

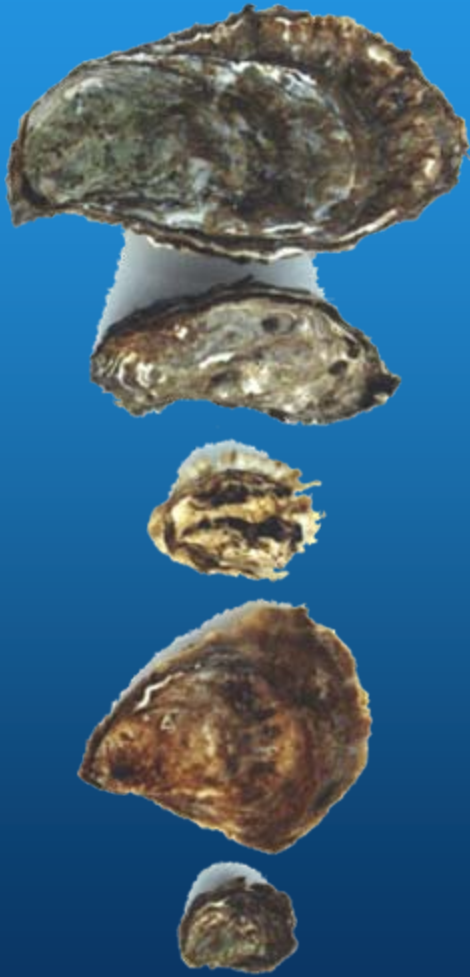
Pacific Oyster Summer Mortality Disease on the U.S. West Coast: 50 Years Later



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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



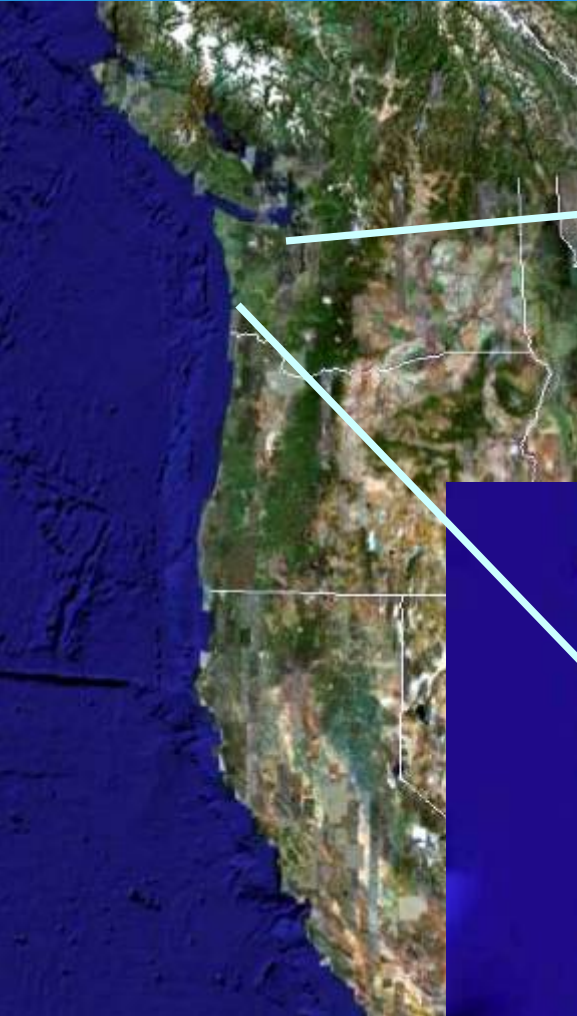
Recent WC research

- Identify environmental factors triggering a mortality-inducing stress response;
- Evaluate the relationships 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

