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

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July 27, 2020

Setting the stage

- Welcome
- Introductions
- Having trouble getting through to join the discussion?
  - Mute/Unmute - On Zoom, on phone, or press *6
    - Suggest using mute button on phone once unmuted on Zoom
  - Raise hand - *9
  - Email hello@strategicearth.com
  - Text 714-330-7976
  - Chat box at the bottom of your screen
- Are you comfortable recording the meeting?

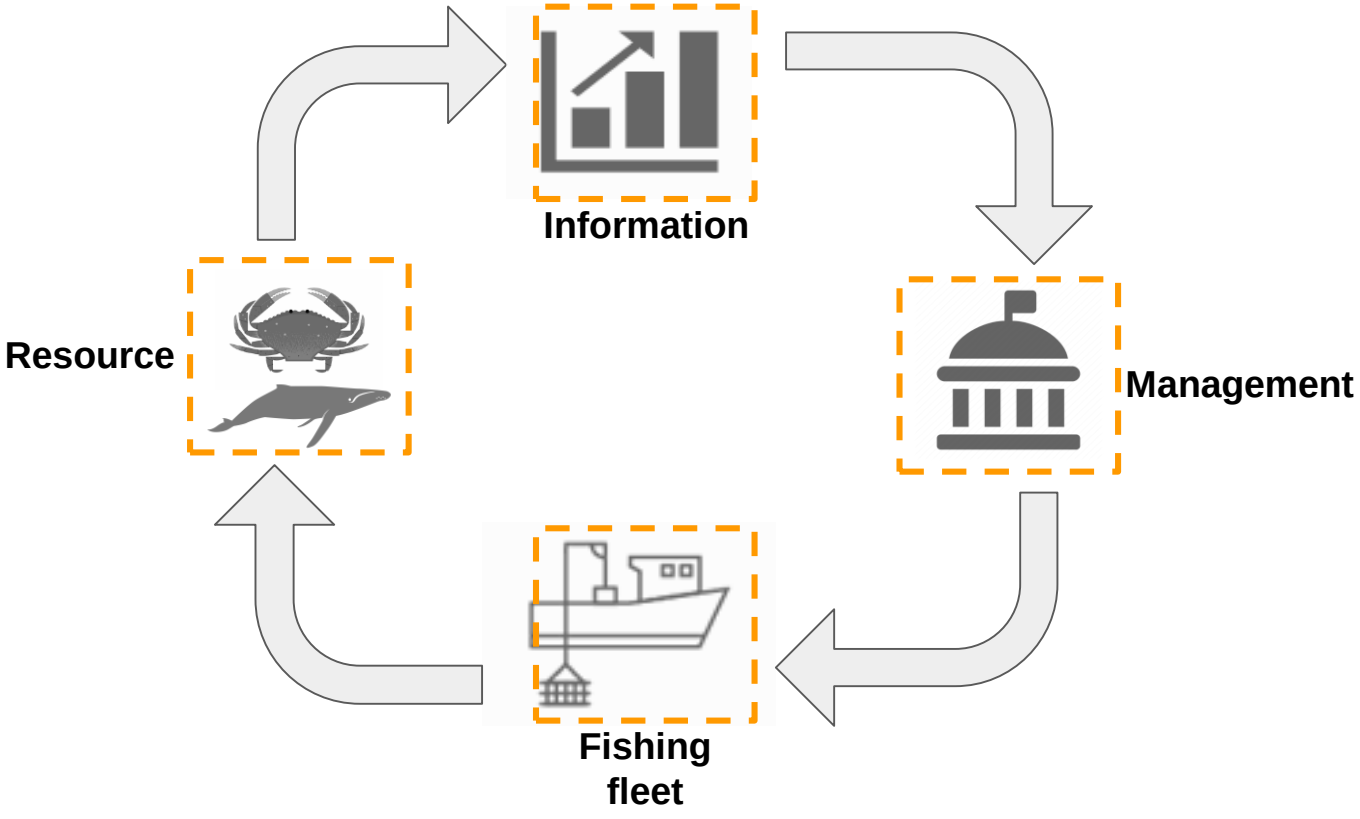
Meeting agreements

- Put yourself on mute
- Be patient when listening to others, do not interrupt
- Respect the opinions of others even if you do not agree
- Personal attacks will not be tolerated

Today’s discussion

- Welcome and introductions
- Project introduction
- What is a Management Strategy Evaluation (MSE)?
- The framework and preliminary results
- Management considerations and next steps

How can we maximize economic and ecological outcomes in fisheries?



Goal for today

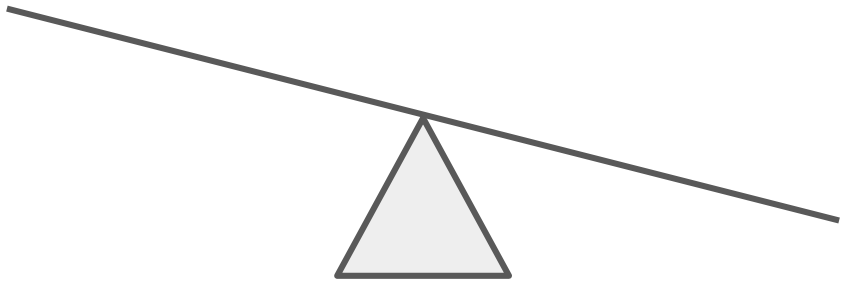
Obtain industry input on how to make this project more representative of on-the-water realities and ideas for how to refine the management strategies evaluated.

Your input can help improve the quality of the work, and make the end product more useful to the crab industry.

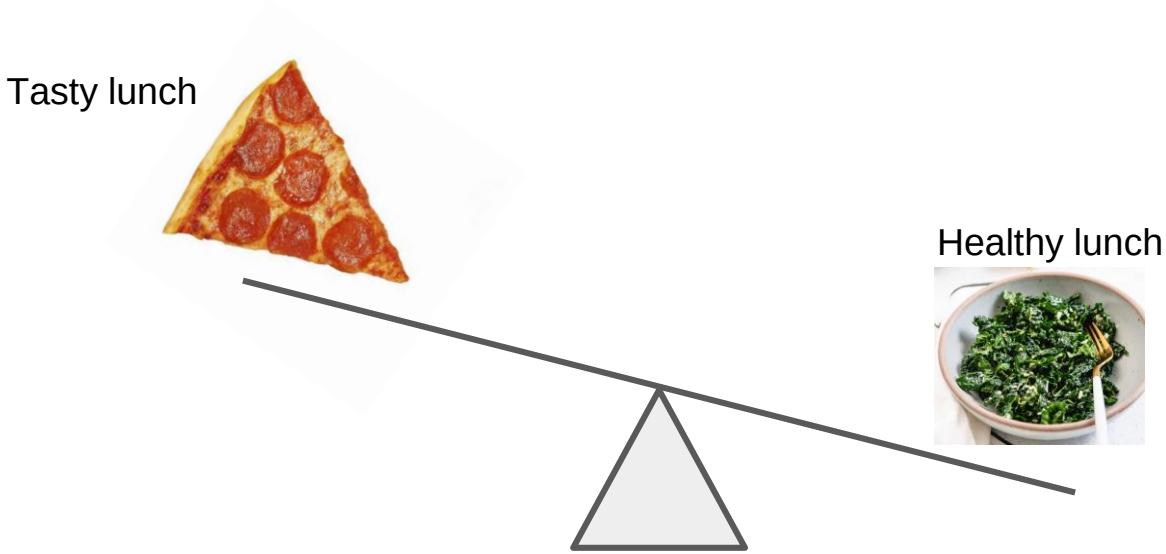
A brief introduction to management strategy evaluation (MSE)

MSE uses simulations to measure the performance of and tradeoffs between alternative management strategies. It is especially useful for testing performance under variable or uncertain conditions.

Balancing trade-offs under uncertainty



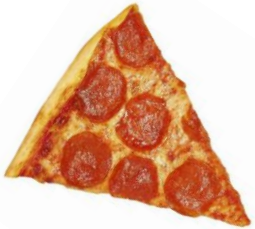
Balancing trade-offs under uncertainty

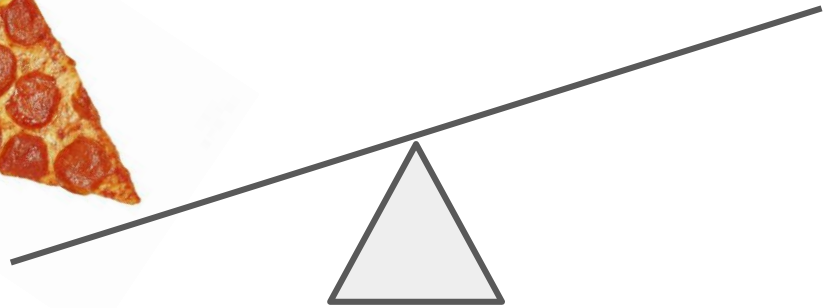


Balancing trade-offs under uncertainty

Healthy lunch

Tasty lunch





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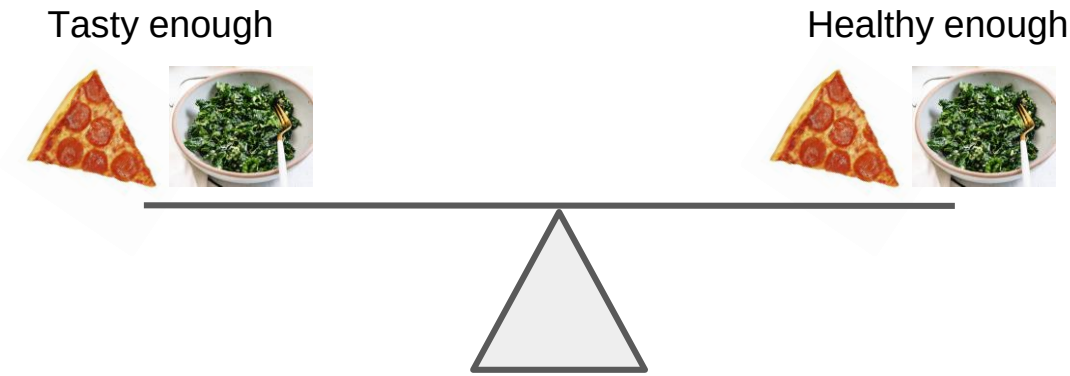

