

Offshore Aquaculture 101: Concepts and Species important to the North Pacific



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Outline

Do we need more fish?

Aspects of net-pens

Why move off-shore?

World Farmed Halibut Production and
Technology

World Farmed Cod Production

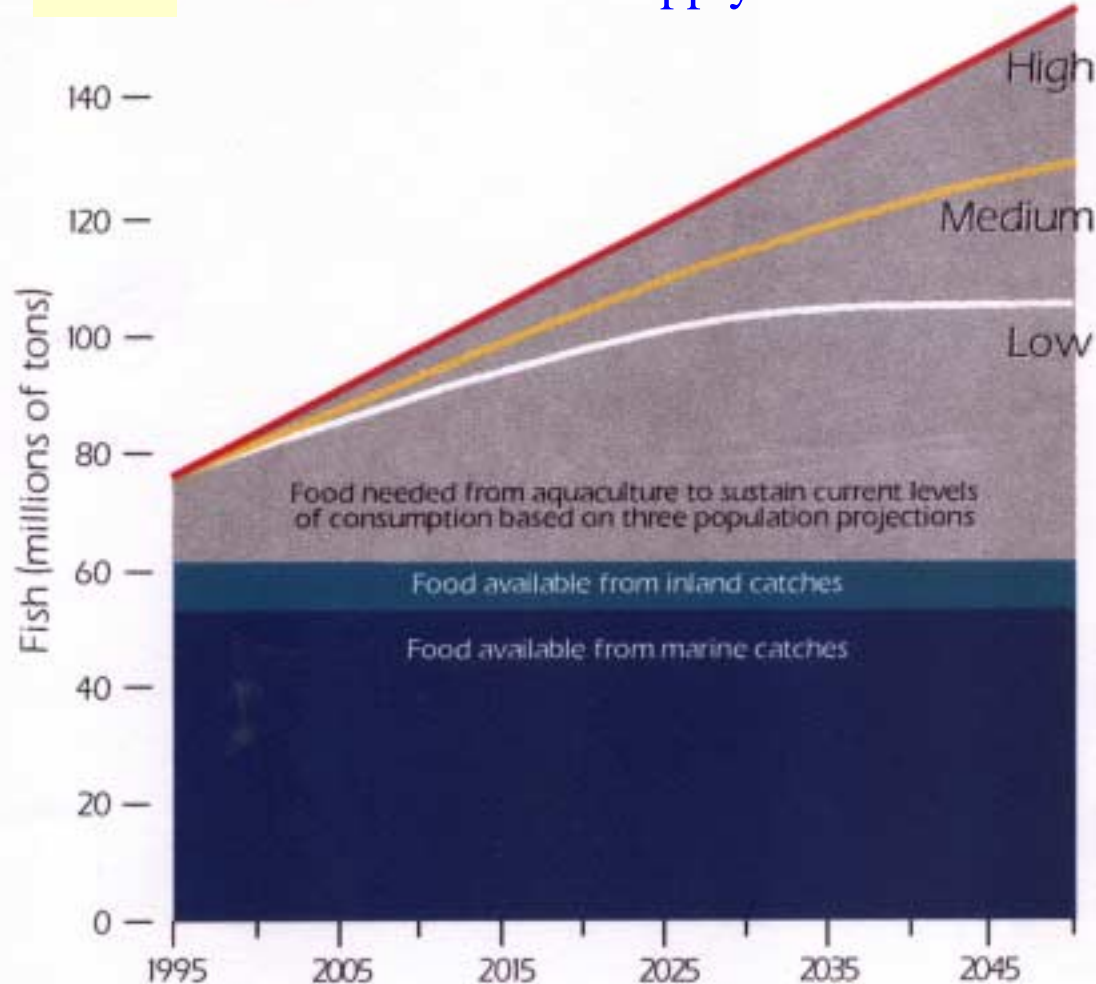
The Sablefish story

Summary



Do we need more fish?

Predicted World Seafood Supply and Demand



- Demand for seafood and other marine products is increasing
 - Population
 - Per Capita Consumption
- The capture fishery is fully tapped and many stocks are depleted
- Aquaculture, especially marine aquaculture, is the only way to increase the supply of seafood



Intensity of aquaculture systems

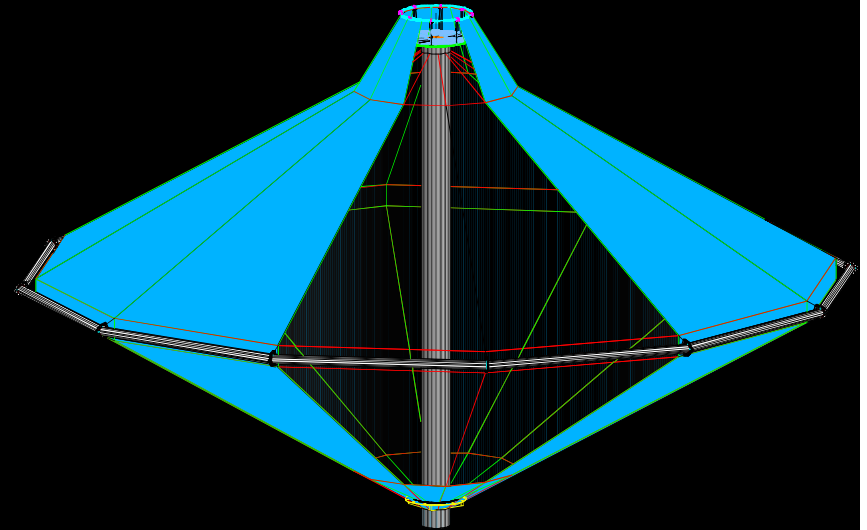
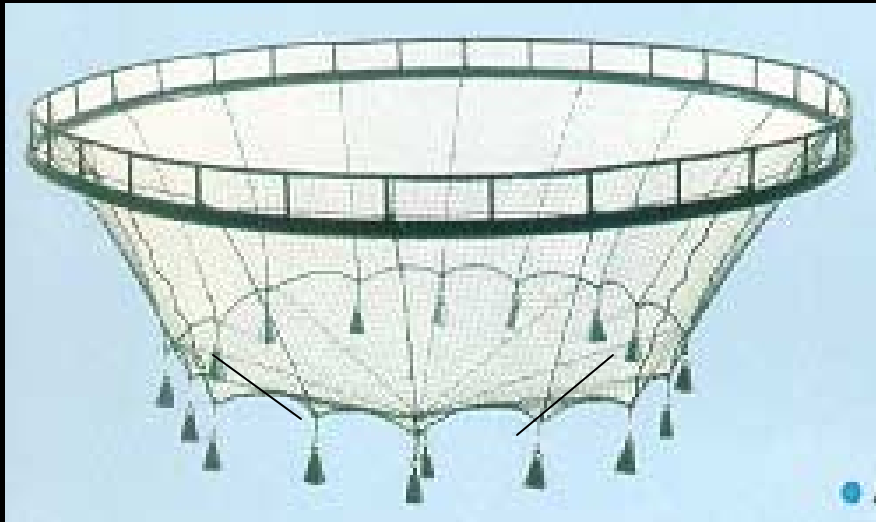