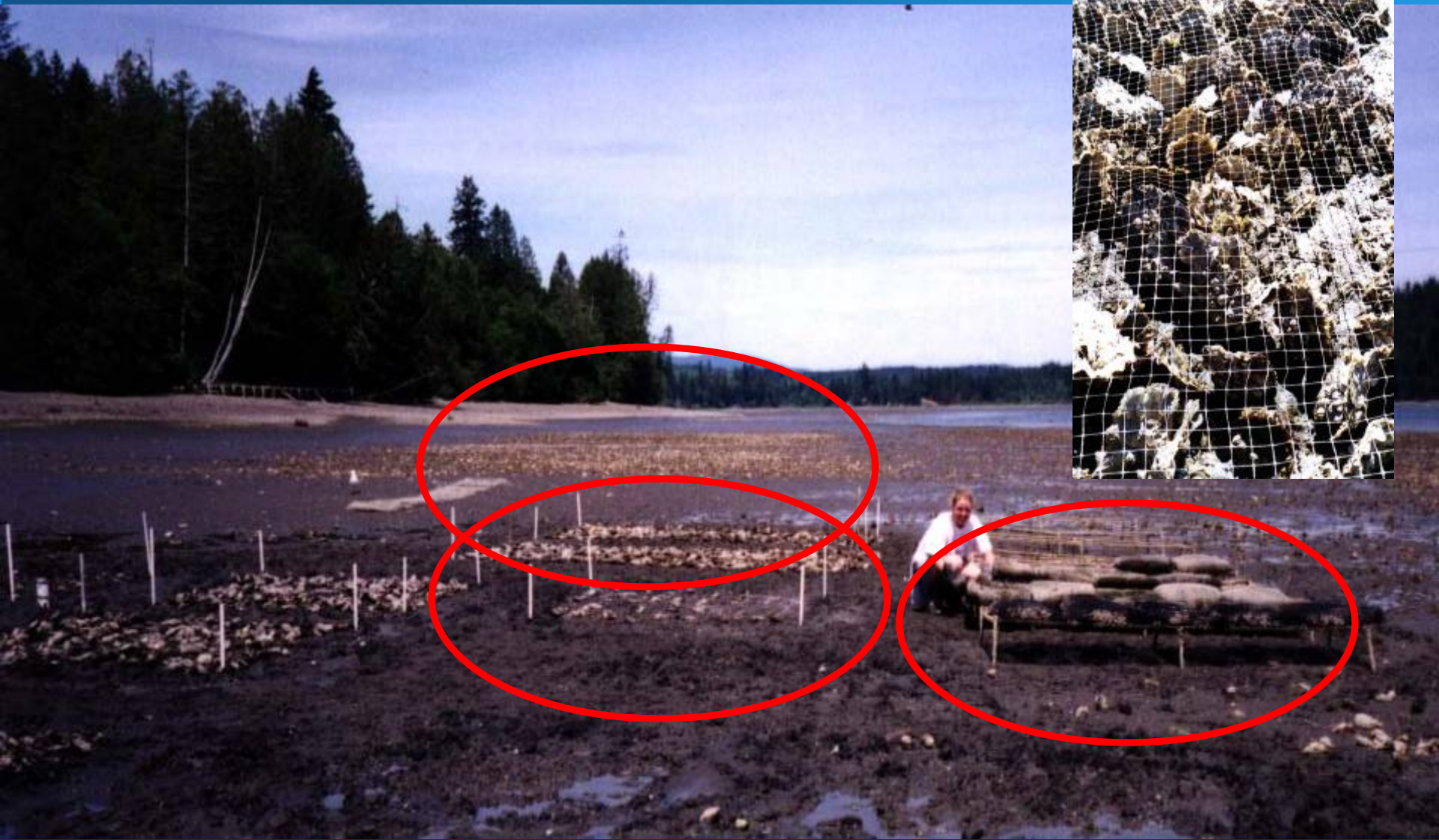
 Coastal estuary, Willapa Bay



Inland waters, Totten Inlet



Early Study Plot Layout





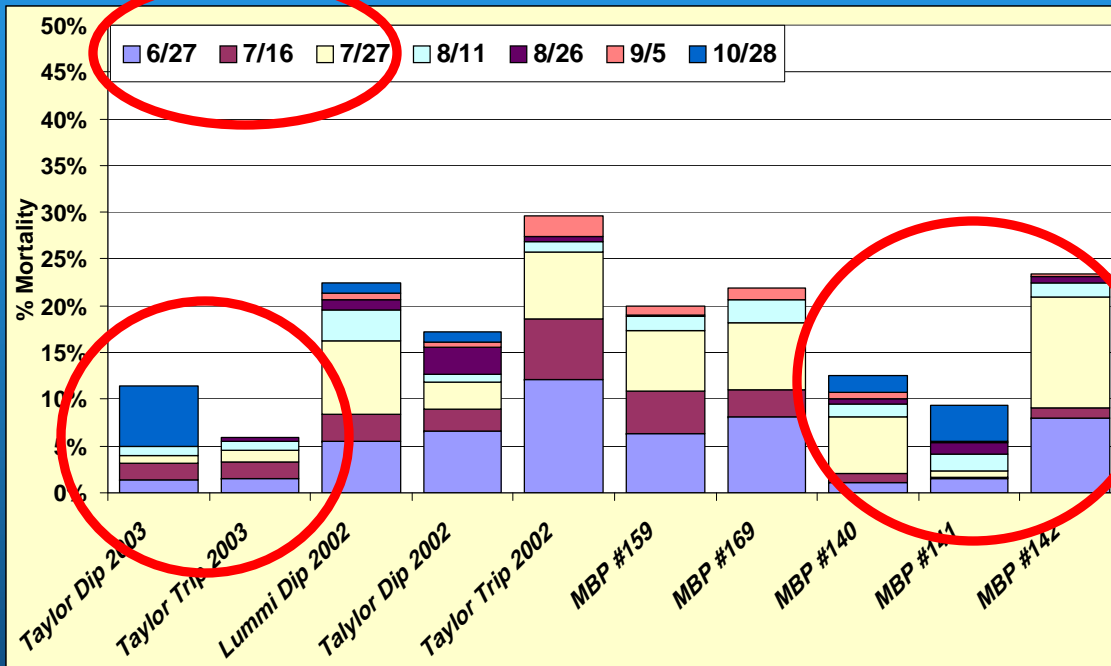
Treatment Groups – Wild and Selected

- 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

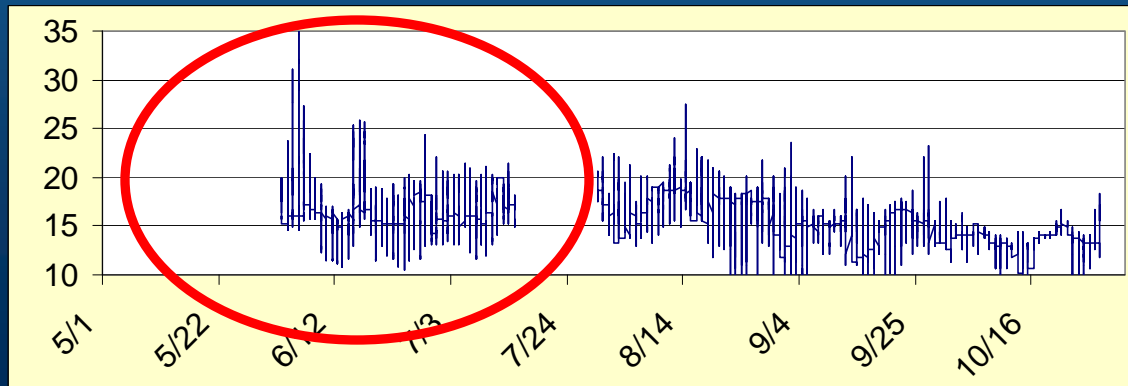
Environmental variables

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

Coastal estuary, Willapa, 2003

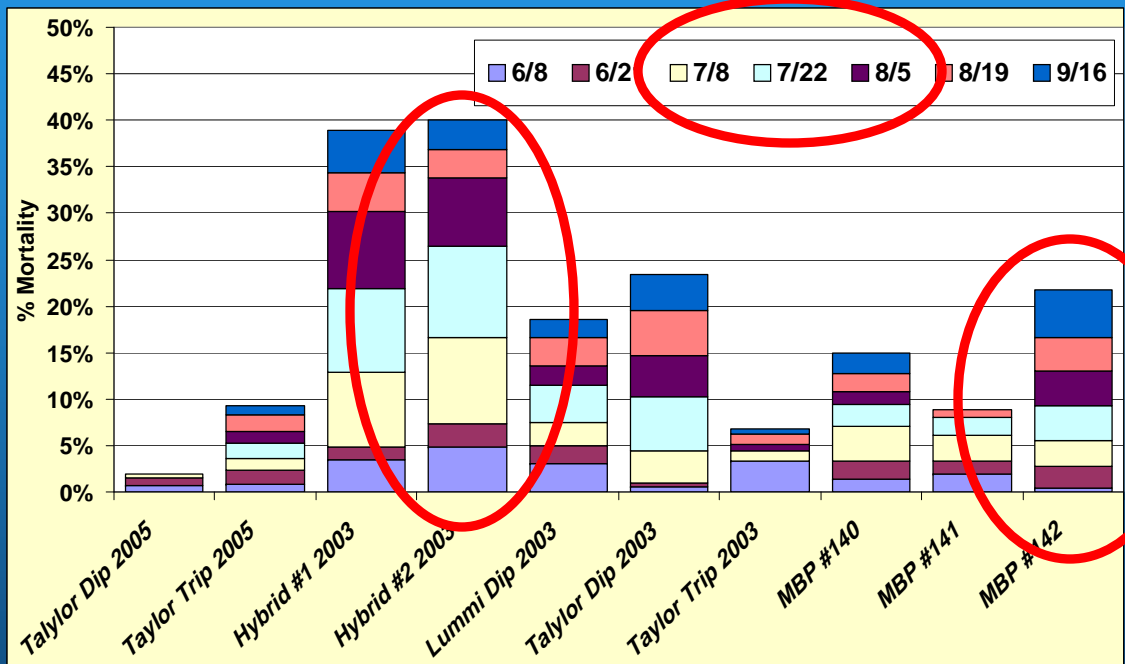


Mortality by treatment group (initial planting early June)

