Taylor Shellfish Farms

West Coast shellfish culture

And ocean acidification impacts




Taylor Shellfish Farms

Overview

- Shellfish farming
- Ecological interactions
- Water quality challenges
- Ocean acidification
- National Shellfish Initiative

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In Memory of Justin Taylor

"Some people climb mountains;
I walk mudflats"

Pacific Coast
SHELLFISH GROWERS ASSOCIATION
Partners with Mother Nature
sustainably farmed
oysters, clams, mussels, scallops

Estimated 2009 West Coast Cultured Shellfish Production

STATE	OYSTERS	CLAMS	MUSSELS	GEODUCKS	TOTAL
Washington	27,669 M/T	4,309 M/T	1,247 M/T	748 M/T	33,974 M/T
	$57.75 million	$19.55 million	$3.16 million	$20.1 million	$100.56 million
California	4,205 M/T	34 M/T	46 M/T	No record	4,684 M/T
	$12.36 million	$0.83 million	$0.95 million		$14.14 million
Oregon	1,080 M/T	No record	No record	No record	1,080 M/T
	$2.25 million				$2.25 million
Alaska	94 M/T	3.6 M/T	0.9 M/T	No record	98 M/T
	$0.44 million	$24,841	$6,610		$473,232
Total	33,048 M/T	4,658 M/T	1,391 M/T	748 M/T	39,845 M/T
	$72,806,242	$20,404,841	$4,114,110	$20,100,000	$117,425,193

	OYSTERS	CLAMS	MUSSELS	GEODUCKS
% of shellfish	83	11.7	3.5	1.8
% of sales ($)	62	17.4	3.5	17.1

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Bush & Callow Acts 1895

- Passed by Washington State legislature to encourage development of aquaculture industry to replenish stocks being depleted by fishery
- Allowed for purchase of tidelands specifically for purpose of growing oysters

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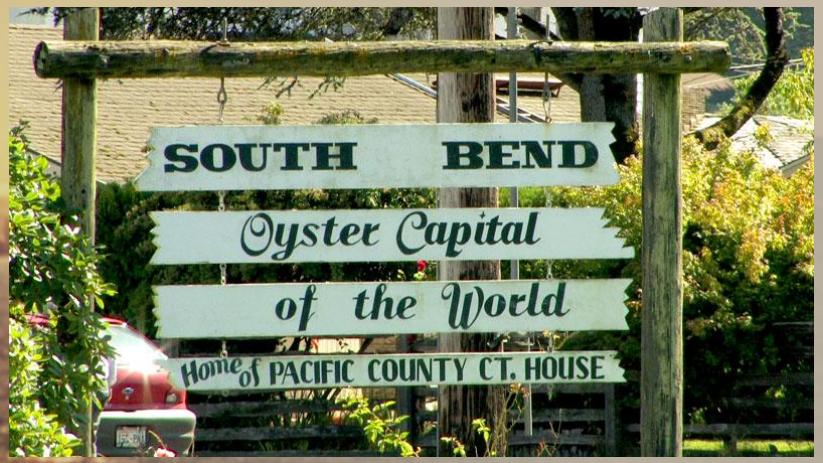
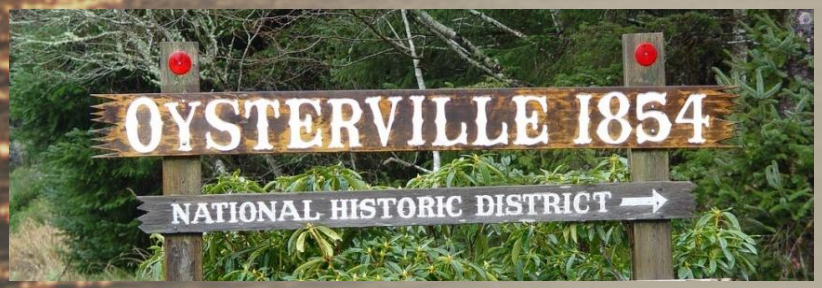
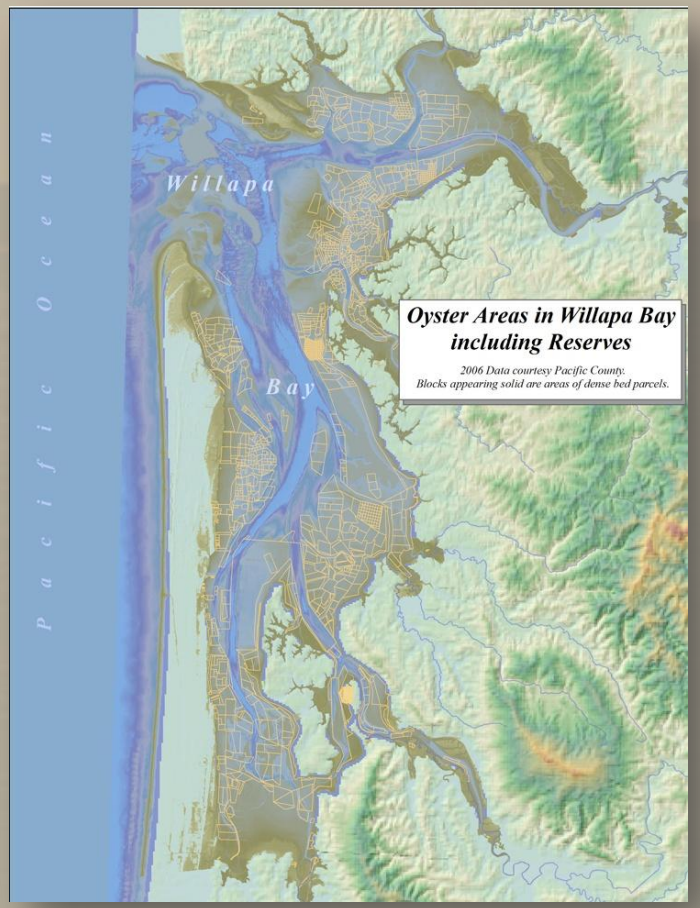
Bush Act land Willapa Bay







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Bush Act land Willapa Bay

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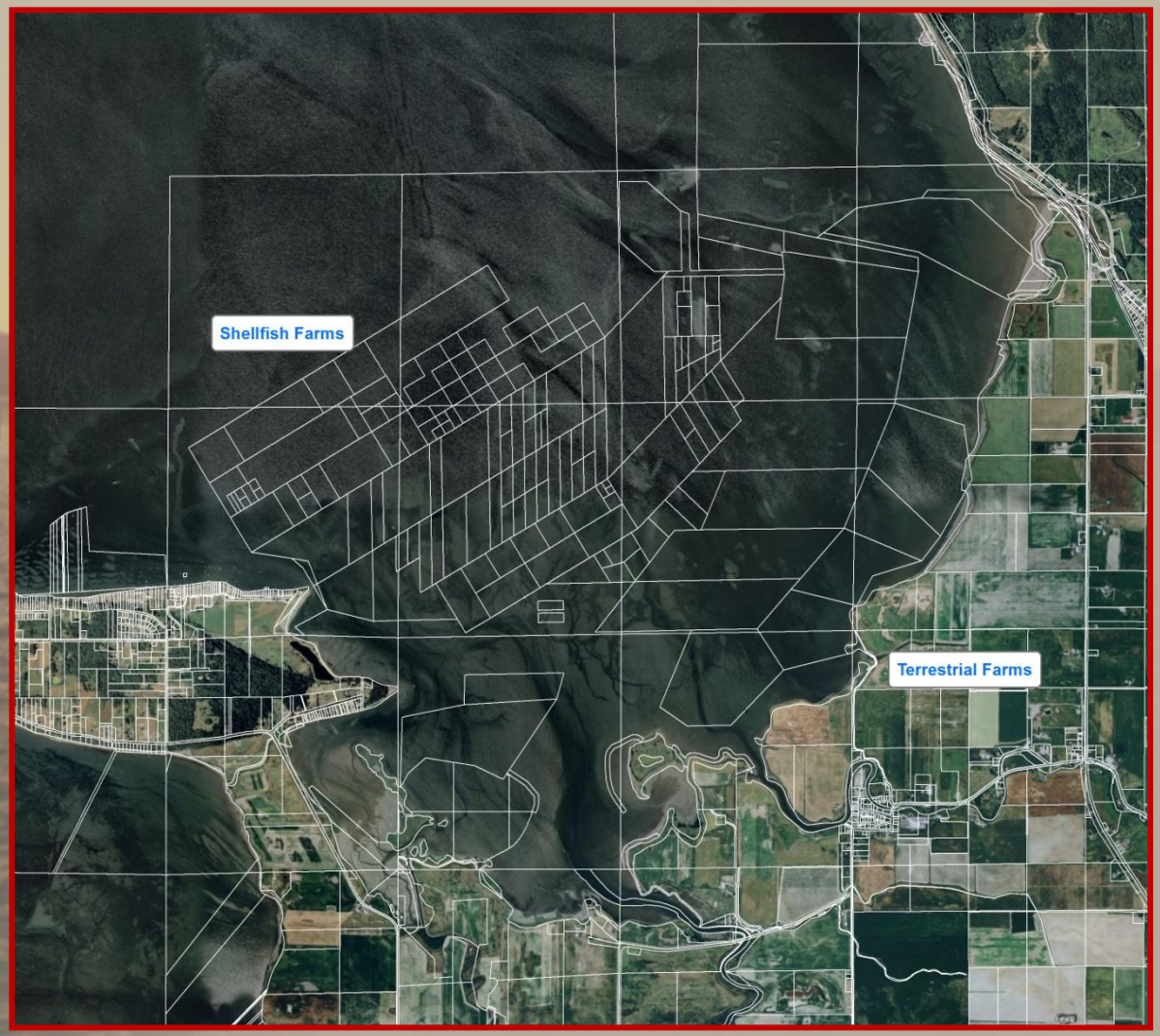
Samish Bay Bush Act tidelands



Important industry to rural economies

- Significant rural employer
- New money into rural economies
  - Most shellfish produced is sold outside region in which it is produced
  - Much of the shellfish is sold outside the state and more all of the time, outside of the country

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Pacific County, WA economy

- ✓Largest private employer in Pacific county
- ✓$10 M annual payroll
- ✓600 directly or indirectly employed
- ✓$32M 2001 gross sales

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Mason County, WA economy

- ✓2nd largest private employer in Mason county
- ✓$17.7 M estimated annual payroll
- ✓625 directly or indirectly employed
- ✓$32.2 M 2001 gross sales

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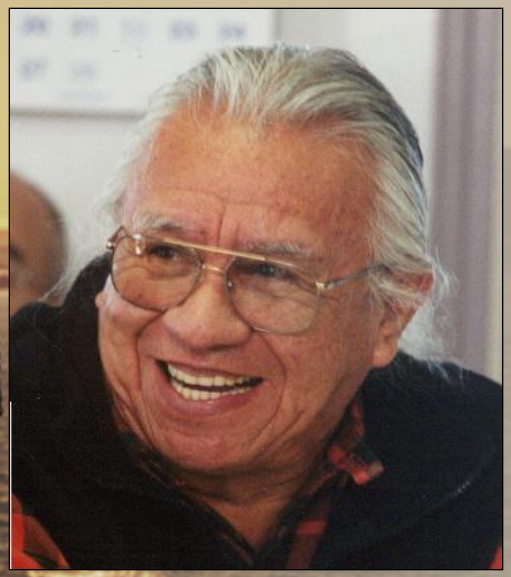
Western Washington's Native American culture includes shellfish



Billy Frank, Chairman
Northwest Indian Fisheries Commission
(used with permission)

"Shellfish are central to the culture of tribes in Western Washington. Healthy shellfish populations and a strong shellfish industry mean a healthy Puget Sound. Shellfish also help keep Puget Sound's waters clean. They have an important place in the Sound's ecosystem."