Advantages of Net-Pens

- Low energy use
- No land use beyond service needs
- Non-consumptive of water
- A lot of fish in a small area



Offshore Cage Types



Gravity type cage



Submersible type cage

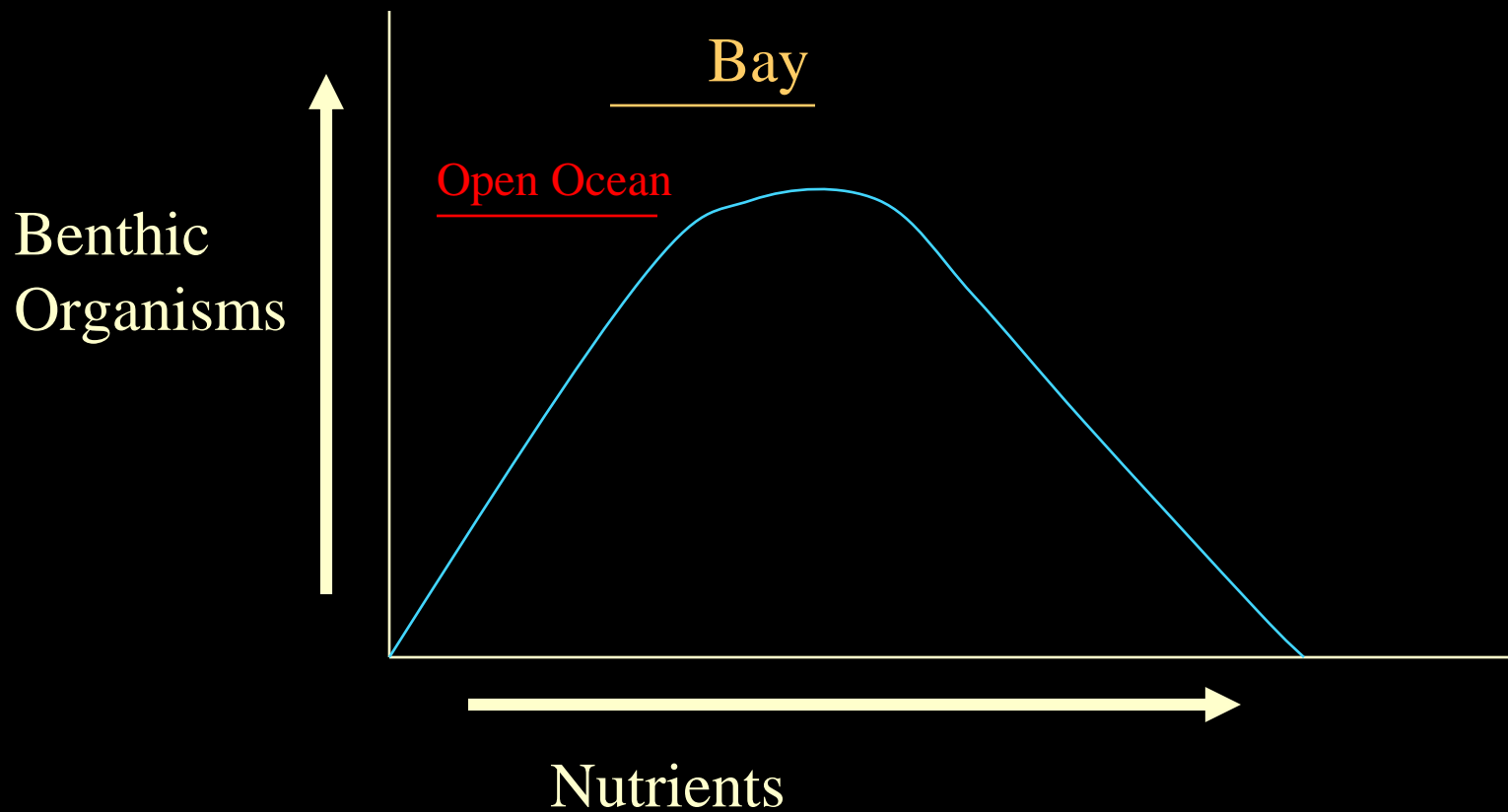


Why move Off-shore?

