Marine Heatwaves: Impacts on Fisheries and Kelp forests

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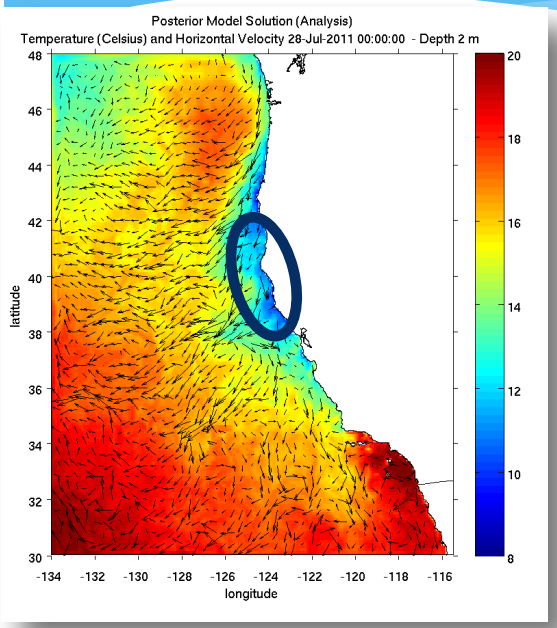
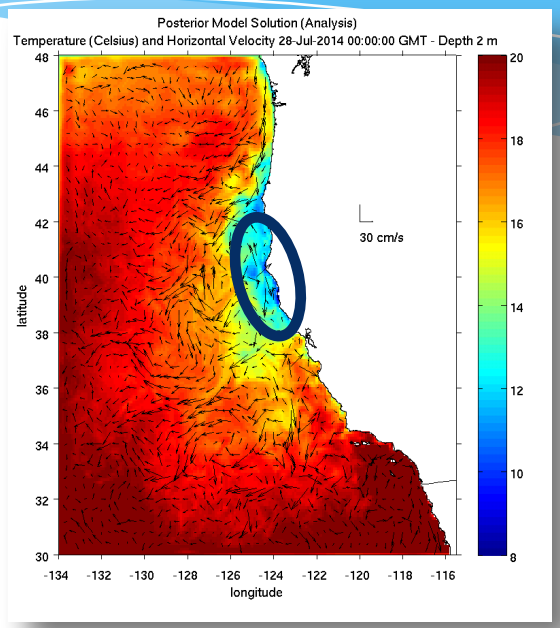
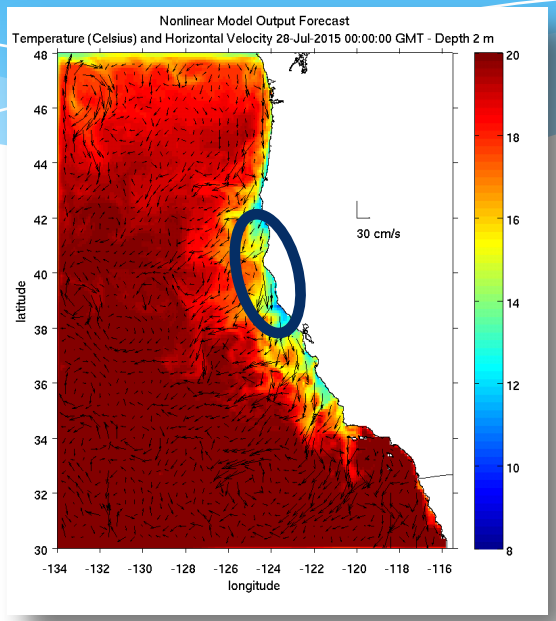
CSUMB Climate Outlook Oct. 2016

Persistent Warm Water Conditions







* **July 28, 2011**

Normal

* **July 28, 2014**

"Warm Blob"

* **July 28, 2015**

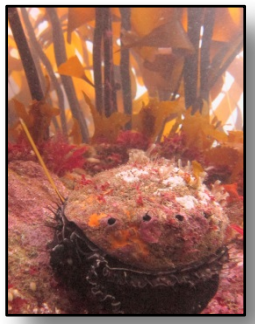
"Warm Blob" + Strong El Niño

http://oceanmodeling.ucsc.edu/ccsnrt/webplots/latest/latest_SST.png

Marine Examples

- **Linking ocean conditions to fishery productivity**
  Dungeness Crab

- **Ecosystem responses to stressors**
  North Coast Kelp Forest



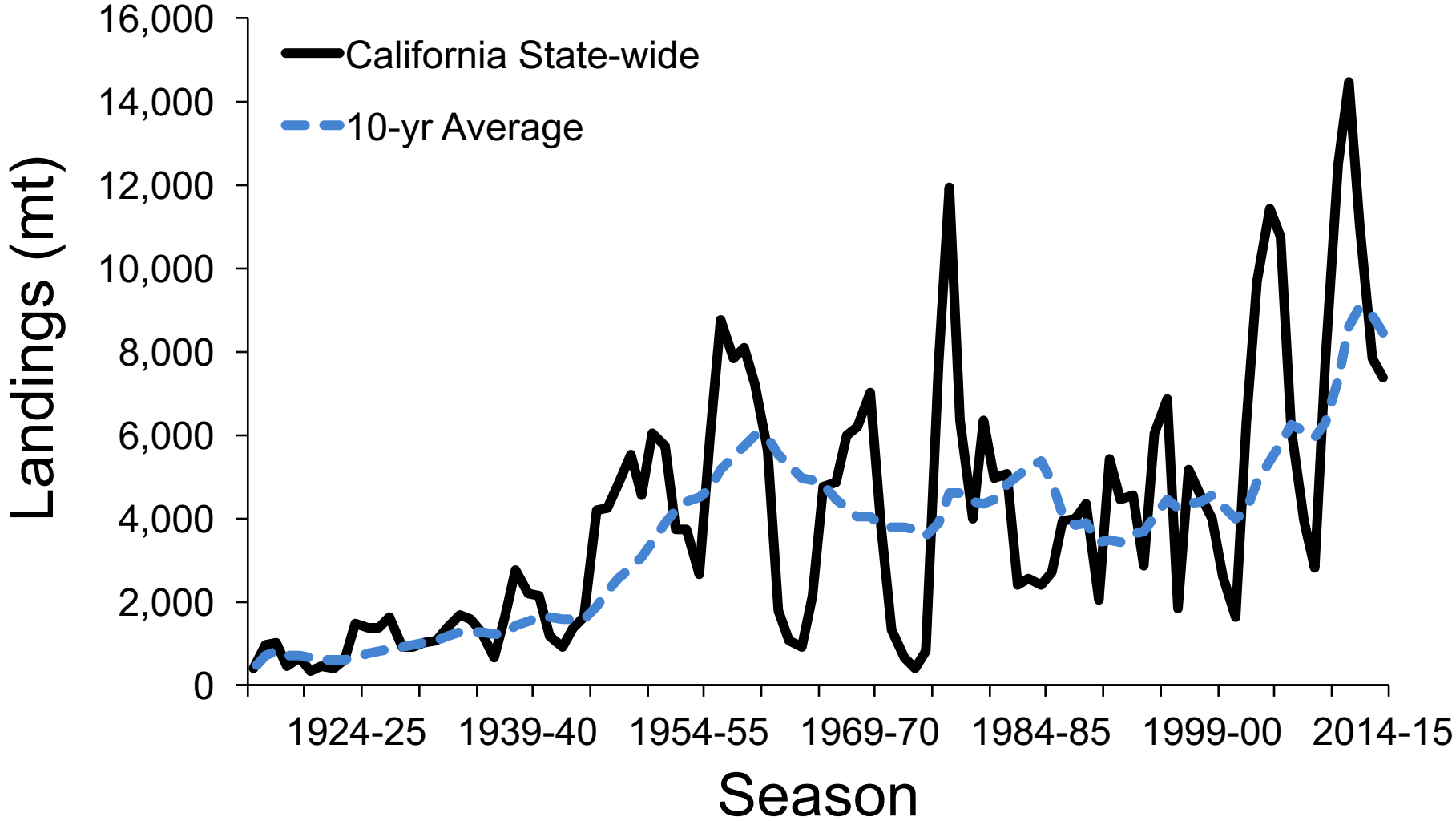
- **Biological responses to stressors**
  Red Abalone