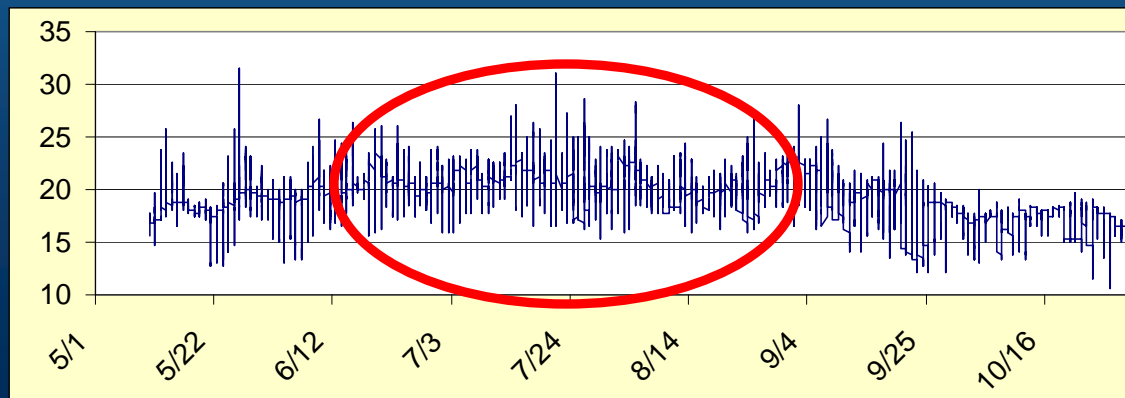


Water temperatures

Coastal estuary, Willapa, 2005



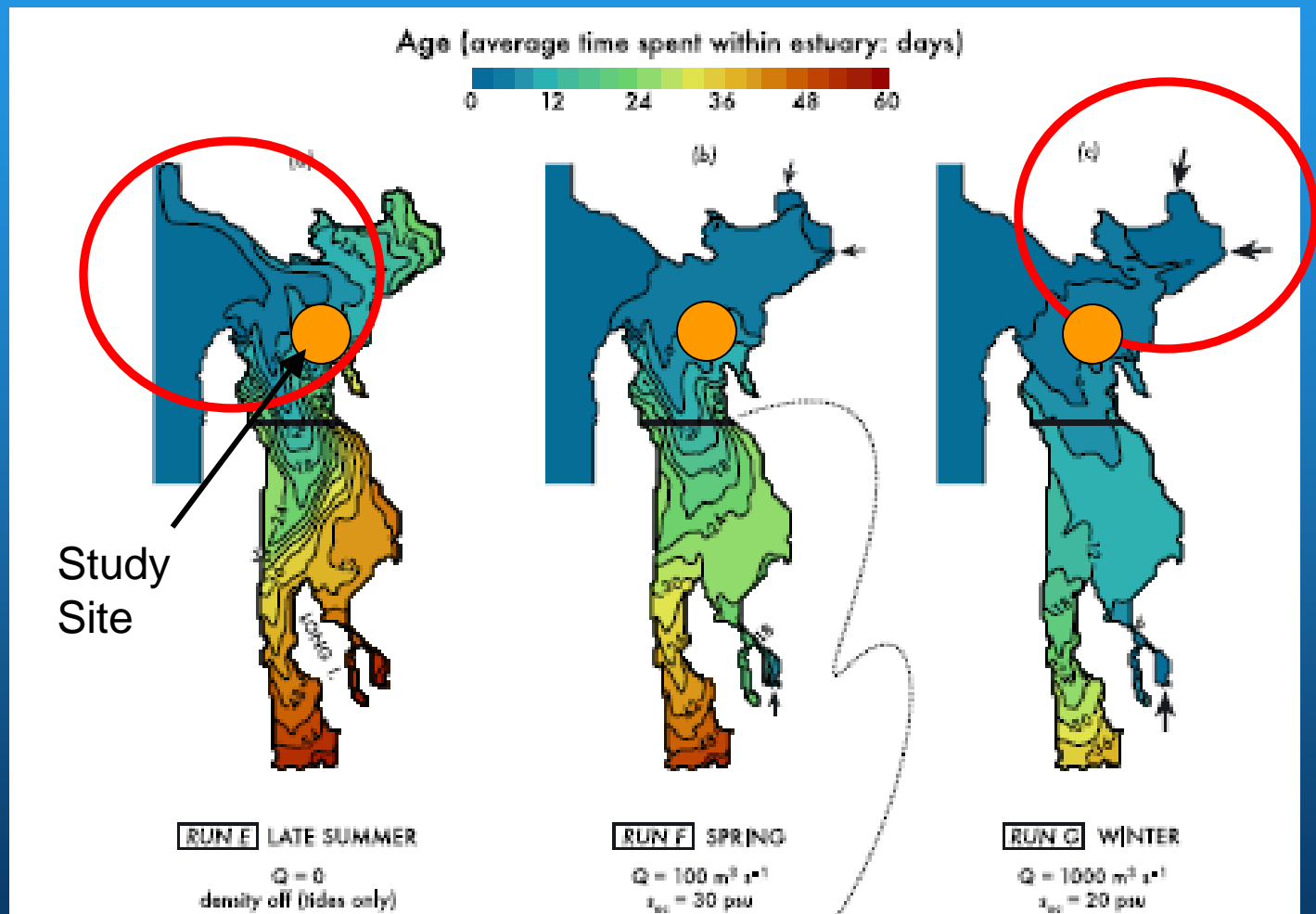
Mortality by treatment group (initial planting early June)



Water temperatures

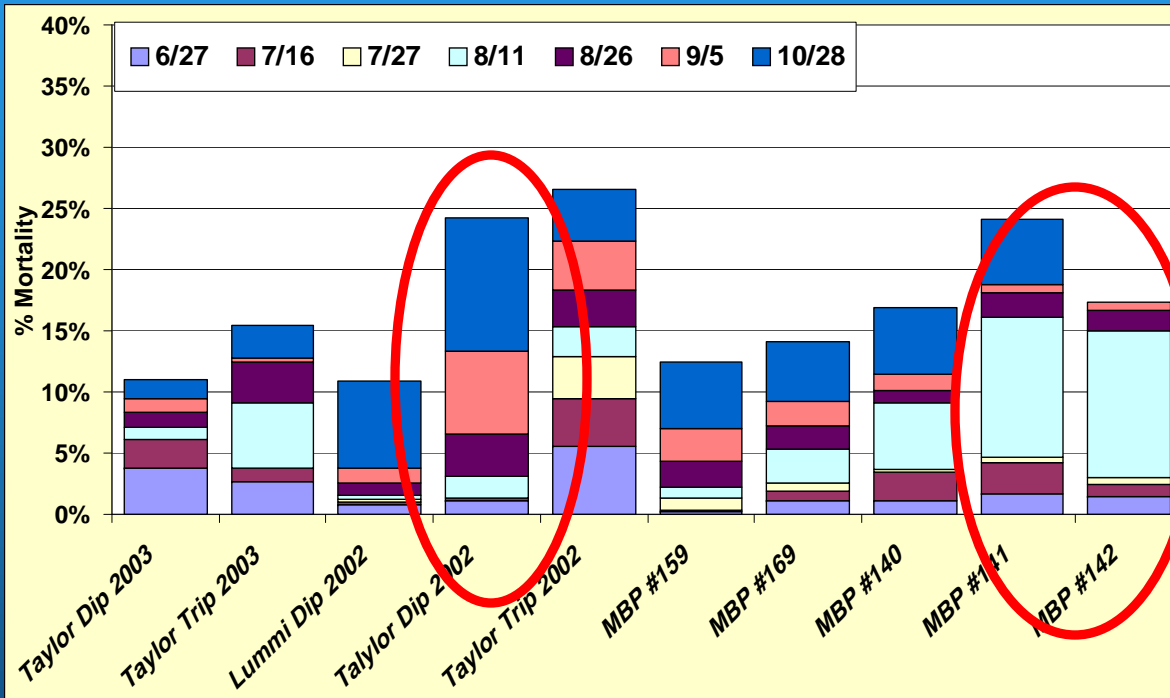
Willapa, ocean influence

Model results from test conditions based on 3 years of data

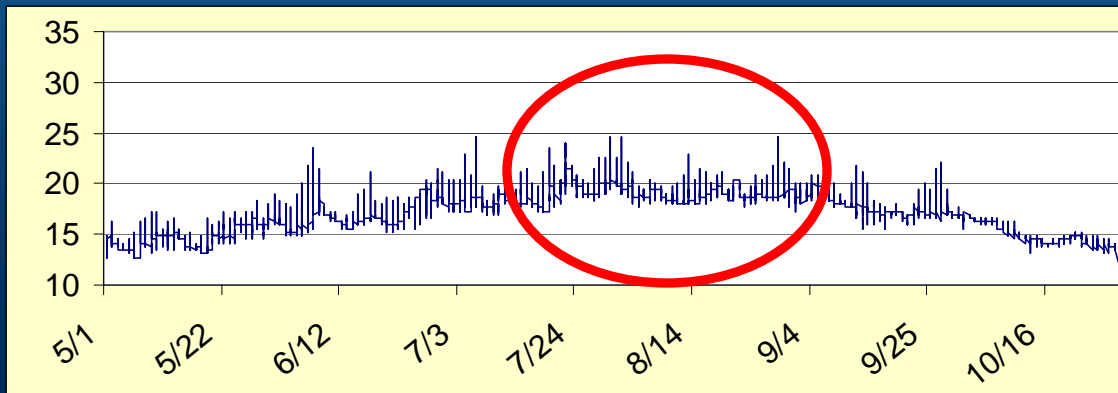


Banas NS, Hickey BM (2005) Mapping exchange and residence time in a model of Willapa Bay, Washington, a branching, macrotidal estuary. *J. Geophys. Res.* 110,