- More Space
- Better Effluent Assimilation Capacity
 - Solids settle to the bottom-impact depends on current, depth and management practices.
 - Dissolved N, CO₂ and P carried away in current
 - Impacts more likely to be positive



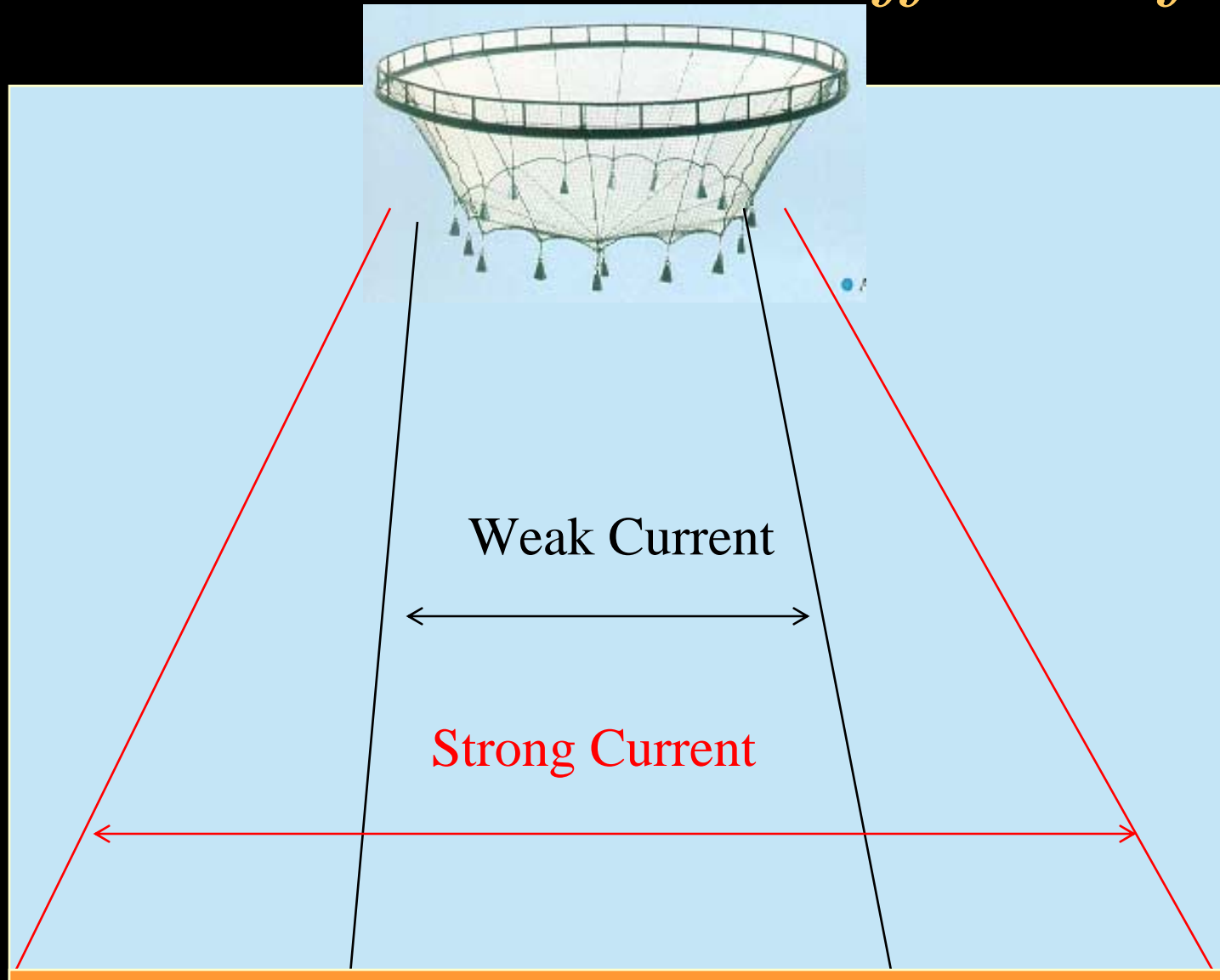
Impacts of Nutrients on Benthos



Similar processes occur in water column

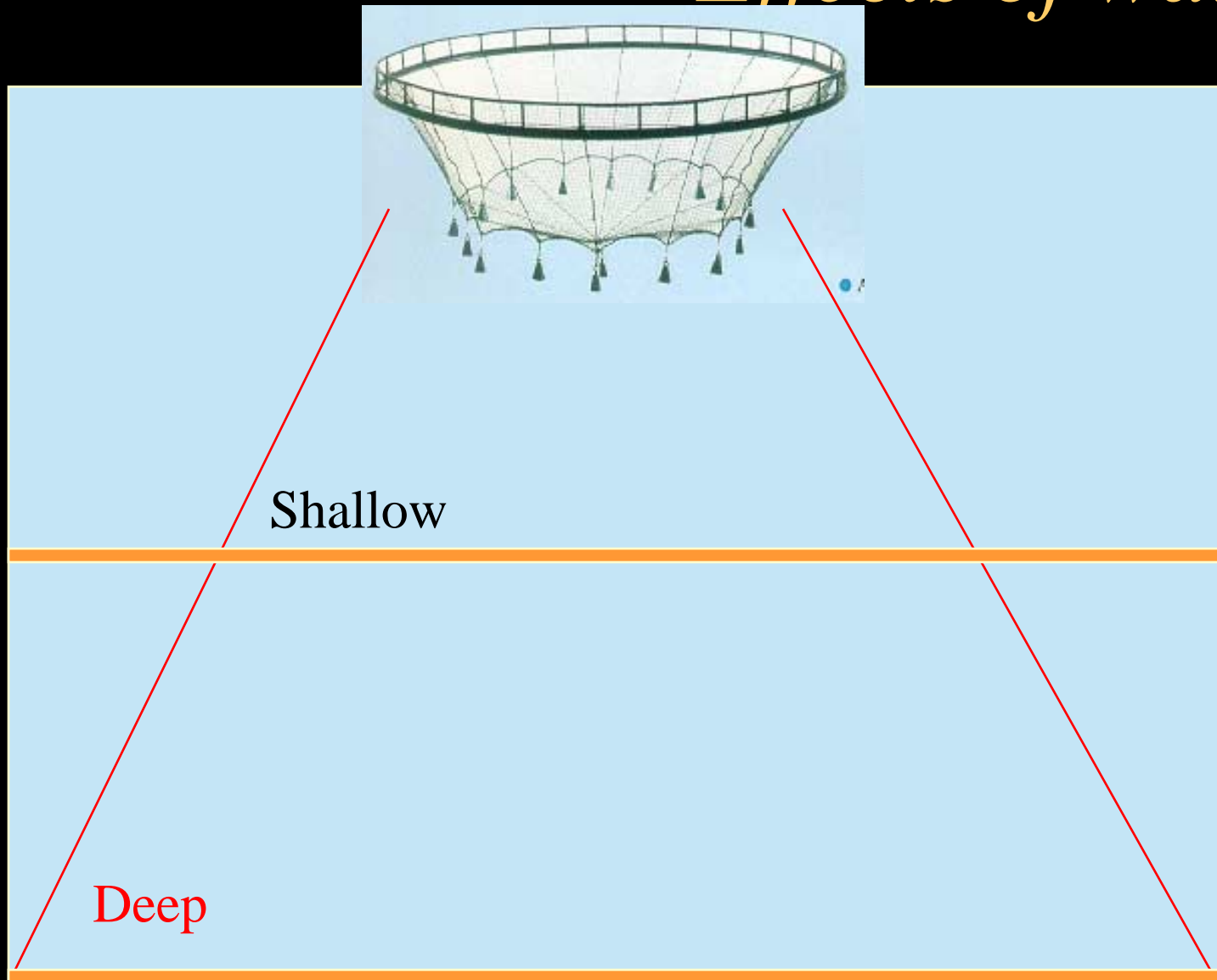


Cage impacts on the bottom: Effects of currents





Cage impacts on the bottom: Effects of water depth



Why move off-shore?

- View issues





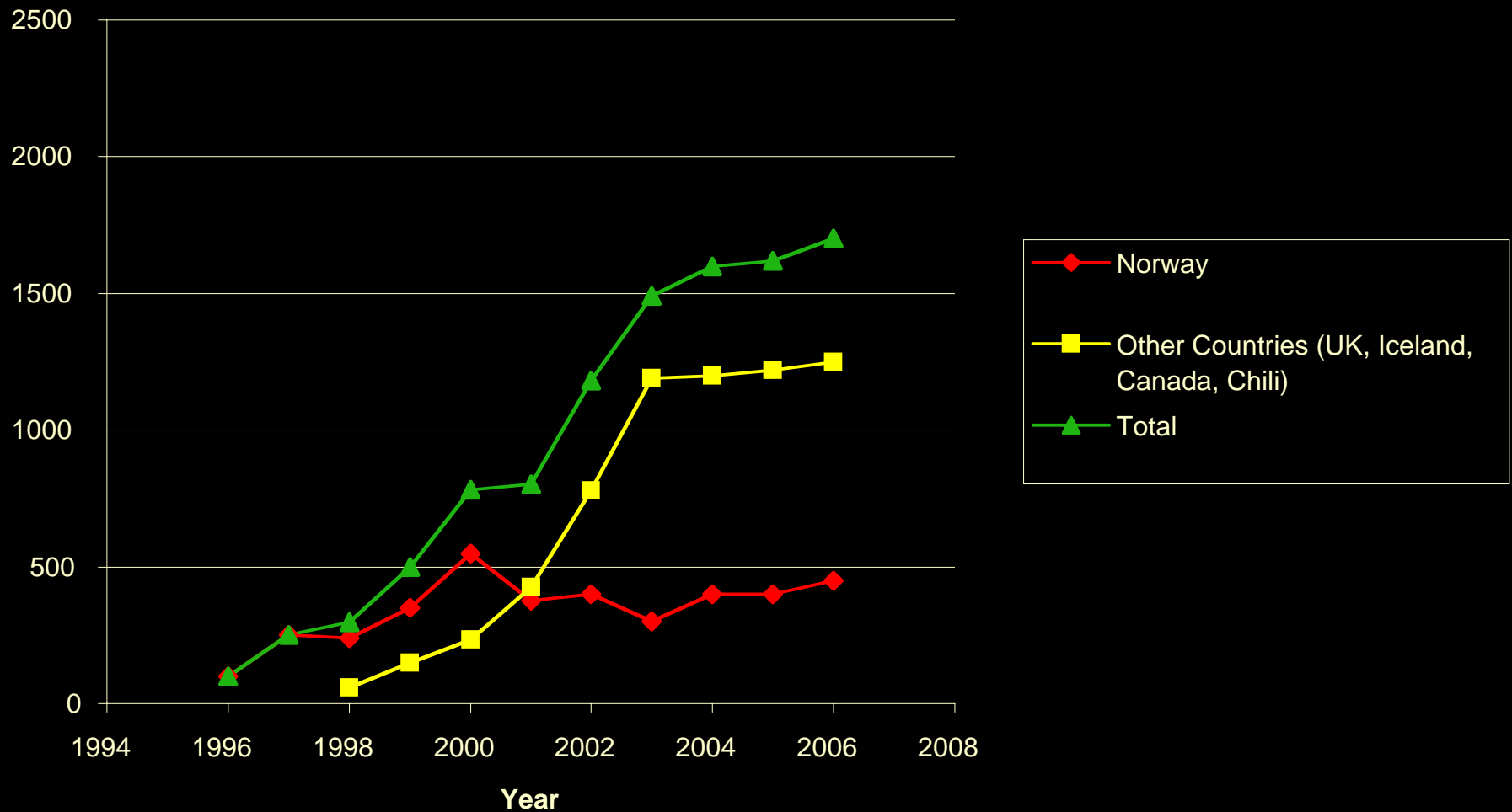
History of Halibut Aquaculture research in Norway

- 1934 Gunnar Rollefsen made in vitro fertilization and described early development.
- 1980 The first two halibut larvae were fed through metamorphosis at Institute of Marine Research (IMR), Flødevigen (Øiestad, V. and Haugen, A.S. 1980; Blaxter, J.H.S., Danielsen, D., Moksness, E. and Øiestad, V. 1983)
- 1983 Silos developed at Austevoll
- 1985 The first two halibut juveniles were produced at IMR, Austevoll.
- 1983-1995 Austevoll developed the first production line for juveniles
- 1987-present Sea-cages for halibut growout, Diet, genetics, health and other areas expand

