Crabs, HABs, and humpback whales: balancing tradeoffs in the California Dungeness crab fishery

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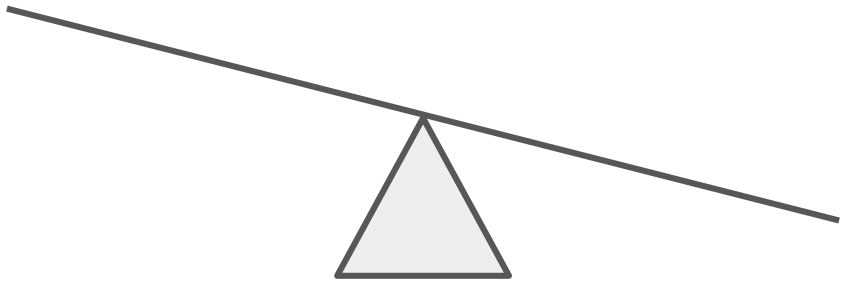
Module 5: Risk and Tradeoff Decisions
West Coast Entanglement Science Workshop

Balancing trade-offs under uncertainty



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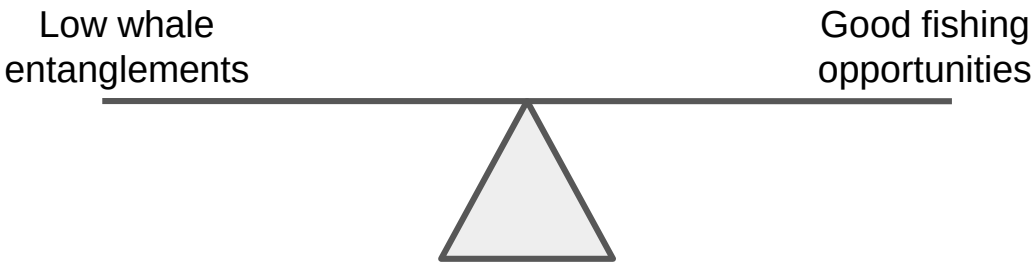

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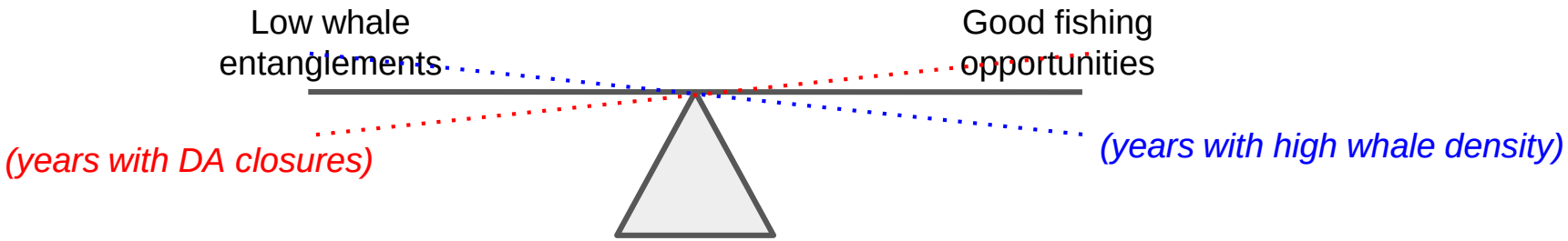
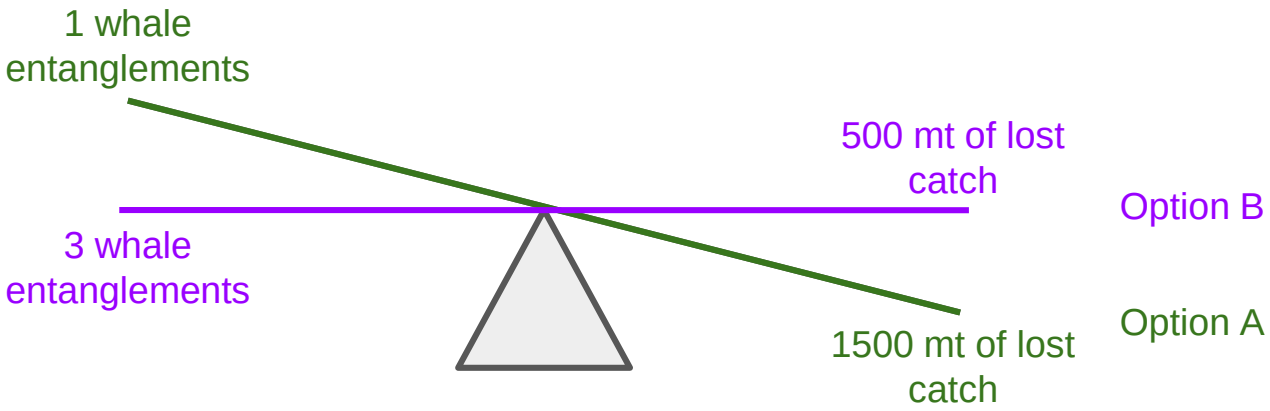


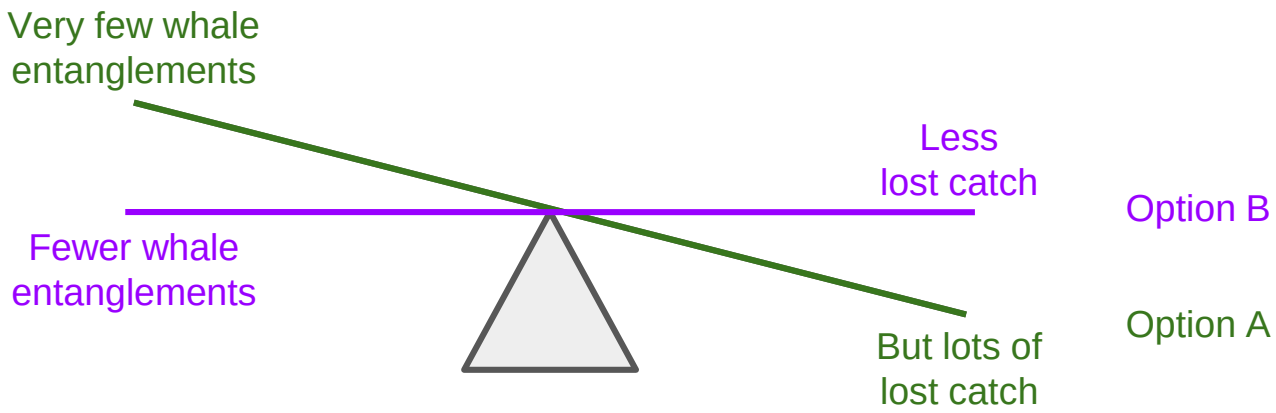
Balancing trade-offs under uncertainty

It cannot say:



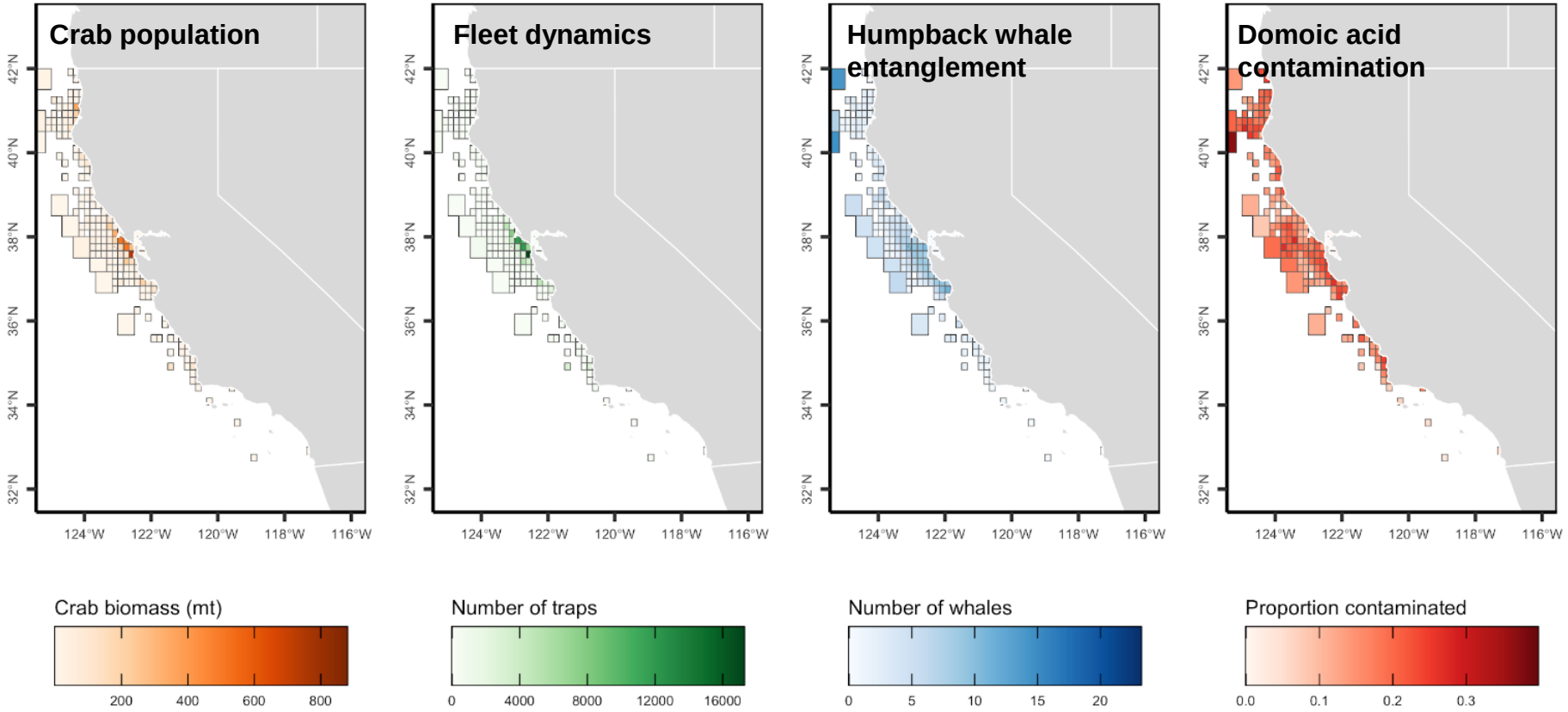
Balancing trade-offs under uncertainty

But it can say:



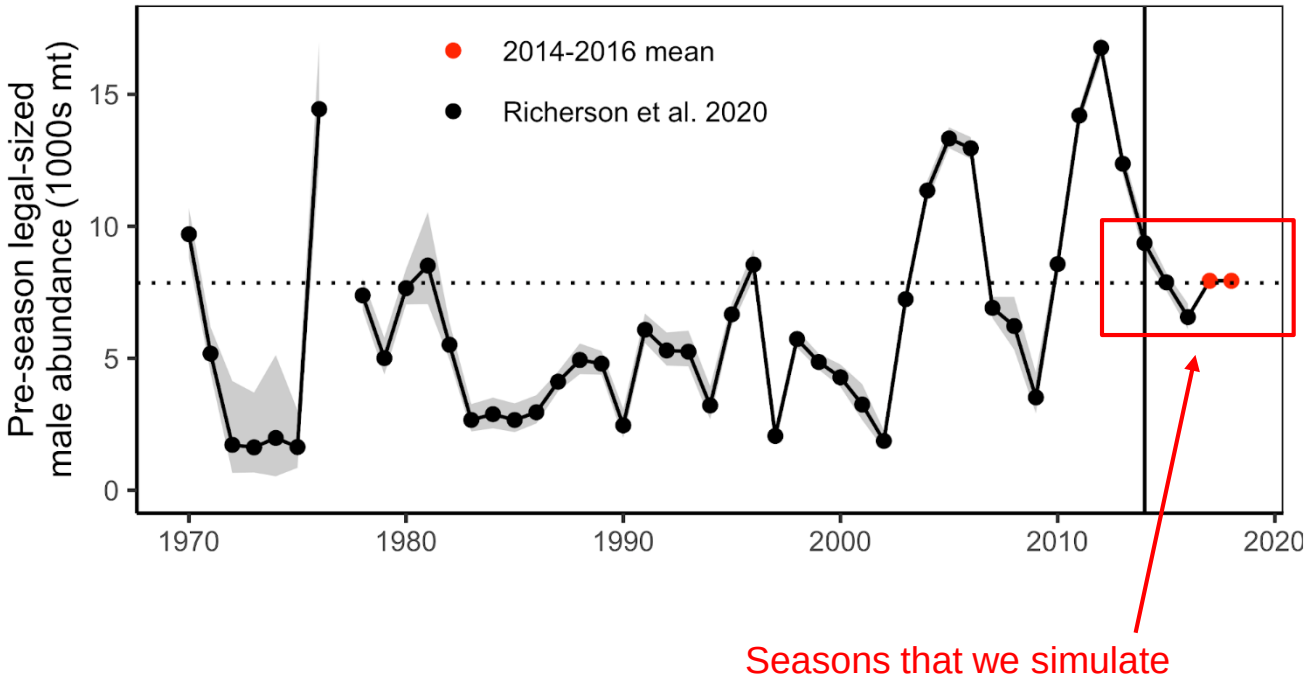
Our framework

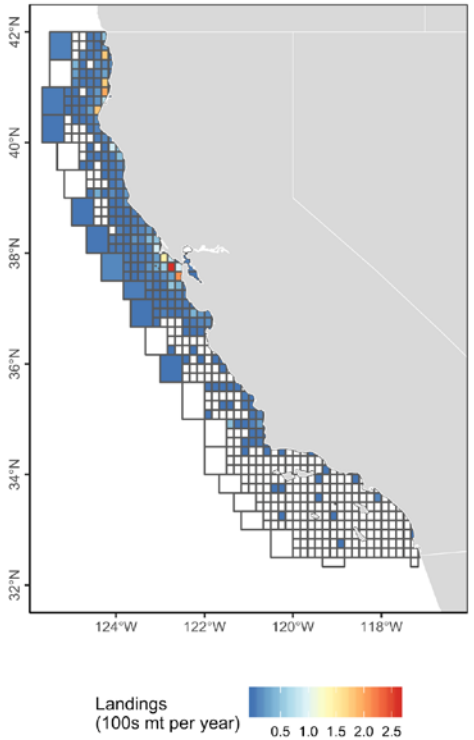
Components of the simulation



Crab population:

The annual abundance and distribution of legal-sized male crabs is based on analysis of fish ticket data.

