

Bloom dynamics of *Heterosigma akashiwo* in Puget Sound and the Strait of Juan de Fuca

Jack Rensel, Rensel Associates Aquatic Sciences

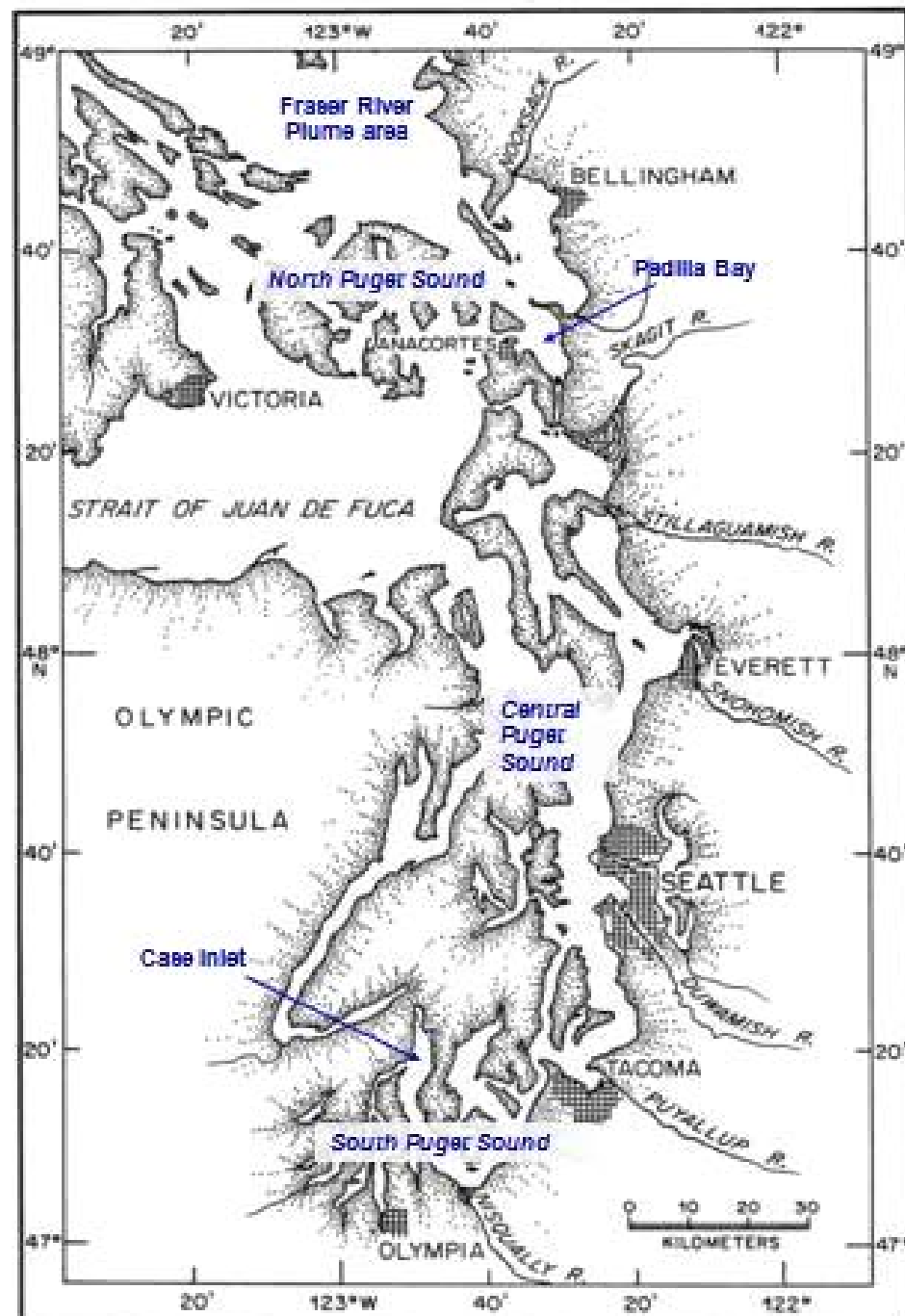
Kevin Bright, American Gold Seafood LLC

PICES 16 October 2007, Victoria, British Columbia

Overview

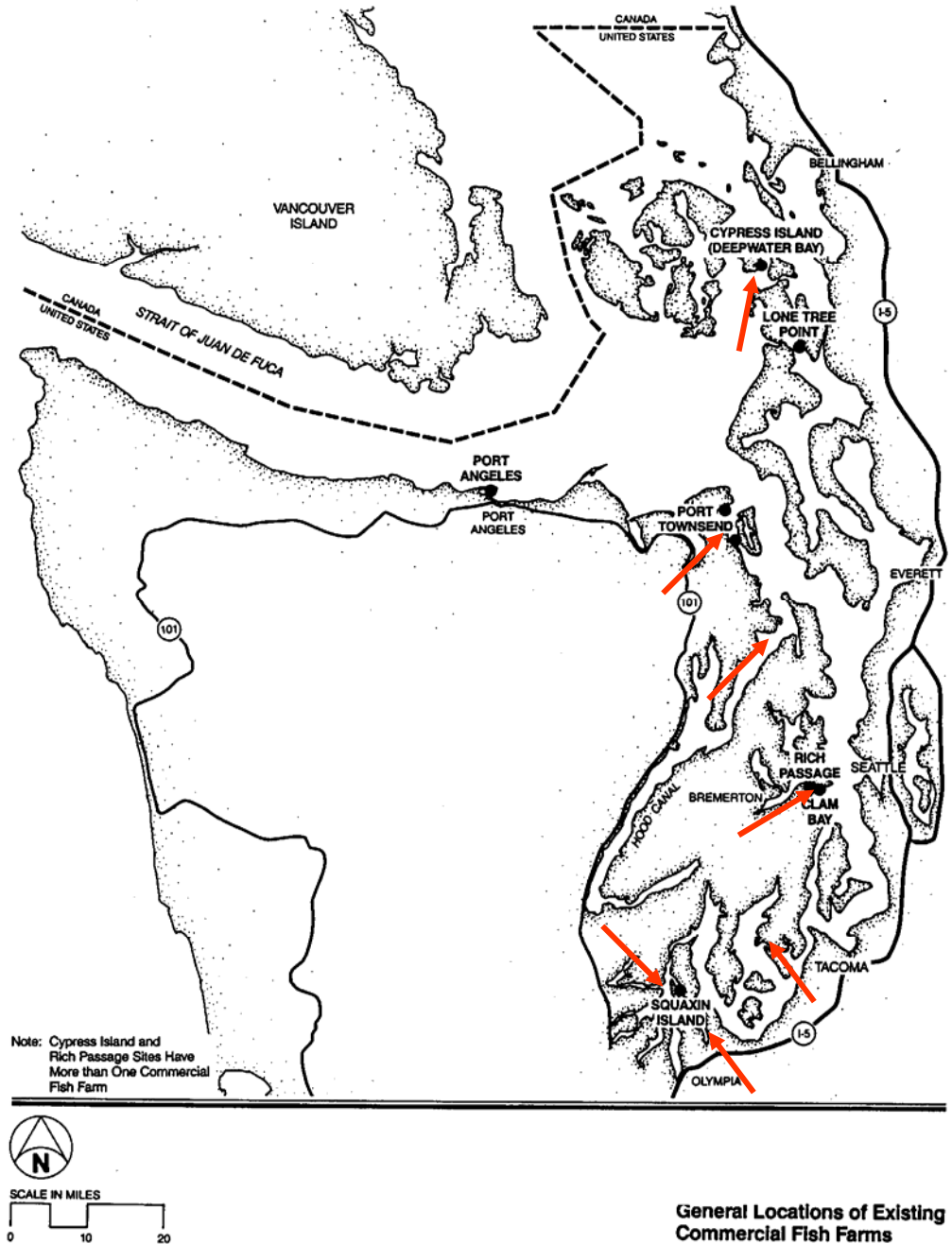
- Probable bloom initiation sites and transport NPS vs.CPS
- Fish farm discharge and bloom embellishment in PNW?
- Refinement of bloom initiation, conceptual model