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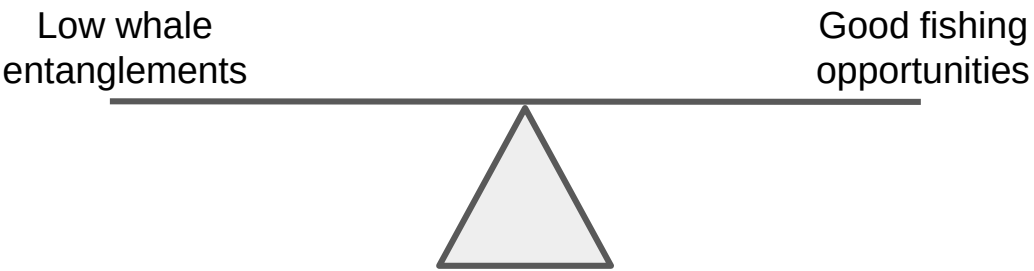
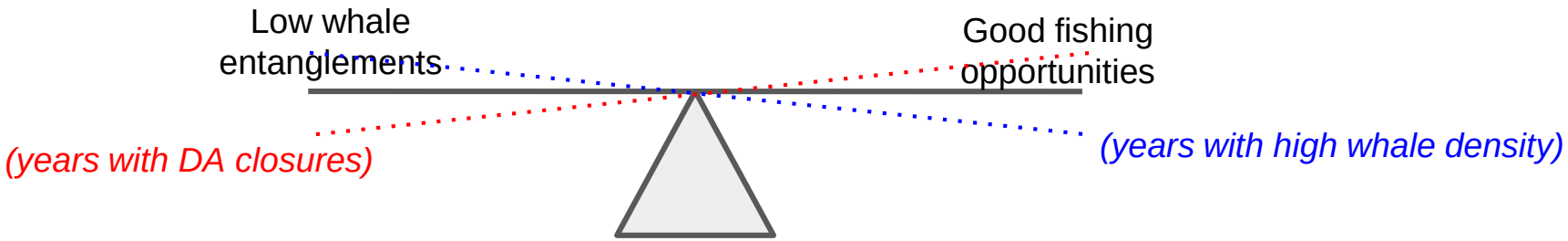
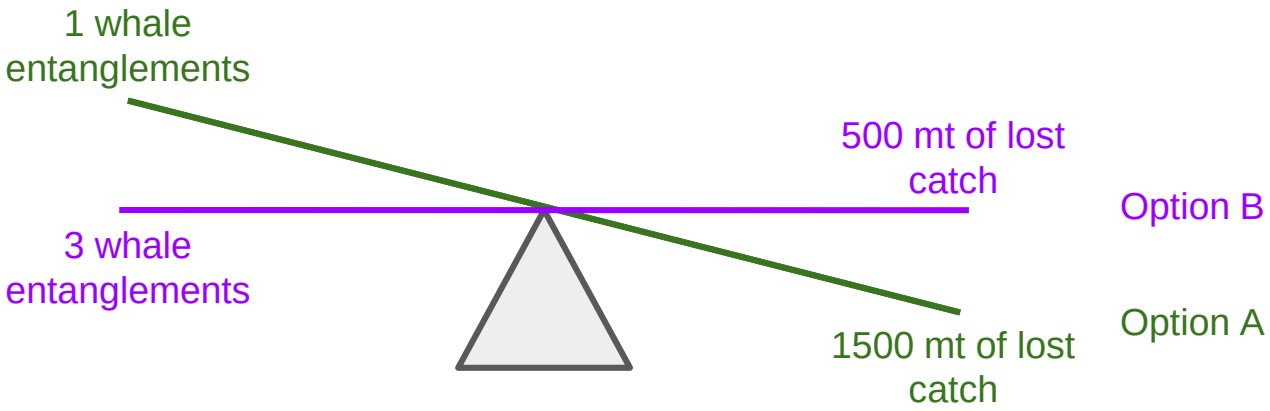


Balancing trade-offs under uncertainty



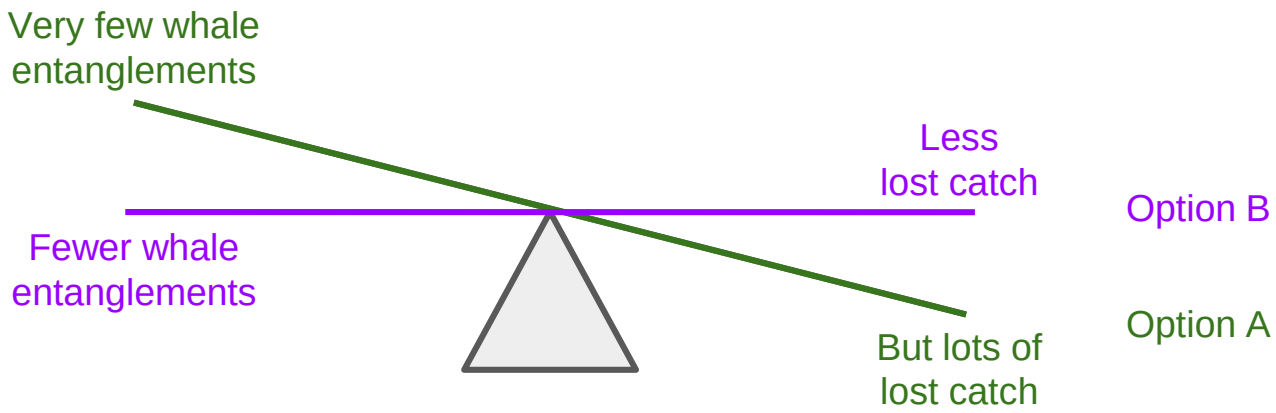
Balancing trade-offs under uncertainty

It cannot say:



Balancing trade-offs under uncertainty

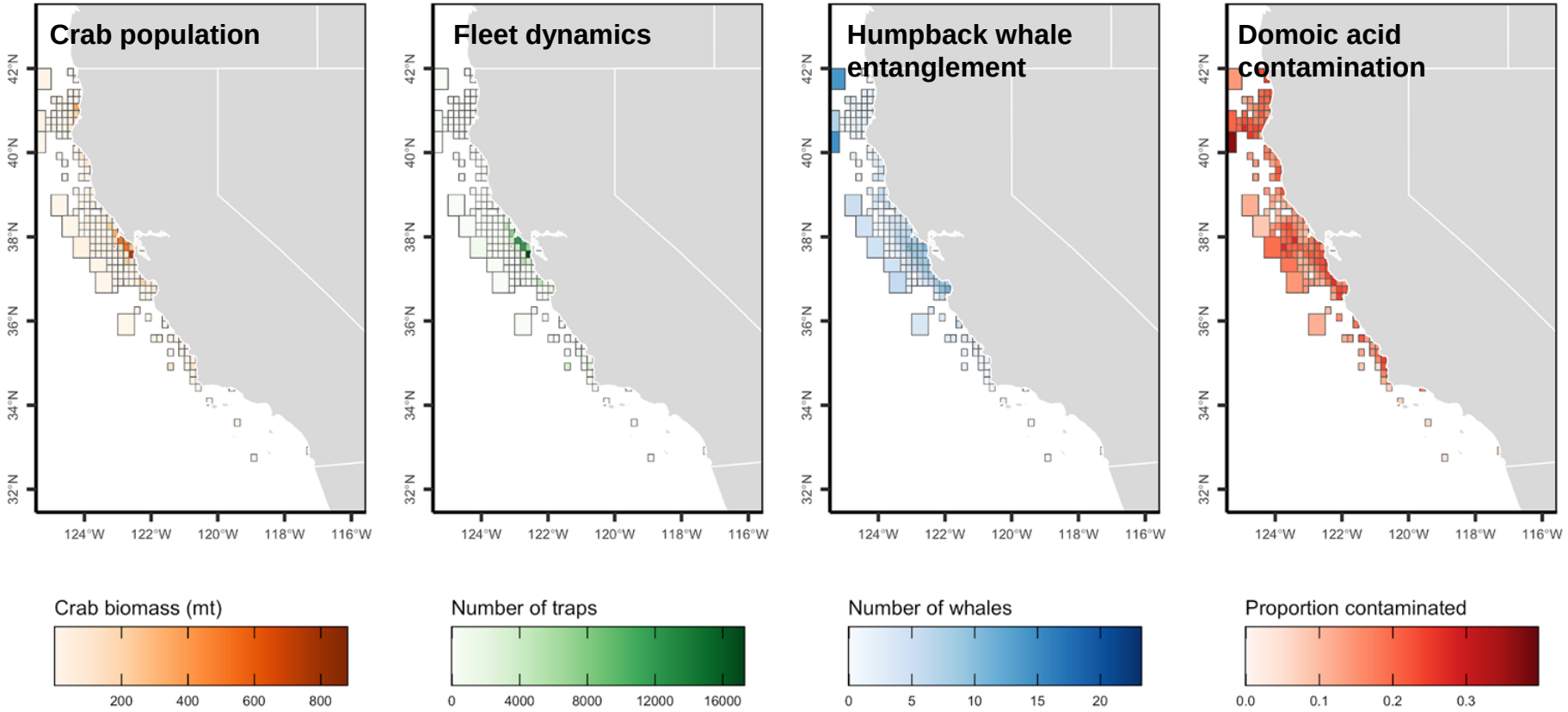
But it can say:



Our objective is to identify management strategies that will maximize economic outcomes for the commercial CA Dungeness crab fishery, while minimizing whale entanglement risk.

