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Entry and transfer of polychlorinated biphenyls (PCBs) in the Pacific sand lance life cycle, Puget Sound, Washington

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Entry and transfer of polychlorinated biphenyls (PCBs) in the Pacific sand lance life cycle, Puget Sound

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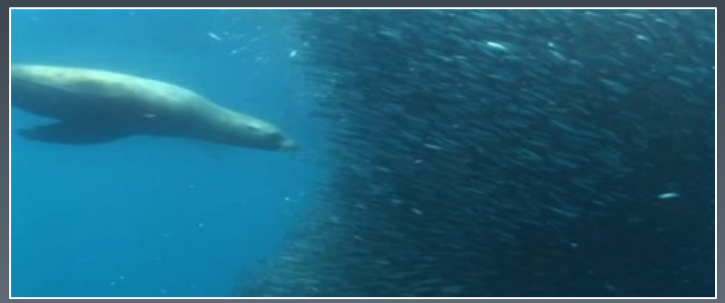
Background

- Pacific sand lance and other forage fishes
  - Pacific herring, surf smelt, Northern anchovy
  - Small, abundant, schooling planktivores
  - Rich in lipids
  - Critical link in marine food web
  - Consumed by fish, marine mammals, and birds
- Sand lance basic biology and status poorly understood
  - Contaminants may play a role
- Status of forage fish influences status of other species
  - Contamination may drive new or higher contamination levels



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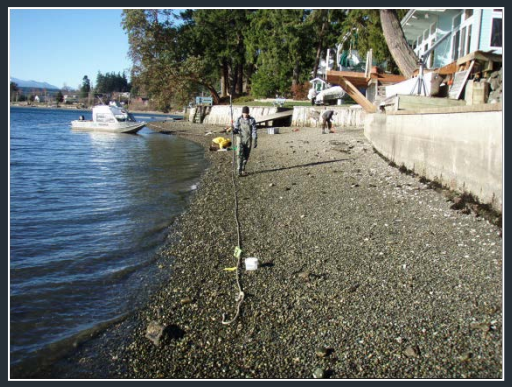
Sand lance



- Beach spawners
  - Small eggs on upper intertidal areas for ~4 weeks
  - Risk of contaminations from terrestrial sources
- Burrow regularly in sediments
  - Potential contamination risk
- Fall - Winter spawning
  - Spawning sites consistent over decades
- Sexually mature at 1-2 years (> 100 mm)
- Fish over 3 years rarely found in quantity
- No known large-scale migrations

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Synoptic Survey

- First data on contaminants in sand lance
- 9 sites
- Collected 2010-2014
- PCBs, PAHs, legacy pesticides & flame retardants
- Samples processed by AXYS Analytical Services
- PCBs
  - EPA method #1668
  - 209 congeners