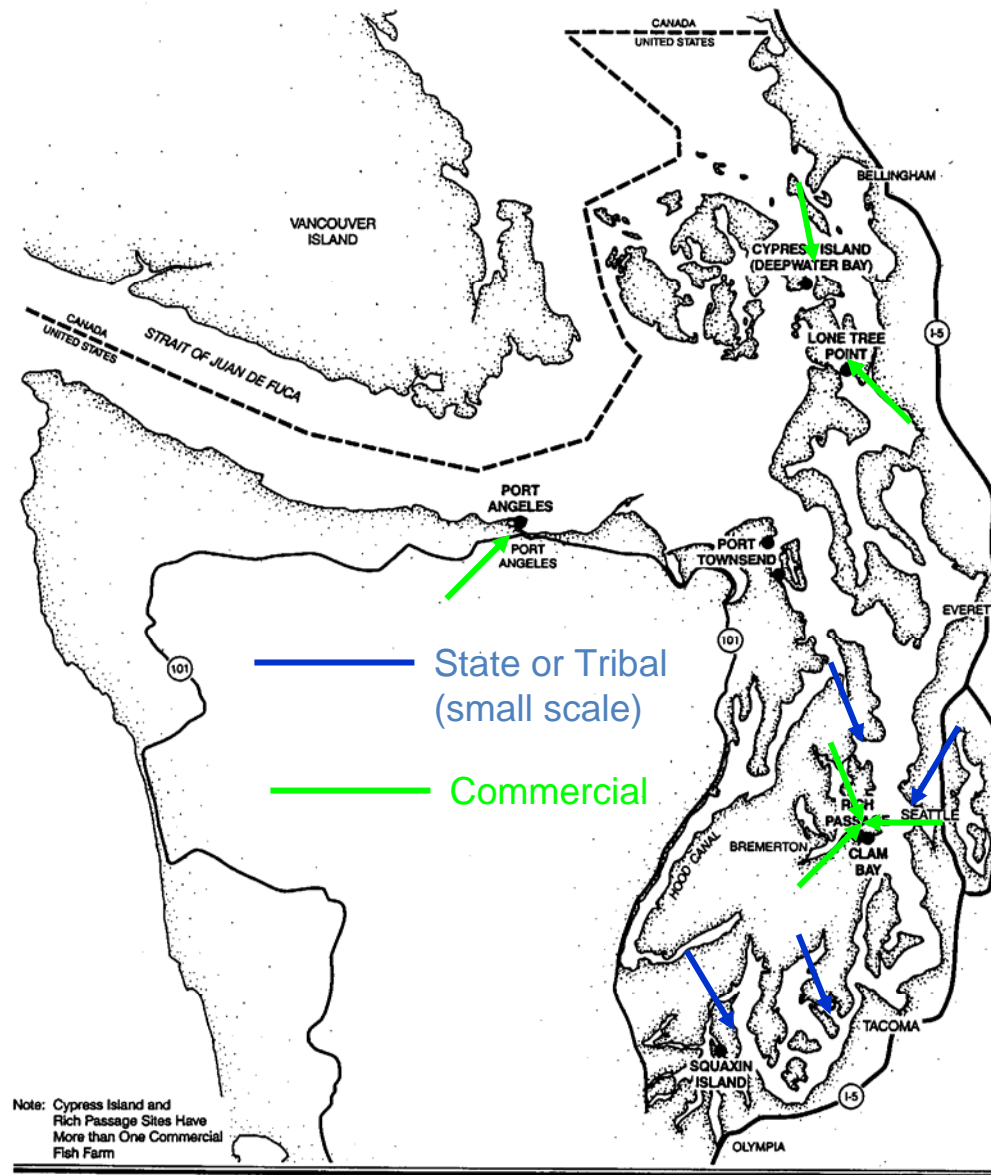
Fish Farm Sites in first years: 1970s

- Two well sited
- Several not so



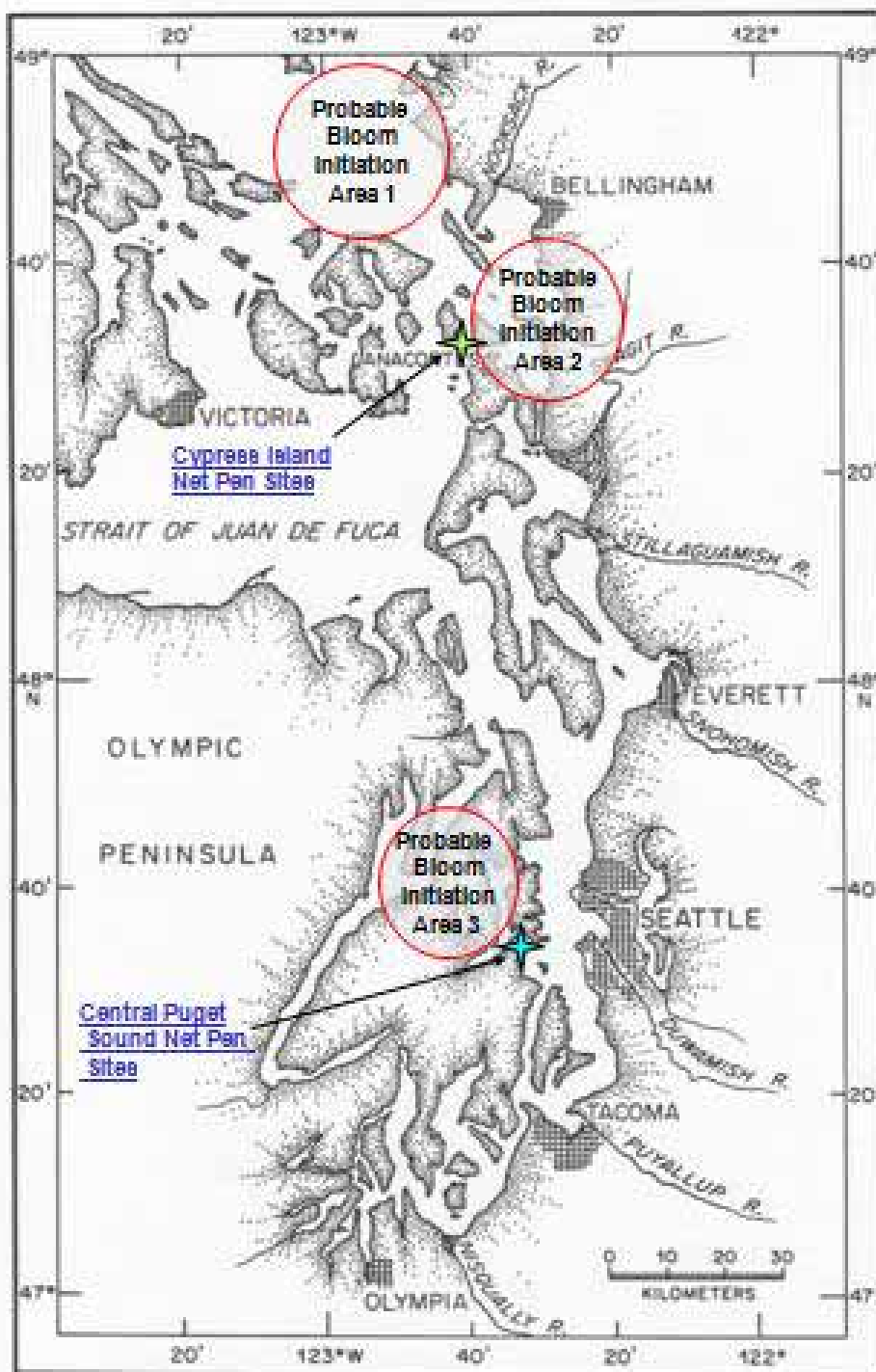
1990 →

Shift to main
channels and/or
nutrient insensitive
areas for
commercial pens



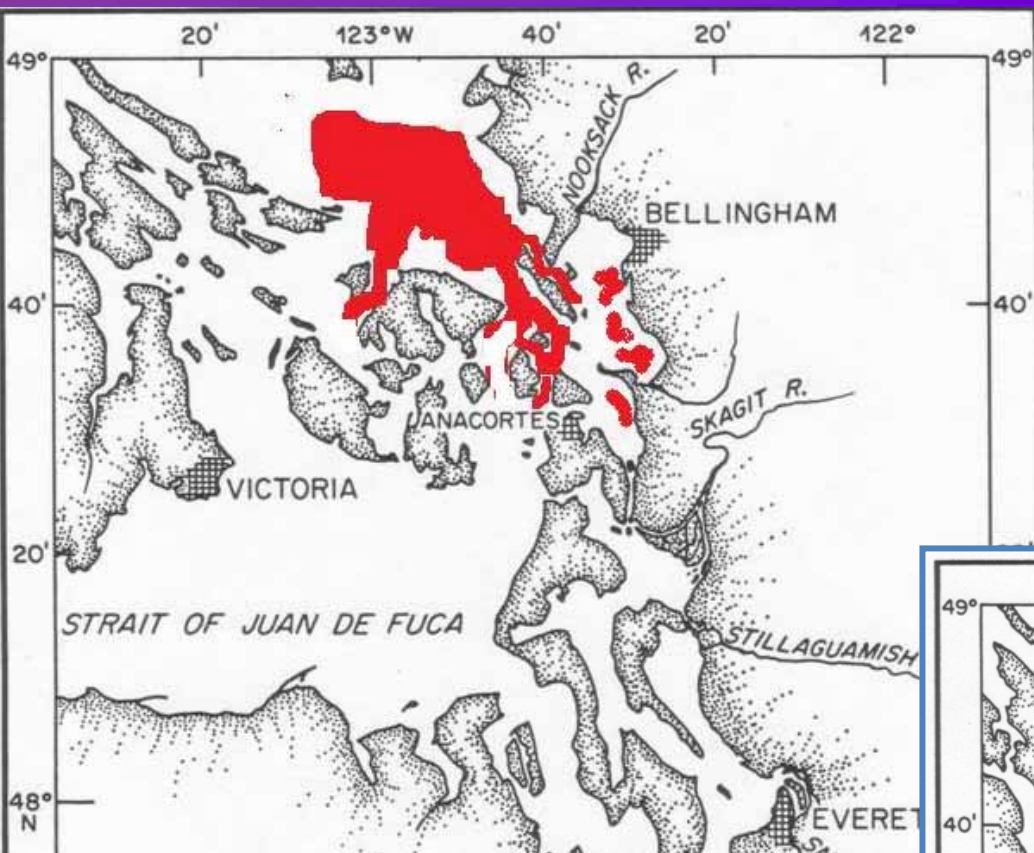
General Locations of Existing
Commercial Fish Farms