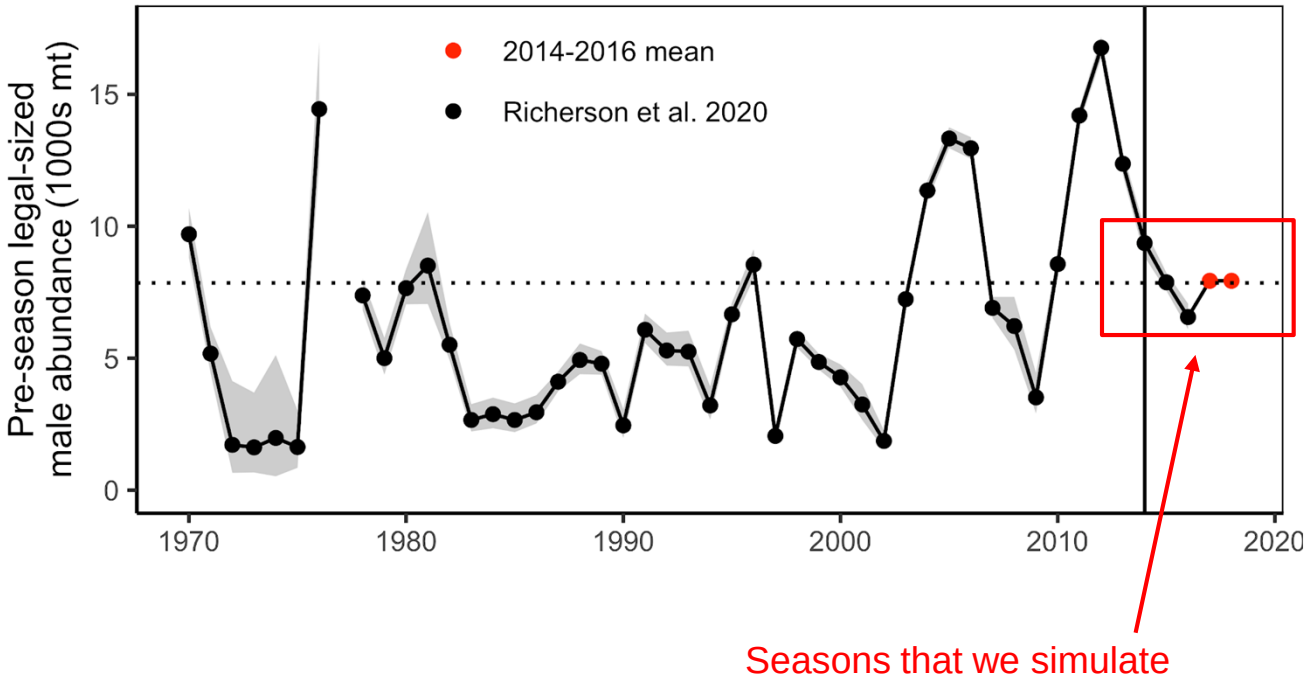
Our framework

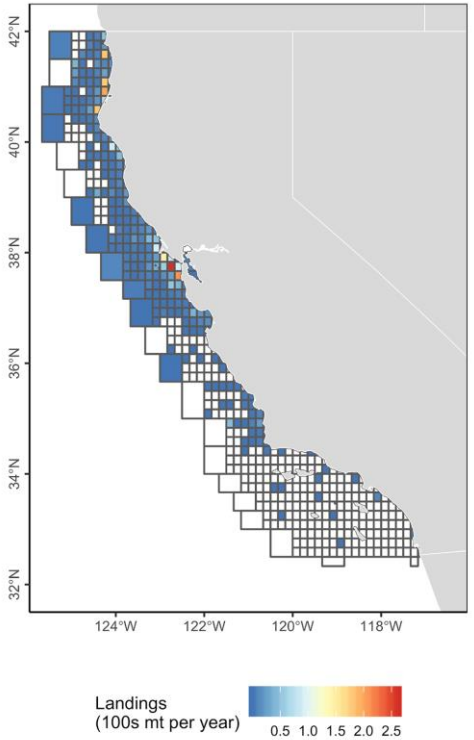
Components of the simulation



Crab population:

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

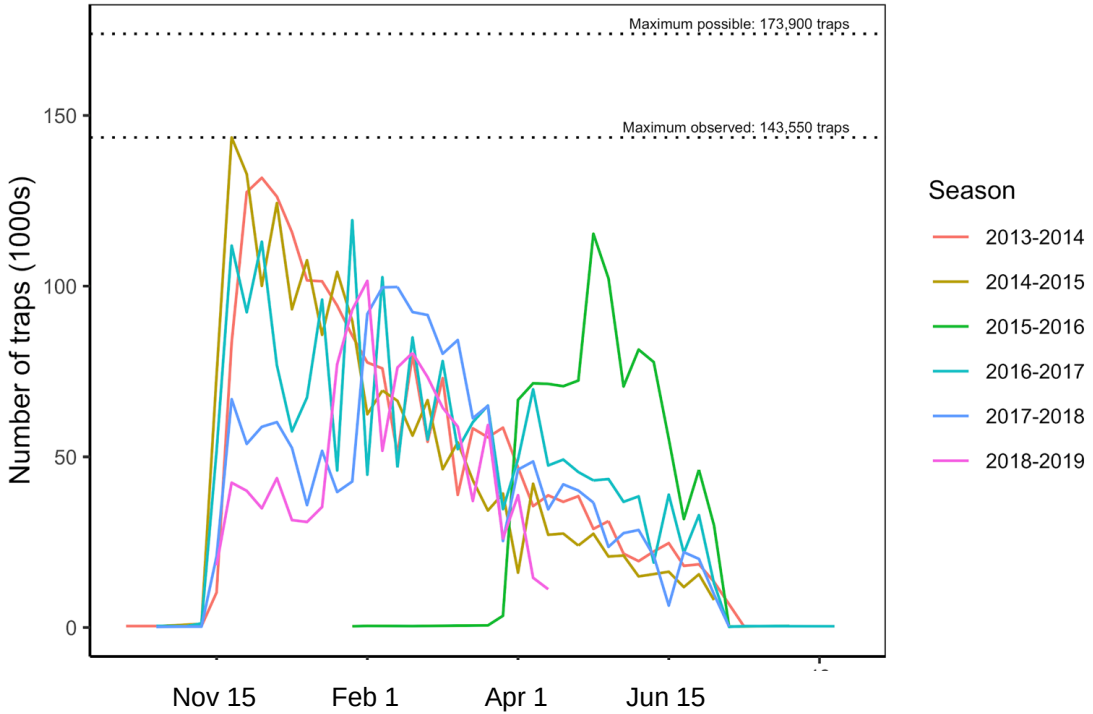




Based on Richerson et al. (2020) and CDFW fish ticket data

Fleet dynamics:

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

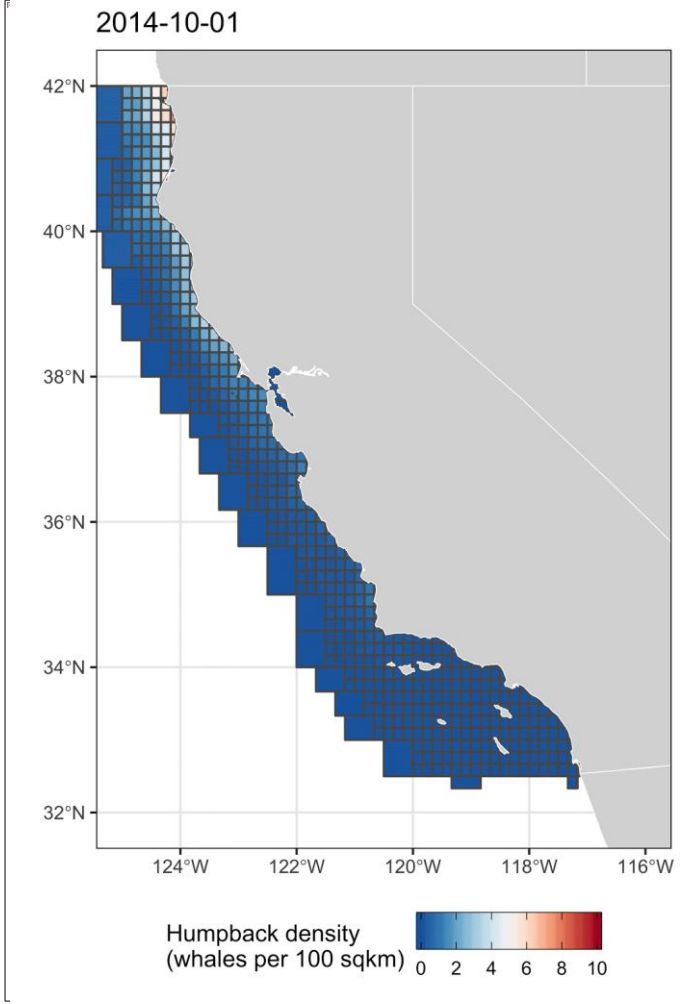


Based on CDFW fish ticket data

Whale densities:

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

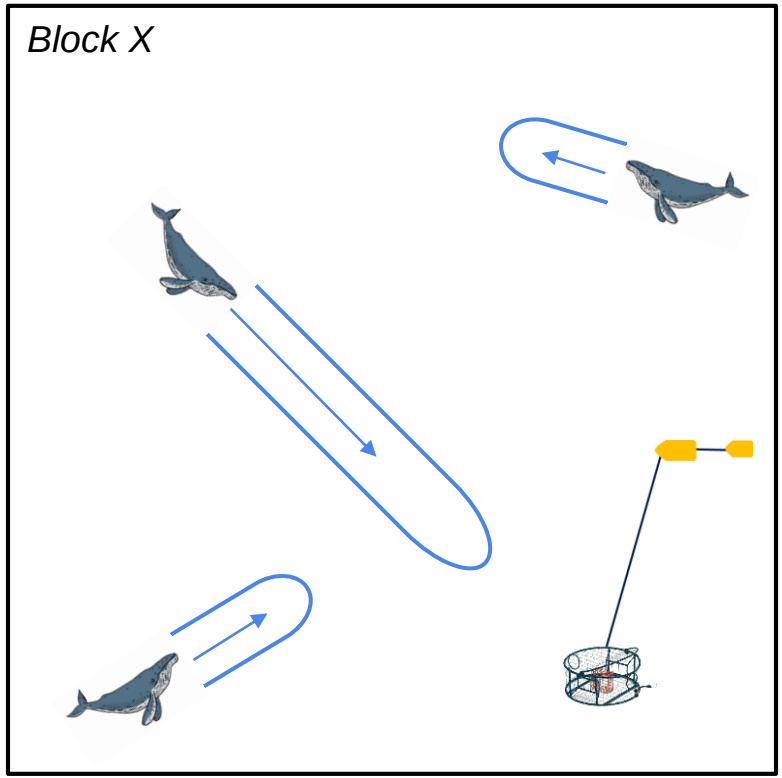
- Whale migration is represented
- Variability between years is represented
- Whales are present coastwide year-round
- Increasing abundance indirectly captured



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:

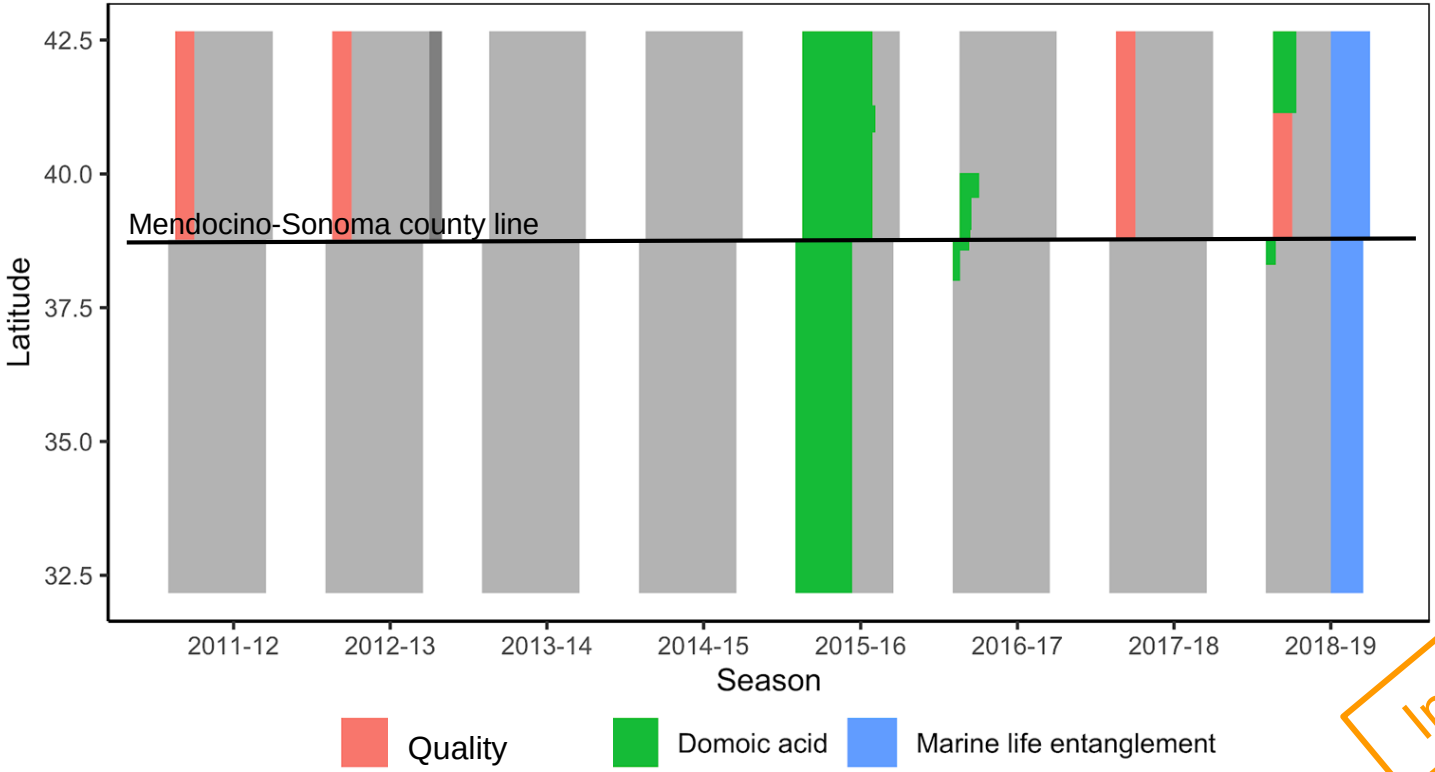
0.0028% probability that an encounter results in a confirmed entanglement

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

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

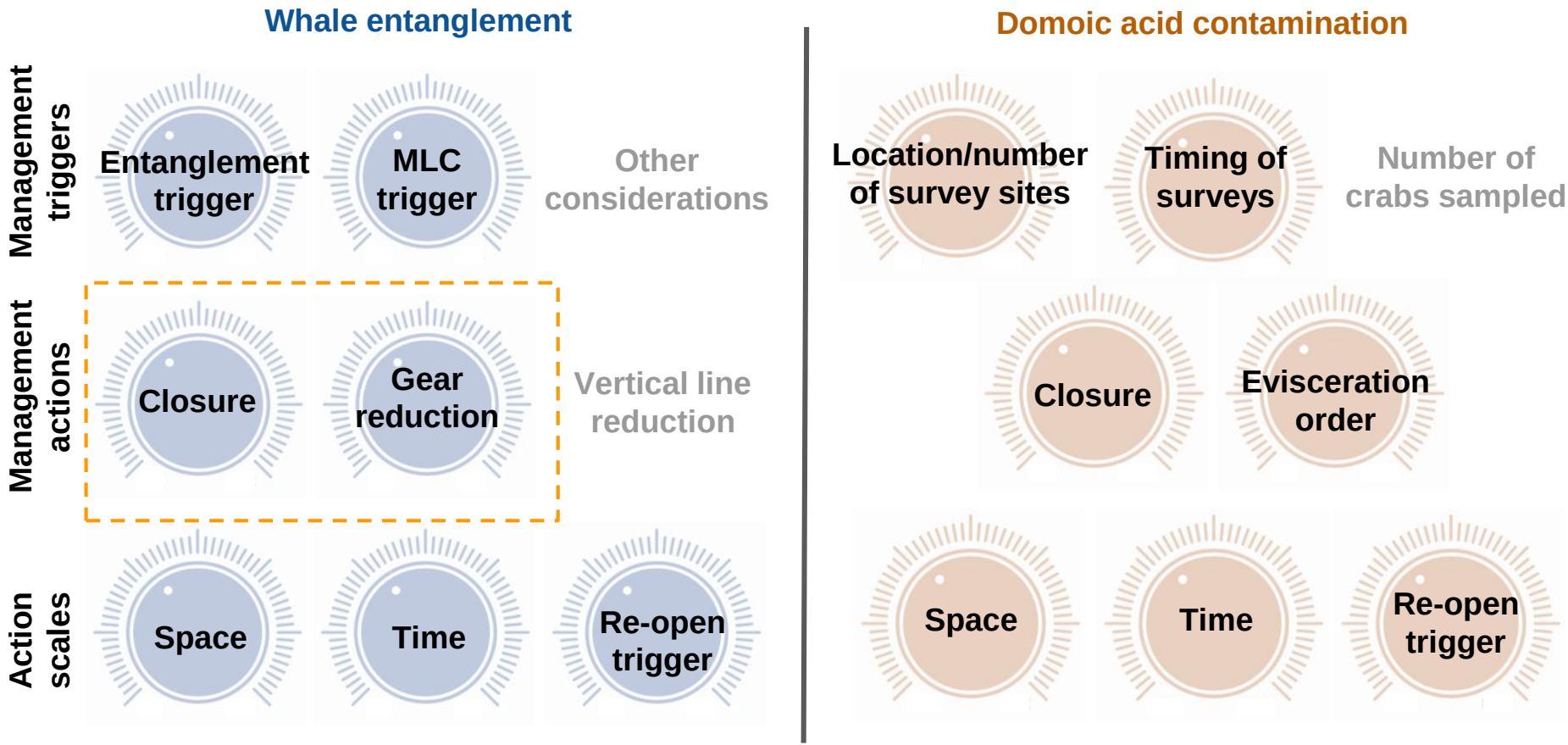
Domoic acid and quality delays:

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



In progress

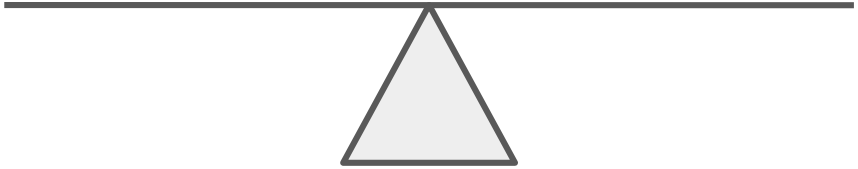
Management dials



Performance metrics

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

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



Preliminary results

Scenarios

Note: We do not evaluate the current RAMP regulations because they are (1) a moving target and (2) vague about the MLC triggers and actions.

