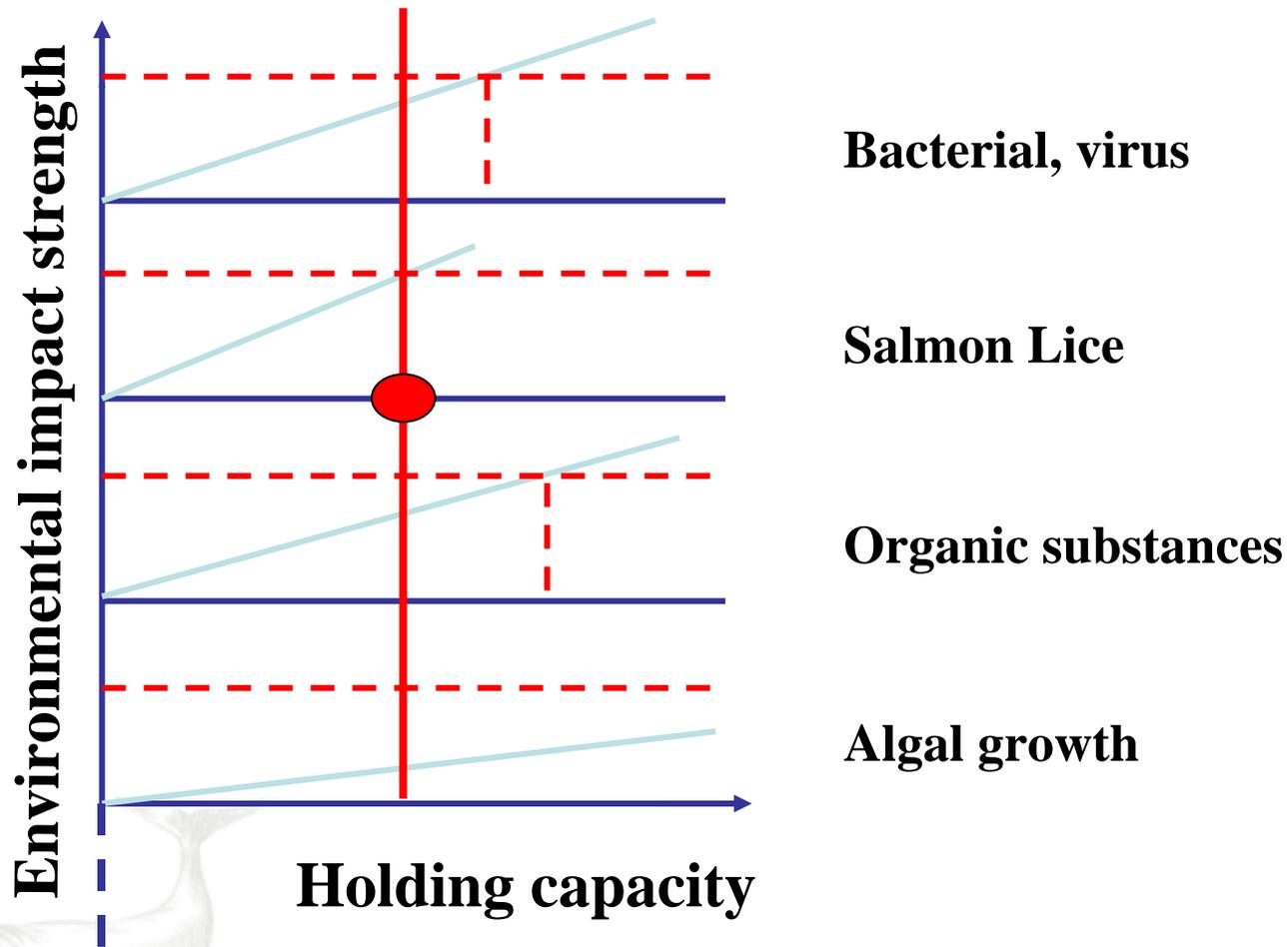
Holding Capacity

Industries choice and responsibility



Ervik, A., 2005

Regional Holding Capacity



What's acceptable ?



Suspectonereis dubiosa



It's completely gone, what now? - - -



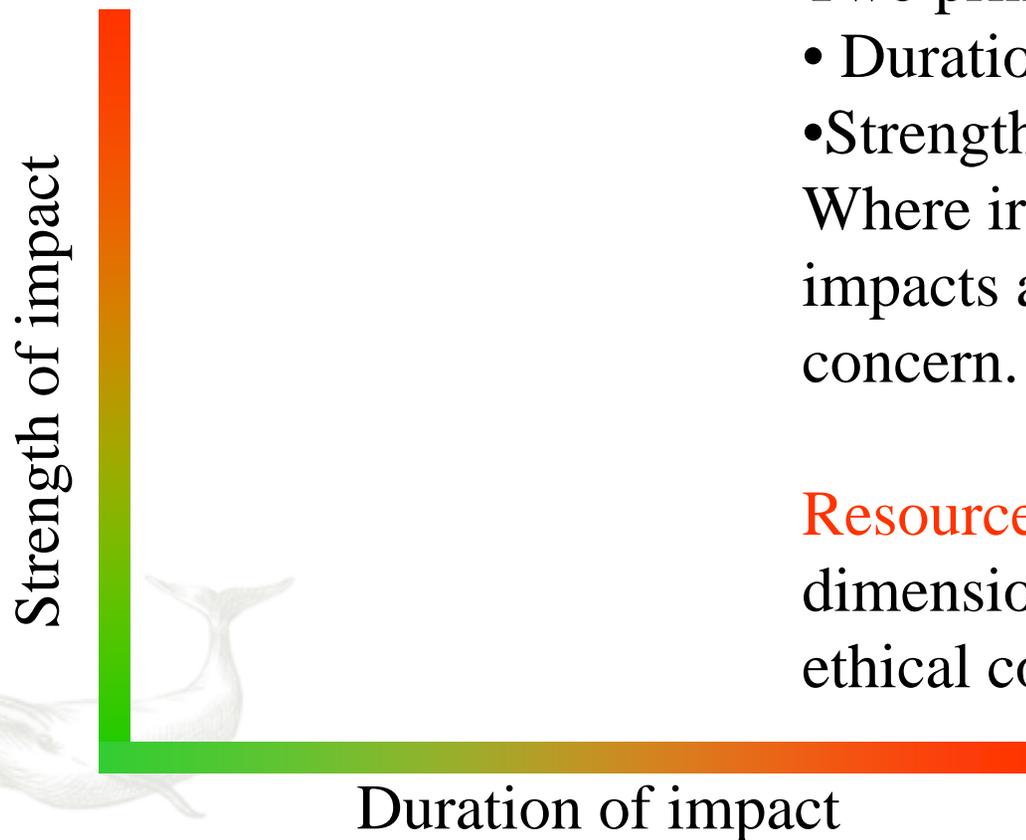
Components of sustainable development:

Two principal components:

- Duration
- Strength

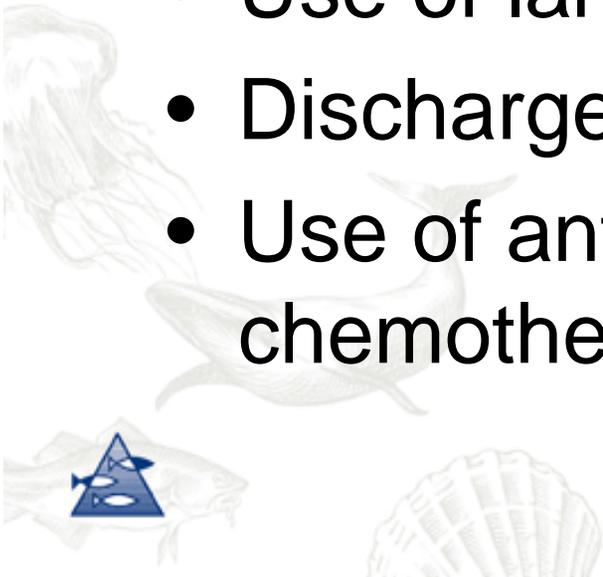
Where irreversible and strong impacts are of particular concern.

Resource consumption is a third dimension, this also with an ethical component

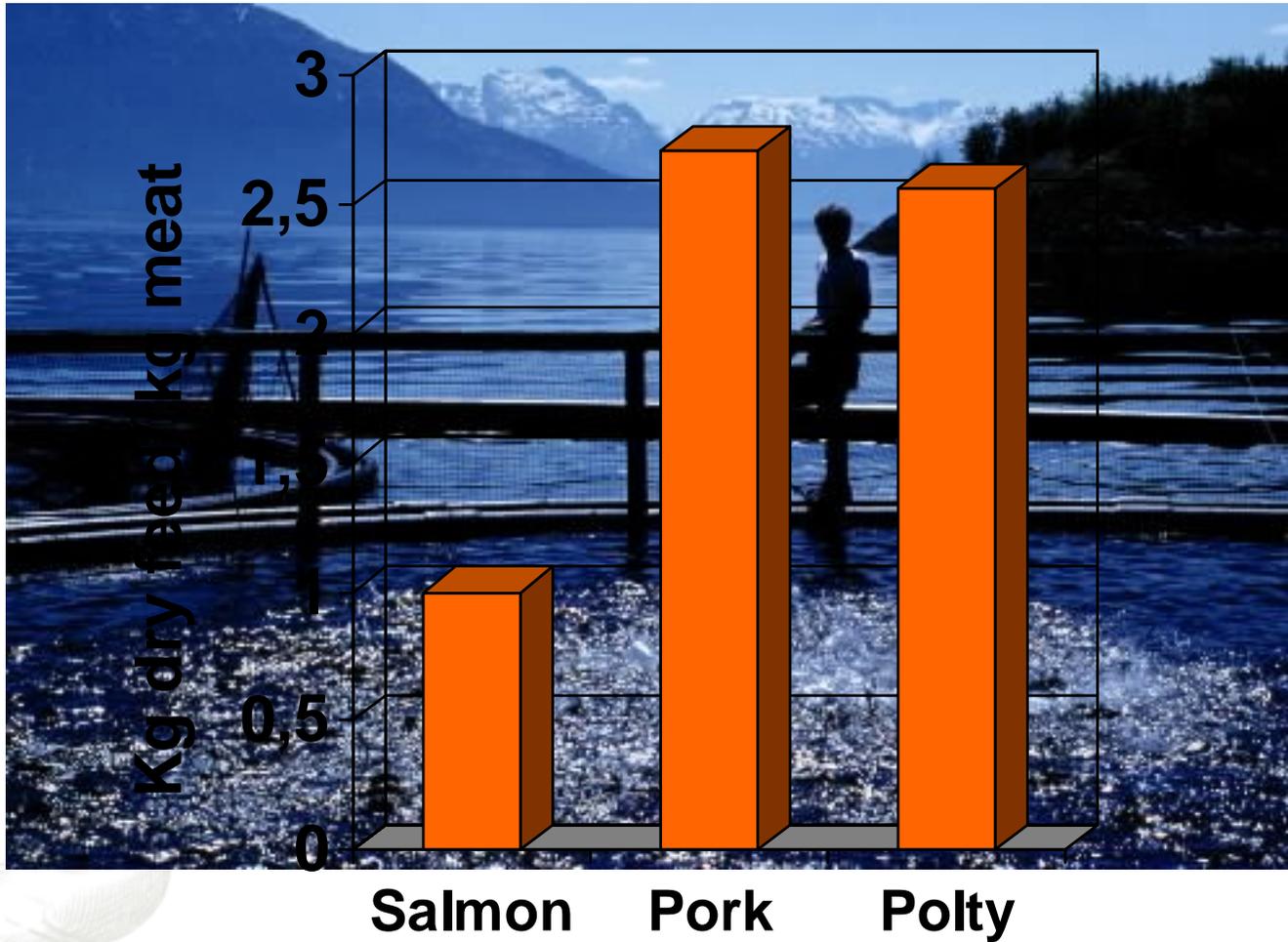


Key question in animal farming

- Use of feed
- Interaction with wild plants and animals
- Spread of diseases and parasites
- Use of land and sea
- Discharges of waste material
- Use of antibiotics and chemotherapeutics



