Occurrence of demersal fishes in relation to near-bottom oxygen levels within the California Current

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Introduction

- Near-bottom waters along the continental slope of the eastern North Pacific are naturally low in dissolved oxygen (DO).

  hypoxia: DO < 1.4 ml l^{-1} or 64 µmol kg^{-1}

  severe hypoxia: DO < 0.5 ml l^{-1} or 21.3 µmol kg^{-1}
- In the northern California Current System, summertime hypoxia is observed on the continental shelf.
- There has been a decline in source water dissolved oxygen of 0.77 µmol kg^{-1} yr^{-1} (38.5 µmol kg^{-1} in 50 years).
- Expansion and shoaling of these low DO waters motivated us to **examine the relationship between low dissolved oxygen and the catch of near-bottom organisms during the NOAA Northwest Fisheries Science Center's (NWFSC) annual groundfish trawl survey off the U.S. Pacific coast.**

NWFSC West Coast Groundfish Trawl Survey

Mission: provide information for management of 90+ groundfish species

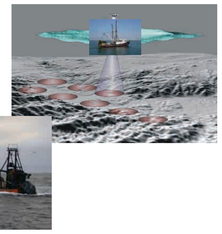
- Annually charter 4 west coast fishing vessels (~20 to 30 m in length)
- 2 passes (N to S) down coast (May – Jul; Aug – Oct.)
- Average 4 – 5 tows per day
- Fish during daylight hours
- 188 fishing days-at-sea; 72 days per pass
- 3 scientists; 3 crew
- ~760 tows per year
- average catch 335 kg per tow
- **Temperature, Salinity and Dissolved Oxygen sensors on trawl**

Data Collection: Biological and Environmental

Biological:
- gender
- individual lengths
- individual weights
- extract otoliths
- remove stomachs
- DNA samples
- maturity
- diet
- special projects

Environmental:
- depth
- temperature
- irradiance –at depth
- dissolved oxygen
- fluorescence
- pressure
- salinity
- turbidity
- bottom type

Continuous via sensors:
- wind speed
- irradiance - surface
- EK 60 – bottom type



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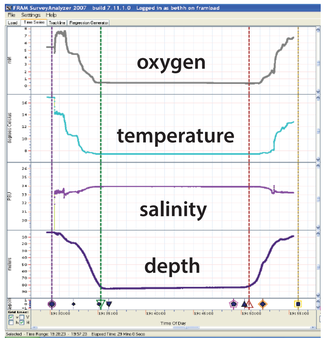
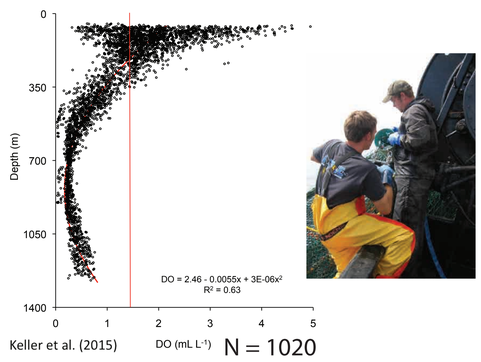
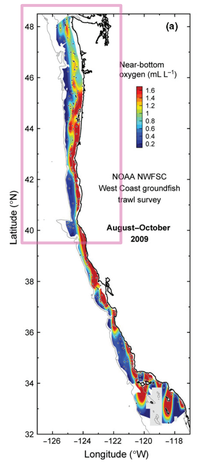
Ruggedized trawl sensor package:
Seabird SBE19+: used to collect near bottom oxygen (ml l^{-1}), temperature (°C), salinity (ppt) and depth (m)