Static → Dynamic

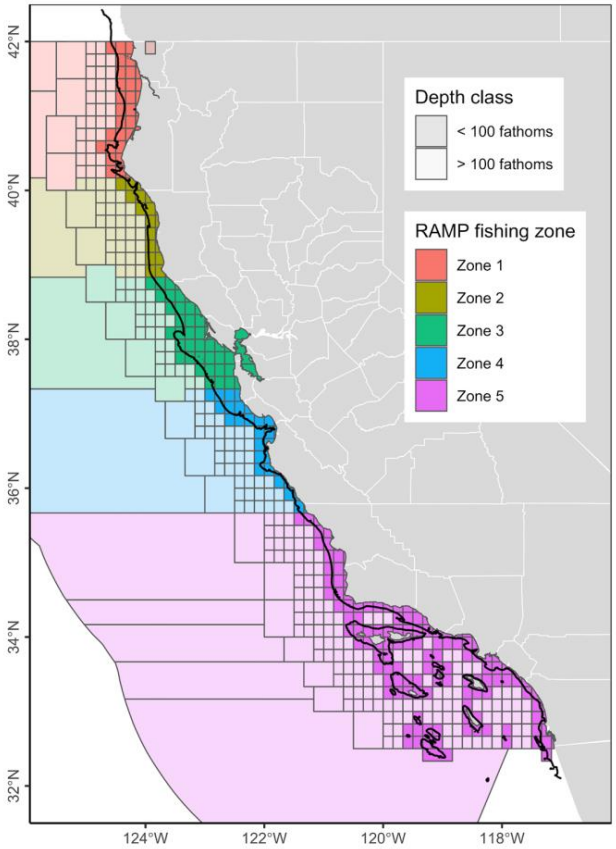
1. Scheduled closure (e.g. April 1 statewide closure)

2. Zone closure(s) triggered based on marine life concentrations (MLC) (Density threshold)

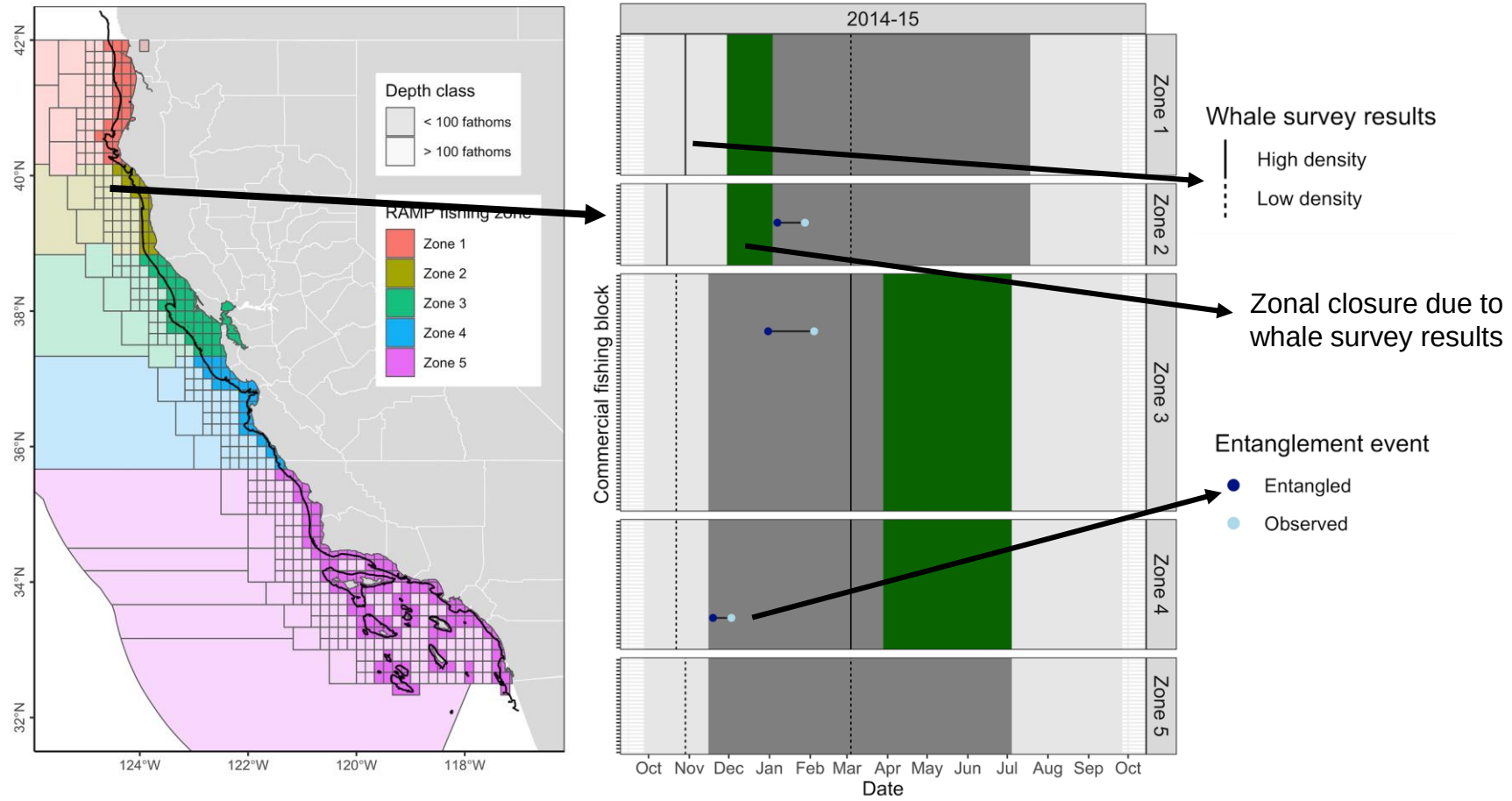
Static → Dynamic

1. Season-long gear reduction (20%)

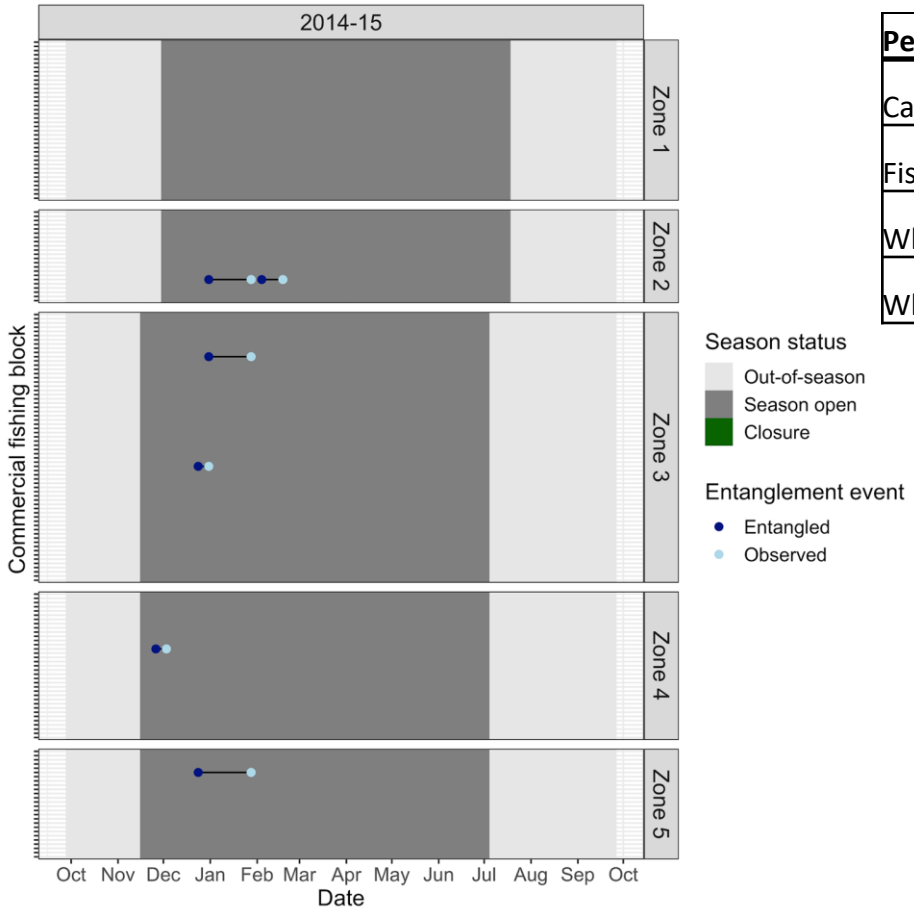
2. Gear reduction triggered by confirmed entanglement (50%)



