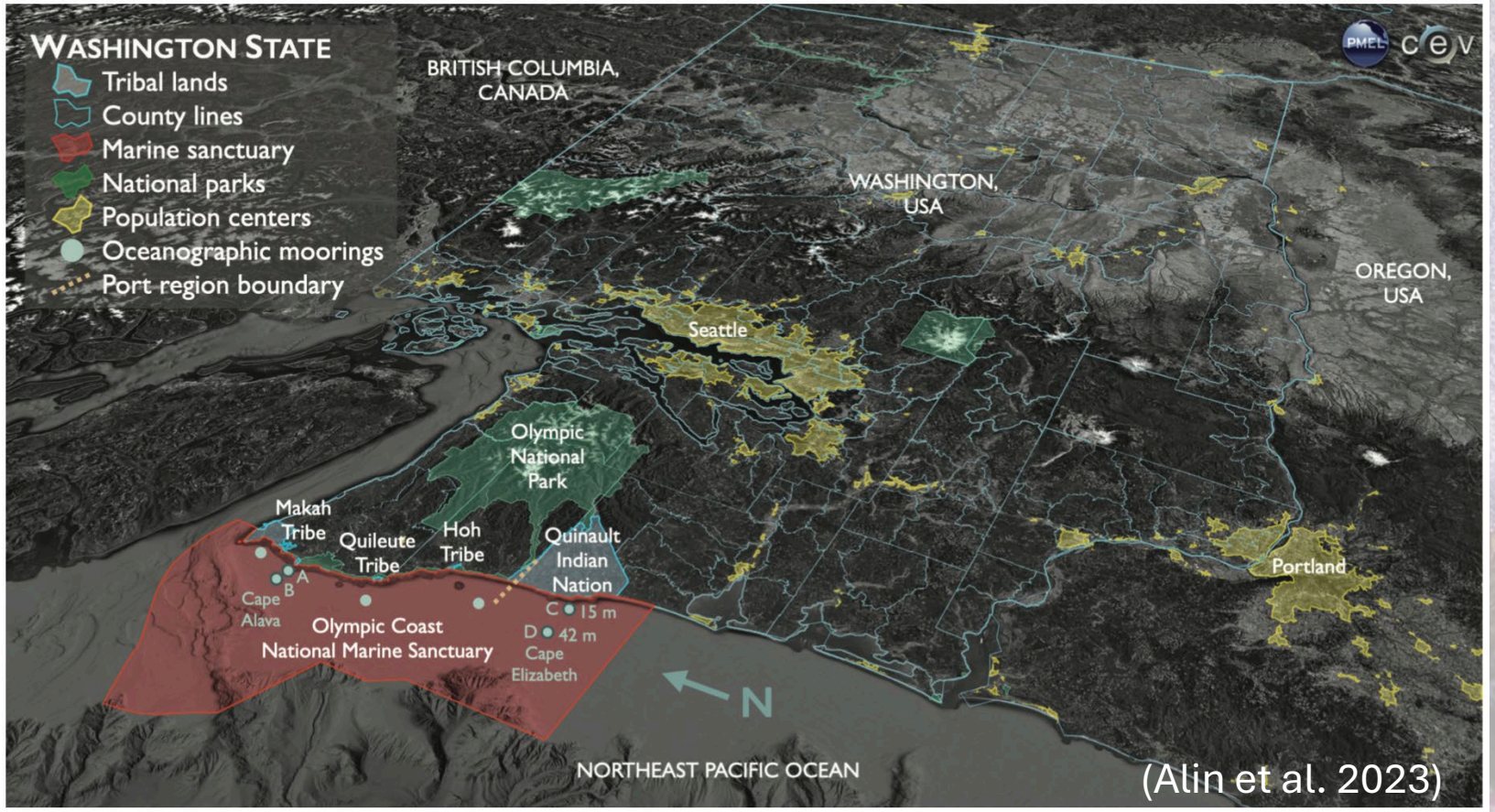
Developing a Dungeness crab (*Metacarcinus magister*) meat quality forecasting management tool

Lara Navarrete J., Siedlecki S., Kaplan IC., Norton EL., Soares F., Corbet K., Buell TV., Vestfals C., Ayres D., George M., Biggs CR., Schumacker J., Hermann AJ., Newton J., Alin SR., & Matassa C.

Dungeness crab is economically important, and the fishery can't open until meat quality is ready.



The 2024/25 season landings brought in $83M (WA) and $96M (OR)

In Washington State the fishery is co-managed between the states and the tribes.

Tribal fisheries are started before non-tribal fisheries, to ensure that tribes have treaty right access to 50% of the catch in their usual and accustomed fishing areas.

Forecasting the opening of the season can improve this 'headstart' date for the tribal fishery.

Implications of opening early include a shorter test fishery for the managers (less resources) and co-management implications.

Environmental conditions impact crabs in the region, making co-management around opening day a challenge.

