# Pacific Oyster Summer Mortality Disease on the U.S. West Coast: 50 Years Later

Dan Cheney, Andrew Suhrbier, Mary Middleton and Aimee Christy

Joth Davis and Benoit Eudeline

Carolyn Friedman

Dennis Hedgecock

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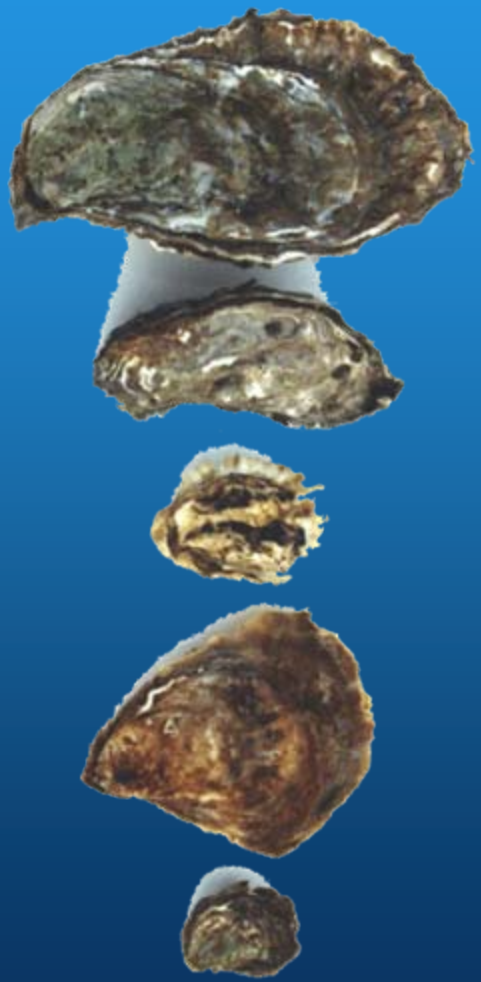
# History on US west coast

- Large scale mortalities first reported in the late 1950's with losses of up to 50% by the early 1960's
- Prompted a long-term study between 1965 and 1972 (summarized by John Glude)
- Paralleled observations in Japan – Matsushima Bay
- Focus was on growth and mortality, reproductive condition, diseases, and water quality
- Entirely based on imported seed from high & low mortality sites and limited local production – no hatcheries were available



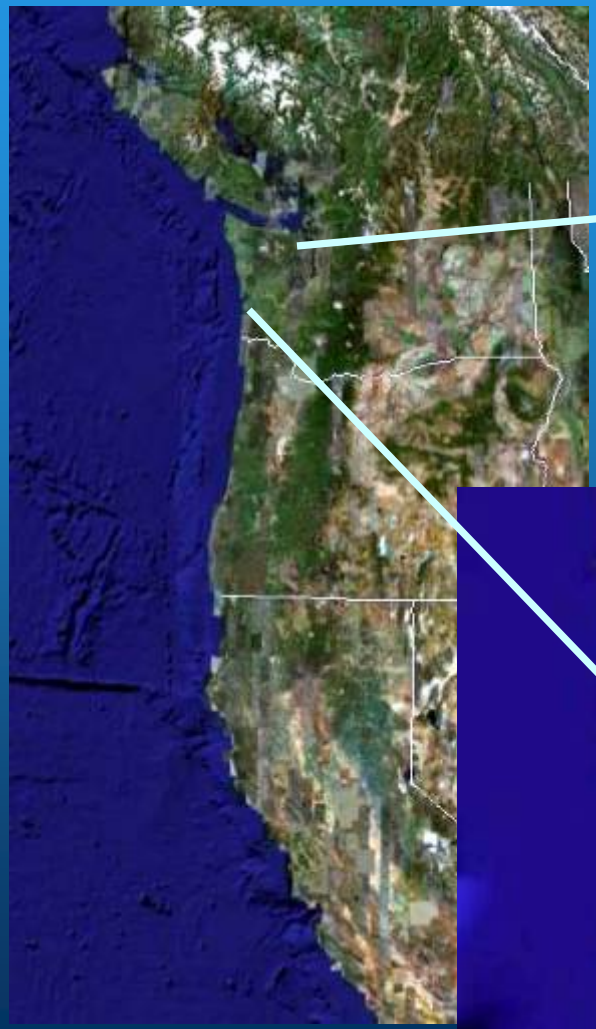
# History on US west coast

- Generally similar to observations from Japan
- Disease organisms were rare, or were associated with other pathologies
- Elevated temperatures and turbidity appeared to be linked to > mortalities
- Seed source experiments were unclear – a low mortality source did not lead to > survival
- Thought that hatcheries could be used to select for > survival
- Mortalities declined after early 70’s

# Recent WC research

- Identify environmental factors triggering a mortality-inducing stress response;
- Evaluate the relation-ships of culture practices to oyster survival;
- Assess responses to potentially harmful phytoplankton;
- Begin research to determine genetic characteristics of enhanced survival in bred and hybrid oysters;
- Begin research to understand the role of reproductive allocation with mortalities; and
- Work with shellfish growers to characterize the extent and timing of mortality events.