Orientation to the results

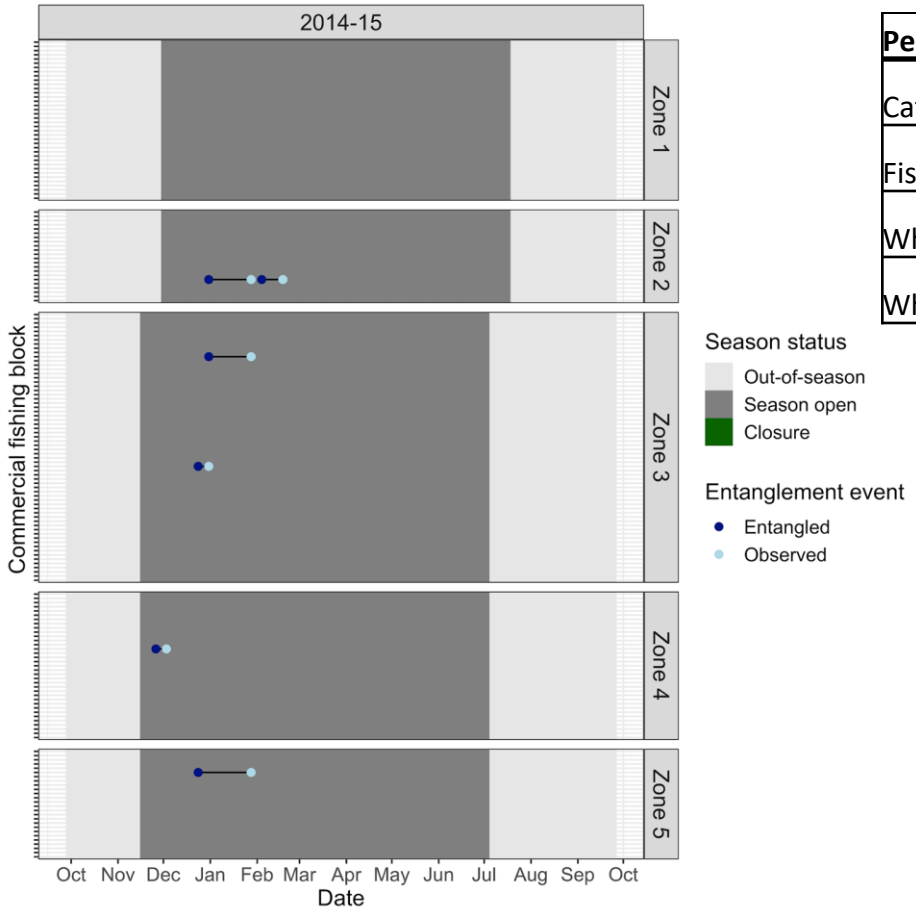


Status quo (baseline scenario)



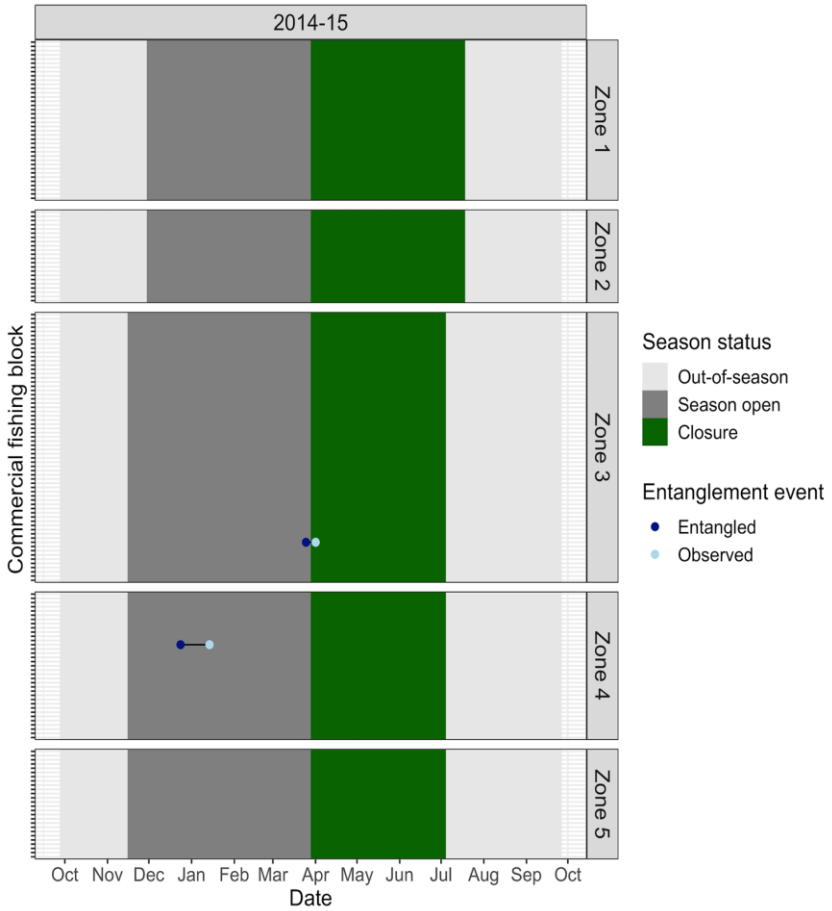
Performance metric	Status quo	Other scenarios
Catch lost (mt)	0 mt	
Fishing weeks lost	0 weeks lost	
Whale encounters	~464,000 encounters	
Whale entanglements	6 entanglements	

Status quo (baseline scenario)



Performance metric	Status quo	Other scenarios
Catch lost (mt)	0 mt	None lost ✓
Fishing weeks lost	0 weeks lost	None lost ✓
Whale encounters	~464,000 encounters	Fewer ✓
Whale entanglements	6 entanglements	Fewer ✓

Early closure (April 1st)

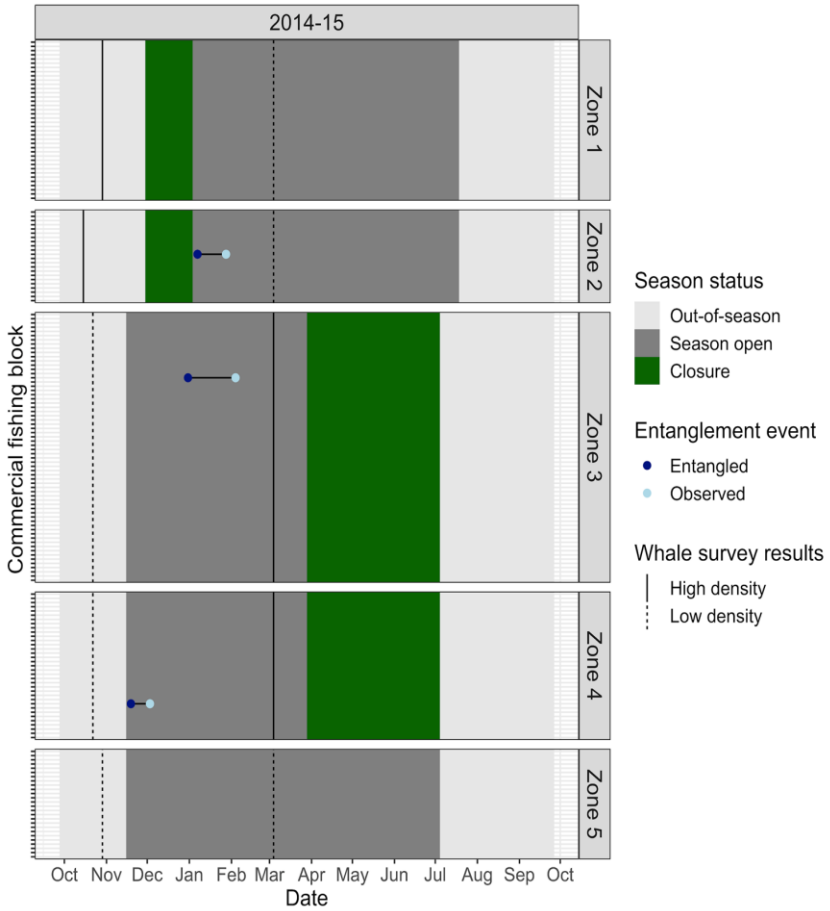


Performance metric	Status quo	Early closure
Catch lost (mt)	0 mt	18 mt lost
Fishing weeks lost	0 weeks lost	6,910 weeks lost
Whale encounters	~464,000 encounters	398,000 encounters
Whale entanglements	6 entanglements	2 entanglements

This strategy reduces whale entanglements but results in many lost weeks of fishing.