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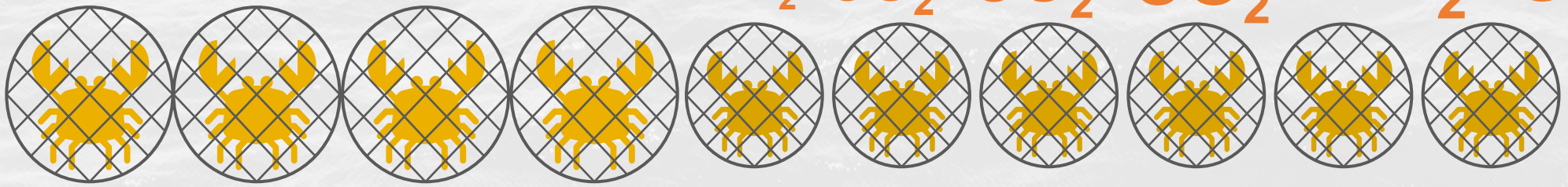


Managers start testing to decide opening day

J-SCOPE **April Forecast**

J-SCOPE **September Forecast**

Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov

Pre-molt

Molting

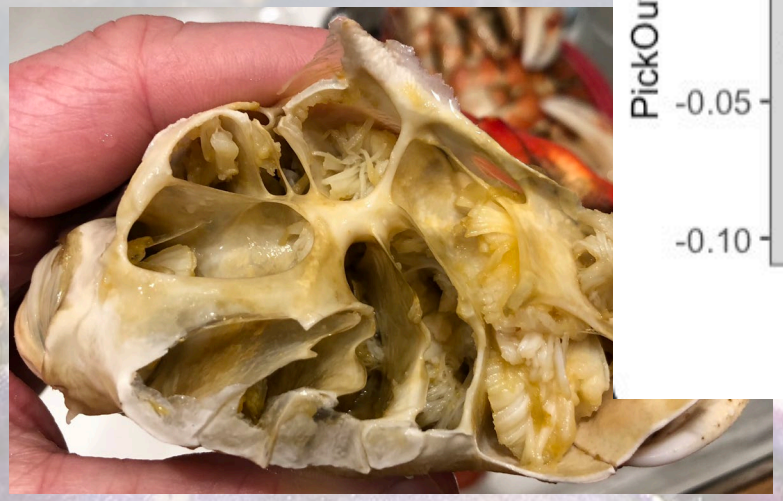
Soft-shell stage

Intermolt

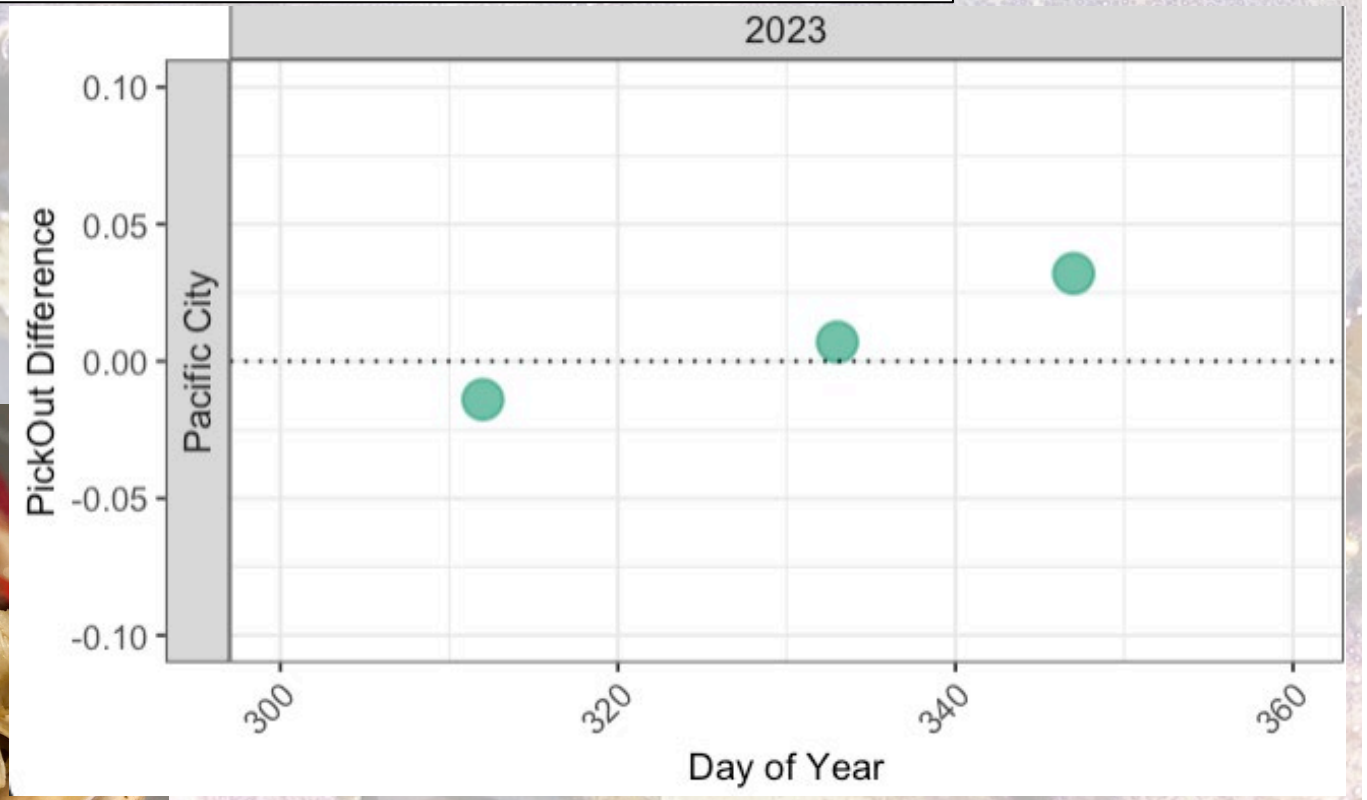
Meat quality determines opening day