vs

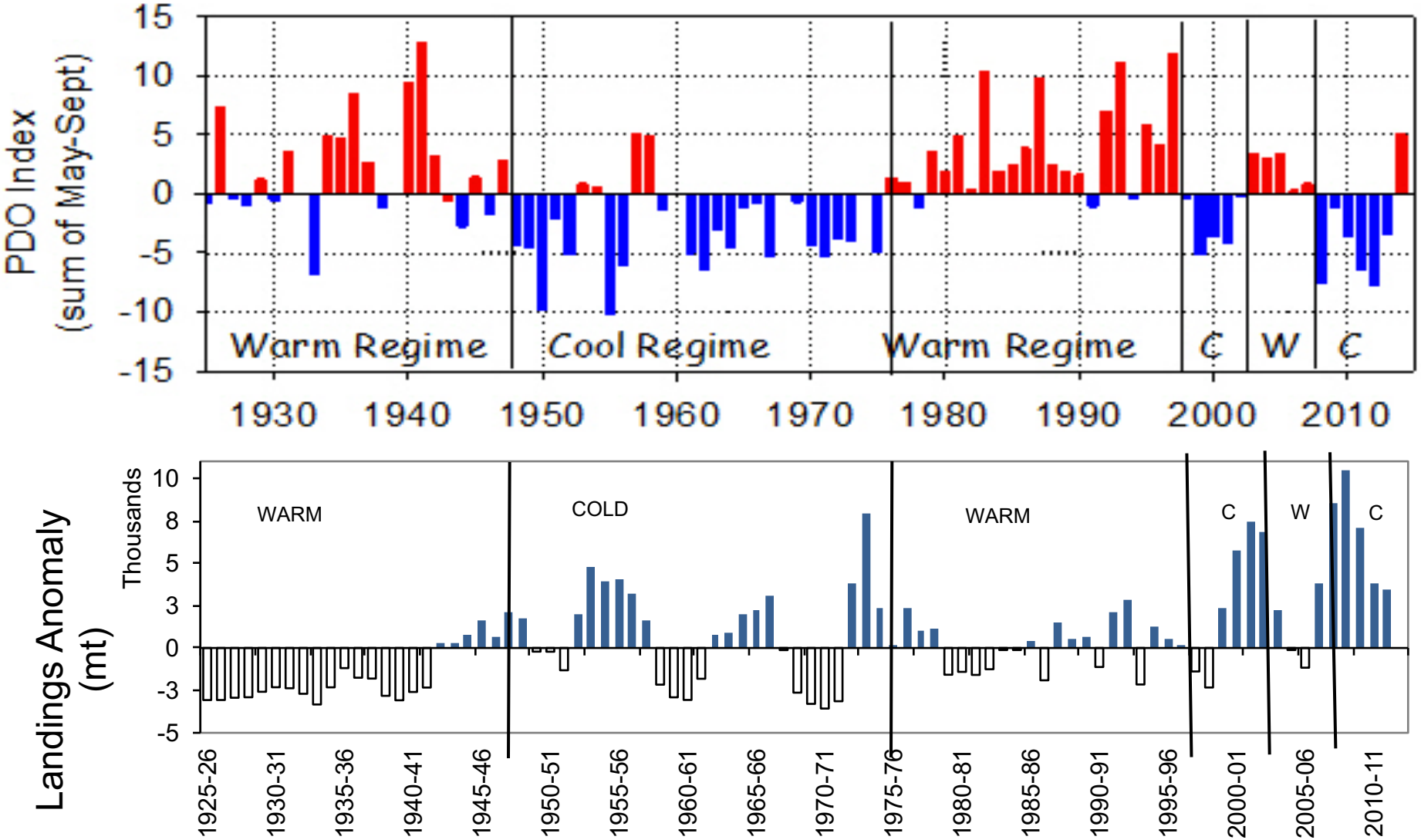
Dungeness Crab Fishery

- $60-$90 million commercial fishery
- Primarily north of Pt Conception
- Two management areas