Torrissen et al 2003

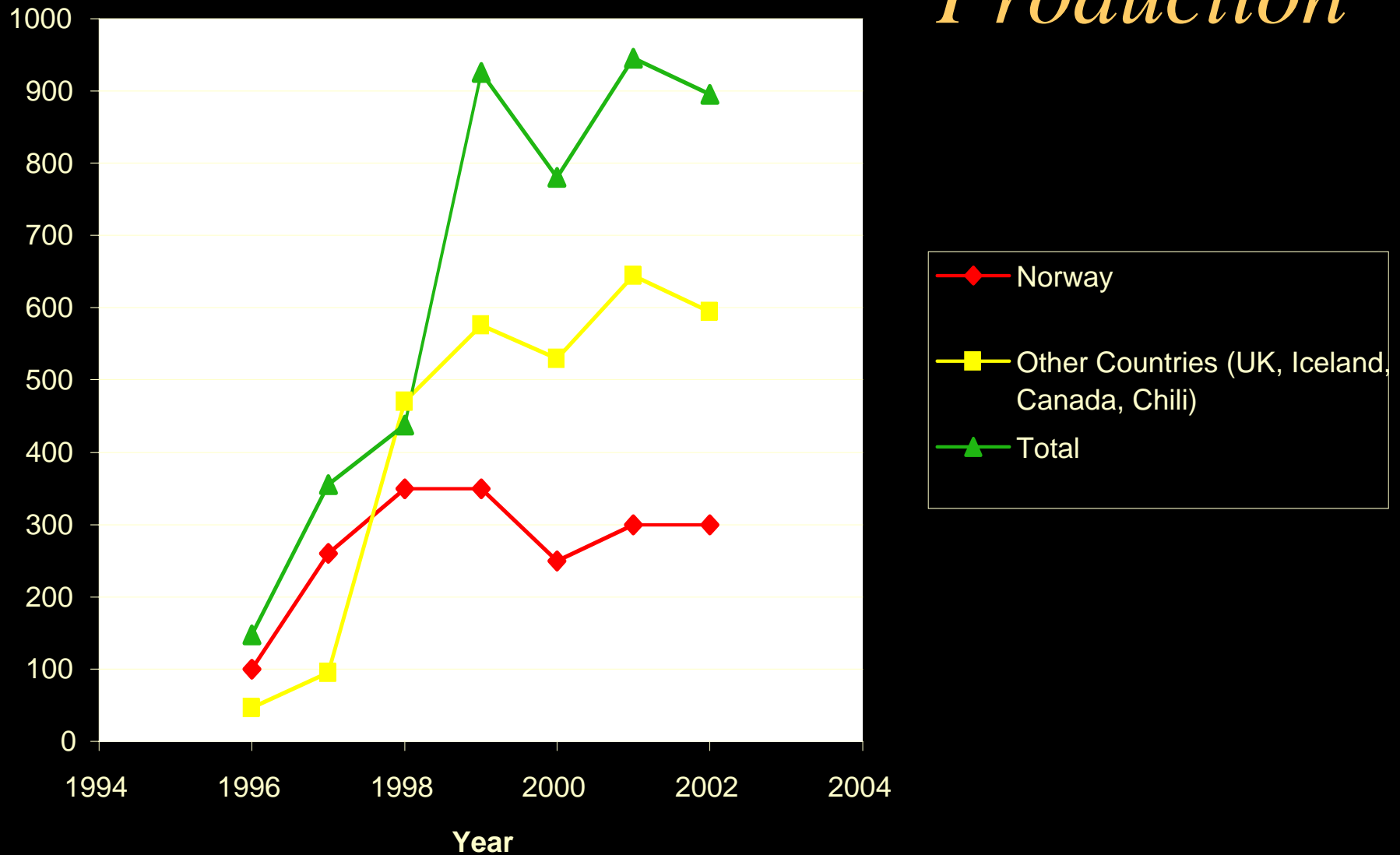


Halibut Aquaculture Production



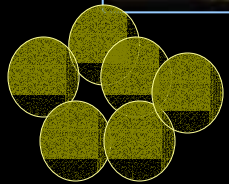


Halibut Aquaculture Juvenile Production





Lifestages



Eggs

10 d



Yolk sac larvae

40 d



Start feeding

50 d



Grow out

1500 d

Metamorphosis

Torrissen et al. 2003

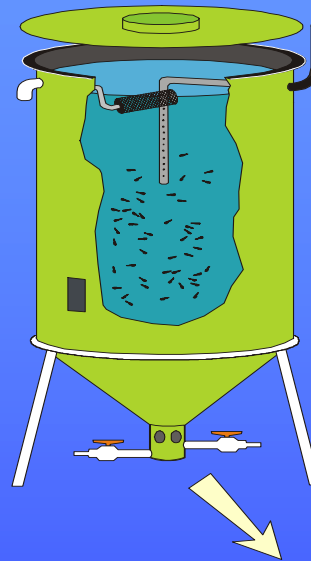


- Complex process
- Shifting from semi-intensive feeding to intensive feeding