Inland waters, Totten Inlet, 2003

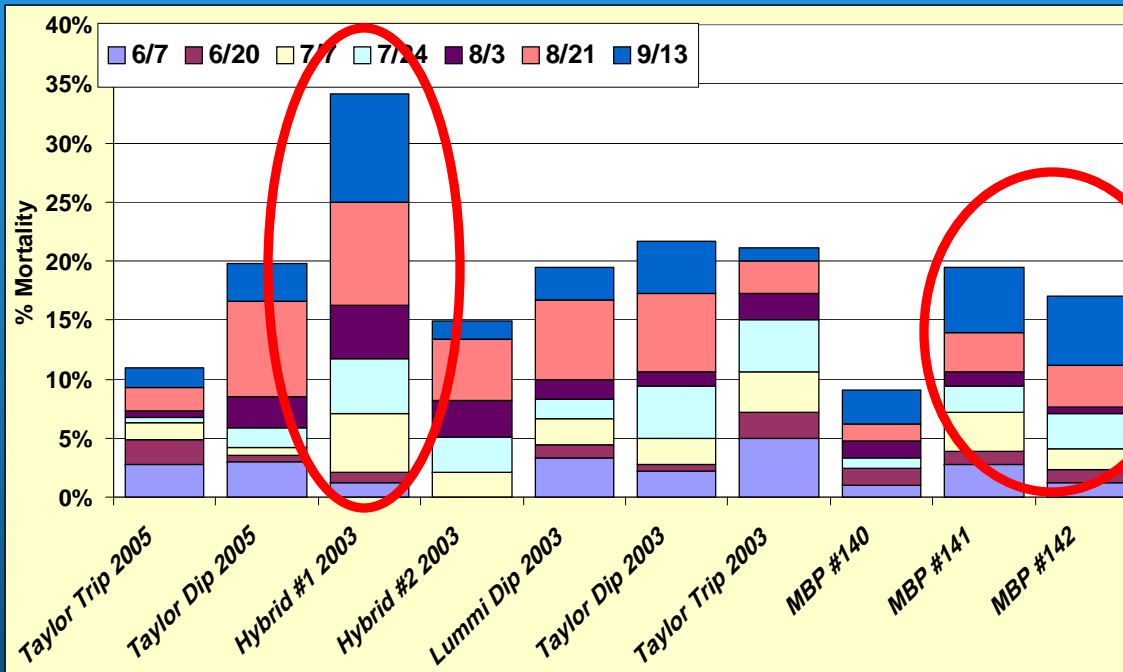


Mortality by treatment group (initial planting early June)

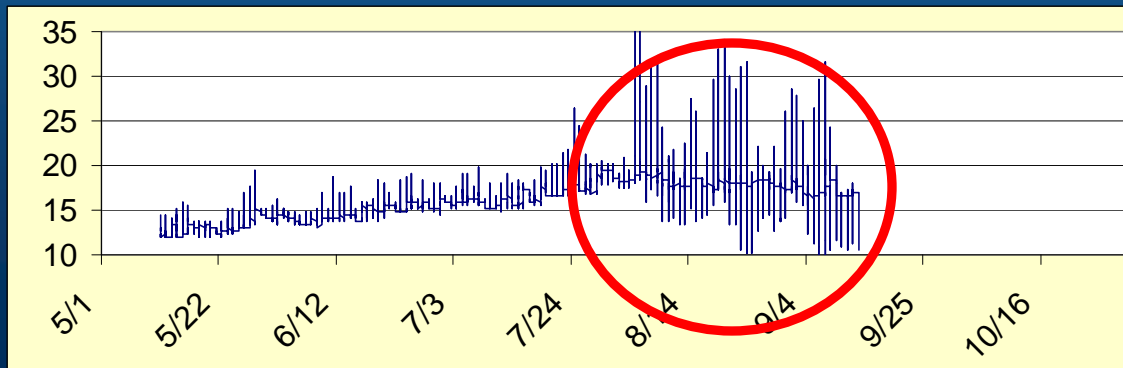


Water temperatures

Inland waters, Totten Inlet, 2005

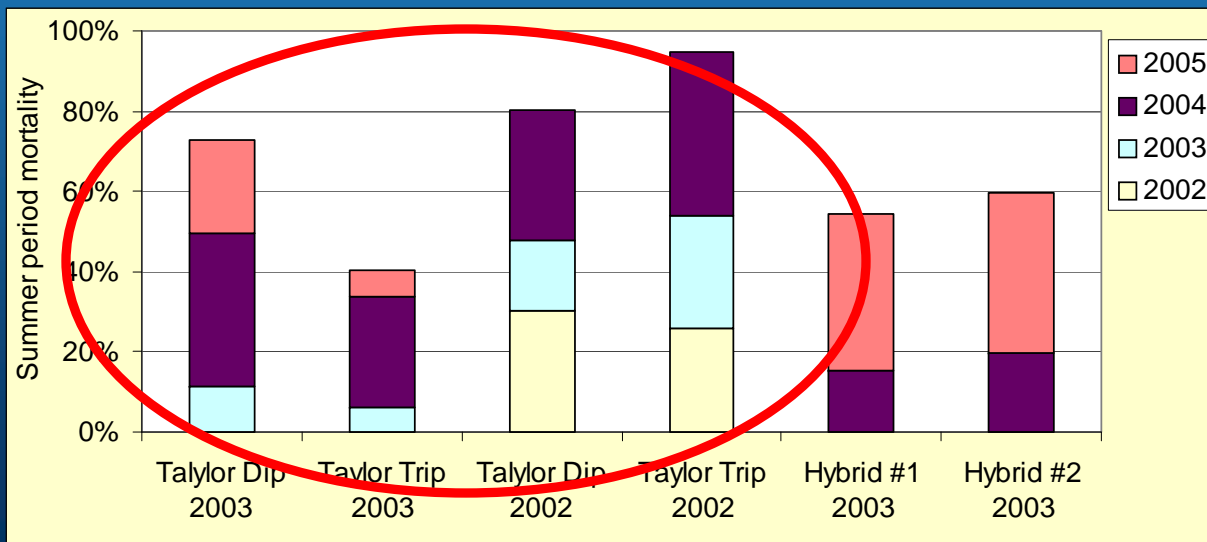
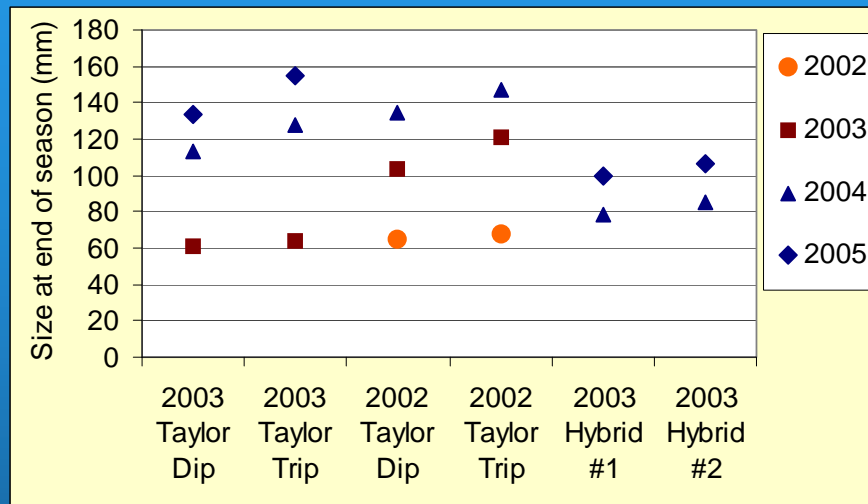
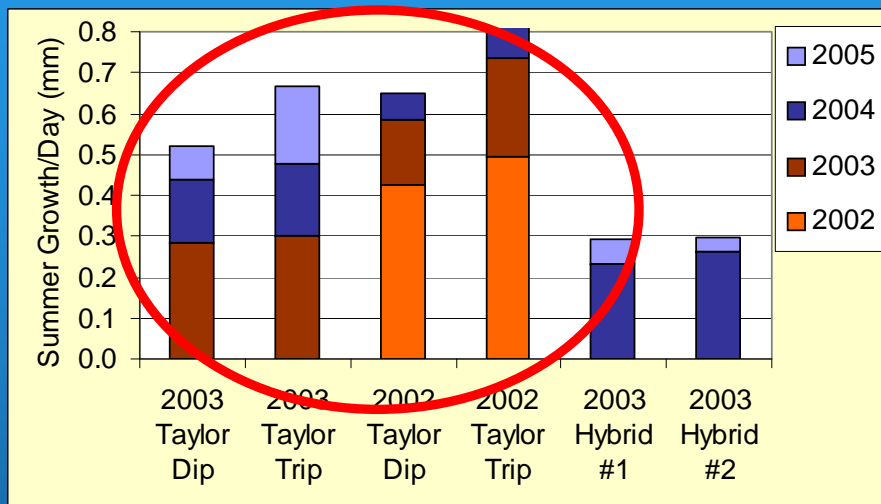


