SALISH SEA
MARINE SURVIVAL PROJECT
www.marinesurvivalproject.com

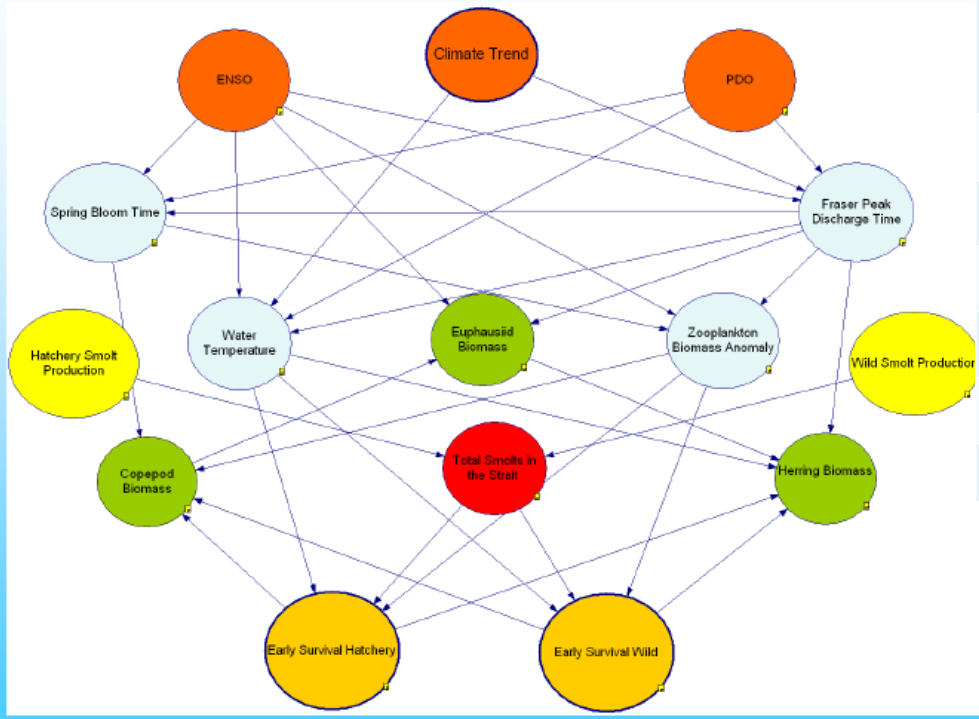
A Zooplankton Monitoring Program for the Salish Sea

Why Monitor Zooplankton?

- **Good indicators of environmental variation:**
- **Key intermediate step in marine food webs**
  - Fish recruitment controlled by prey availability

Strait of Georgia - Indicators for early marine survival of coho salmon

Bayesian network model to identify indicators for Coho salmon early marine survival :