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Oyster culture

Native Olympia oysters

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Oyster culture

Native Olympia oysters

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Pacific oyster

Introduced from Japan 1904

- *Crassostrea gigas*
- *Commercial planting initiated around 1921*
- Dominant species cultured today on the West Coast of the United States

First recorded import (1904)

Receipt provided to Leonard D. Pike (Mary Hopley's grandfather) for oysters which he went to Japan to procure and have shipped to Washington for planting in East Sound on Orcas Island.

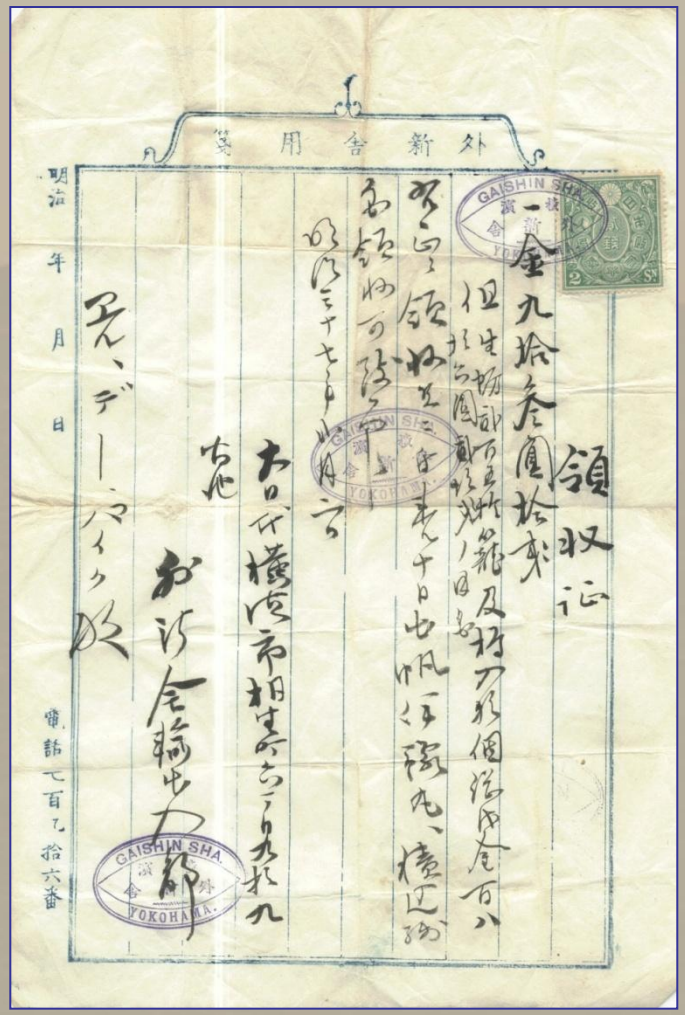
Receipt

93.10 (Japanese yen)

We have received the above amount as an initial payment (down payment) for 105 bamboo baskets of live oysters. The total amount is 186.20 yen.

The oysters will be shipped on 10th by Iyo-Maru (name of ship) February 2, 1904 from Yokohama, Japan.

Gaisinsha (name of company)



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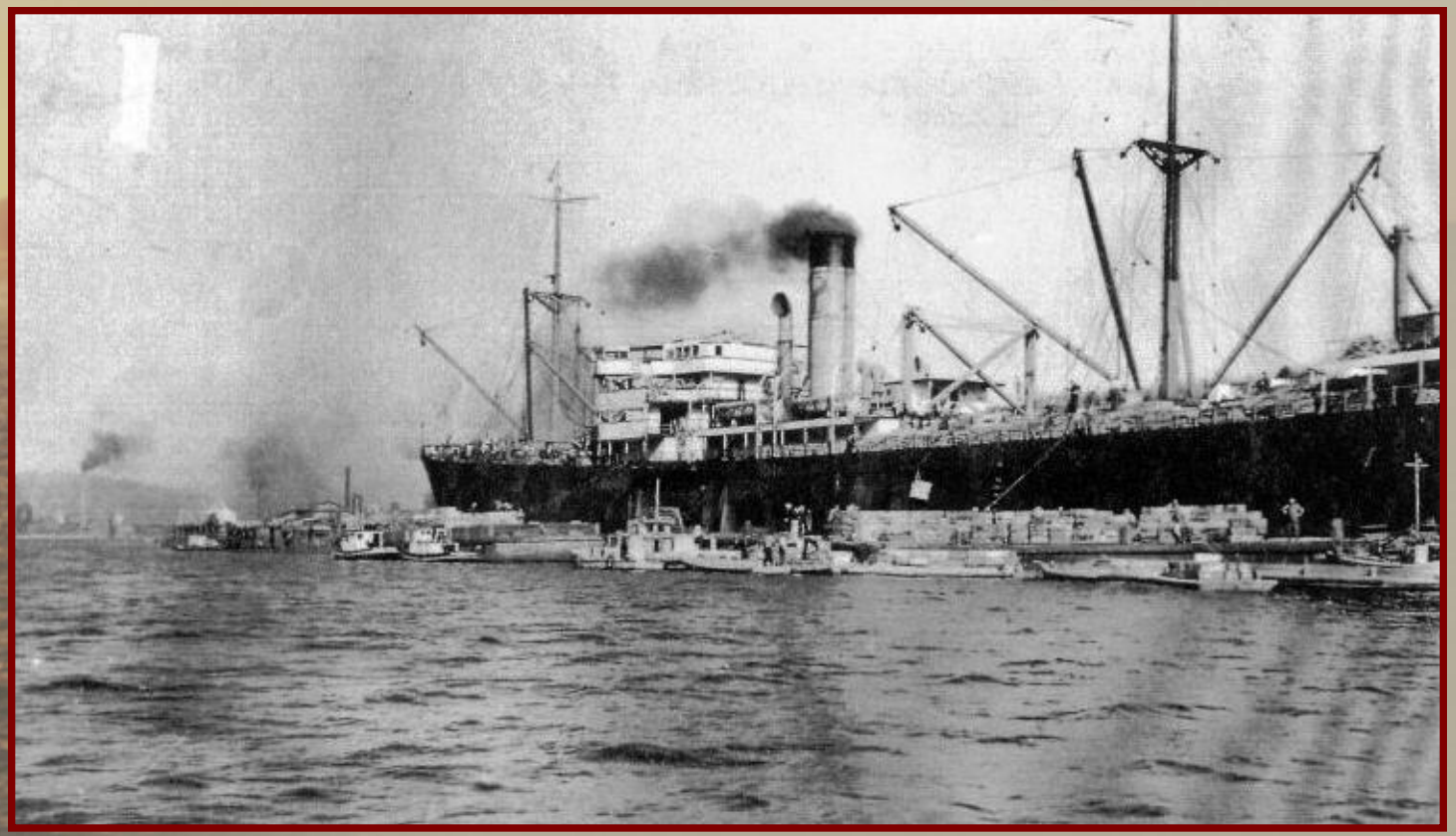
Pacific oyster seed imported annually from Japan



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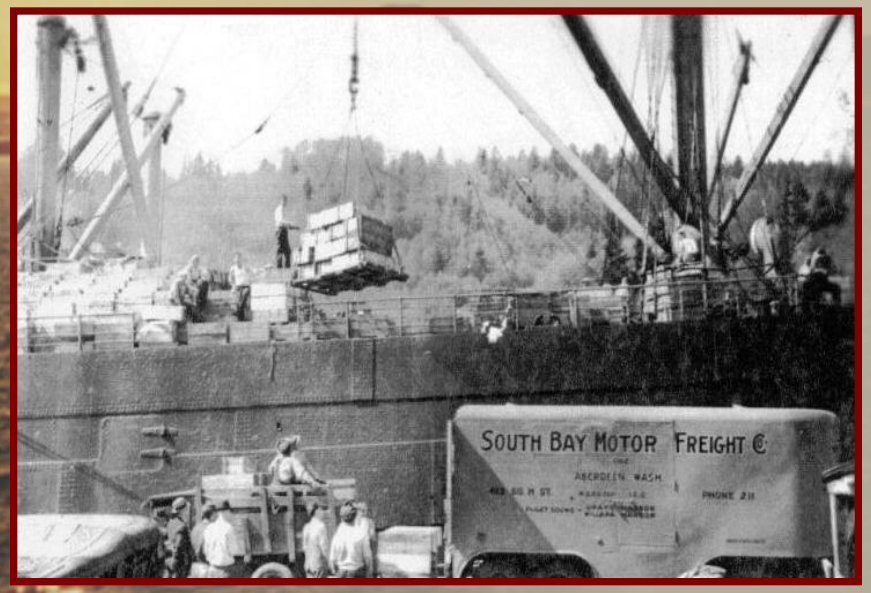
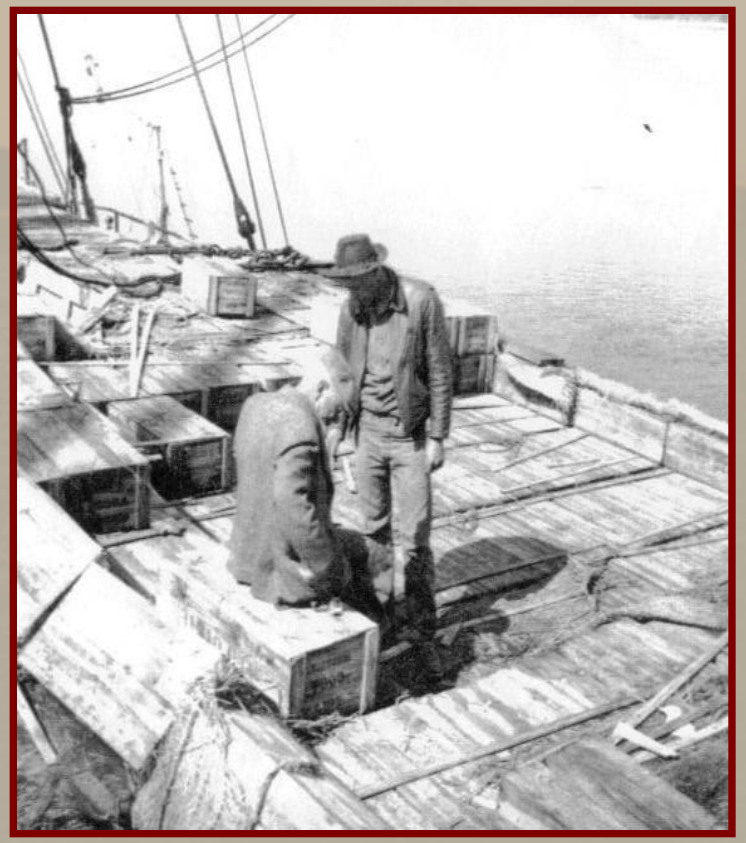
Upon arrival from Japan, distributed to regional growers





