

An ecosystem perspective on ocean climate, krill and forage fish dynamics for informing mitigation of whale entanglements

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Ecosystem perspective on 2015-16 whale entanglements

Our working hypothesis combines:

1. A long-term increase in whale abundance

2. Large Marine Heatwave - driven habitat compression + prey switching:

- Persistent marine heat wave (fall 2014-2016) compressed productive habitat; increase in prevalence and persistence of Domoic Acid
- Declines in krill and increased inshore concentration of anchovy in Central California
- Humpback whale prey-switching from shelf-break/slope krill to on-shelf anchovy

3. Amplified co-occurrence in 2015 and 2016 with the delayed opening of the crab fishery

End result: consecutive years with unusually high time-space overlap of foraging whales and fishing gear.



Ocean Climate Conditions (ENSO, marine heatwave, upwelling)

Record upwelling and cool temperature conditions

Development of the “Blob”; fall 2013/winter 2014

Fall 2014 – heatwave evolves into coast-wide pattern

Spring/Summer 2015 – record HAB, Domoic Acid contamination; weak upwelling

Return to near-normal conditions; mid-late 2017



2013

2014

2015

2016

2017

Whale Foraging Conditions (krill, anchovy)

High krill population; widespread distribution

Average krill year, increase in anchovy south of Monterey Bay

Krill populations decline, anchovy are locally abundant within Monterey Bay and the Gulf of the Farallones

Surge in krill population; Potential increase in anchovy

Most humpback whales feed offshore along shelf-break/canyons where krill hotspots are concentrated

Humpback whales shift distribution onto the shelf, prey-switch to anchovy; overlap with fishing gear

Most humpback whales feed offshore along shelf-break/canyons where krill hotspots are concentrated

Ecosystem assessment of ocean climate and forage species dynamics provides scientific guidance for the RAMP

- Basin-scale ocean climate and regional conditions drives winter and springtime upwelling and production of alternate forage species communities off CA
- ***Pre-season*** assessment includes tracking (a) regional abundance and distribution of krill and anchovy and their likelihood of increasing/decreasing, (b) ENSO forecasts and regional temperature anomalies in North Pacific
- ***Mid-season*** assessment includes: monitoring winter upwelling, sea surface temperature, current transport, storms and atmospheric conditions (e.g., North Pacific High); for making predictions of spring forage community
- ***Late-season*** assessment includes: incoming information on forage species distributions from fisheries surveys, observations from fishers and remote-sensing of ocean conditions

My perspectives

(1) Entanglements are a West Coast problem, not strictly CA, and requires coastwide research.

(2) Entanglement working groups benefit from scientific advice on ocean and forage variability

- Defuses roadblocks among stakeholders
- Provides scientific support for moving forward with risk assessments and management strategies
- ***Take steps early on to communicate science to working groups***



(3) Science-fisher engagement facilitated partnership aimed at finding solutions to minimize whale entanglements

- Dynamics of the fleet, historical context on past crabbing seasons, fishing hotspots
- Crabbers as key observers for whales/forage during under surveyed winter season
- Communicating ocean and forage conditions from working groups out to port associations; help getting the message out.

UNDERSTANDING WHALE ENTANGLEMENTS OFF THE U.S. WEST COAST

Changes in Ocean Conditions

- Persistent marine heat wave
- Massive bloom of toxic algae

Changes in Whales' Prey

- Lower krill abundance off shelf break
- Switch to low abundance anchovies nearshore
- Humpback whales seek other prey further north



Changes in Whale Presence & Abundance

- Recovering whale populations
- Humpback whales switched prey, found closer to shore



Changes in Dungeness Crab Fishery

- Harmful algal bloom delayed opening of fishery in 2016
- More crab fishing gear when whale concentrations were high



400%
increase of confirmed whale entanglements

Record increases in whale entanglements in recent years. Confirmed whale entanglements on the WA, OR, CA coast increased 400% to a historic high of 50 in 2015, from an average of 10 per year pre-2014.

While many entanglements in recent years have been reported in Central CA, we know at least some of these entanglements occurred elsewhere along the West Coast.

Fishing Gear

Most of the whale entanglements are due to unknown types of fishing gear; of the fishing gear that we can identify, trap/pot fisheries are the primary source.

Gear from the commercial Dungeness crab fishery, the largest trap fishery off the West Coast, has the highest number of confirmed entanglement reports.

Management & Mitigation

Fishery management coastwide could ask these following questions related to entanglement before/during seasons and take actions as a result.

- Are there delays in the fishing season or other factors that may lead to higher fishing effort when whales are on the fishing grounds?
- Does the distribution of krill and forage fish on fishing grounds suggest an increased risk of fisheries interactions with whales?
- Are there known or expected high concentrations of whales on the fishing grounds?
- Are there recent higher numbers of whale entanglements in the fishery or nearby?

For more information: https://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/fisheries_interactions.html



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