

# Assessing humpback whale entanglement risk off California and Oregon

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# Humpback whale entanglement risk

- **Motivation:**

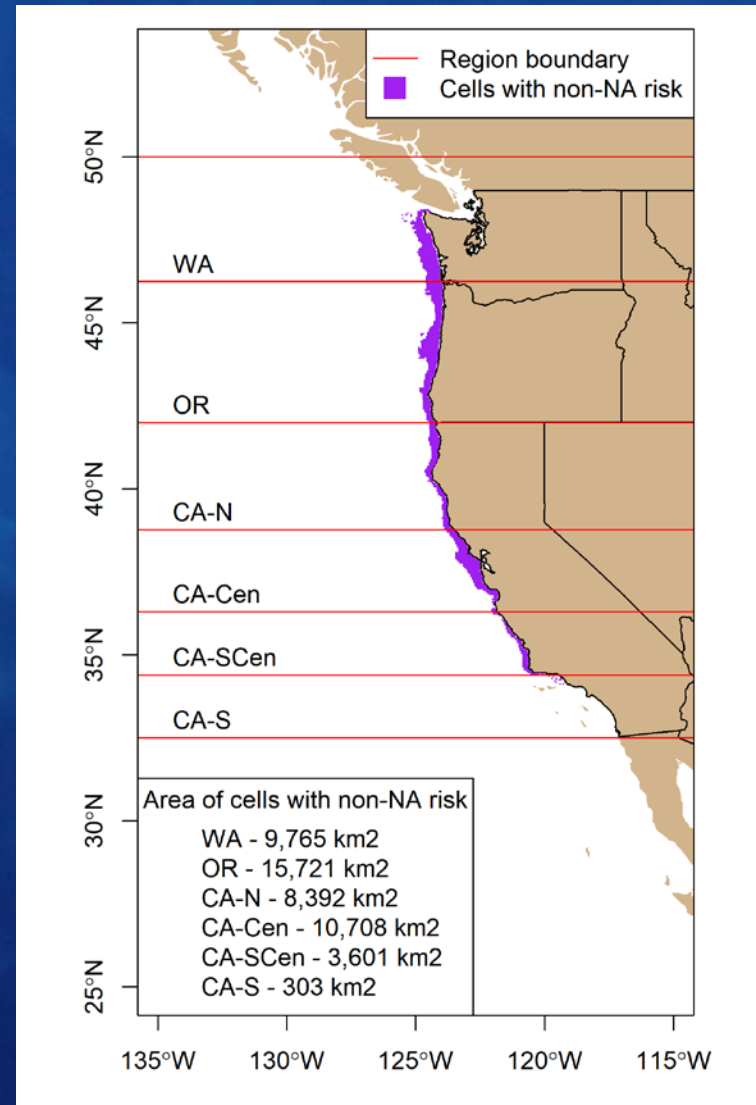
- Need to understand entanglement risk along West Coast and explore effectiveness of potential management measures.

- **Data sets**

- Humpback whale density model (*Forney et al., in prep; presented in Module 2*)
- Spatial fishing effort estimates (from VMS and landings; *Feist et al., in review*)