# Test sites



Totten Inlet

Willapa Bay

# Coastal estuary, Willapa Bay

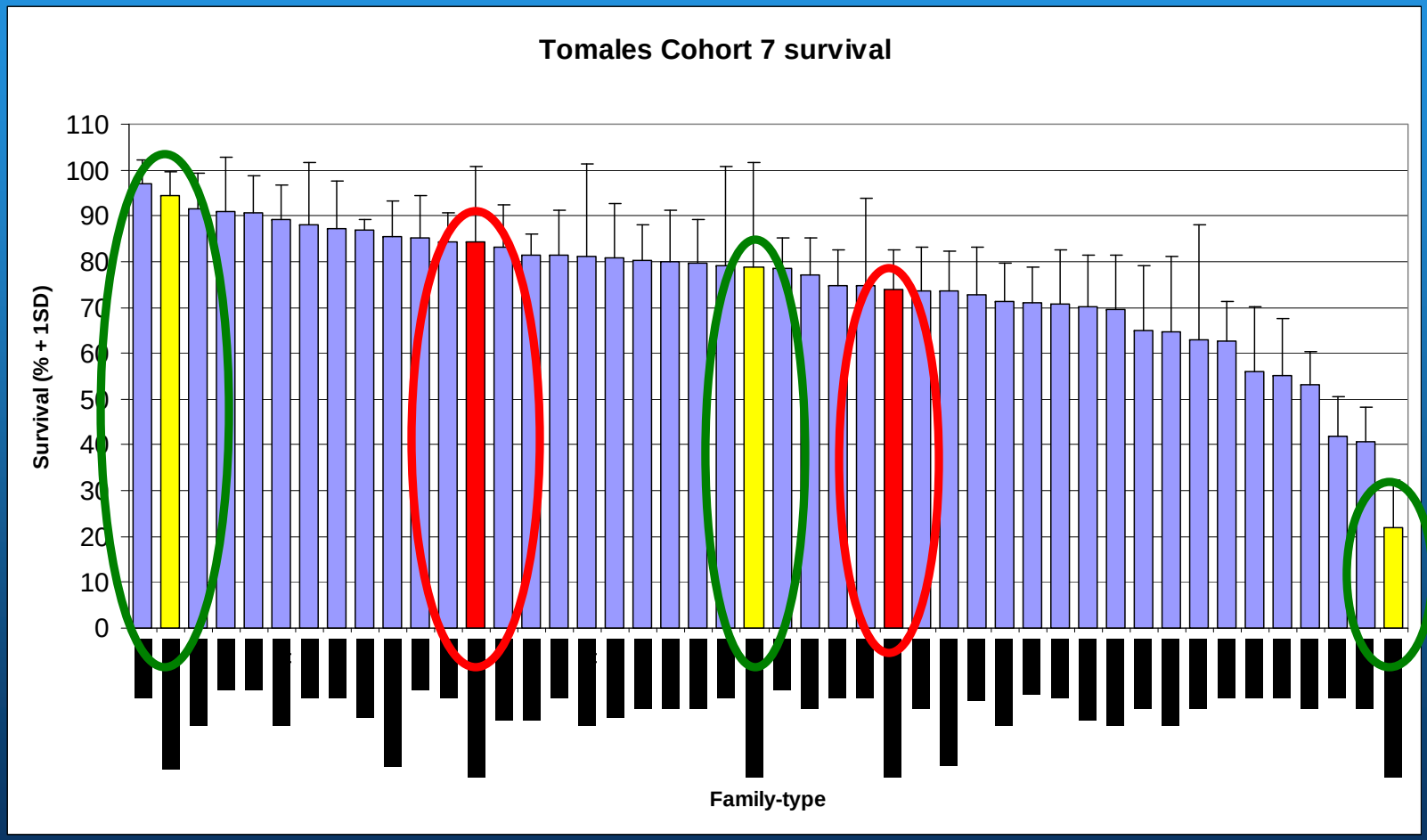
# Inland waters, Totten Inlet

# Early Study Plot Layout

# Treatment Groups – Wild and Selected

- Taylor Shellfish Farms (annual plantings)
  - Diploids (unselected wild stocks)
  - Triploids (unselected from Tetraploids)
  - Hybrids (51 & 35)
  - Diploids, Pair-mated (wild stocks)
  - Triploids, Pair-mated (wild stocks)
- Lummi Tribal Hatchery
  - Diploids
- OSU Molluscan Broodstock Program
  - 115, 116
  - 159, 169
  - 140, 141, 142

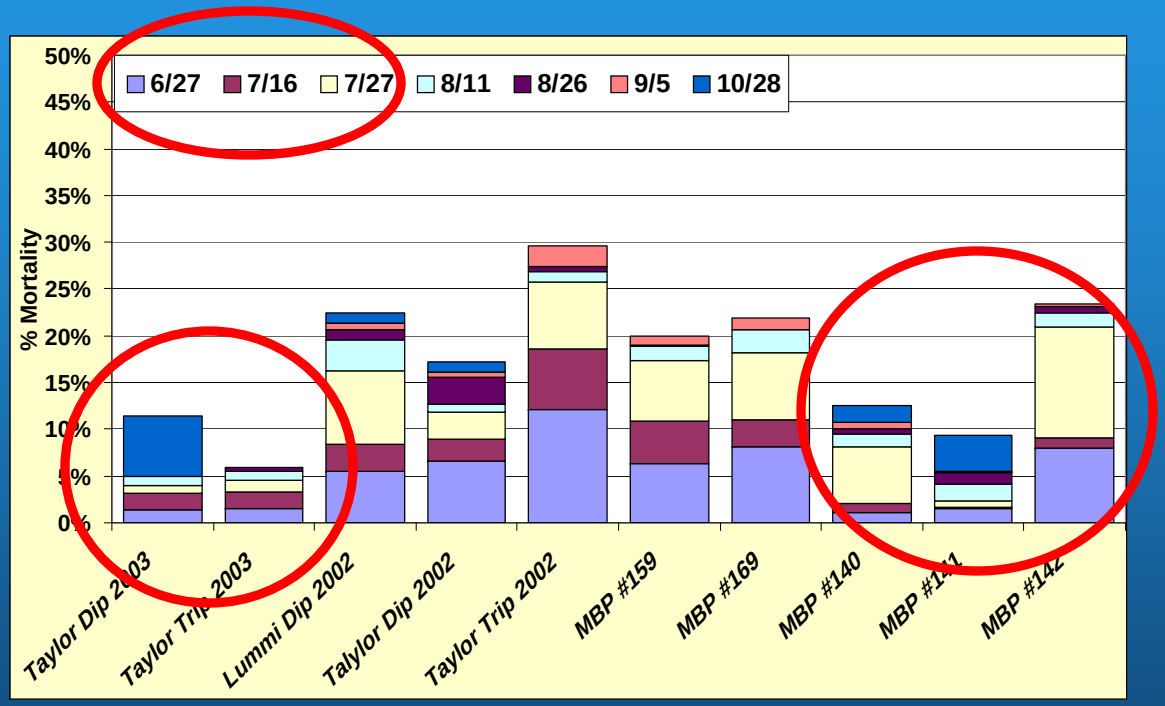
# MBP selected families



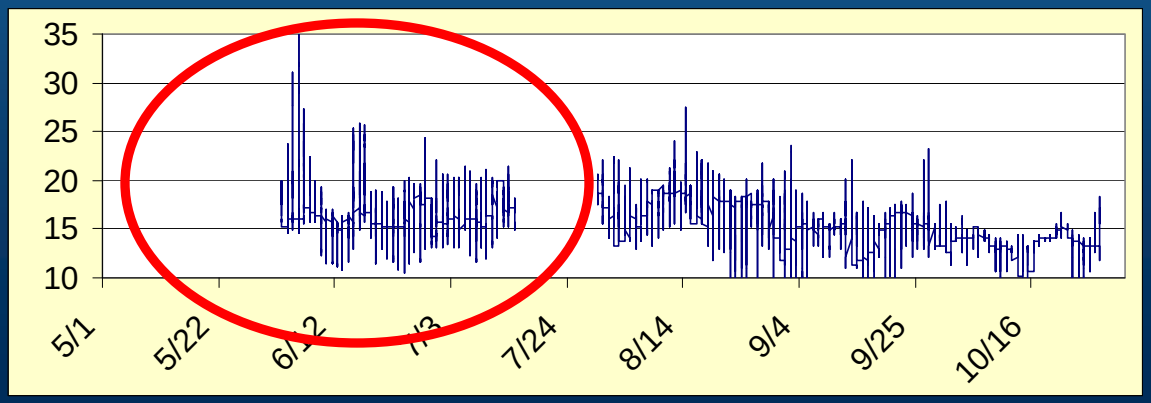
# Environmental variables

- Temperature (water and air)
- Dissolved oxygen
- Salinity
- Phytoplankton
- Chlorophyll
- Turbidity
- Redox potentials
- Rainfall/runoff
- Current/tidal elevation

# Coastal estuary, Willapa, 2003

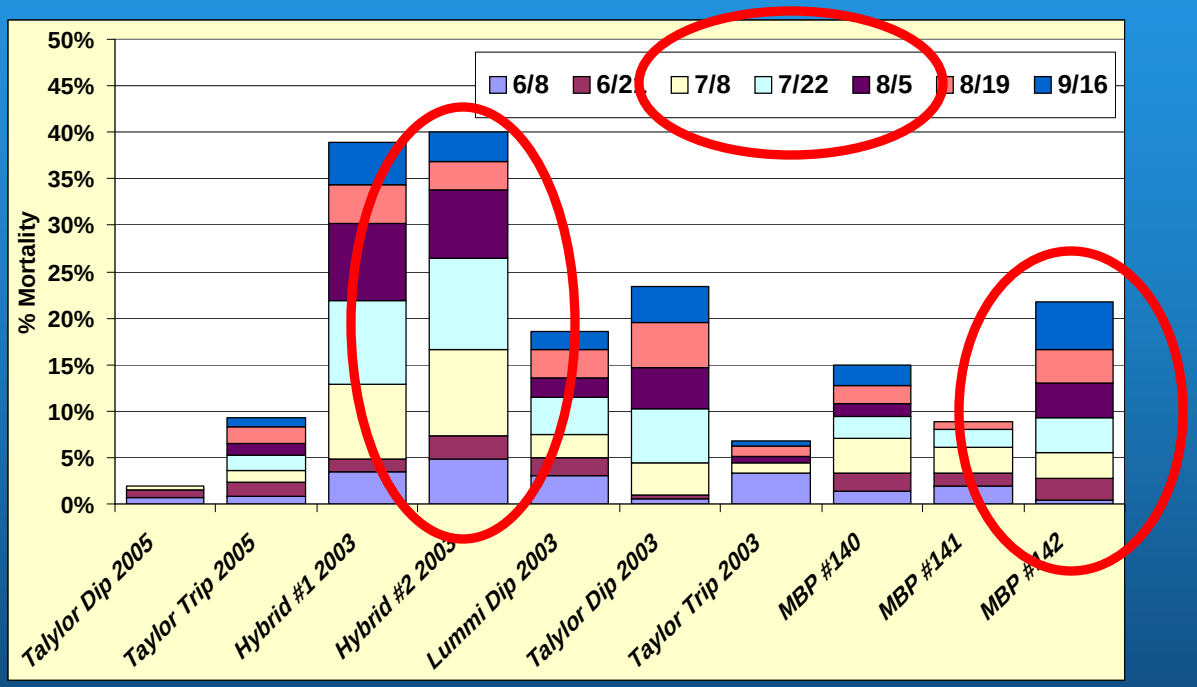



Mortality by treatment group (initial planting early June)