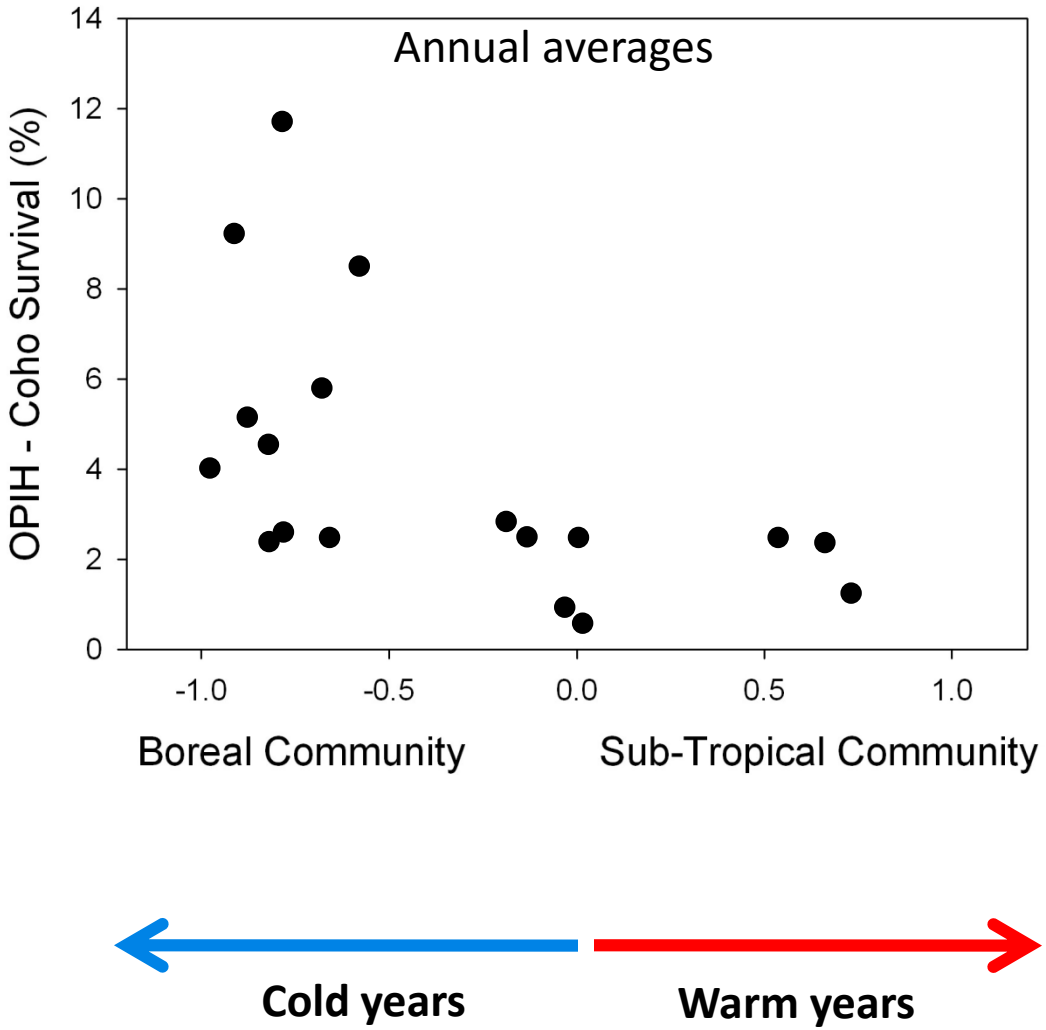


Indicator	Diagnostic value
Zooplankton biomass anomaly	0.212
Calanoid copepod biomass	0.083
Herring biomass (pre-fishery)	0.073
Water temperature	0.056
Fraser peak discharge time	0.043
Euphausiid biomass	0.032
ENSO	0.029
PDO	0.021
Log spring bloom time	0.006

Slide courtesy of Ian Perry

Araujo et al. 2013 Prog. Oceanogr

Newport Oregon timeseries → the Copepod Community Index



W. Peterson (NOAA)

Little data on zooplankton in Puget Sound

→ Gap in our understanding of ecosystem

- Puget Sound Ecosystem Monitoring Program (PSEMP) Marine Waters Working Group identified zooplankton information as one of the highest priority information gaps in their 2013 ‘gap analysis’
- Salish Sea Marine Survival Program prioritized zooplankton sampling as a primary need.

What do we know about zooplankton in Puget Sound?

Species composition
Which are important prey taxa

Life history patterns of several species*

Depth distributions

Seasonal cycles
Spatial patterns
Interannual variability

Terribly lacking:

- Time series spanning >2 years
- Consistent methodology

    - Seasonal cycles
    - Interannual variability

- Dynamics of critical prey taxa (crab larvae, euphausiids, amphipods) – difficult to capture with simple nets

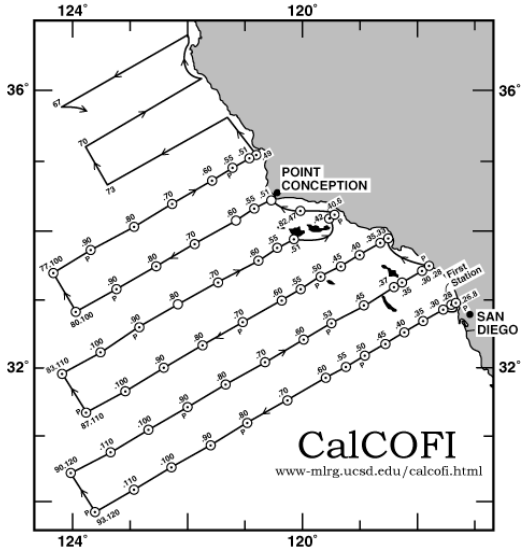
- Spatial patterns and “hot-spots” of abundance