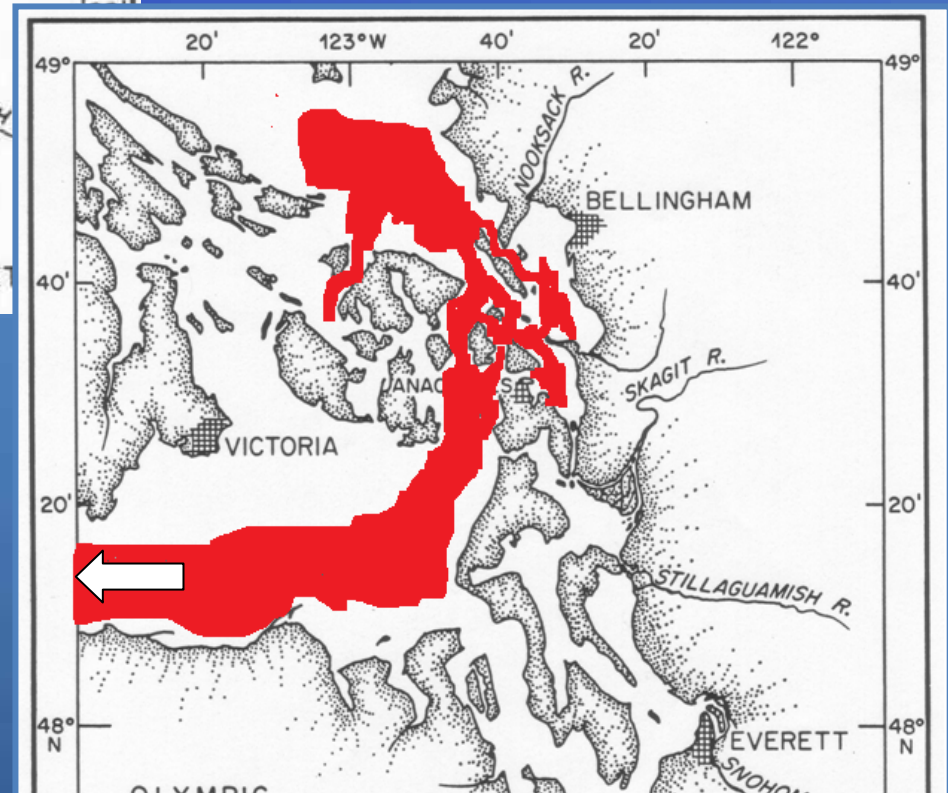
Likely bloom initiation locations

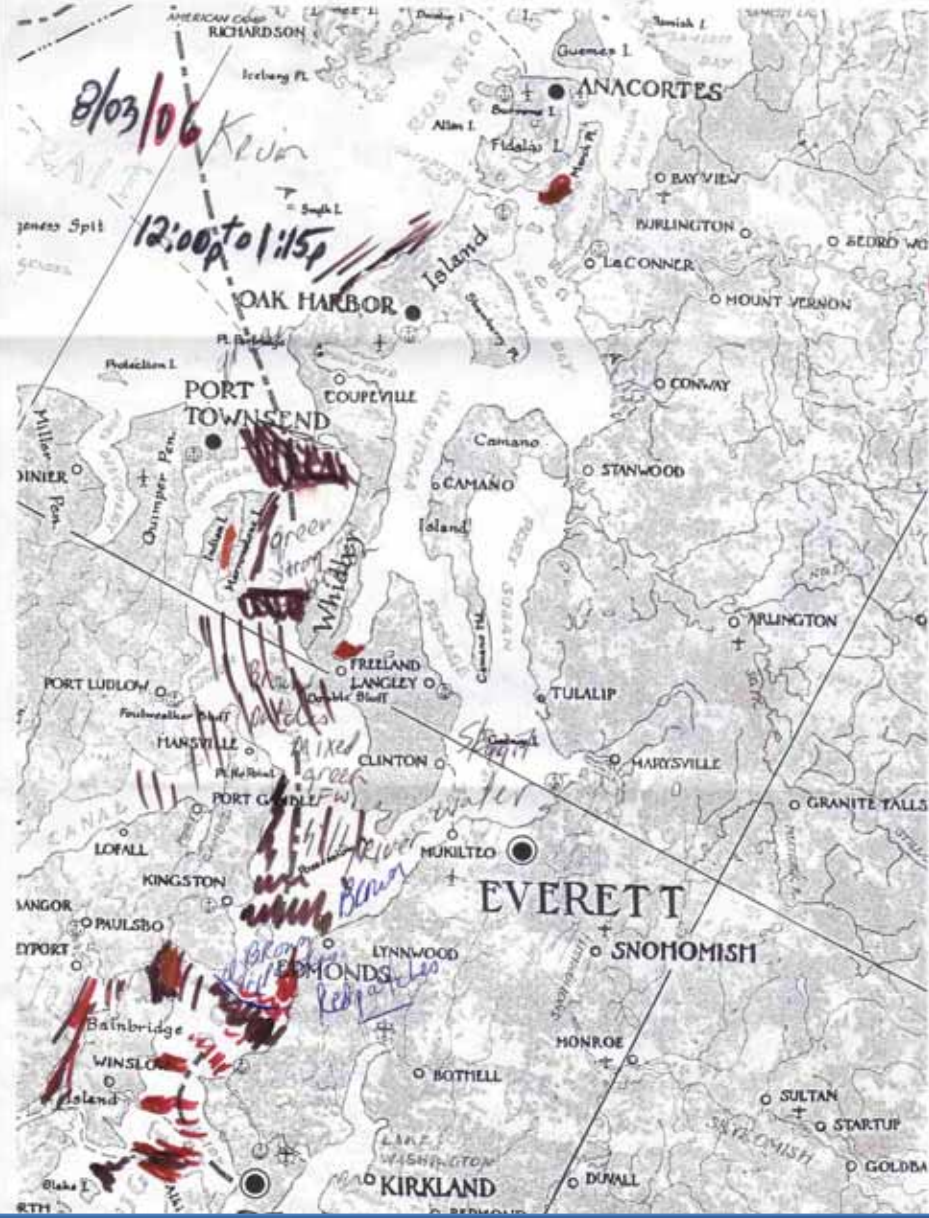
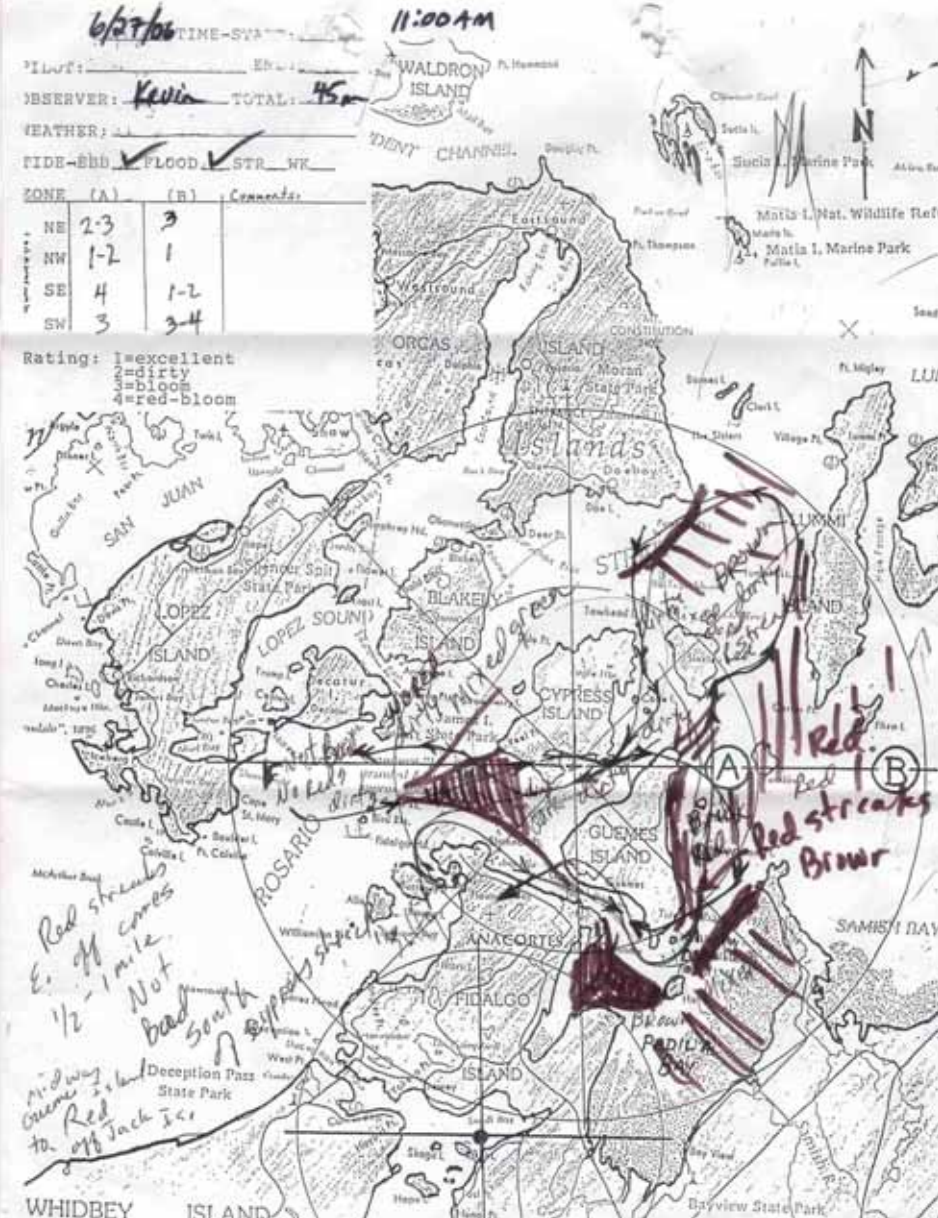
- Soft sediments
- Vertically stratified, Temp.