100 Years Statewide Landings: 1924 to 2014-15

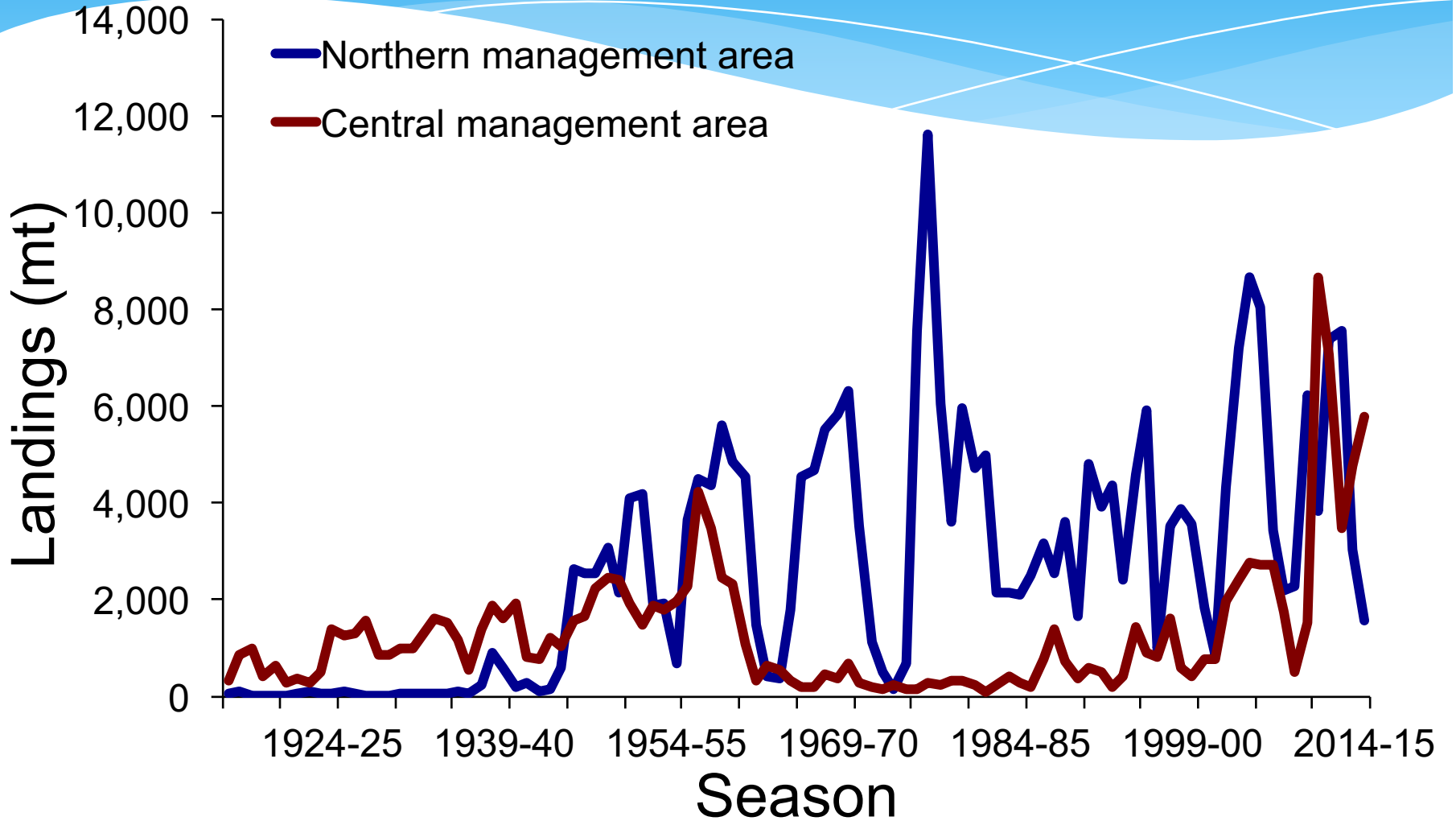


Dungeness Crab Landings Higher during Cold Phase PDO



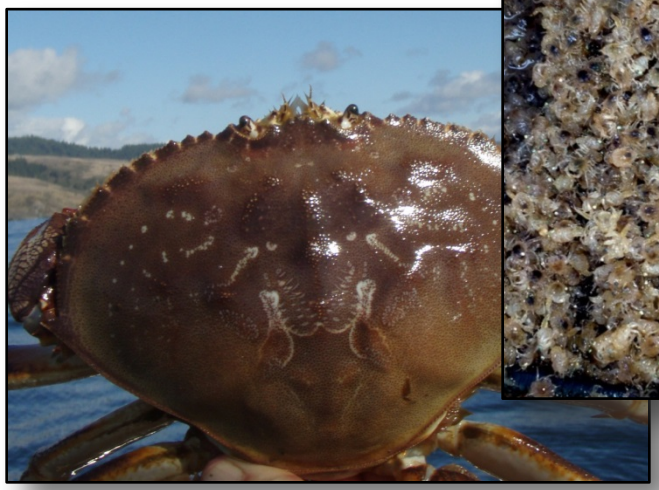
P. Kalvass DFG

Landings by Management Area 1915-16 to 2014-15

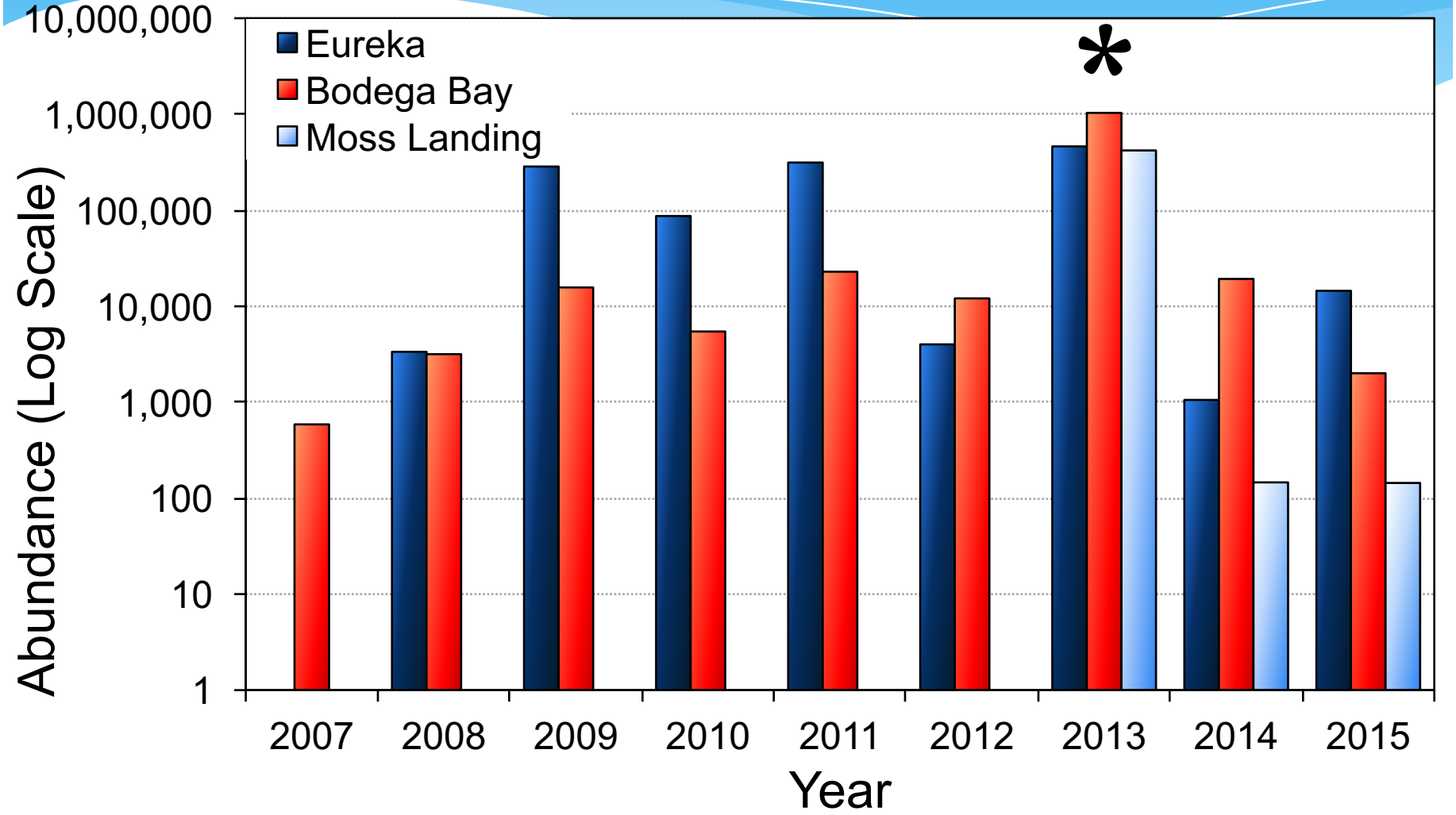


Dungeness Crab Research

- Compare fishery landing and SST anomalies
- Annual megalopae recruitment by area

