Role of Long-term Data Sets on Settlement of Marine Invertebrates in Understanding Effects of Ocean Acidification

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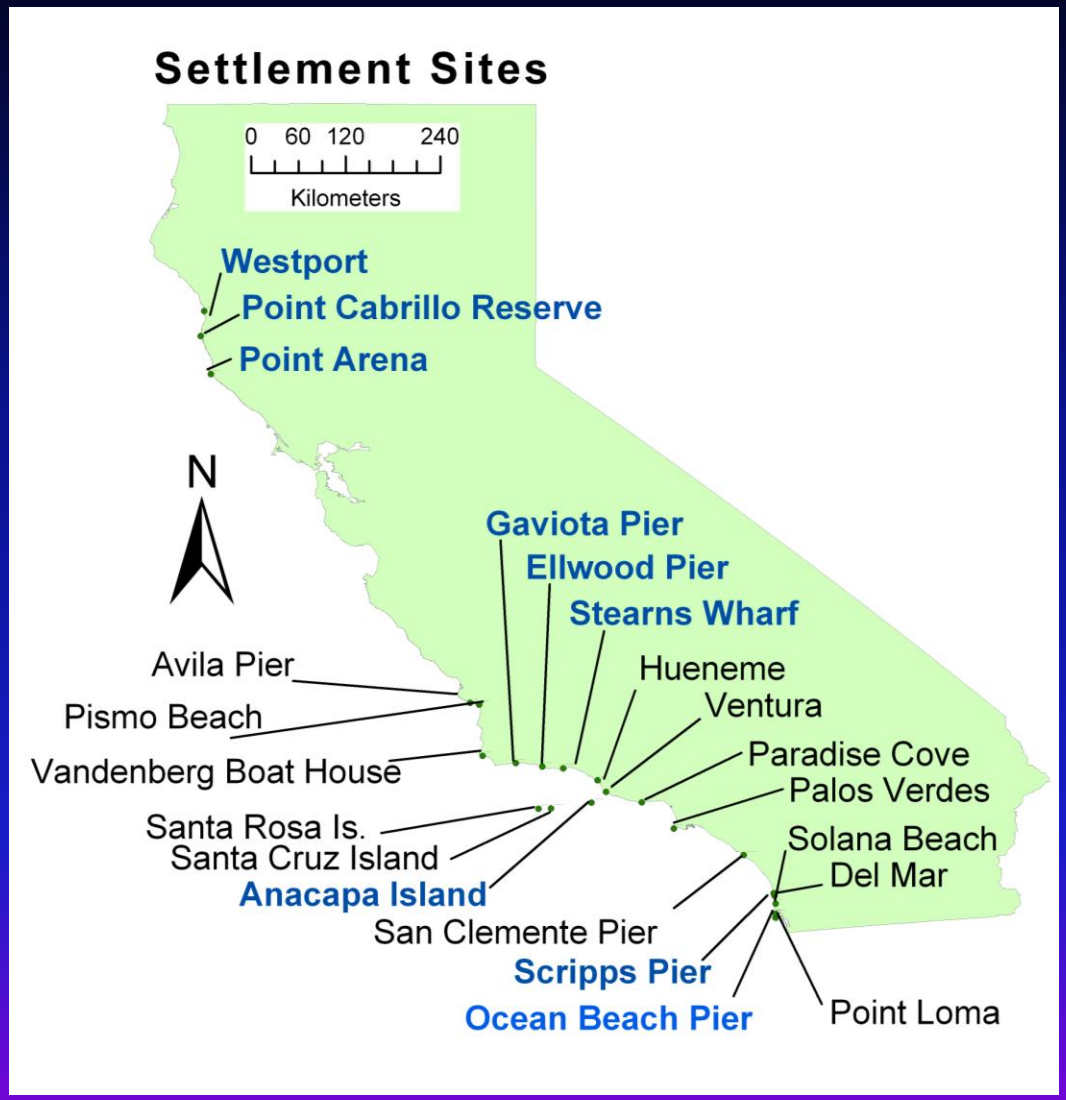
Introduction

- How could long-term data sets on larval settlement contribute to understanding the effects of OA?
- Sampling Design
- Some Results – Spatial & Temporal Variability over varying scales
- Summary & Next Steps