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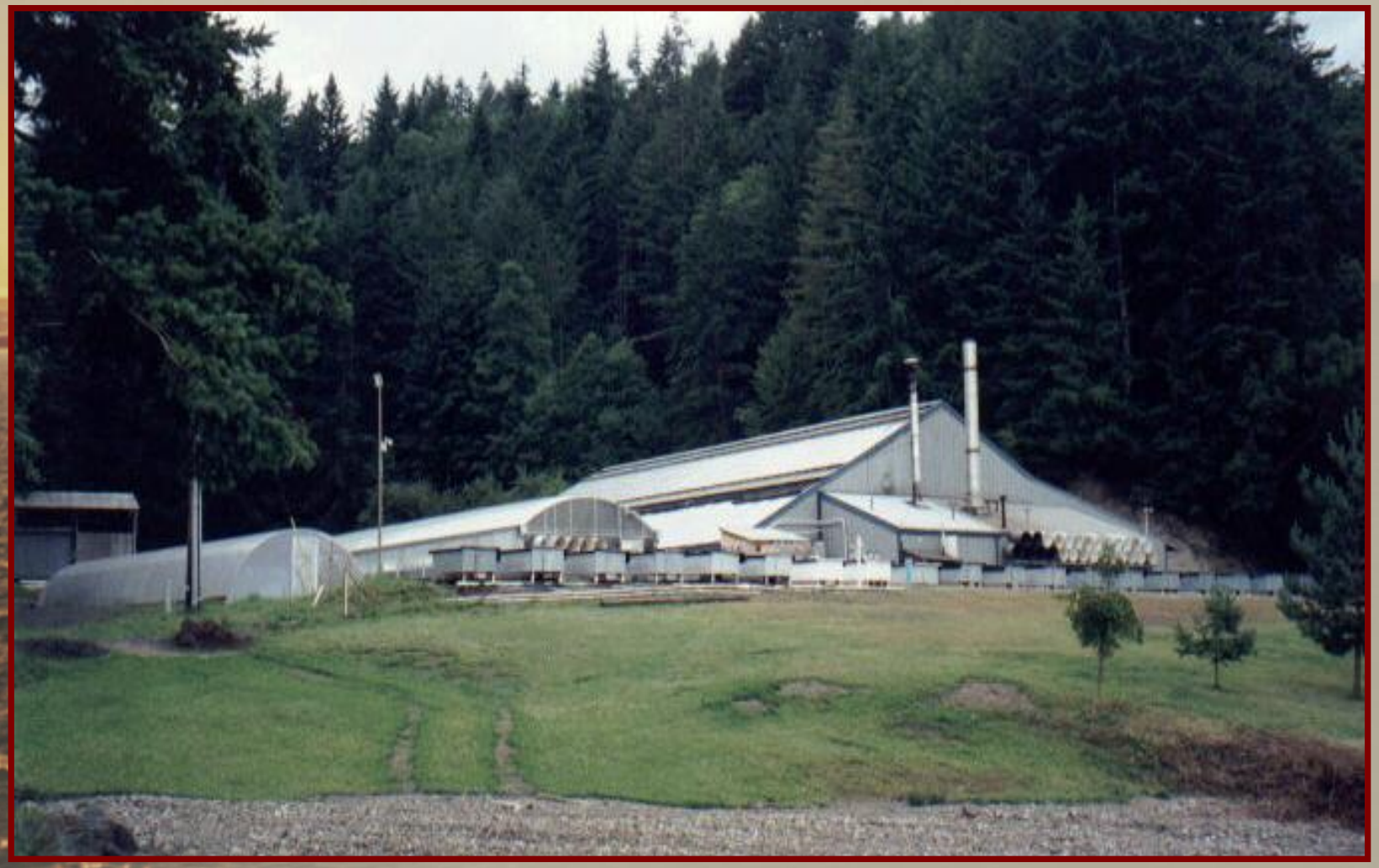
Hatchery seed production



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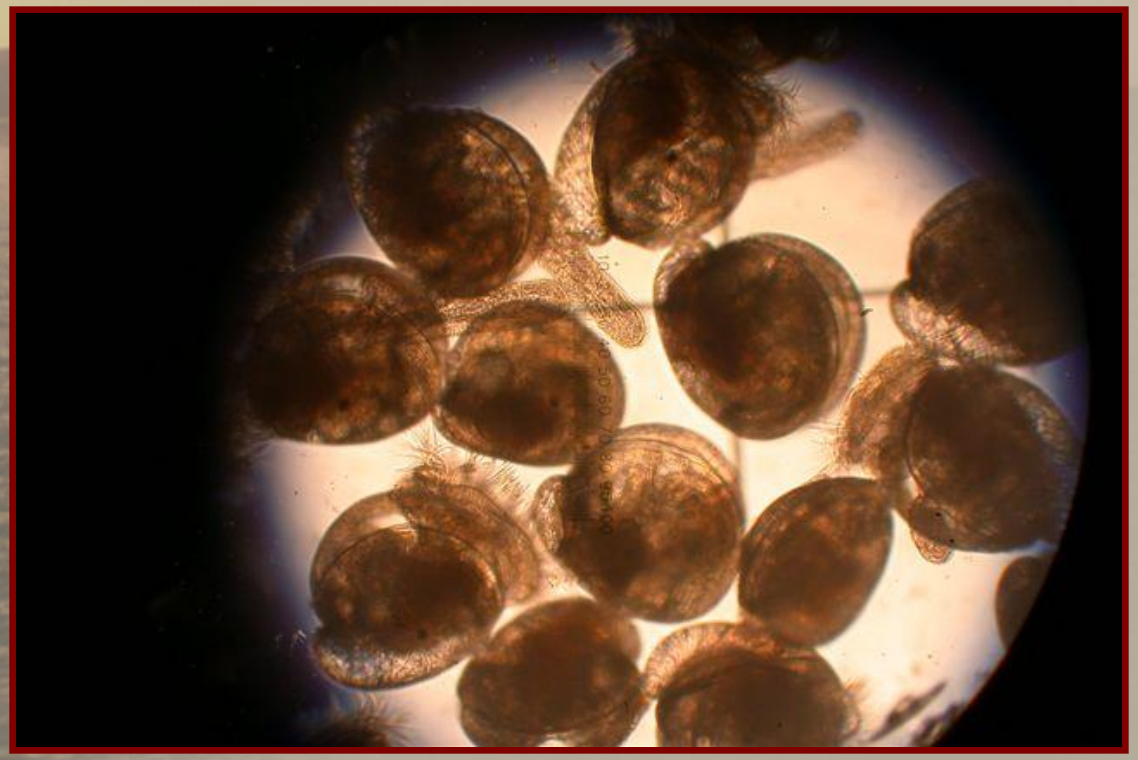
Molluscan shellfish life cycle

Microscopic planktonic larvae



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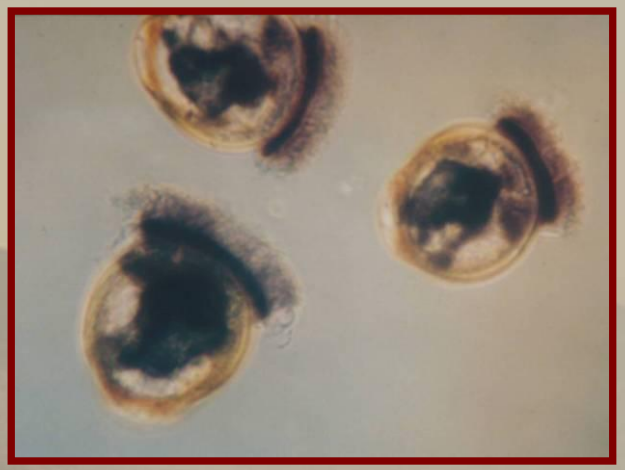
Hatchery seed production



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High density flow-through larvae culture

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Kona, Hawaii nursery

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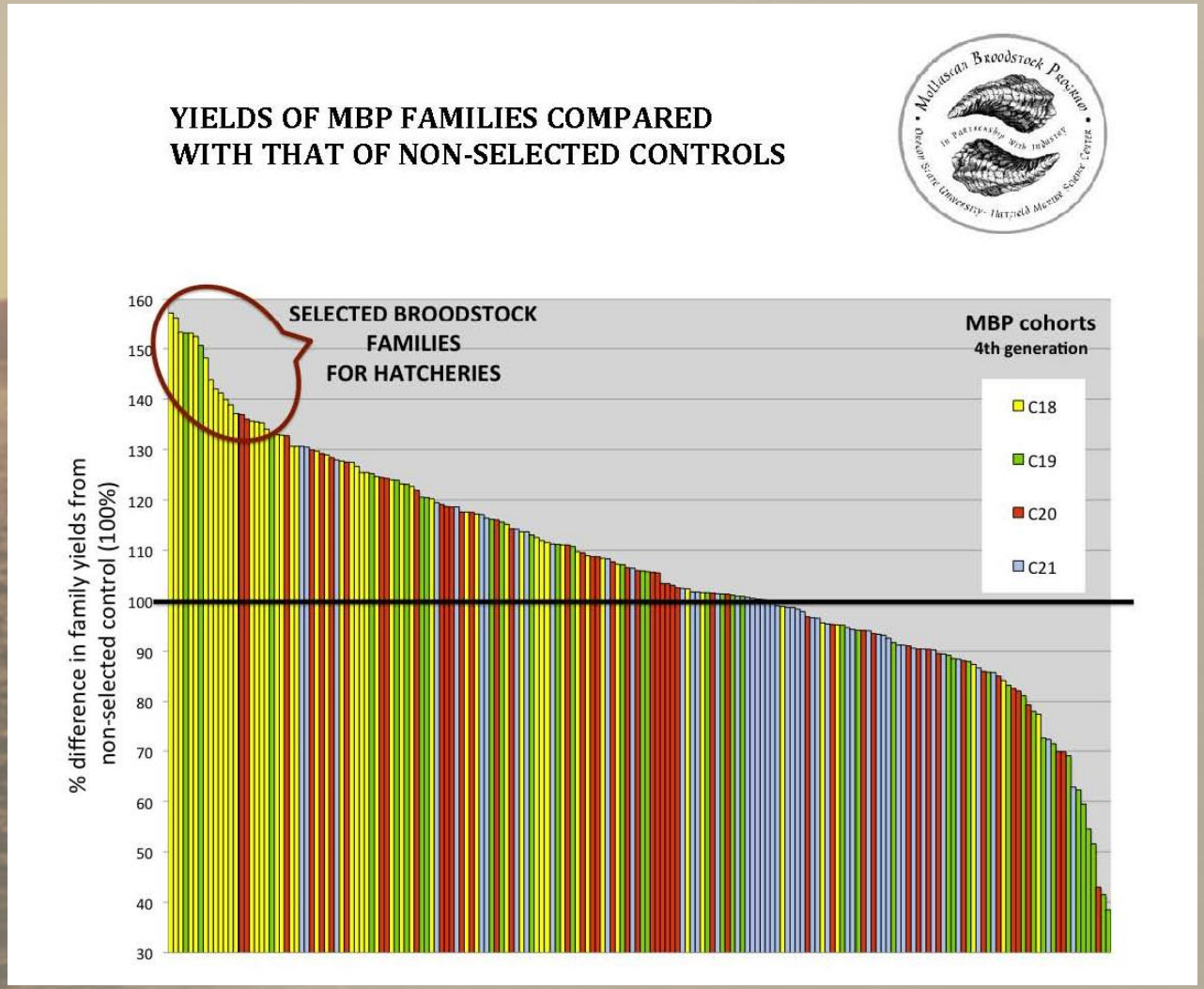
Selective breeding program



