Assessment of Extent and Drivers of Coastal Hypoxia in the California Current: Preliminary Findings

Center for Ocean Solutions Coastal Hypoxia Working Group

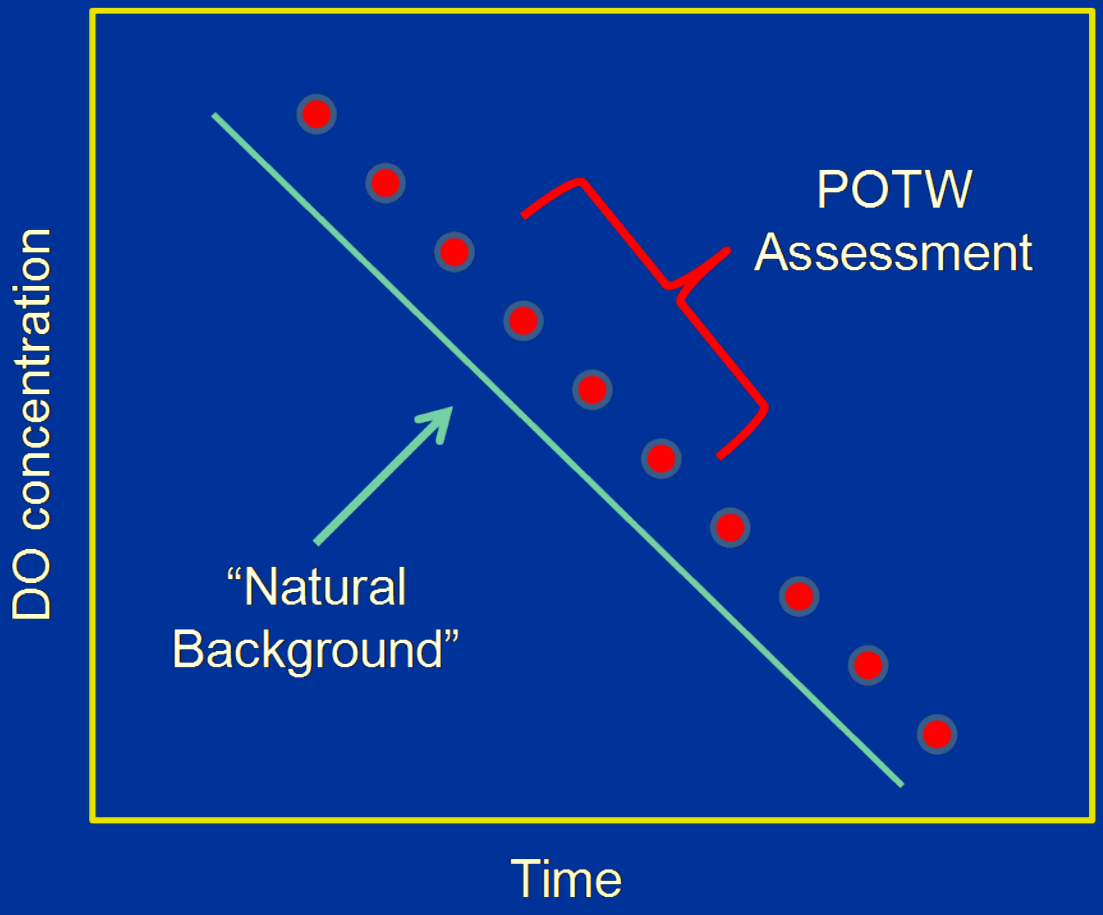
BACKGROUND

- **Management of DO has typically more of a focus in estuaries and inland waters**
  - Hypoxia has not drawn the same level of management attention in coastal waters
- **California Ocean Plan calls for no more than a 10% deviation in oxygen concentration from background**
  - This is generally examined at local spatial scales at specific discharge points
  - Generally don’t see a problem
- **There is growing evidence that we are looking at the wrong scales**
  - Need to also consider regional scales and beyond

THREE SCALES OF INTEREST

- **Local**
  - End-of-pipe or river mouth
- **Regional**
  - Increased nutrient loads result in increased productivity
- **Offshore**
  - Unrelated to regulated discharges