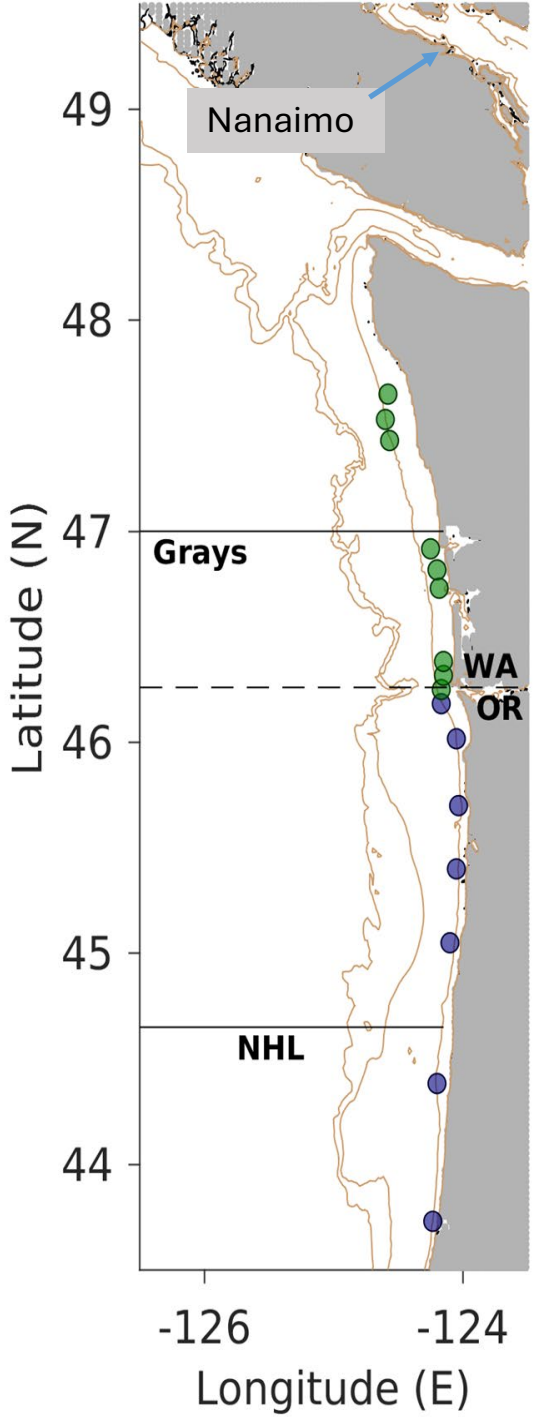
$$\text{Pickout rate} = \frac{\text{packed weight (i.e., picked out meat including tips)}}{\text{boat weight (i.e., the weight of the entire crab)}}$$

> 0.24 for the fishery to open



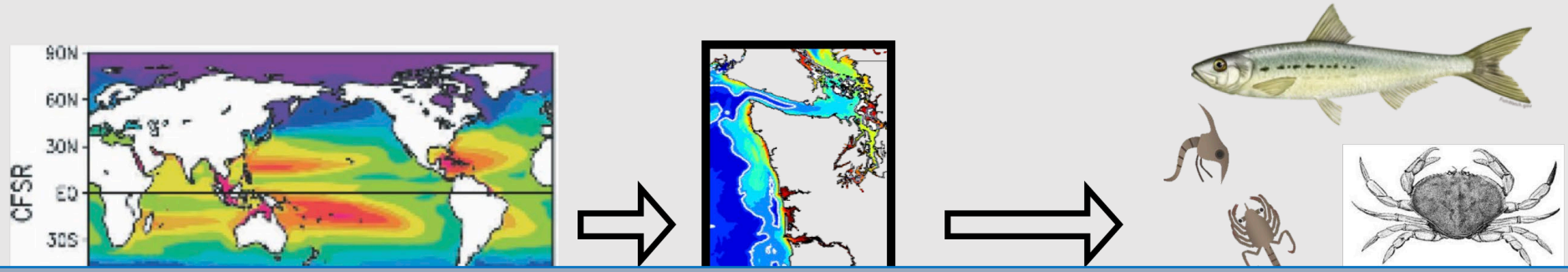
Credit: Simone Alin





Develop a management tool, e.g., a meat quality forecast, that may help improve sampling efficiency and give an estimate for the season opening timeline