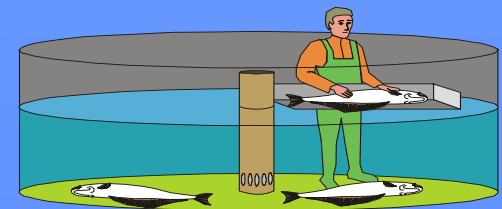
van der Meeren, T., 2003

PRODUCTION OF JUVENILE HALIBUT

SILO FOR KEEPING YOLK SAC LARVAE



STRIPPING OF BROODSTOCK



EGG INCUBATION



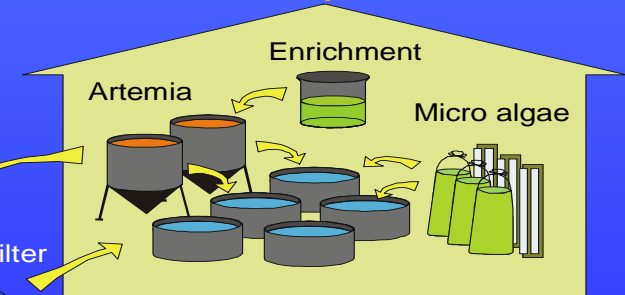
START FEEDING

Semi-intensive production



Kveitelarver i store tanker eller plastposer

Intensive production

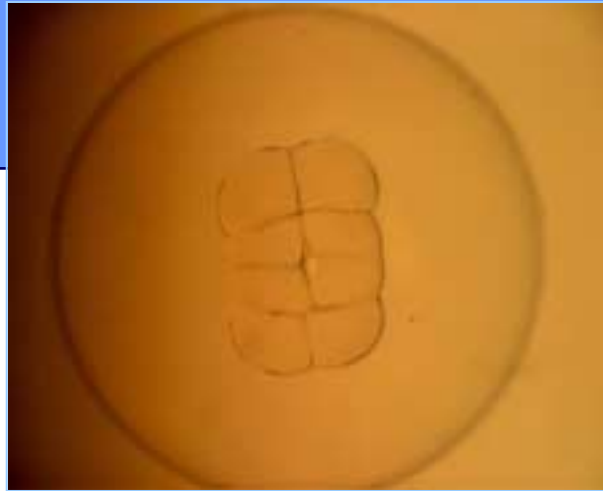
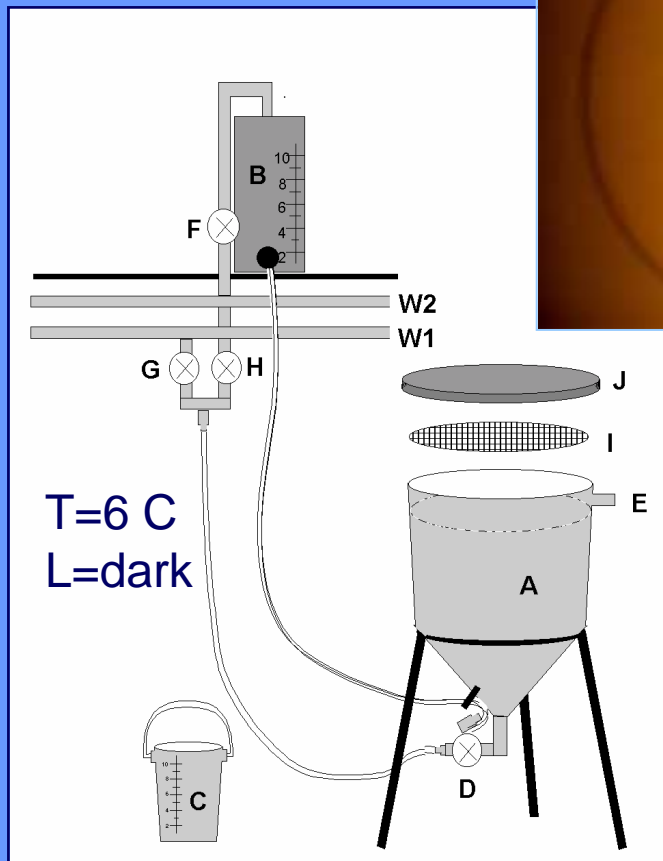