- **Approach:**

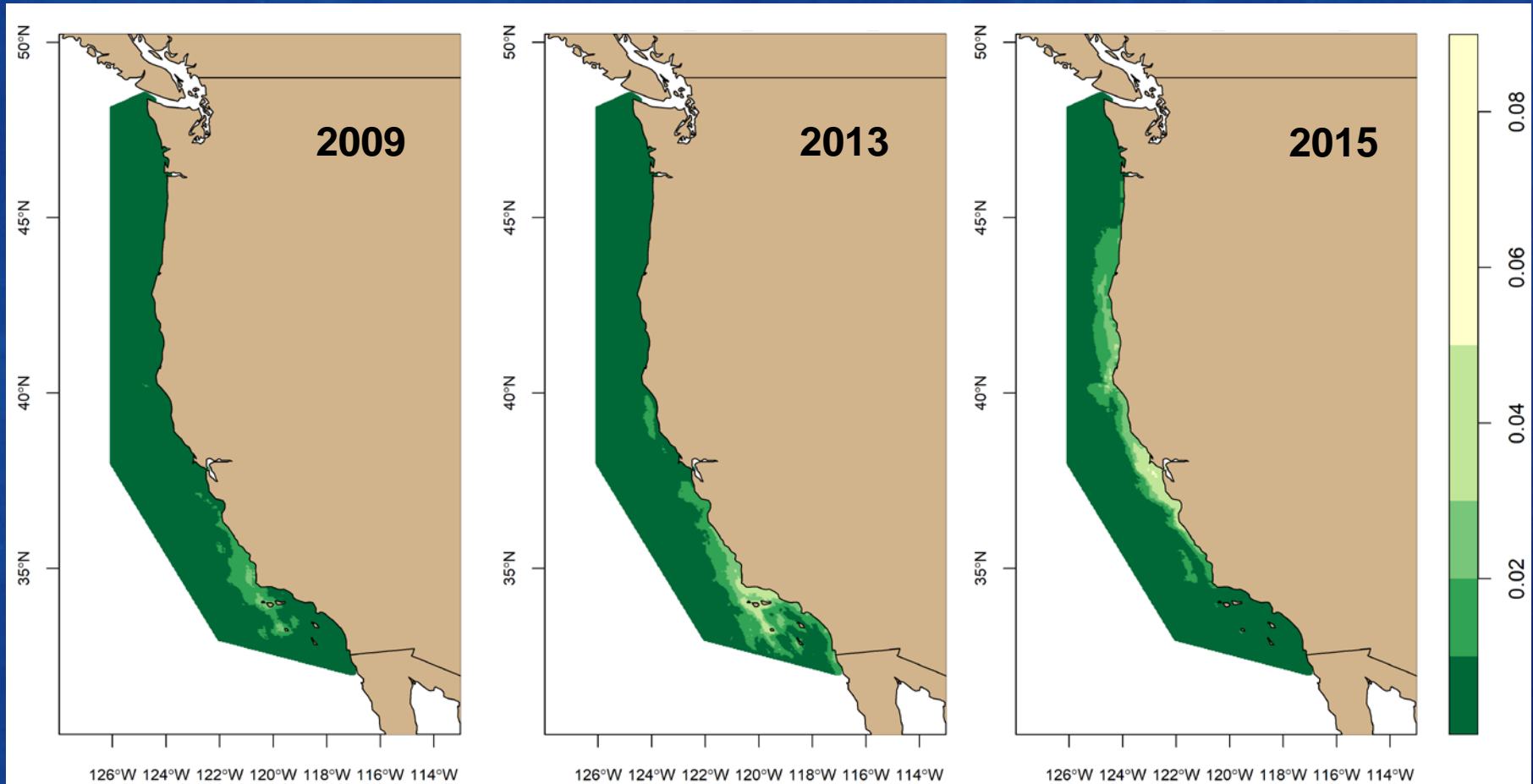
Risk = proportional to co-occurrence  
(commonly used metric of risk)