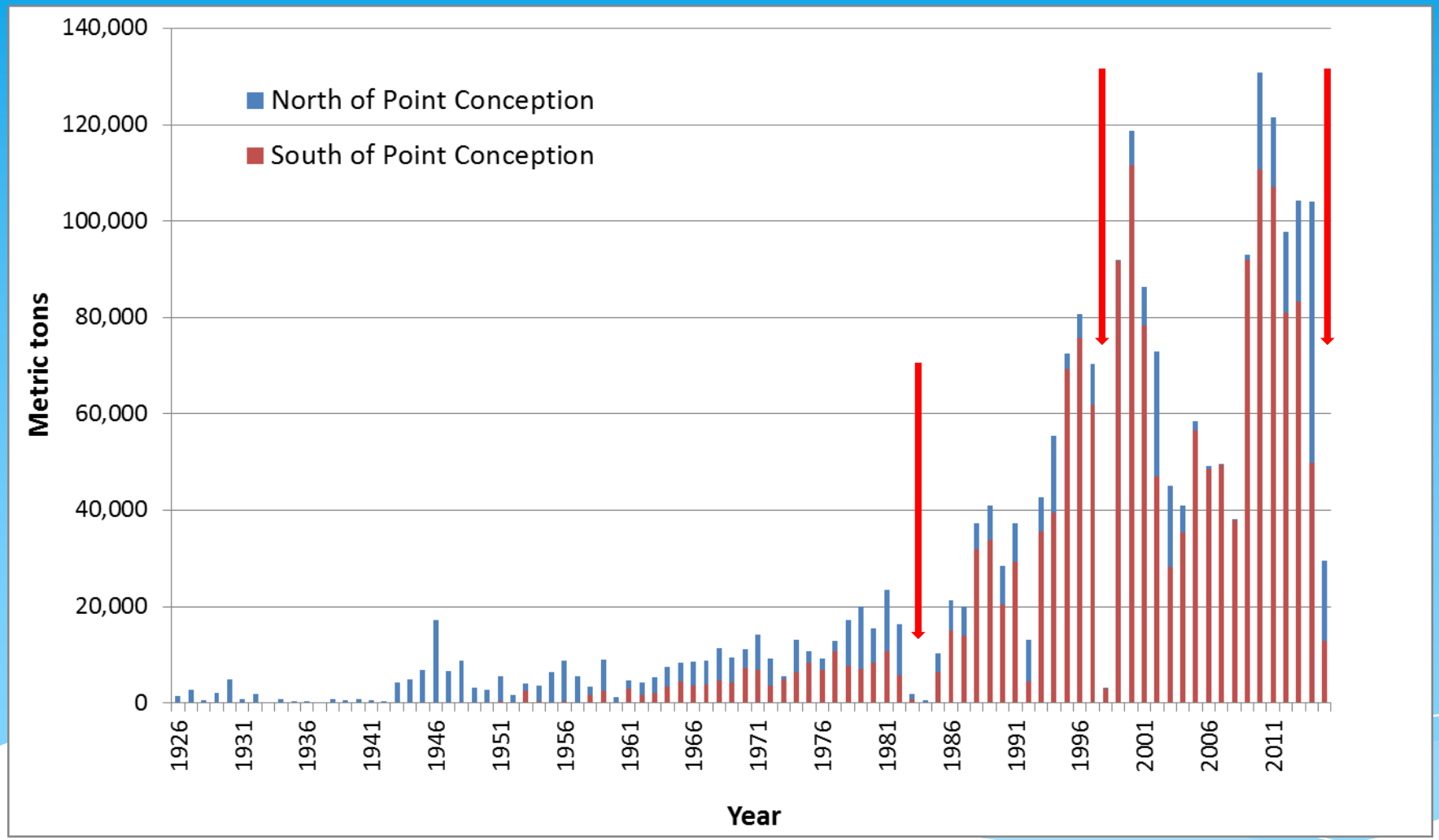


Dungeness Crab Megalopae Abundance 2007-2015



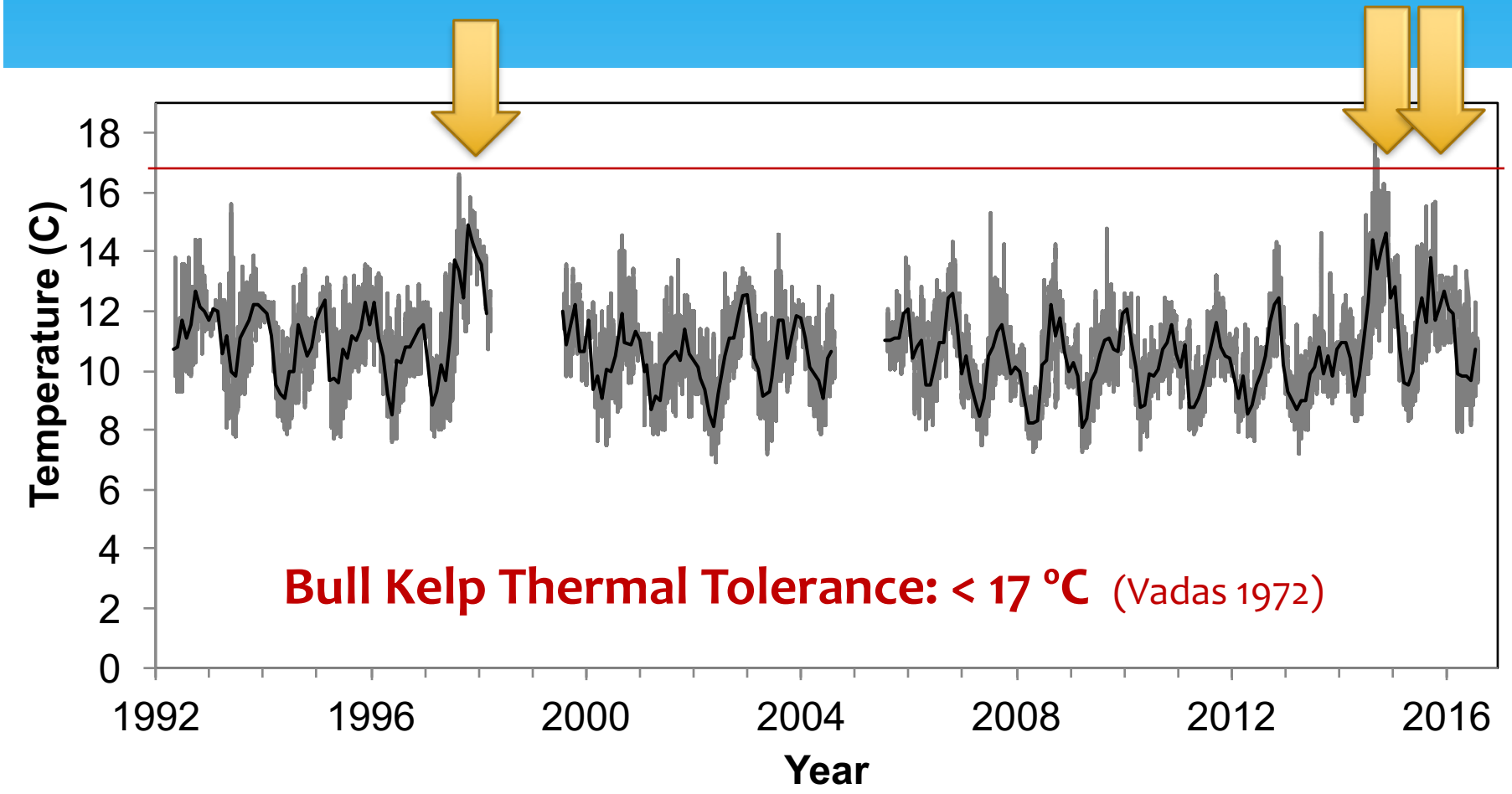
Market Squid

CA Commercial Landings History: 1981 to 2015