POTW ASSESSMENTS CAN BE WITHIN 10% OF "BACKGROUND" AS WE WATCH COASTAL WATERS BECOME HYPOXIC



HYPOXIA IS ON THE RISE IN WEST COAST NEARSHORE WATERS

- **Depth to low oxygen zone appears to be shallowing**
  - Dead zone in Oregon Coast, with invertebrate mortality
  - Decline in dissolved oxygen in Monterey Bay
- **In other regions, attributed to eutrophication**
- **On West Coast, oceanographic conditions are a driver**
  - Oceanic deep water typically low in oxygen
  - Waters are brought to the surface during upwelling
- **Two implications for management**
  - Management of ocean discharges
  - Shifting baseline of natural background for assessing local effects

COS HAS ASSEMBLED TEAM TO STUDY COASTAL HYPOXIA IN CALIFORNIA CURRENT

- **Identifying key questions, approach and products**

- **Interdisciplinary**
  - Physical oceanographers
  - Fish and invertebrate ecology and physiology

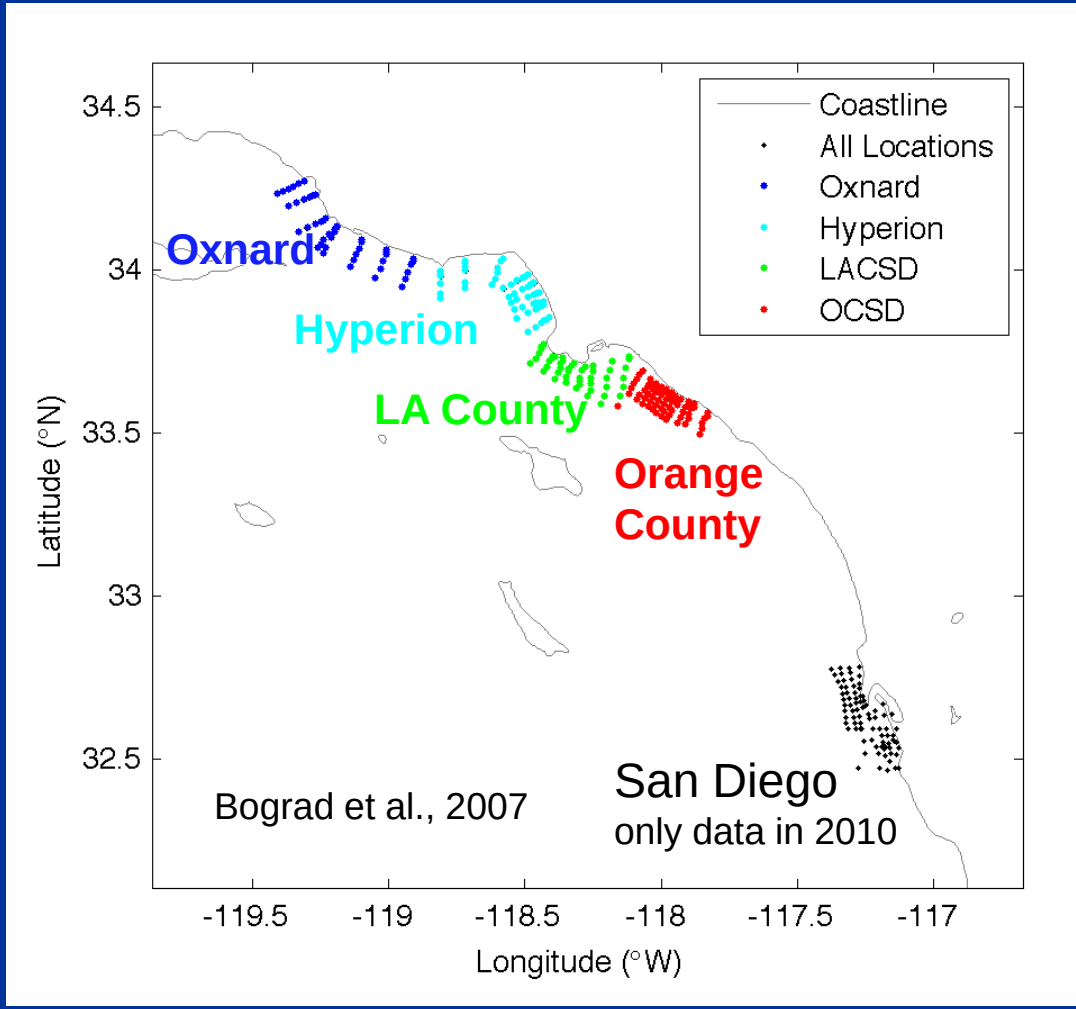
- **Multi-institutional**
  - MBARI
  - Stanford
  - Naval Postgraduate School
  - NOAA Fisheries
  - Moss Landing Marine Laboratory
  - Invited SCCWRP to participate

