

Long-Term Studies in Port Valdez, Alaska

Highlights of 40+ Years of Research

Environmental/Biological interactions

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Port Valdez
40 Years
Studies 1971-2011

Acknowledgments

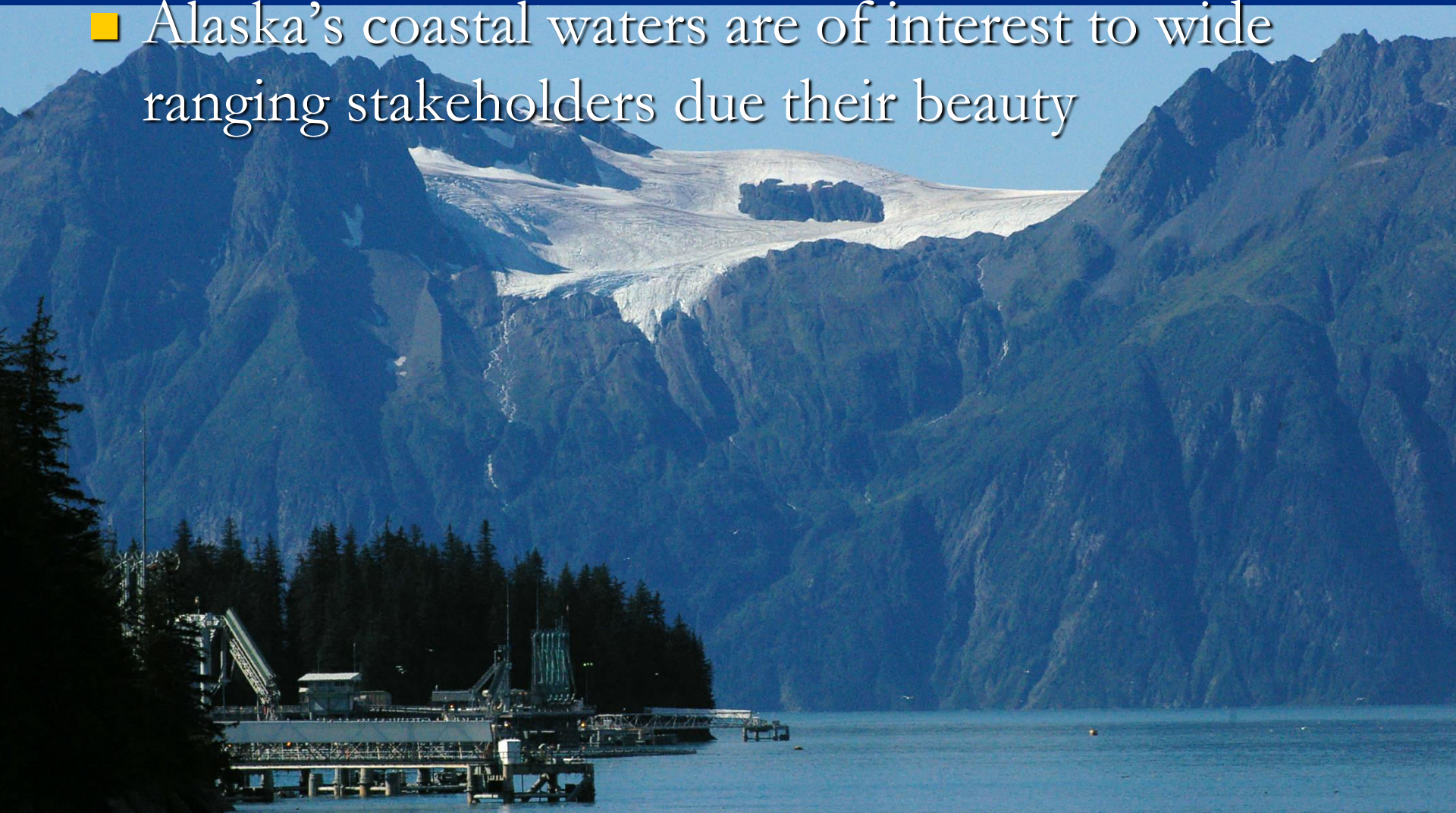
The environmental studies in Port Valdez were funded by the Alyeska Pipeline Service Co.

We thank the many technicians and students who have assisted on the project, David Connor of Alyeska Pipeline Service Co. for his support, and the captains and crews of the M/V Valdez Star for their assistance in sampling.



Alaska's Coastal Aesthetics

- Alaska's coastal waters are of interest to wide ranging stakeholders due their beauty



Alaska's Coastal Resources

- Alaskan's care deeply about their resources they depend on.



Alaska's Coastal Resources

- Even for personal use and subsistence.



Alaska's Coastal Resources

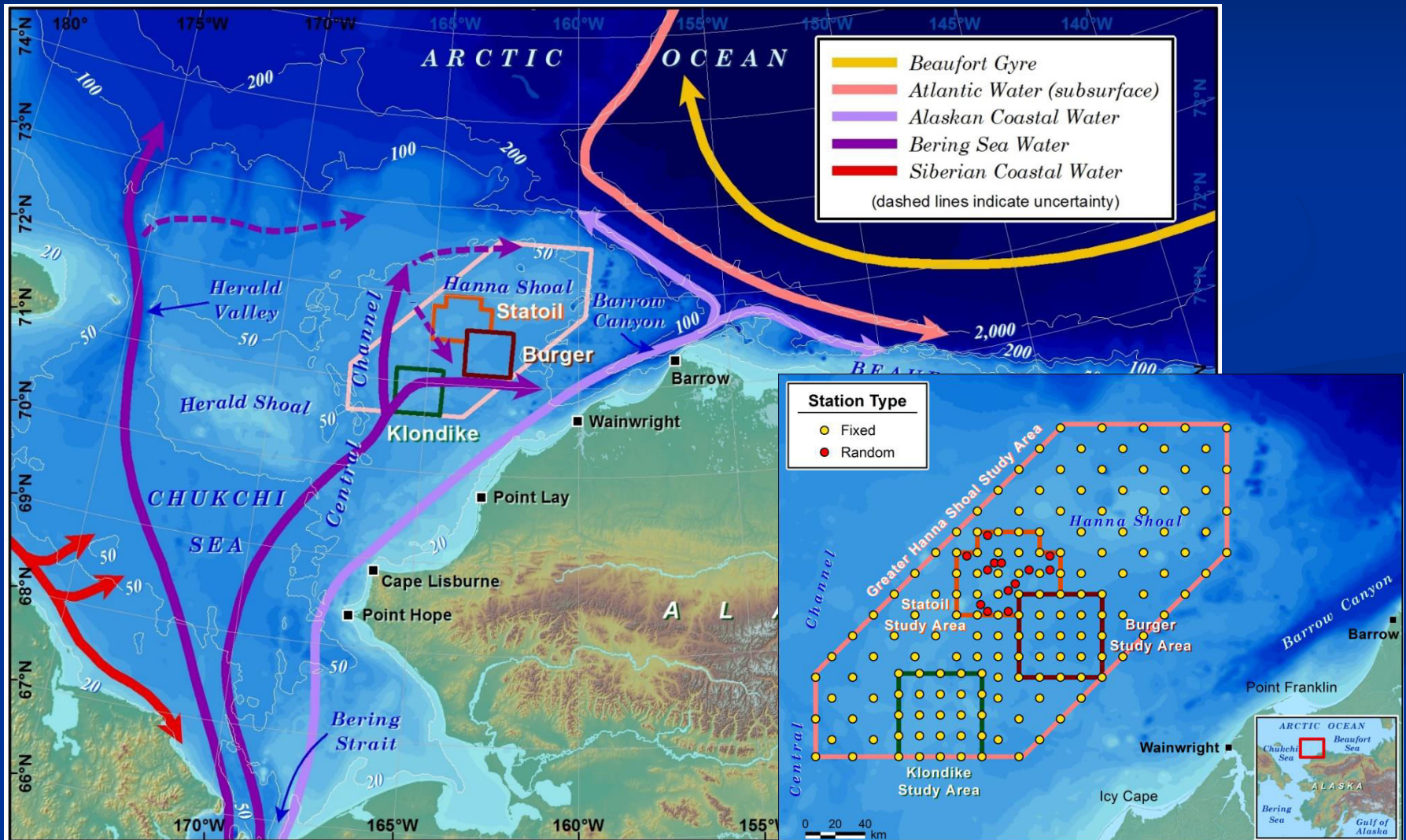
- Resource include numerous marine mammals and birds.