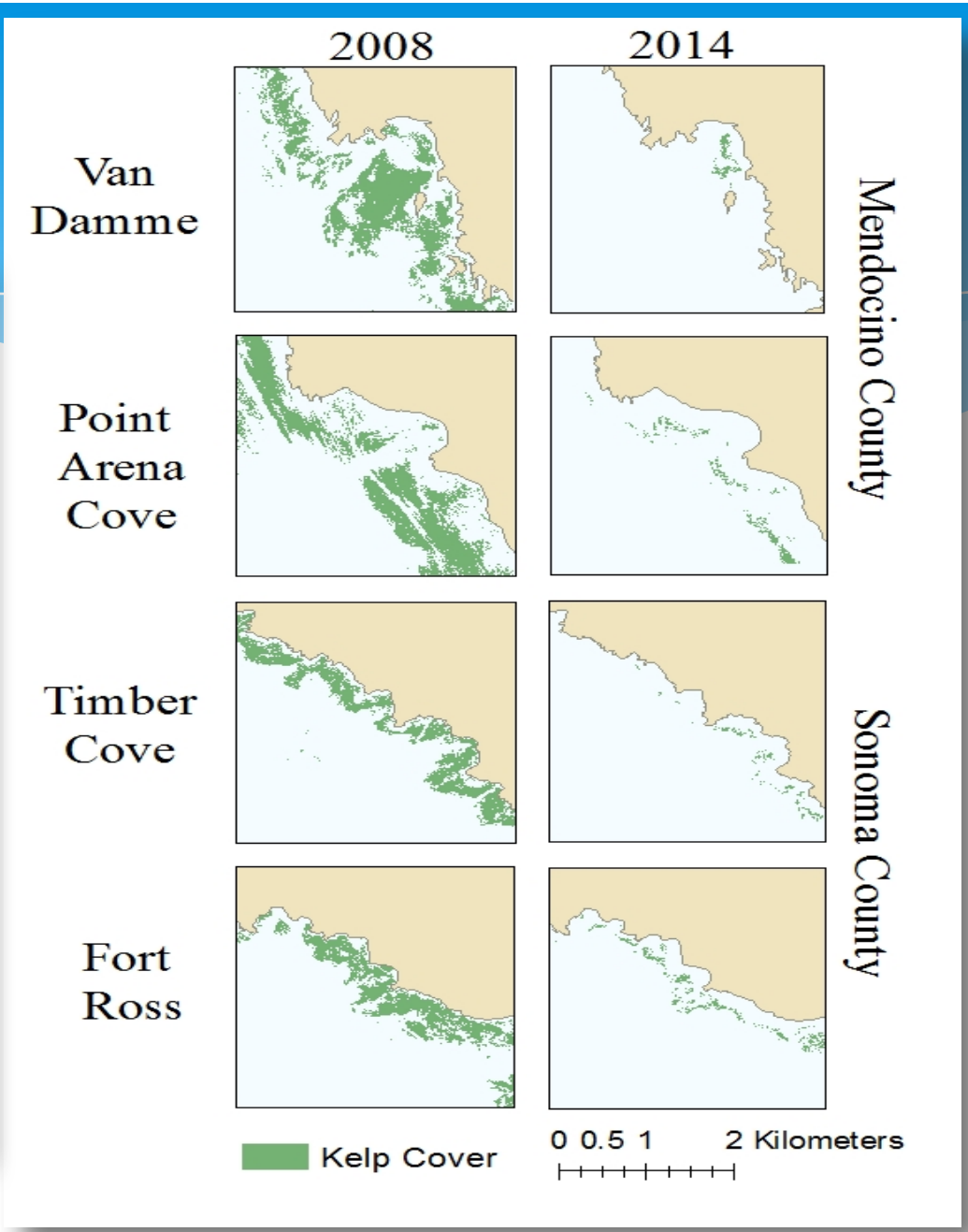
Department Fish Bulletins 1926 to 1968, California Fisheries Information System (CFIS) for years 1969 to 2014, and voluntary electronic submission and field data for 2015 Prelim.