Mortality by treatment group (initial planting early June)



Water temperatures

Growth & mortalities, Willapa Bay



Dissolved oxygen

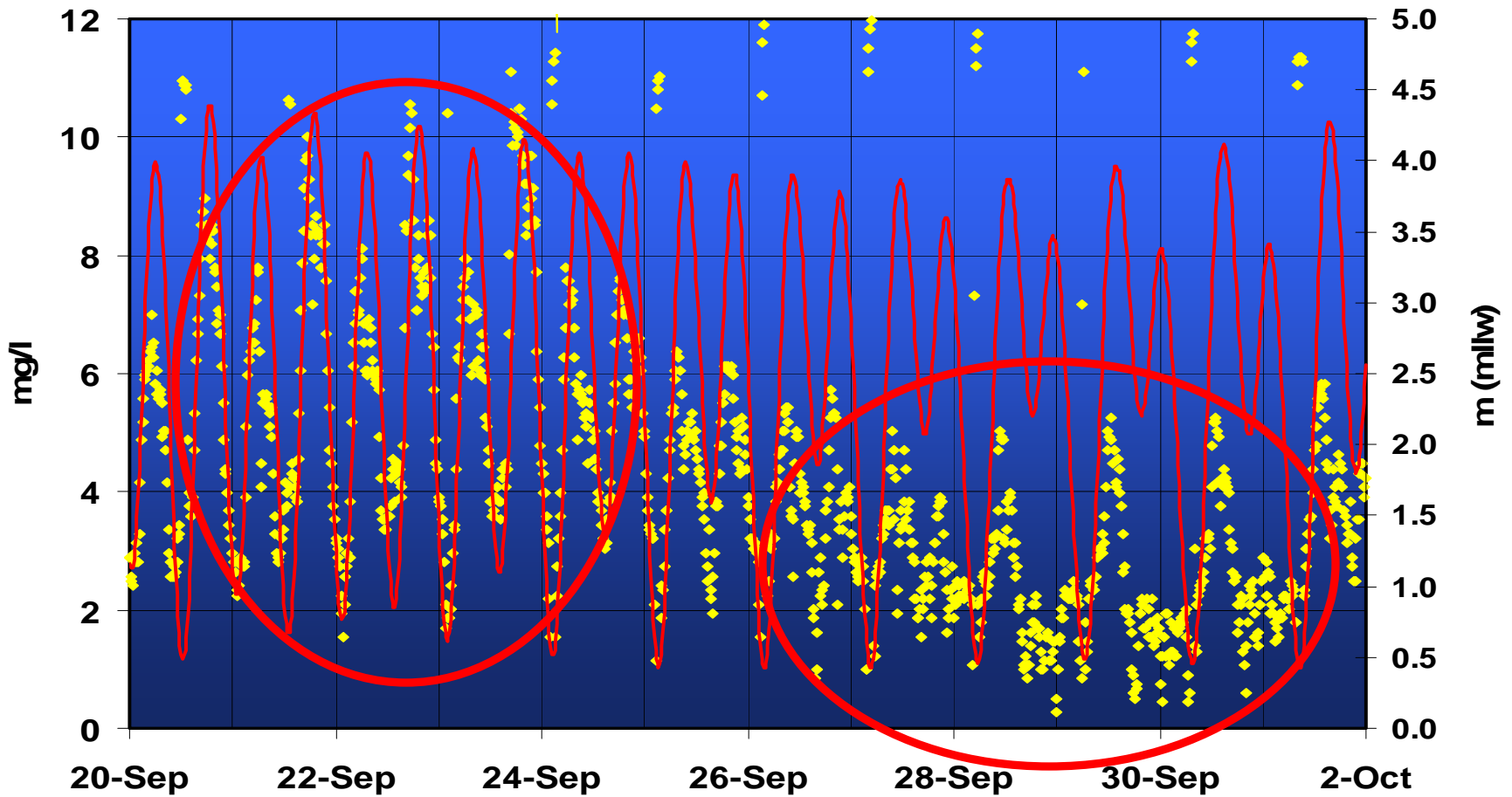


Dissolved oxygen and temperature loggers placed at 10 cm and 100 cm off the bottom



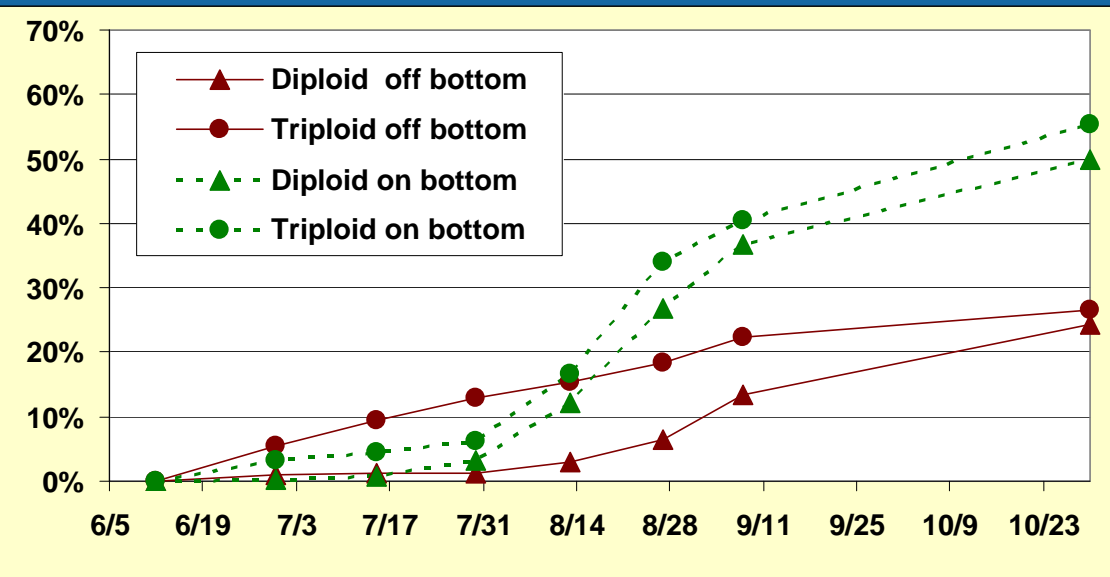
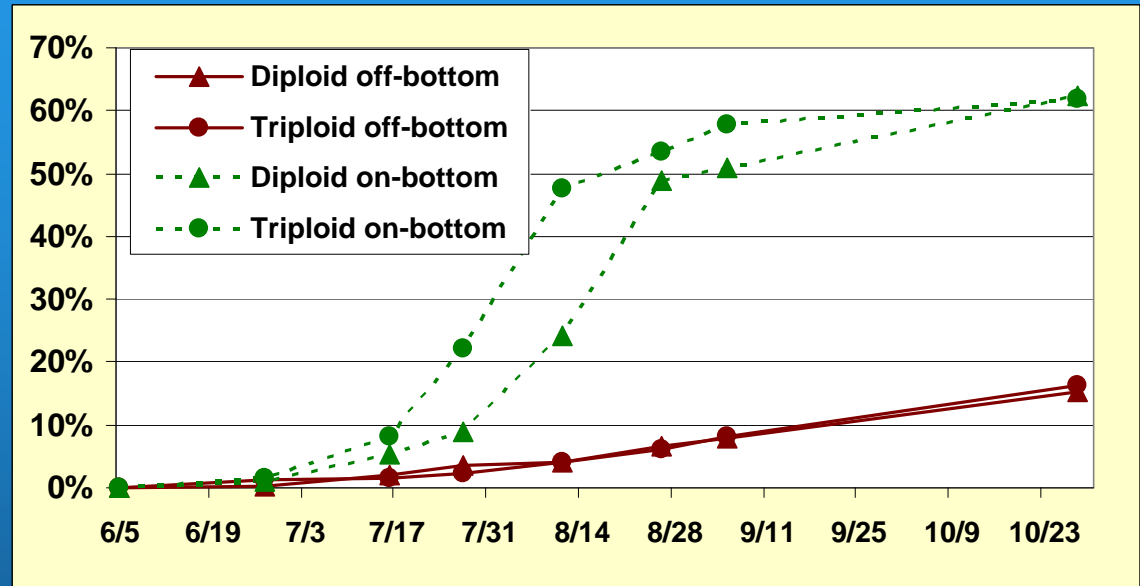
Dissolved oxygen