Water temperatures

# Coastal estuary, Willapa, 2005

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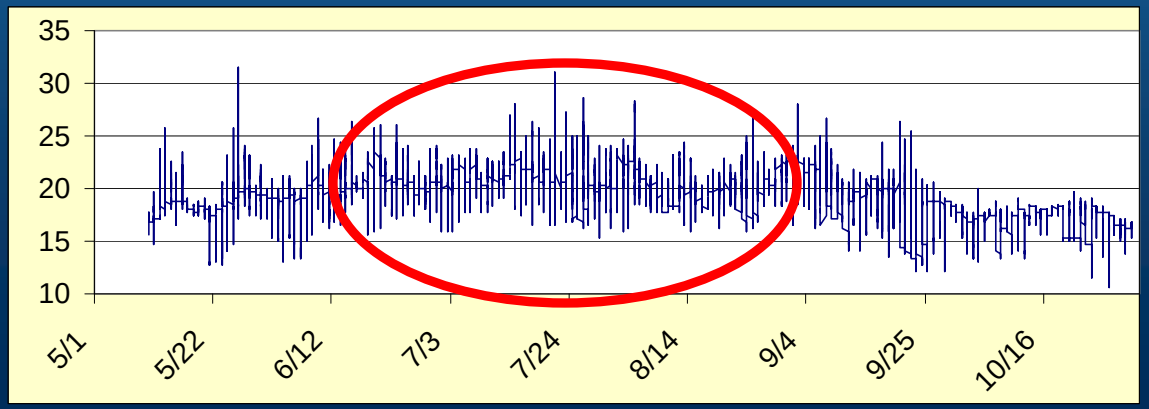
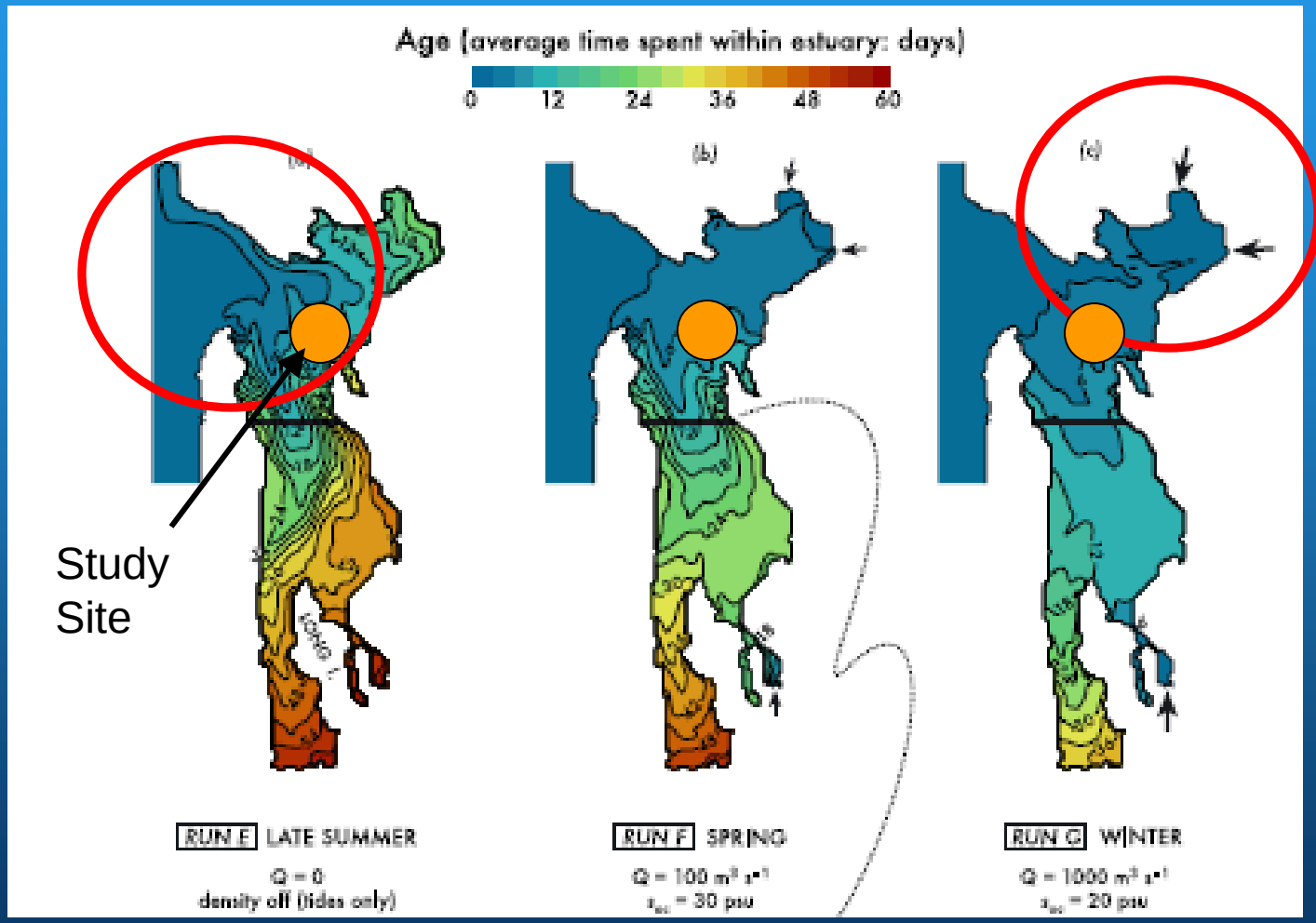



Water temperatures

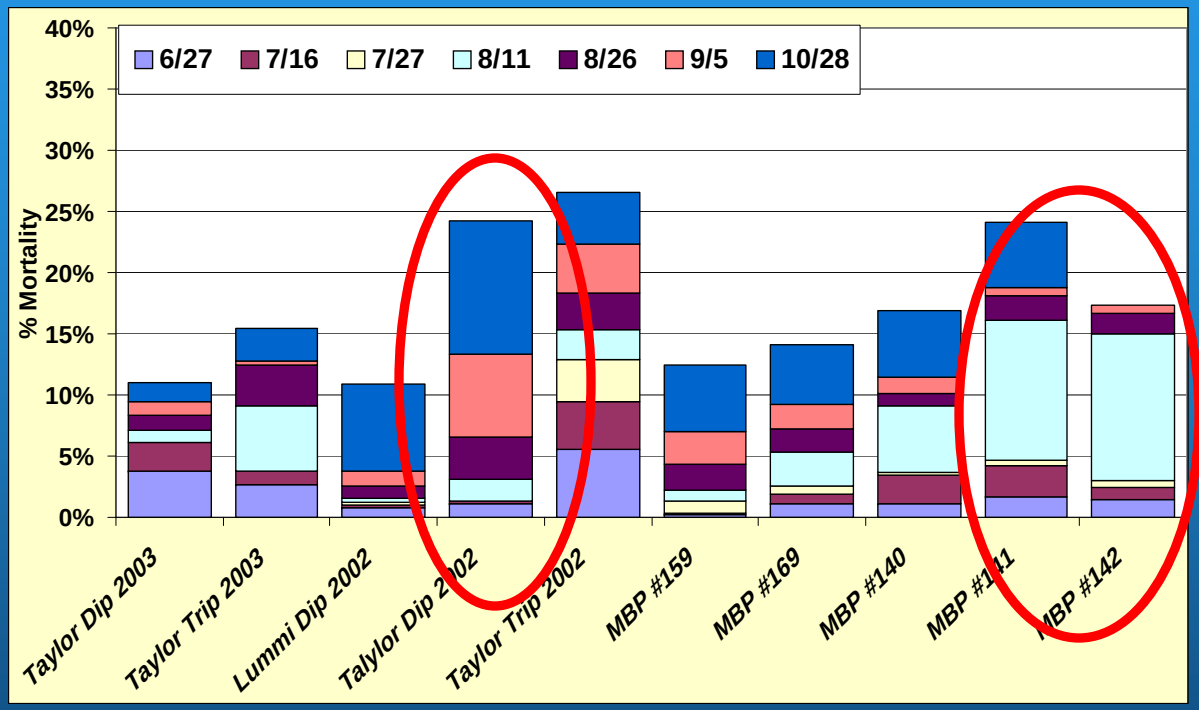
# Willapa, ocean influence

Model results from test conditions based on 3 years of data




Banas NS, Hickey BM (2005) Mapping exchange and residence time in a model of Willapa Bay, Washington, a branching, macrotidal estuary. J. Geophys. Res. 110,