Alaska's Coastal AK MAP Regions



Chukchi Sea Environmental Studies Program (CSESP)

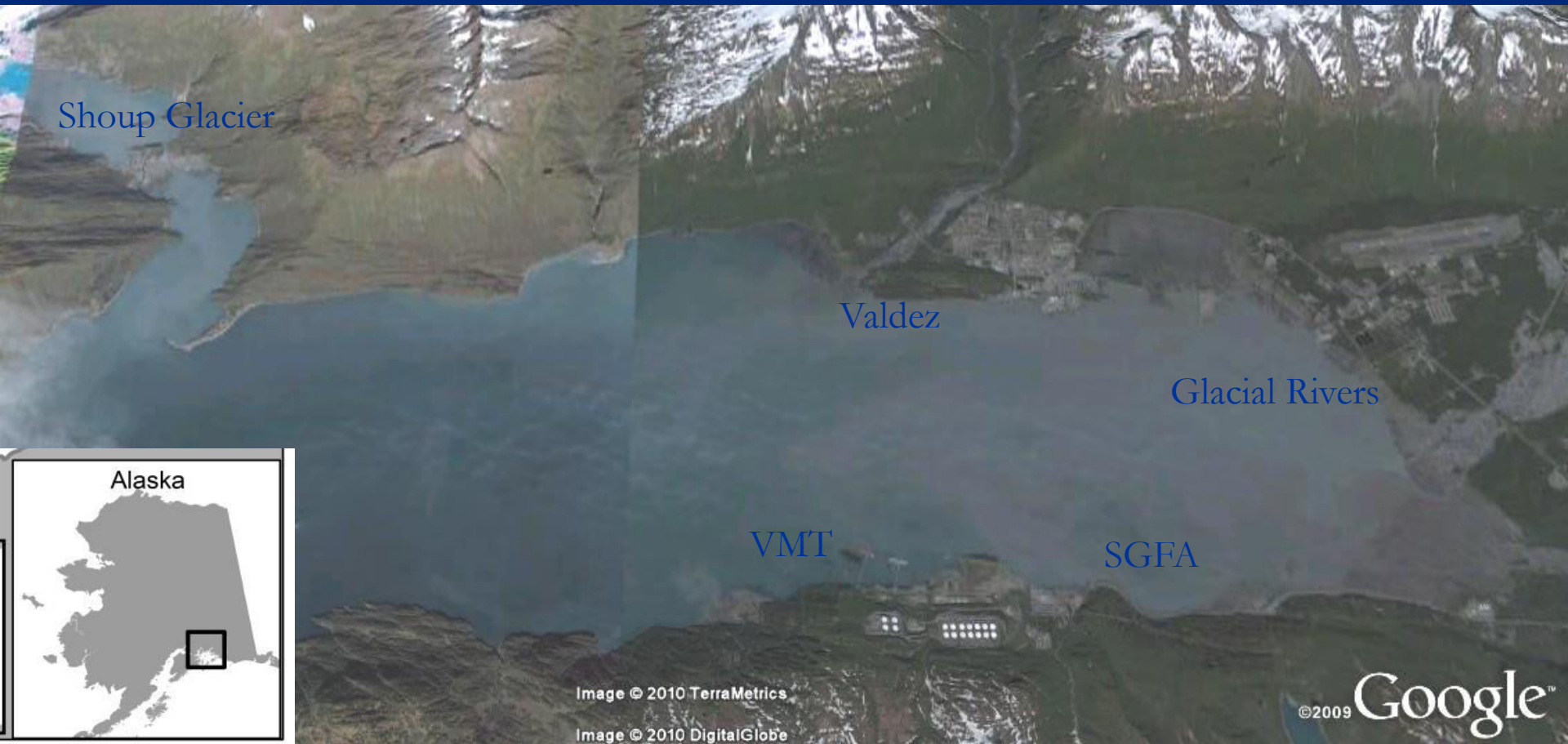


Port Valdez Environmental Studies Program (PVESP)

- A long-term environmental project monitoring sediments adjacent to a treated ballast water outfall.



Port Valdez: a glacial fjord



Unique Features of Glacial Fords

- Glaciers and glacial sediments.
- Steep sides.
- Sharp environmental gradients.
- Sites of human activities & change.



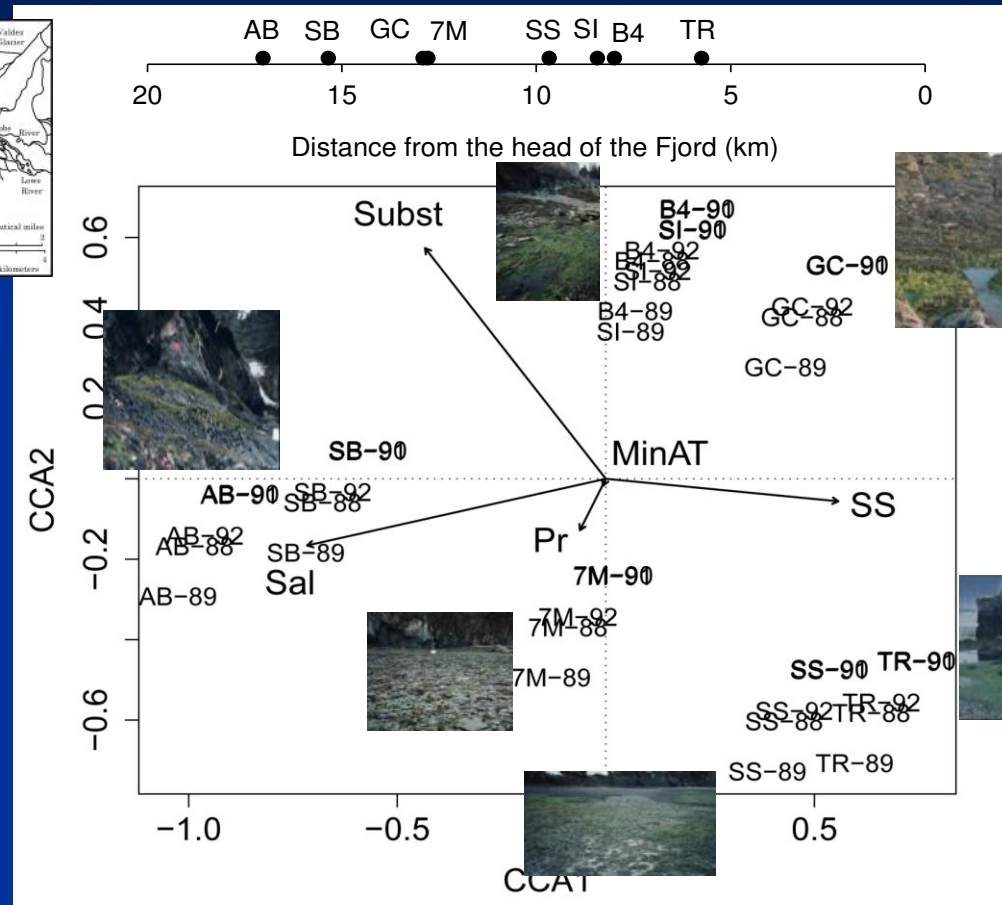
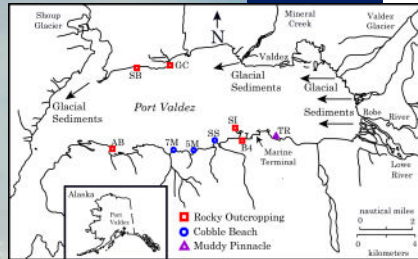
Facts about Port Valdez



- Was heavily impacted by sediment slumping and tsunami scouring after a 9.2 magnitude earthquake in 1964,
- Is the site of a major marine oil terminal, and
- Is the site of a shoreline fish hatchery.

Intertidal Studies 1976-1992

Influence of Physical Factors (1988-1992)



High Salinity,
Lower glacial sediments

Low Salinity,
High glacial sediments

Freshwater Influences

Intertidal/shoreline gradients

Rocky Shore



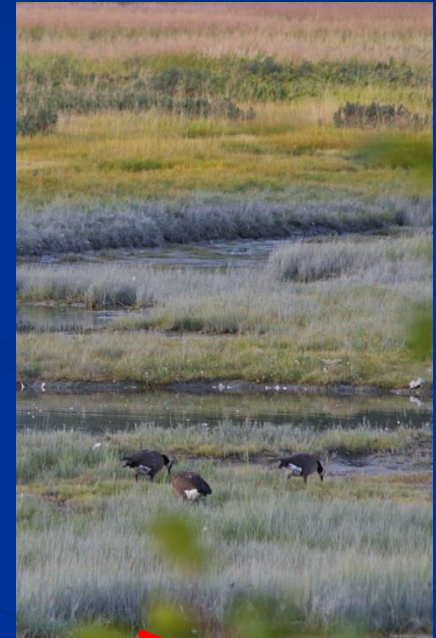
Cobble Beach



Mudflat and Pinnacle



Brackish-water
Grasses



High Salinity,
Lower glacial sediments

Low Salinity,
High glacial sediments



Freshwater Influences



**Subtidal Studies
1971-2012**

Sampling for Benthic Inverts

The target animals are sediment-dwelling invertebrates.

Samples are collected with a vanVeen grab (0.1 m²).



Sampling for Benthic Inverts



Samples are washed through 1.0 mm screen and the animals sorted, identified, counted and weighed.



Benthic Invertebrates of



Galathowenia oculata



Why monitor Invertebrates?

Sediment-dwelling invertebrates are preferred organisms for biological monitoring because:

They can't escape changing environmental conditions.

They must either adapt, move, or die.