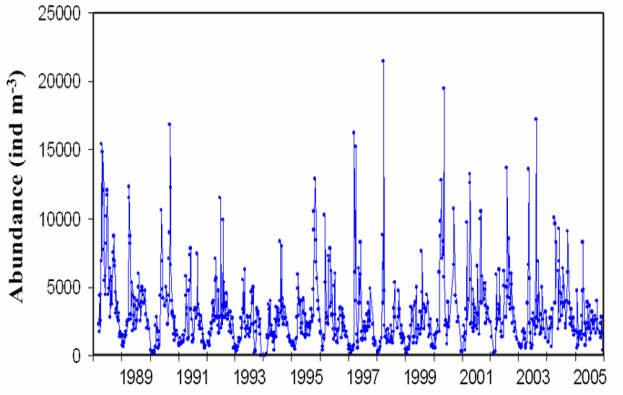
Sampling considerations:

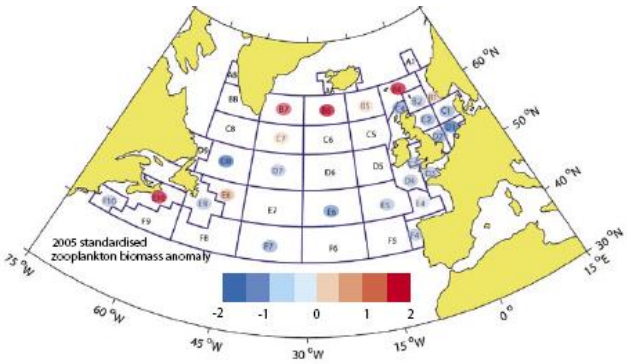
Spatial and temporal design

Regularly-sampled stations vs. variably-selected stations within ‘Statistical Areas’

Seasonal sampling of many locations vs. regularly (bi-weekly to monthly) at few locations







Design tradeoffs:

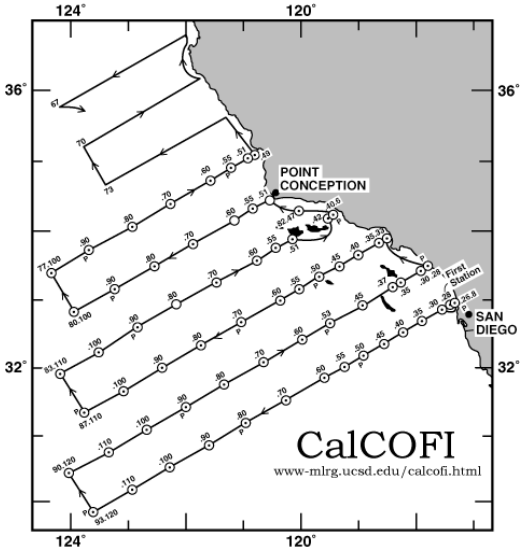
Seasonal sampling of many locations

Advantages:

- Captures spatial patchiness well; can quantify and/or filter patchiness
- Can compare 2D patterns (chl a, T, S, currents)

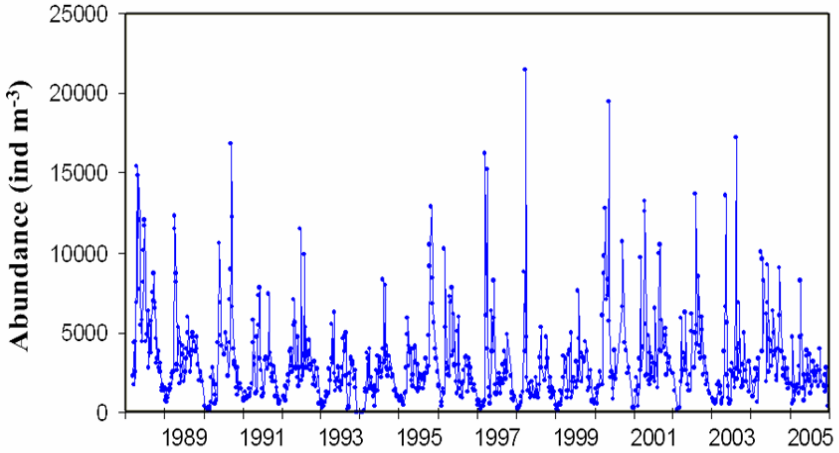
Disadvantages:

- Requires large block of sampling time
- Does not resolve temporal cycles well
- Aliases phenology changes → artificial interannual variability



Design tradeoffs:

Regular, frequent sampling at a single location

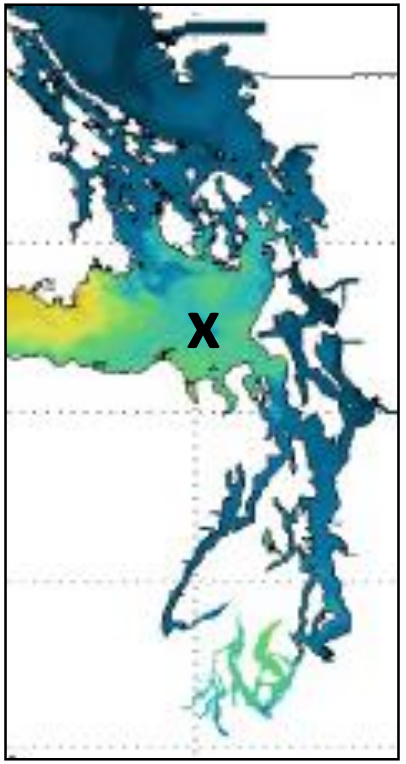


Advantages:

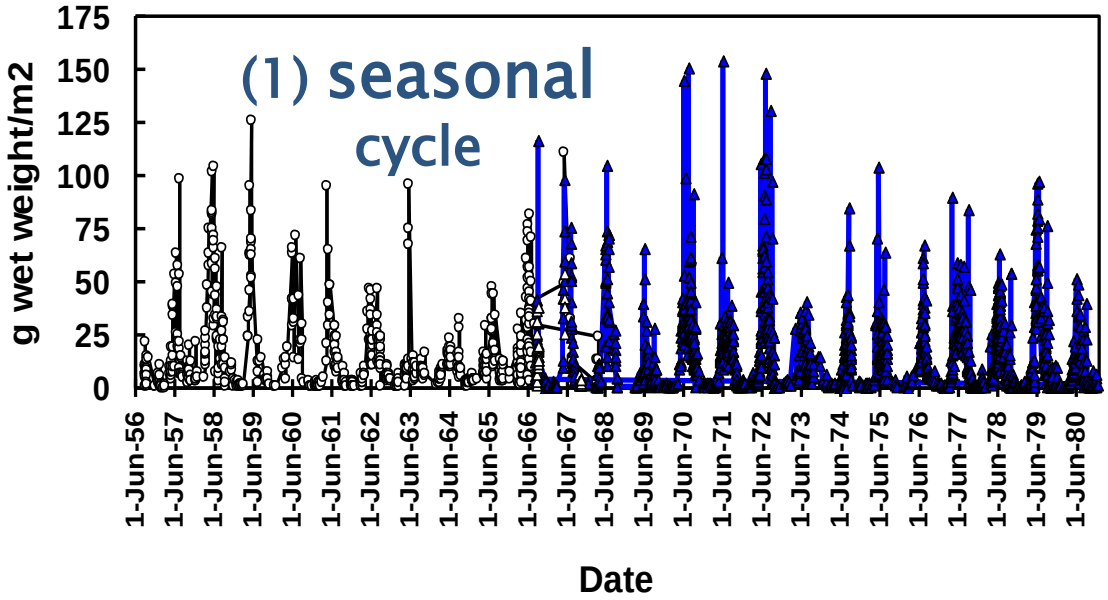
- Simple to conduct
- Provides clear, intuitive time series – simple to analyze and visualize
- Data can be robustly compared to other time series data collected on similar time scales

Disadvantages:

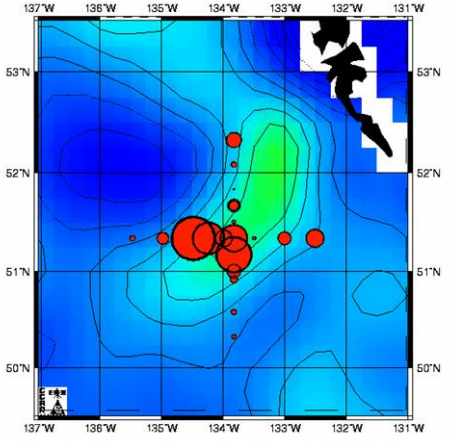
- Lacks information of spatial patchiness
- Lacks within-sampling period replication



Components of zooplankton variability to consider:

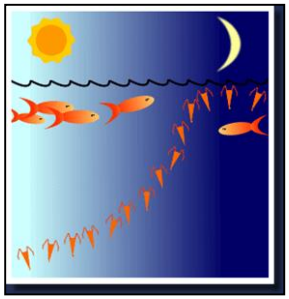


(2) small-scale and transient patchiness



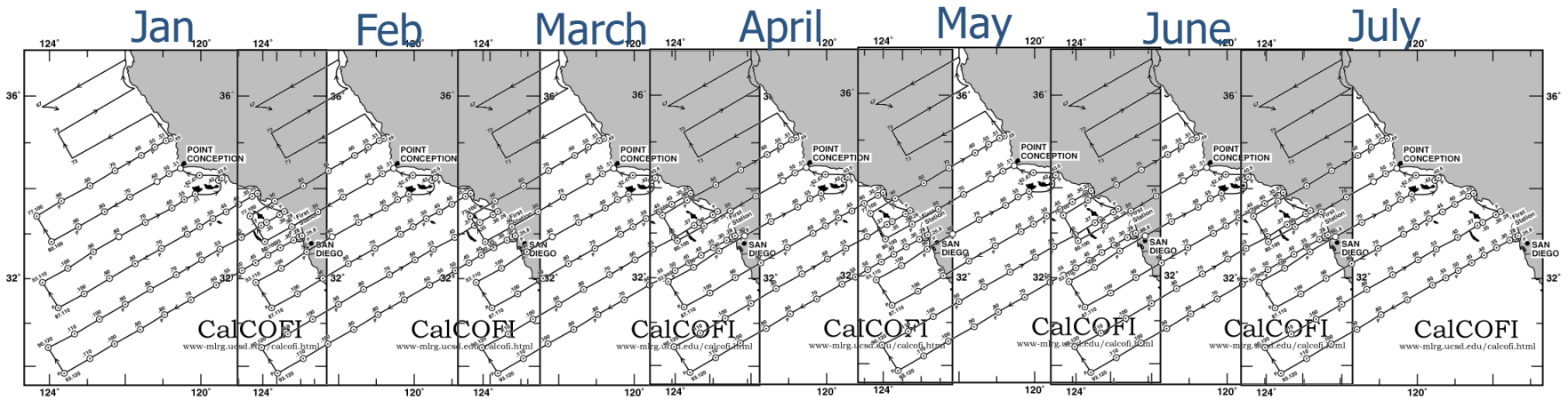
Pseudocalanus mimus abundance (red circles) near a coastal-origin eddy (mapped sea surface height). Mackas & Galbraith 2002.

(3) Changes in vertical distribution & catchability



DVM cartoon from website of Marianne Moore, Wellesley Univ.

Tradeoffs


Jan
Feb
March
April
May
June
July
POINT CONCEPTION
SAN DIEGO
CalCOFI
www-mlrg.ucsd.edu/calcofi.html

Tradeoffs

- **Need to balance:**
  - Costs vs. information gained
    - Sampling and analysis
  - Technical difficulty
    - Ship capabilities and size of net set the taxa that can be adequately sampled
    - Diversity of habitats sets the number of different sampling strategies
  - Statistical power
    - Irregular and ‘opportunistic’ sampling limits confidence in results