Building a forecast system: J-SCOPE



J-SCOPE produces 6–9-month seasonal forecasts - We just delivered our 12th January forecast. Applied to sardine and hake, and now we have found a decision point for crabs

~200 km atmospheric resolution
~50 km ocean resolution

~1.5 km resolution
Physics and biogeochemistry (temperature, salinity, chlorophyll, nitrate, oxygen, pH, aragonite saturation state)
http://faculty.washington.edu/pmacc/cmg/cmg.html; Siedlecki et al. 2016

Sardine (Kaplan et al., 2016)
Hake (Malick et al. 2020)
Juvenile crab (Norton et al. 2020)
Adult crab (Norton et al. 2023)

J-SCOPE

Oceanographic conditions hypothesized to influence meat quality

Temperature

MQ decreases, narrow thermal preferences
(Curtis & McGraw, 2012; Robertson et al., 2002)



Oxygen

MQ varies, they move to shallower waters
(Froehlich et al., 2014: Roegner et al., 2011)

Ocean Acidification

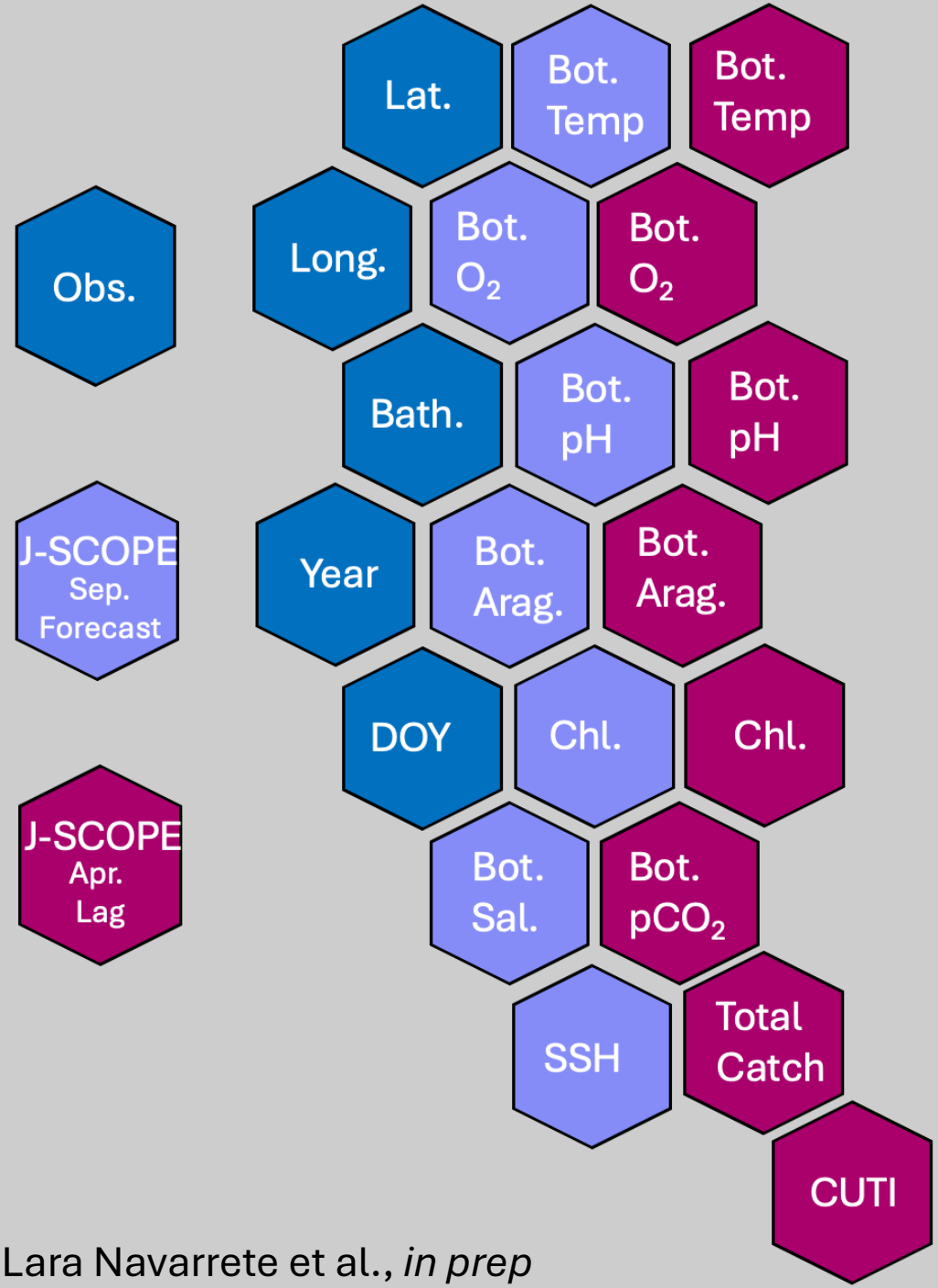
pCO_2

MQ decreases, OA puts a strain in physiology
(Durant et al., 2022; McElhany et al., 2025; Pane & Barry, 2007)

