

Marine Aquaculture and Marine Ecosystems: Environmental Impacts of Farming Finfish

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Blue Mussels



Shrimp farms



NOAA: pursue offshore aquaculture

- **Grow fish in cages sited well out into the ocean**
- **Legislation prepared by NOAA introduced in the U.S. Senate in June 2005**
- **NOAA's Goal: \$5 billion/yr. aquaculture industry. Finfish are focus of R&D.**

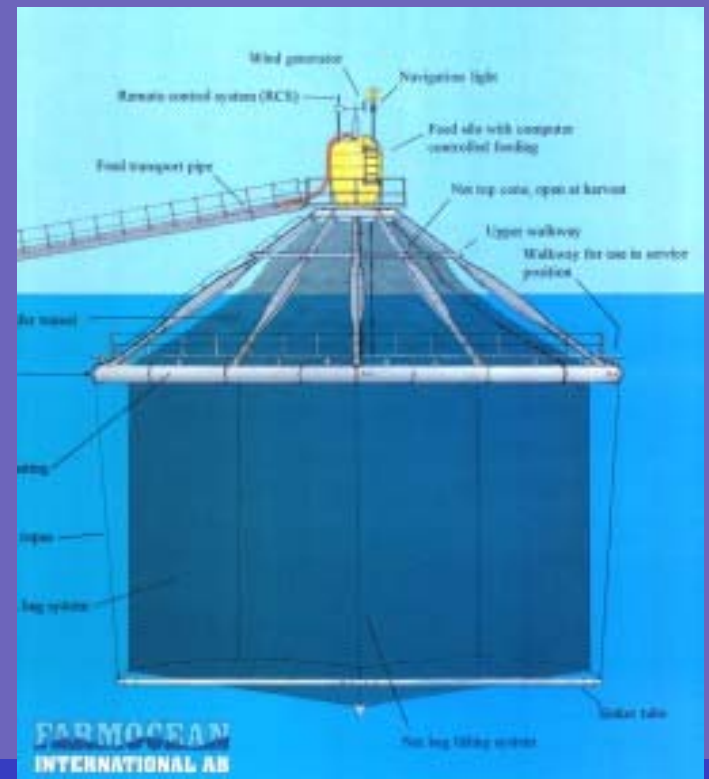




Salmon farming

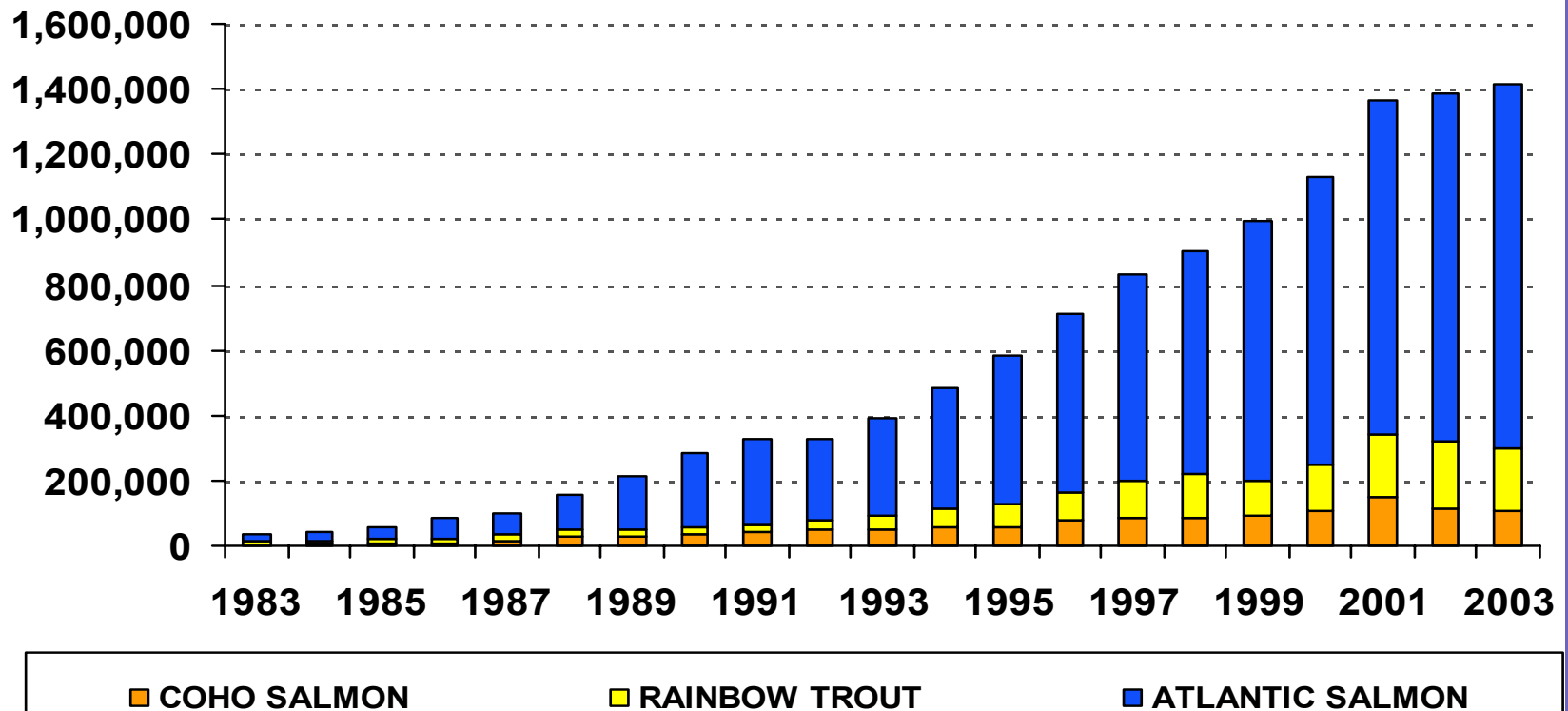


An underwater view of the submerged sea cage with divers. -Oceanic Institute photo



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Global production of farmed salmonids grown in marine waters, 1983 to 2003

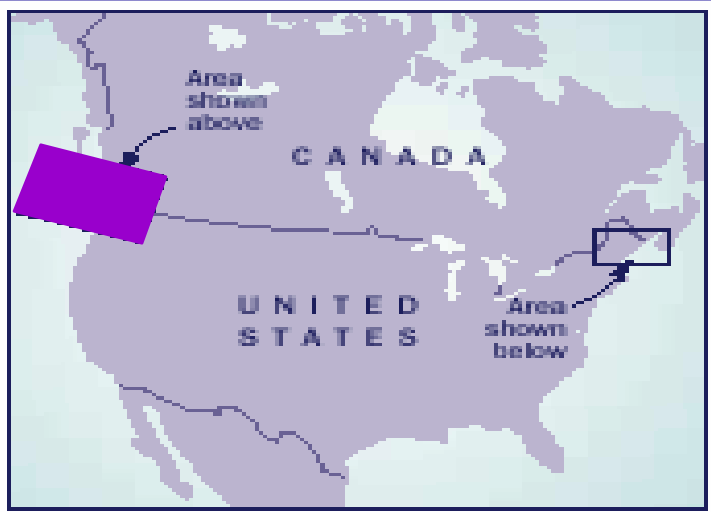


Source: FAO, 2005, figure courtesy of A.G.J. Tacon.