Marine Succession

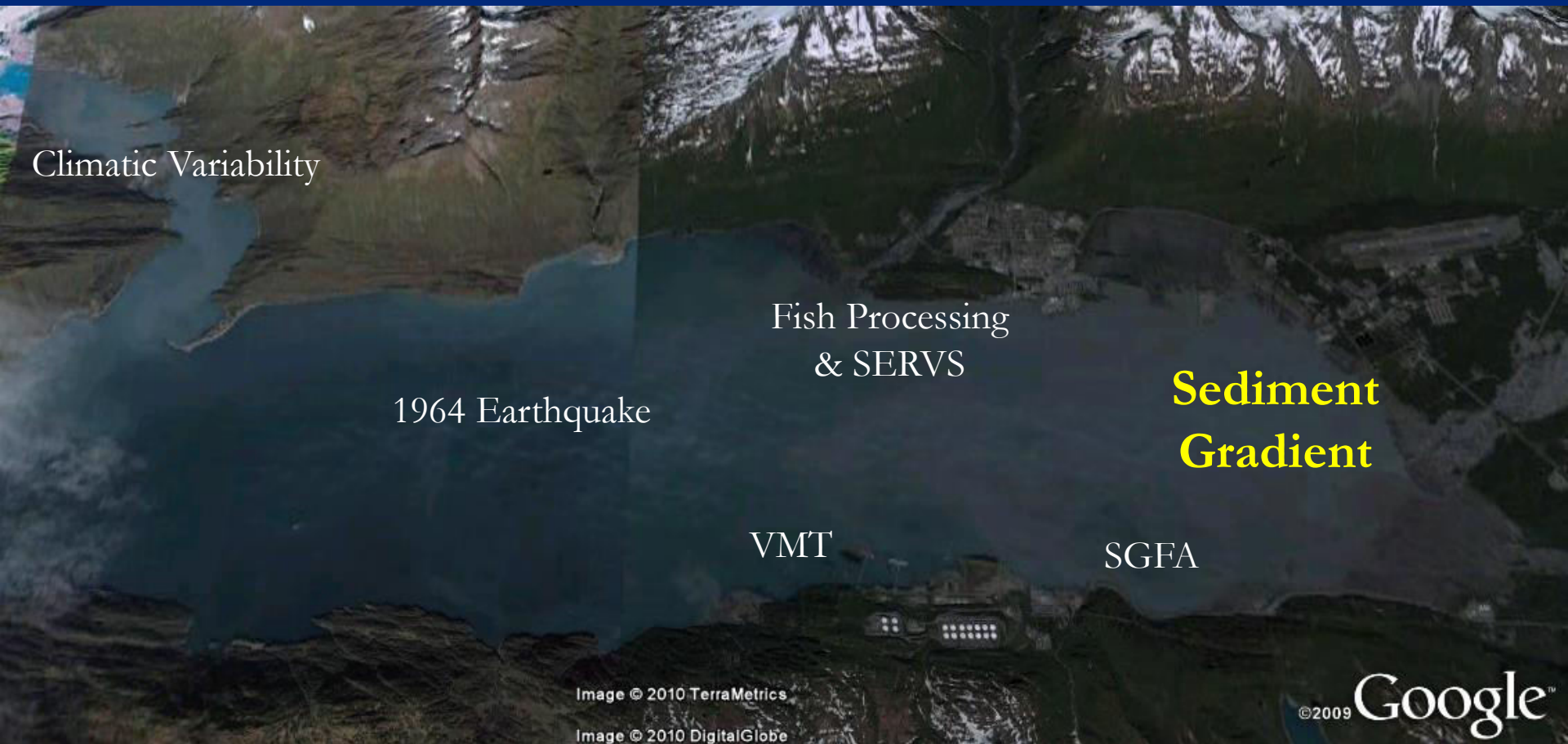


Diversity

Disturbance

No Disturbance

Sources of Variability in Port Valdez

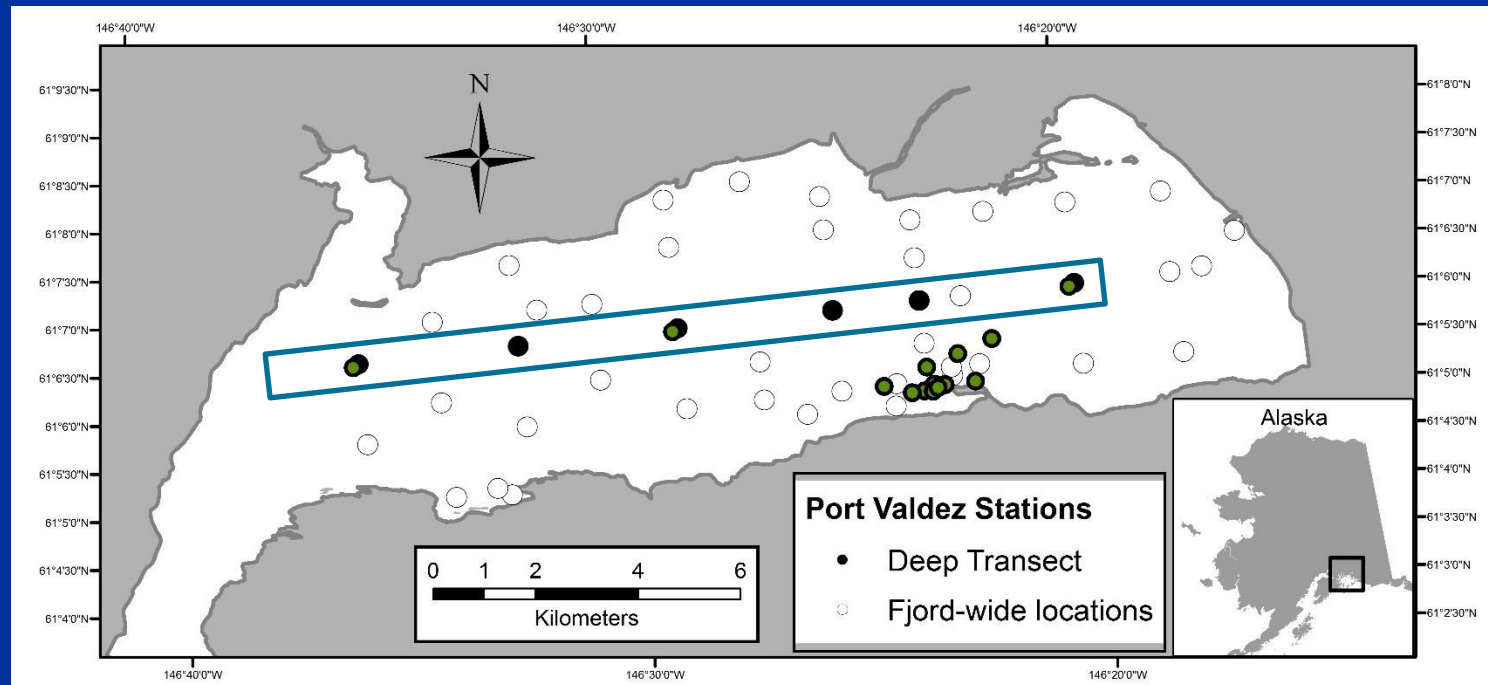


Lower
Sediment
Loads

Higher
Sediment
Loads

Fjord-wide sampling

- In 1971, 1976, 1982, 2002, sediments were sampled throughout the fjord.



Spatial Trends in the Deep Basin: Effects of glacial sediments

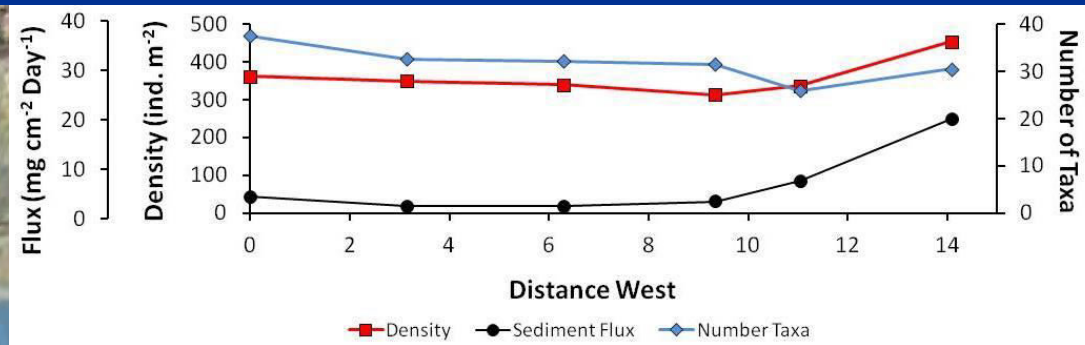
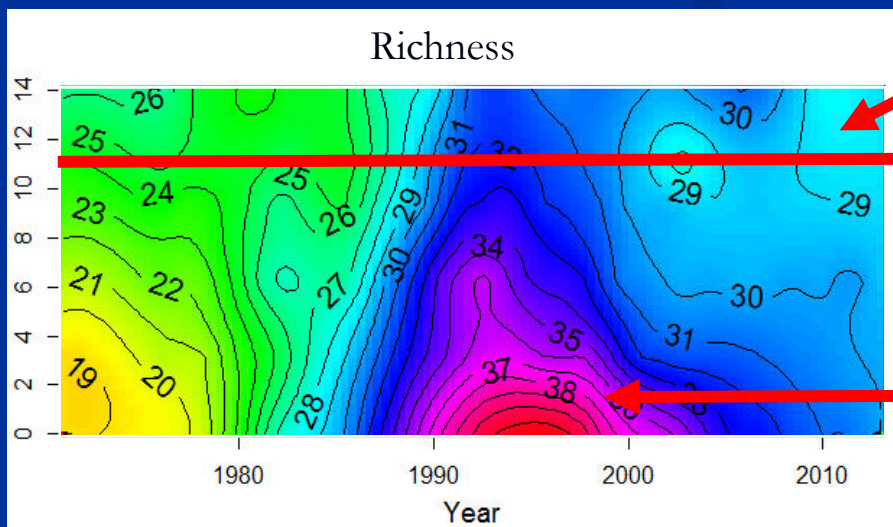
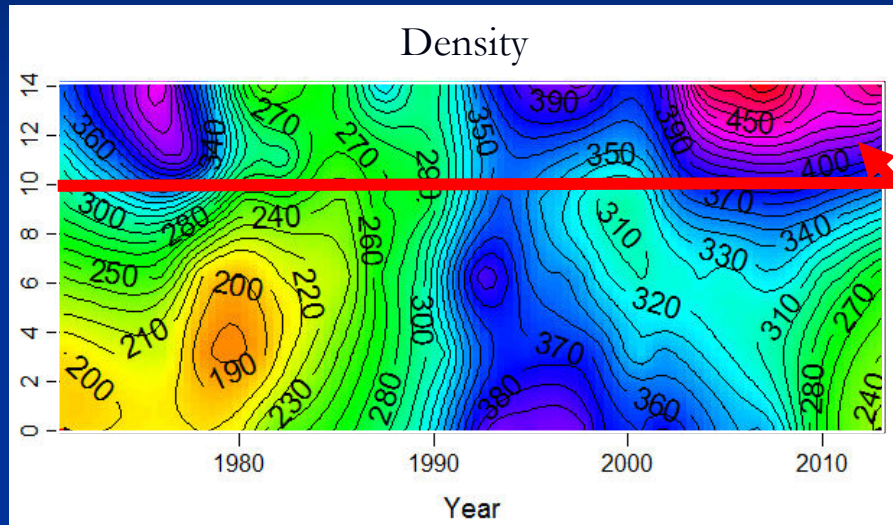
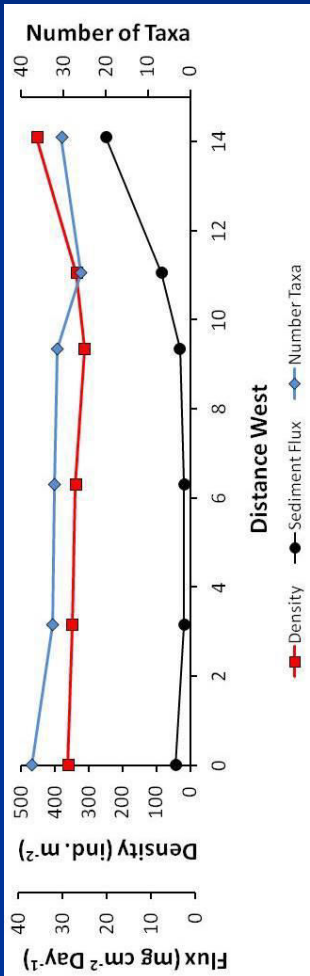


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Spatial Trends in the Deep Basin: Effects of glacial sediments



Density and richness are higher in these areas associated with greater sedimentation.