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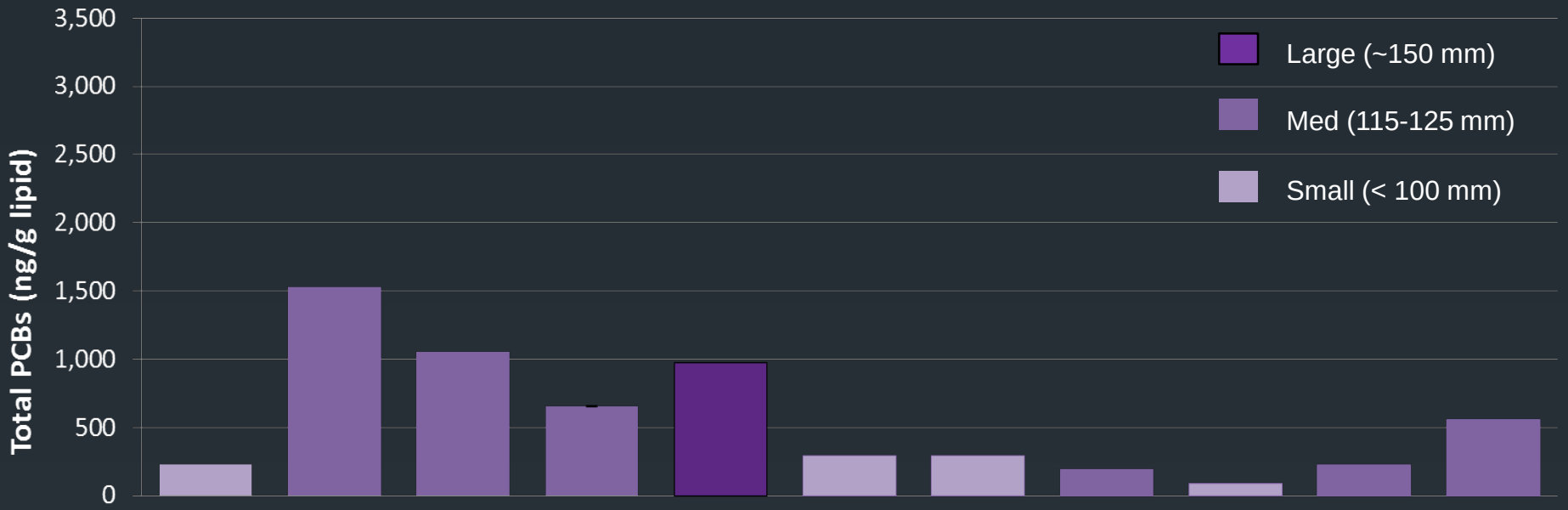
Synoptic Survey: PCBs



Site	Nisq Delta	Eld Inlet	Comm Bay	Eagle Hrbr	Eagle Hrbr	Lib Bay	Agate Pass	N Bbrdge Isl	Lopez Isl	Clay Bch	Clay Bch
% Lipid	4.2	1.6	2.7	4.6	4.4	4.5	3.9	7.6	2.6	2.2	1.4
Season Year	S 2014	W 2013	W 2014	S 2012	S 2012	S 2012	S 2012	S 2012	S 2014	W 2010	W 2011

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South → North

Synoptic Survey: PCBs

- PCBs in immature fish (less than ~ 1 year old, ~ 80 mm)
- Interested in pathways for entry of PCBs
  - Are very young fish contaminated?
- Compare Eagle Harbor and Clayton Beach
  - Opposite ends of the continuum and regular spawning/rearing sites
  - Sampled early juveniles and adults at both sites in Spring 2016

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Eagle Harbor vs. Clayton Beach--Spring

- Outside of spawning period
  - No gonad development, adults not dimorphic
  - Sex ratio likely 1 : 1

- Young of the year (YOY) or Age-0 fish
  - Definition includes all of first year
  - Our samples more focused:
    - Recently transformed from larval stage
      - Occurs ~ 30 mm
    - Have adult shape, but lack pigmentation
    - Weak swimmers with limited range
      - Commonly found near spawning beaches
    - Growing very quickly

- ***Goal:*** collect YOY in April & May at both sites
  - Measure changes in PCB concentrations over short period