# Inland waters, Totten Inlet, 2003

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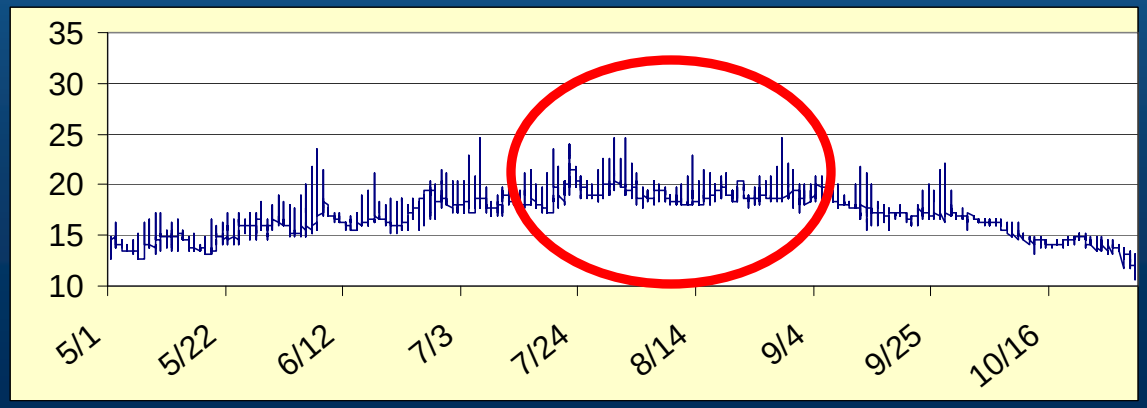
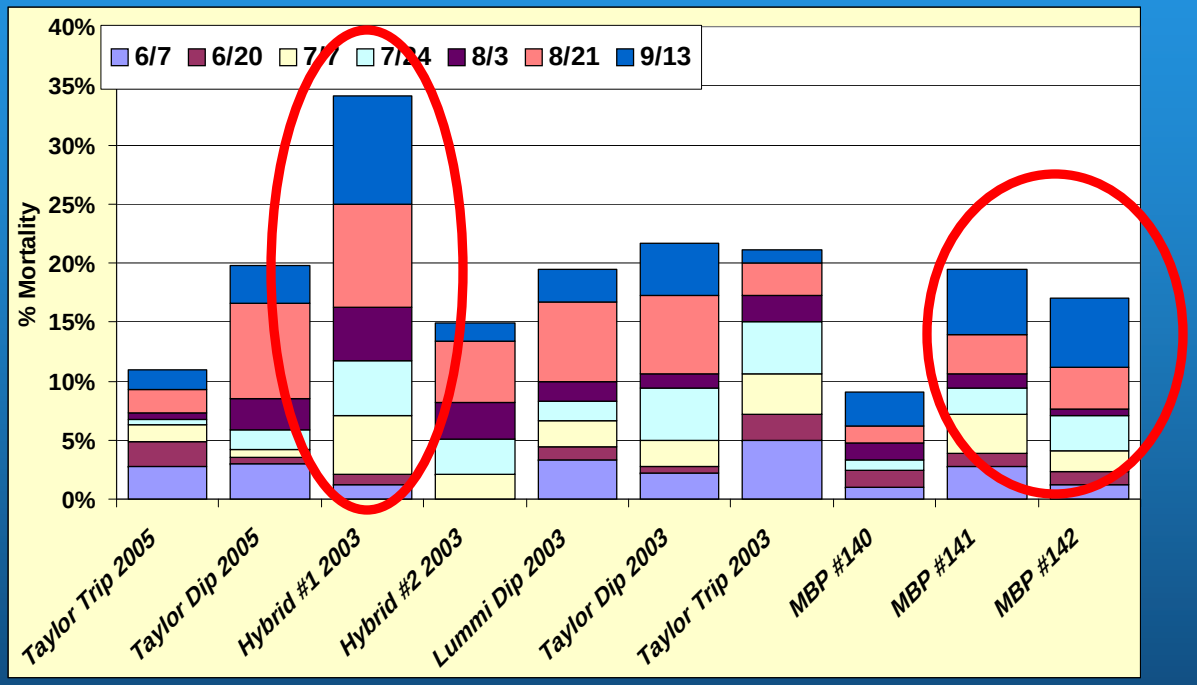