■ Sites Leased for Salmon-farming

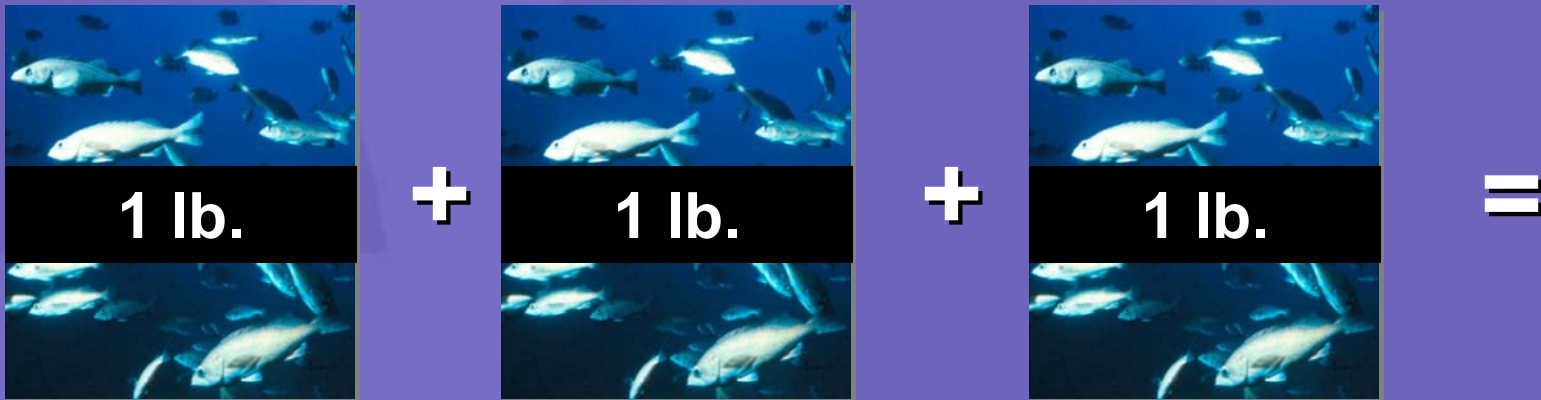
Note: Sites in close proximity may be indicated by a single square.



