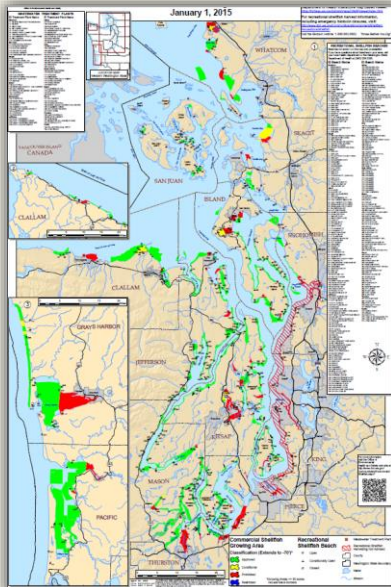


Exploring Drivers of Fecal Coliform Pollution Trends in the Puget Sound

Authors: Lindsey Hamilton, Scott Berbells, Lawrence Sullivan, Jean Snyder
Washington State Department of Health



Washington Commercial Shellfish

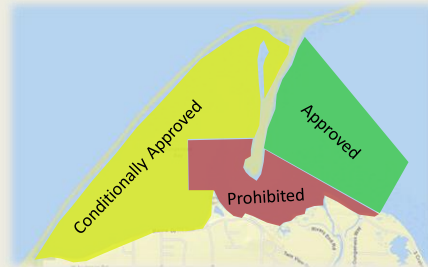


- 105 Growing Areas
- 270 million dollar industry
- Cultural Significance



Commercial Shellfish Regulation

- WA Department of Health (DOH) is the designated shellfish authority
- National Shellfish Sanitation Program
- RCW 90.72.030 requires formation of Shellfish Protection District when a growing area experiences a classification downgrade



Shellfish Protection Districts



Agriculture



On-site Sewage



Stormwater



Pet Waste

14 active Shellfish Protection Districts doing water quality restoration



How are we doing?

- How have fecal coliform levels in marine waters changed over the last 25 years?
- Are trends driven by changing environmental factors or water quality restoration efforts?
- What restoration actions seemed to have significant impacts on water quality?

Study Areas

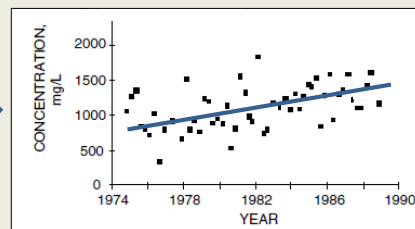
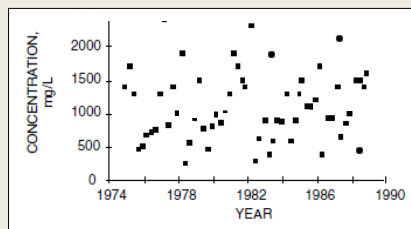
- 15 Growing Areas
 - All located in Puget Sound, WA, USA
 - All have had fluctuating water quality
 - Most have had active Shellfish Protection Districts
- Variety of watershed Characteristics
- 1989-2015



Growing Area Trend Analysis By Season

Multiple Linear Regression

$$\text{Fecal Coliform} = \alpha + \beta_1 \text{Salinity} + \beta_2 \text{Surface Water Temp} + \beta_3 \text{Rainfall (API)} + \beta_4 \text{Sample Date}$$



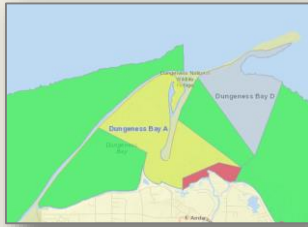
MLR Trend Results

15 Growing Areas:

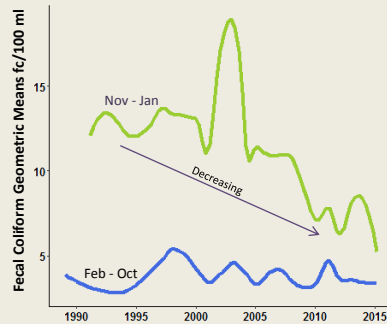
- No increasing trends in areas with Shellfish Protection Districts
- Declining trends detected in 10 out of 15 growing areas
- No apparent regional trends