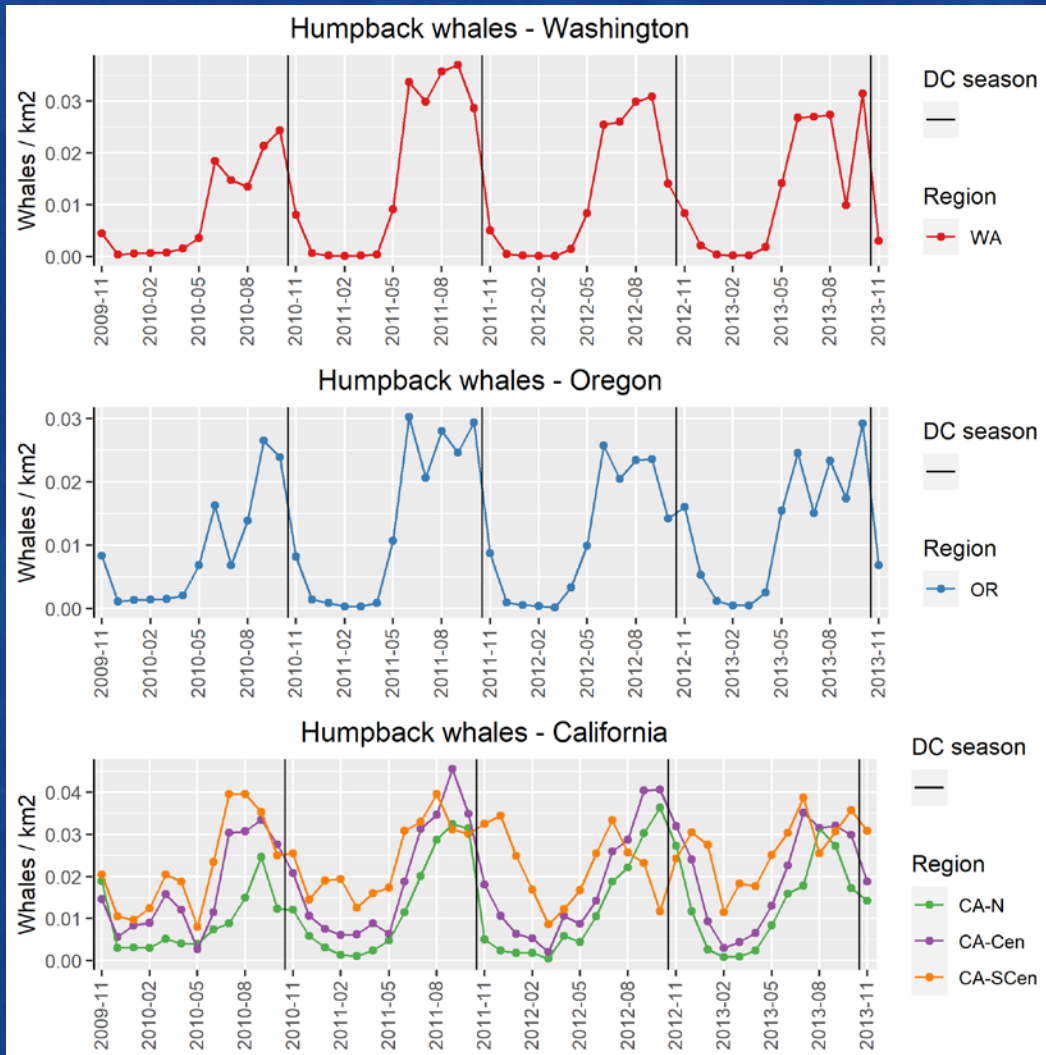
# Humpback whale density model

(*Forney et al.*, presented during Module 2 on Aug 27, 2020)