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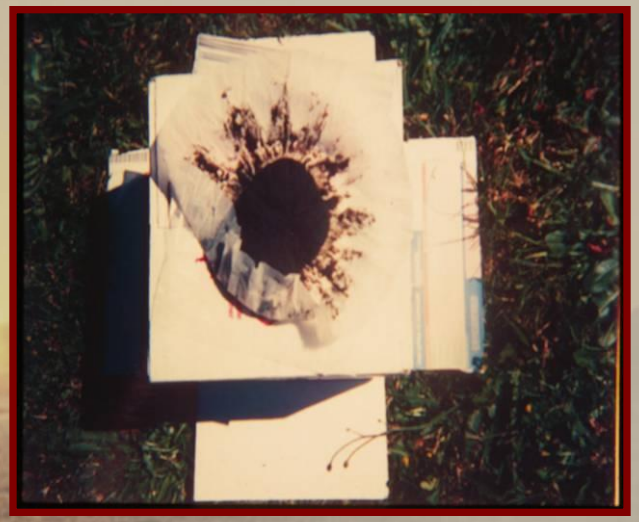
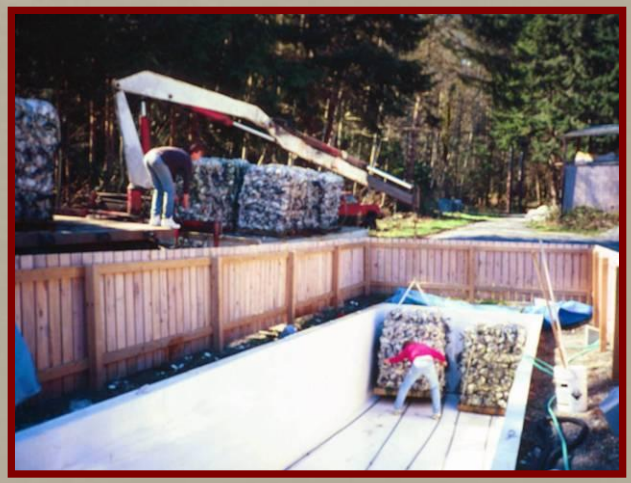
Oyster culture
(clusters for shucked meat)





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Oyster seed

"Spat"

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Planting oyster seed

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“cluster” oyster culture

3-4 years to maturity

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“cluster” oyster culture

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“Longline” Oyster Culture

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“Longline” Oyster Culture

Taylor Shellfish Farms

“Longline” Oyster Culture

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Oyster harvest

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Oyster harvest

Taylor Shellfish Farms

“cluster” oyster harvest

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“picking” oyster tubs

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Oyster “singles” bed - Totten

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Oyster rack & bag culture

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Oyster bag culture on bottom

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Manila clam culture

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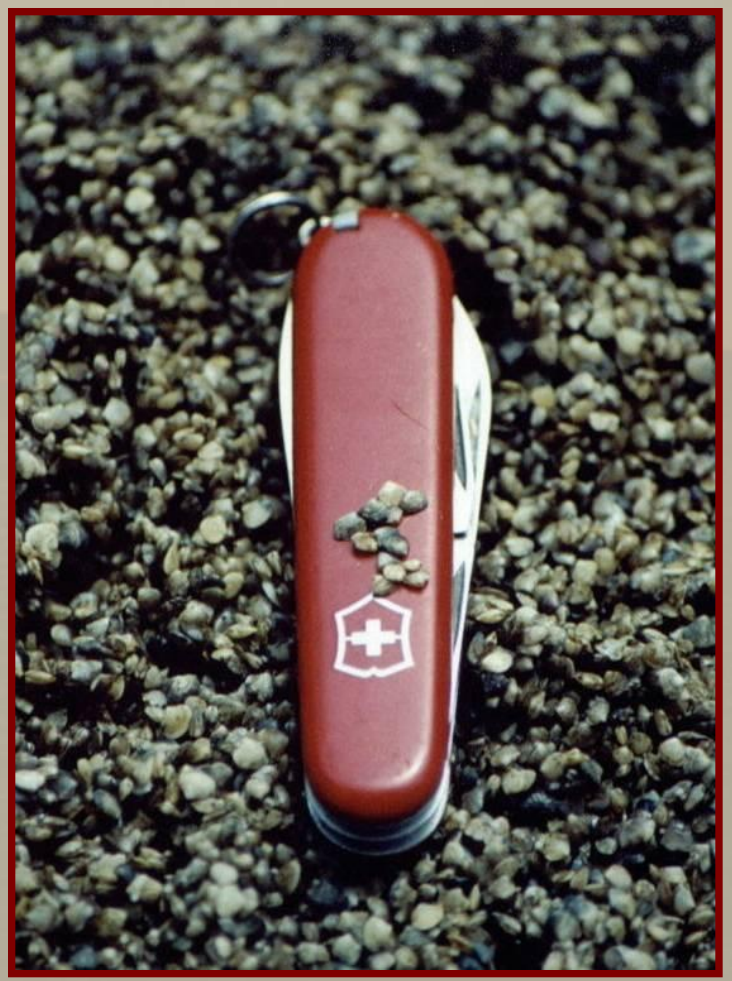
Manila clam seed



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Planting clam seed

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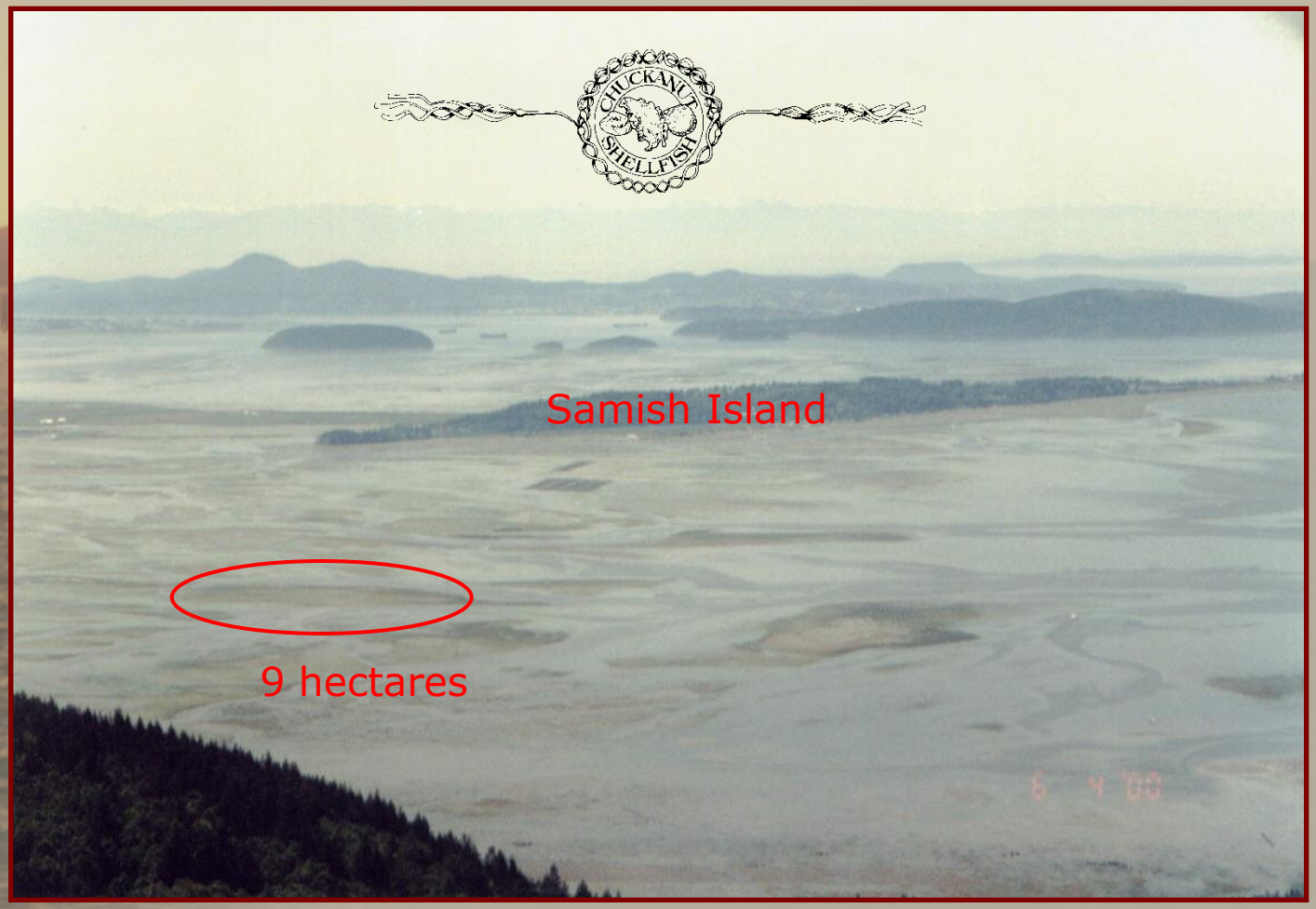
Manila clam harvest

Chuckanut Shellfish



Rows of Manila clams

Mechanical harvesting?

Roozengaarde green house tulip bulb harvster

Clam (tulip bulb) harvester

Mechanical clam harvesting

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Breeding for shell patterns

NOAA funded research on effects

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Geoduck Culture

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Geoduck seed/nursery

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Geoduck Culture

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Mature geoduck bed

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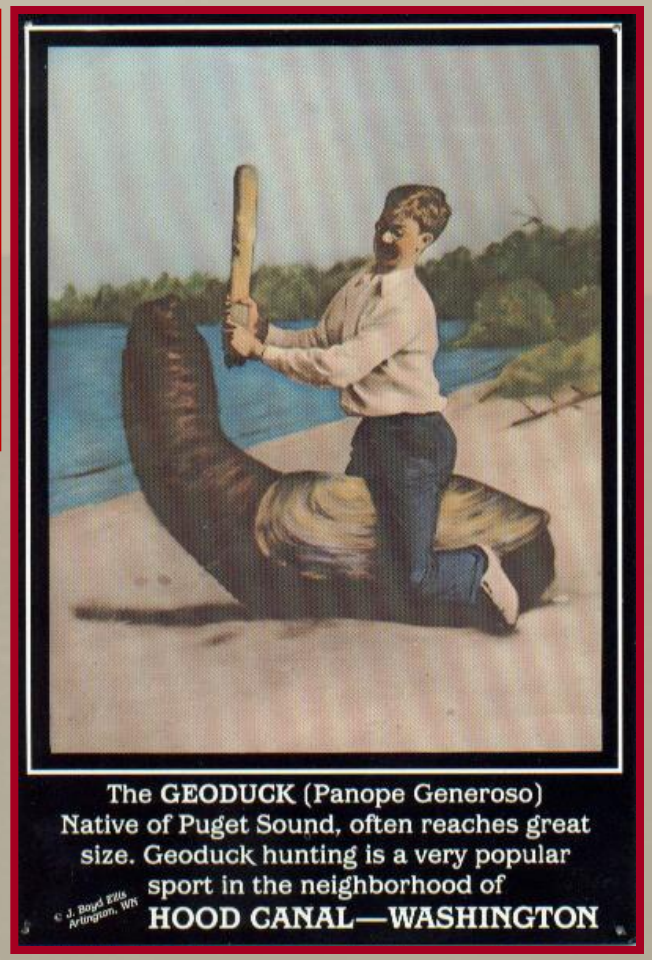
Ready for harvest!



In six years...