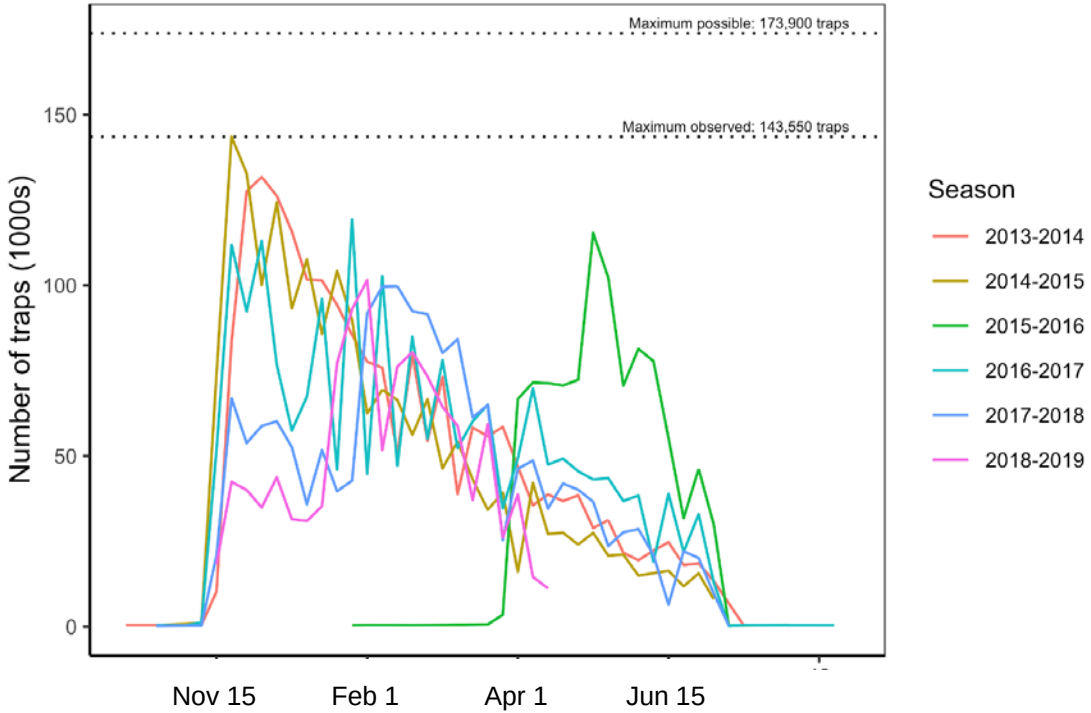




Based on Richerson et al. (2020) and CDFW fish ticket data

Fleet dynamics:

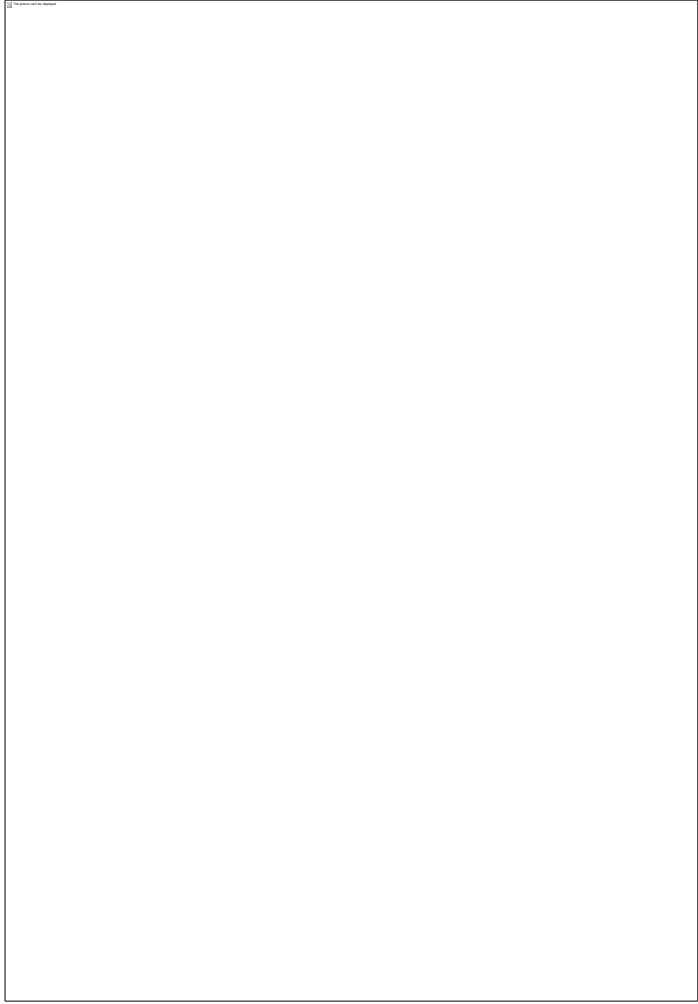
Each season opens with 130,000 traps and weekly effort declines as abundance declines based on analysis of fish ticket data.



Based on CDFW fish ticket data

Whale abundance and distribution:
Weekly distribution of whales is based on time of year and oceanography and is ground-truthed against survey data.