Late November – early December (14-day) predicted density and distributions



# Humpback whale density model



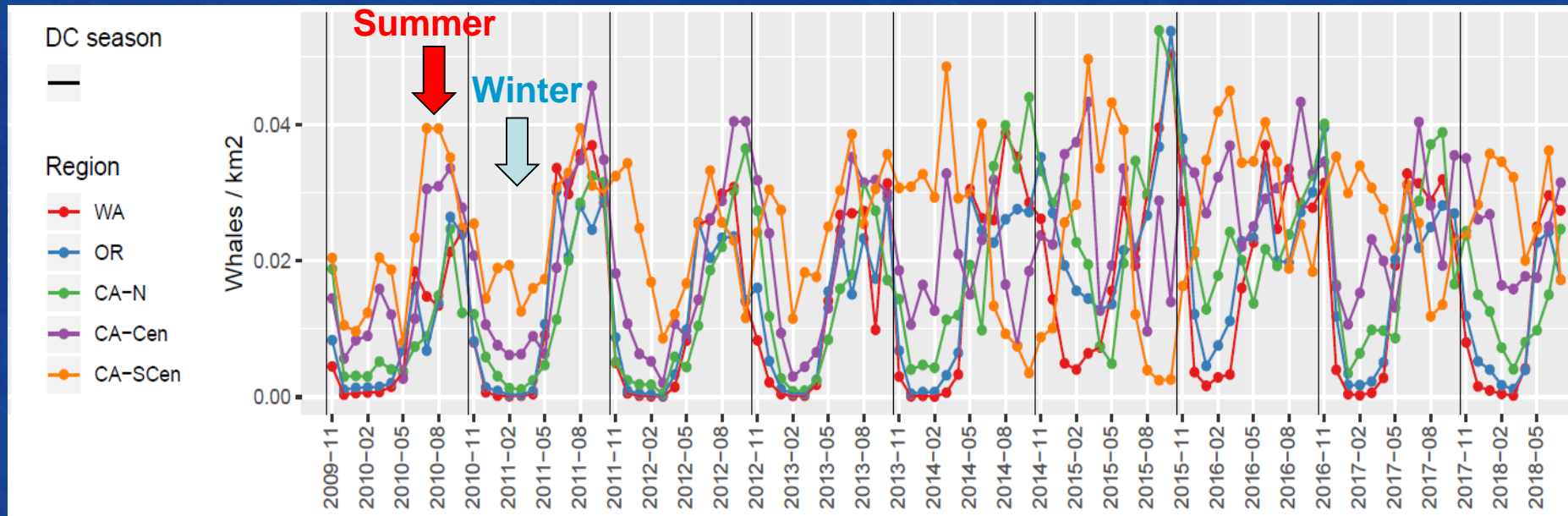
Nov 2009 – 2013

by State

- Winter decrease as whales migrate to breeding grounds
- Spring/Summer increase as whales return to forage

# Humpback whale density model

Seasonal cycle, 2009-2018 by region



**Seasonal migration evident  
(peak during summer, mostly  
gone in winter)**



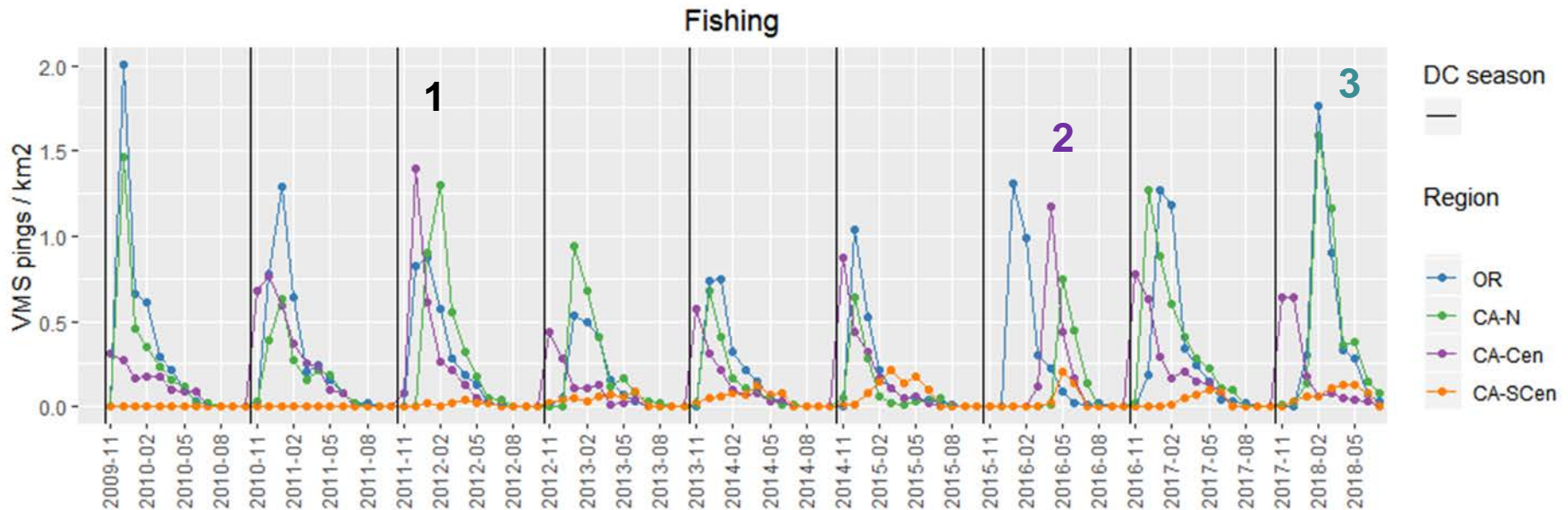
**Seasonal signal  
disrupted during  
Marine Heat Wave**  
*(Santora et al. 2020)*