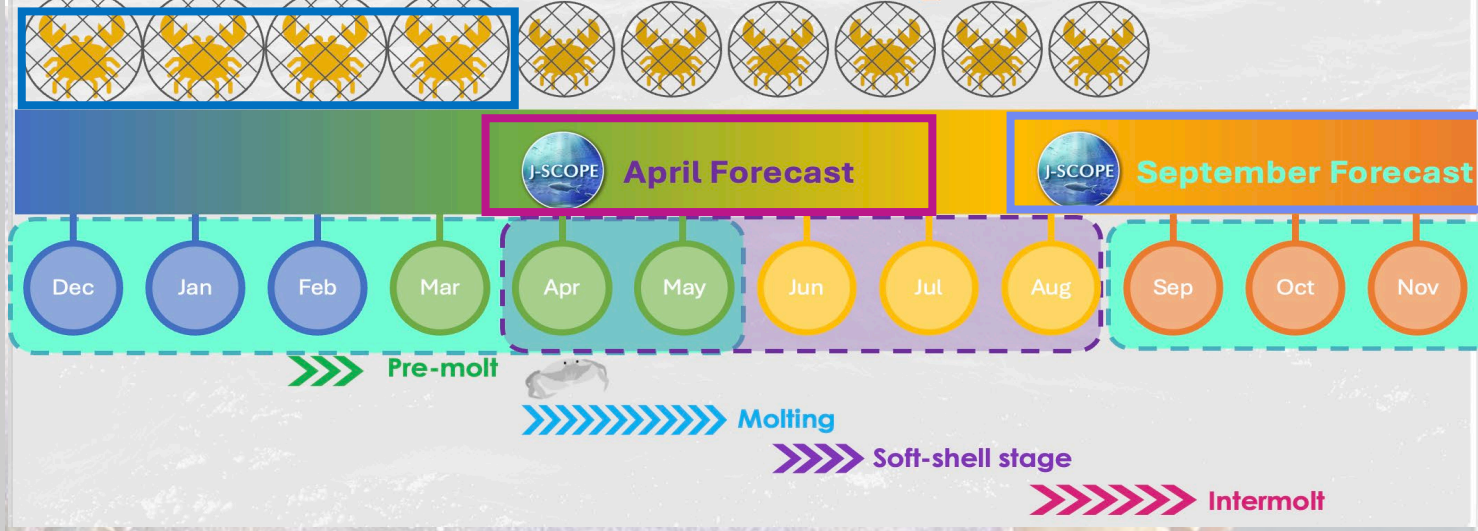
Primary Production

MQ varies, response to food availability

Lara Navarrete et al., *in prep*



Lara Navarrete et al., *in prep*



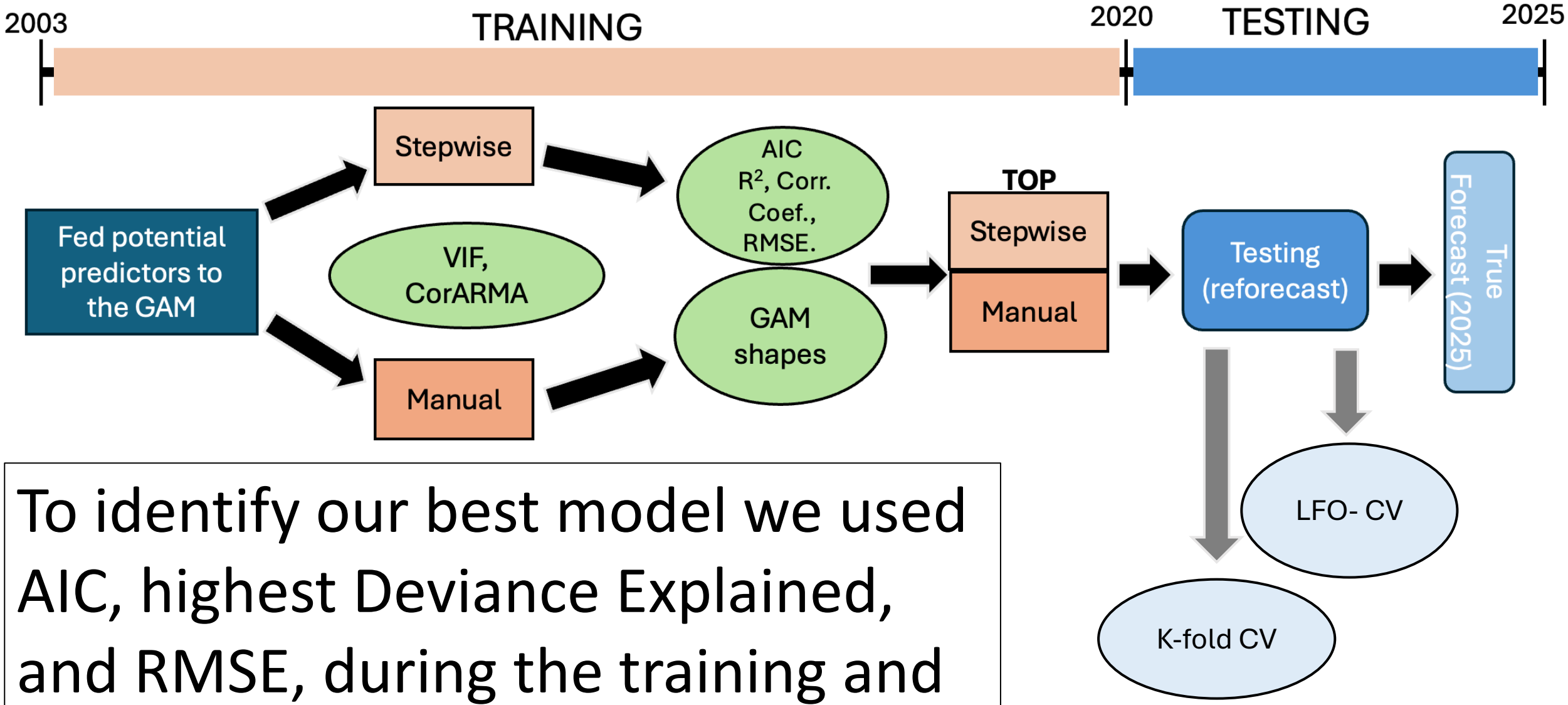
To build the statistical model we started with the static variables