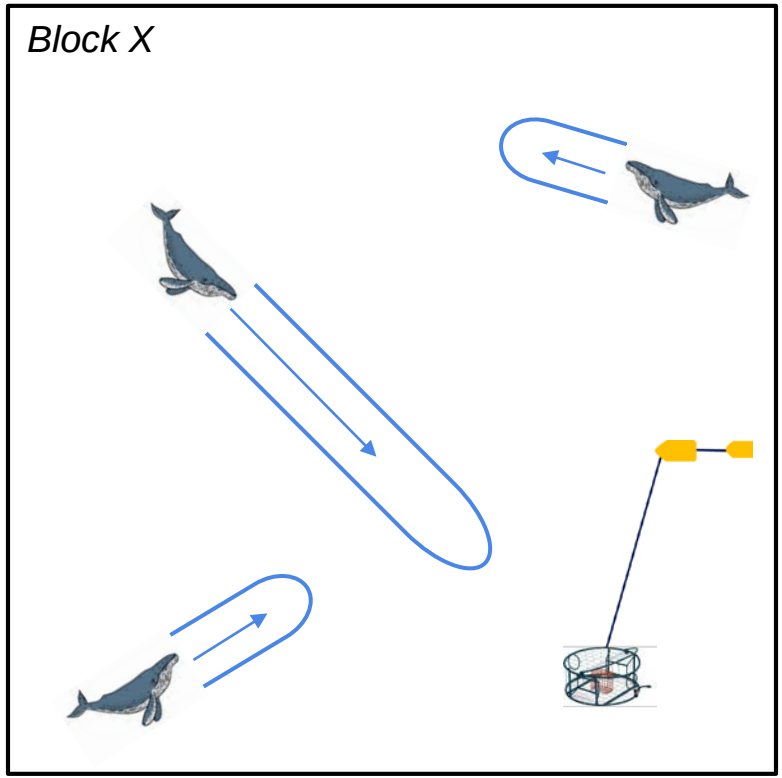
- Whale migration is represented
- Variability between years is represented



Based on Forney et al. (in prep)

Whale-trap encounters and entanglements:

The probability that a trap “encounters” a whale is based on whale density, size, and swimming speed.



From the 2014-15 to the 2018-19 seasons:

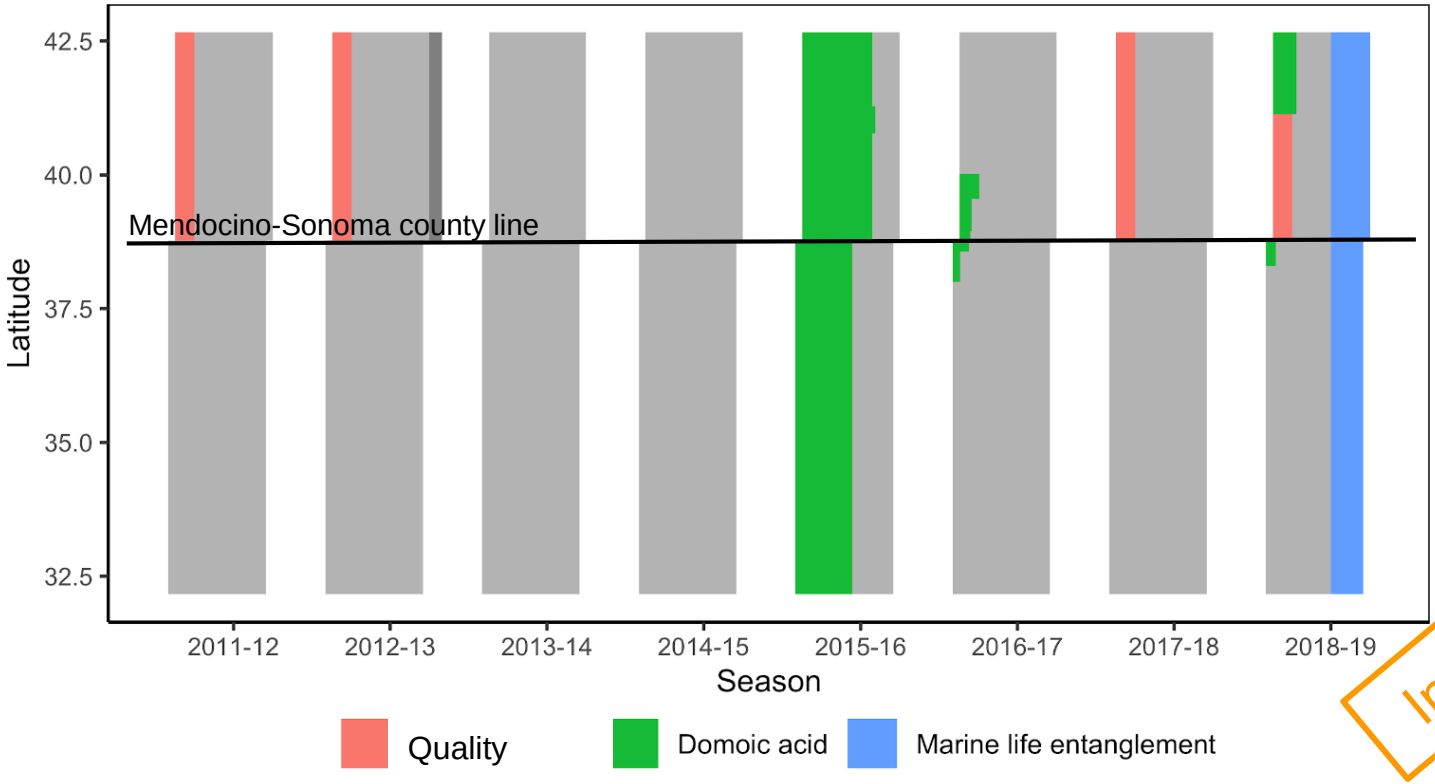
0.0028% probability that an encounter results in a confirmed entanglement

$$= \frac{\text{Confirmed entanglements}}{\text{Estimated encounters}}$$

An “encounter” is defined as a whale passing within a body length of a trap

Domoic acid and quality delays:

We test how whale risk management strategies are impacted by season delays based on both historical and simulated delays.



In progress

Management dials

Management triggers

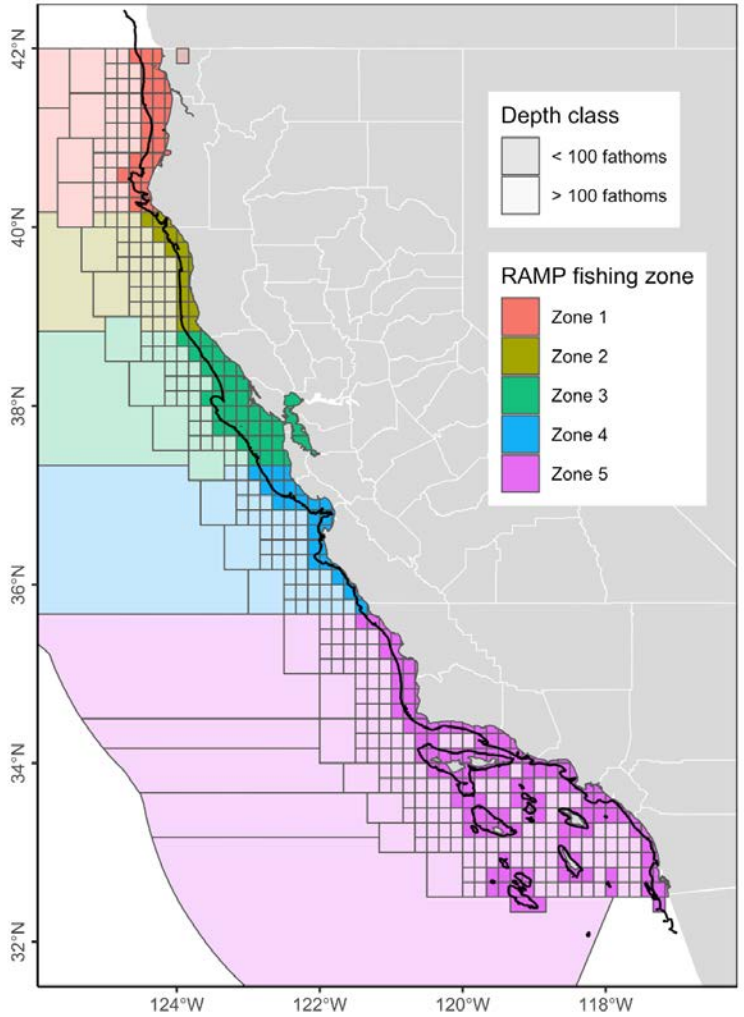
- Entanglement trigger
- MLC trigger
- Other considerations