- Where cells first observed
- Could be elsewhere
- Frequency of blooms low but extent is huge

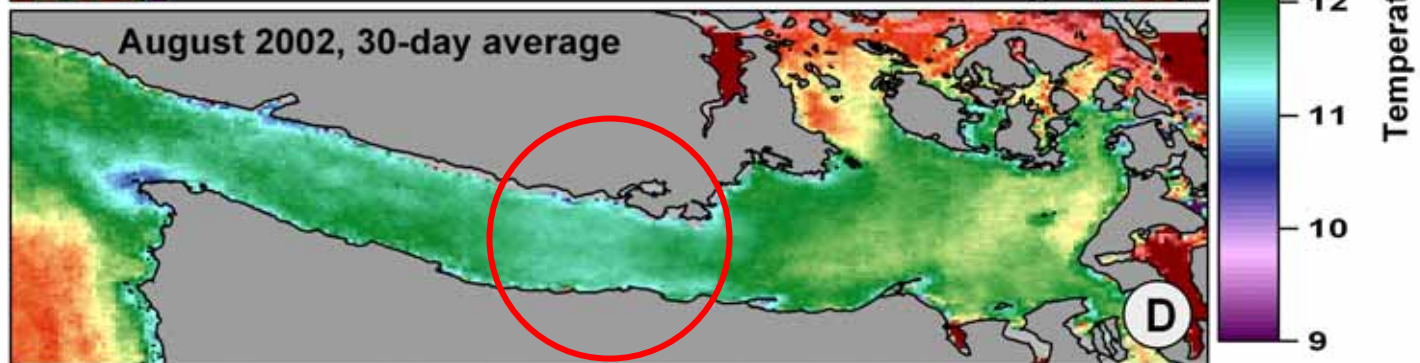
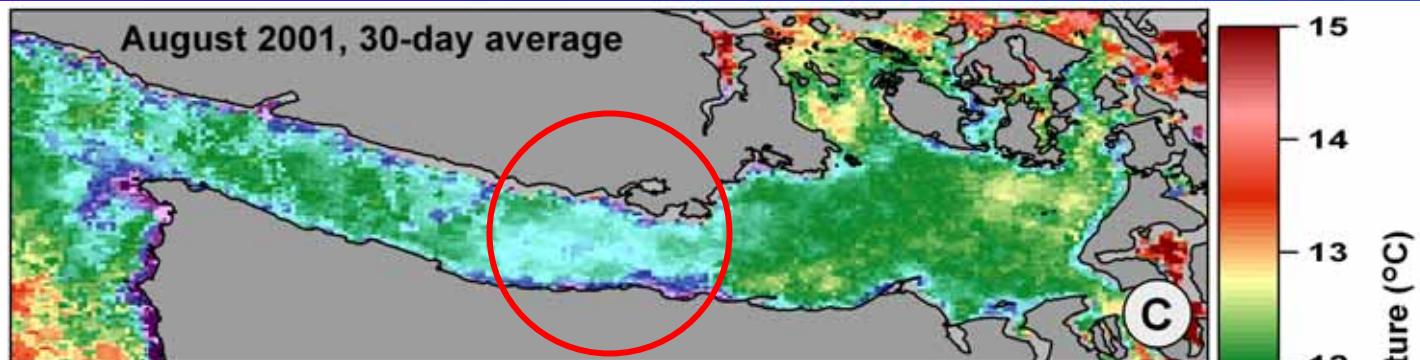
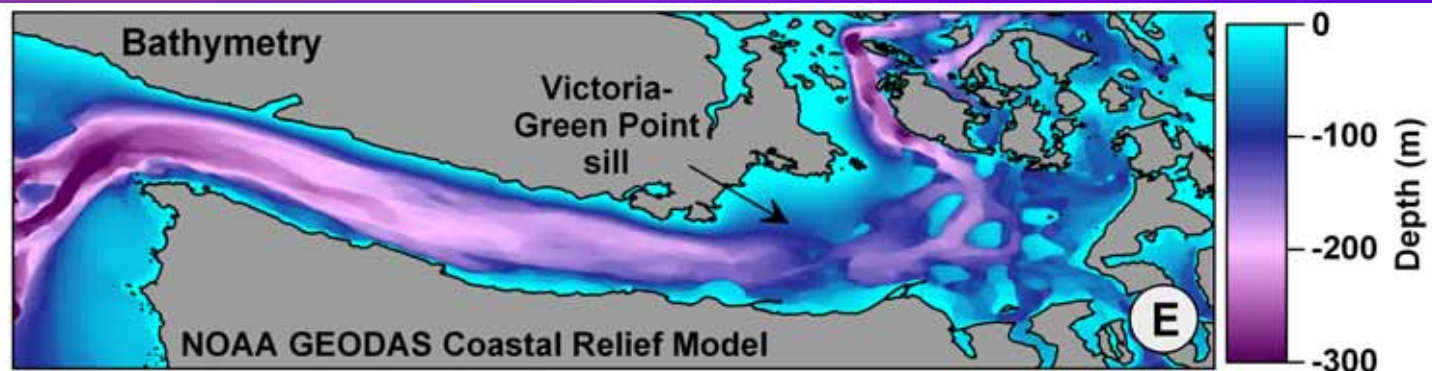