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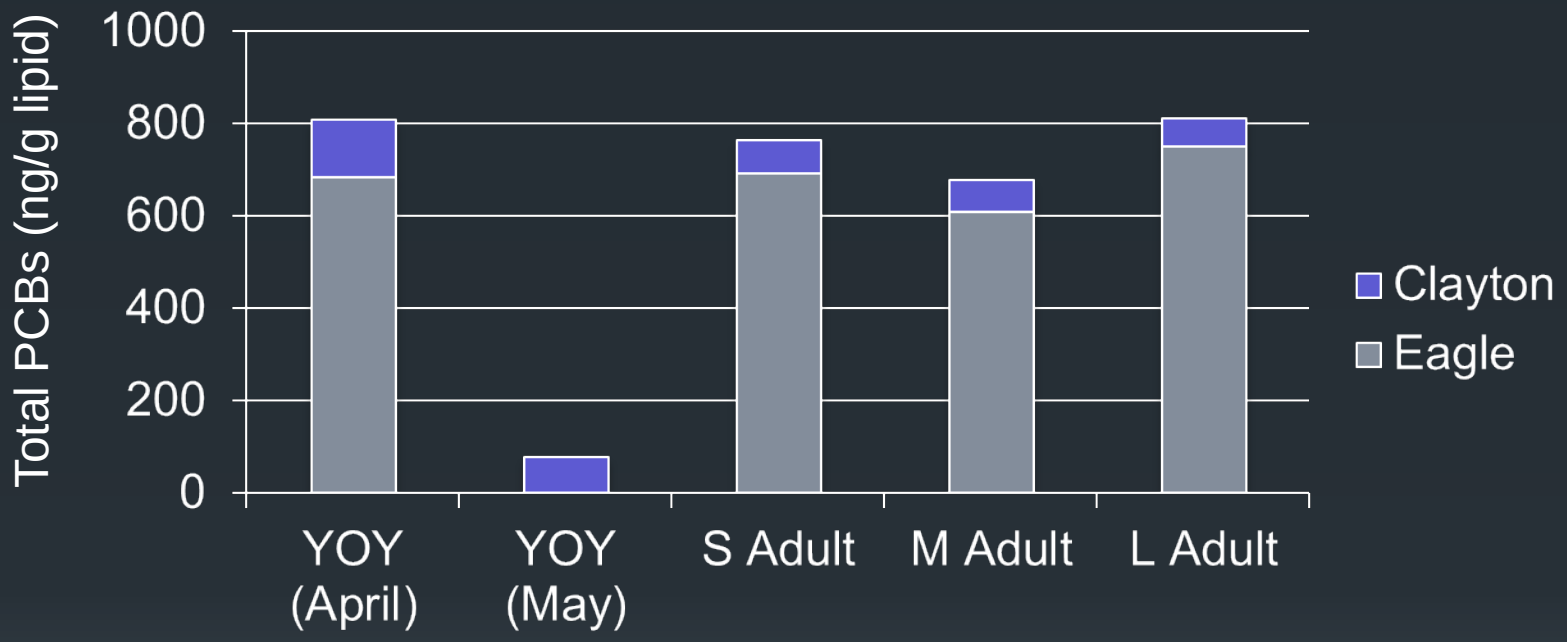
Eagle Harbor vs. Clayton Beach--Spring



1.8%	1.4%	5.2%	6.2%	7.0%	% Lipid	Clayton
44	50	106	124	142	Size (mm)	Clayton
1.8%		5.5%	7.5%	7.6%	% Lipid	Eagle
44		107	124	150	Size (mm)	Eagle