Dungeness Bay Trends

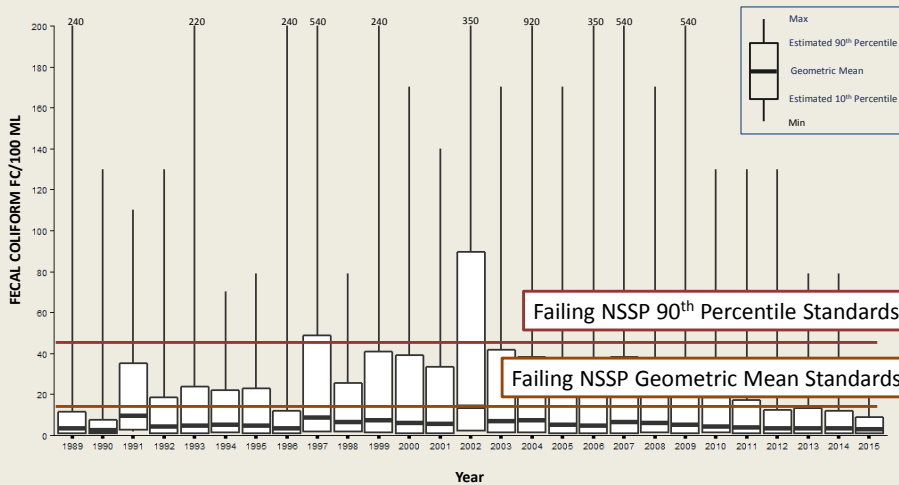


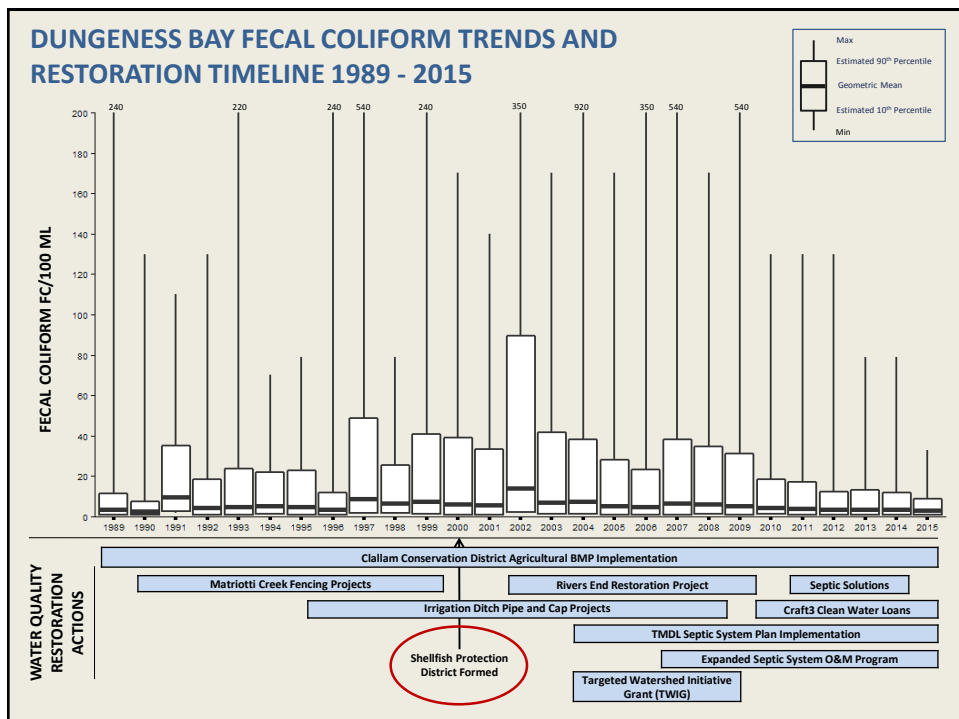
SEASONAL FECAL COLIFORM TRENDS



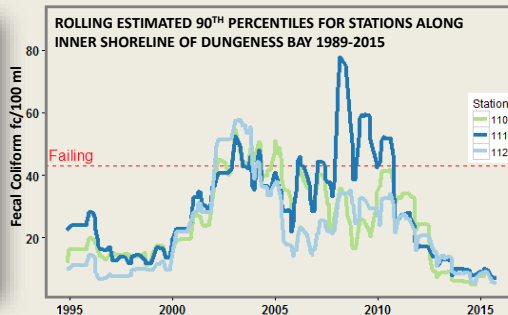
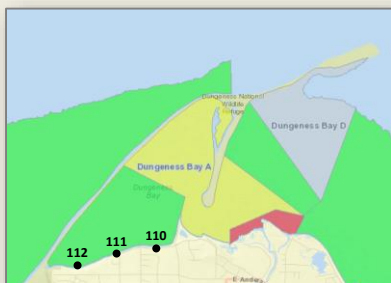
Growing Area Box Plots