A peak due to other sources.

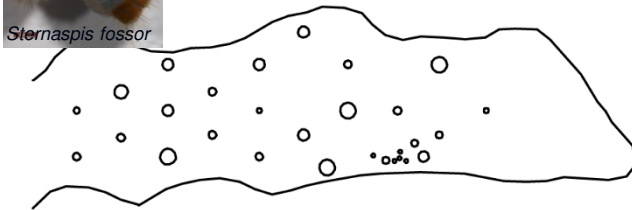
Response to Sediment Gradient

These animals have higher abundance towards the west.



Sternaspidae

- 283
- 142
- 71
- 28

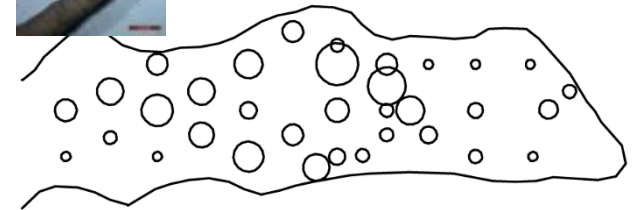


Maldanidae

- 200
- 100
- 50
- 20

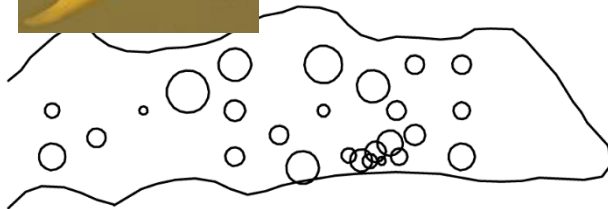


2002



Trichobranchidae

- 50
- 25
- 12
- 5

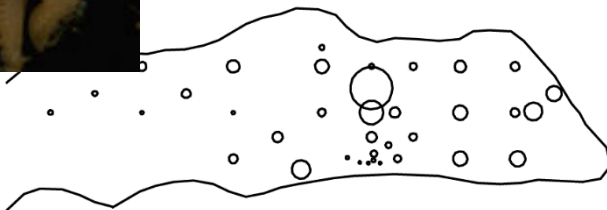


These animals have higher abundance towards the east.



Paraonidae

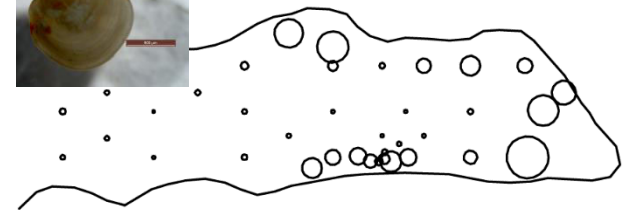
- 660
- 330
- 165
- 66



Thyasiridae

- 1710
- 855
- 428
- 171

Adontorhina cyclica



Sources of Variability in Port Valdez

**Climatic
Variability**

1964 Earthquake

Fish Processing
& SERVS

Sediment
Gradient

VMT

SGFA

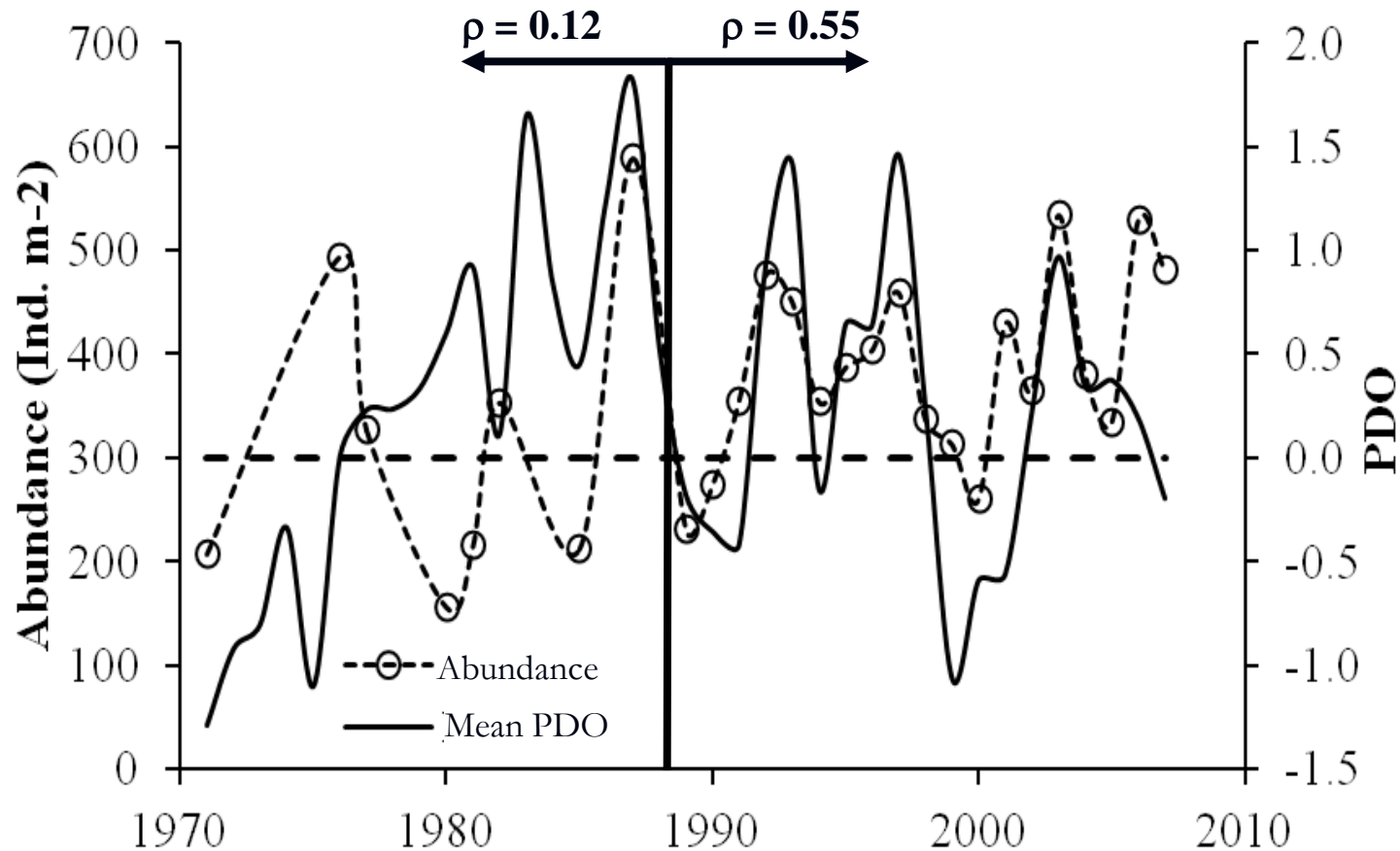
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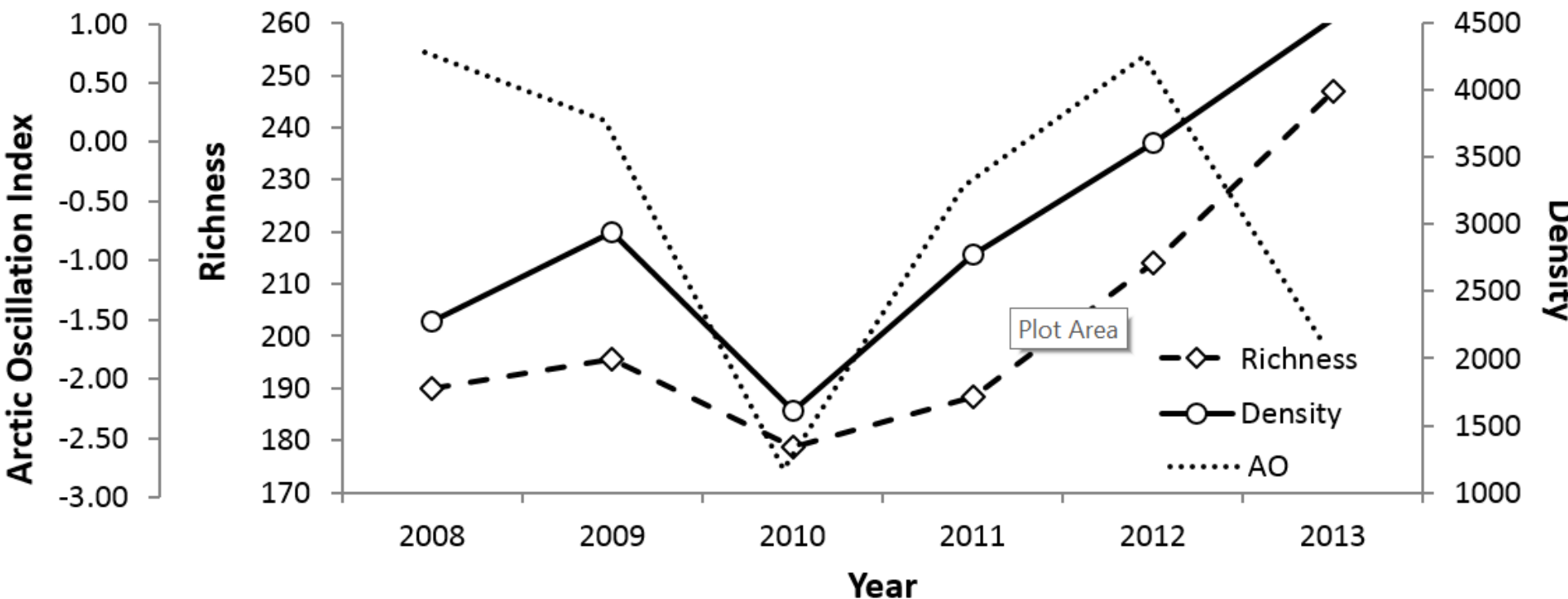
Climatic Variability

Benthic Abundance vs. PDO



Climatic variability: Benthic communities vs. AO

- A similar trend was observed in the Chukchi Sea.