COASTAL HYPOXIA: KEY WORKGROUP QUESTIONS

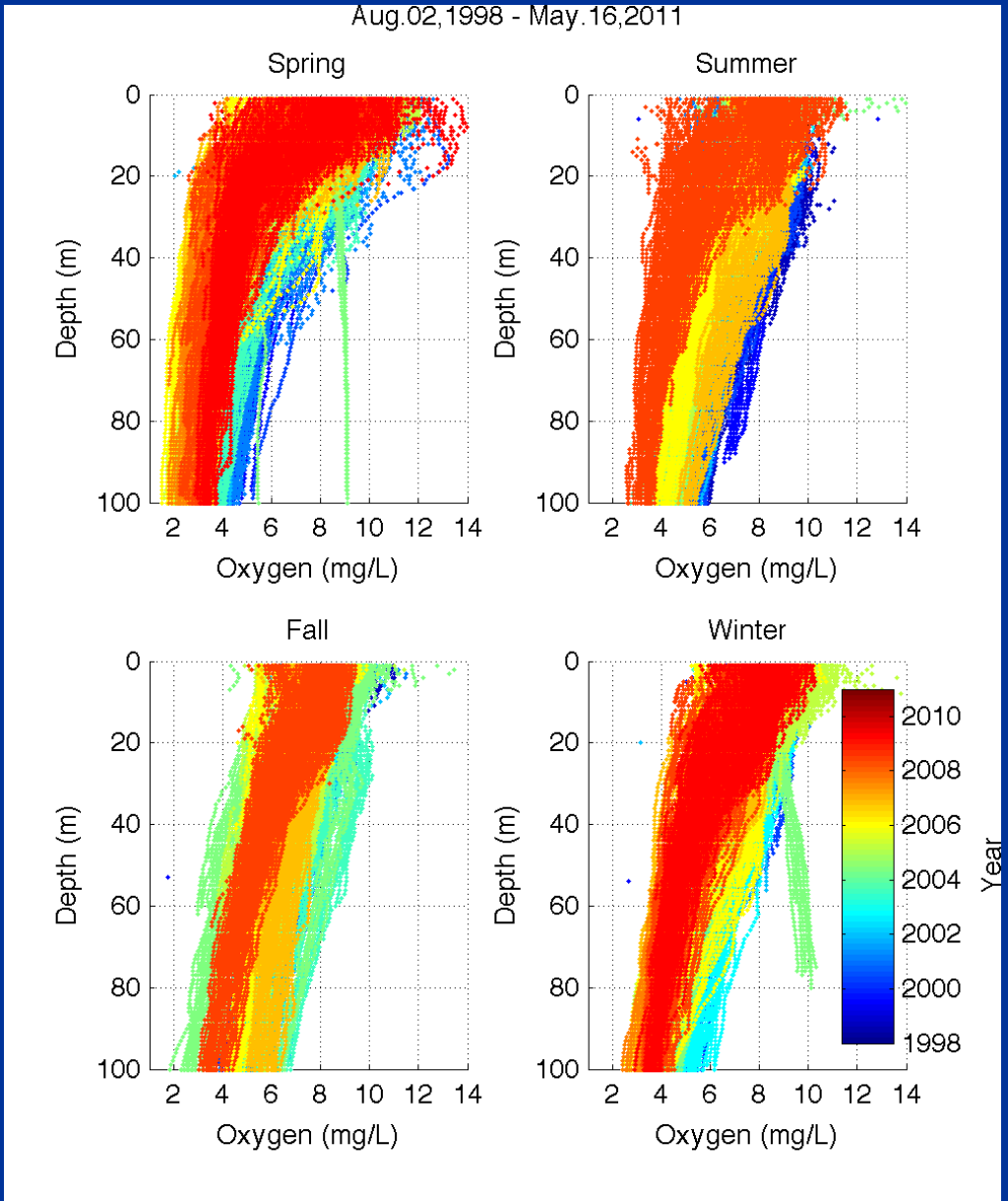
- **What is the magnitude, extent and duration of hypoxia in the California Current ecosystem?**
  - Southern California Bight
  - Monterey Bay
- **What are the ecological effects of this hypoxia?**
- **What is contribution of anthropogenic activities to coastal hypoxia?**