Static

MLC-triggered zonal closures (0.3 whales per km^2)

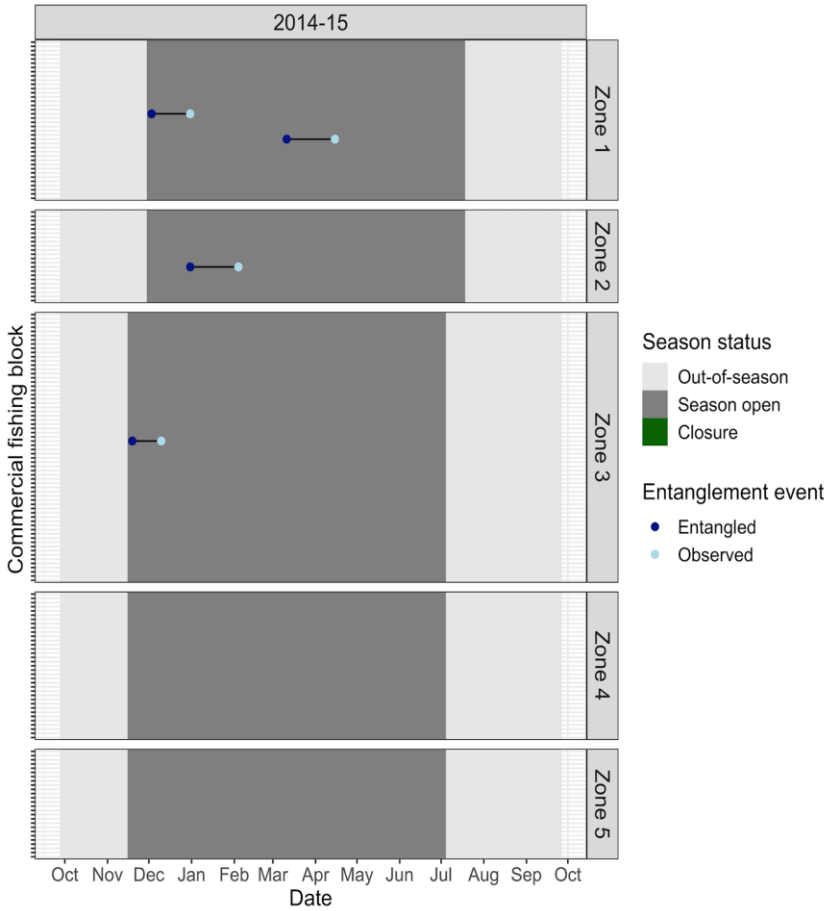


Performance metric	Status quo	Triggered closure
Catch lost (mt)	0 mt	112 mt lost ✗
Fishing weeks lost	0 weeks lost	7,934 weeks lost ✗
Whale encounters	~464,000 encounters	392,500 encounters ✓
Whale entanglements	6 entanglements	3 entanglements ✓

This strategy reduces whale entanglements but results in even more lost catch and lost weeks of fishing than an April 1 closure.

Dynamic

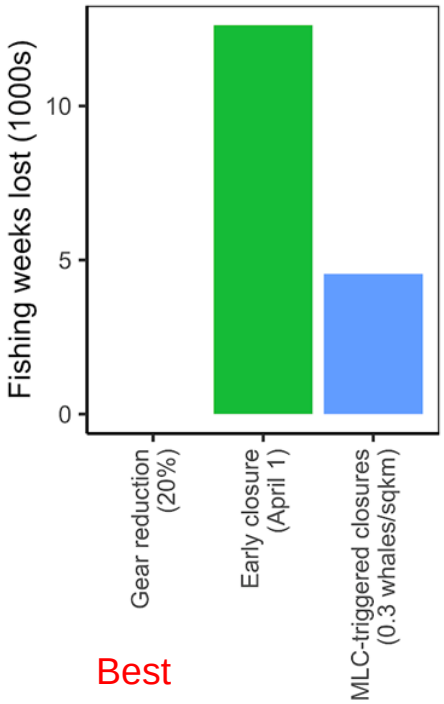
Gear reduction (20%, season long)



Performance metric	Base scenario	Gear reduction	
Catch lost (mt)	0 mt	64 mt lost	✗
Fishing weeks lost	0 weeks lost	0 weeks lost	✓
Whale encounters	~464,000 encounters	369,000 encounters	✓
Whale entanglements	6 entanglements	4 entanglements	✓

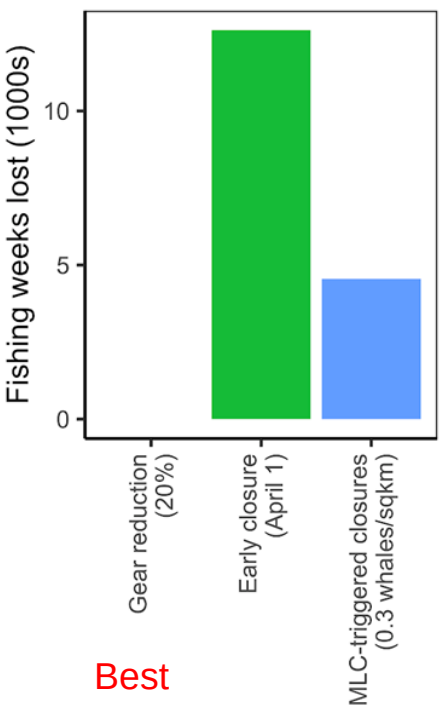
- **This strategy reduces entanglements (and results in the fewest number of expected encounters) without losing any weeks of fishing.**
- **It results in more lost catch than an early closure but less than MLC-triggered zonal closures.**

Overall performance comparison (over all 5 seasons)



Preliminary results

Overall performance comparison (over all 5 seasons)



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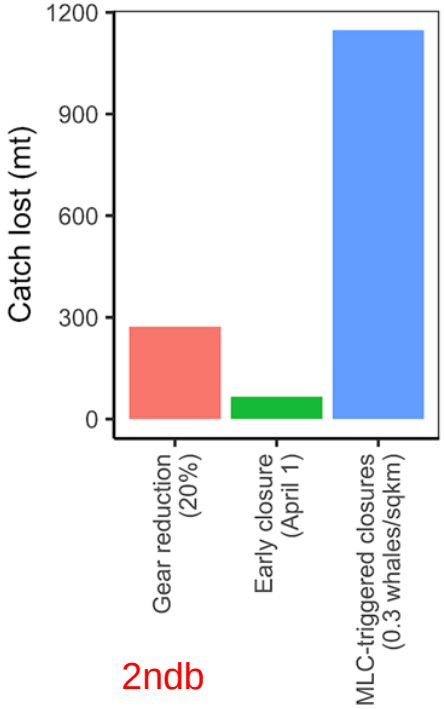

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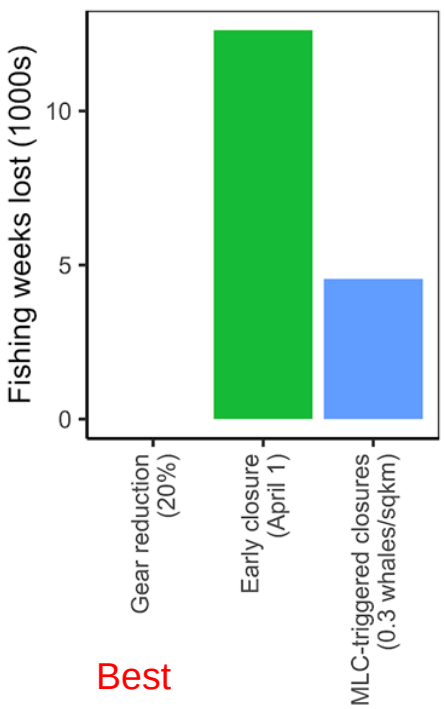
Preliminary results

Overall performance comparison (over all 5 seasons)



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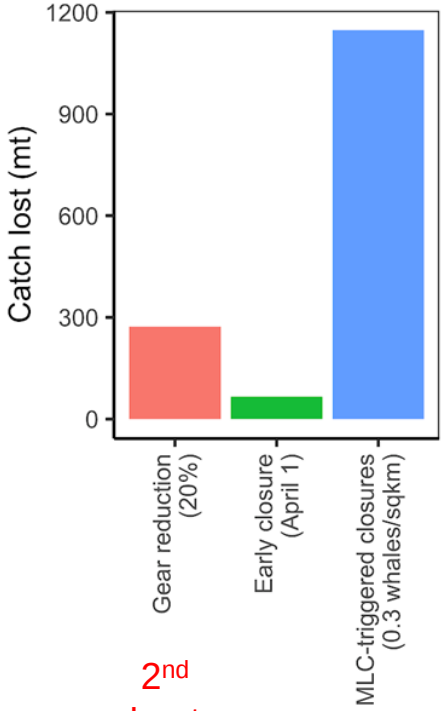

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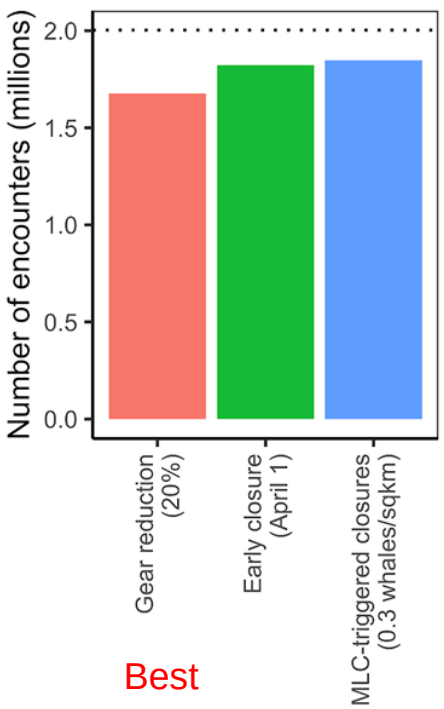

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Preliminary results

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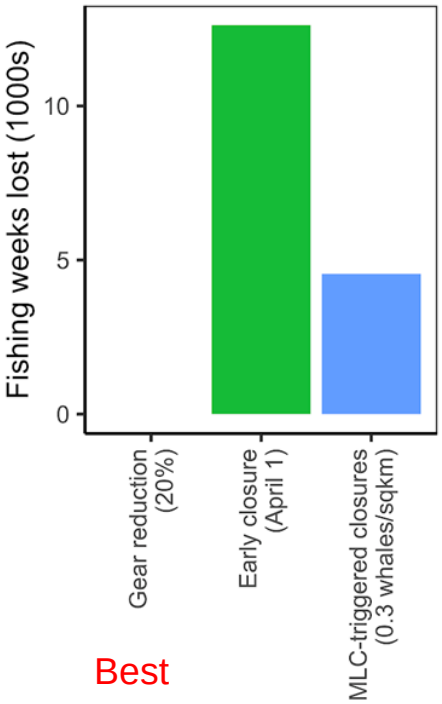