Benefits of long-term studies on larval settlement

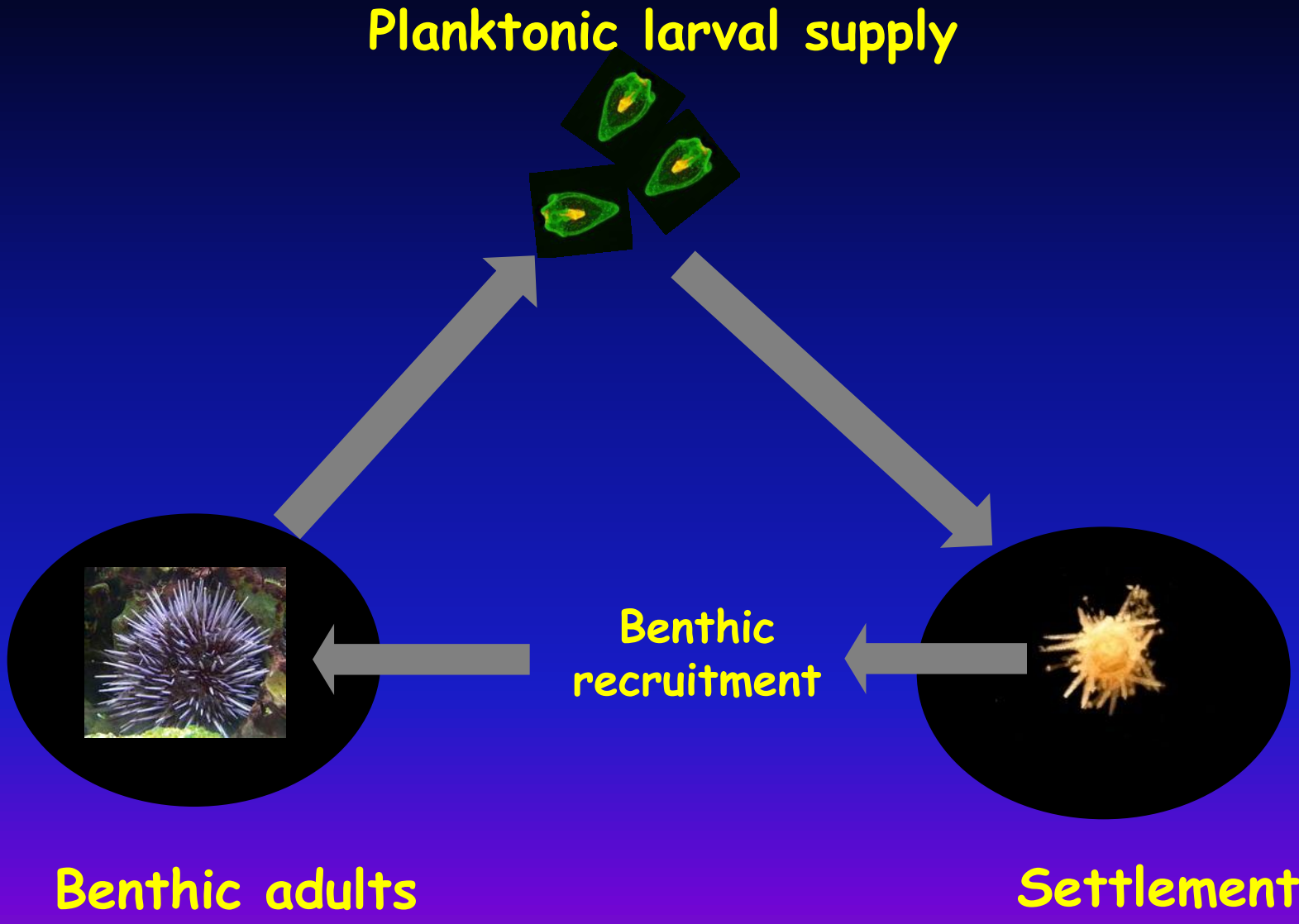
1. Targets early and most vulnerable life stages
2. Encompasses large geographical range over which the severity of ocean acidification is likely to vary.
3. Long baseline (~ 20 years)
4. Provides opportunity to distinguish signals of shifting oceanographic regimes (e.g. El Nino/La Nina conditions and Pacific Decadal Oscillations) from effects of OA
5. Provides archival collection that may be useful in analyzing effects of OA

Project description



- 30 sites from northern, central, and southern California
- Begun in 1990 and continues through the present
- Time series range from 2 to 20 years
- Frequency – weekly to bi-weekly
- Samples archived in EtOH