Management actions

- Closure
- Gear reduction
- Vertical line reduction

Action scales

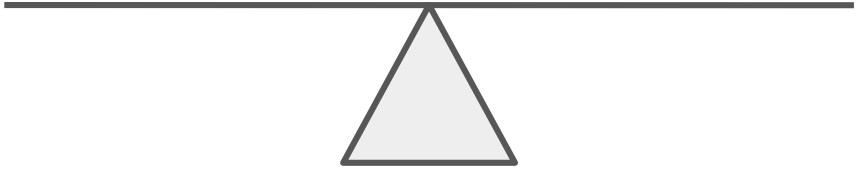
- Space
- Time
- Re-open trigger



Performance metrics

1. Total catch (mt)
2. Time on the water (weeks)

3. Number of trap-whale encounters
4. Number of trap-whale entanglements

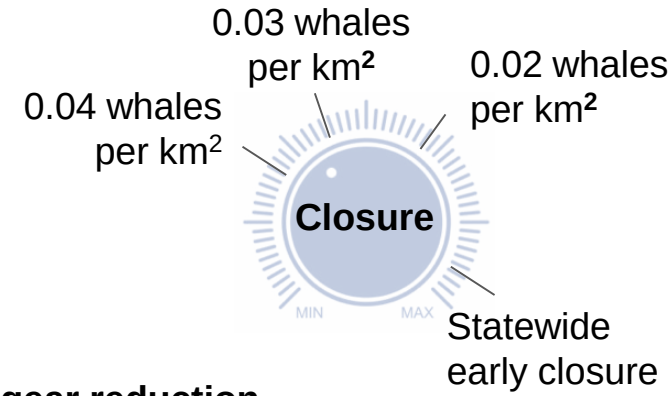


Note: We are working to translate total catch (mt) into total revenues ($)

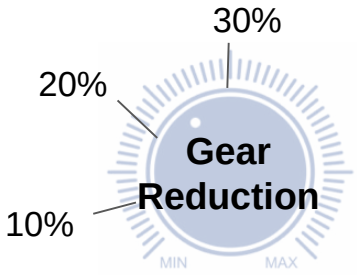
Preliminary results

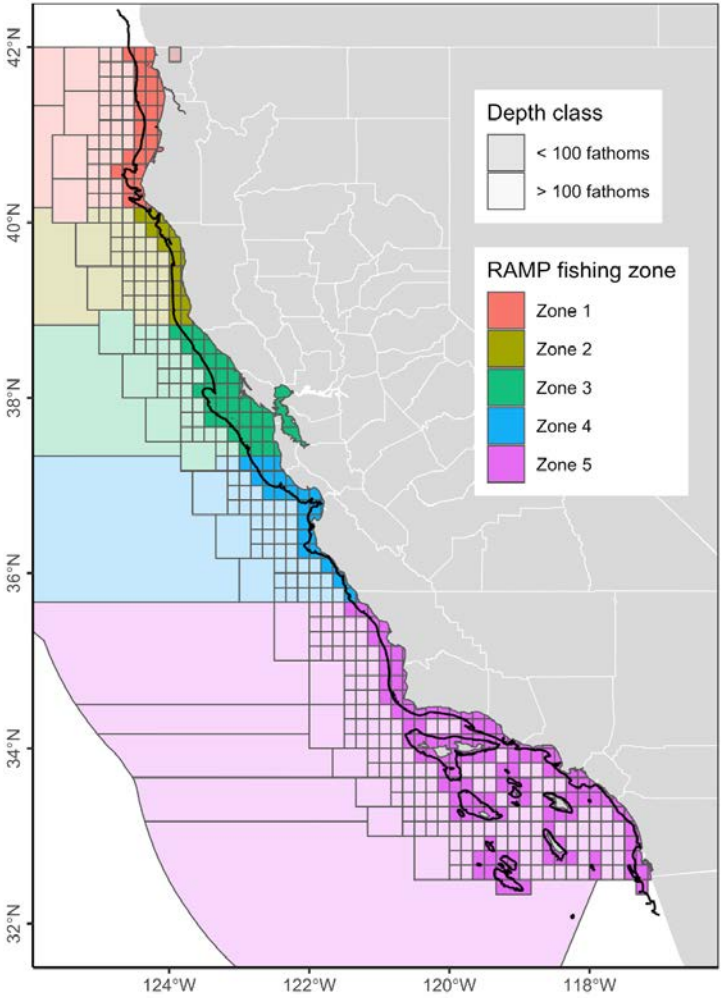
Management scenarios

MLC-triggered zonal closures (fall/spring)

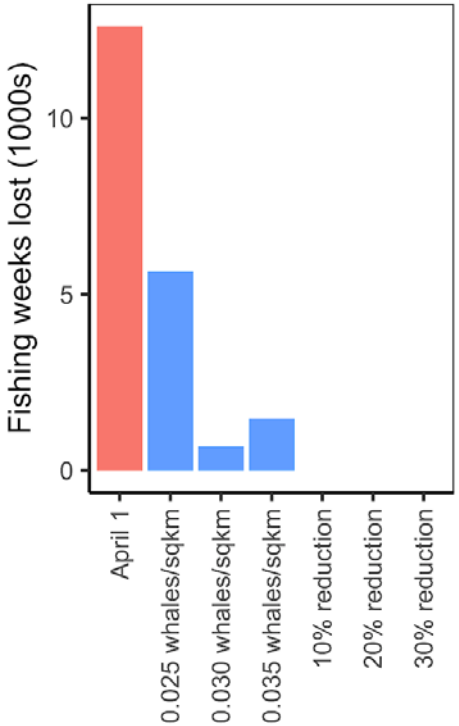


Whole-season gear reduction





Overall performance comparison (over all 5 seasons)