Probable Bloom Transport

- Fraser River plume
- Shallow bays, N.E. shores
- Rapid advection to ocean
- < one week duration







For Strait, bathymetry gives clues to circulation

SST images/data: fortnightly neap tidal series pulses bloom advection

Recurring mid Strait cold water anomaly* NOT neap tidal pulsing of freshwater**

*Rensel et al. 2007 Bull. Fish. Res. Agen. 19, 113-129 **Griffin and LeBlond 1990

Nitrogen Status of Main Basin & Strait

~ Phytoplankton Growth Limiting Nitrate Concentrations
($\frac{1}{2}$ saturation constants)

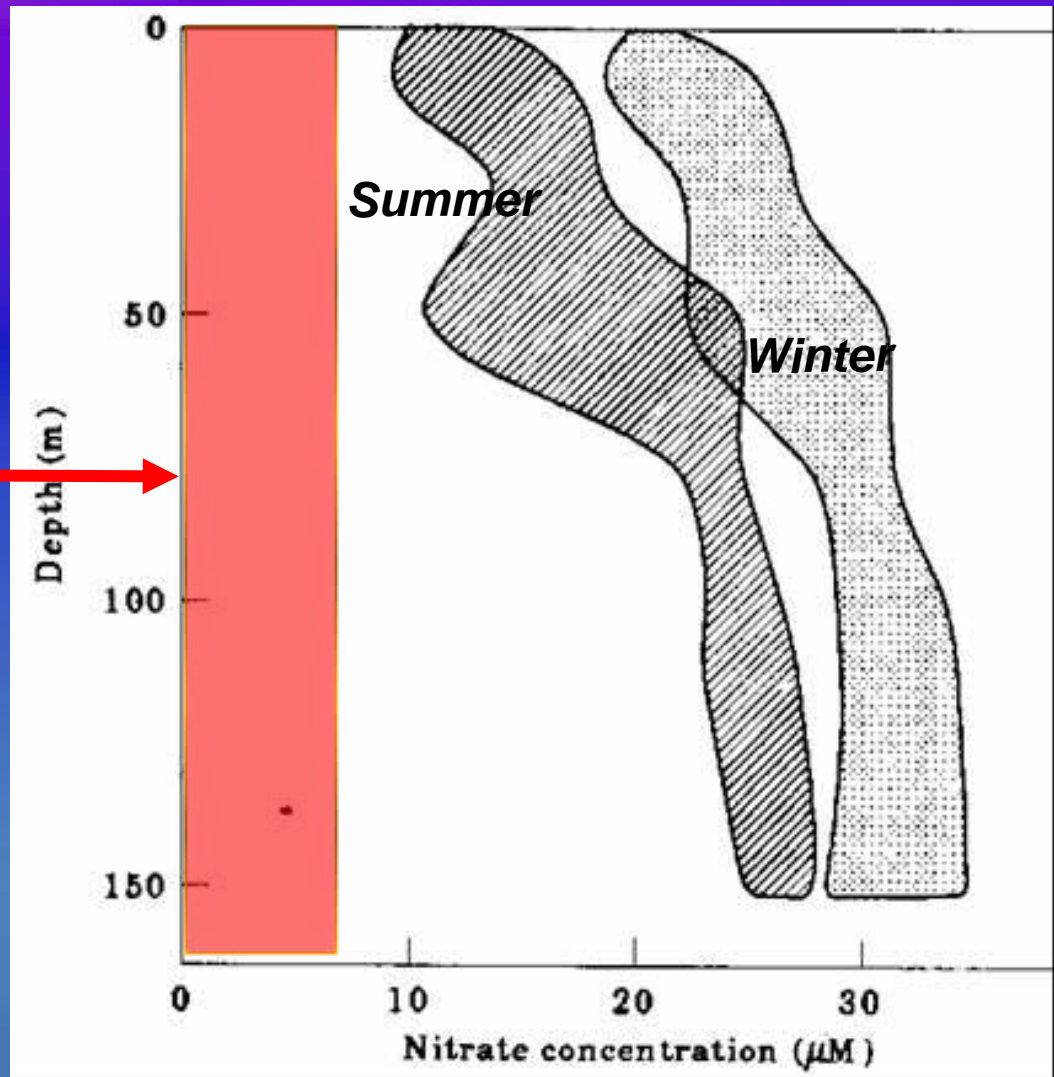
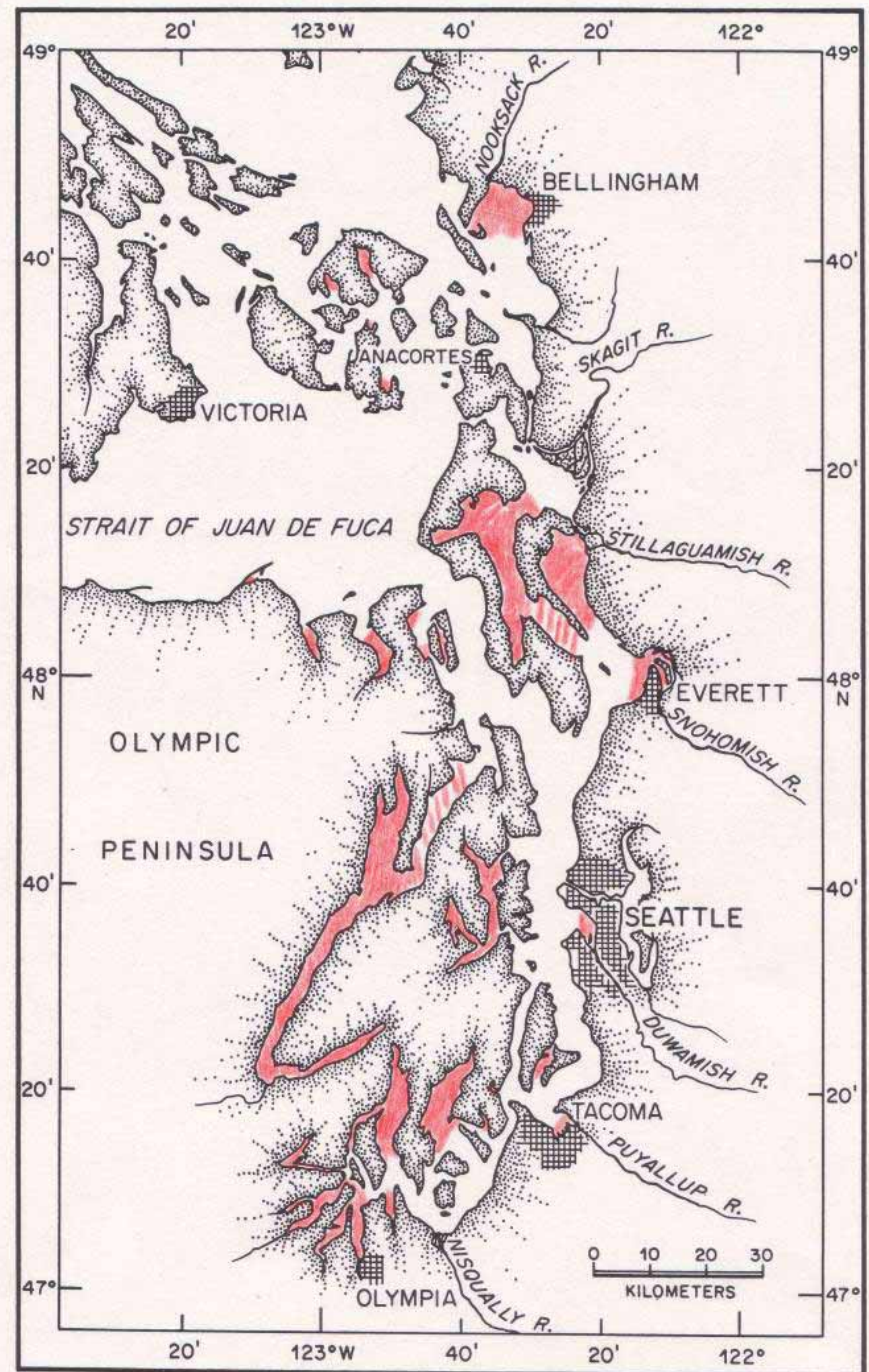
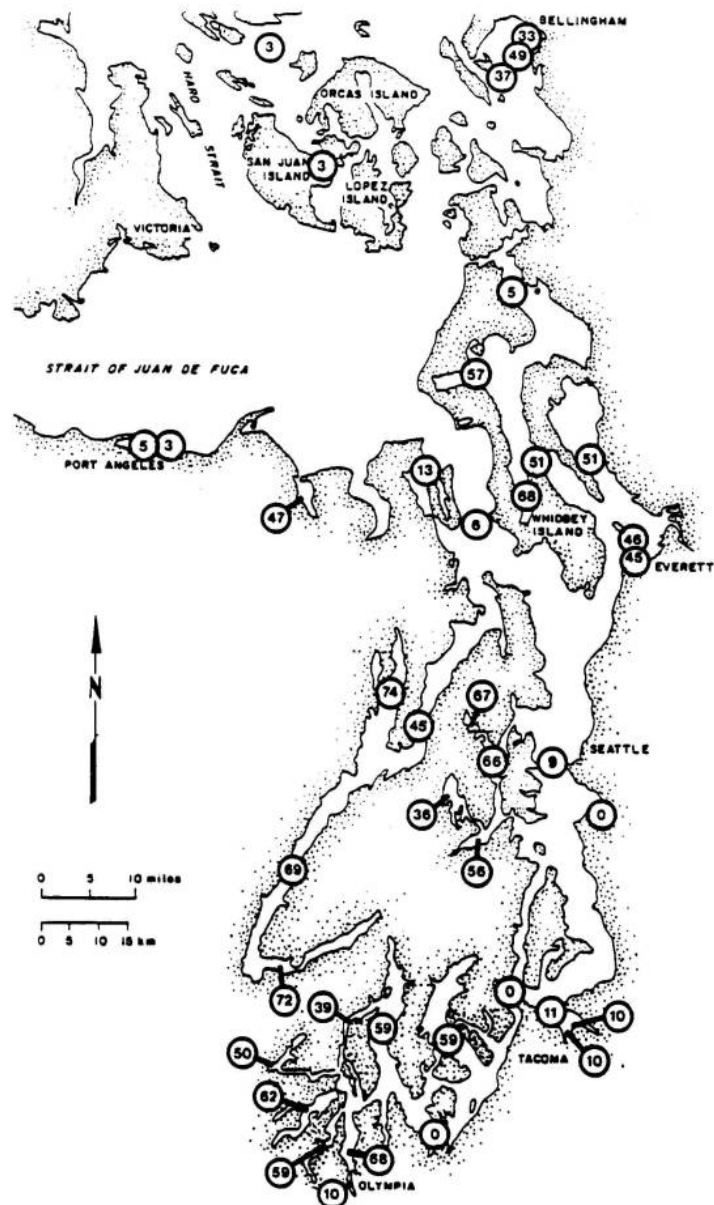