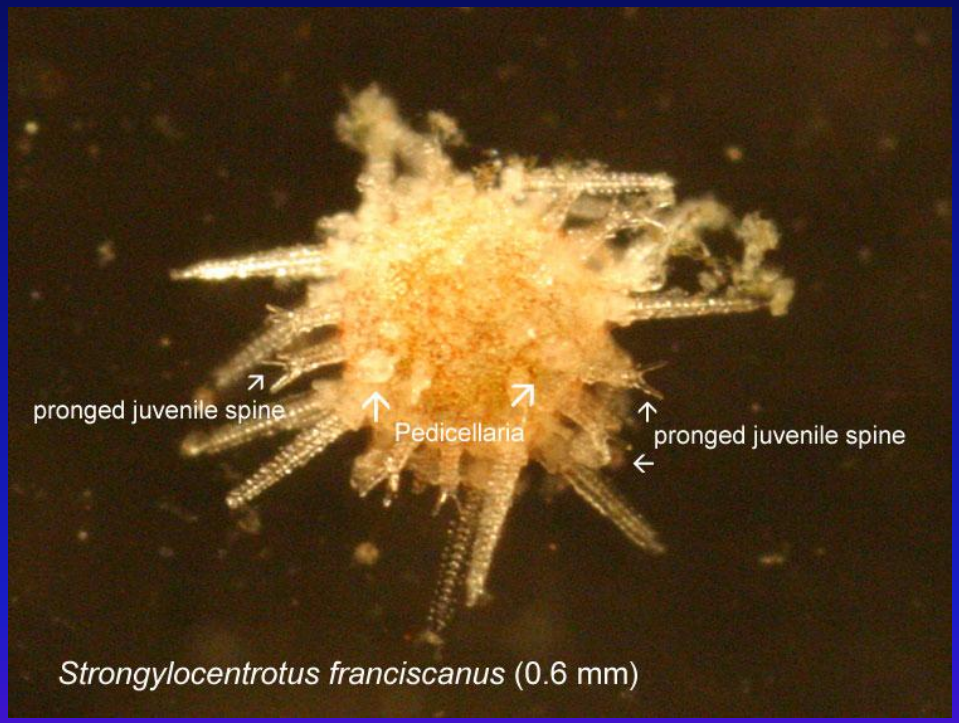
Two phase life cycle




Settlement collectors
(tuffys and brushes) on
surface at Santa Cruz
Island


Settlement collectors
(brushes) near bottom in
Point Loma kelp forest

Newly settled sea urchins

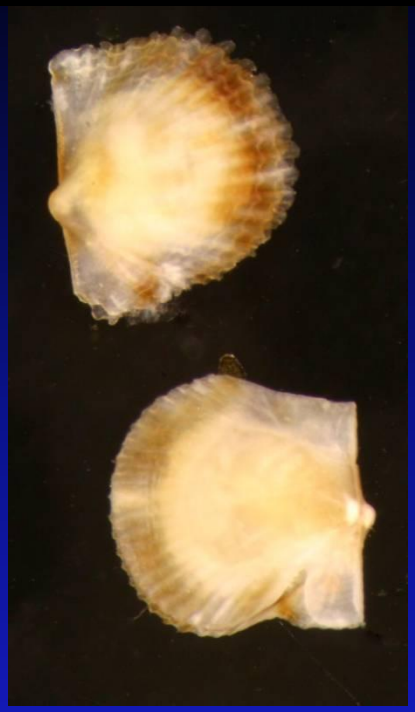


Mollusks

Hiatella arctica

Mytilus spp.