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geoduck tubes = habitat

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Mussel Culture

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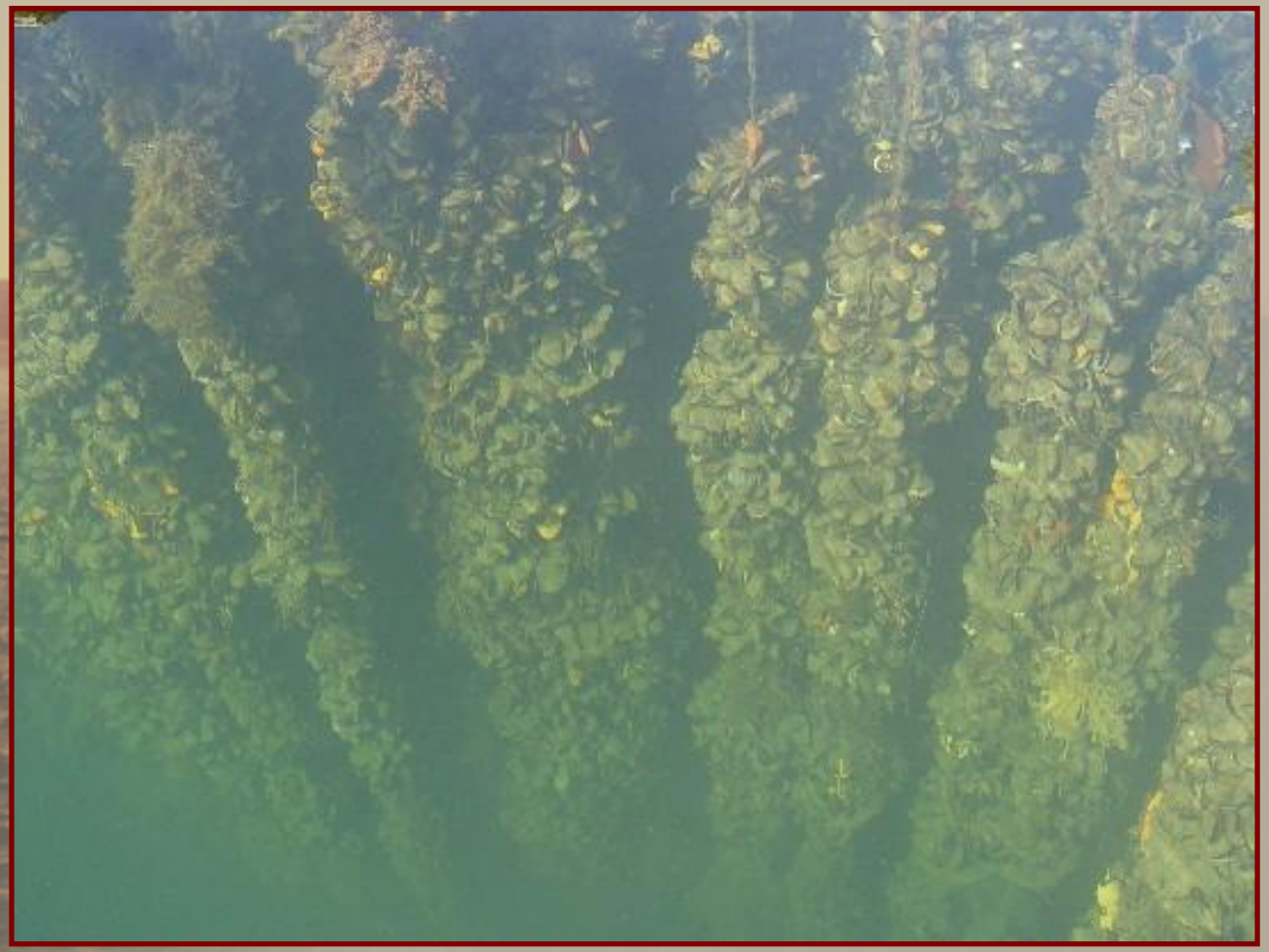
Mussel Culture



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Mussel Culture

Ecological value of shellfish

- Ecological services provided by shellfish
  - ✓Nutrient removal
  - ✓Water filtration improves water clarity improving light penetration for eelgrass photosynthesis and reducing fouling on eelgrass blades
  - ✓Enhance nutrients available to eelgrass
  - ✓Habitat and refuge for variety of species

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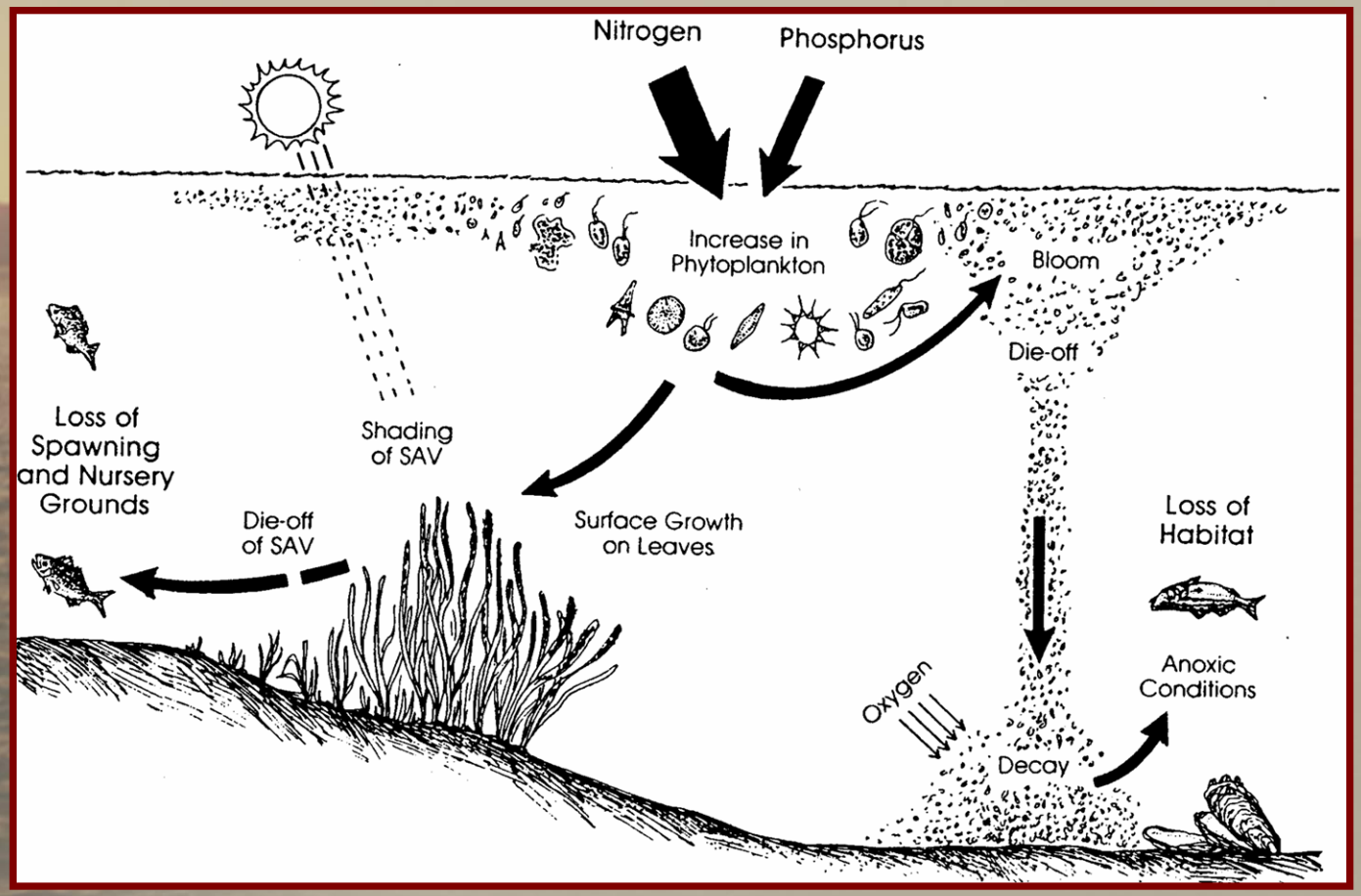
Nutrient pollution

Shellfish absent from system



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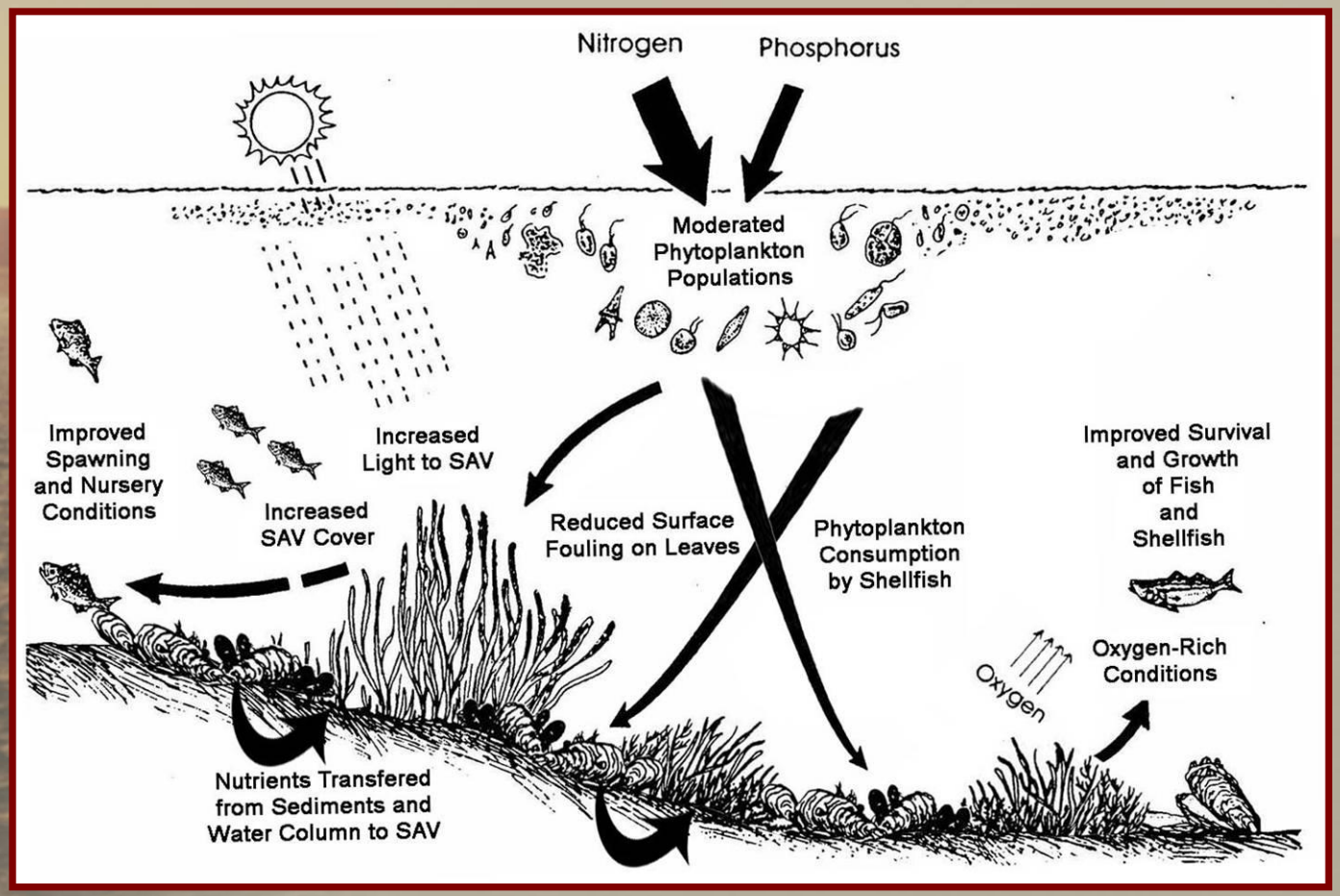
Nutrient pollution