Gjødsel

Demning

Plankton

Hatchery Incubator



Harboe, T., 2003



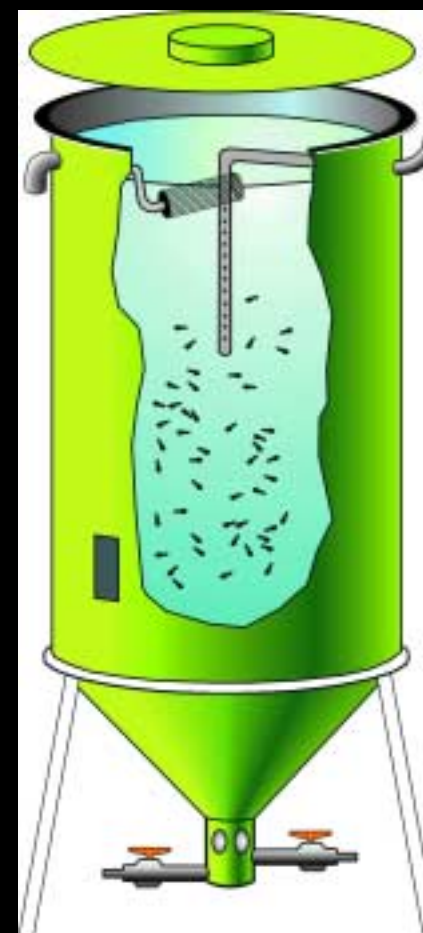
Incubator – Yolk sac larvae



T= 6 C

L= dark

Synchronised hatching=light/dark



van der Meeren, T., 2003

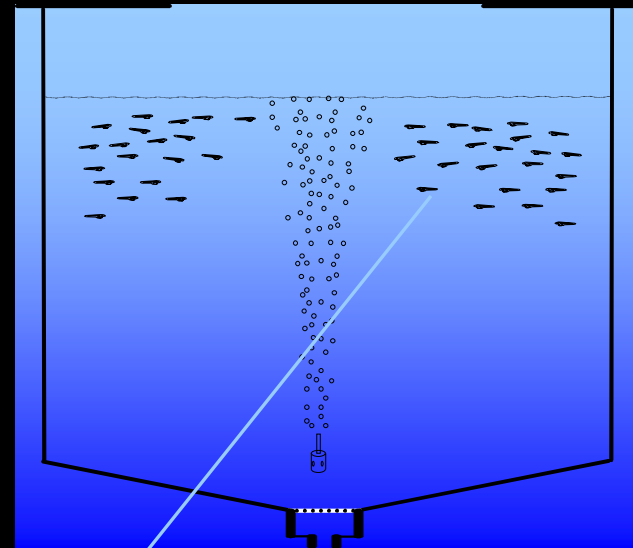
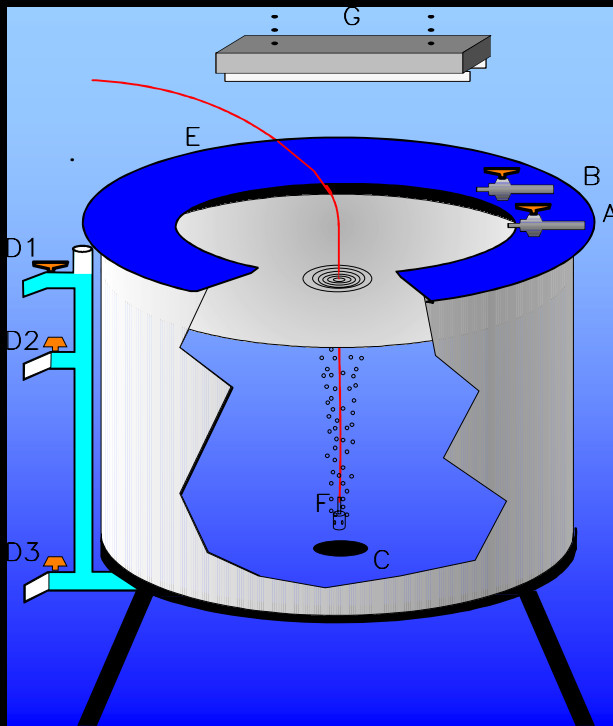


Semi-intensive larval rearing system





Intensive larval feeding tanks



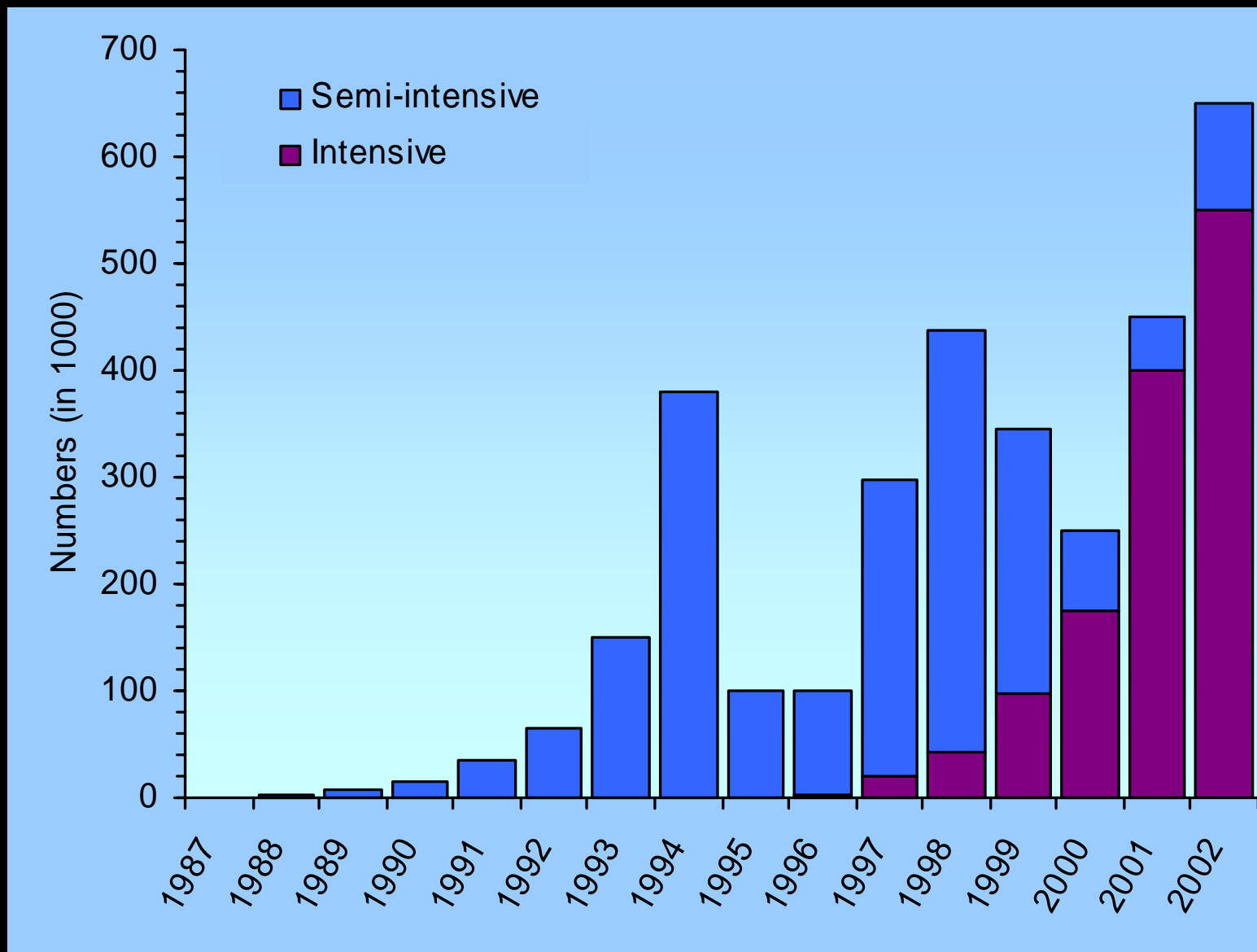
$t = 12\text{ }^{\circ}\text{C}$
Light aeration