APPROACH TO ASSESSING EXTENT AND TRENDS

- **Analysis of existing nearshore data**
  - Central Bight Working group's CTD data (1999-2011)
  - Comparison to CALCOFI data
- **Comparison to trends in Monterey Bay**
  - Bograd et al. 2008



OXYGEN CONCENTRATION IS DECLINING OVER TIME CONSISTENTLY FOR ALL SEASONS



DECLINES ARE STATISTICALLY SIGNIFICANT ACROSS ALL DEPTHS AND BY AGENCY

Agency	% Change in DO Over 12 Yrs		
	10 m	30 m	50 m
Oxnard	-8%	-34%	-41%
Hyperion	-12%	-42%	-46%
LACSD	-17%	-44%	-44%
OCSD	-8%	-34%	-46%

COASTAL HYPOXIA: KEY MANAGEMENT QUESTIONS

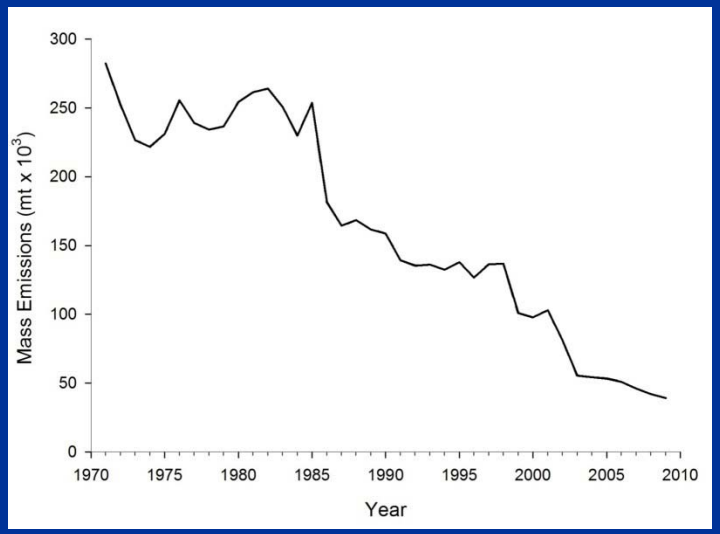
- **What is the magnitude, extent and duration of hypoxia in the California Current ecosystem?**
  - Predictions of trends
- **What are the ecological effects of this hypoxia?**
- **What is contribution of anthropogenic activities to coastal hypoxia?**

INVESTIGATING DRIVERS

- **Local**
  - DO is declining as a direct consequence of BOD inputs from POTWs or rivers
- **Regional**
  - Increased nutrient loads result in increased productivity
- **Offshore**
  - Unrelated to regulated discharges
- **Additional Possibility: not a real trend**

DO DECLINING FROM BOD INPUTS?

- **BOD loads from POTWs have declined over period of hypoxia increase**



BOD Mass Emissions from Combined Large POTW Effluent to the SCB 1971-2009
Lyon and Sutula, AR 2011

- **CTD surveys don't show substantial end-of-pipe effects of BOD discharge on background levels**
- **Planned analyses: Indirect Effects-Increase in accumulated sediment organic matter over time?**

DO DECLINES FROM ANTHROPOGENICALLY-ENCHANCED PRODUCTIVITY?

- **Increasing phytoplankton blooms in nearshore over last 10 years**
- **Chronic bloom hotspots co-occurring with POTW outfalls and river mouths**
- **Magnitude of POTW nutrient loads comparable to that of upwelling in some SCB subregions**
- **Future analysis: Dynamic simulation modeling**
  - — Build on ROMs + NPZ model under development for Bight Offshore Water Quality Study

DO DECLINES DRIVEN BY OFFSHORE INFLUENCES?