State-wide early closure

MLC-triggered zonal closure

Whole-season gear reduction

Preliminary results

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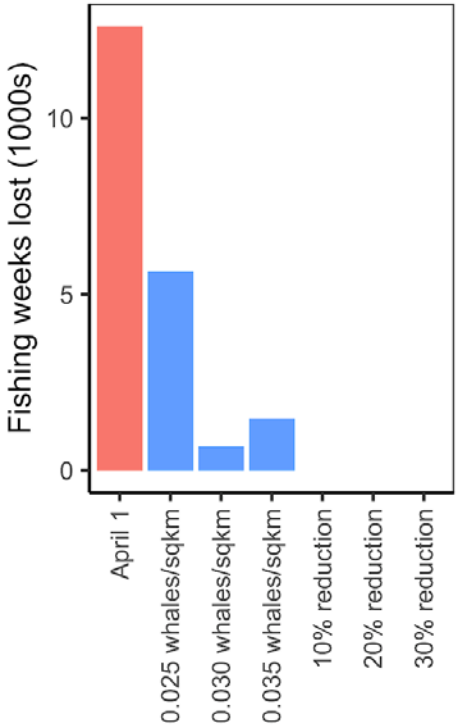

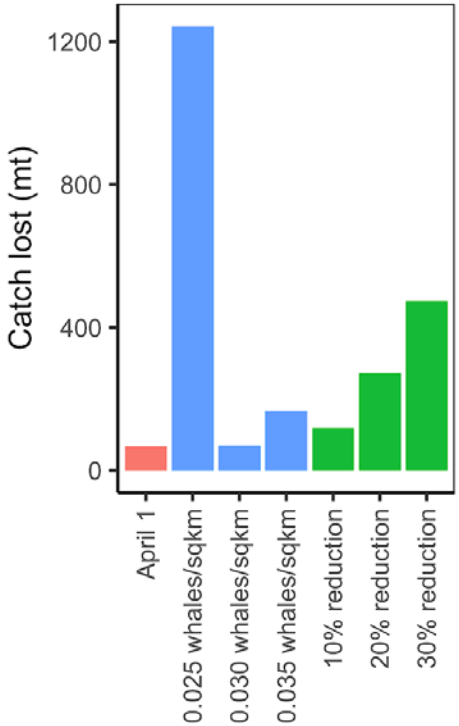

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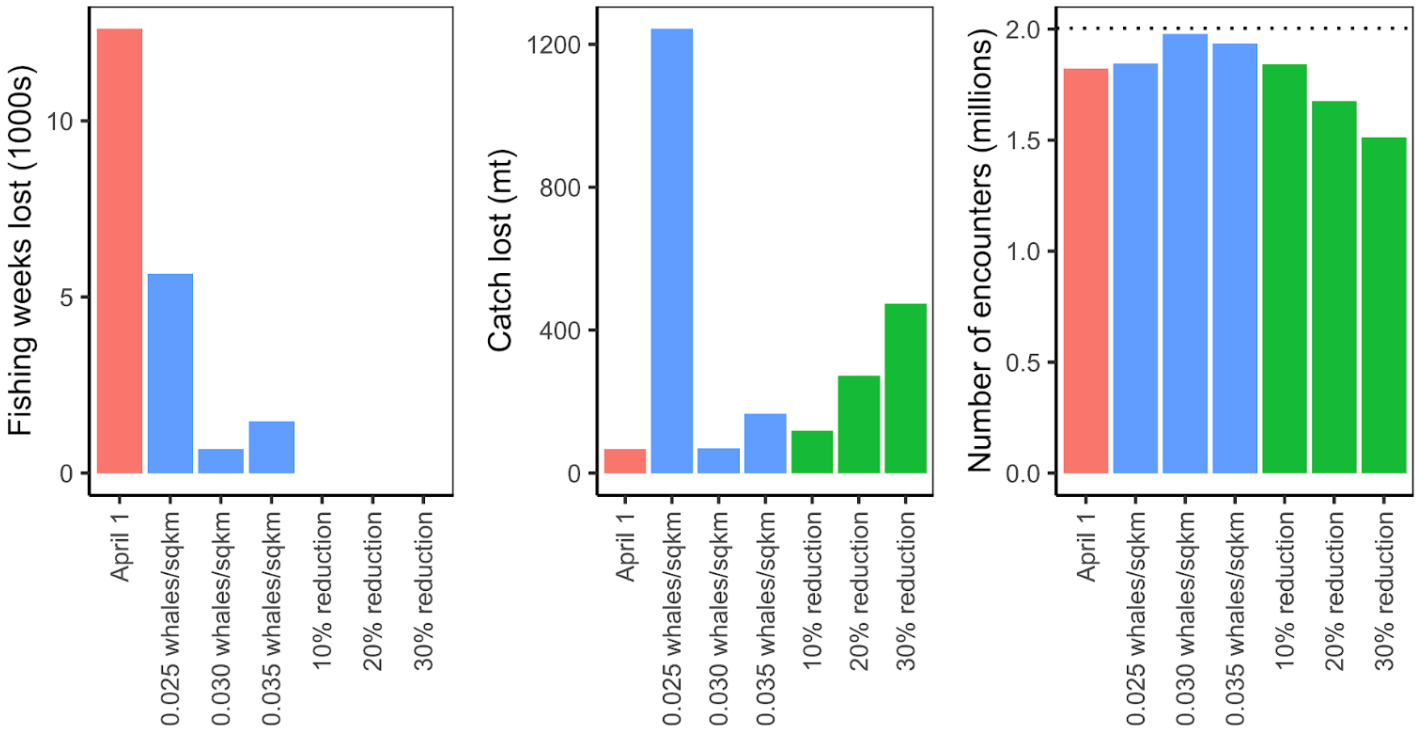

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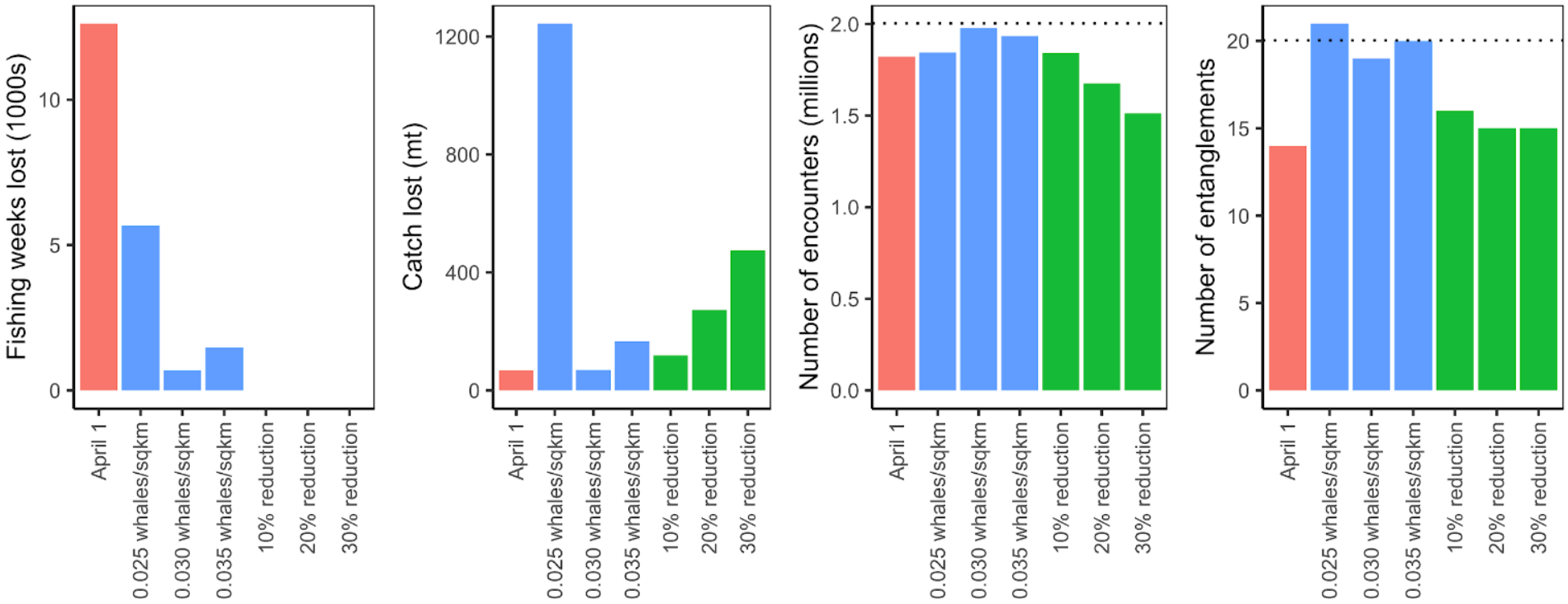