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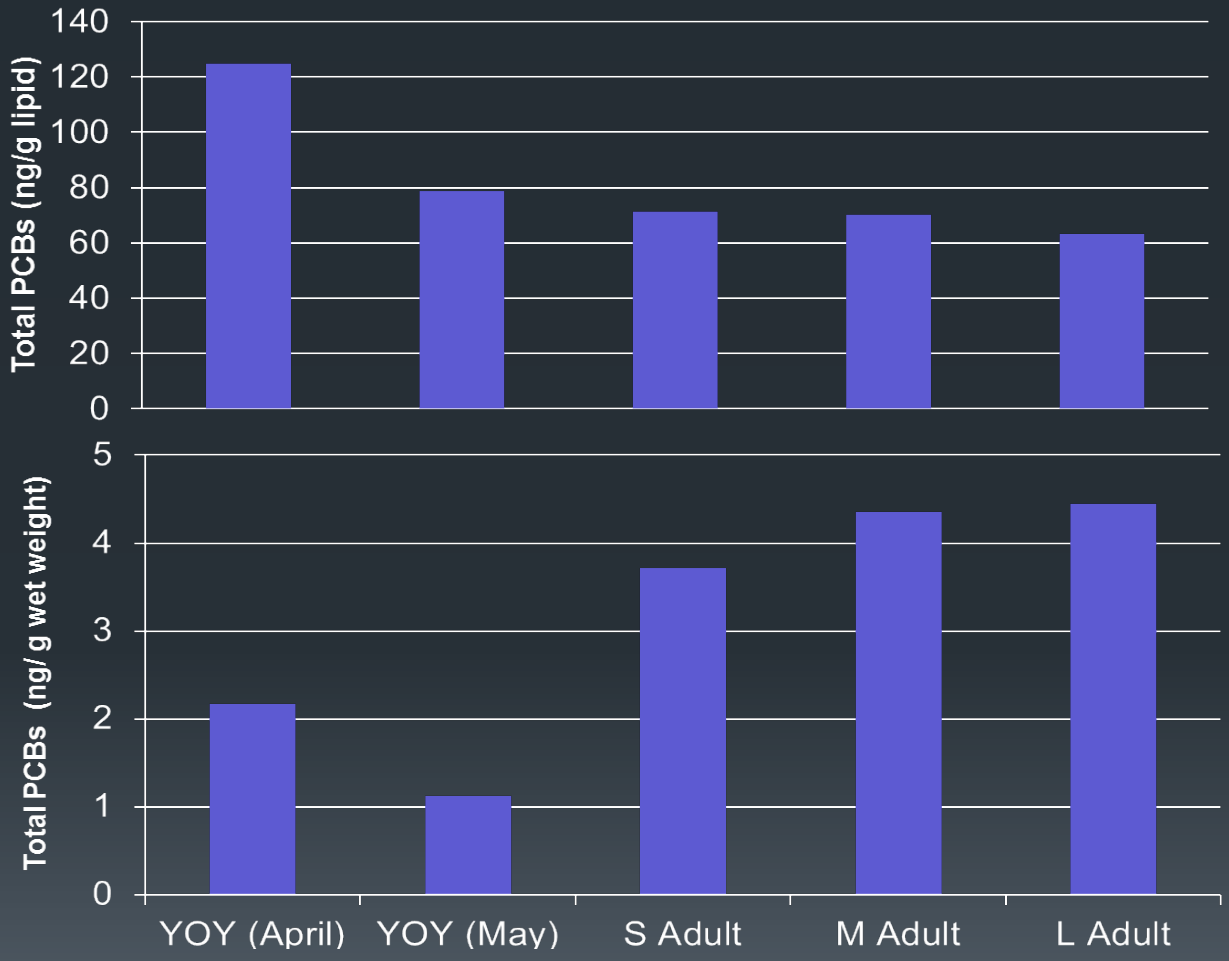
Clayton Beach -- Spring



- ***Lipid Normalized***:
- Highest levels in smallest YOY
  - 1.8% lipid
- May YOY similar to all 3 sizes of adults
  - 1.5% lipid YOY
  - 5 - 7% lipid adults
- Very early juveniles are contaminated

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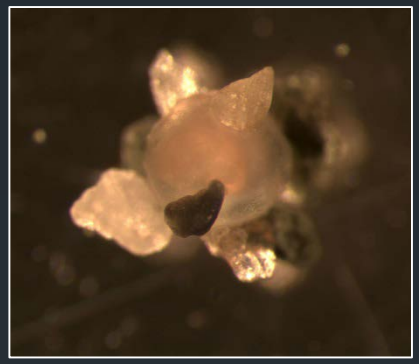
Eagle Harbor vs. Clayton Beach--Winter



- Collecting eggs from spawning beaches not viable option
  - Small eggs (< 1 mm) covered in sand grains
  - Potential PCB exposure on beaches
- Collected sexually mature males and females at both sites
- Assayed whole body males (including gonads)
- Removed eggs from females and assayed whole body without eggs
  - Egg samples represent the individual females assayed
  - Eggs were 15-25% of total body mass