Sources of Variability in Port Valdez

Climatic Variability

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The 1964 Earthquake

March, 1964, the magnitude 9.1 earthquake struck in Prince William Sound.

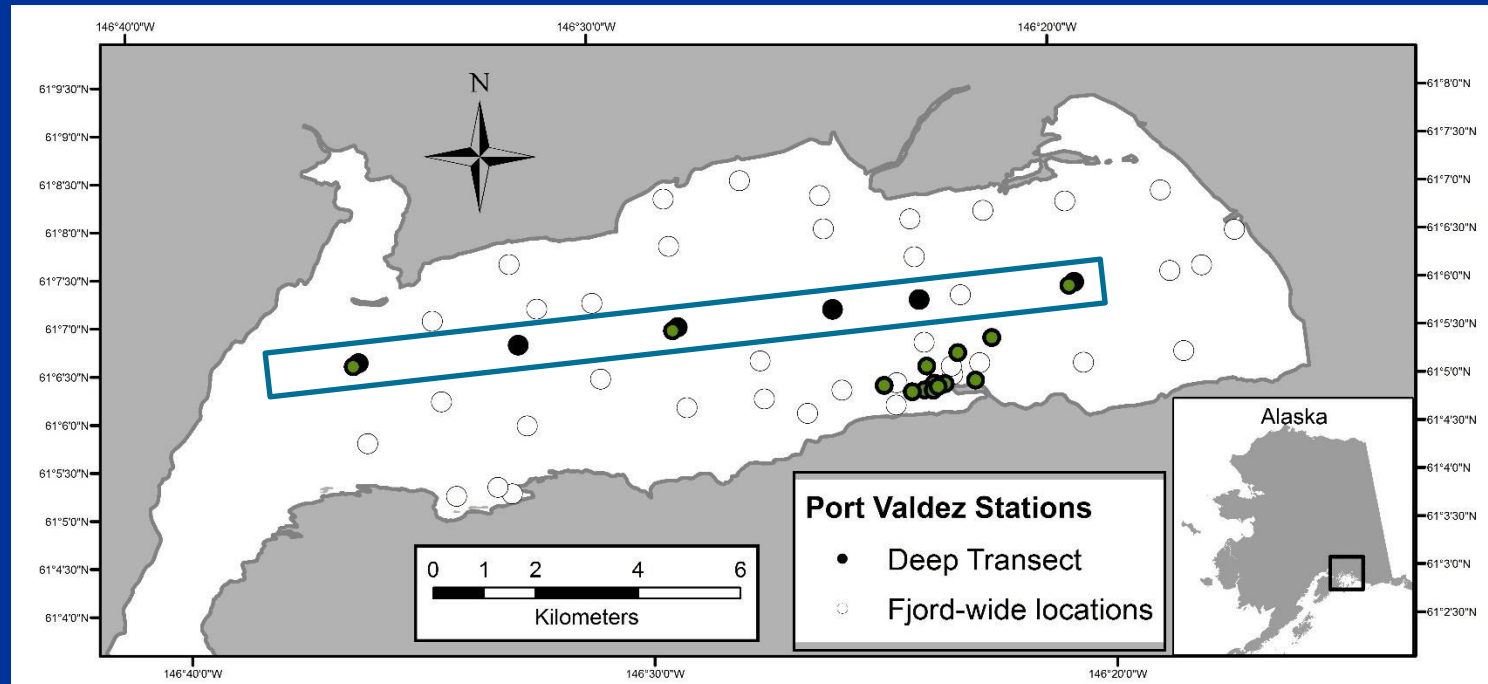
Port Valdez was on the axis of uplift so there was little change in geomorphology.

The earthquake largely influenced marine flora and fauna by:

- the destruction caused by massive sediment slumping
- and tsunamis.

Fjord-wide sampling

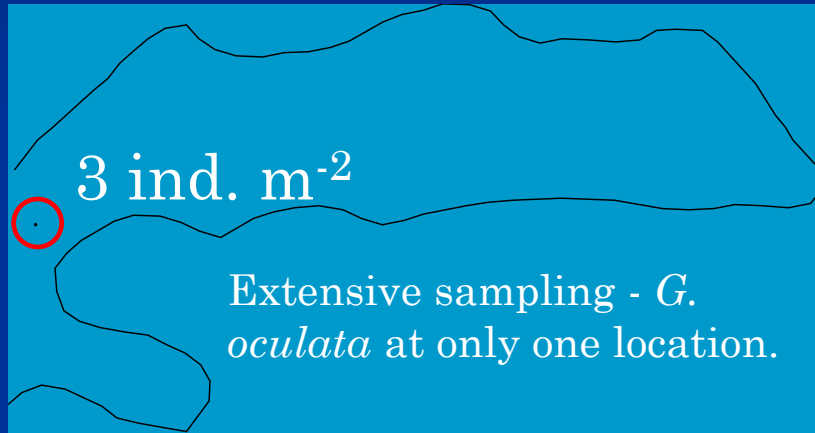
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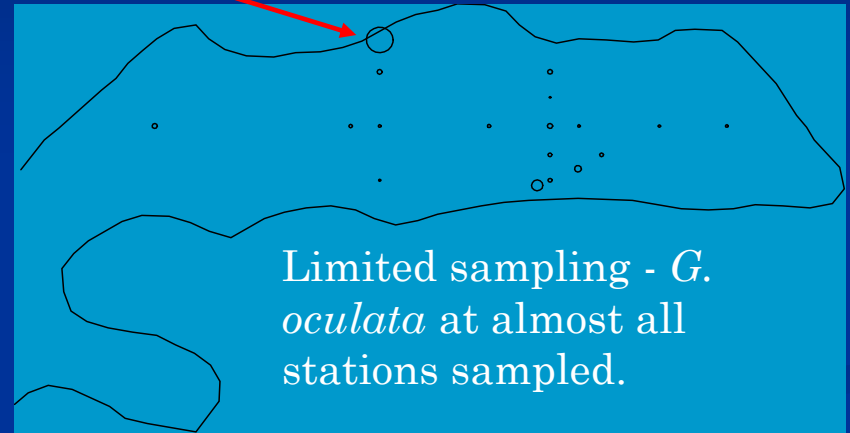
Trends in the Deep Basin: *Galathowenia oculata*