Daily 10-m Seawater Temperature
Mendocino County



Kelp Fly Over Data CDFW

Photo A. Weltz Fort Ross 2015

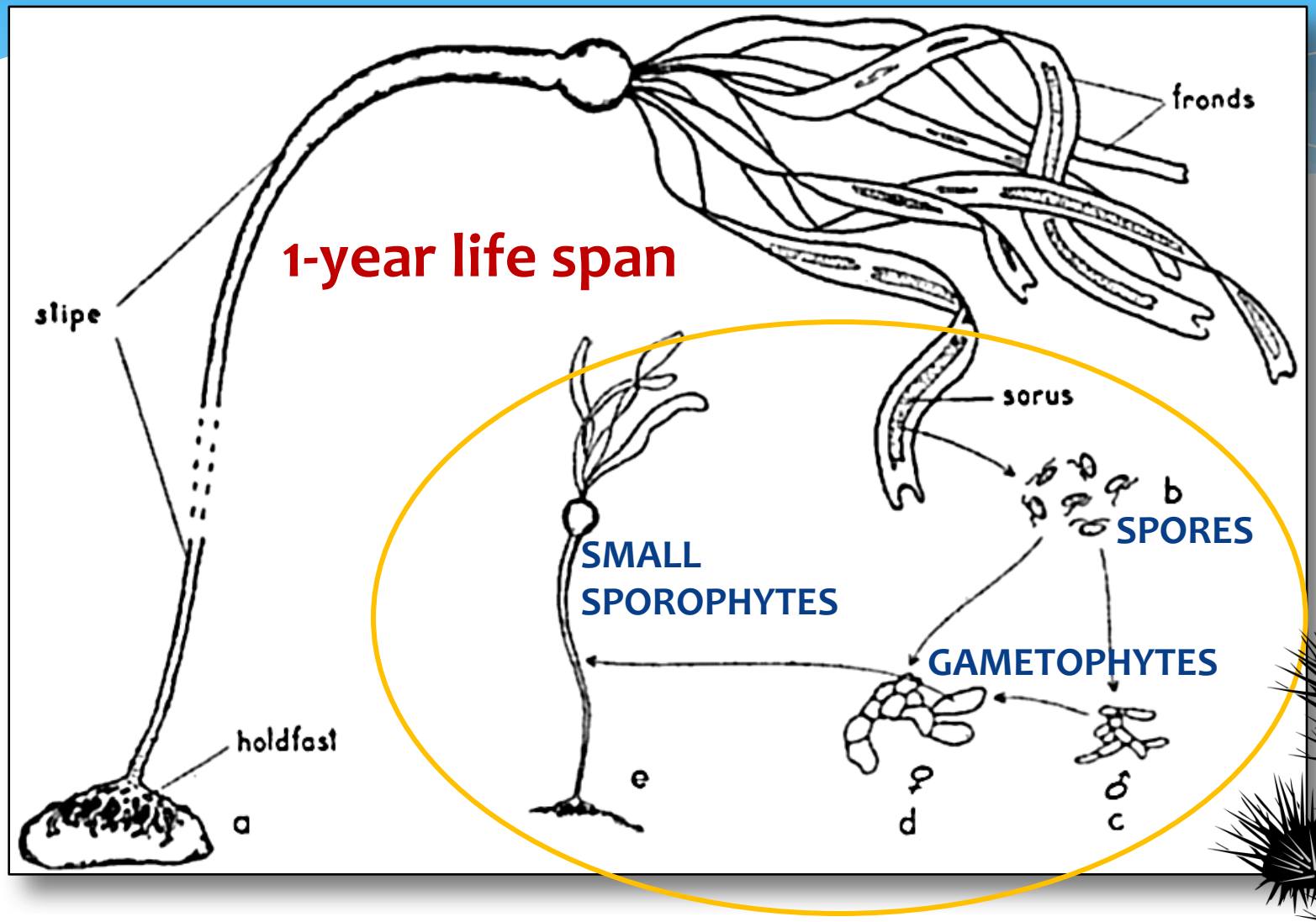


Data M. Fredle

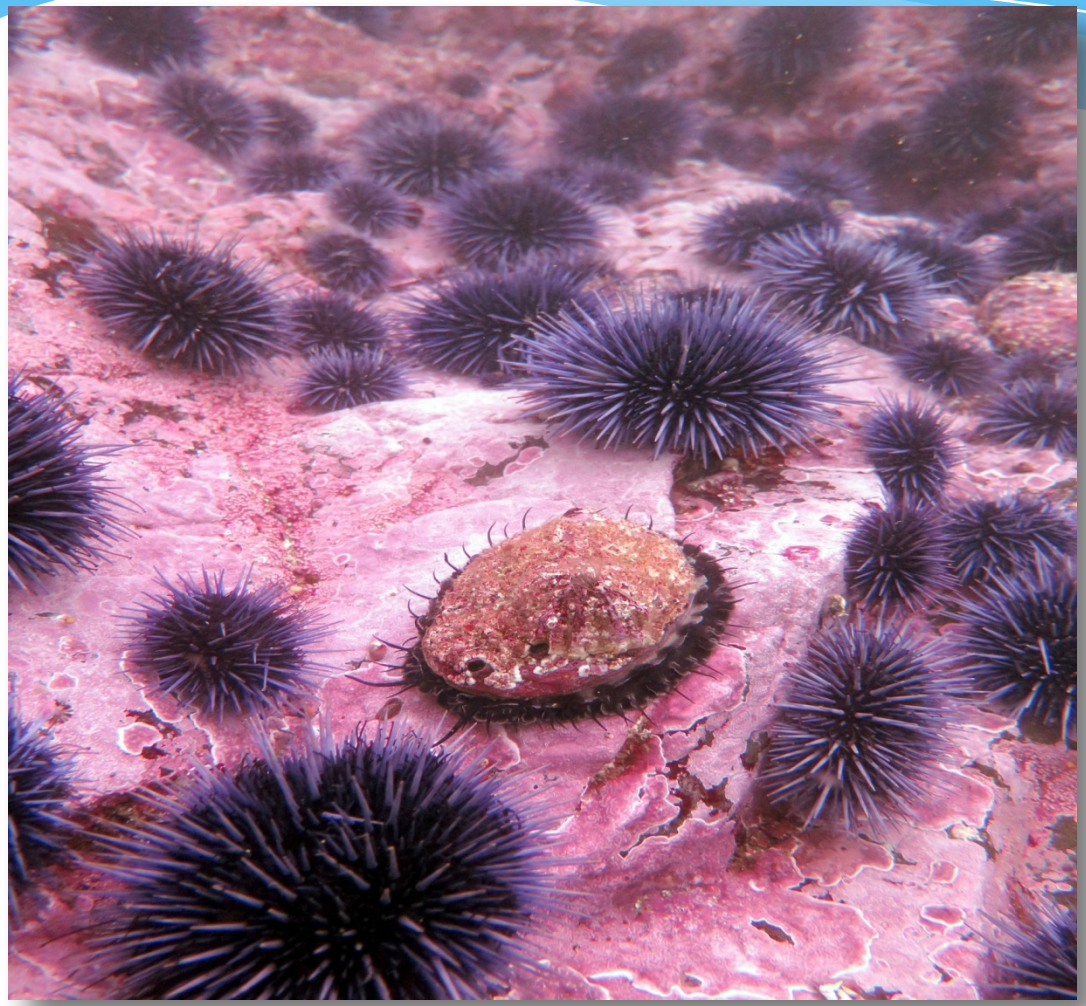
Ocean Cove / Salt Point
September 13-14, 2012
K. Joe

Ocean Cove / Salt Point
September 14, 2016
C. Catton

Nereocystis Vulnerability



Unprecedented Large-Scale Purple Sea Urchin Explosion in 2015



> 60x historic densities in N. California

Ecosystem Tipping Point: Oregon and Washington State

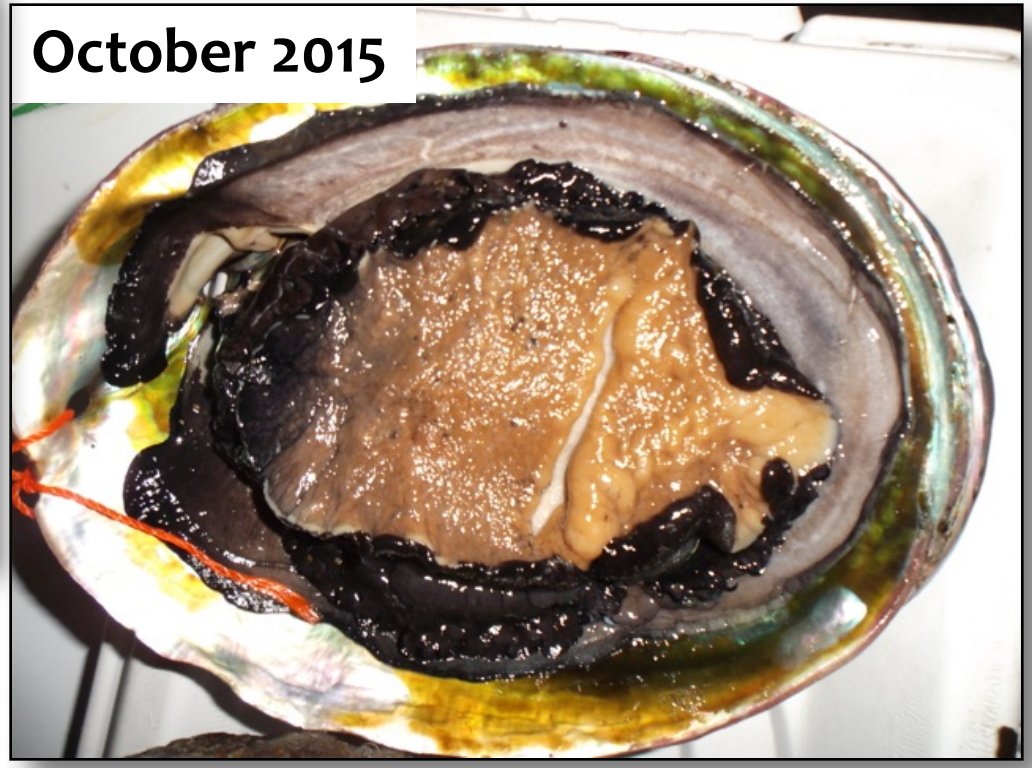
Photo A. Maguire

Starving Conditions in Northern California (2014-2015)

Poor Fishery Product and Resource Health

66% drop

in north coast urchin catch and fishery value in 2015



S. Holmes

12 year average 254,00 to 148,000 in 2014

Regulation Change

What is Happening in the “Cold” 2016 La Niña

* CeNCOOS Data Products : Ocean Observing System
* BUOY 46014 - PT. ARENA
* Water Temp 50.5 °F Fri, Jul 01 52.7°F 35 yr avg mean

* Warmer than 35 year average 85% so far in 2016

Future Indications

* Dungeness crab and DA (now “hot” razor clam)
* Squid landings ?
* Abalone fed in lab 12 months still not reproducing
* Sea urchins persisting in 2016 and growing in numbers
* Lack of bull kelp in many areas
* Return of the Blob???