We add on the ocean conditions (dynamic variables) that are biologically relevant

We added lagged variables to consider conditions from the prior upwelling season

*Managers suggest predictors as part of the co-design process

Model selection



To identify our best model we used AIC, highest Deviance Explained, and RMSE, during the training and testing periods.

Lara Navarrete et al., *in prep*

We found a model that is able to predict ~73% of the deviance in Dungeness crab meat quality (MQ)

Model	AIC	Training		Testing		Predictors
		Deviance Explained	**RMSE**	**Deviance Explained**	**RMSE**	
Manual	-1134.84	72.8%	0.014	24.4%	0.036	Lat, Temperature, Oxygen, Oxygen lagged, Total Catch, CUTI, DoY, Year

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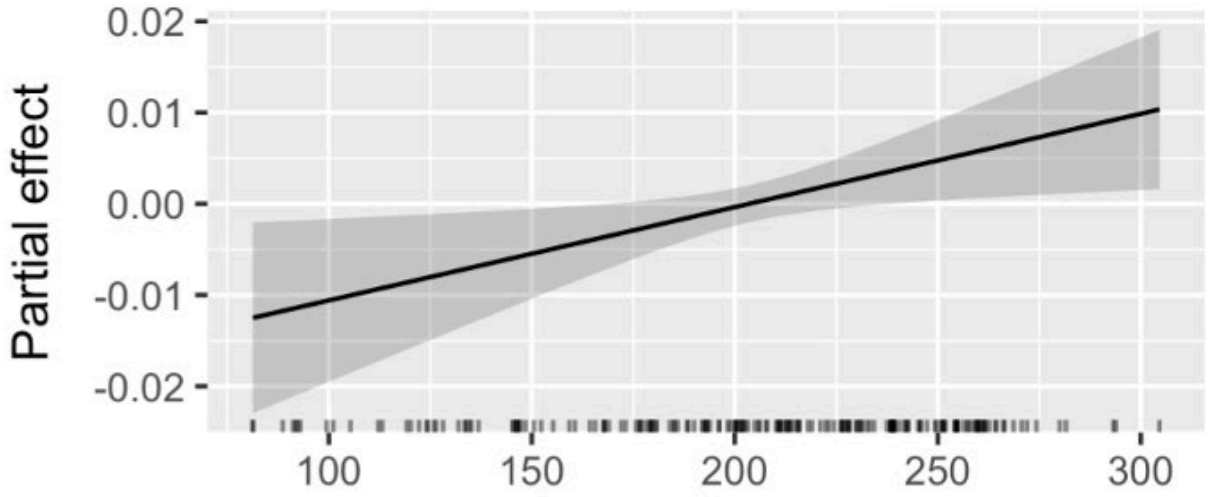
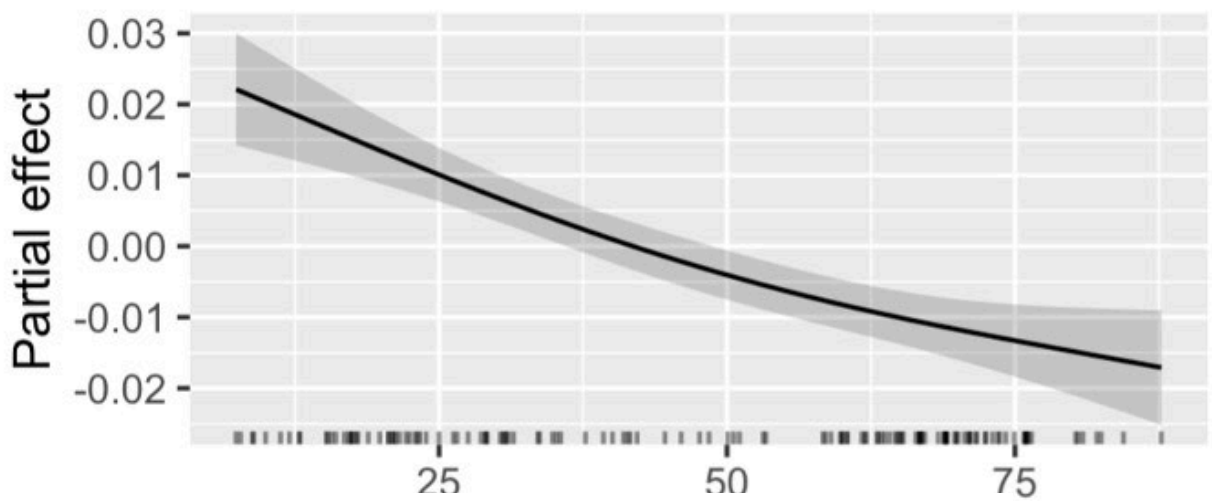
JSCOPE oceanographic variables explain 7% of that deviance, O_2 during the upwelling season adds 6.2%