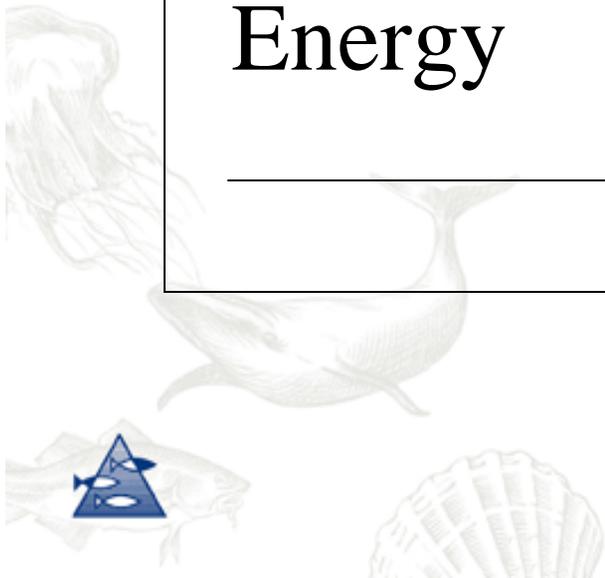
Use of feed: **Feeding of salmon**



Use of feed:

Protein and energy utilization

	Salmon	Chicken	Pigs
Protein	30-40%	18%	13%
Energy	27%	12%	16%



Use of feed:

Feeding “fish” to fish

use marine products as feed ingredients

- Renewable resource
- Byproducts 40-60% of catch
- Upgrade low value to high value
- Resource management – over exploiting resources



Use of feed:

- The most efficient farmed animal
 - More complete metabolism
 - Weightless in water
 - Large number of offspring
 - Poikilotherm
- No permanent environmental impact



Interaction with wild plants and animals:



Interaction with wild plants and animals:

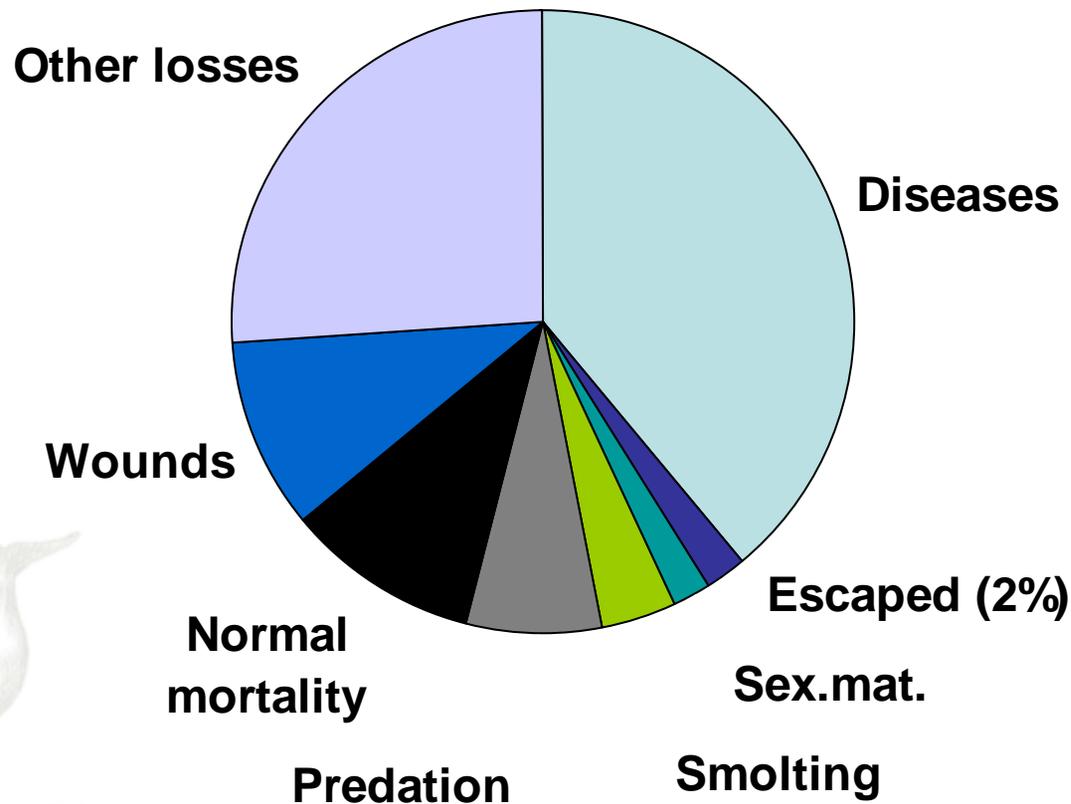
Losses in salmon sea cage production

Total losses:

16,7 mil. A. Salmon
2,9 mil. Rainbow trout

Total annual stocking:

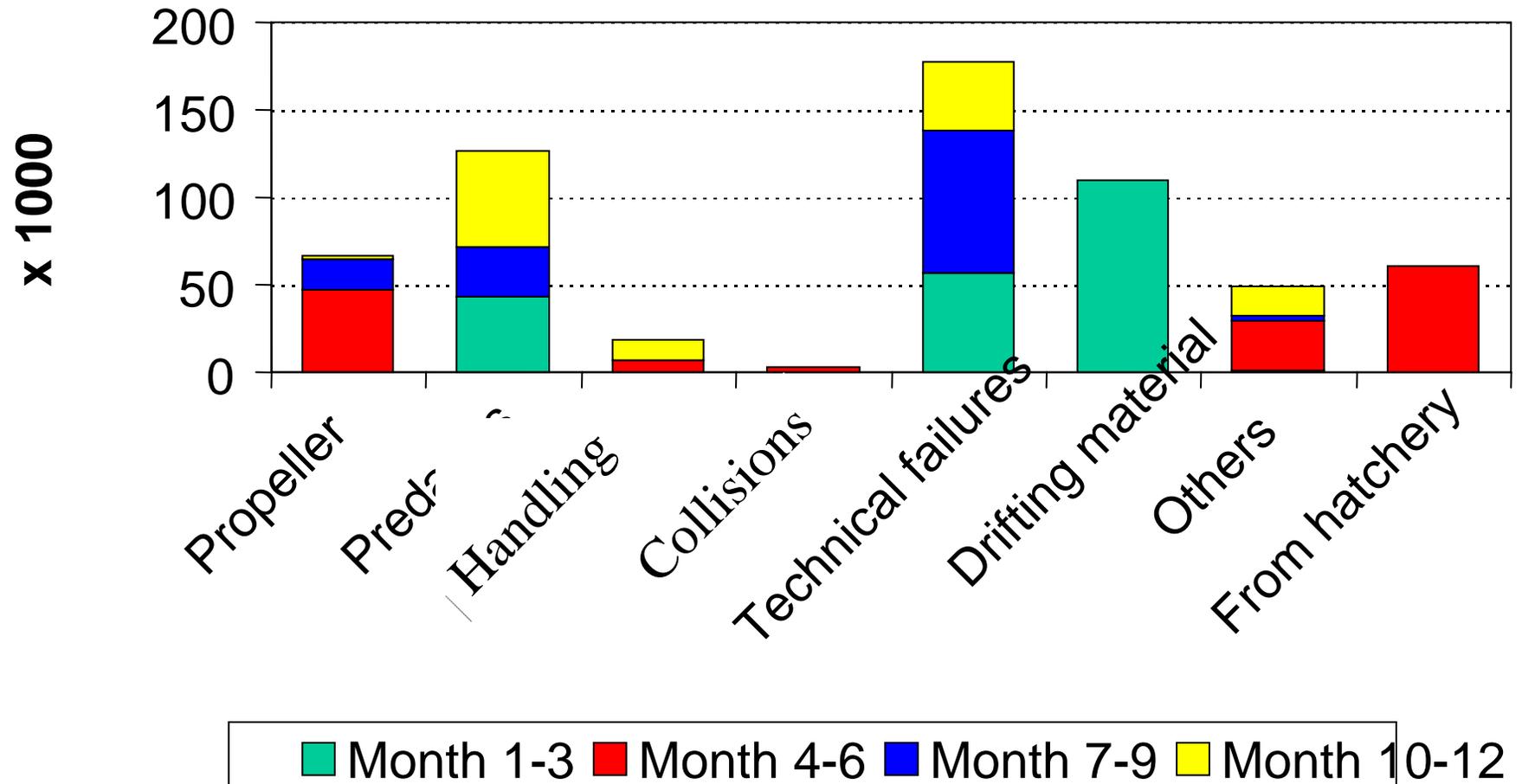
130 mil. A. Salmon
30 mil. Rainbow trout



Fiskeridirektoratet 2003

Interaction with wild plants and animals:

Causes for reported escapes in 2002



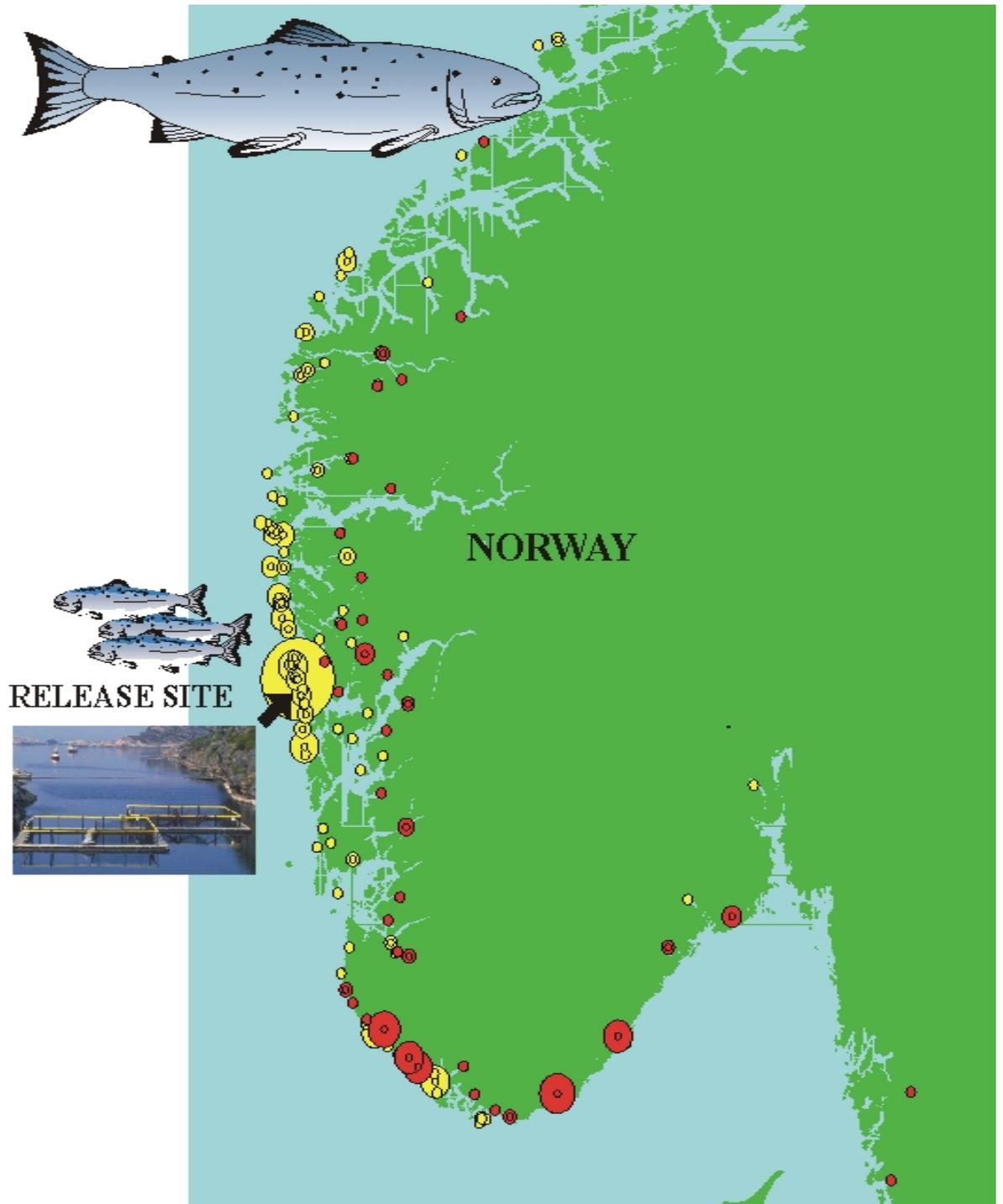
GEOGRAPHICAL DISTRIBUTION OF CATCHES OF SEA RANCHED SALMON GRILSE

Straying was high after coastal releases

CAUGHT IN SEA



CAUGHT IN RIVER

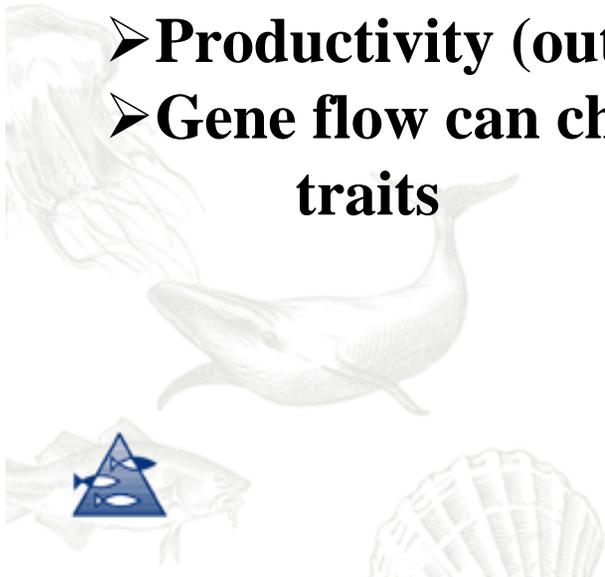


Interaction with wild plants and animals:

Effects of gene flow from domesticated to wild stocks :
lessons from egg planting experiments in natural
habitats

- **Low survival, high growth of domesticated juveniles**
- **Offspring of domesticated salmon exclude wild juveniles**
- **In hybrid families, growth and survival are intermediate**
- **Changes in migratory behavior**
- **Productivity (output of smolts) reduced by 30-55%**
- **Gene flow can change wild stocks at single genes and in fitness traits**

(McGinnity et al 1997; Fleming et al 2000)



Interaction with wild plants and animals:

- Escapees from fish farm may permanently influence wild counterparts.
- The primarily limiting factor for future growth of Norwegian salmon farming



Spread of diseases and parasites:

Transmission of diseases and parasites

- Transmission of diseases and parasites from farmed fish to wild fish and vice versa.
- Increased no. of hosts for pathogenic organisms in fjord systems
- Increased infectious pressure on fish farms



Spread of diseases and parasites:

Potential pathogens

- Bacterial (ex: Furunculosis)
- Viral (ex: ISA, IPN)
- Eucaryotic parasites (salmon lice)



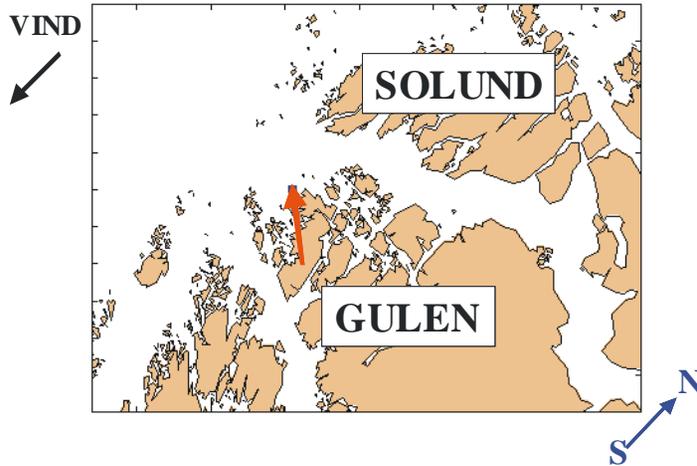
Spread of diseases and parasites:

Salmon Lice

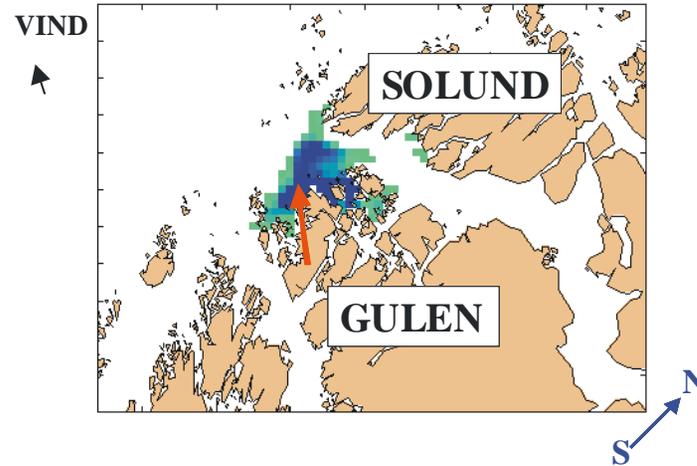


Simulated dispersion of salmon lice in Sogn: hydrography and wind.