**→ How did the disruption affect whale entanglement risk?**

# Fishing Effort

Landings-informed VMS analysis, by CA/OR Region

*Feist et al., manuscript in review*



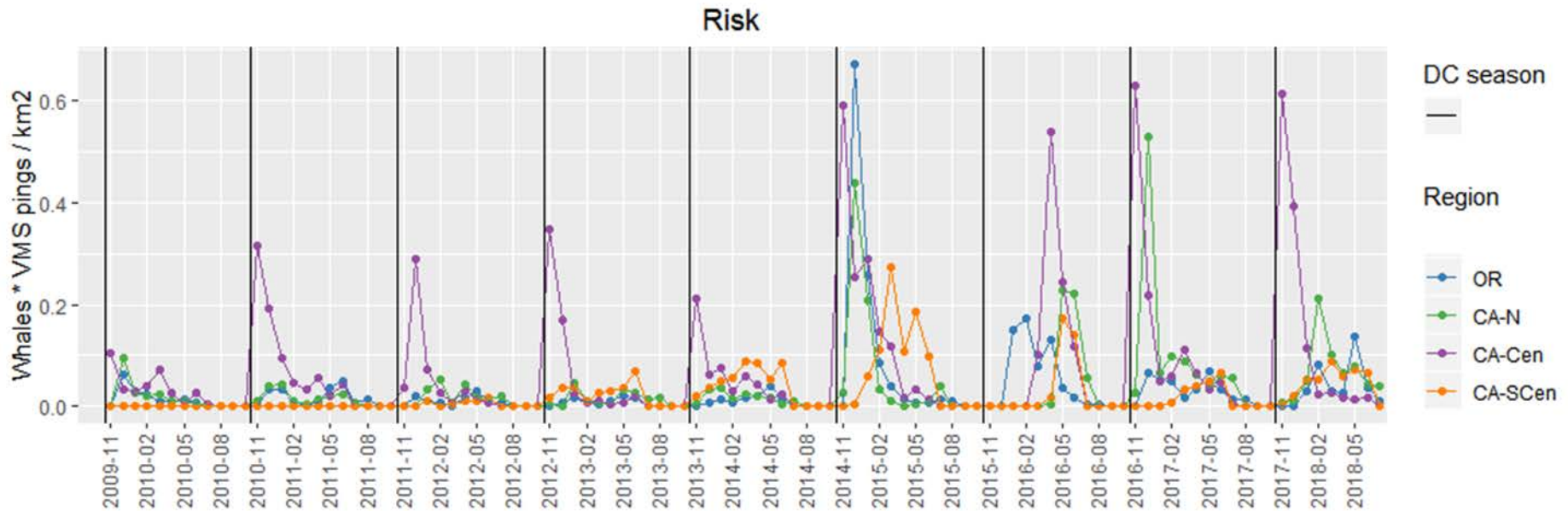
1. 2011-2012: Fishing effort peaked during winter (Dec-Feb)

2. 2016: CA fishing peaked in April-May (delayed season start)

3. 2018: Fishing in CA-N and OR peaked in Feb-Apr

# Humpback whale entanglement risk

Product of whales  $\times$  VMS pings per square kilometer



## 2009-2013:

- Risk greatest in **central CA** during November/December

## 2014-2018:

- Risk further increases in **central CA** during November/December
- Risk increases off **northern CA** and **Oregon**
- 2015-2016 fishing season: risk peaked during spring because of season delay

# Hindcast effectiveness of potential management scenarios for reducing whale entanglement risk (by region)

## Examples:

1. Delayed opening (to reduce fall entanglement risk)
2. Early closure (to reduce spring entanglement risk)

## Starting point:

Eliminate effort that would have occurred during those times.