Two different ways O_2 influences MQ: metabolic growth in fall and plenty of food in a compressed habitat in summer

O_2 in the fall (current season)



O_2 during summer (upwelling season)



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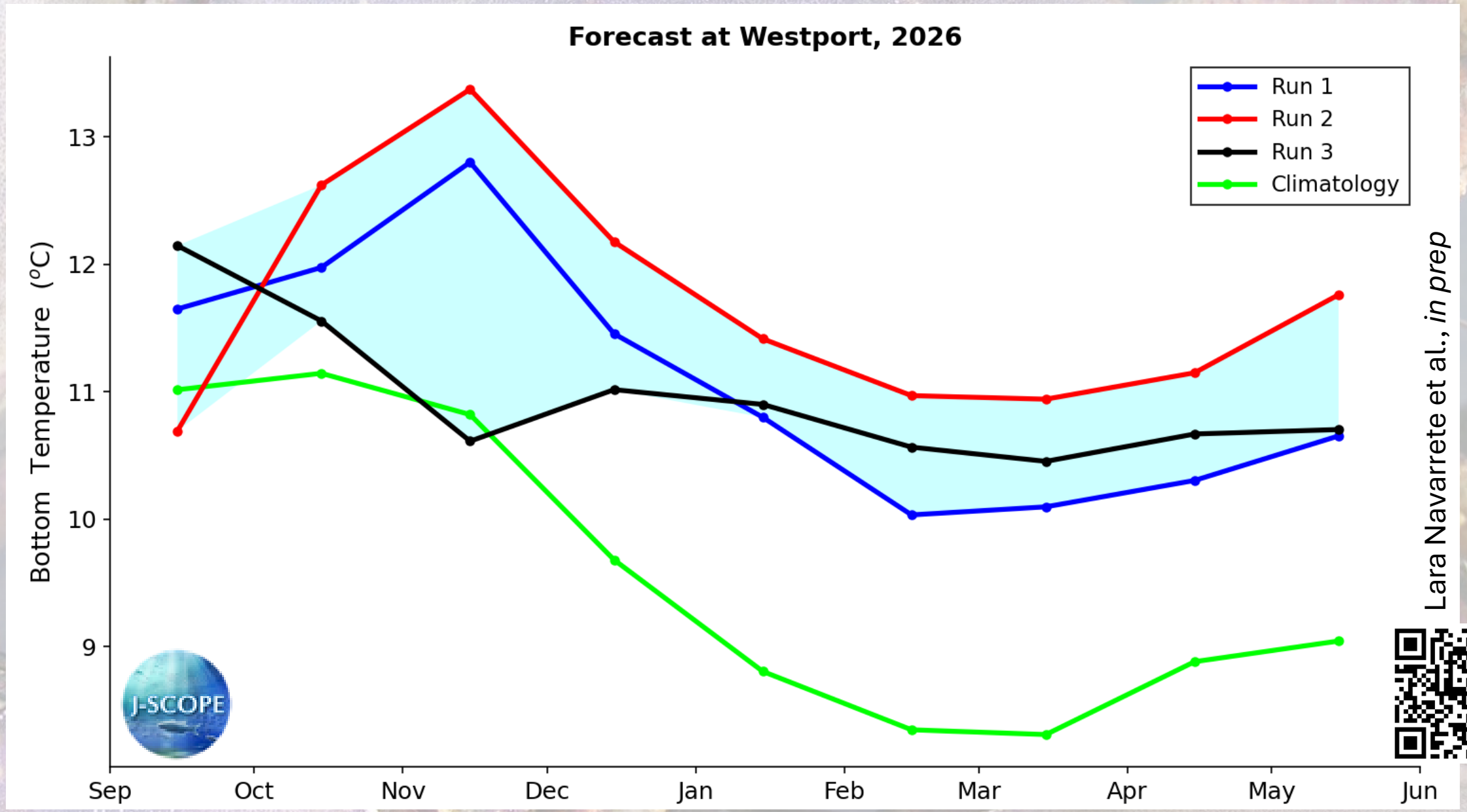
BT forecasted to be anomalously warm this fall – El Niño