14. April 2000, kl. 00

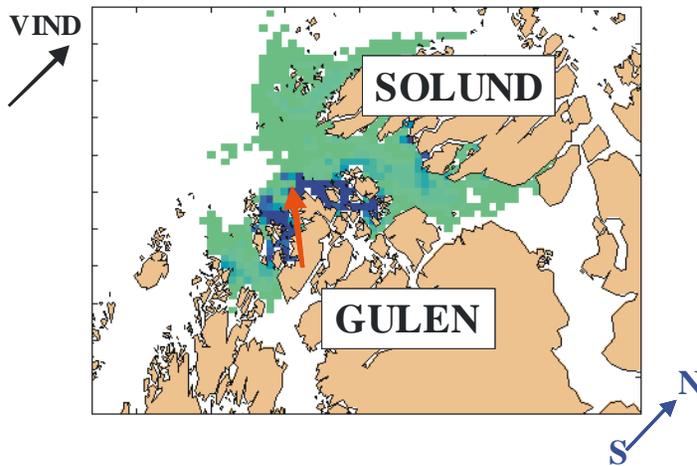


16. April 2000, kl. 18

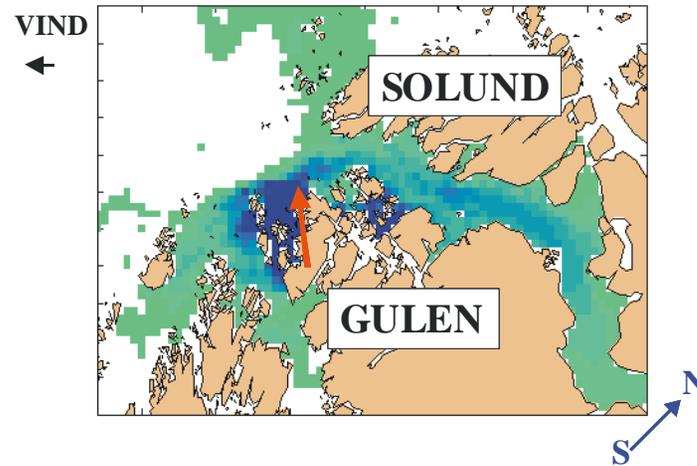


Simulated dispersion of water at 10 m depth on a farming site in Guleen.

19. April 2000, kl. 18



23. April 2000, kl. 18



Wind from south will bring the water into the Sogne Fiord.

Spread of diseases and parasites:

- Most bacterial and viral diseases may be prevented by vaccines
- Effective management prevents spread of diseases
- Salmon lice may decrease survival rate of wild salmonids
 - Development of vaccines against parasites has high priority
- Salmon lice the second limiting factor for Norwegian salmon farming



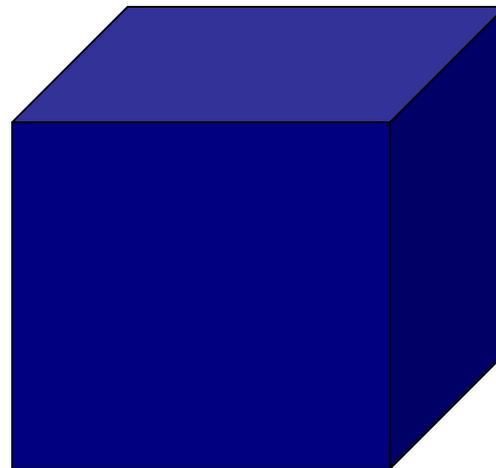
Use of land and sea:

Aquaculture vs agriculture

Agriculture is using area



Aquaculture is utilizing volume



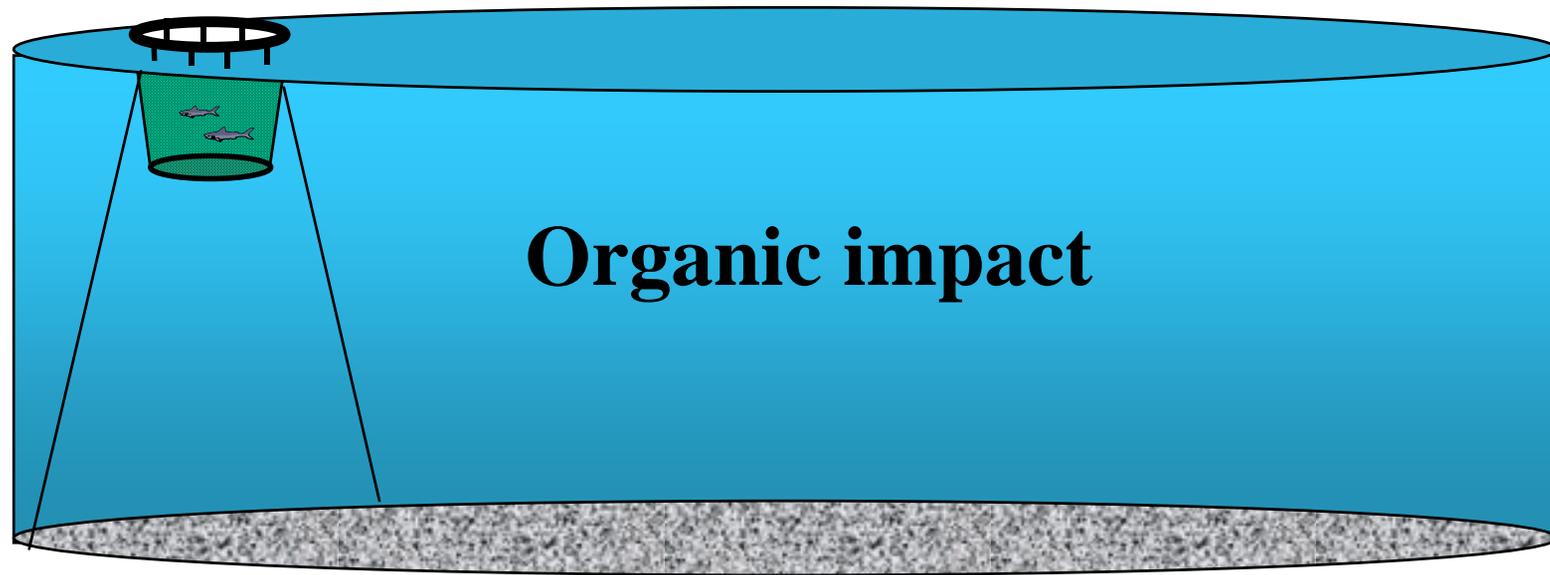
Use of land and sea:

Aquaculture sea use

- Efficient use of sea
- Limited or no permanent impact on area used



Discharges of waste material.