Water temperatures

# Inland waters, Totten Inlet, 2005

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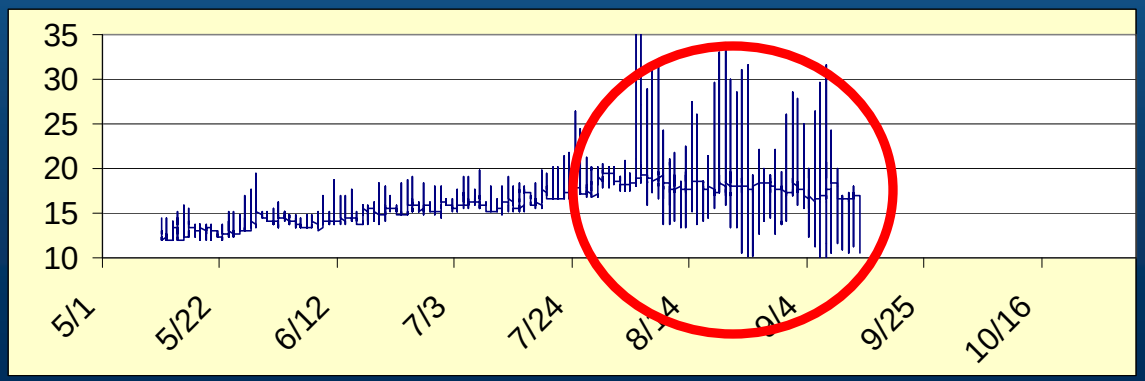
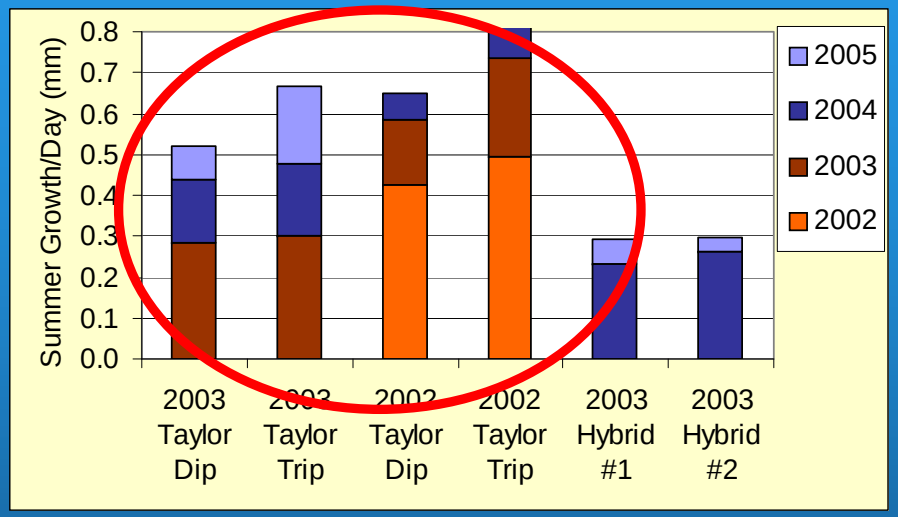
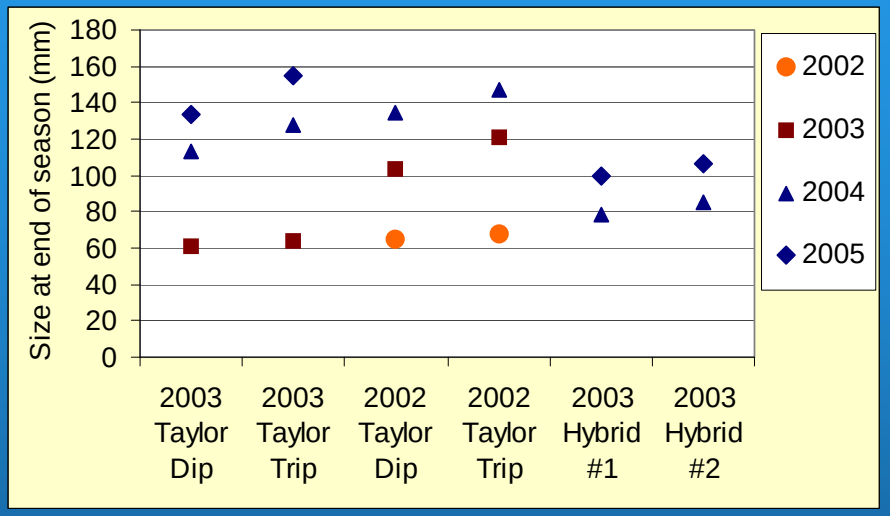
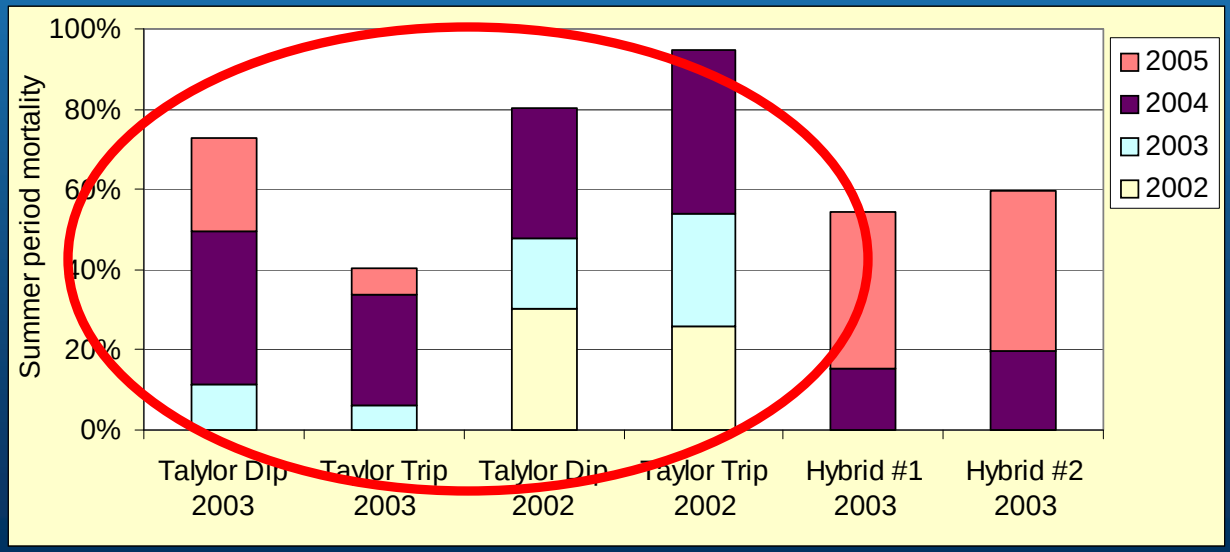