Figure after
P. Harrison et al. 1994

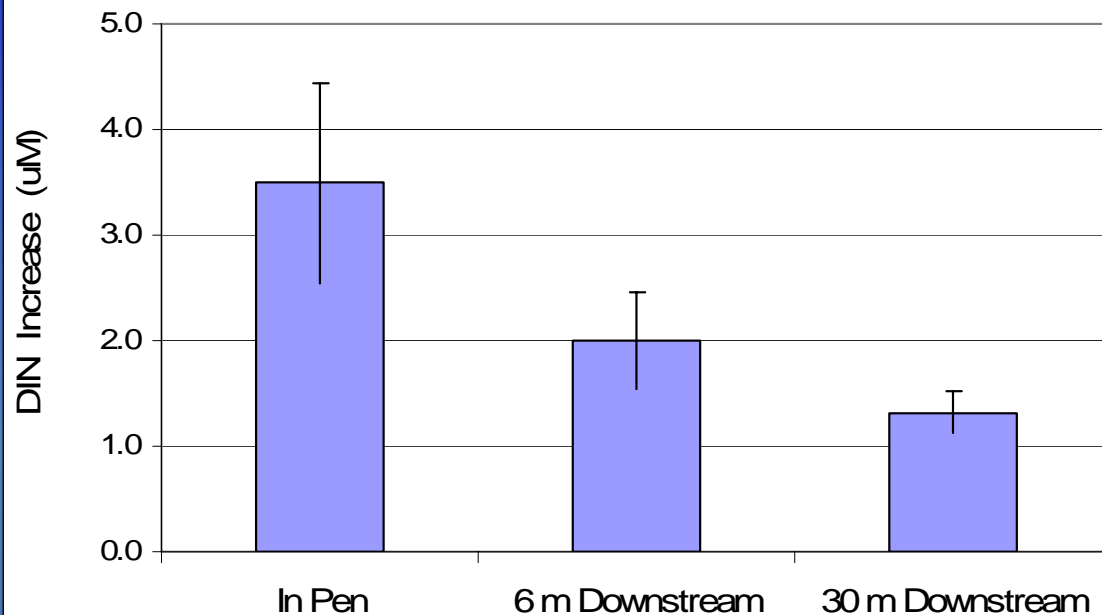
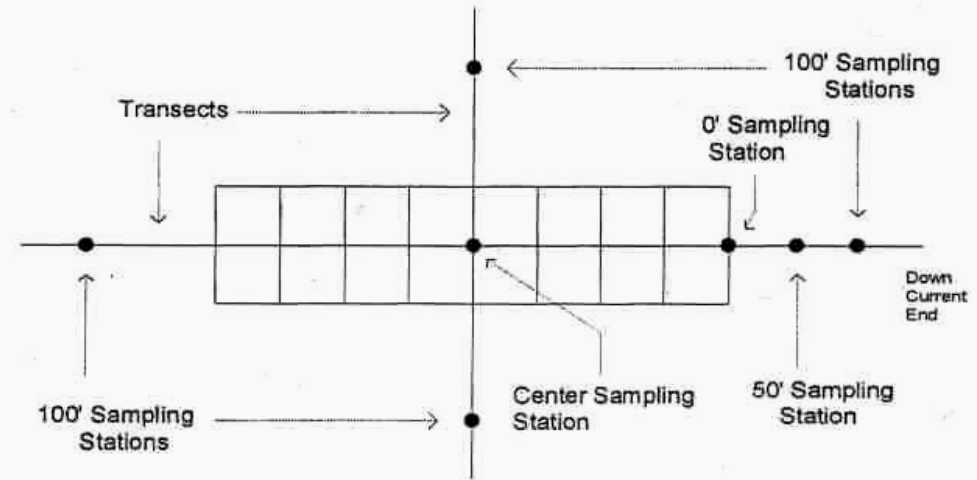
- Unlike most coastal U.S. waters in summer, N discharge is apparently not an issue in main basin & strait
- Light limitation - vertical mixing limits microalgal growth