Local zone

Sedimentation of large particles

Large benthic impact

Sea farm the primary source

Intermediate-zone

Sedimentation of smaller particles

Some benthic impact

Sea farm the major source

Regional zone

Dissolved substances

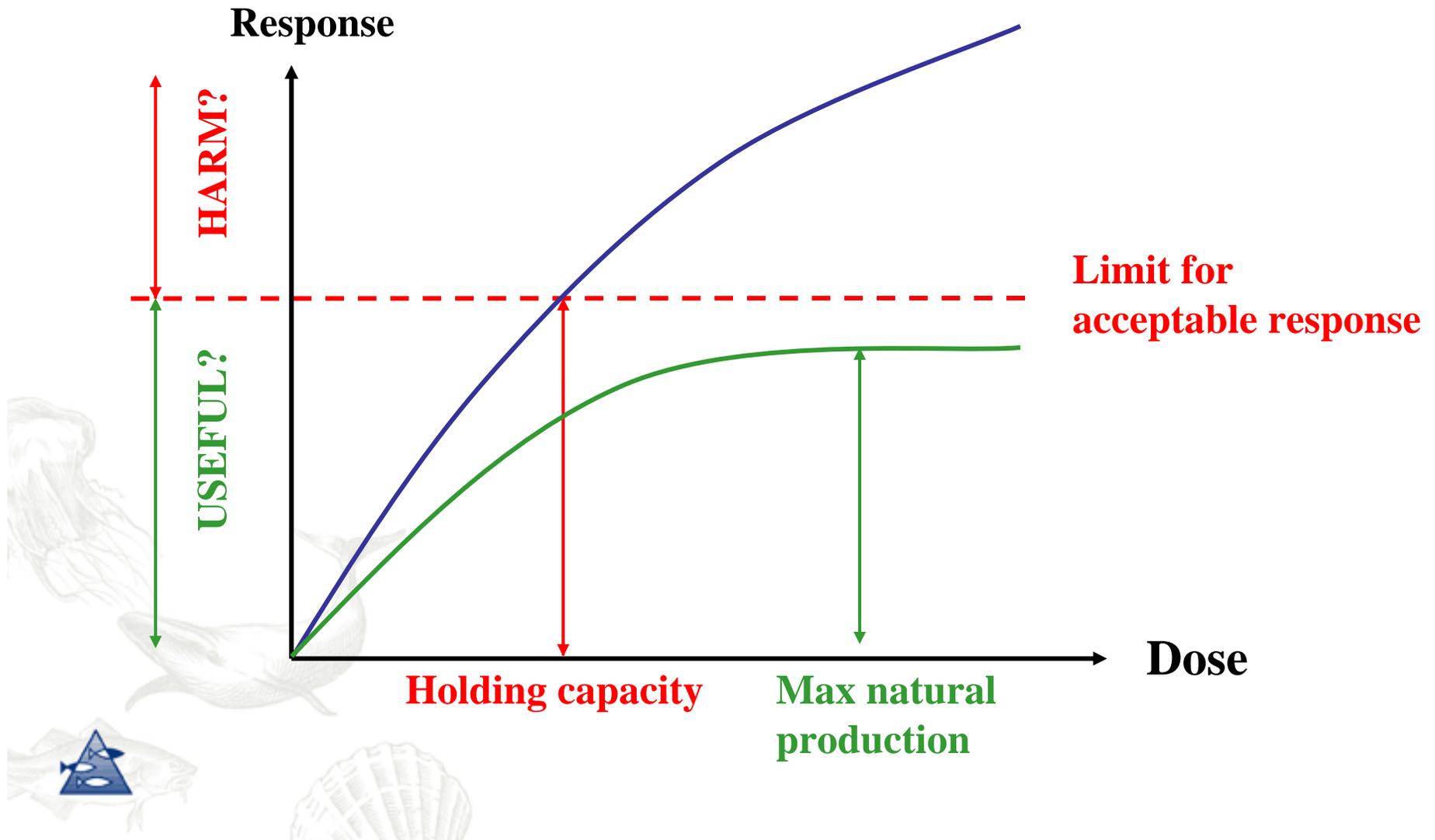
Increased primary prod.

Sea farm one among several

Ervik, A., 2005

Discharges of waste material:

Pollution or fertilizing



Discharges of waste material:

- Local negative effects can be large
 - Will cause reduced productivity and losses in the farm.
- Increased primary production
- No permanent effects