Water temperatures

# Growth & mortalities, Willapa Bay



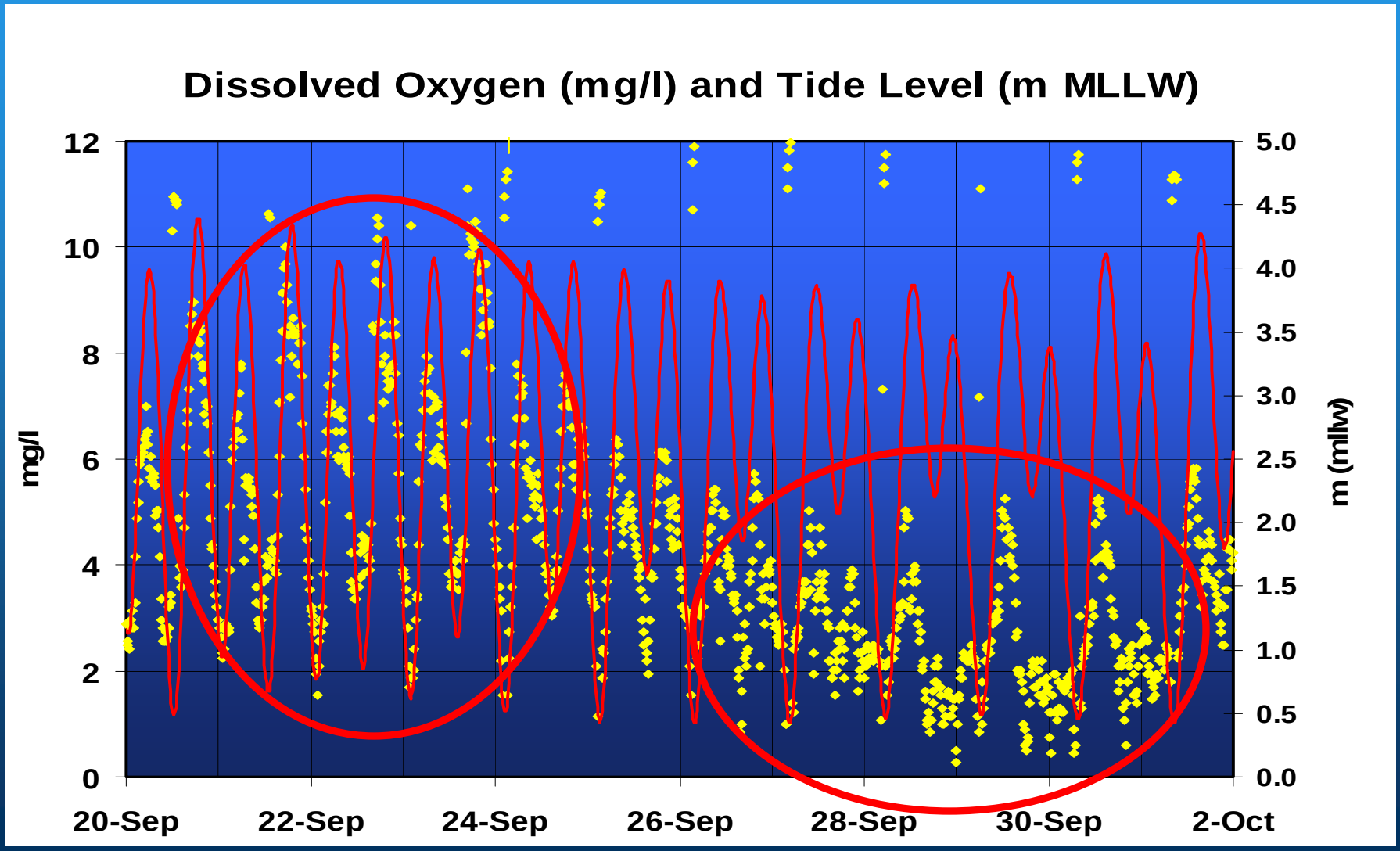



# Dissolved oxygen

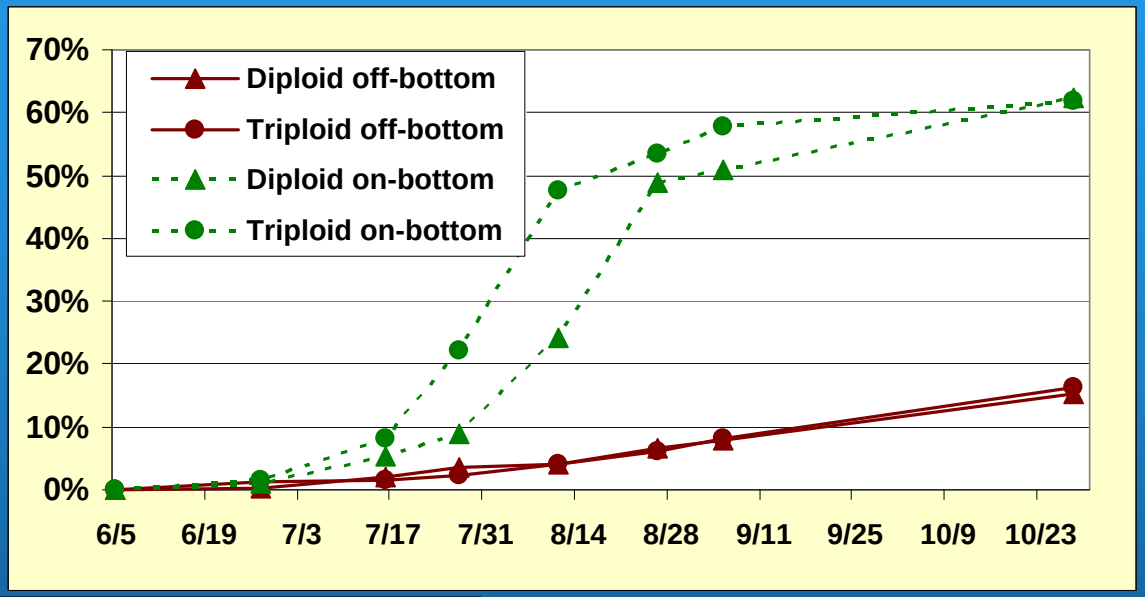
Dissolved oxygen and temperature loggers placed at 10 cm and 100 cm off the bottom

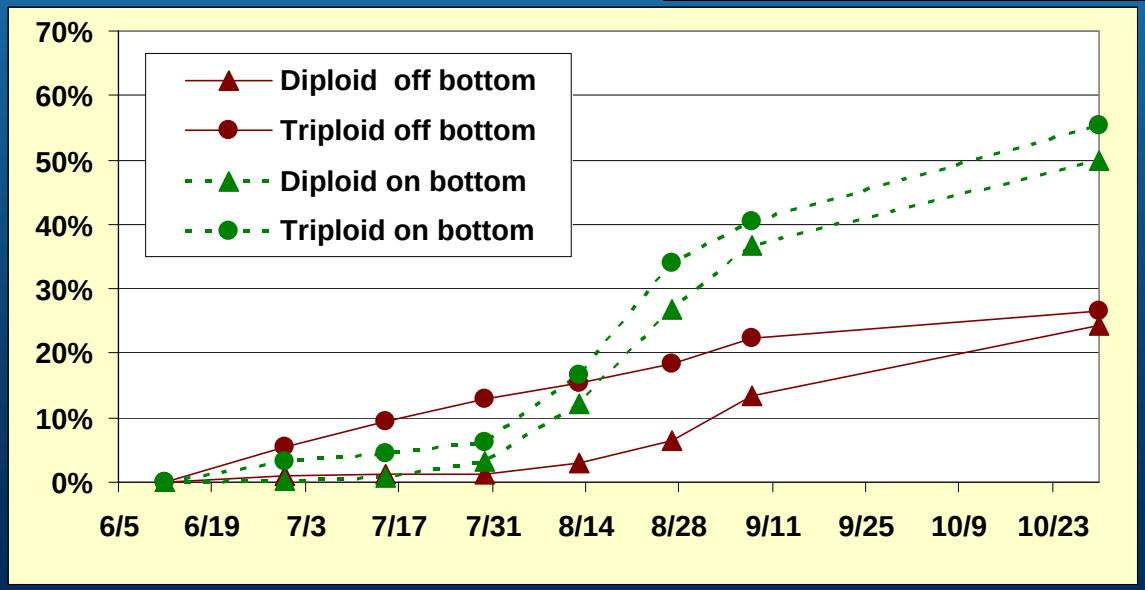
# Dissolved oxygen



# On and off bottom cages

Silty (fine) sediments

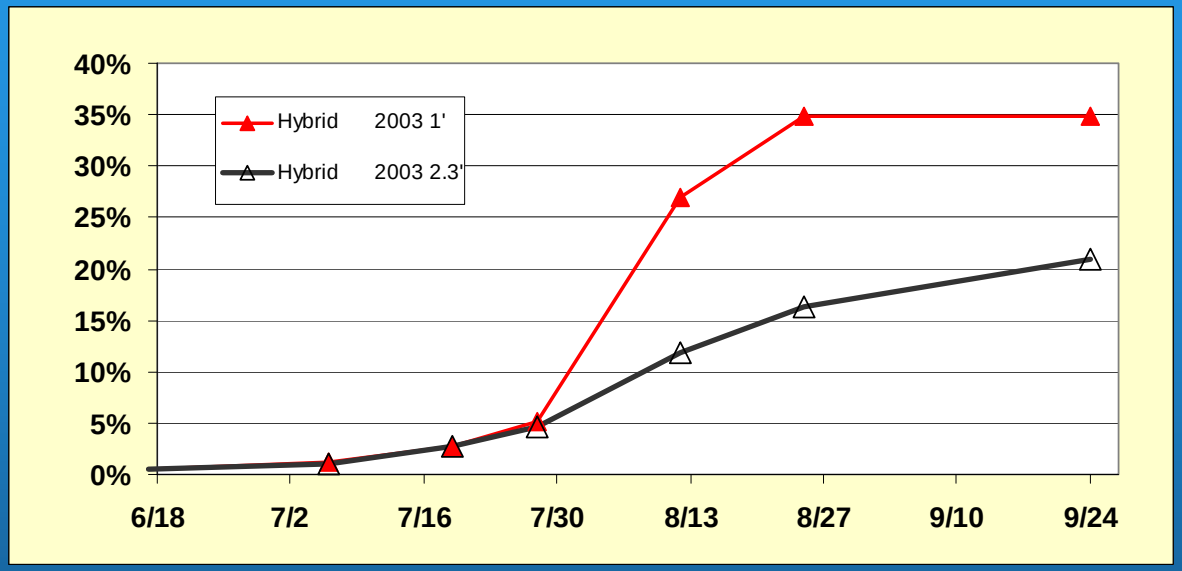


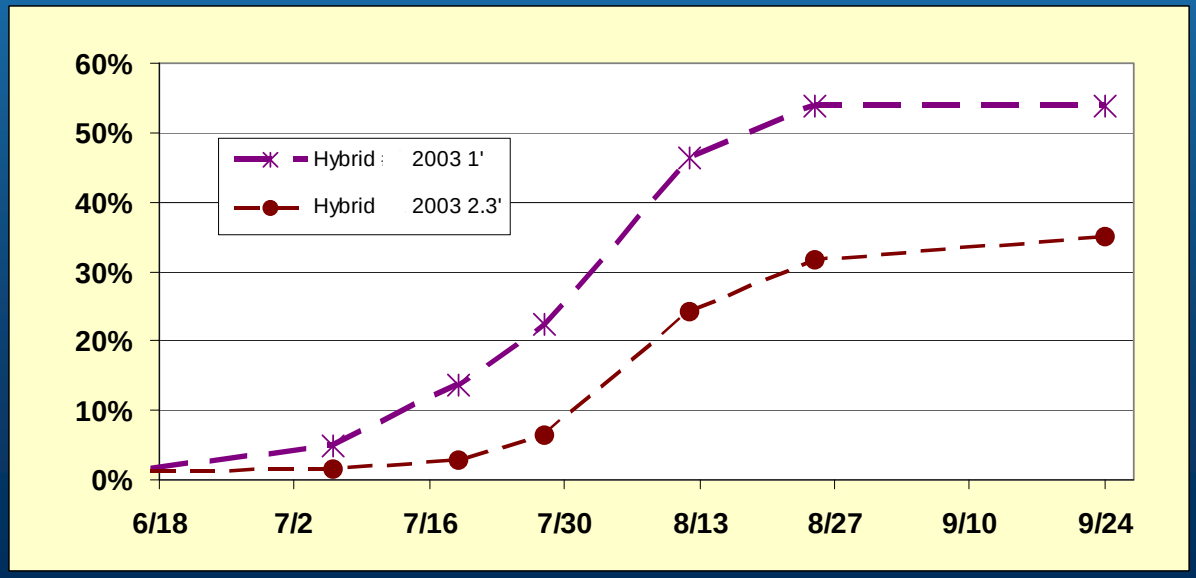




Sandy (coarse) sediments

# 30cm (1′) and 70cm (2.3′) off bottom

30cm




70cm

# Phytoplankton

Dominant phytoplankton taxa at summer mortality sites

**Diatoms**

- ***Psuedo-nitzschia spp.***
- ***Chaetocreros spp.***
- ***Detonula pumila***
- ***Cylindrotheca closterium***
- ***Actinoptychus senarius***
- ***Stephanopyxis spp.***
- ***Thallassiosira spp.***