Shellfish present in system



Shellfish as water purifiers

In the next slide you will see a time lapse video clip with:

- Two four liter aquariums
- 300,000 cells of algae per ml
- 60 clams in one, none in the other
- 28 minutes compressed into 15 seconds

Note there are an estimated half billion cultured clams in Washington State

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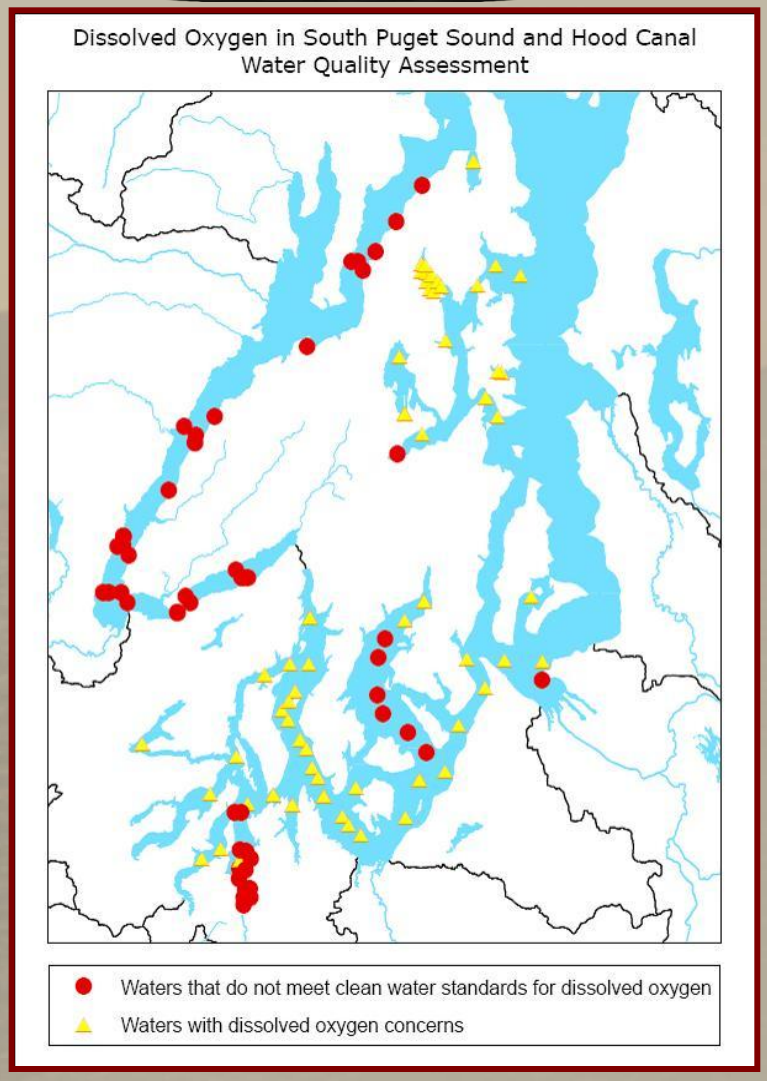
South Sound dissolved oxygen



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South Sound dissolved oxygen

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Shellfish as a water purifier…

8 How to revive the Chesapeake Bay

Filter it with billions and billions of oysters

Eastern oysters are experts at sucking up the algae and silt that plague the Chesapeake.

BY TIM ZIMMERMANN

The sight of oozing sores has a way of making people sit up and take notice. And that's what happened last summer when thousands of fish in a few Chesapeake Bay tributaries began turning up dead, covered with gory lesions. The culprit turned out to be toxic algae known as *Pfiesteria piscicida*, and this "cell from hell" soon became the suspected cause of distressing symptoms—including nausea, fatigue, and memory loss—reported by dozens of bay watermen. Local seafood sales plummeted as *pfiesteria* hysteria added to the public's growing belief that America's largest estuary was in serious ecological trouble.

The *pfiesteria* outbreak was all the more disturbing because the Chesapeake is a lot healthier in many ways than it was 25 years ago. Programs to reduce the flow of industrial pollutants and excess nutrients into the 100,000 streams and rivers that drain into the bay, and stricter catch limits on struggling fish populations, such as rockfish, have helped stabilize some of the bay's vital signs.

But other key indicators—including annual algal blooms, sparse underwater grasses, and low levels of dissolved oxygen—reveal that these traditional cleanup measures have not fully kept up with the environmental toll of a still growing human population. Algae, including *pfiesteria*, thrive on phosphorus, nitrogen, and other nutrients that flood into the bay—not from industrial messes but from a variety of ordinary human sources. Waste-water treatment plants' effluent is laden with nutrients, as is runoff from suburban lawns and agricultural lands, including chicken farms. With the bay area's population projected to grow at least 12 percent by 2010, and regional regulatory efforts to reduce the nitrogen flowing into the bay lagging, the traditional approach to Chesapeake cleanup clearly needs a boost.

A growing number of scientists and conservationists say the boost could come from one of the bay's most renowned—

- Pre-exploitation the oysters in Chesapeake Bay could filter all the water in the bay in 3 to 5 days
- today with less than 1% of the historic oyster volumes it takes a year!

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Shellfish as water purifiers

The New York Times
Sunday, January 13, 2008

New York and Region

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

Making Up Their Beds and Hoping the Oysters Will Move In

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Swedish model

Odd Lindahl, Rob Hart, Bodil Hernroth, Sven Kollberg, Lars-Ove Loo, Lars Olrog, Ann-Sofi Rehnstam-Holm, Jonny Svensson, Susanne Svensson and Ulf Syversen

Improving Marine Water Quality by Mussel Farming: A Profitable Solution for Swedish Society

Eutrophication of coastal waters is a serious environmental problem with high costs for society globally. In eastern Skagerrak, reductions in eutrophication are planned through reduction of nitrogen inputs, but it is unclear how this can be achieved. One possible method is the cultivation of filter-feeding organisms, such as blue mussels, which remove nitrogen while generating seafood, fodder and agricultural fertilizer, thus recycling nutrients from sea to land. The expected effect of mussel farming on nitrogen cycling was modeled for the Gullmar Fjord on the Swedish west coast and it is shown that the net transport of nitrogen (sum of dissolved and particulate) at the fjord mouth was reduced by 20%. Existing commercial mussel farms already perform this service for free, but the benefits to society could be far greater. We suggest that rather than paying mussel farmers for their work that nutrient trading systems are introduced to improve coastal waters. In this context an alternative to nitrogen reduction in the sewage treatment plant in Lysekil community through mussel farming is presented. Accumulation of bio-toxins has been identified as the largest impediment to further expansion of commercial mussel farming in Sweden, but the problem seems to be manageable through new techniques and management strategies. On the basis of existing and potential regulations and payments, possible win-win solutions are suggested.

Figure 1. Map showing Swedish Skagerrak coast.

INTRODUCTION

Eutrophication of coastal waters, which causes increased primary production and often leads to hypoxia, is a serious environmental problem in many places worldwide (1, 2). In the NE Atlantic region, i.e. the Skagerrak coastal waters (Fig. 1), eutrophication threatens fish production, and marine biodiversity (3, 4). The international goal of reducing nitrogen and phosphorus from anthropogenic, land-based sources to the sea by 50% between 1985 and 2005 (North Sea and OSPAR 1950s to the 1980s. During the last decades, nitrogen inputs have been consistent, but phosphorous inputs have exhibited a slight decrease (4).

Of the total anthropogenic waterborne supply of nitrogen to the Swedish Skagerrak waters, roughly 20% or 2200 tonnes come from point sources like municipal wastewater and industries, and the rest, about 8500 tonnes, from diffuse sources like agriculture (6). The most obvious measures for reducing nutrient loads, such as upgrading large water-treatment plants to comply with EU regulations and reducing emissions from large industries, have now been implemented, but with insufficient effect on the overall situation (4). Other measures, such as changes in agricultural practices and the restoration of wetlands, have also been implemented, but again with insufficient

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Shellfish & Water Quality

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Ocean acidification

- Is the Pacific Ocean's chemistry killing sea life?
- Seattle Times
- 6/14/2009

The Seattle Times Sunday

JUNE 14, 2009

$1.50

seattletimes.com

OYSTERS IN DEEP TROUBLE

Is the Pacific Ocean's chemistry killing sea life?