Puget Sound sampling locations

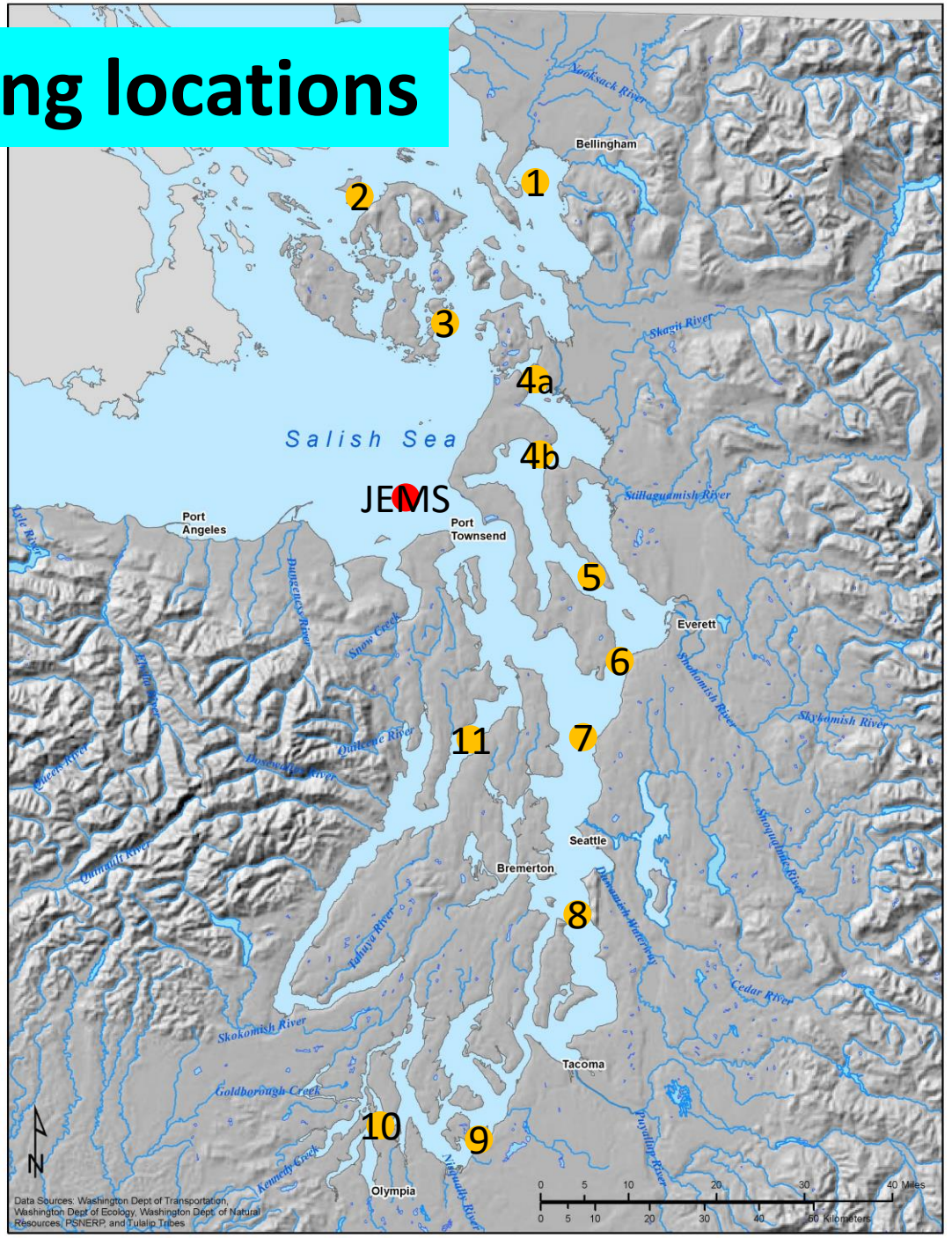
At each location

(except JEMS):