State-wide early closure

MLC-triggered zonal closure

Whole-season gear reduction

Preliminary results

Preliminary management considerations

1. We have developed a flexible tool for measuring tradeoffs between alternative management strategies.

1. Whales are present throughout the fishing season coastwide and the extent of zonal closures will be sensitive to the MLC trigger, zone layout, and survey design.

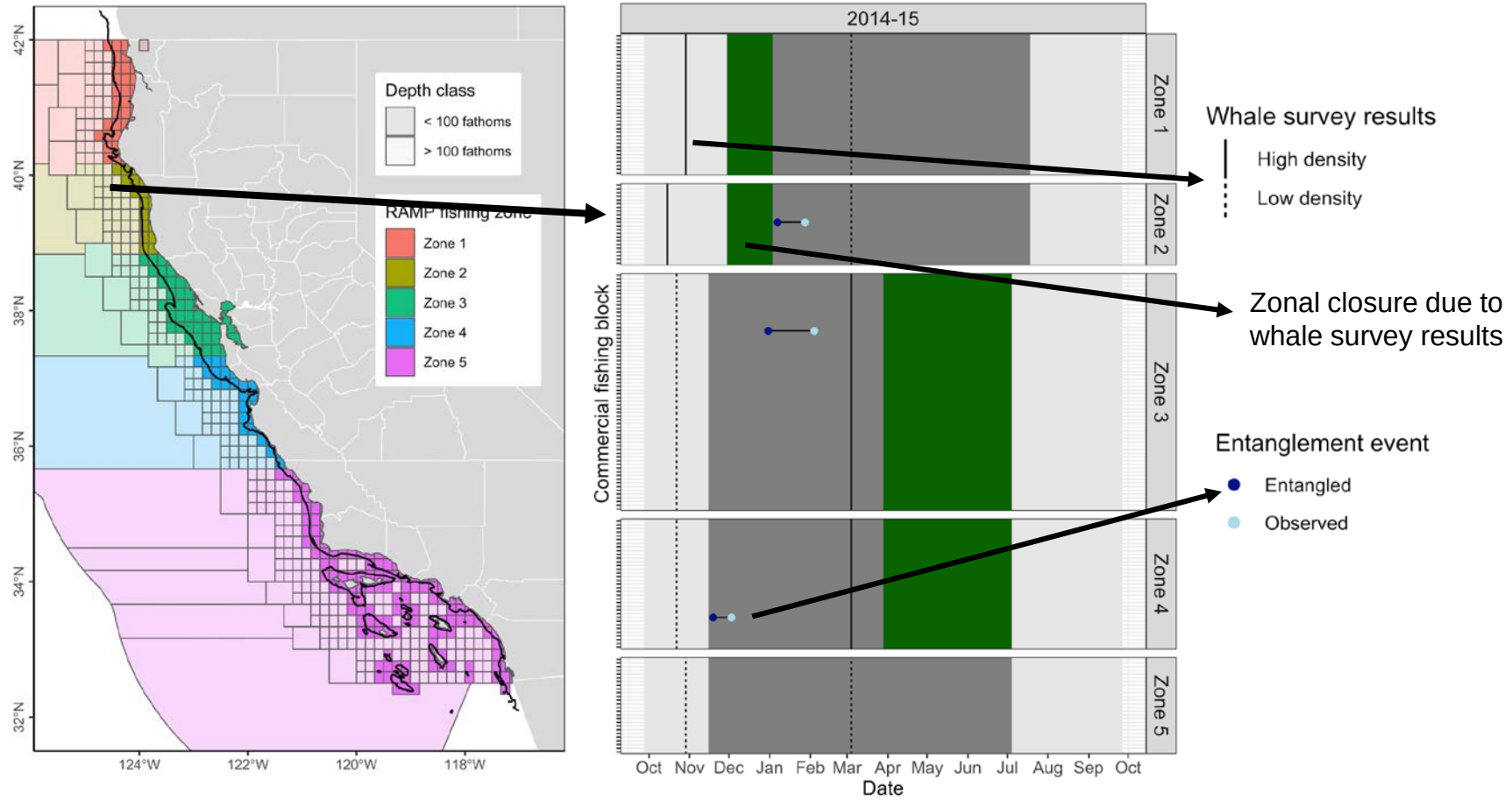
1. Zonal closures may not reduce entanglements as much as expected because effort gets displaced and concentrated elsewhere.

1. Mid-season gear reductions are not likely to significantly reduce the number of whale-trap encounters because effort declines too quickly.

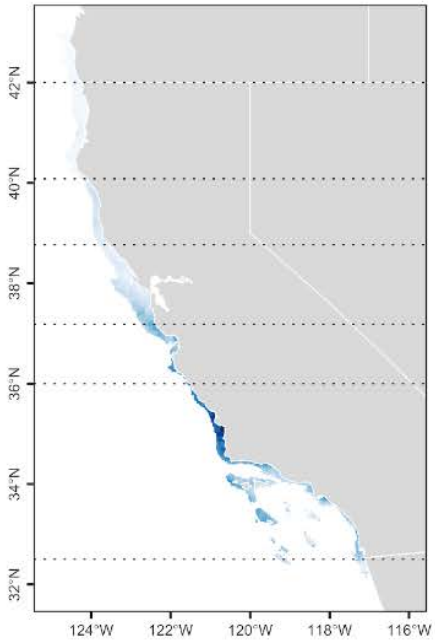
1. Whole-season gear reductions could maintain high catch while also reducing the number of entanglements (to levels comparable to zone closures).