Dissolved Oxygen (mg/l) and Tide Level (m MLLW)



On and off bottom cages

Silty (fine) sediments

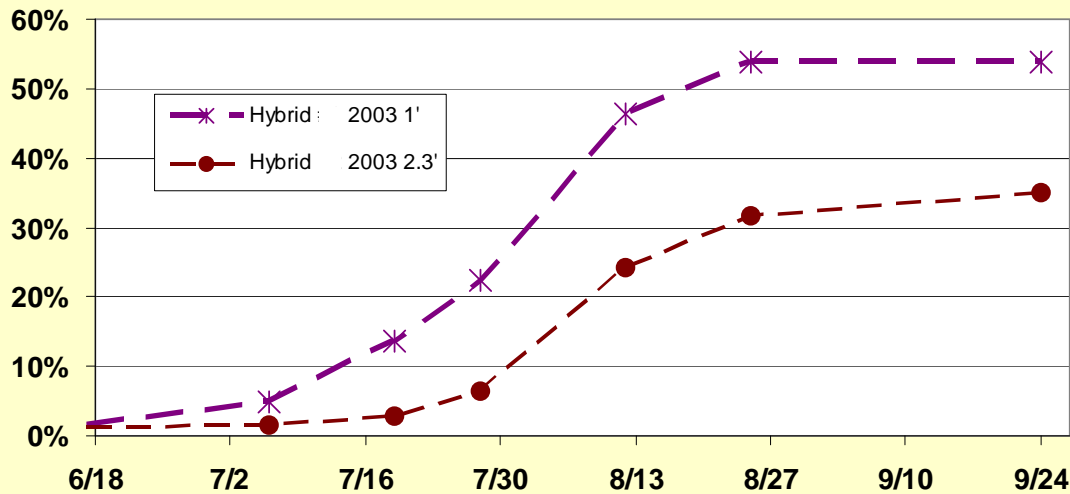
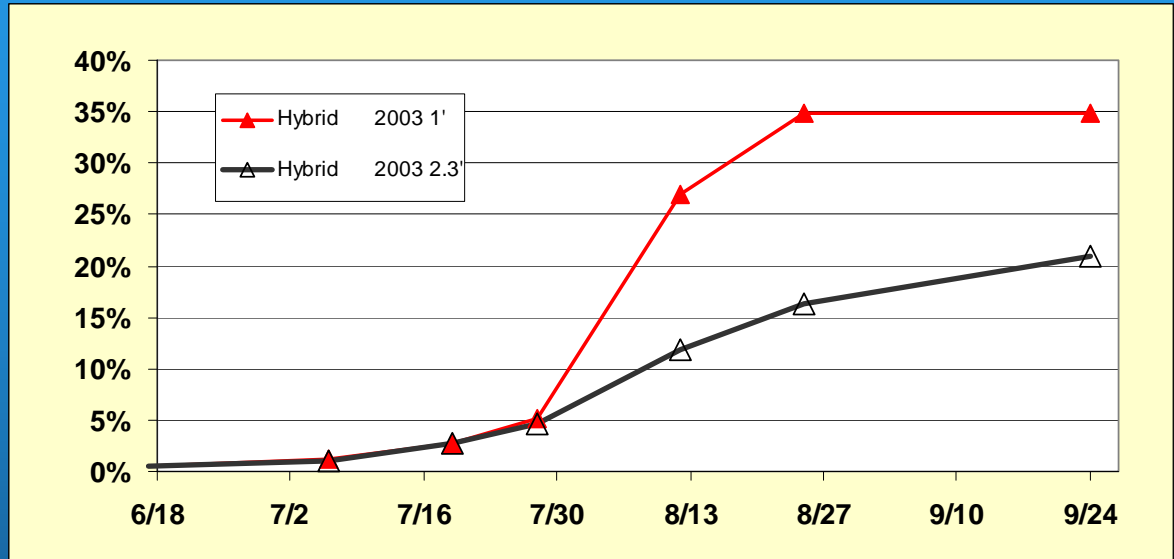


Sandy (coarse) sediments

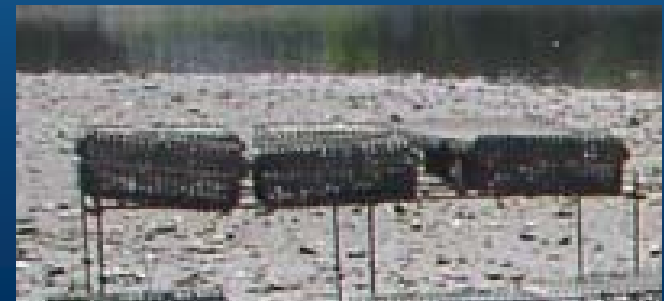


30cm (1') and 70cm (2.3') off bottom

30cm



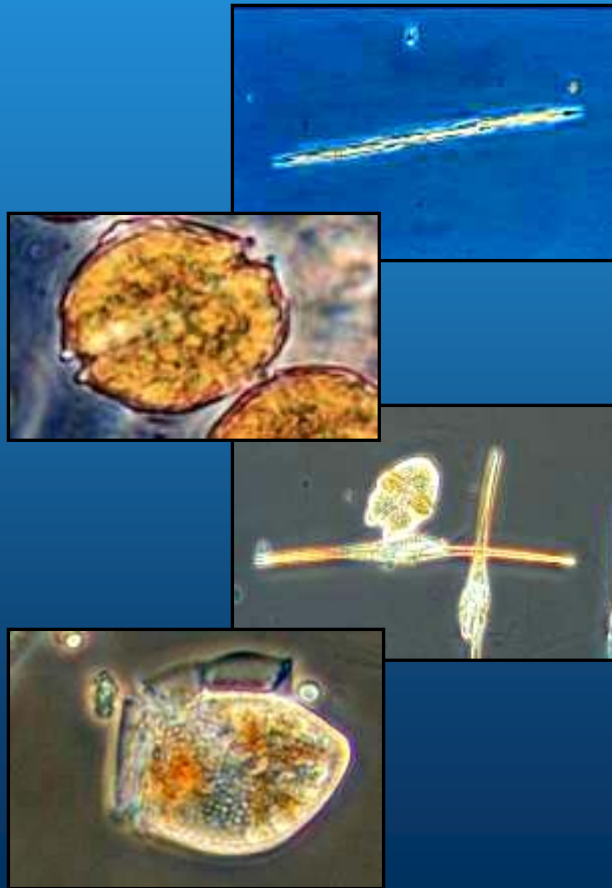
70cm





Phytoplankton

Dominant
phytoplankton taxa at
summer mortality sites



Diatoms

Pseudo-nitzschia spp.