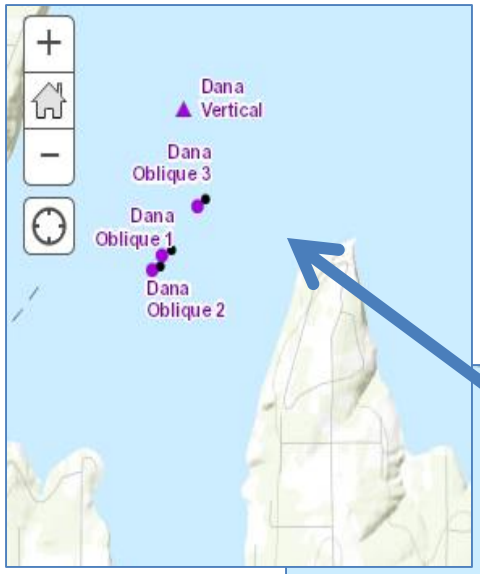
Bi-weekly sampling
April - Sept

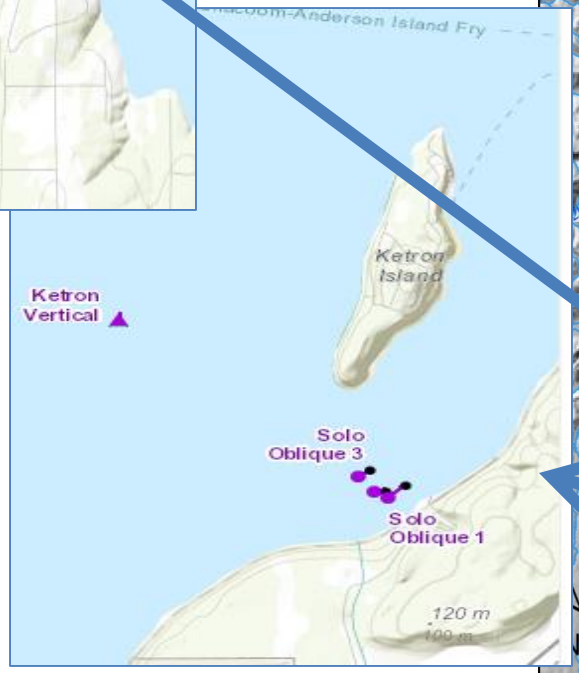
- "Prey Field" Sampling:
=Oblique bongo net tows over upper 30 m, 335 µm mesh

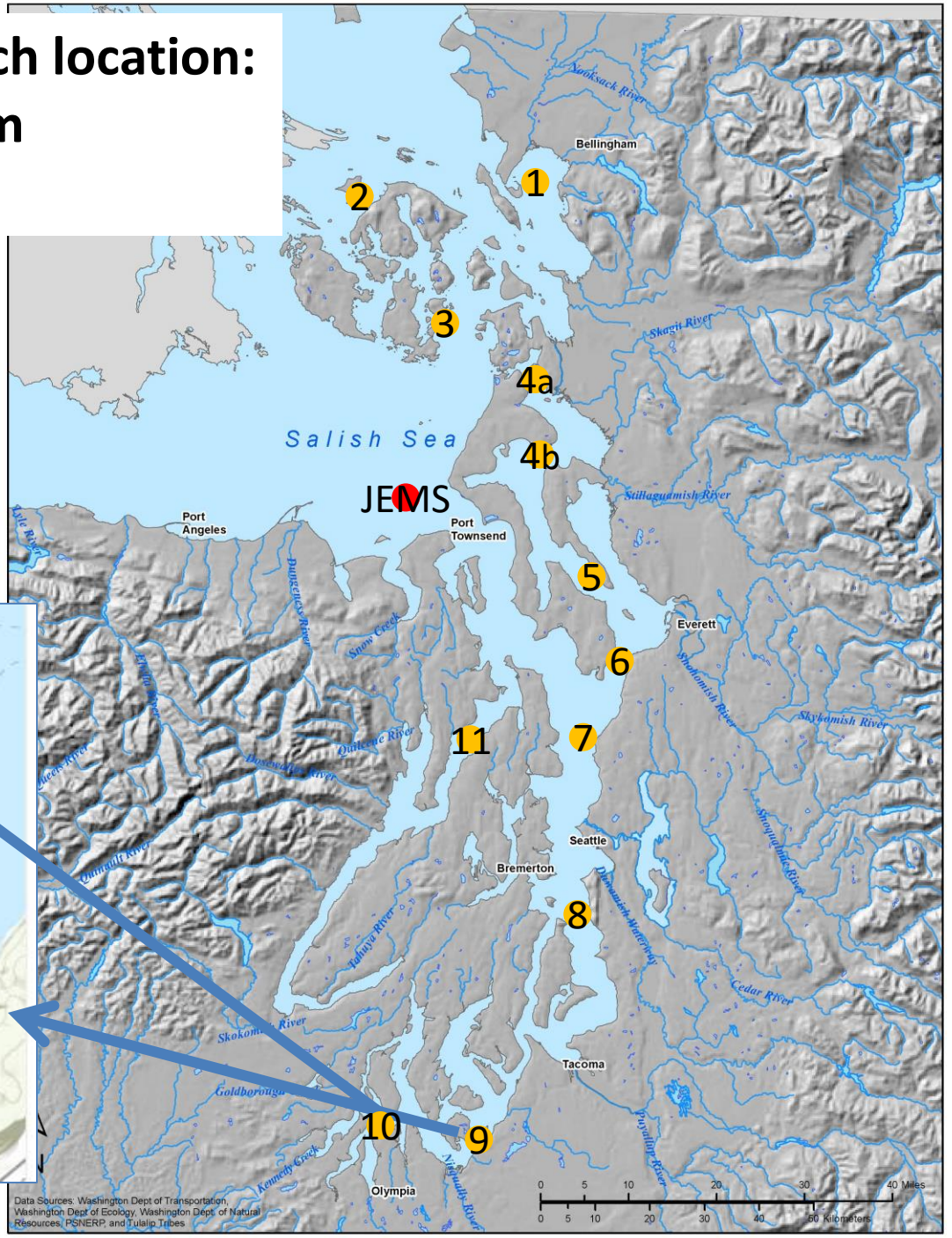
- Environmental Indicator:
=Full water column vertical tows, 200 µm mesh