Opportunities

* Ocean Temp Monitoring – Gliders and shore stations
* Forecasting tools for El Niños or warming
* NOAA Red yellow green light
* Monitoring fishery productivity – recruitment
* Produce fishery landings products

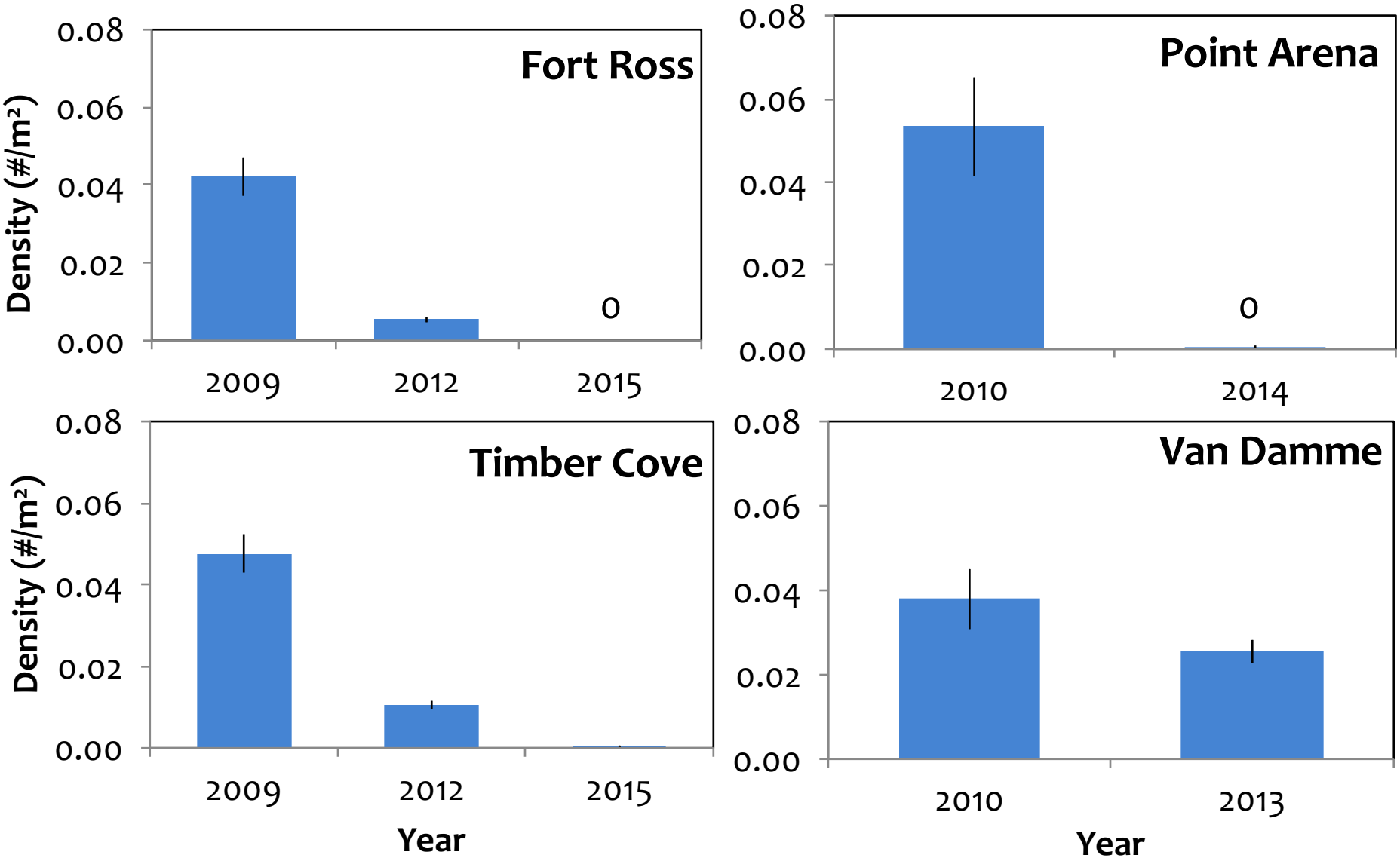
Ocean Ecosystem Indicators
Juvenile Chinook Salmon Survival, 1998-2014

- Higher Pacific Decadal Oscillation (PDO) values and above average summer sea surface temperatures, among other indicators, ranked 2014 as one of the worst for juvenile survival.

Ecosystem Indicators	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PDO (December-March)	16	6	3	12	7	17	11	15	13	9	5	1	14	4	2	8	10
PDO (May-September)	10	4	6	5	11	15	14	16	12	13	2	9	7	3	1	8	17
ONI Jan-June	17	2	1	5	13	14	12	15	7	11	3	9	16	4	5	7	9
46050 SST (May-Sept)	15	8	3	4	1	7	17	14	5	16	2	9	6	10	11	12	13
NH 05 Upper 20 m T winter prior (Nov-Mar)	17	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2
NH 05 Upper 20 m T (May-Sept)	13	10	12	4	1	3	17	15	7	8	2	5	11	9	6	14	16
NH 05 Deep Temperature (May-Sept)	17	6	8	4	1	9	12	14	10	5	2	7	13	11	3	16	15
NH 05 Deep Salinity (May-Sept)	17	3	7	4	5	13	14	8	6	1	2	11	15	10	9	12	16
Copepod Richness Anomaly	17	2	1	7	6	13	12	16	14	11	9	10	15	4	5	3	8
N. Copepod Biomass Anomaly	16	13	9	10	3	15	12	17	14	11	6	8	7	1	2	4	5
S. Copepod Biomass Anomaly	17	2	5	4	3	13	14	16	12	10	1	7	15	9	8	6	11
Biological Transition	17	11	6	7	8	12	10	16	15	3	1	2	14	4	9	5	13
Winter Ichthyoplankton	17	8	2	4	6	15	14	10	13	12	1	9	3	11	7	5	16
Chinook Juv Catches (June)	16	4	5	14	10	12	15	17	11	8	1	6	7	13	3	2	9
Coho Juv Catches (June)	16	7	11	5	6	2	13	17	14	3	4	8	9	12	15	1	10
Mean of Ranks	15.9	6.5	5.8	6.6	5.8	11.6	13.5	14.5	11.1	8.4	2.8	7.3	11.2	7.3	5.9	7.3	11.3
RANK of the Mean Rank	17	5	2	6	2	14	15	16	11	10	1	8	12	7	4	8	13
Principle Component Scores (PC1)	6.70	-1.93	-2.55	-1.71	-1.96	1.81	2.94	4.41	1.02	-0.66	-4.70	-1.30	1.45	-1.47	-2.11	-1.35	1.42
Principle Component Scores (PC2)	-0.72	0.09	0.24	-1.10	-1.81	-1.36	2.17	-0.97	-1.20	0.38	-1.26	0.49	-1.11	1.08	0.57	1.90	2.62
Ecosystem Indicators not included in the mean of ranks or statistical analyses																	
Physical Spring Trans (UI Based)	3	6	16	13	4	10	12	17	10	1	5	2	7	9	14	8	15
Physical Spring Trans (Hydrographic)	16	3	12	7	5	11	13	17	6	8	1	8	15	3	10	2	14
Upwelling Anomaly (Apr-May)	7	1	14	3	6	11	10	17	7	2	4	5	12	14	12	9	16
Length of Upwelling Season (UI Based)	6	2	15	9	1	10	8	17	5	3	7	3	12	14	12	11	16
NH 05 SST (May-Sept)	10	6	5	4	1	3	16	14	8	12	2	15	9	7	11	13	16
Copepod Community Structure	17	5	4	8	1	13	14	16	15	10	2	6	12	9	7	3	11
Coho Juv Catches (Sept)	11	2	1	4	3	6	12	14	8	9	7	15	13	5	10	NA	NA