Chaetoceros spp.

Detonula pumila

Cylindrotheca closterium

Actinopterychus senarius

Stephanopyxis spp.

Thalassiosira spp.

Dinoflagellates

Ceratium spp.

Heterocapsa Triquetra

Protoperidinium spp.

Noctiluca scintillans

Gymnodinium spp.

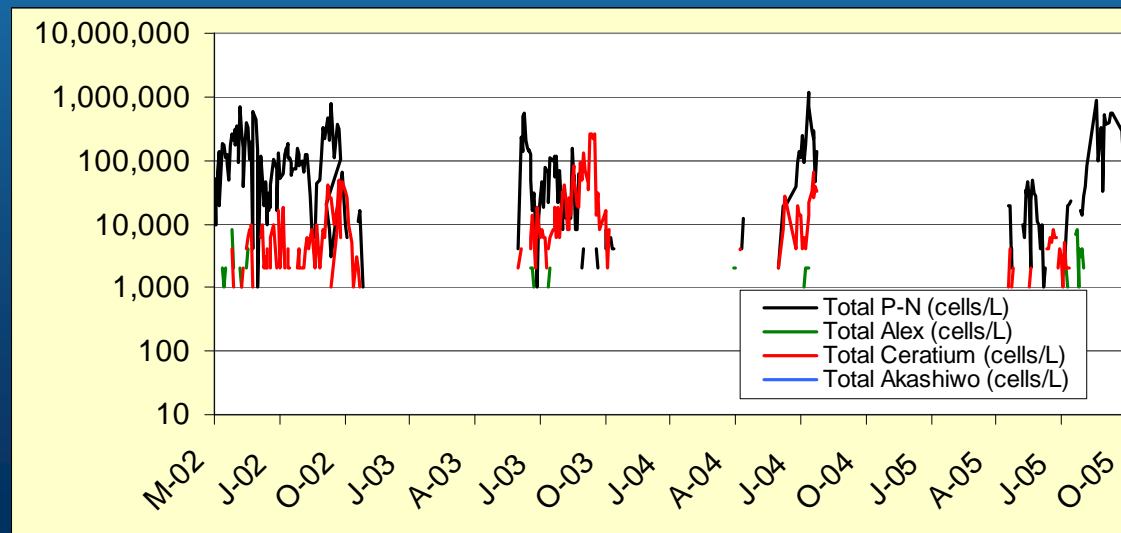
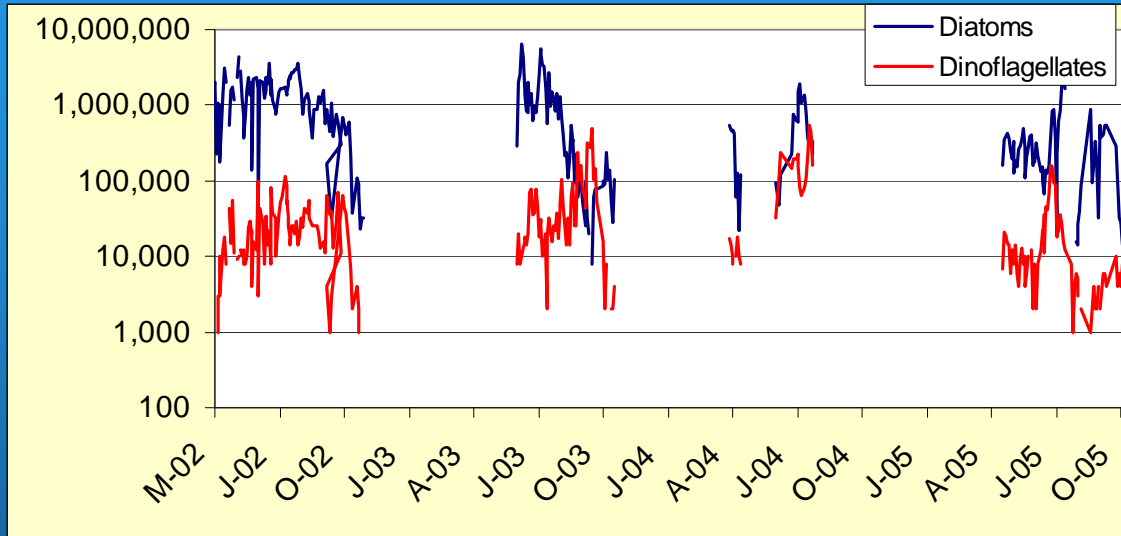
Scrippsiella trochoideum

Dinophysis spp.

Others

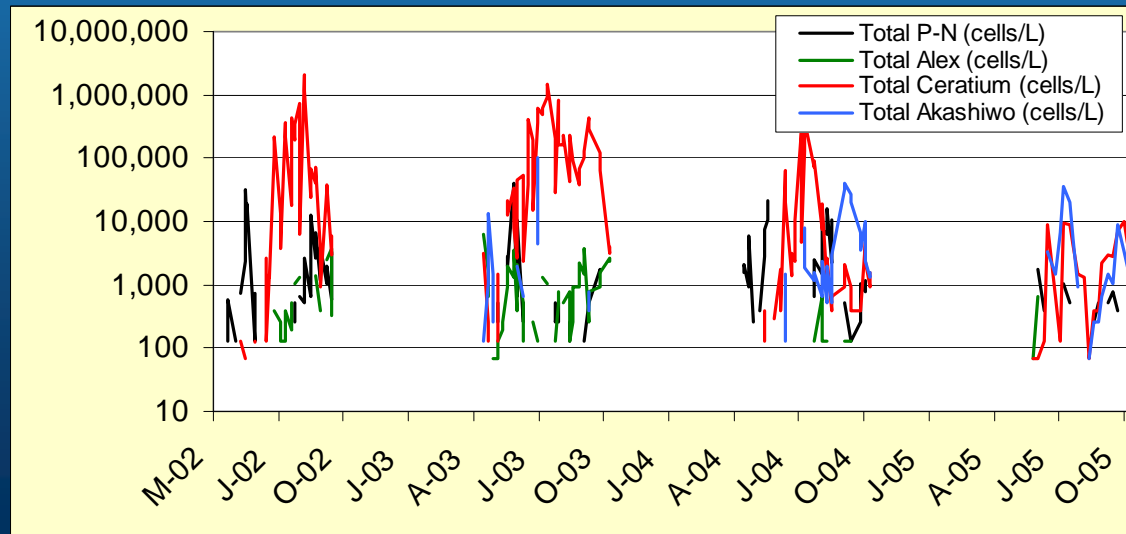
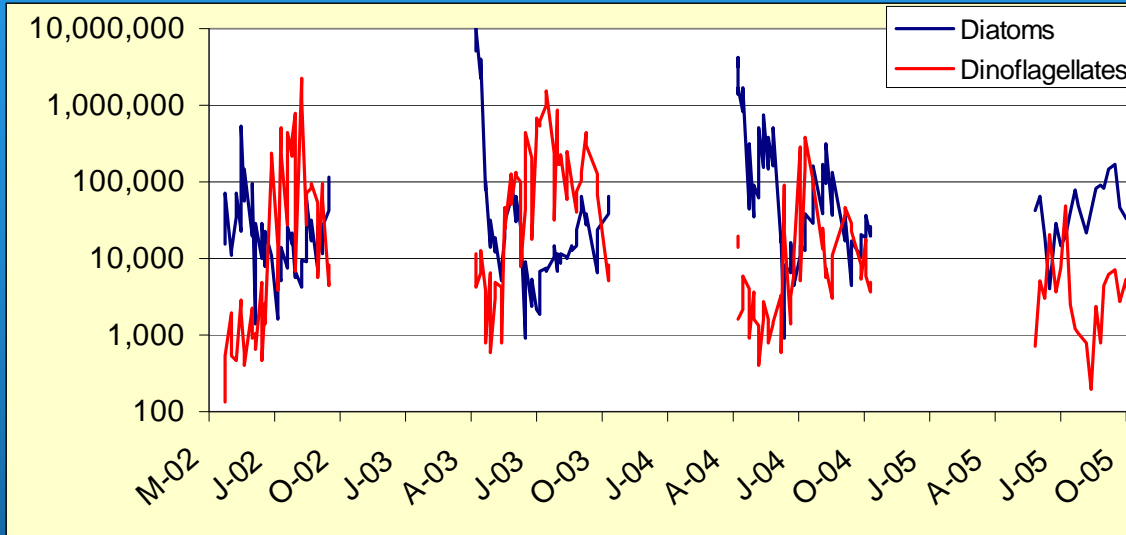
Heterosigma akashiwo