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Eagle Harbor vs. Clayton Beach--Winter

- Approach:
  - Evaluate several size classes of males and females
  - Use co-collected males and females
- November 2016 field collection — completed in 4 days
- Divided fish at each site into:
  - Small (~100 mm), estimated to be first year spawners
  - Large (> 100 mm), estimated to be 2nd or 3rd year spawners
- Mean fork lengths:

	Eagle Harbor	Clayton Beach
Small Females	100 mm	97 mm
Small Males	100 mm	97 mm
Large Females	139 mm	133 mm
Large Males	140 mm	133 mm

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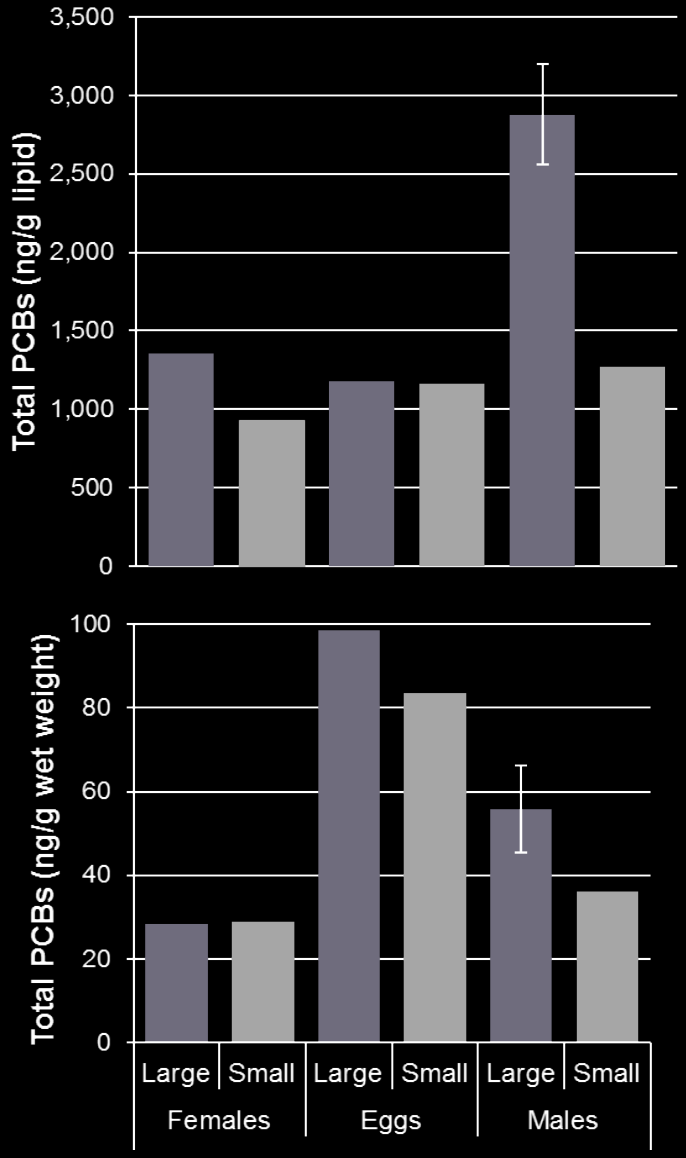
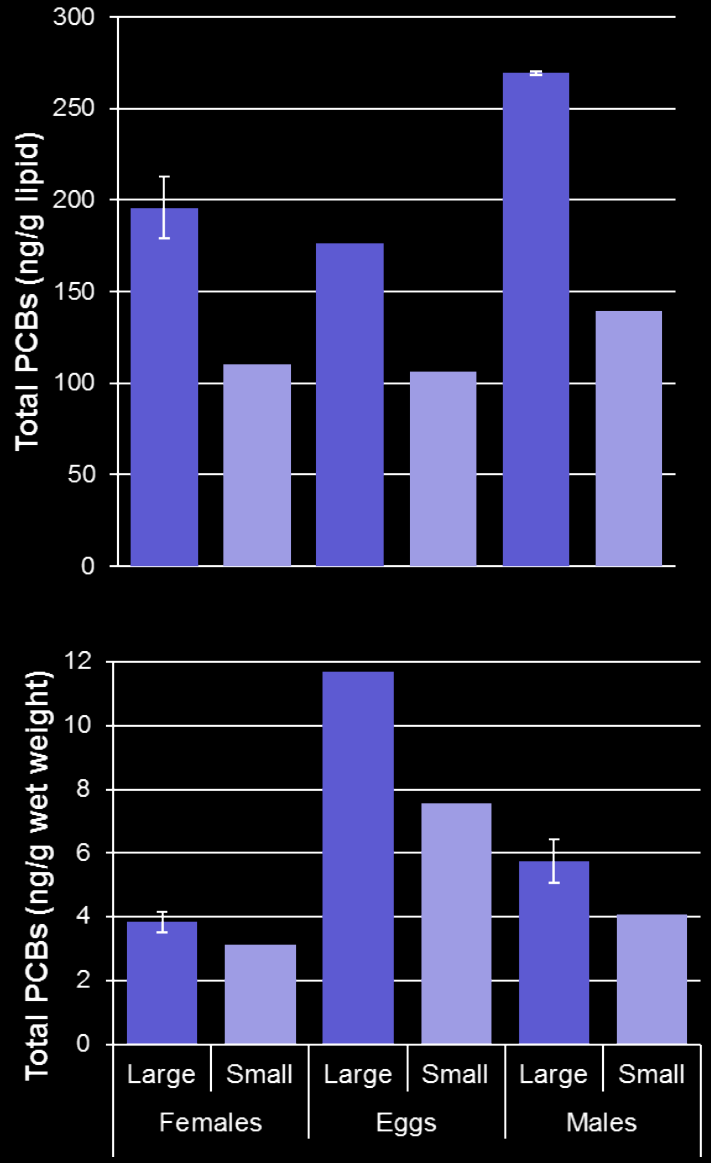
Eagle Harbor