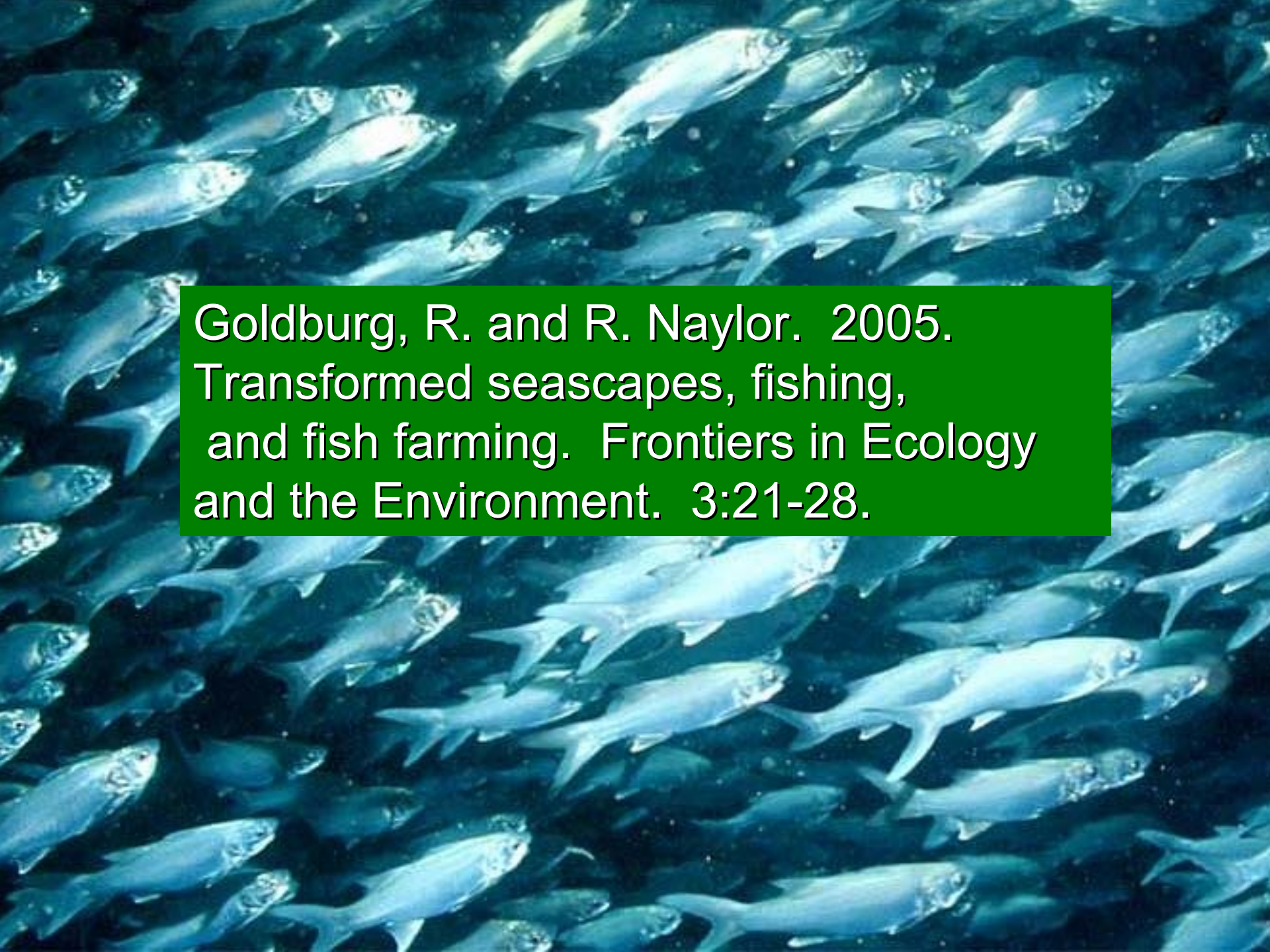
Issues

- Salmon feed
- Water pollution
- Salmon escapes
- Are other issues

Environmental Issues – Net Loss of Fish



Producing one pound of farmed salmon requires roughly three pounds of wild caught fish

A large school of silver fish, likely tilapia, swimming in clear blue water. The fish are densely packed and moving in various directions, creating a dynamic scene. The water is a deep, clear blue, and the fish have a silvery, reflective sheen.

Goldburg, R. and R. Naylor. 2005.
Transformed seascapes, fishing,
and fish farming. *Frontiers in Ecology
and the Environment*. 3:21-28.