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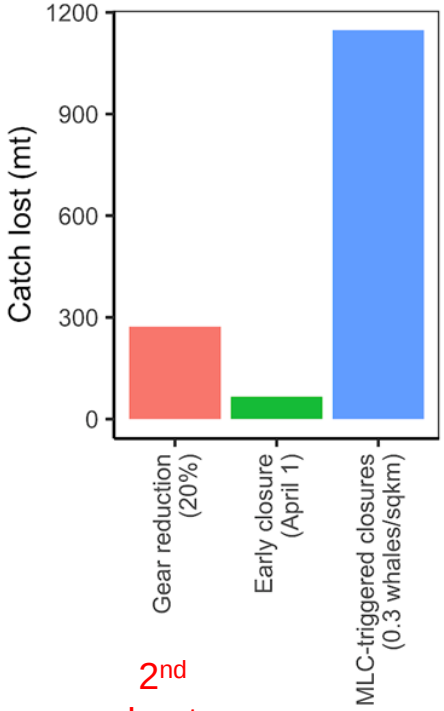

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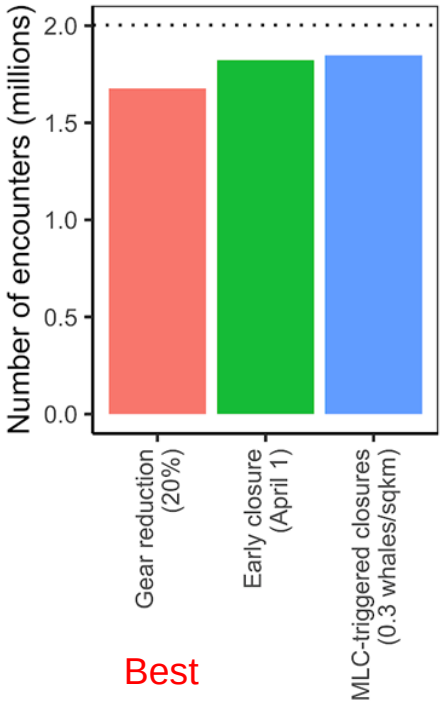

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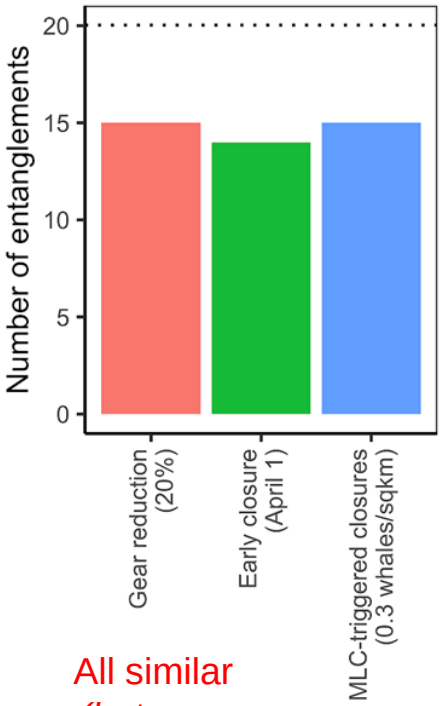

All similar *(but gear reduction less variable)*

Preliminary results

Preliminary management considerations and next steps

Preliminary management considerations

- We have developed a flexible tool for measuring tradeoffs between alternative management strategies.
- 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.
- Zonal closures may not reduce entanglements as much as expected because effort gets displaced and concentrated elsewhere.
- Mid-season gear reductions are not likely to significantly reduce the number of whale-trap encounters because effort declines too quickly.
- Whole-season gear reductions could maintain high catch while also reducing the number of entanglements (to levels comparable to zone closures).

Looking ahead

- **July 31 -** Receive industry feedback (please send to Jenn Humberstone)
- **August 15 -** Incorporate industry feedback
- **August 15 -** Test robustness to domoic acid closures
- **August 25 - September 3 -** Entanglement workshop
- **September 30 -** Submit analysis for peer review in a scientific journal

Entanglement Science Workshop

Entanglement Science Workshop Agenda Overview	
Tuesday, Aug 25th 9:00am-1:00pm	➢ CA-OR-WA management frameworks for entanglement risk in the commercial Dungeness crab fishery ➢ Forecasting and monitoring marine species dynamics (Part I)
Thursday, Aug 27th 9:00am-1:00pm	➢ Forecasting and monitoring marine species dynamics (Part II) ➢ Forecasting and monitoring fishing dynamics
Tuesday, Sept 1st 9:00am-11:00am	➢ Entanglement science ➢ Socio-economic considerations
Tuesday, Sept 1st 1:00pm-5:00pm	➢ Special Topic: Overcoming barriers to gear innovations
Thursday, Sept 3rd 9:00am-1:00pm	➢ **Evaluating management strategies** ➢ **Closing discussion**

Register here: https://form.jotform.com/201906789551161

Email for more information: entanglementscience@gmail.com

Guiding questions

1. Are there other management measures that we should evaluate?
2. Are there other performance metrics that we should measure?
3. Are there details about the fishery that we should better understand to even better inform the simulations?

Thank you

Please contact Chris or Jenn with follow-up questions/comments:

Chris Free (UCSB): cfree14@gmail.com
Jenn Humberstone (TNC): jenn.humberstone@tnc.org

Key Themes from 7/27 Industry Outreach Webinar

The next 4 slides highlight key themes heard from participants during the 7/27 webinar.

Participants noted several limitations to the data used to inform the framework, which could affect the ability of the framework to accurately simulate fishery, crab and humpback whale dynamics.

- **Fleet dynamics:** Fish ticket data used to inform simulation of fleet dynamics is often inaccurate. The Project Team noted that clearly erroneous data points (e.g., Dungeness crab fishing south of Pt Conception) can be scrubbed from the final analysis.
- **Humpback whale dynamics**: Forage data are not directly represented in the framework. The Project Team shared that oceanographic conditions are used in the framework to indirectly understand forage distribution due to the spotty nature of forage data. Dr. Karin Forney will be presenting on these details during the Entanglement Science Workshop.
- **Crab resource dynamics:** The Project Team clarified that the framework does not attempt to represent shifts in density of crabs- it assumes that gear is deployed where the crab is (and spatial information on fishing effort is informed by fish ticket data).
- **Accounting for trends for key data:** It is important to consider how trends for different data inputs may affect results over time (i.e., Humpback whale populations are increasing, but total traps fished can not increase).

7/27 Key Themes - continued

Participants noted further considerations around assumptions and data limitations, with a discussion around what we can do to address data limitations, and what we can learn about data priorities from this body of work.

- **Encounters and entanglements**: Suggestions to not use years of anomalous conditions and years prior to the implementation of best fishing practices since it may result in an overestimation of probability of entanglement and estimated number of encounters. The Project Team commented that rather than taking an average of entanglements over the last five seasons, more recent seasons could be used to ensure the model reflects any impacts of industry best practices.
- **Evaluating Data Limitations:** Participants commented that this work shows that there are important data gaps to fill to support management of this issue.
    - The Project Team explained that to help address data limitations and uncertainty, analyses can be conducted to evaluate how sensitive results are to data limitations and assumptions. This sensitivity analysis can help identify priority data needs to inform management decisions.
    - Further, because all management approaches are evaluated using the same inputs, data limitations are constant across management approaches tested allowing an assessment of performance of the different management approaches compared to one another (see slides 14-15).

7/27 Key Themes- continued

Participants provided feedback on the performance metrics used to evaluate management strategy outcomes [slide 25]:

- **Encounters/Entanglements:** Participants noted that management could be designed with the objective of reducing the number of whale:gear encounters rather than focusing on entanglements given how difficult they are to predict (e.g., vertical line reduction, gear reduction, or pingers).
- **Economic Metrics:** Total catch will underestimate economic impacts since it does not capture differences in the price of crab throughout the season, differences in economic impacts between ports based on other available fishing opportunities, and downstream impacts (e.g., loss of local markets when a fishing zone shuts down). The inclusion of fishing opportunity (in fishing weeks) was appreciated as a metric important to smaller vessels that depend on a longer fishing season.

7/27 Key Themes- continued

Participants provided perspectives on differences in socio-economic impacts and enforceability of gear reductions vs closures, and advise on future communications regarding this project.

- **Gear reductions vs closures:** Gear reduction seems to have the most potential for equitable implementation. If there was a need for an early season gear reduction, reversal of that reduction in the spring would be an important consideration due to low CPUE. Area closures are a concern because they will result in effort shifts and would have greater impacts on vessels who can't travel. Additionally, loss of time on the water has disproportionate impacts to those who depend on the full fishing season for income. Enforcement cost and feasibility are also important considerations for any management measure. Gear reduction seems simpler to enforce.
- **Other Management Options:** There are some limitations to management approaches that can be tested with this framework. Depth restrictions cannot be evaluated because the scale of fishing effort data - based on reporting at the fishing block level- is too broad
- **Communicating this project and results:** Despite the data caveats, the project provides a useful tool. It will be important to carefully communicate what the MSE tells us and what it cannot tell us. The project will also be important in highlighting priority data gaps.