- Found to be a likely cause in areas away from major anthropogenic inputs
  - Monterey Bay (Bograd et al. 2007) and Oregon Coast (Chan et al. 2008)
- Not clear how relevant this is for SCB
- Planned Analysis:
  - Analyze offshore data (CALCOFI) to look for parallel trends and relationship to indices of upwelling and PDO
  - Statistical modeling to partition DO variability into physical vs biological drivers

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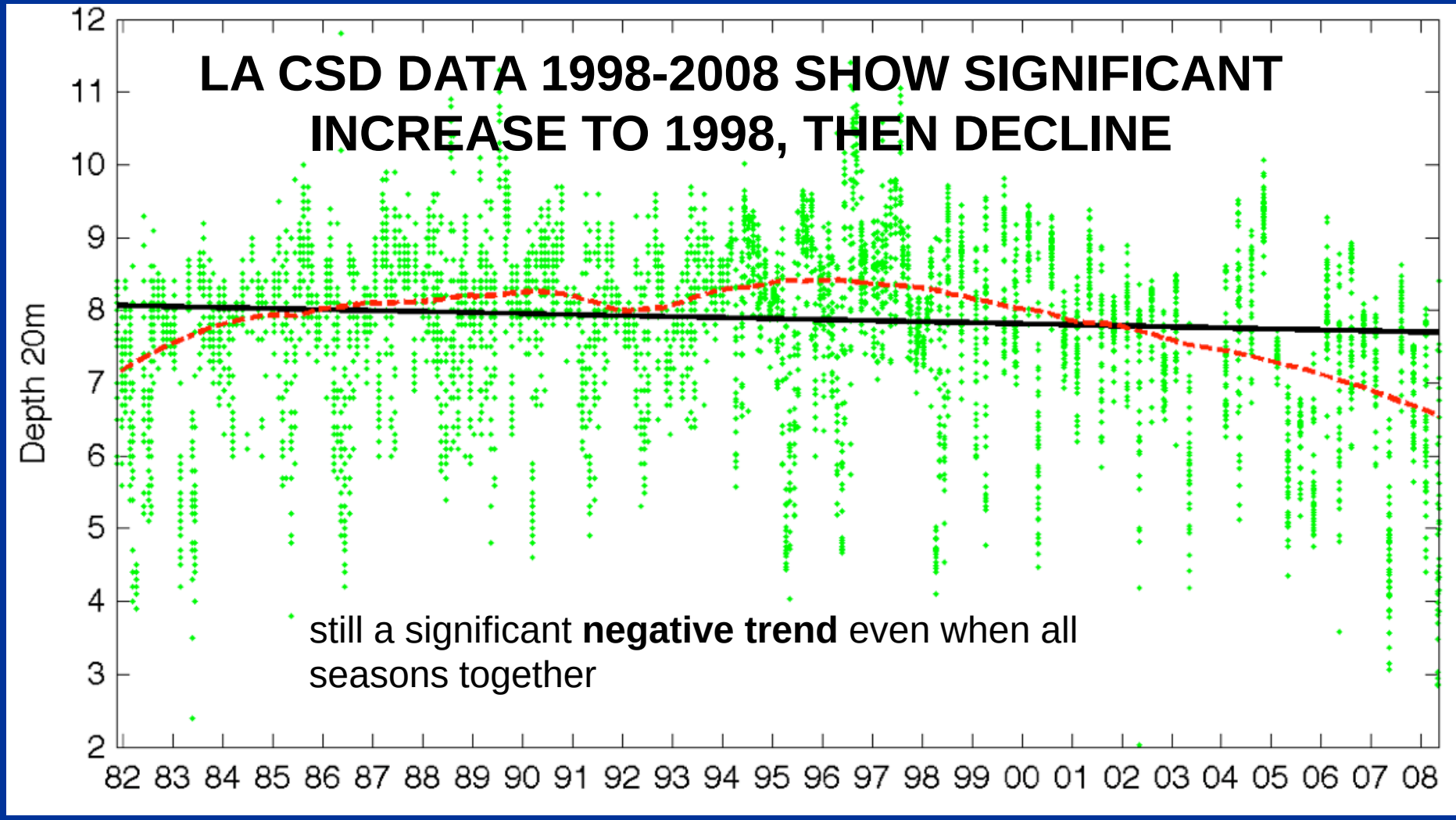
ARE THESE TRENDS CONSISTENT OVER LONGER DATA SETS?



COMMISSION AGENCIES COLLABORATING TO INVESTIGATE IF TREND IS REAL

- Look for older data
- All four member agencies have and will share it
  - City of LA has data back to 1950s
- Center for Ocean Solutions has offered to key punch data

TIMING

- Four subgroups formed to work on different aspects of problem
- COS convening regular working group meetings to continue synthesis
- Update to Commission in approximately a year
- Aiming for synthesis session at Coastal and Estuarine Research Federation Conference in Fall 2013