Leptopecten latiauratus



Eulithidium pulloides

Mitrella carinata

Donax gouldii

Crustaceans

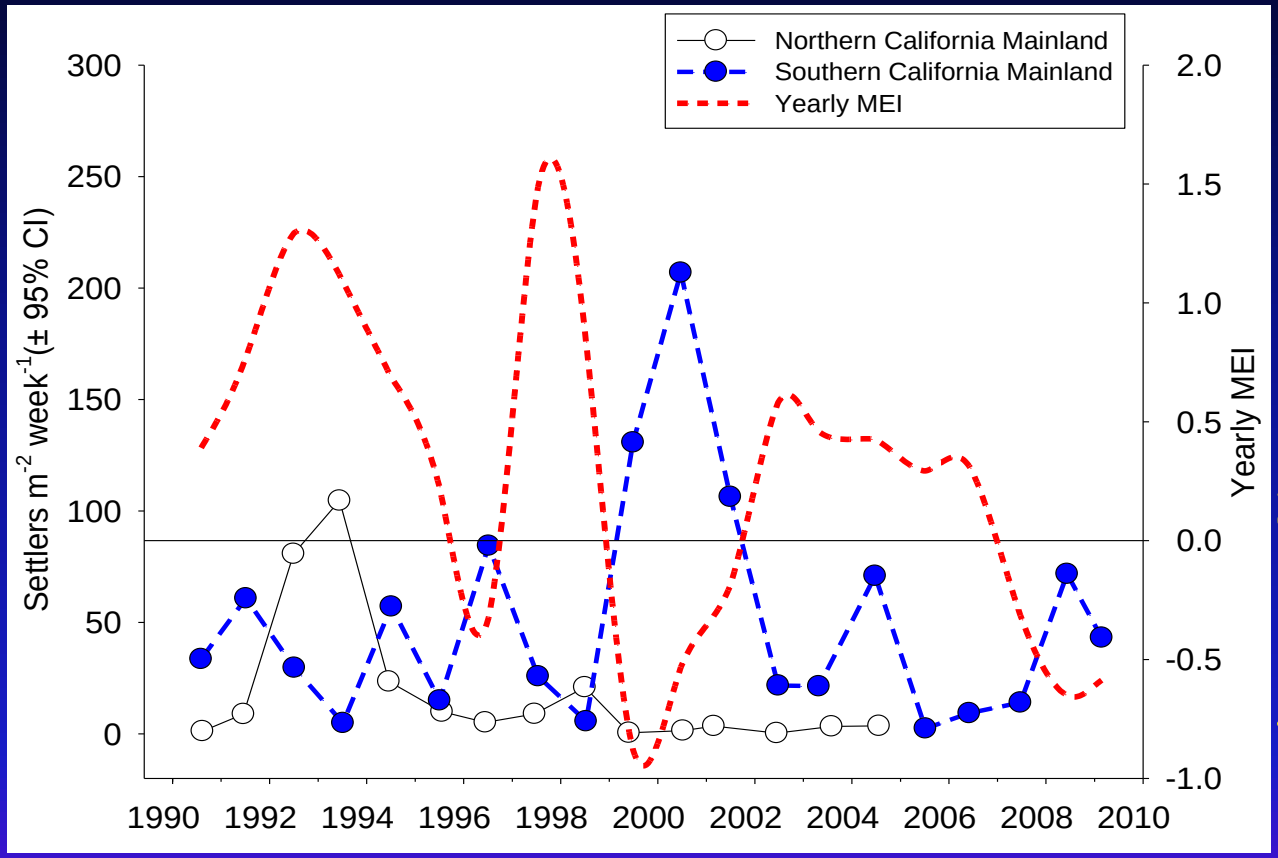
Pachygrapus crassipes

Cancer antennarius

Cancer productus

Panulirus interruptus

Results – Relationship to general oceanographic conditions & sea urchin settlement: Correlations with MEI

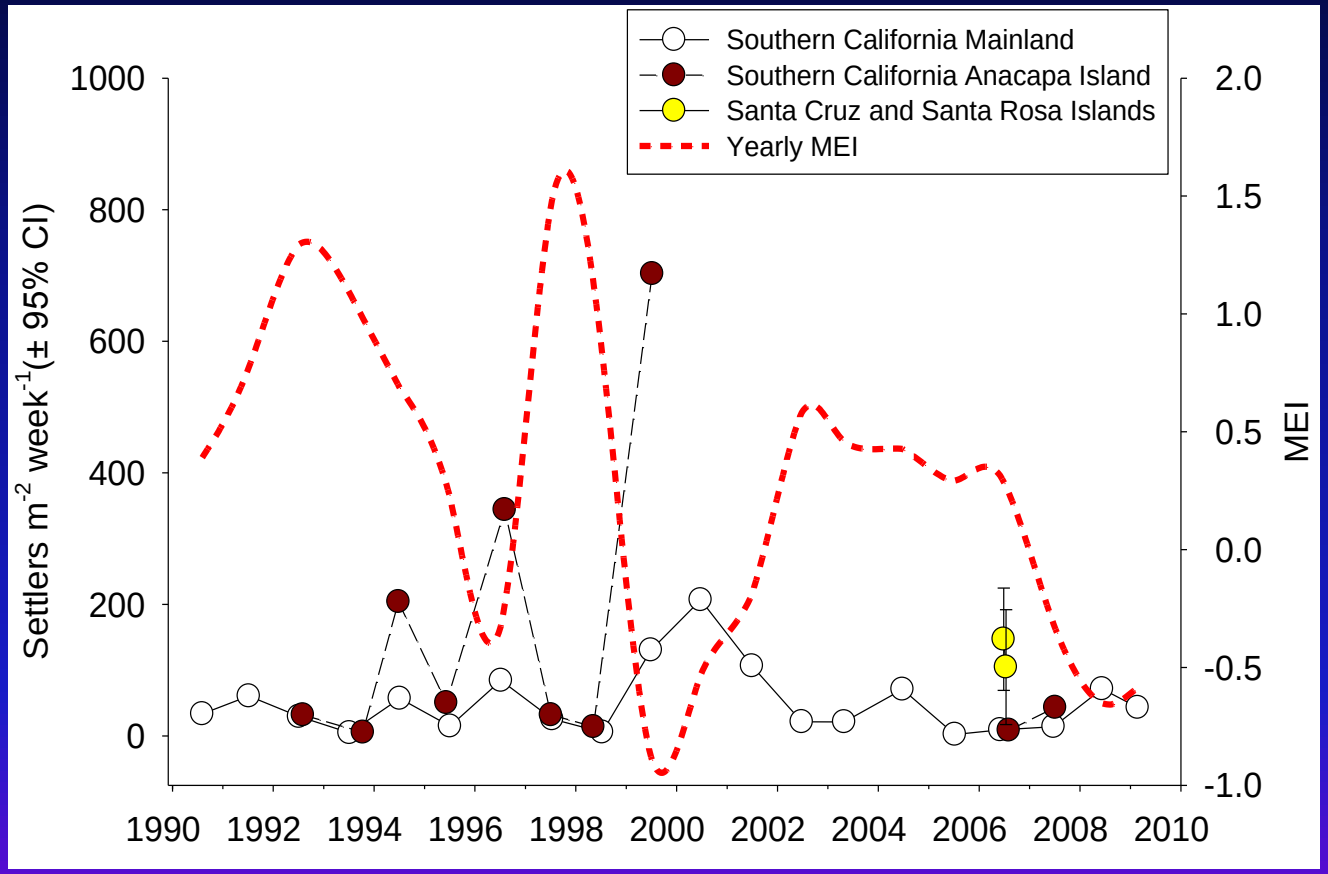


1. Settlement positively correlated with El Nino conditions (MEI) in northern California (r=0.42); reverse pattern in southern California (r=-0.61)