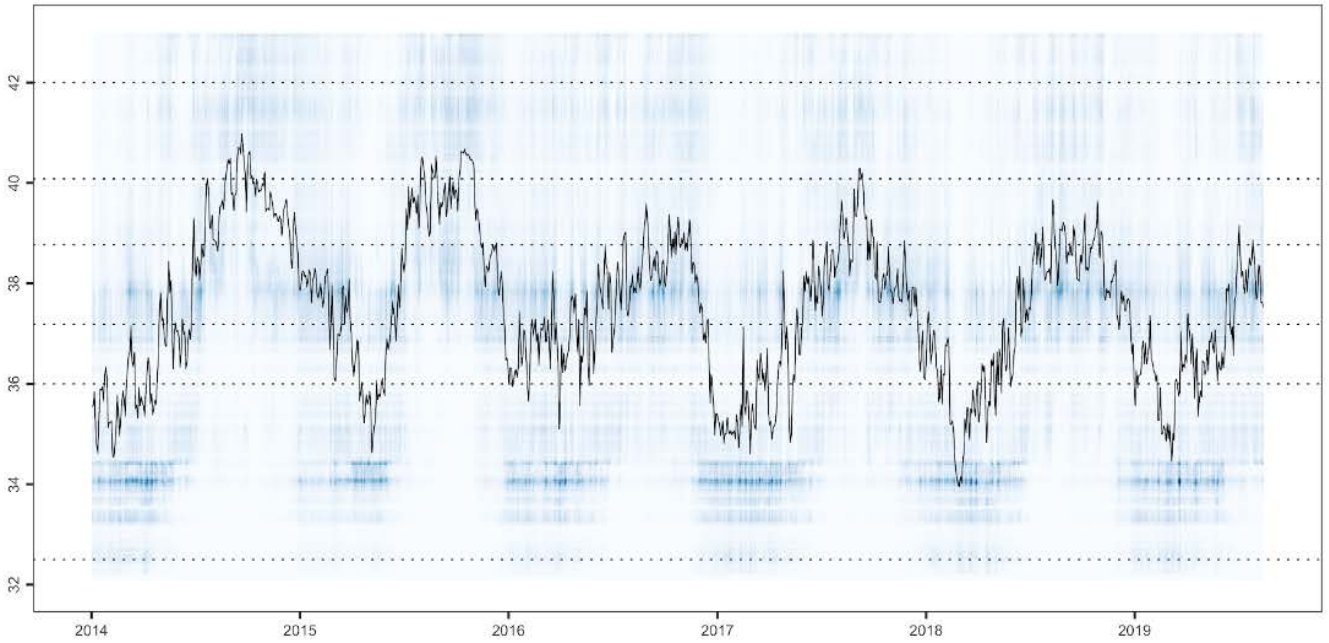
Extra slides

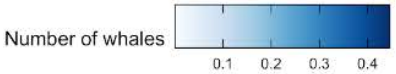
Orientation to the results



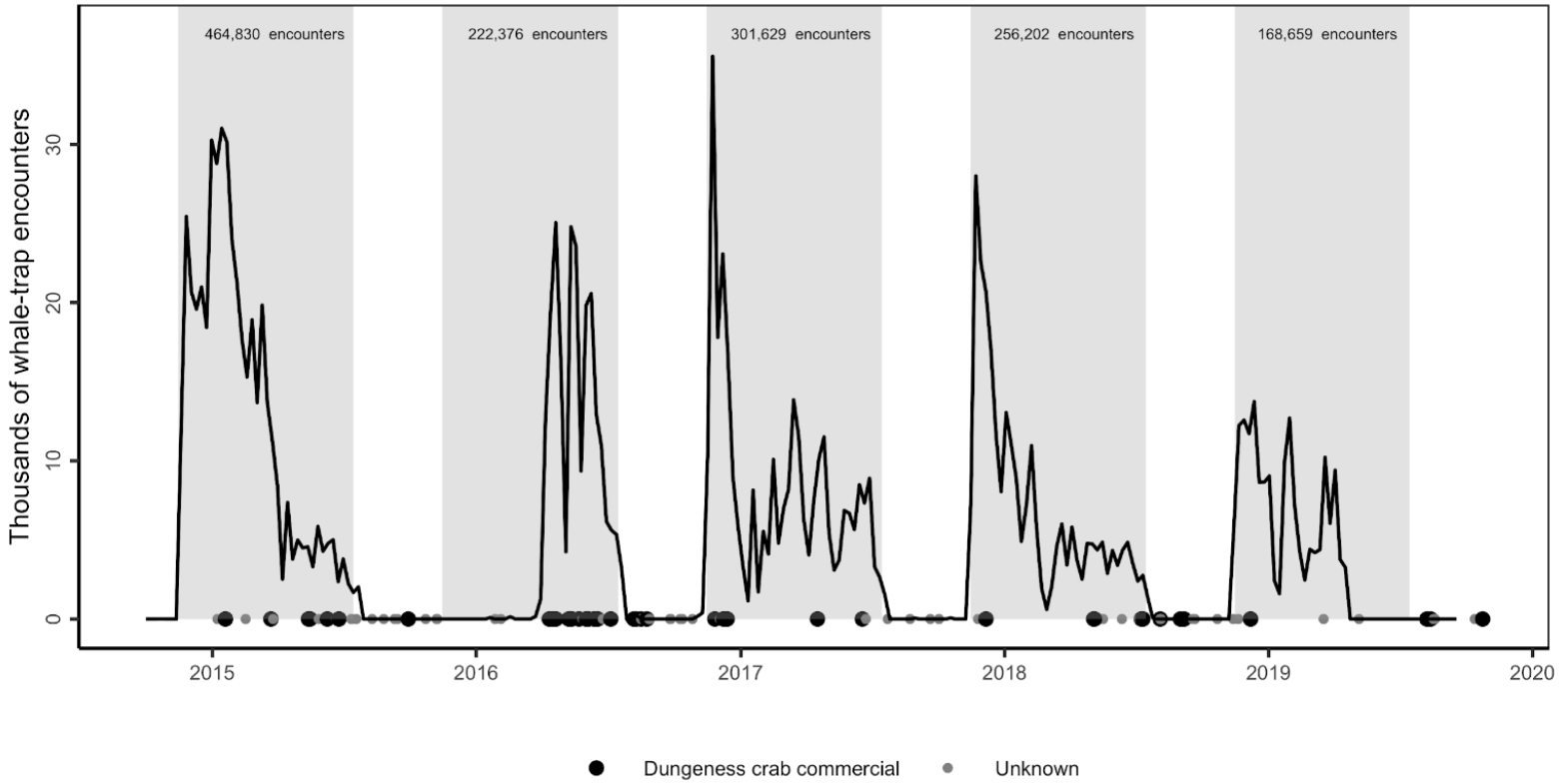
Whale abundance over space and time







Reconstructing historical encounter rates to estimate the probability that an encounter leads to an observed entanglement



Location of Dungeness crab catch over space and time