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

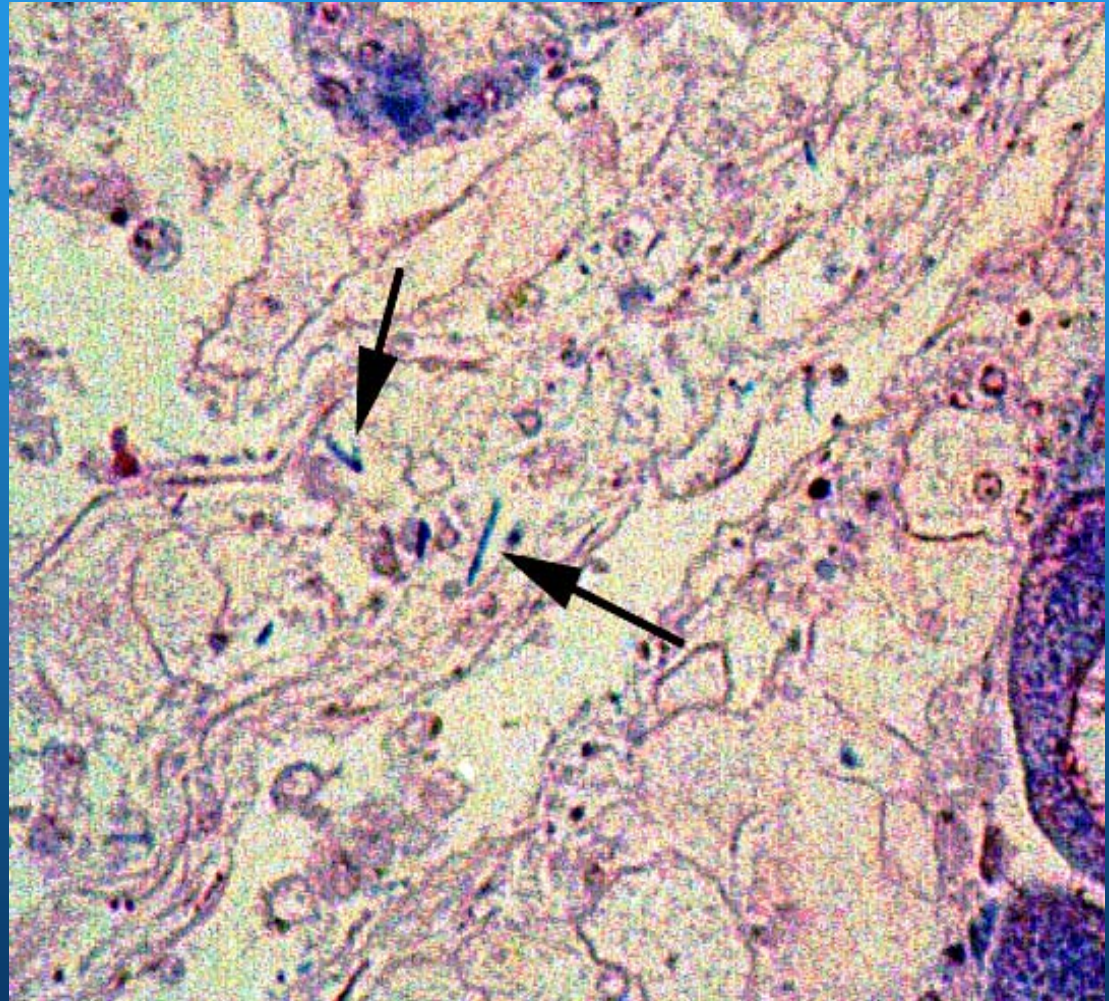
Phytoplankton, Totten Inlet



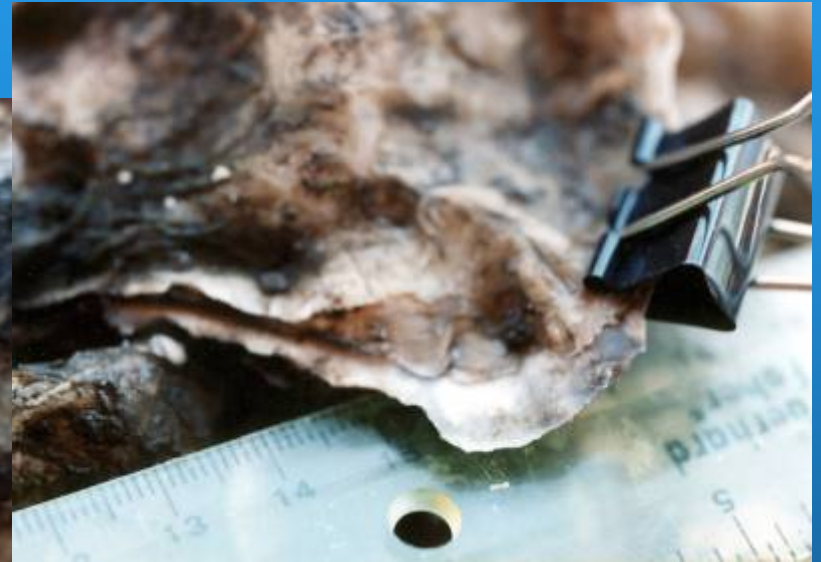
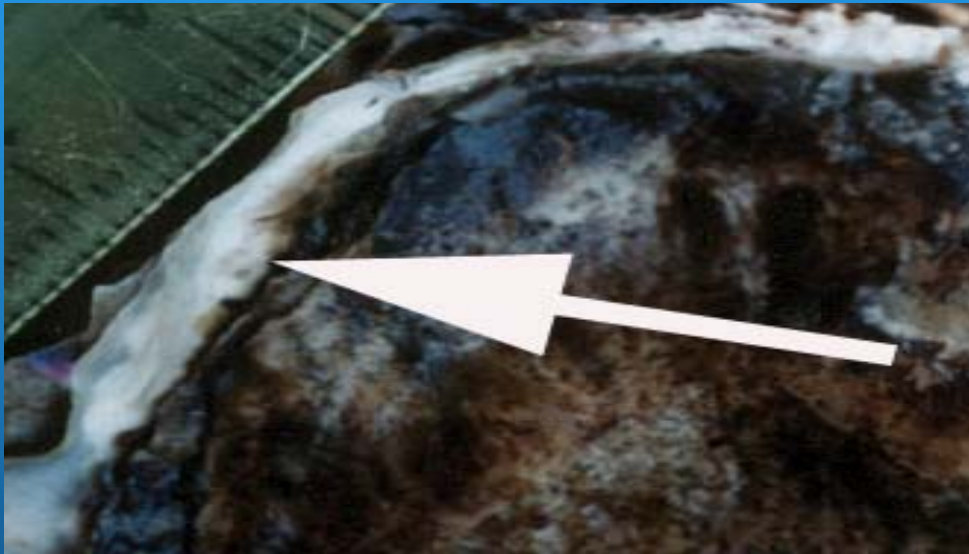
- Relatively low summertime levels of diatoms.
- Dinoflagellate numbers were high.
- Selected taxa dominated by Ceratium, but toxic species were uncommon

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.