DUNGENESS BAY GROWING AREA



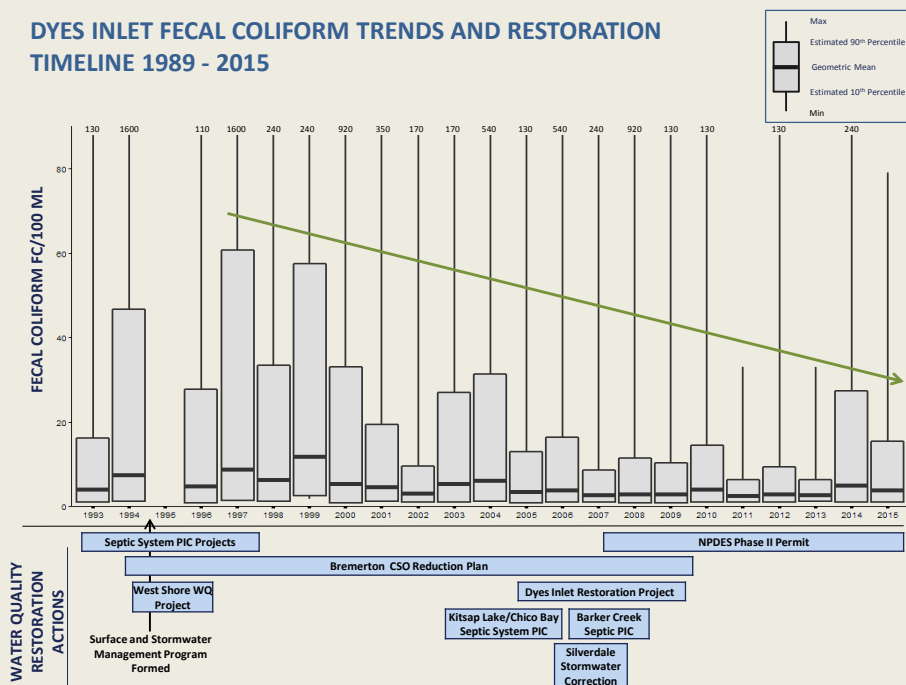


Dungeness Bay Shoreline Stations

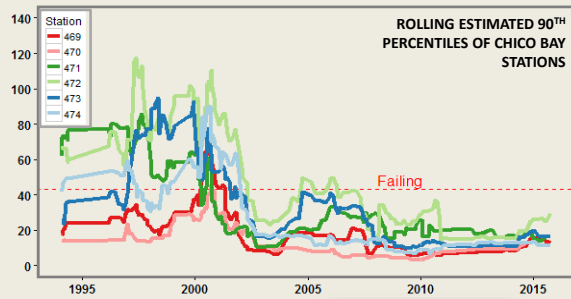


An irrigation Pipe and Cap project prevents agricultural water from discharging into the inner bay.

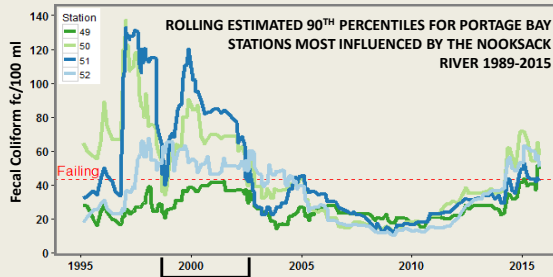
DYES INLET FECAL COLIFORM TRENDS AND RESTORATION TIMELINE 1989 - 2015



Chico Bay in Dyes Inlet

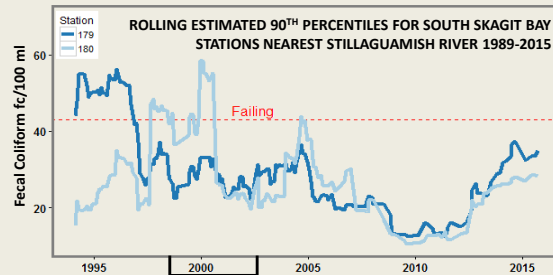


Kitsap County Health addressed wildlife and on-site septic system issues in Chico Bay.