2. Strong influence of a few large events

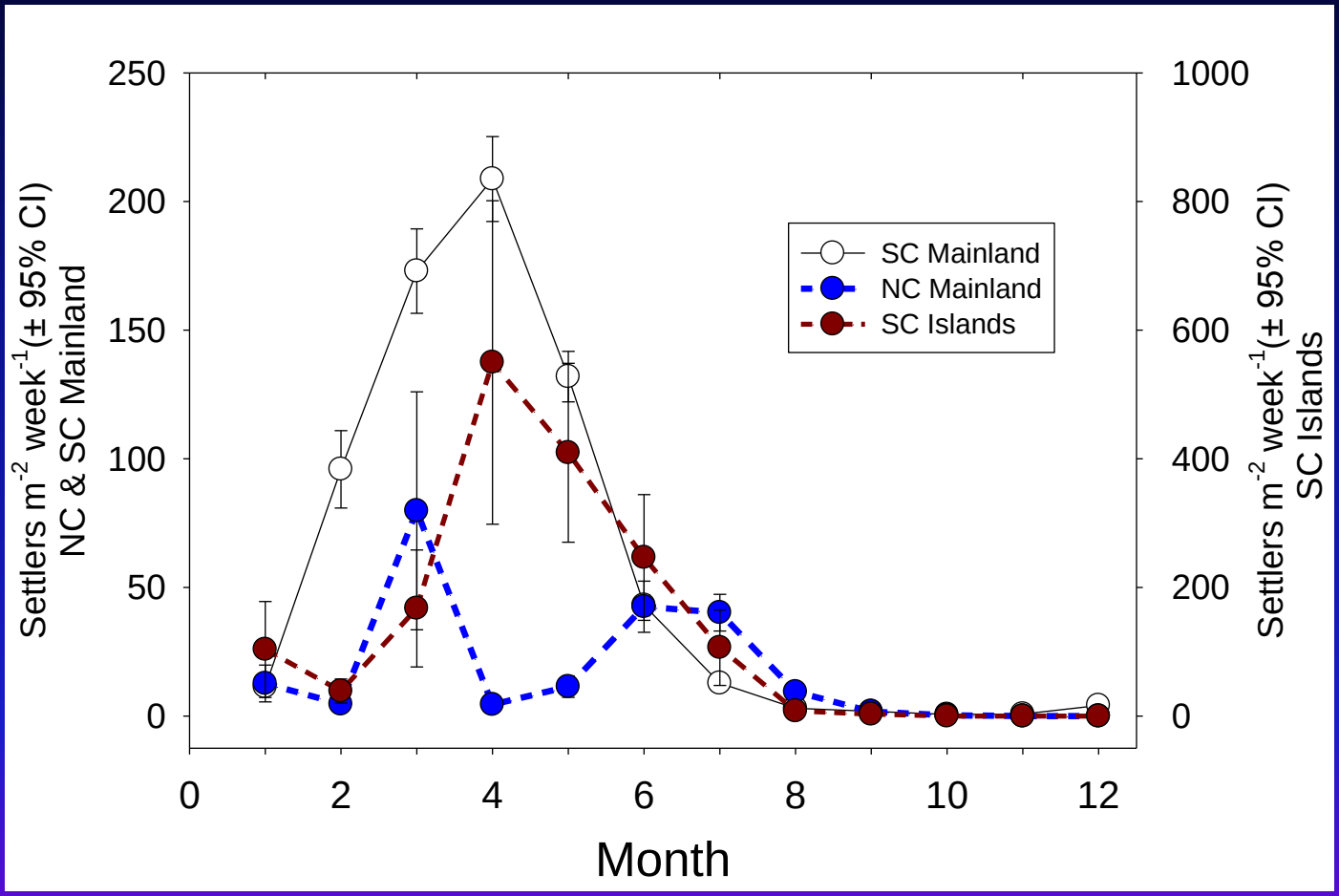
3. Declining trend in northern California, but not in southern California

Results – Relationship to general oceanographic conditions & sea urchin settlement – details from southern California