Clayton Beach



Conclusions

- **Sand lance have restricted range / site fidelity**
  - Eagle Harbor values >10x higher than Clayton Beach

ng/g lipid	Eagle	Clayton
Highest	2900	270
Lowest	600-700	65-70
Mean	~1100	~175

- **Evidence of bioaccumulation**
  - Winter collection shows a size effect
  - Higher concentrations in large fish
  - Clear trend for males and females at both sites

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Conclusions

- Our findings in relation to:
  - *3 year old Pacific herring (from West et al. 2008)*
    - From 3 sites in Puget Sound
    - PBC concentrations from 1500-2500 ng/g lipid
    - Sand lance concentrations were lower
      - Large males at Eagle Harbor were similar

  - *Environmental samples*
    - Fine bed sediment, nearshore suspended sediment, & suspended particulate matter near fish locations
    - Much lower than sand lance concentrations
    - Typically >10x lower on a dry weight basis

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Conclusions

- Sand lance demonstrate maternal transfer of PCBs to their eggs
  - Eggs from both sites & size classes contain PCBs
  - Concentrations in females and their eggs were similar
    - Lipid content 6.5 – 8.5% in eggs, and 2-3% in females and males
  - Concentrations in males were higher than females and eggs
    - Especially in large fish – 2nd - 3rd year spawners
    - Weaker trend in smaller fish – first year spawners
- New route of entry / re-entry of PCBs into food web