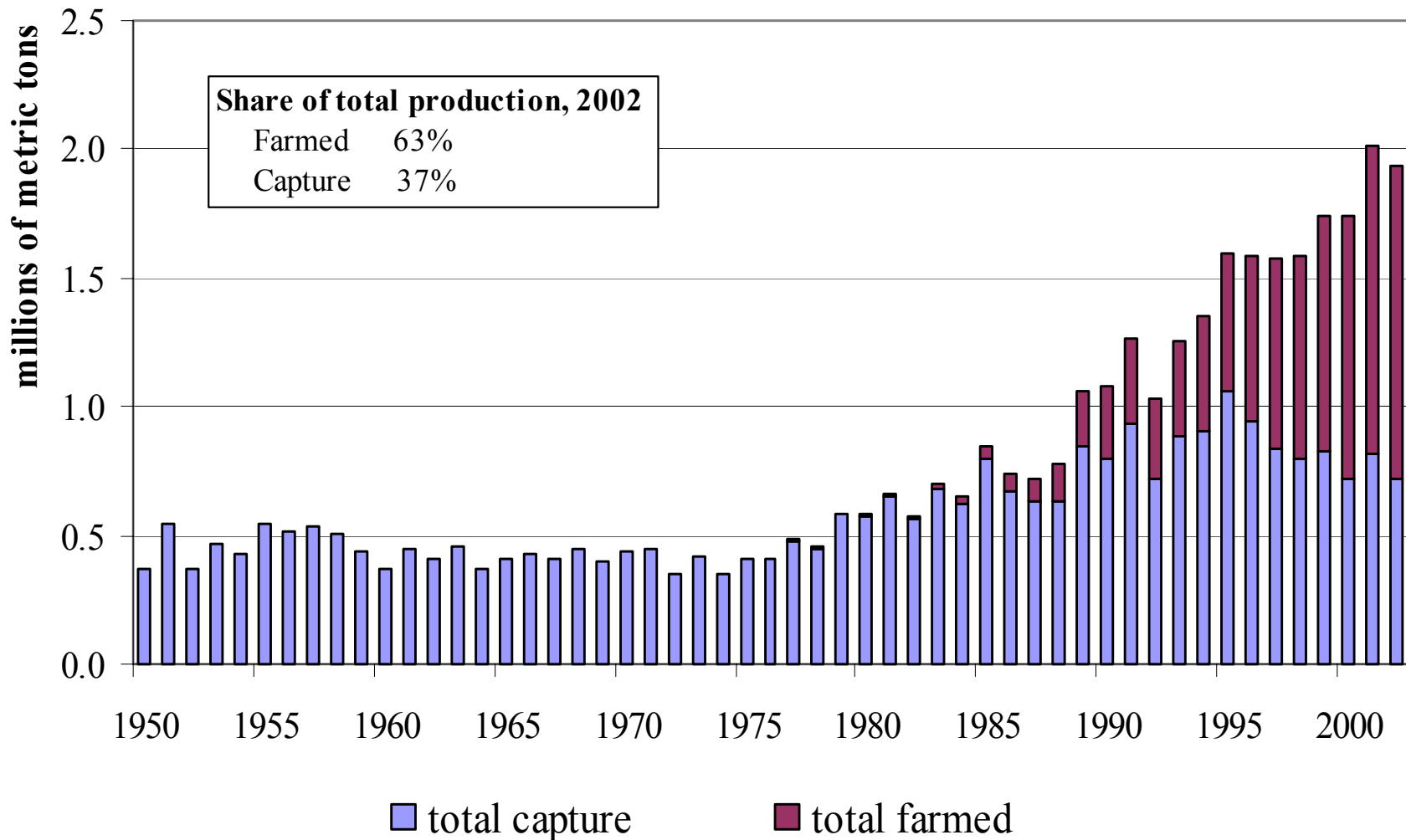
Efficiency argument

- **ARGUMENT:** Catching small, low trophic level fish to feed large, high trophic level farmed fish is more efficient than leaving small fish in the ocean to be consumed by wild predatory fish caught by fishermen.
- If aquaculture is **substituting** for fishing, this argument has merit.
- If aquaculture is **supplementing** fishing, this argument is not relevant. Growth in aquaculture increases demand for small low trophic level fish that are finite in supply and critical food for wild fish and other marine predators.