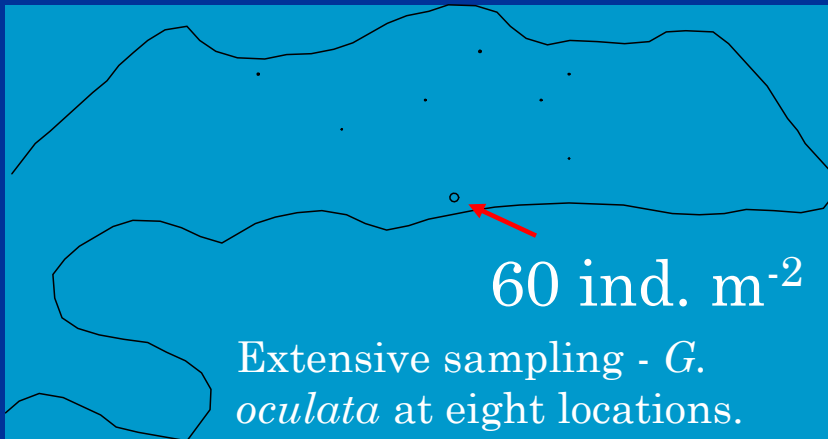
1971



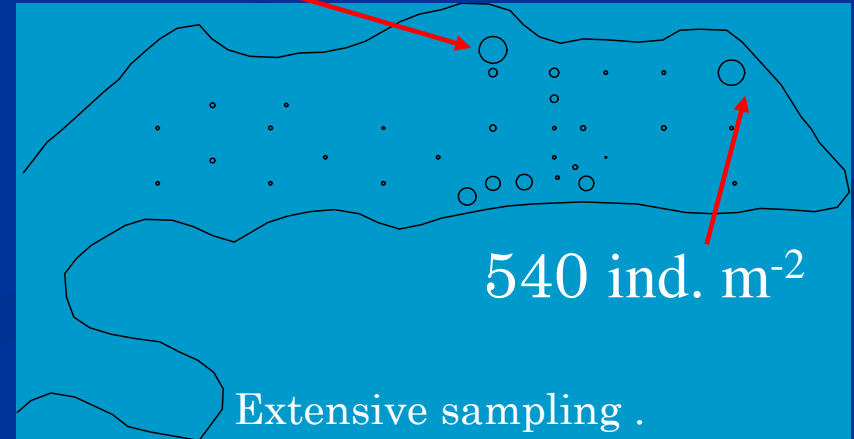
564 ind. m⁻² 1982



1976

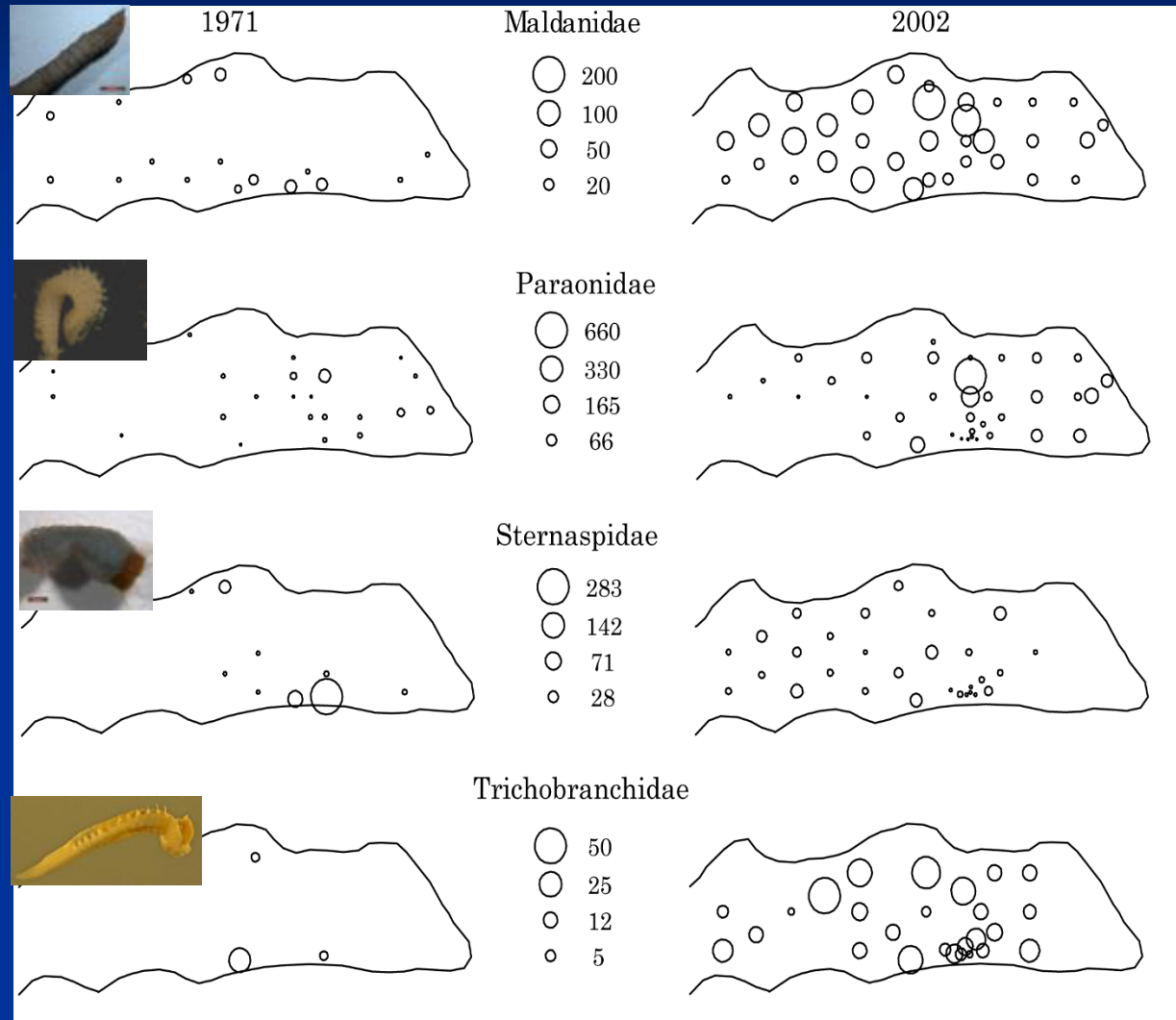


6,430 ind. m⁻² 2002



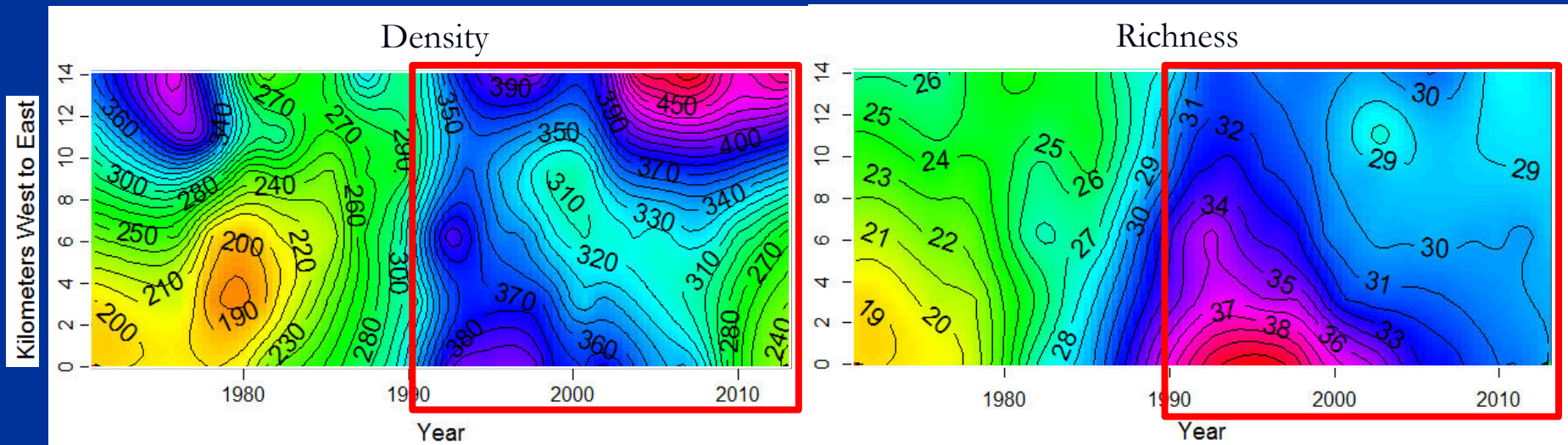
Trends in the Deep Basin

A number of taxa recolonized and redistributed themselves within the sediments of Port Valdez.



Temporal Trends in the Deep Basin:

The community appears to stabilize around 1989.