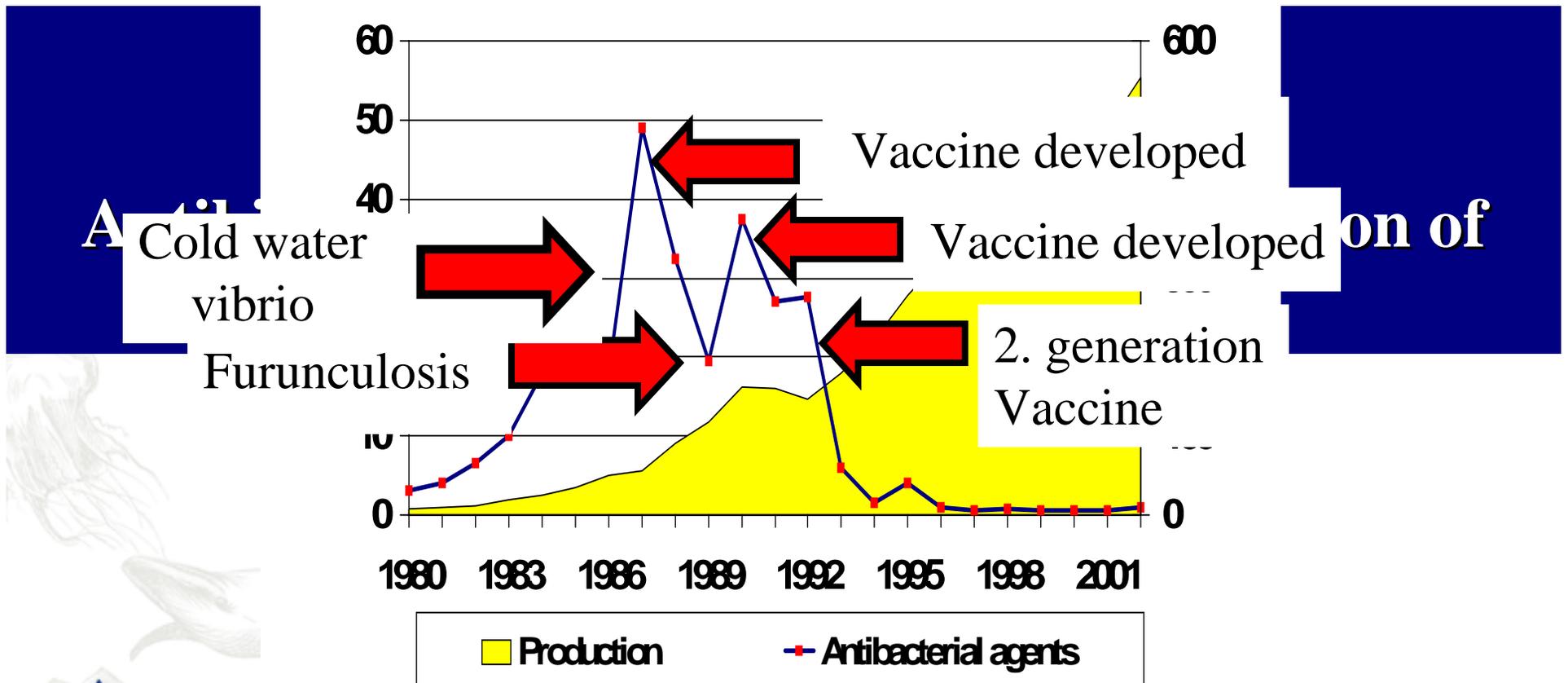


Use of antibiotics and chemotherapeutics:

Antibiotics in Norwegian aquaculture

Antibacterial agents
(metric tons)

Production
(metric tons x 10³)



Lunestad, 2004

Use of antibiotics and chemotherapeutics:

- Low use of antibiotics compared to other meat production
- Chemotherapeutics for salmon lice treatment may influence benthic fauna in farm vicinity
- No permanent impacts



Summary and conclusions:

Aquaculture in Norway

- Annual production of 600 000 tons of salmon and trout
- Theoretical holding capacity of 10-20 million tons if:
 - Escapees kept less than today
 - Salmon lice infection rates reduced by 80% compared to the situation in certain areas.



Summary and conclusions:

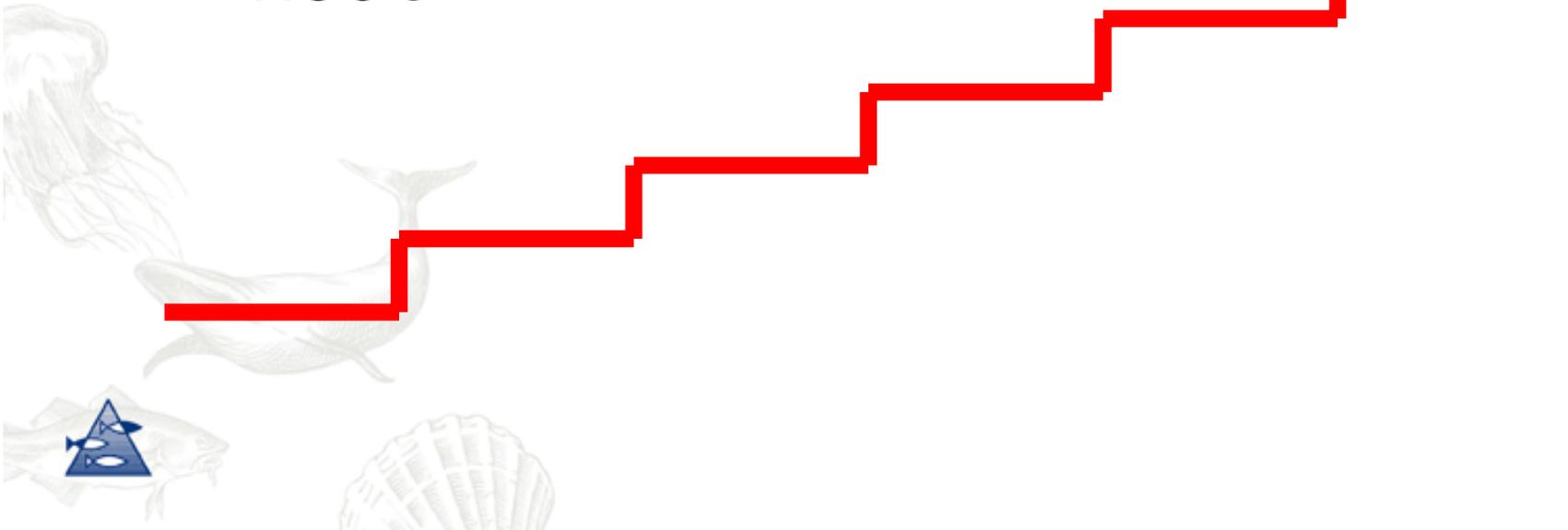
- Aquaculture – The most sustainable meat production in Europe.
 - Most feed effective
 - Most area effective
 - Least use of chemotherapeutics & antibiotics
 - No release of methane
 - Positive effect on wild harvest and the fishmeal industry



Summary and conclusions:

Step by step

- For a more sustainable production in cooperation between:
 - Farmers
 - Government
 - NGO's





Institute of Marine Research, Austevoll facility