Can also run alternate scenarios e.g., effort = Nov/Dec level whenever season starts, redistribute effort to other months, etc.

→ Can test many scenarios within this framework

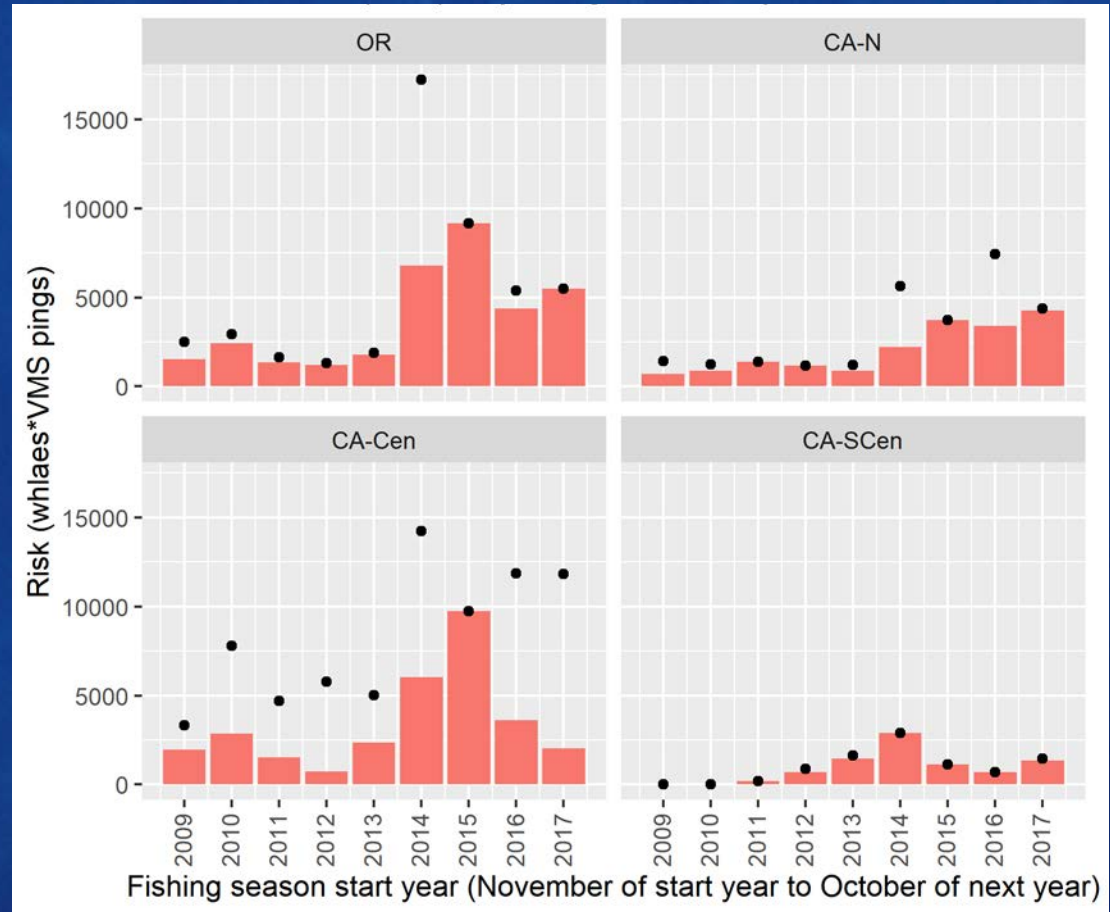


# Delayed Opening – Jan. 1<sup>st</sup>

Compare estimated risk with (bars) and without (black dot) management action

## Results:

- **Central CA:** Greatest risk reduction off central CA (note: Nov 15 start date)
- **Oregon:** Reduces risk in markedly in 2014 and slightly in 2016
- **Northern CA:** Reduces risk in 2014 and in 2016