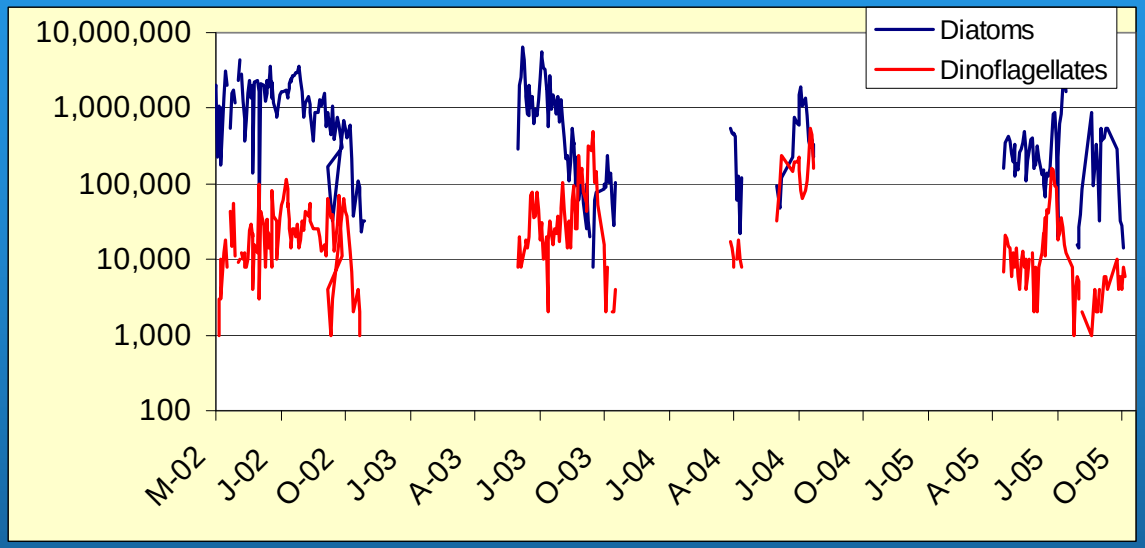
**Dinoflagellates**

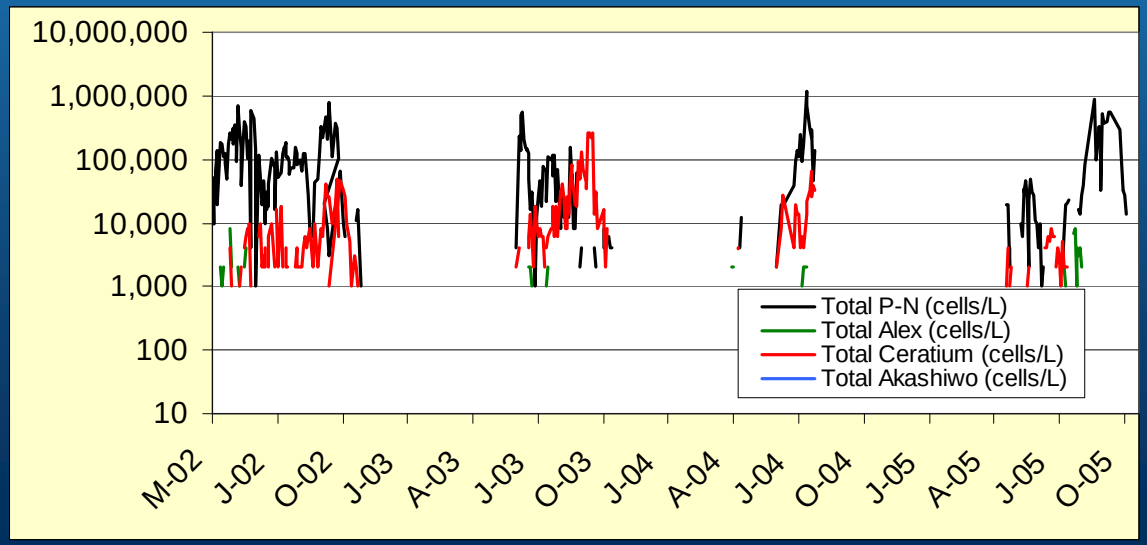
- ***Ceratium spp.***
- ***Heterocapsa Triquetra***
- ***Protoperidinium spp.***
- ***Noctiluca scintillans***
- ***Gymnodinium spp.***
- ***Scrippsiella trochoideum***
- ***Dinophysis spp.***