Harboe, T., 2003



Juvenile production in Norway



Kristiansen, T. And Harboe, T., 2003

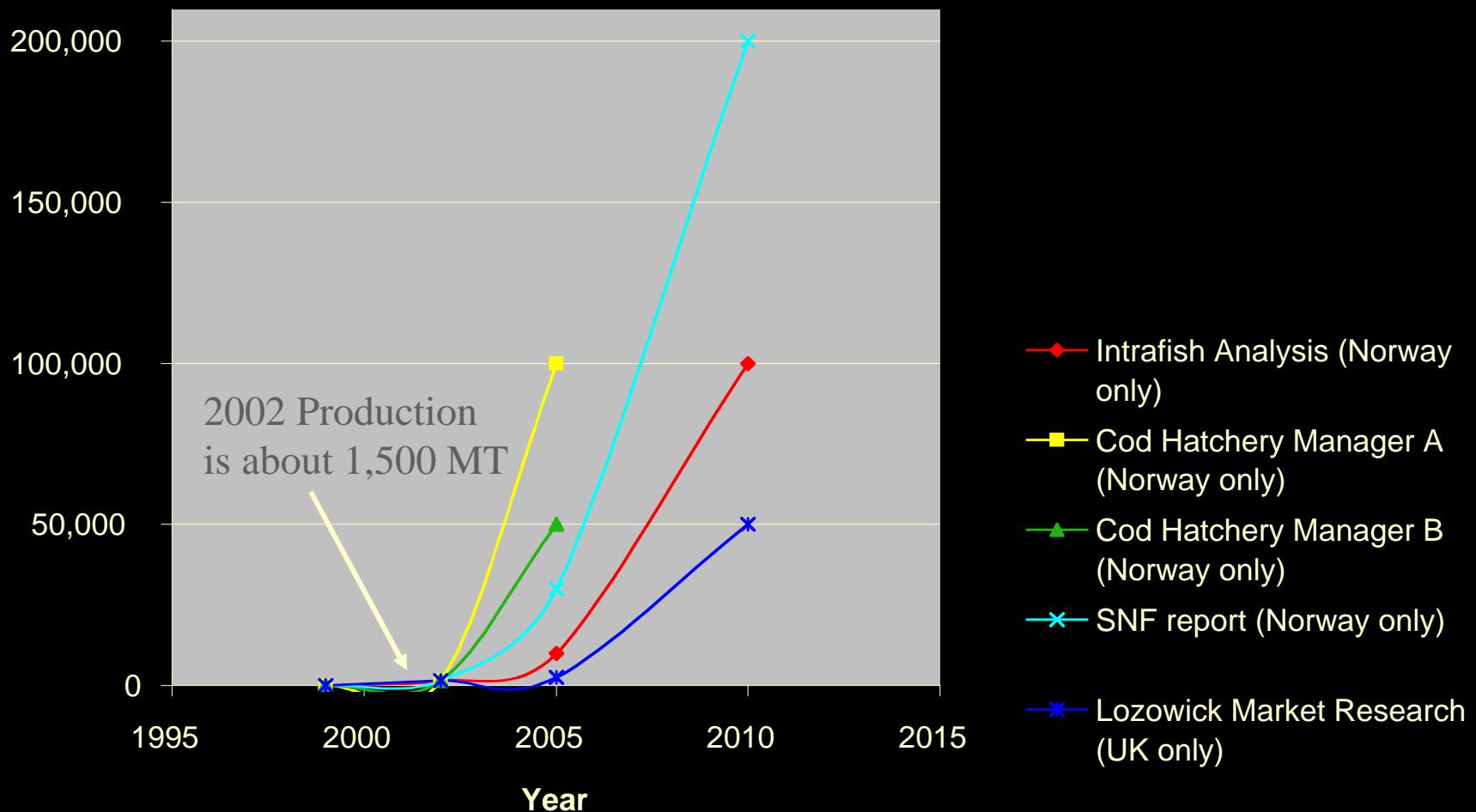


Halibut Aquaculture in the US?

- Only Atlantic Halibut at this point - Pacific Halibut is a different species.
- UNH offshore aquaculture project
 - 1200 juveniles from a Canadian hatchery grown in Sea Station cage off of New Hampshire coast
 - Also testing Haddock, Cod and Summer Flounder
 - <http://ooa.unh.edu/>



Cod Production Estimates



Note: Halibut is just now at 1500 MT annual production despite a much longer commercial history.



Advantages of Cod over Halibut

- Easier Seed production
 - Less than a week as eggs then hatch and start feeding.
 - No long yolk sac phase - no need for silos
 - Quick growth to the juvenile stage
 - More robust larvae
- No need to modify salmon net-pens for grow-out
- Traditional market is larger



6 months





The Sablefish Story

- Early life history mirrors halibut
 - Complex and expensive to produce seed, however methods already developed for halibut work for sablefish.
- Grows well in salmon net-pens
- More efficient with feed than salmon
- No swimbladder - can be raised in cages without access to the surface



Development of Sablefish farms

- Commercial hatcheries in BC
 - 1 existing - production growing from about 100 fish in 1999 to 40,000 in 2002, perhaps 180,000 next year. Destroyed 1.2 million larvae due to a lack of market (\$CN 5-7 each).
 - 1 existing that has never produced more than a few thousand
 - 1 new that plans on producing up to 250,000 next year.



Development of Sablefish farms

- Grow-out of Sablefish in BC
 - About 20 salmon lease holders have permits to grow sablefish, but only 3-4 actually have.
 - Very limited production (perhaps 50 MT) but expected to grow over the next decade.



Summary

- Off-shore aquaculture has benefits and costs associated with it relative to other fish producing activities.
- Most of the development of species important to the north Pacific is for the Atlantic counterparts. Little work on Pacific species.
- Halibut production is stalled, but could pick-up in the next few years
- Cod is coming - perhaps in a big way. Technology is not an issue, however financing is.
- Sablefish production is low and mostly experimental, but the technology is available from the Halibut industry.
- Development outside of the US on these species and technologies will continue even if there is little activity within the US