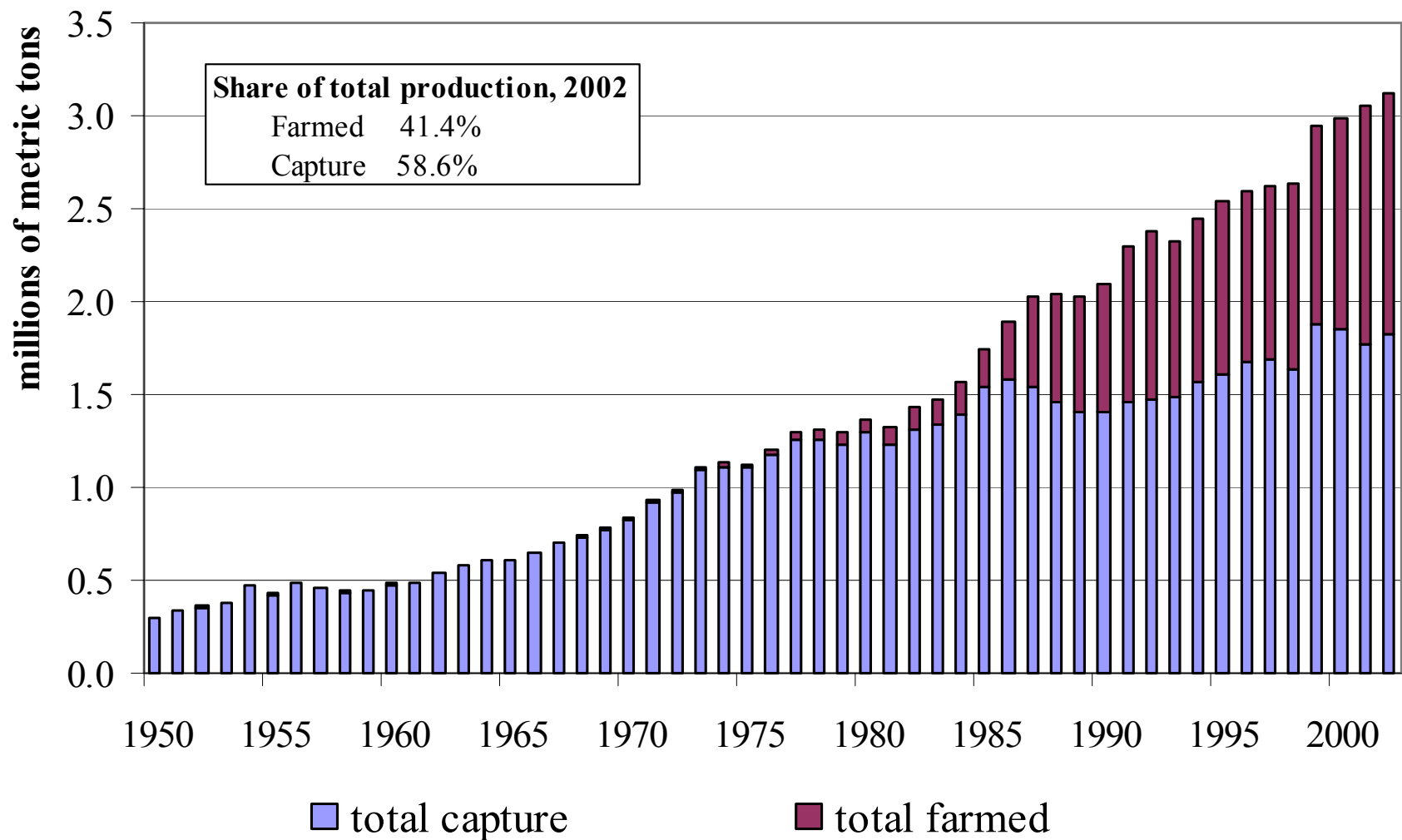
Change in ex-vessel Prices for Alaskan Salmon, 1988-2002 (\$/lb)

Species	1988 Price	2002 Price	Change from 1988-2002 (%)
Chinook	2.69	1.23	-54
Chum	0.86	0.13	-81
Coho	1.72	0.37	-78
Pink	0.79	0.06	-92
Sockeye	2.37	0.55	-77
Farmed Atlantic	3.11	1.21	-61

Global salmon production, 1950-2002

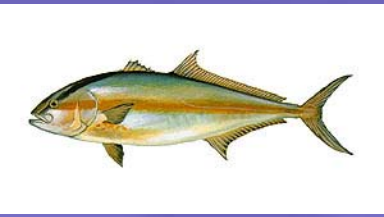


Global shrimp production, 1950-2002



UPSHOT: Evidence indicates that aquaculture is supplementing, not substituting for, marine fisheries. Marine aquaculture must thus reduce its use in fish feeds of meal and oil made from wild caught fish





Amberjack

4.5 FL, HI



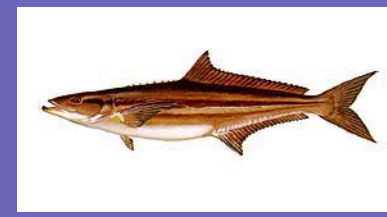
Red Snapper

4.1 FL



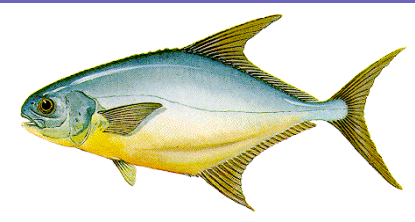
Red Drum

4.3 AL, FL, TX



Cobia

4.5 FL, PR



Florida Pompano

3.8 FL



Atlantic salmon

4.2



Summer Flounder

4.5 NH



Mutton Snapper

3.9 PR



Halibut

4.2 NH



Pacific Threadfin

3.8 HI



Atlantic Cod

4.3 NH



Haddock

3.5 NH

ANOTHER FEED ISSUE:

Farmed salmon have relatively high levels of contaminants which come from their feed

SOLUTIONS TO REDUCE CONTAMINANTS:

- 1. Reduce fish meal and oil content of feeds**
- 2. Source fish meal and oil that is lower in contaminants (e.g. from South America)**
- 3. Use new technologies to remove contaminants from bulk quantities of fish oil**



NUTRIENT POLLUTION: Salmon farming discharges large amounts of fish feces and other wastes

Decreasing water pollution

✓ Decreased feed wastage

✓ Reduced pollution feeds

X Waste capture systems

- Floating bag and tank systems

- Integrated aquaculture

Estimated nitrogen discharge from a \$5 billion offshore aquaculture industry

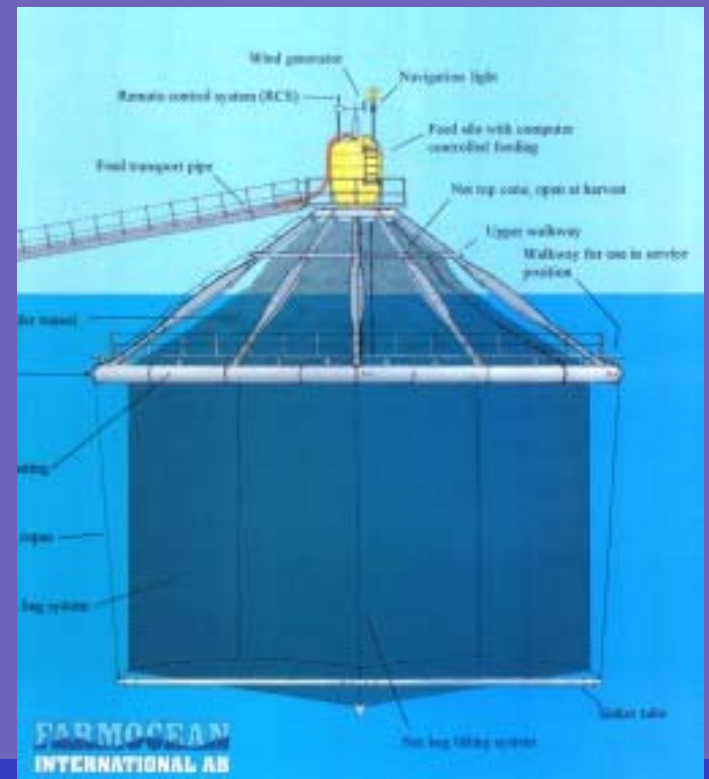
- **Use figures from salmon farming to make estimates**
- **Annual nitrogen discharges would be roughly equal to that from the North Carolina hog industry (about 10 million hogs) or to the nitrogen in untreated sewage from 17.1 million people.**
- **Discharges are small compared to many nitrogen fluxes in the ocean, but are too large to ignore in policy-making.**

Impact on wild fisheries: Substantial numbers of farmed salmon escape from salmon farms





An underwater view of the submerged sea cage with divers. -Oceanic Institute photo



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**Main Pass/Breton Sound
Before and after Hurricane Katrina**