1. Large Island-Mainland differences
2. Same general correlation with El Nino conditions (MEI)

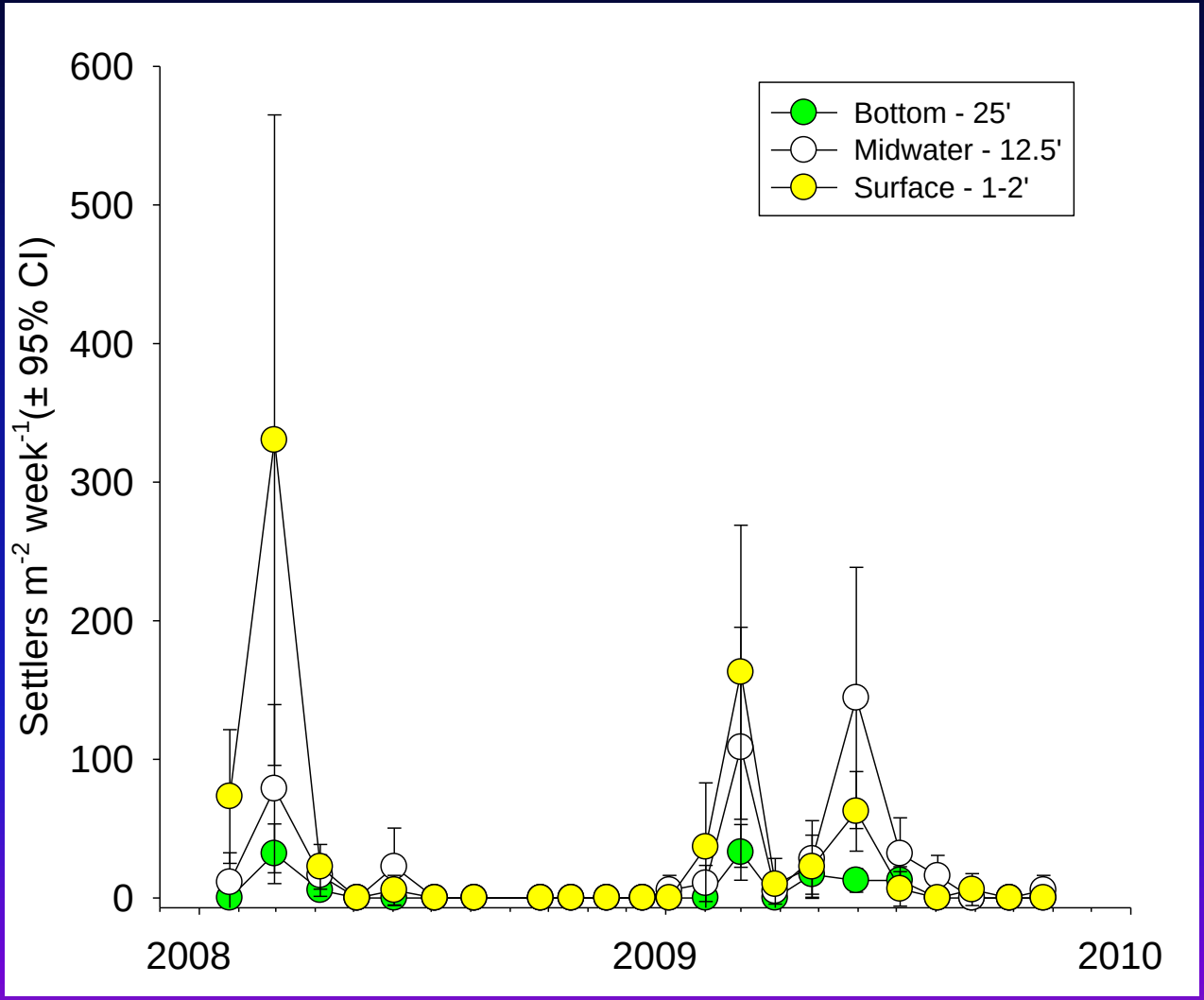
Results – long-term seasonal patterns of sea urchin settlement by large geographic region