Nutrient Sensitivity Rating: Percent of Surface water measurements $< 0.7 \mu\text{M}$ DIN (Rensel and PTI for EPA 1991)

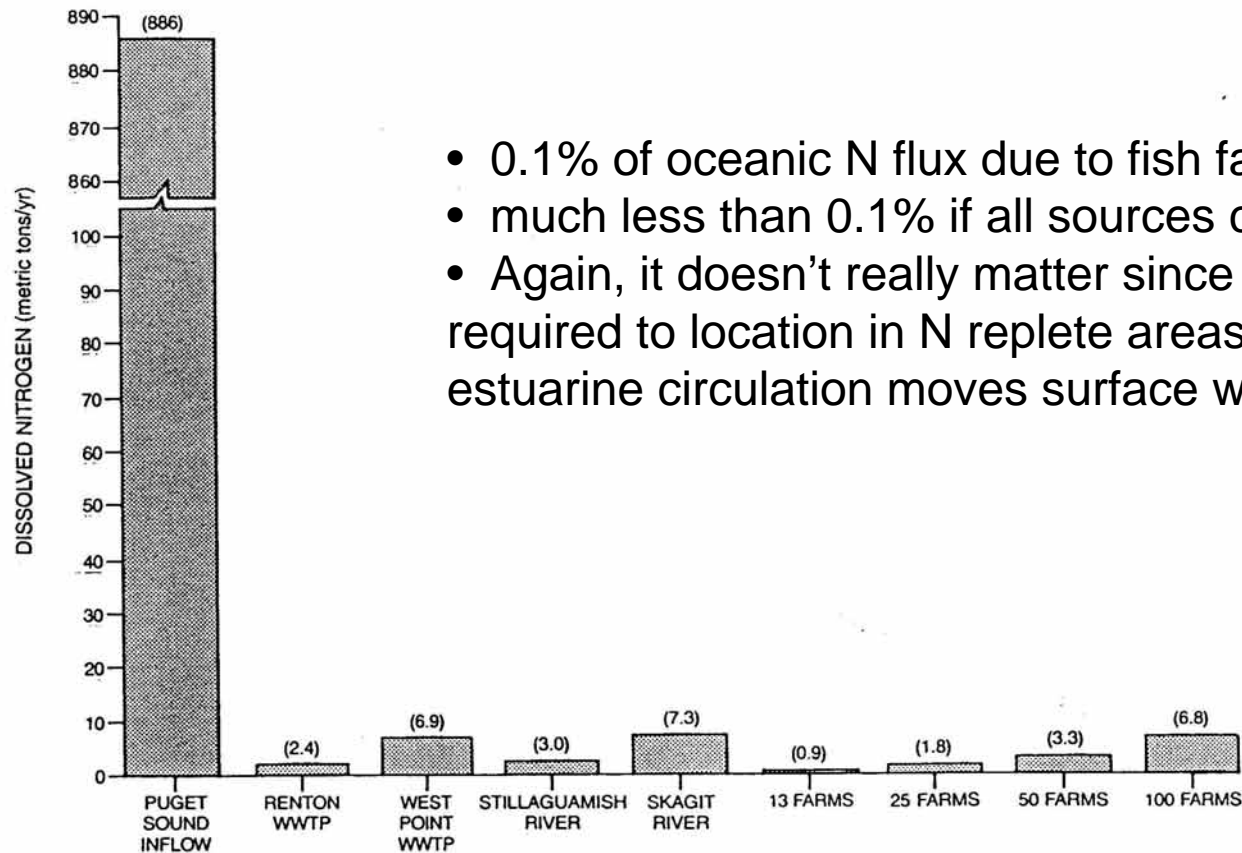


Fish Farm N Production

- Bioenergetics studies (e.g., Brett & Zala 1976)
- My work for State of Washington agencies



Rensel 1991. In WDF, Programmatic EIS for State of Washington Dept. of Fisheries



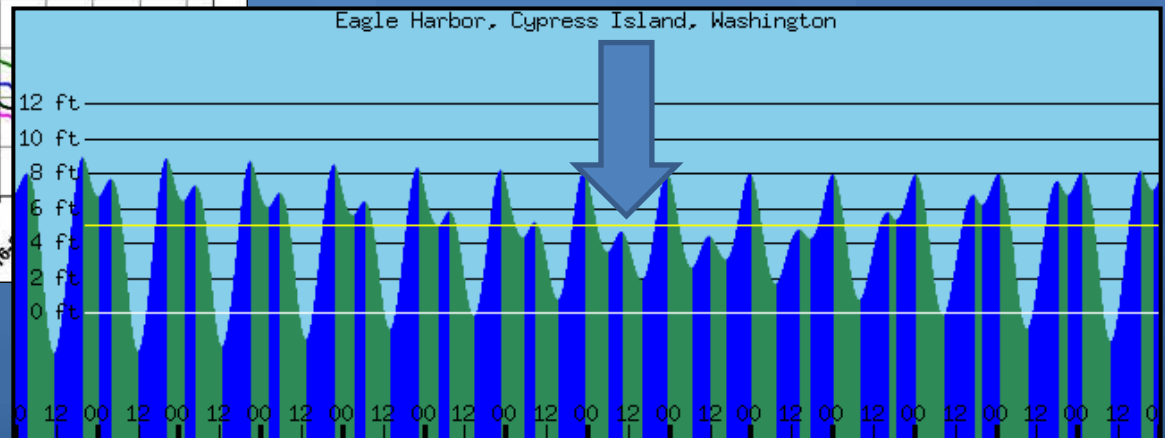
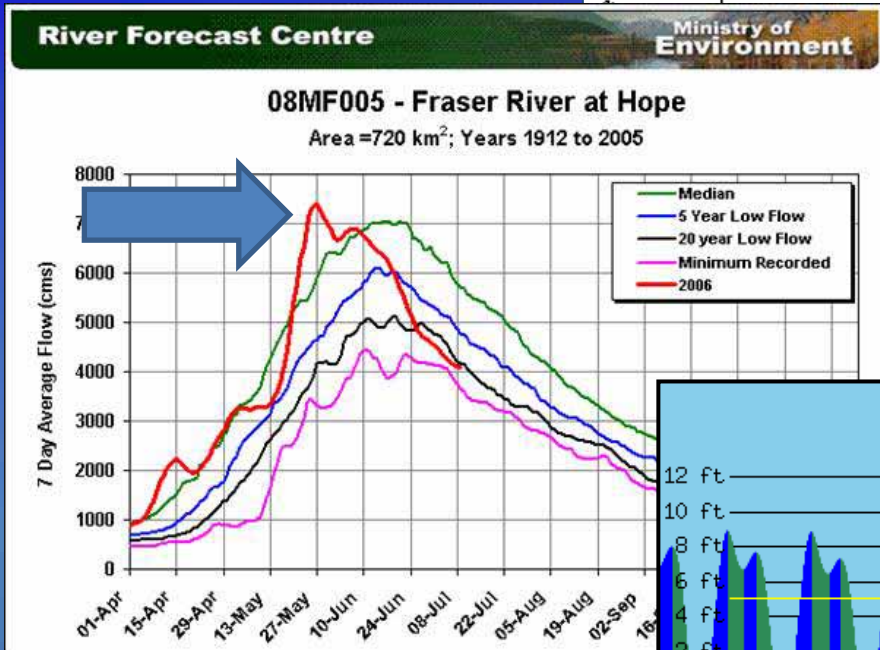
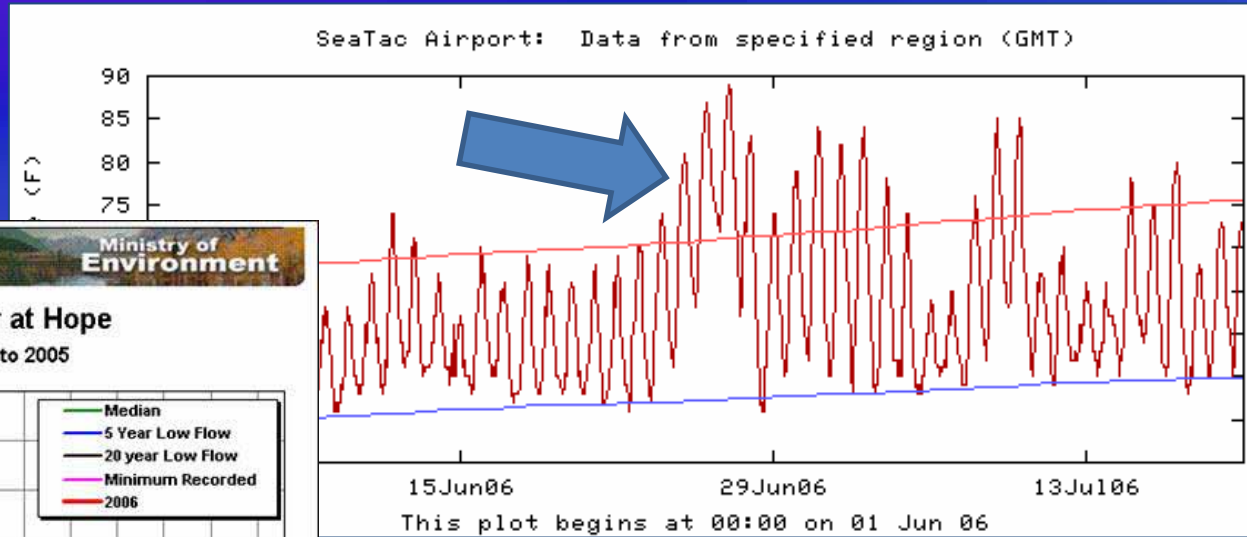
- 0.1% of oceanic N flux due to fish farms
- much less than 0.1% if all sources considered
- Again, it doesn't really matter since farms are required to location in N replete areas and estuarine circulation moves surface waters to sea