Washington Dairy Nutrient Management Act

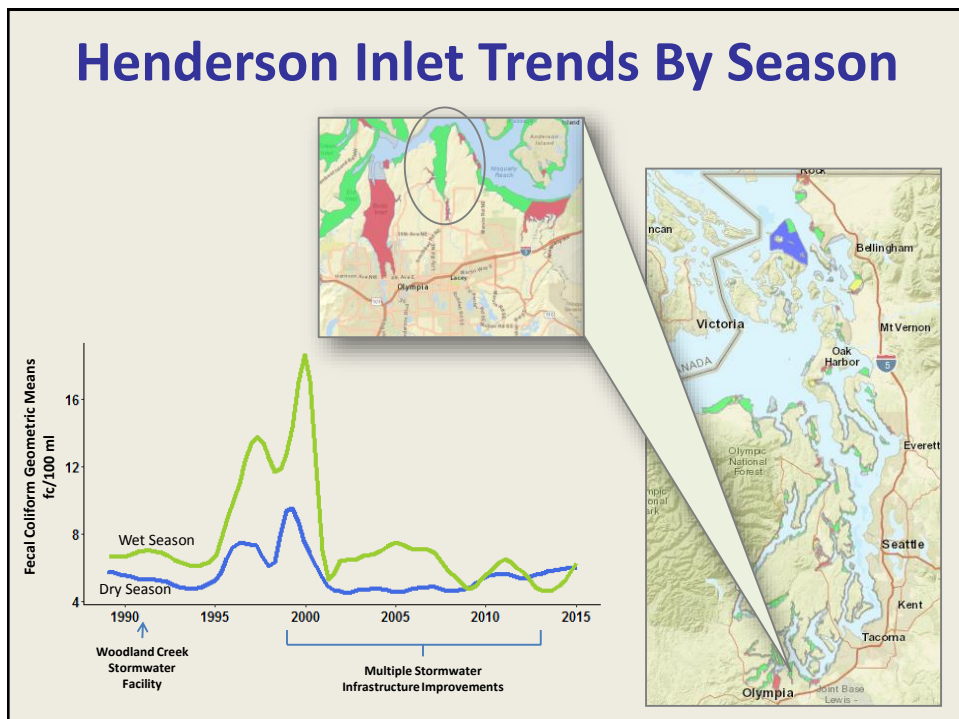
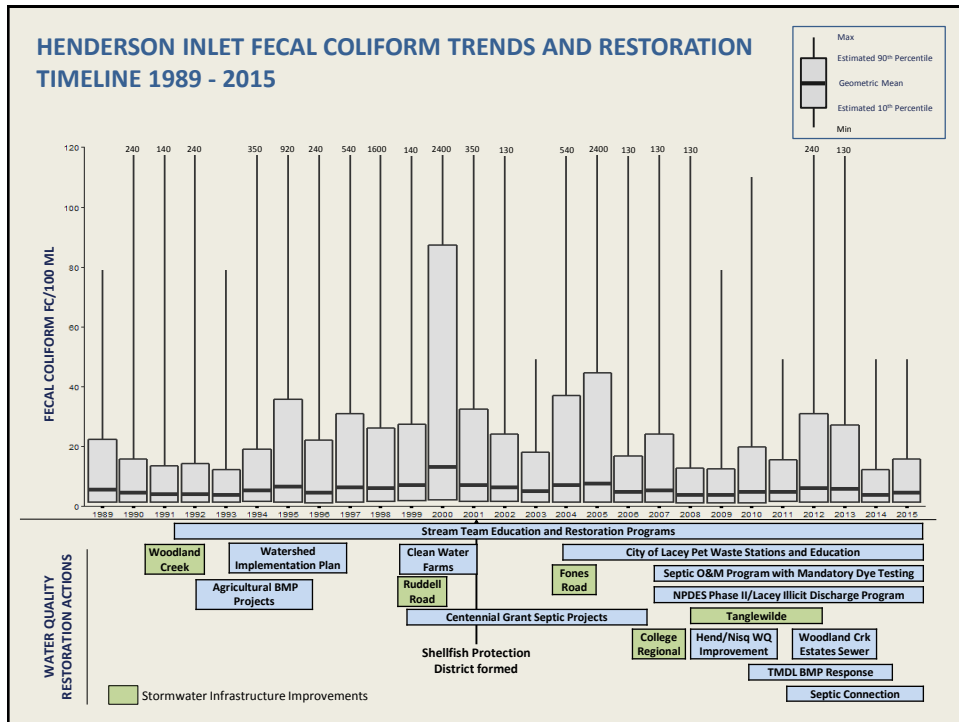
Portage Bay



Washington Dairy Nutrient Management Act

South Skagit Bay





What We Think

- All watersheds should have well organized and funded septic operations and maintenance programs, combined with cost share programs.
- There should adequately funded and staffed programs to provide education, and technical and financial assistance to agricultural operations.
- We need sustained funding for all of our Shellfish Protection Districts.

Thank You!



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