# Early Closure – April 1<sup>st</sup>

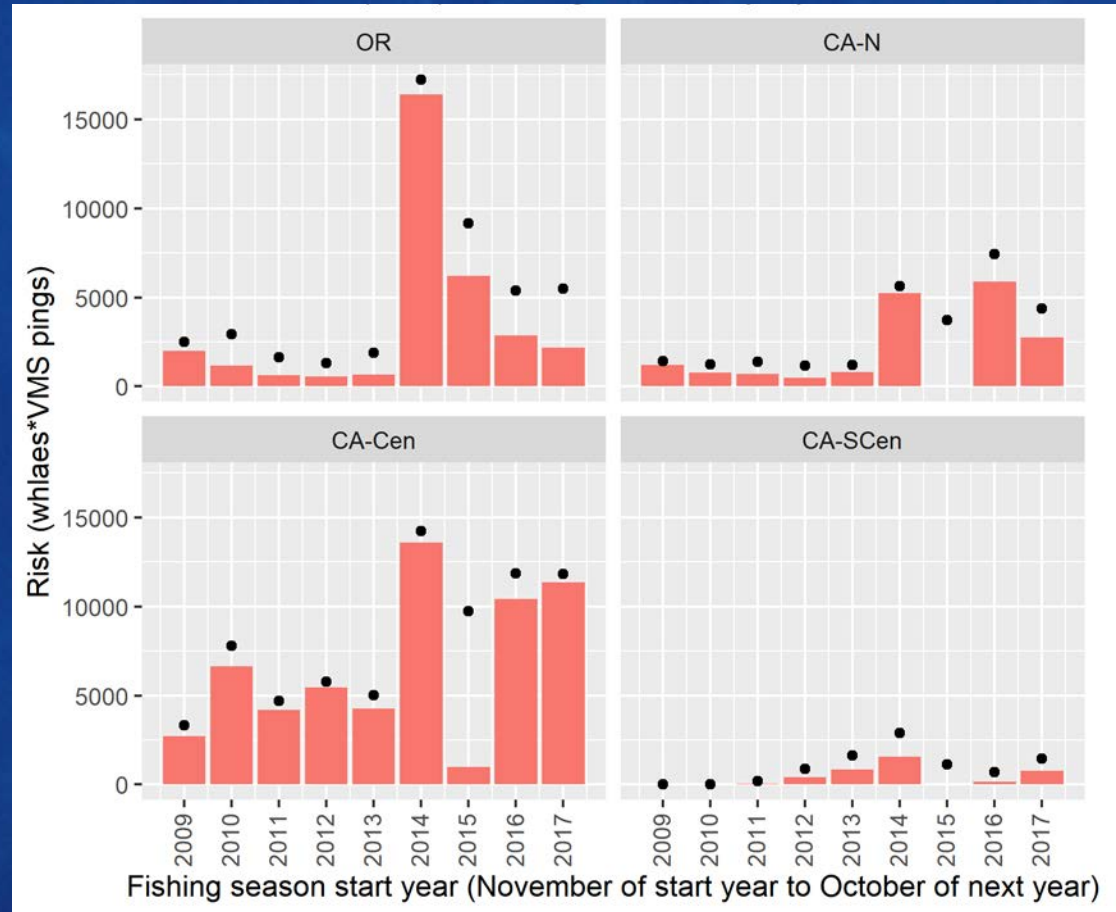
Compare estimated risk with (bars) and without (black dot) management action

## Results:

- **All regions:** Closing the season April 1st would have reduced risk
- **CA:** In 2015 this would have prevented virtually all fishing because of domic acid delay

## Next Steps:

Examine risk reductions relative to cost to fishery



# Summary

- Our estimates of risk appear to capture periods of greater entanglement risk, based on reported entanglements.
- Delayed opening and early closures could reduce risk, however...
  - ... it is critical to understand how/if effort will be redistributed
  - ... socio-economic impacts to the fishery need to be evaluated relative to risk reduction (*see Samhour and Free presentations, next!*)
- Management solutions are likely to be region-specific, and optimal strategies may vary from year to year.
- Can evaluate alternatives within our analysis framework

# Thank you!



<http://swfsc.nmfs.noaa.gov/PRD/>

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