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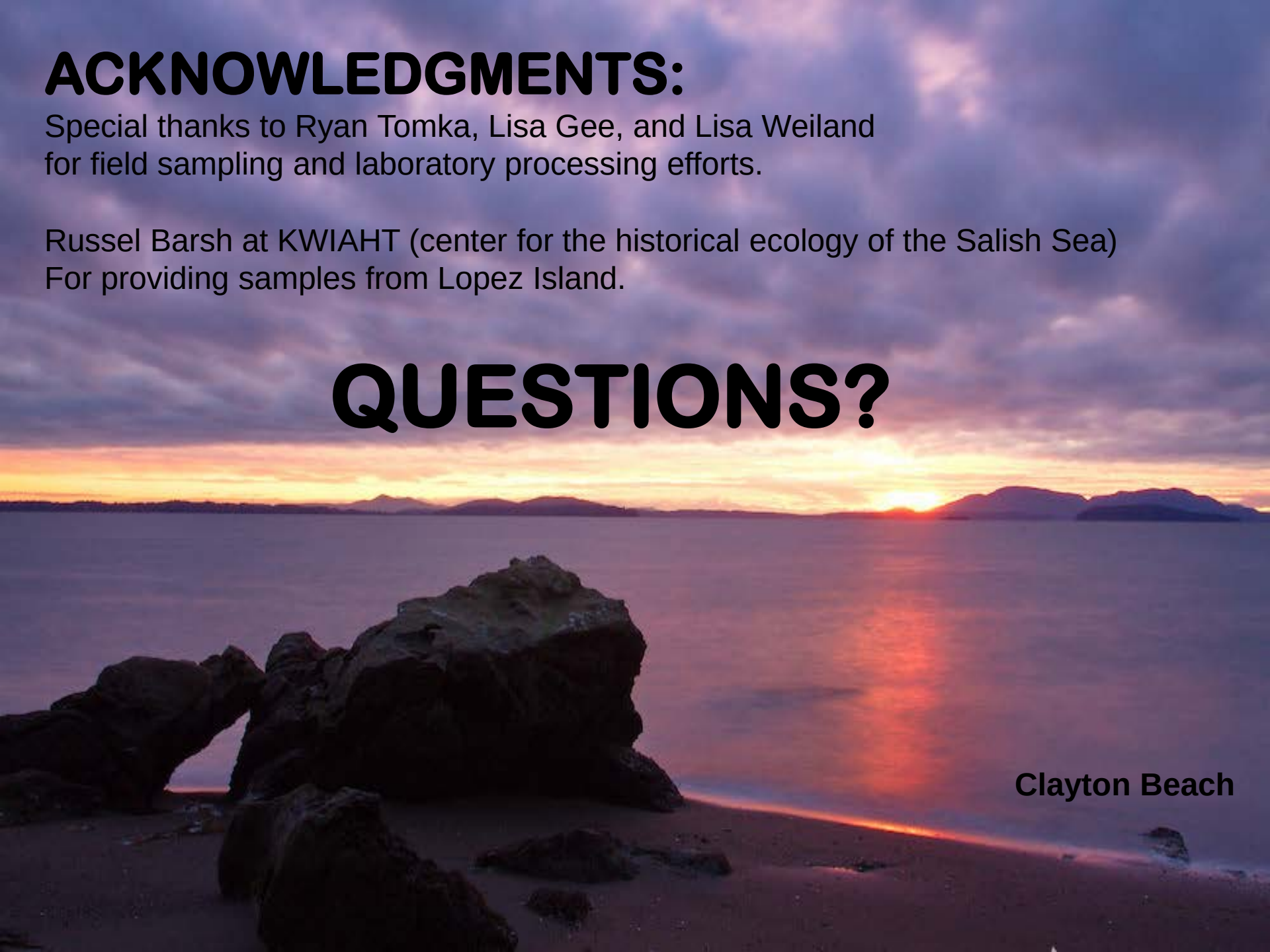
QUESTIONS?



Clayton Beach

- % Lipid summary for sand lance samples
  - Eggs 6.5 – 8.5%
  - YOY 1 – 2%
  - Adults 5 – 8%

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