1. Similar patterns on mainland & islands in SC

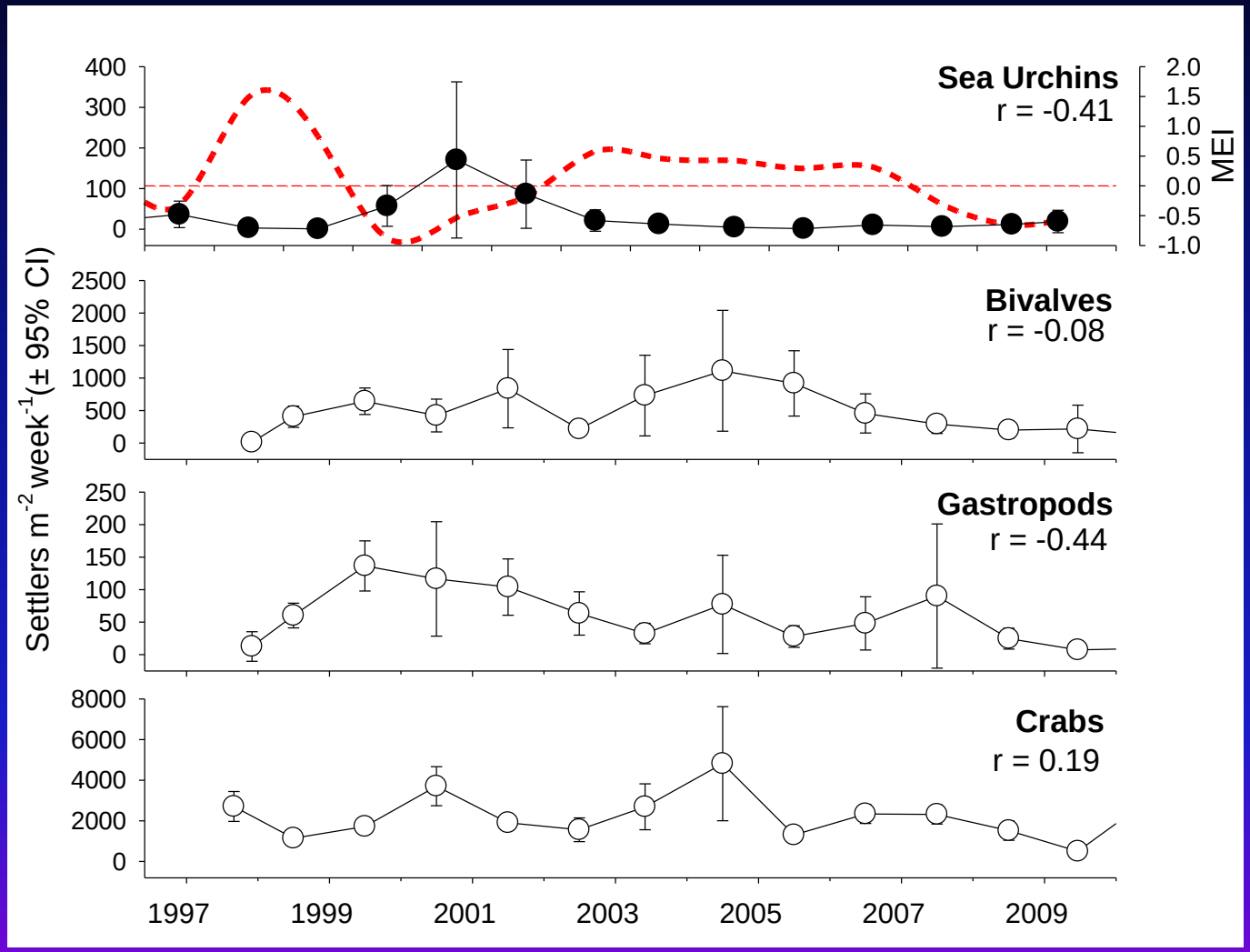
2. Twin peaks in NC

Results – Variations in Sea Urchin settlement with depth: Avila Pier



1. Significant settlement north of Point Conception
2. Significant difference in settlement related to depth
3. Possible reflection of local changes in pH related to depth?

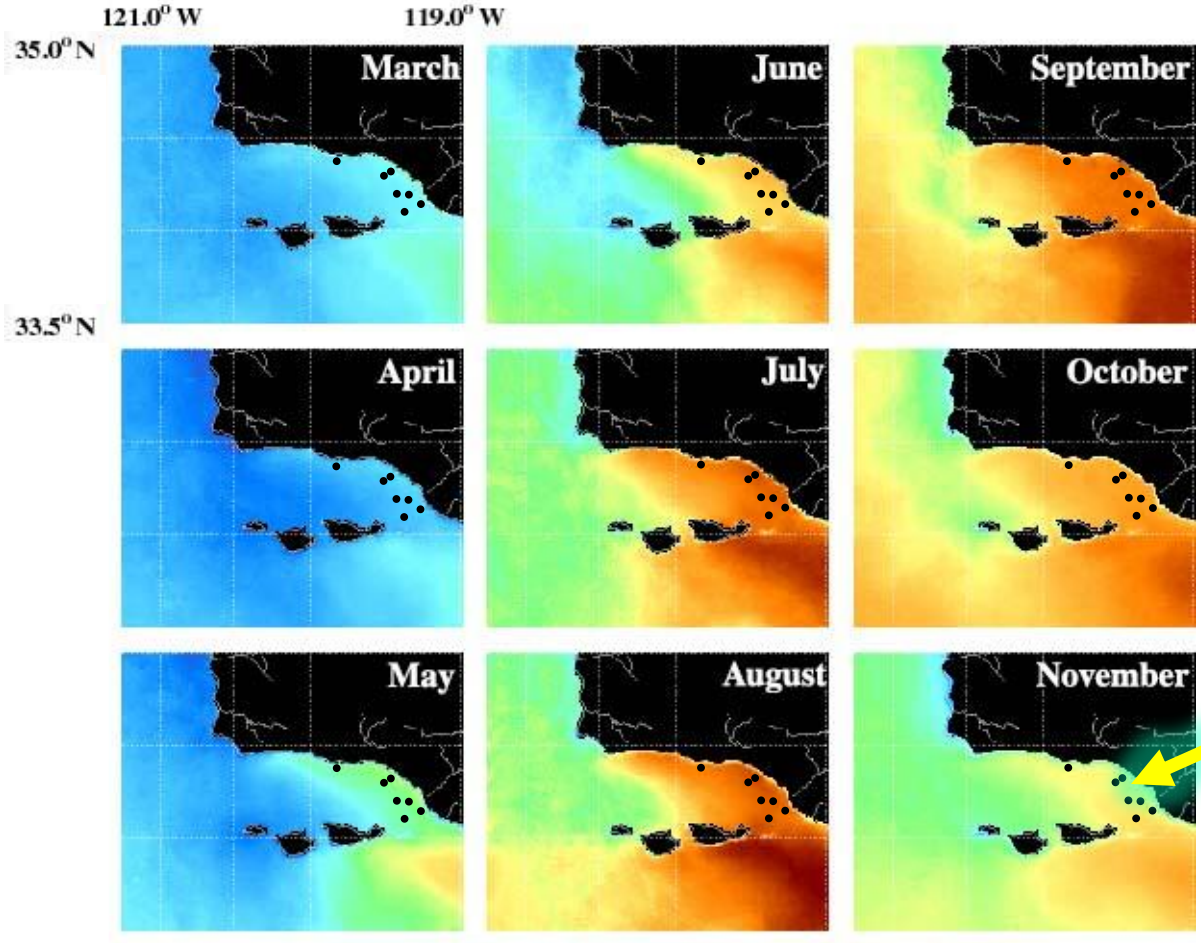
Results - Relationship to general oceanographic conditions Urchins, Bivalves, Gastropods, and Crabs in San Diego