Northwest's top 100 companies? Nope, just 87 this year

Former UW student Knox tells of shock over Brit's murder

Fury erupts in Iran after contested vote

OYSTERS IN DEEP TROUBLE

< Oysters

West Coast hatcheries

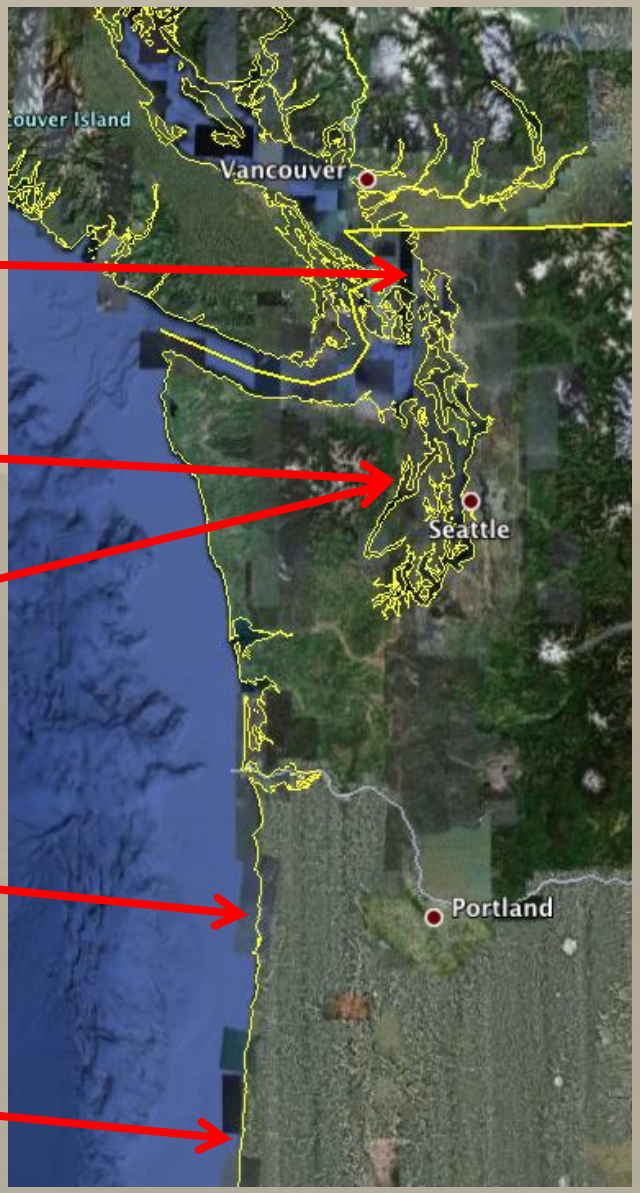
Lummi Hatchery

Taylor Hatchery

Coast Seafoods Hatchery

Whiskey Creek Hatchery

MBP Hatfield Center



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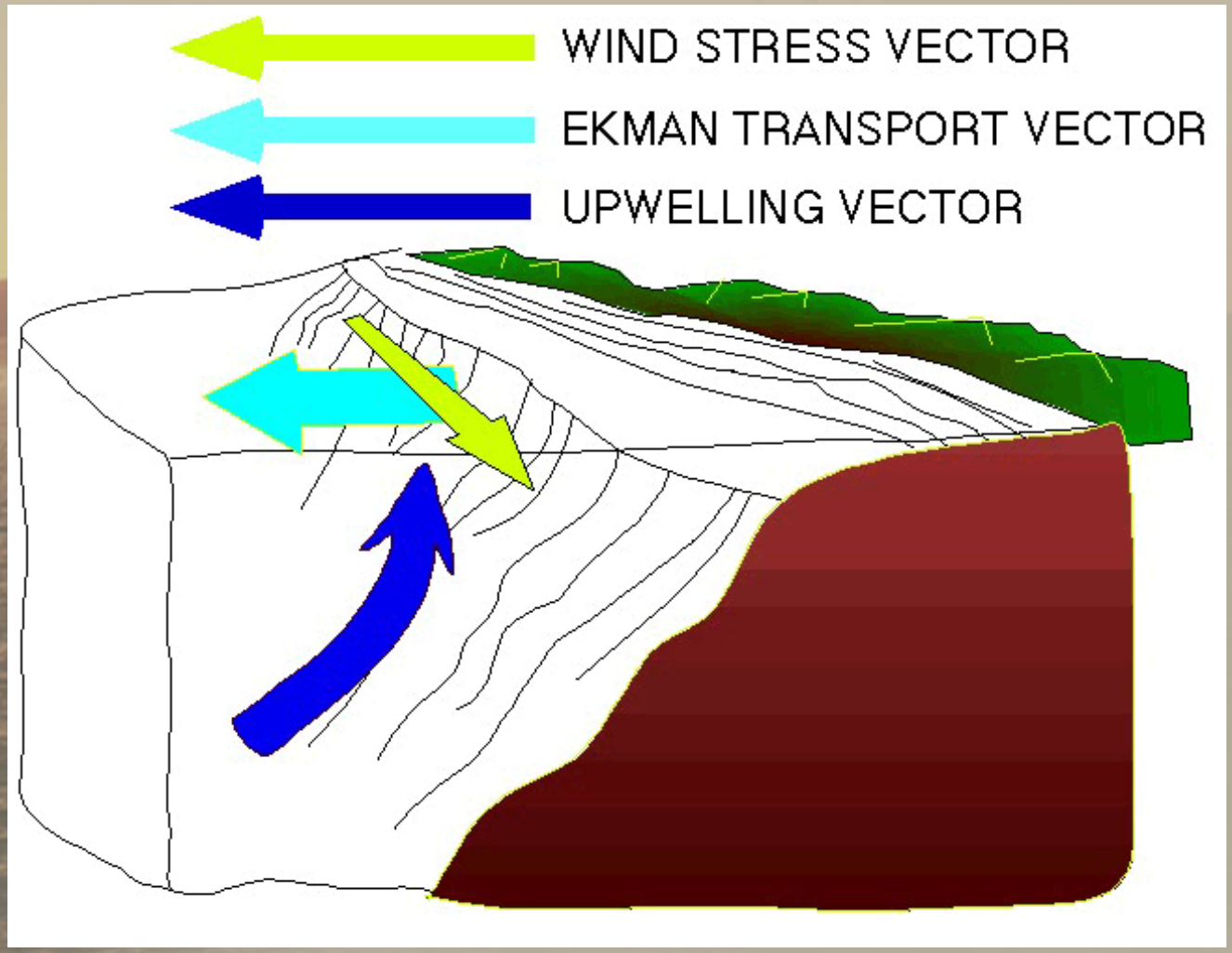
Upwelling



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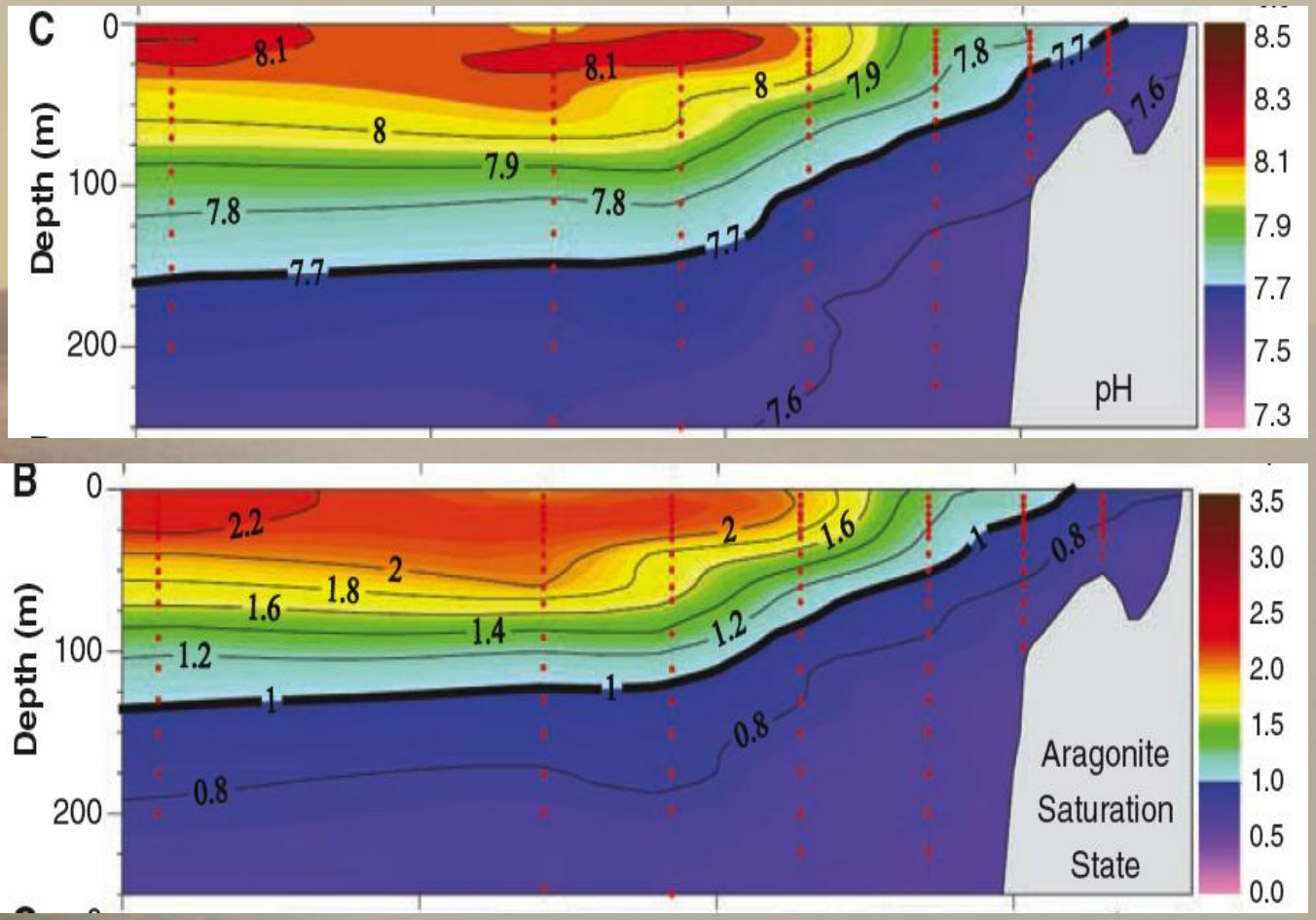
pH & aragonite saturation

St. George, CA.
summer 2007



Feely et *al.* 2008. Science 320: 1490 - 1492

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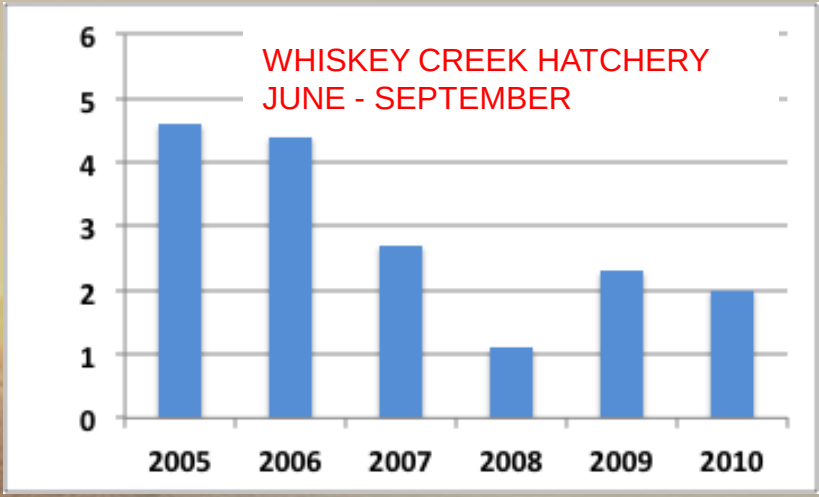
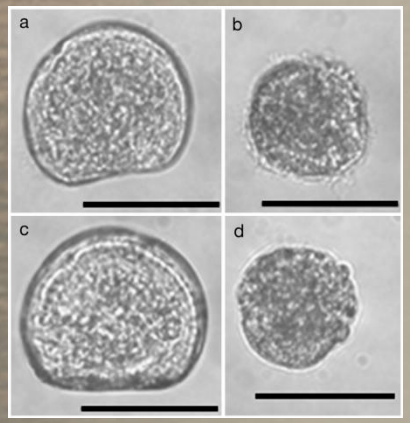
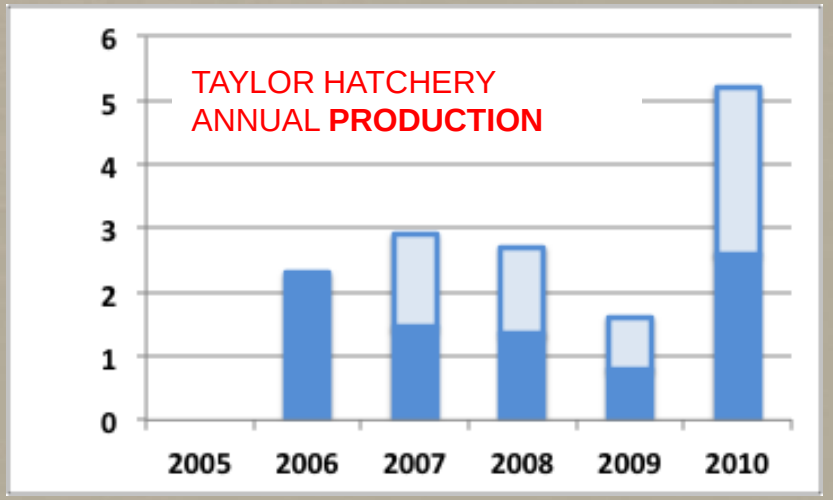
Impacts on larvae production