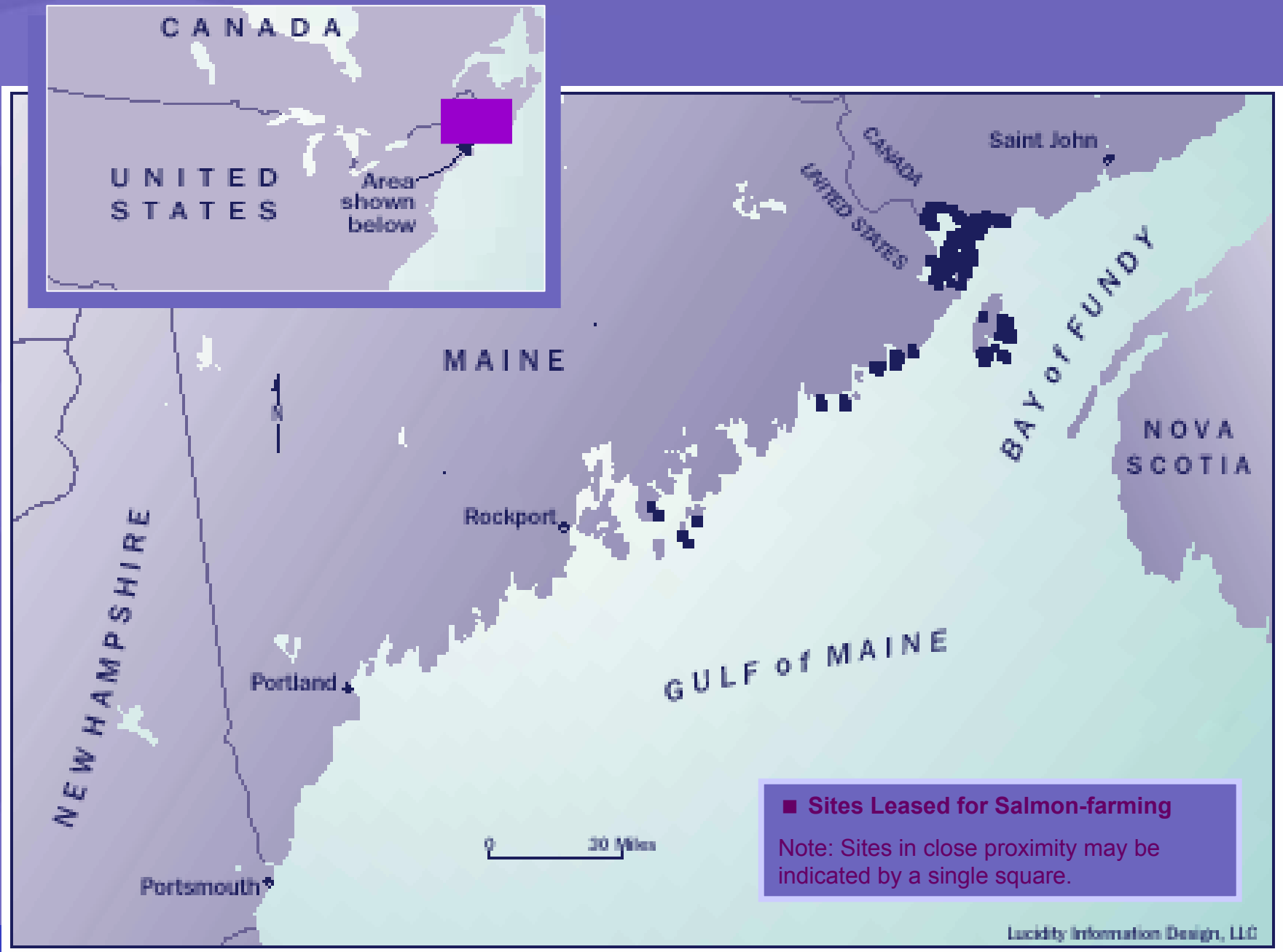


Naylor et al. 2005. Fugitive Salmon: Assessing Risks of Escaped Fish from Aquaculture. *BioScience* 55: 427-437.



Impact of Salmon Escapes in the Pacific Northwest





ENVIRONMENTAL DEFENSE



Offshore aquaculture: Escapes of truly marine finfish are different than escapes of anadromous salmon

- Marine fish may breed in ocean cages, making containment impossible
- Potential impact on genetic structure of wild populations little understood



Impact on wild fisheries: spread of diseases and parasites

Sea lice



June 15, 2006
Tribune Channel



Denham Island
June 12, 2001



Old Pass June 11, 2001

Conclusion

Some types of aquaculture development can have substantial impacts on wild fisheries and the marine environment



Off-shore moi farm, Hawaii



Benefit of offshore aquaculture – greater dilution of fish wastes