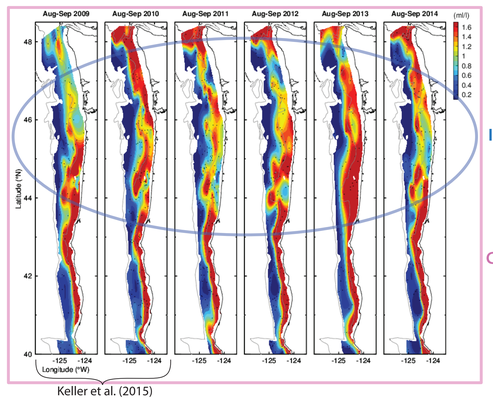
Near-bottom Dissolved Oxygen (2008 – 2014)





Some near-bottom shelf waters < 200 m are hypoxic (1.43 ml l^{-1}, red vertical line); the Oxygen Minimum Zone is visible centered around 700 m depth.

Near Bottom Dissolved Oxygen: Northern California Current

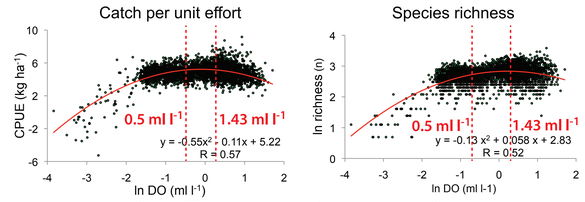


Inter-annual variability

Coast-wide study

Note the large amount of inter-annual variability in the northern California current.

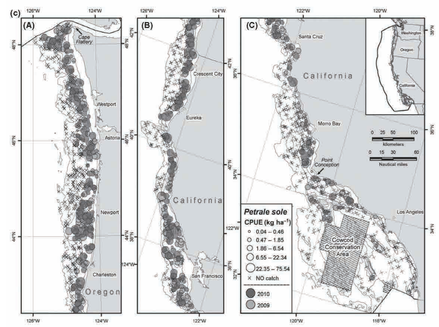
Catch per unit effort (CPUE) and Species Richness as a function of near-bottom dissolved oxygen



For stations with Severe Hypoxia:
DO < 0.50 ml l^{-1}
CPUE R = 0.79
Richness R = 0.72

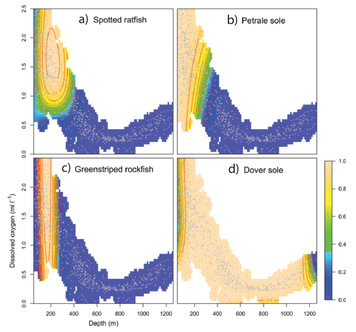
R = 0.57 **N = 1020** **R = 0.52**

What about individual species?



Petrale sole
(Eopsetta jordani)

Presence – absence data for four selected groundfish species



a) Spotted ratfish: Probability of occurrence decreases sharply for DO below 1 ml l^{-1}

b) Petrale sole: Probability of occurrence starts to decrease at 1 ml l^{-1}

c) Greenstriped rockfish: No change in probability of occurrence in relation to DO

d) Dover sole: High probability of occurrence at wide range of DO values but at depths <200 m probability decreases sharply at shallower depths and higher DO values.

Conclusions

- Benefit of using NOAA annual groundfish surveys to obtain environmental data over entire U.S. west coast.
- Ruggedized trawl sensor package.
- Collaboration of NOAA and university scientists.
- CPUE (fish and invertebrate catch) varied significantly and positively with bottom oxygen within hypoxic areas regardless of year or geographic area.
- Species richness (fish and invertebrates) varied significantly and positively with bottom oxygen within hypoxic areas – both depth and/or geographic areas may influence these relationships.
- Spotted ratfish and petrale sole were sensitive to changes in near-bottom oxygen, while greenstriped rockfish and Dover sole were not.

Reference: Keller, A., L. Ciannelli, W. W. Wakefield, V. Simon, J. A. Barth and S. D. Pierce, 2014. Occurrence of demersal fishes in relation to near-bottom oxygen levels within the California current large marine ecosystem. *Fisheries Oceanography,* **24,** 162-176.