**Others**

- ***Heterosigma akashiwo***

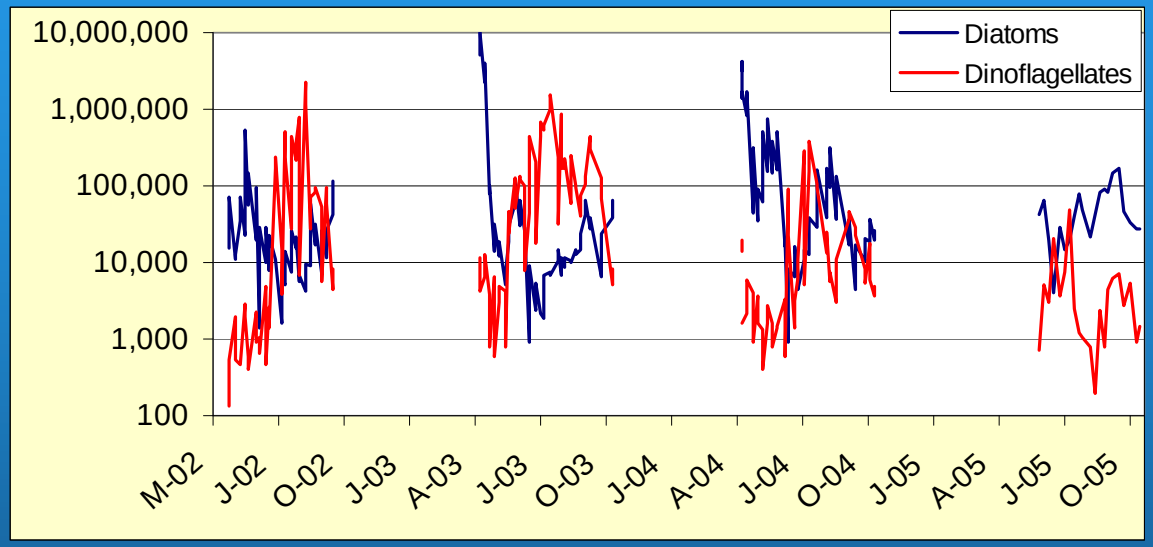
# Phytoplankton, Willapa

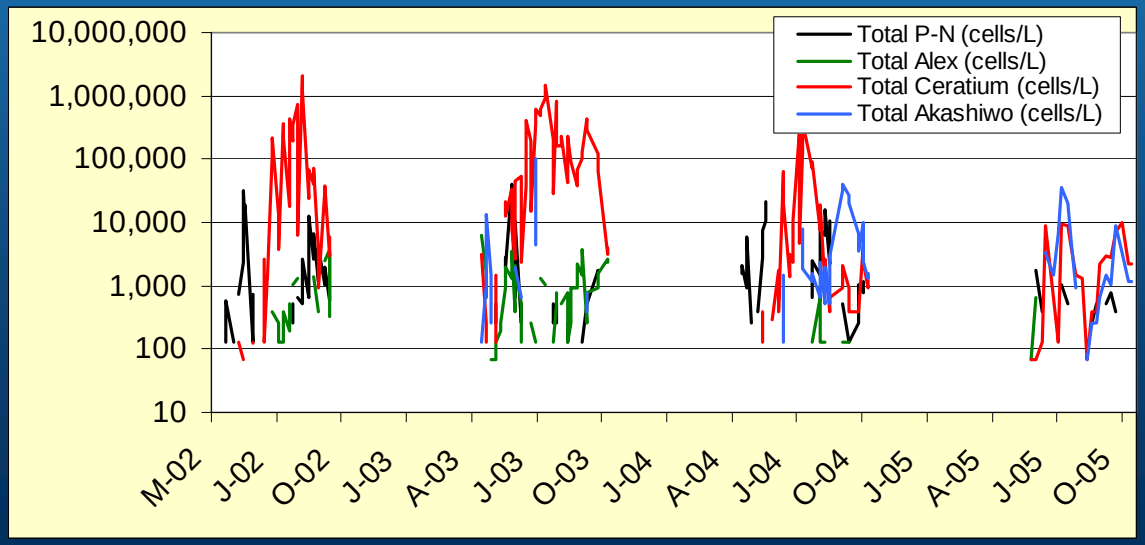



- Diatoms were particularly abundant through most of the summer
- Dinoflagellate numbers were generally low
- Ceratium and Pseudo-nitzschia were most abundant toxic taxa

# Phytoplankton, Totten Inlet

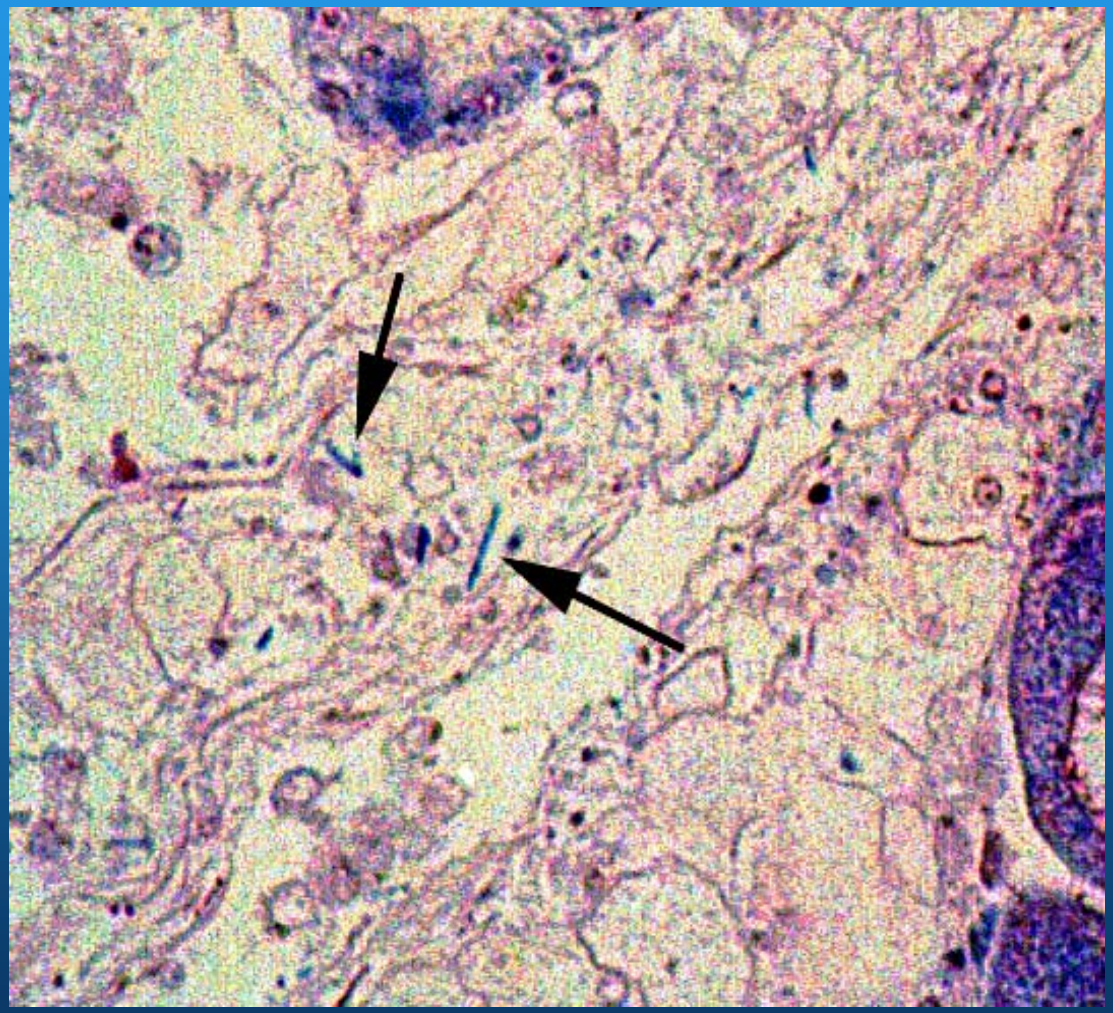


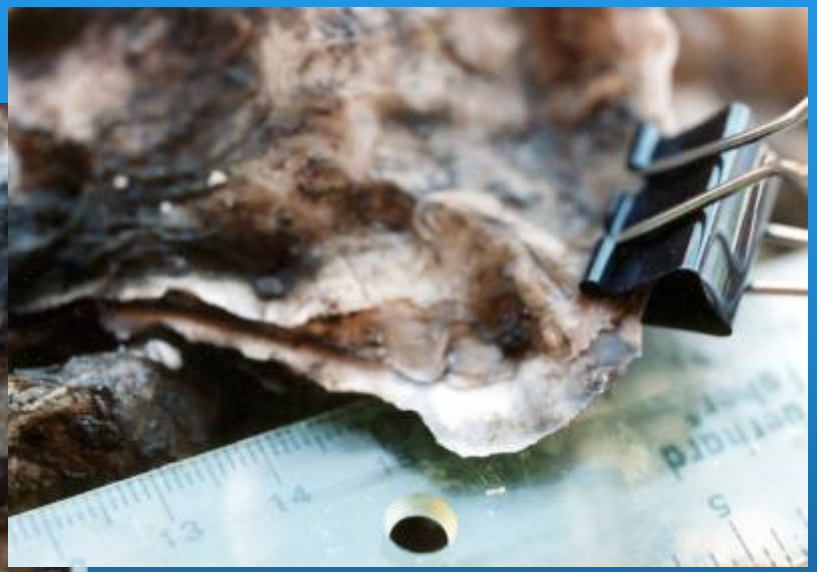

- Relatively low summertime levels of diatoms.
- Dinoflagellate numbers were high.
- Selected taxa dominated by Ceratium, but toxic species were uncommon

# Systemic Bacterial Infections

- Associated with morbidity and mortality episodes
- Uniform morphologic type
- An interaction with environmental stress
- Vibrio and herpes clearly indicated in larval and juvenile mortalities



# Asymmetrical shell growth



- Triploid oysters showing overgrowth of flat shell (right valve) by cupped shell
- About 30% of samples (n=969) with multifocal necrosis of gill tissue
- Pathology possibly due to overheating and exposure during low tides

# Current research

- Test the hypothesis that a small number of genes control resistance to summer mortality through genomic mapping of variation in survival, growth and reproductive allocation.
- In conjunction with a breeding program focused on selecting for resistance to summer mortality, to determine how variation in reproductive allocation may interact with stress conditions associated with summer mortality.
- To evaluate selected environmental parameters and observations which appear to predict increased summer mortality risk and can be used to assess the performance of outplanted treatment groups.
- To ensure there is a timely response to oyster mortality events on commercial oyster beds, and harvest areas and provide feedback on those events to producers.