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Sediment
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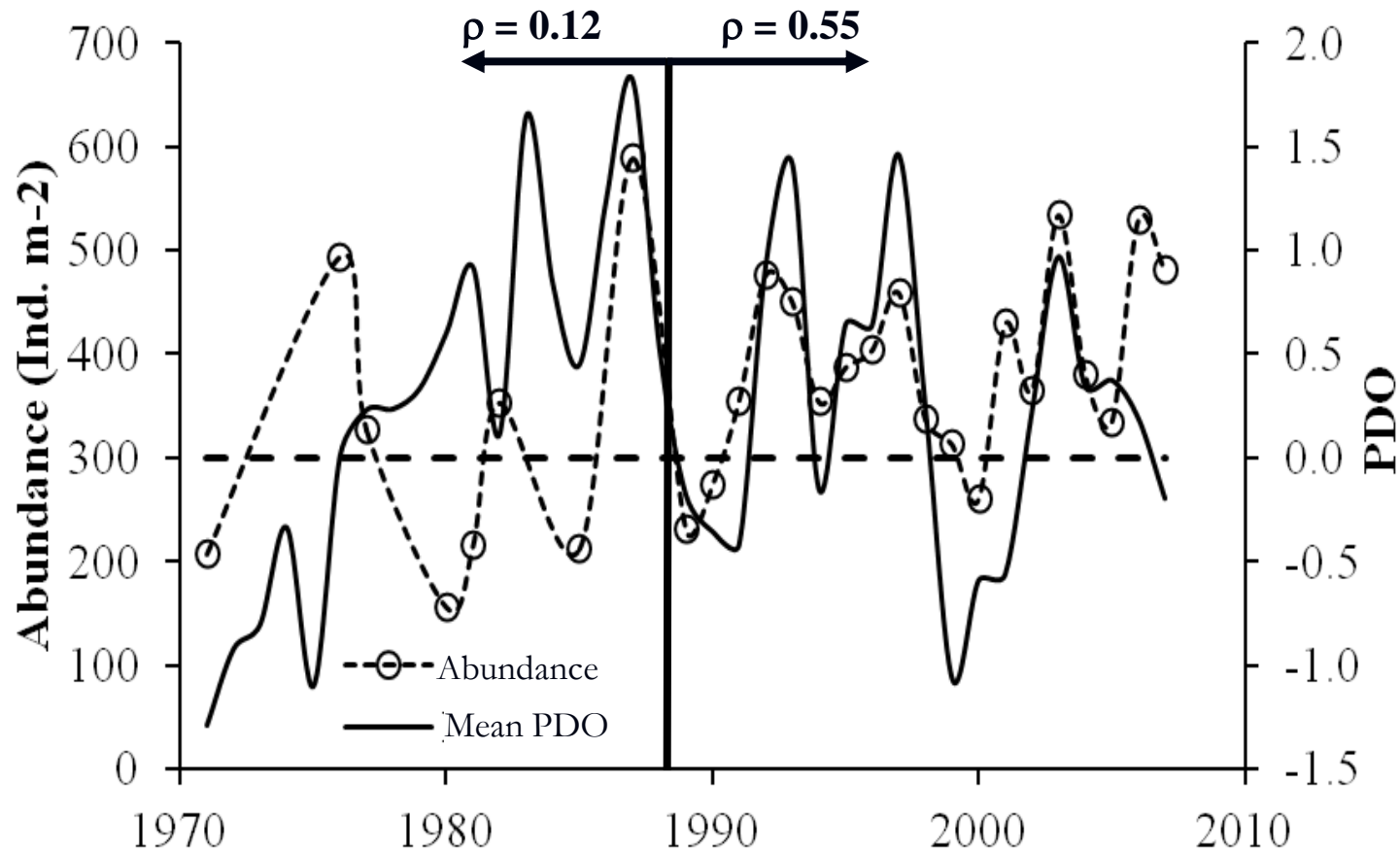
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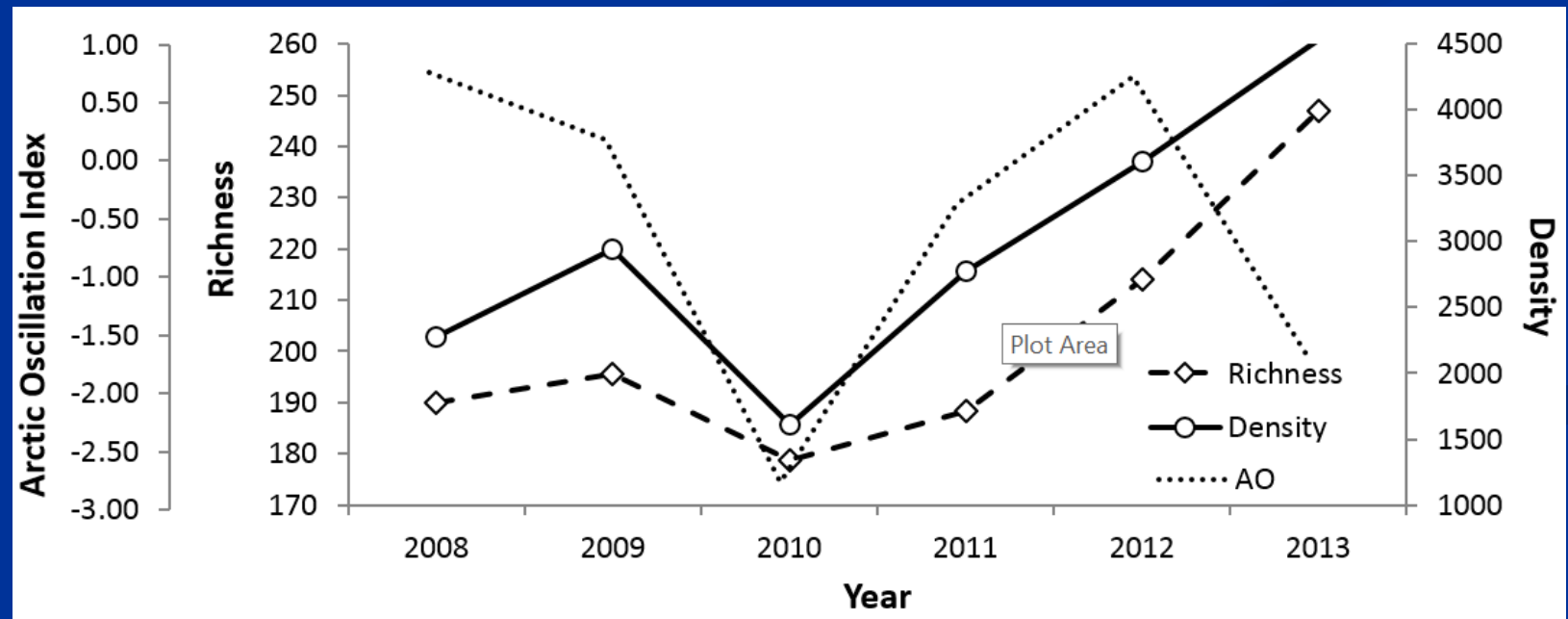
Climatic Variability

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Climatic Variability

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**Solomon Gulch
Fish Hatchery**

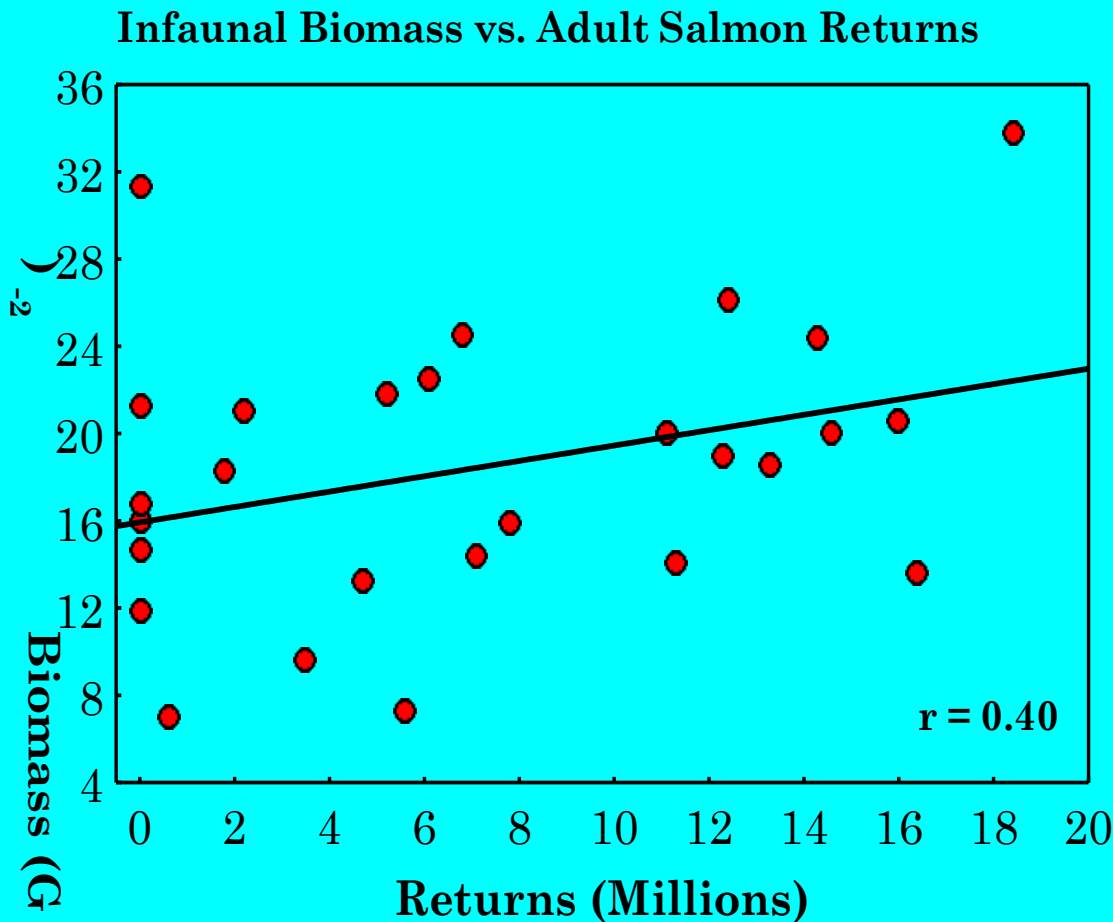
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Hatchery Salmon and the Benthos

Carcasses of returning adult salmon may provide greater food for fauna down to the deep basin.



Sources of Variability in Port Valdez

Climatic Variability

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Gradient

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SGFA

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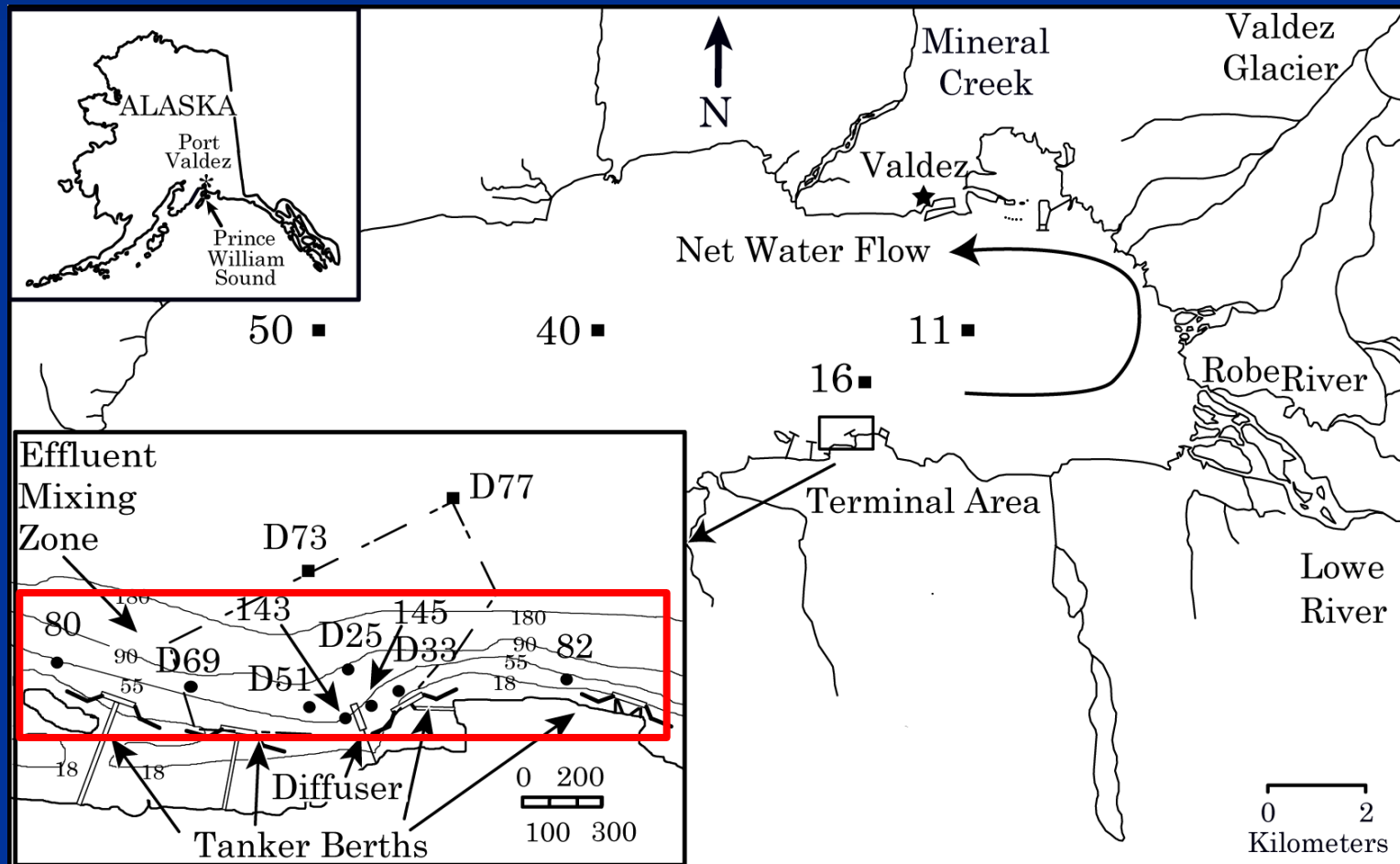
The Valdez Marine Terminal

The marine oil terminal became operational in 1977.