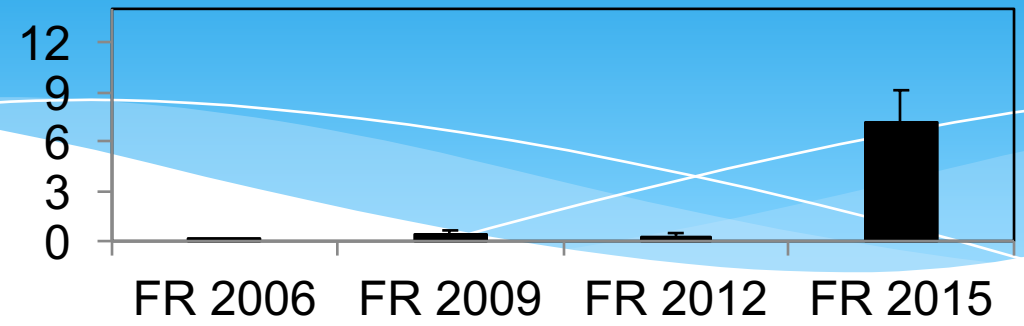
*Source: NOAA NWFSC, http://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/figures/Table_SF-02.JPG

Pycnopodia Densities

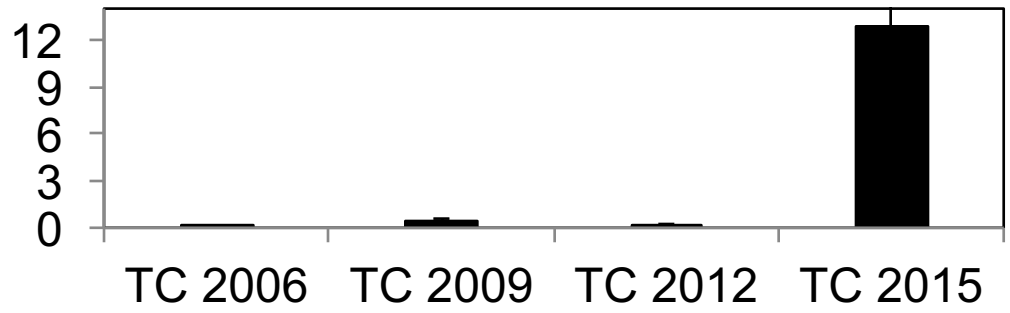


Purple Urchin Density (m^{-2})

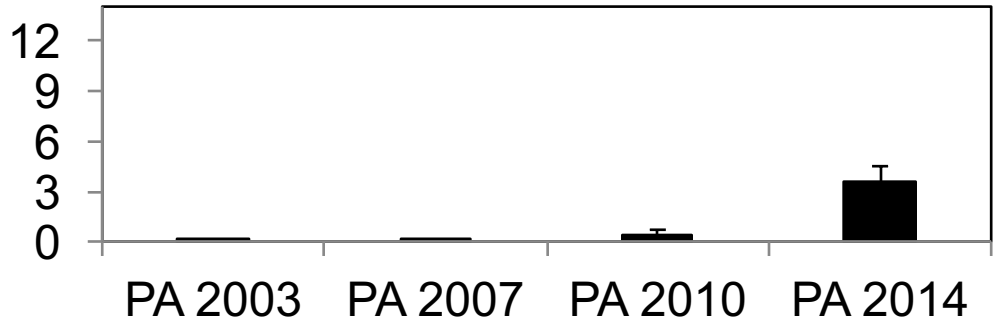
Fort Ross



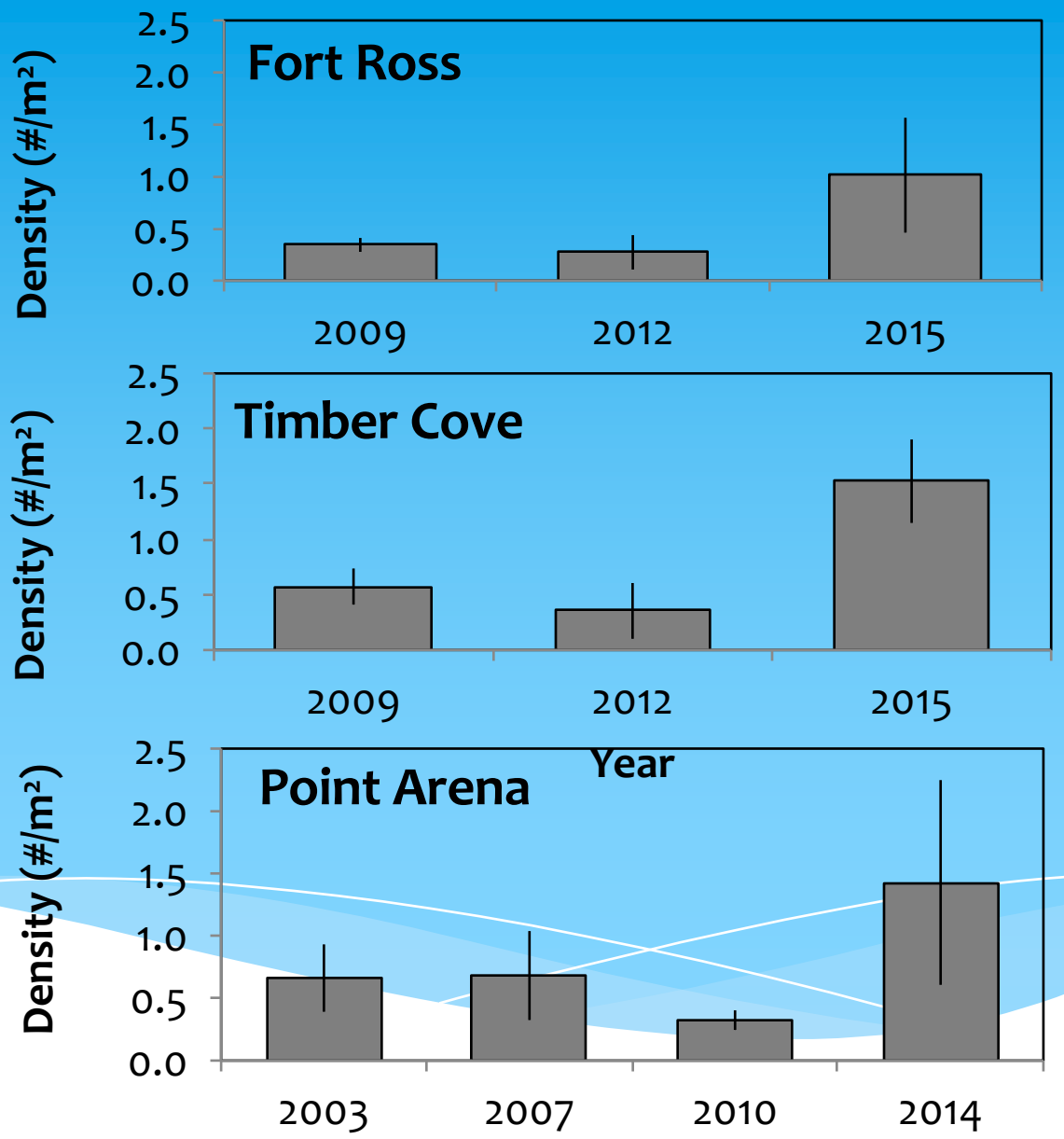
Timber Cove



Point Arena



Red Urchin Densities



Nearshore Pre-condition Stressor: Sea Star Wasting Disease North 2013

Photo A. Maguire