Figure 27.
Nitrogen Loading From Tidal and Freshwater Inflow,
Renton and West Point Wastewater Treatment Plants,
Stillaguamish and Skagit River, and Various Levels
of Fish Farm Development

Why 2006 bloom?

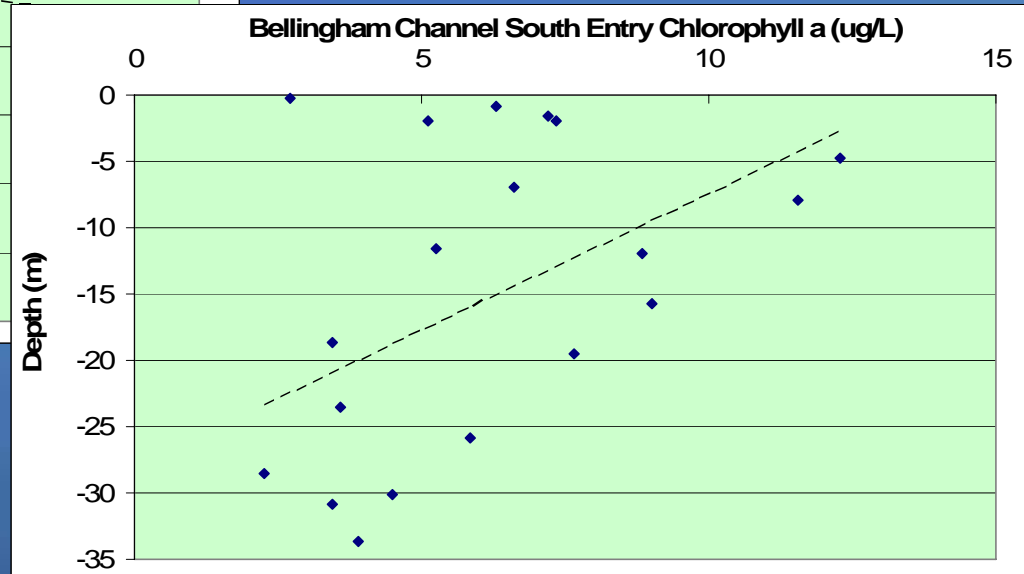
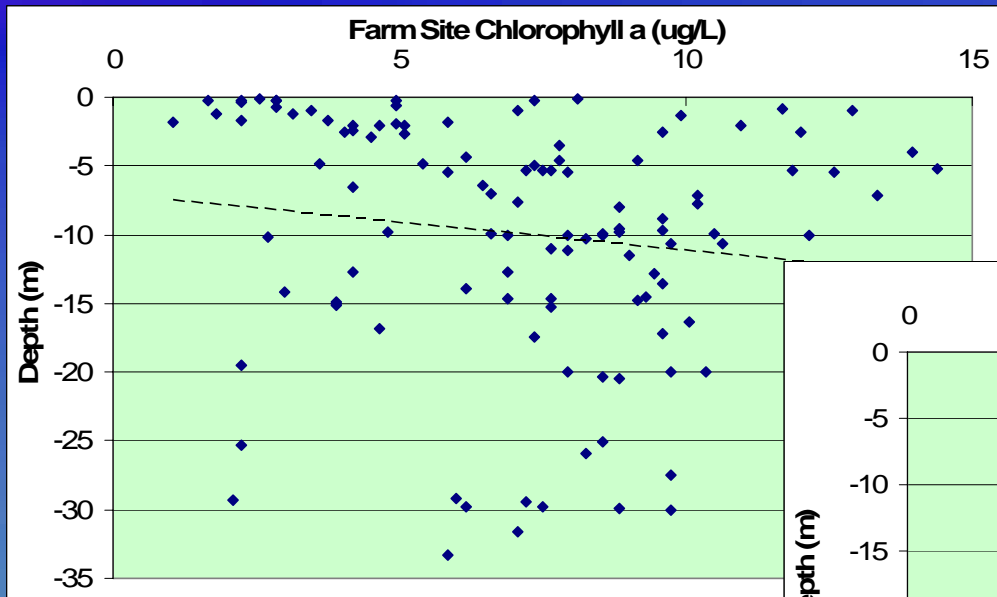
Converging physics leading to vertical stratification
NPS example from 2006

Model used by growers



Wild fish susceptibility

- Larval and juvenile fish most susceptible and seen dead in every bloom (e.g., Hershberger et al. 1997)
- Salmonids and non-salmonids, especially in bays.... Sablefish outlier?
- Dead fish sink in our cool temperate waters, dispersed & preyed upon
- Not all blooms are restricted to the surface, physics rules!



Conclusion and Opinion

- These topics subject of NOAA OAR report in final preparation
- Modeling of *Heterosigma* bloom initiation & transport is highly feasible
- We know a lot about *Heterosigma* dynamics in Puget Sound but fish mortality cause remains to be solved
- If it could be demonstrated that wild fish & the food web are regularly affected, there would be more political will to tackle bloom dynamics and the etiology of fish mortality. Alternatively,
- If congress approves the National Offshore Aquaculture Act (S.1195), introduced by Senators Ted Stevens (R-AK) and Daniel Inouye (D-HI) it will likely spur additional HAB research.