Ballast water from incoming tankers is treated onshore and discharged at about 60-80 m.



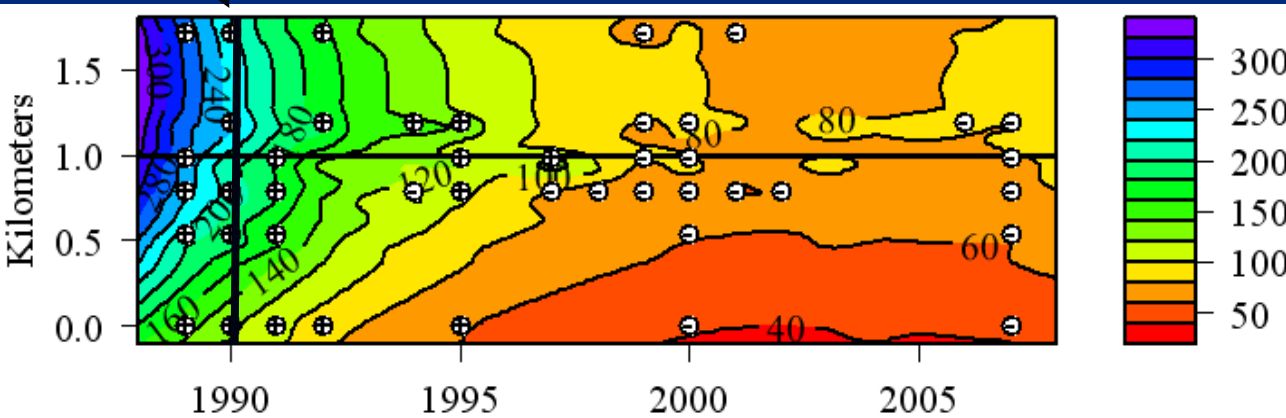
Port Valdez Environmental Monitoring Sites



Treated Ballast-Water Discharges

Biological treatment
phase added

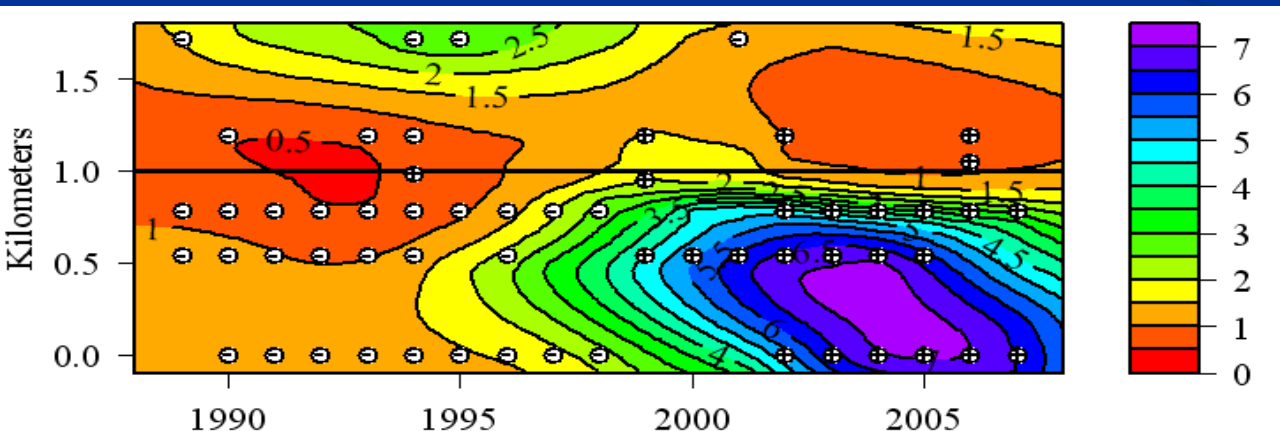
PAH (ng g⁻¹)



- Decreasing PAH concentrations over time.

Percent Sensitive Species

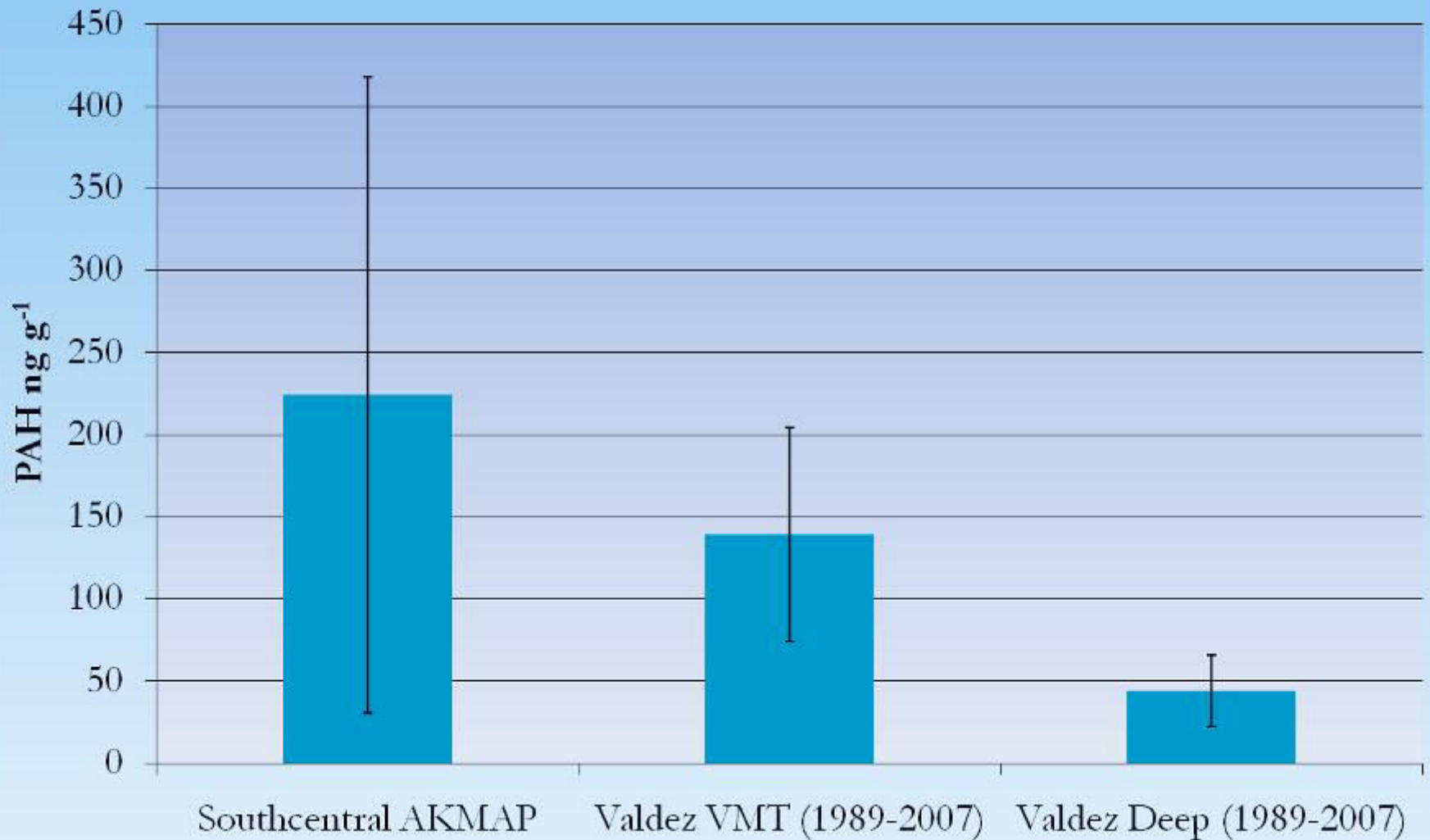
(*Galathowenia oculata* and *Melinna cristata*)



- The percent abundance of two tube-dwelling polychaetes increases with lower PAH.

Hydrocarbons in Southcentral Alaska

Average Total PAH



Other Studies in Port Valdez

- Intertidal studies: Barnacle, limpet and mussel ecology.
- Interactions of multiple stressors and indirect effects.
- Food webs (isotope) studies.
- Effects from the salmon hatchery.
- Chemical and hydrocarbon studies.
- Geological, physical, biological, and fisheries oceanography.
- Marine mammals (sea otters) and sea birds.
- Microbial studies and more!

What We've Learned

- Faunal responses to and recovery from stress mediated by fjord characteristics:
 - Seasonal stratification, deep basin, and strong sediment gradient important factors for infauna.
- Earthquake had long-lasting effects:
 - Benthic fauna appeared to have re-adjusted ~1989/1990, 26 years later.
- Interactions between sources of stress can have unanticipated effects.

Not the end, but the beginning!