Kurihara et al 2007



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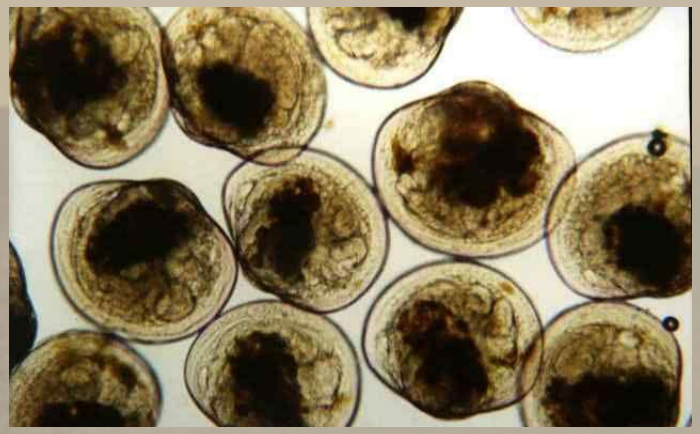
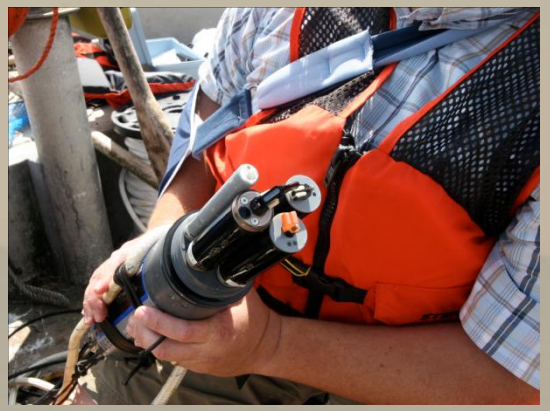
Early life stages most vulnerable

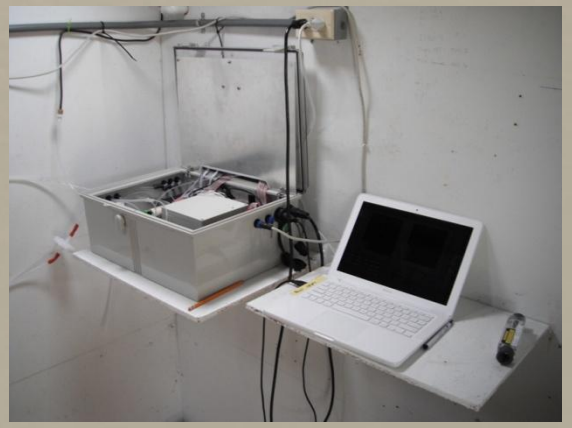


Amorphous calcium carbonate > Aragonite > Calcite

Panic/adaptation

- Taylor Shellfish – ramped up research and monitoring at Dabob Bay Hatchery
- Expanded larvae production capacity at Kona, Hawaii hatchery to offset Dabob production set backs.

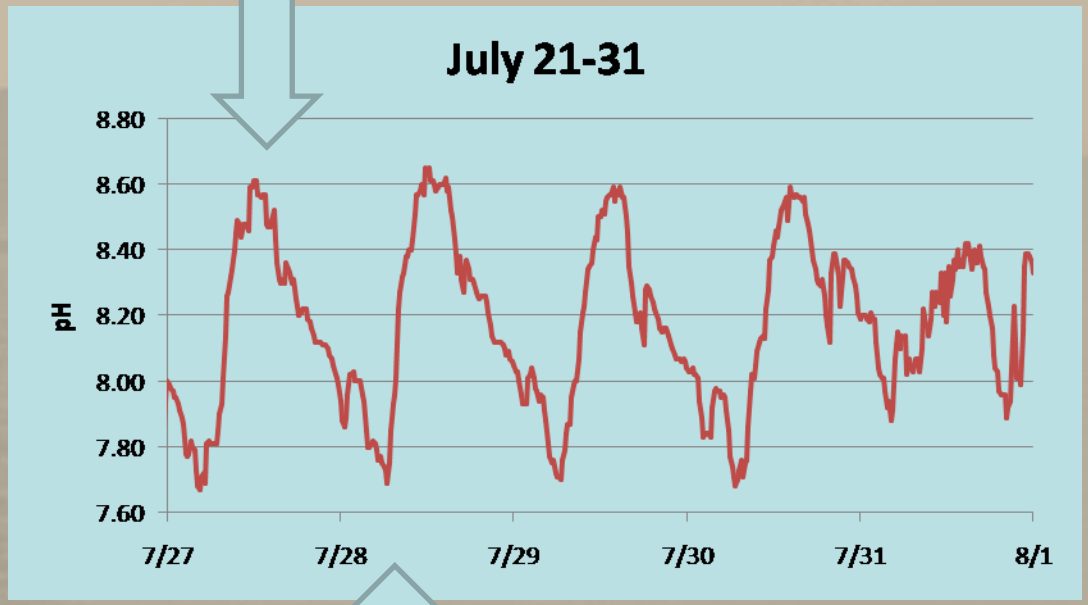




Managing around the problem

- Put small larvae into tanks filled in the afternoon or overnight – Works if the sun is out
- 24 hour notice– Upwelling takes a day or two to start up, so when winds from the North, fill tanks late in the day and spawn like crazy

SPAWN!



DON'T SPAWN!

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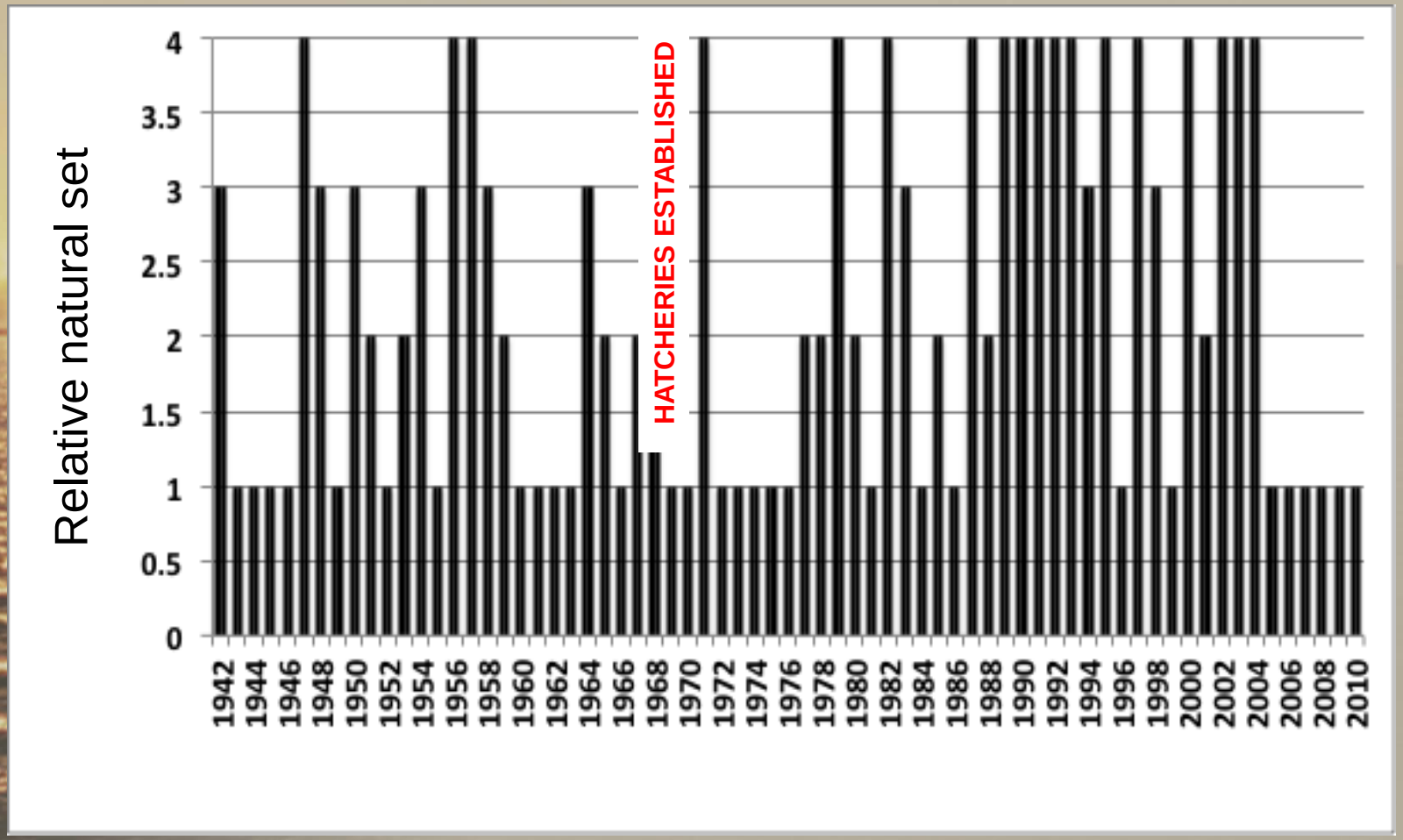
Natural recruitment failure



DATA OF WASHINGTON DEPT. FISHERIES AND WILDLIFE

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What we don't know

- What characteristics of upwelled water are harmful? (e.g. pH, PCO2, DIC, DOM, reduced compounds or a combination of these factors)
- How does upwelling affect *vibrio tubiashii*?
- How can hatcheries best address the long-term problems

Taylor Shellfish Farms

Canary in the mineshaft?

"Miners would try to alert themselves to dangerous levels of carbon dioxide in a mine shaft by bringing a caged canary with them as they worked. The canary would inevitably die before CO_2 reached levels toxic to people."

Serinus canaria domestica

Source: Wikipedia

Taylor Shellfish Farms

National Shellfish Initiative Opportunity?

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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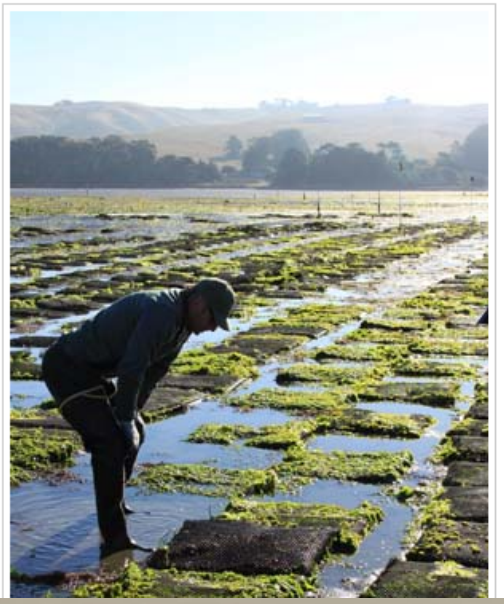
Commerce and NOAA release national aquaculture policies to increase domestic seafood production, create sustainable jobs, and restore marine habitats

June 9, 2011

The Department of Commerce and NOAA today released national sustainable marine aquaculture policies to meet the growing demand for healthy seafood, to create jobs in coastal communities, and restore vital ecosystems. Foreign aquaculture accounts for about half of the 84 percent of seafood imported by the U.S., contributing to the $9 billion trade deficit in seafood.



"Our current trade deficit in seafood is approximately $9 billion," Commerce Secretary Gary Locke said. "Encouraging and developing the U.S. aquaculture industry will result in economic growth and create jobs at home, support exports to global markets, and spur new innovations in technology to support the industry."

"Sustainable domestic aquaculture can help us meet the increasing demand for seafood and create jobs in our coastal communities," said Jane Lubchenco, Ph.D., under secretary of commerce for oceans and atmosphere and


Questions?