1. Negative correlations with MEI for sea urchins and gastropods
2. Weak positive correlations for crabs
3. No correlations for bivalves

Oceanographic gradients in the Santa Barbara Channel

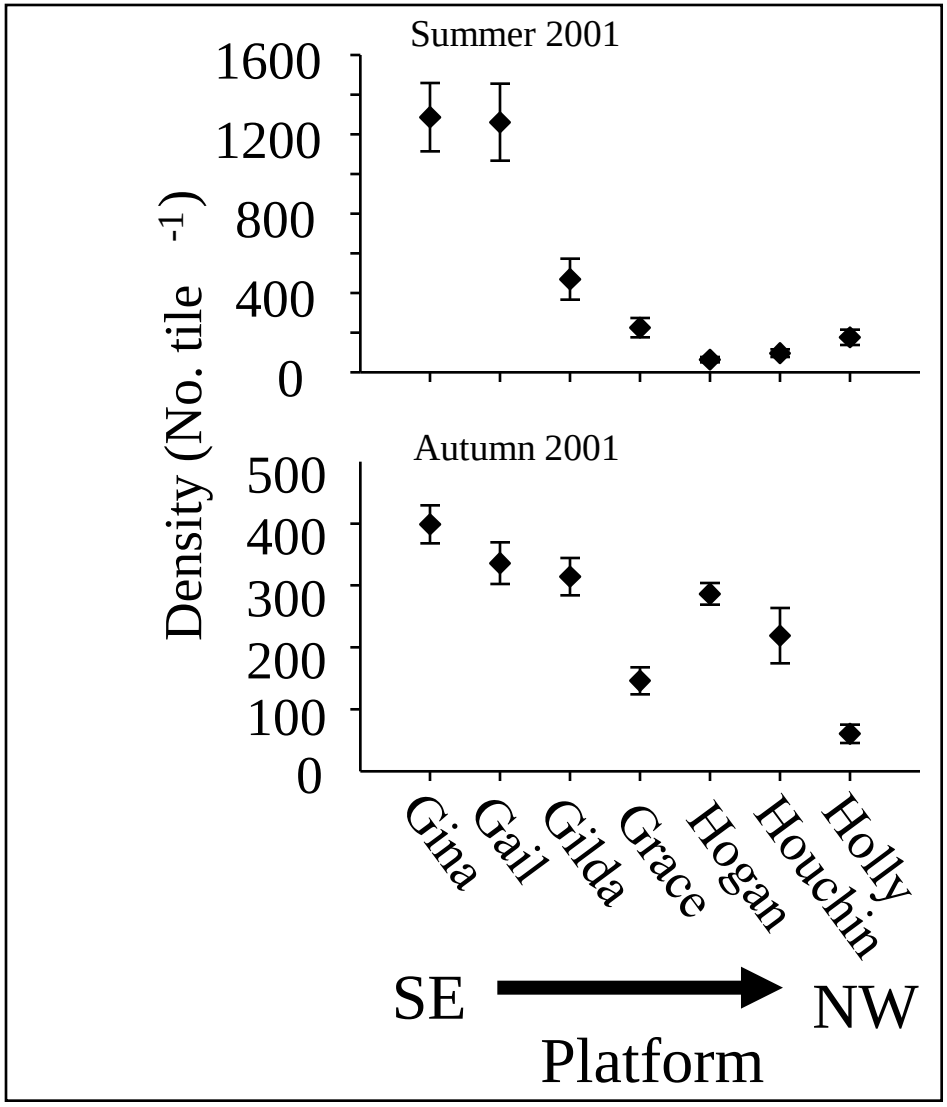
Siegel & Otero, 2004



oil platforms

10 °C 15 °C 20 °C

Seasonal and spatial patterns of *Balanus trigonus* (barnacle) settlement on oil platforms



Tiles deployed for 3 months each season

Page et al. 2008

Summary

1. Cost-effective & sustainable

2. Long-term data over large geographical range

3. Can detect episodic nature of settlement and non-OA drivers (e.g. ENSO, PDO)?

4. Complements laboratory experiments

5. Provides range of species which may respond differently to OA

6. Provides potential for experiments at specific sites by measuring settlement across environmental gradients

Next steps

1. Physical data needs
   - Time series measures of pH or pCO2;
   - Temperature and salinity data at different depths in the water column
   - Measures of upwelling, tidal bores, internal waves

2. What useful information can be derived from archived samples (e.g. changes in test thickness)?

3. Increasing spatial coverage
   - Humboldt Bay
   - Coos Bay
   - Offshore oil platforms