4 Depth strata sampled at each location:
Oblique tows at ~30,50, 100 m
Vertical tow at >100 m



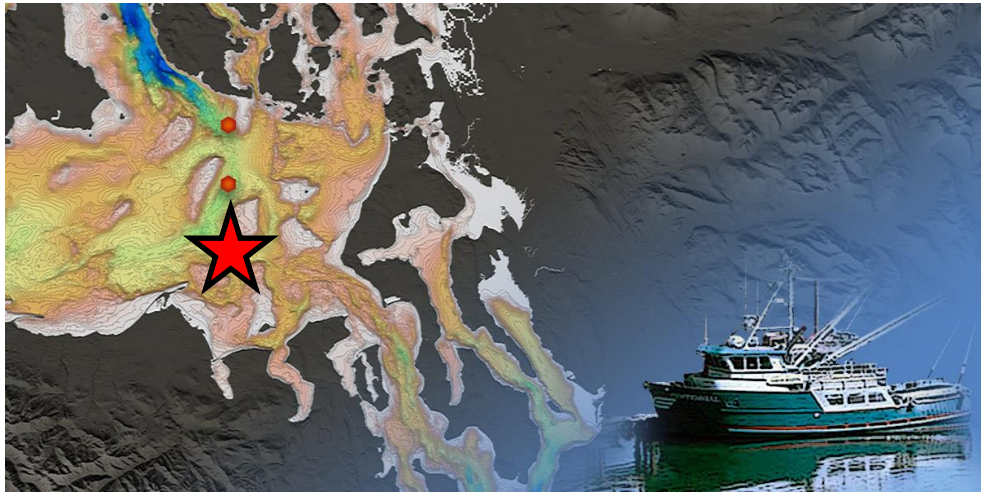




JEMS Joint Effort to Monitor the Strait

Longest timeseries of zooplankton in Salish Sea (10+yrs)

Sponsored by Washington Department of Ecology
Analysis funded by UW, LLTK, and (future) Port Gamble S'Klallum Tribe



- CTD casts (T,S,D,DO)
- Bottle chlorophyll, nutrients, oxygen
- Zooplankton net tows
  - 75-cm diameter, 150µm mesh vertical tows

DEPARTMENT OF ECOLOGY
State of Washington

Gaps in current Puget Sound program

- **Best for ~1mm-1cm size class** (missing small, fragile and large taxa)
- **Only sampling prey field in surface layers during the day** (good for juvenile salmon, poor for other fish)
- **Sampling over salmon outmigration** (missing much of seasonal cycle)
- **Sampling only during day** (missing twilight and night sampling)
- **Sampling only in 'pelagic' zone** (missing <30 m depth)

LONG LIVE THE KINGS

PugetSoundPartnership
LEADING PUGET SOUND RECOVERY

Sea Grant
Washington

King County

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Partnerships and funding

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