Co–Designed True Forecast 2025-26

A true forecast means we delivered it before the testing started

Co-design led us to provide the forecast at each site, forecast a particular day of year, and uncertainty measures

There is a spatial trend going from north to south, in the model and the climatology.

In the southern sites, the re-forecasts are biased the most (late).

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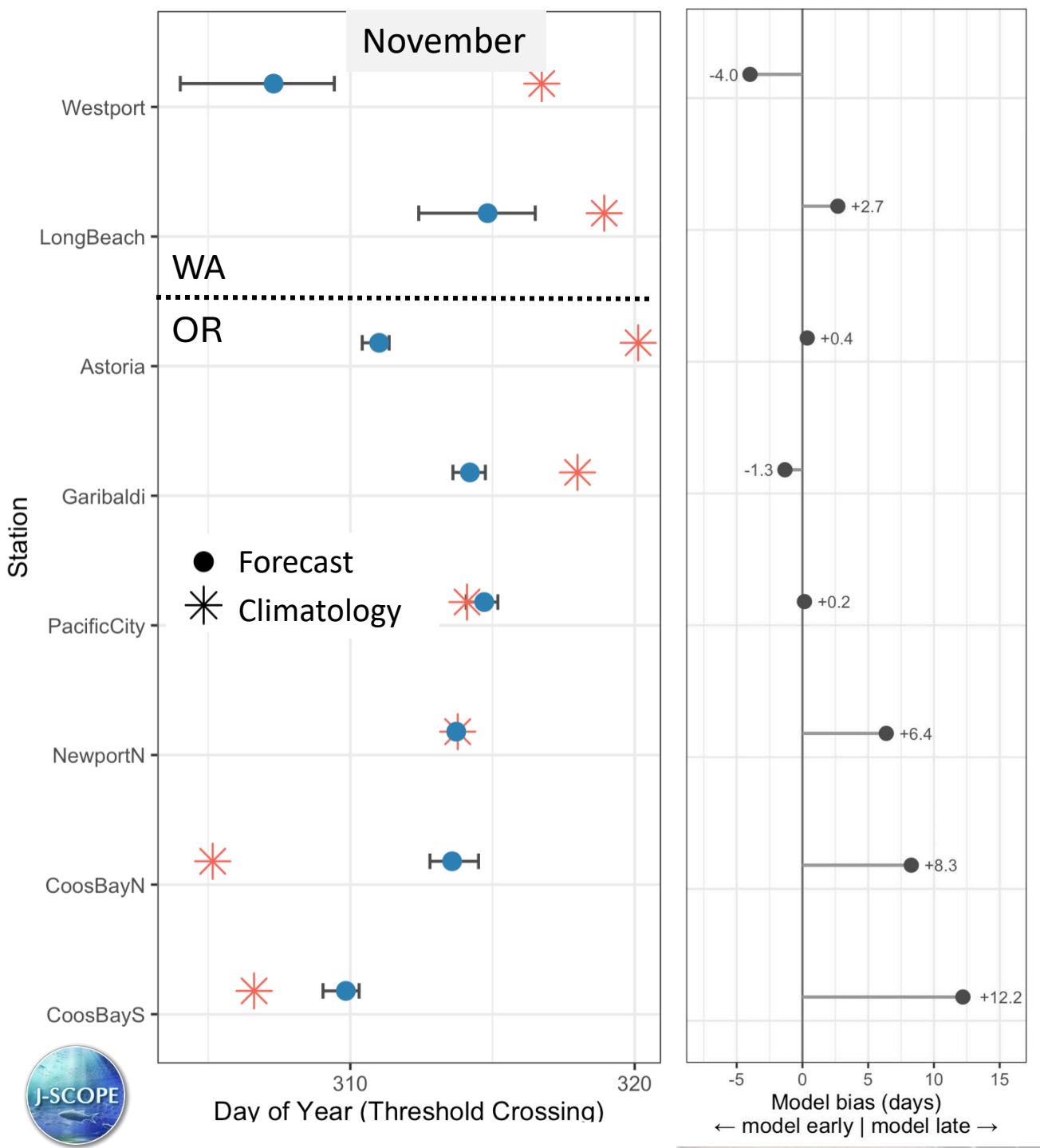
Error bars = ensemble mean + earliest/latest DoY

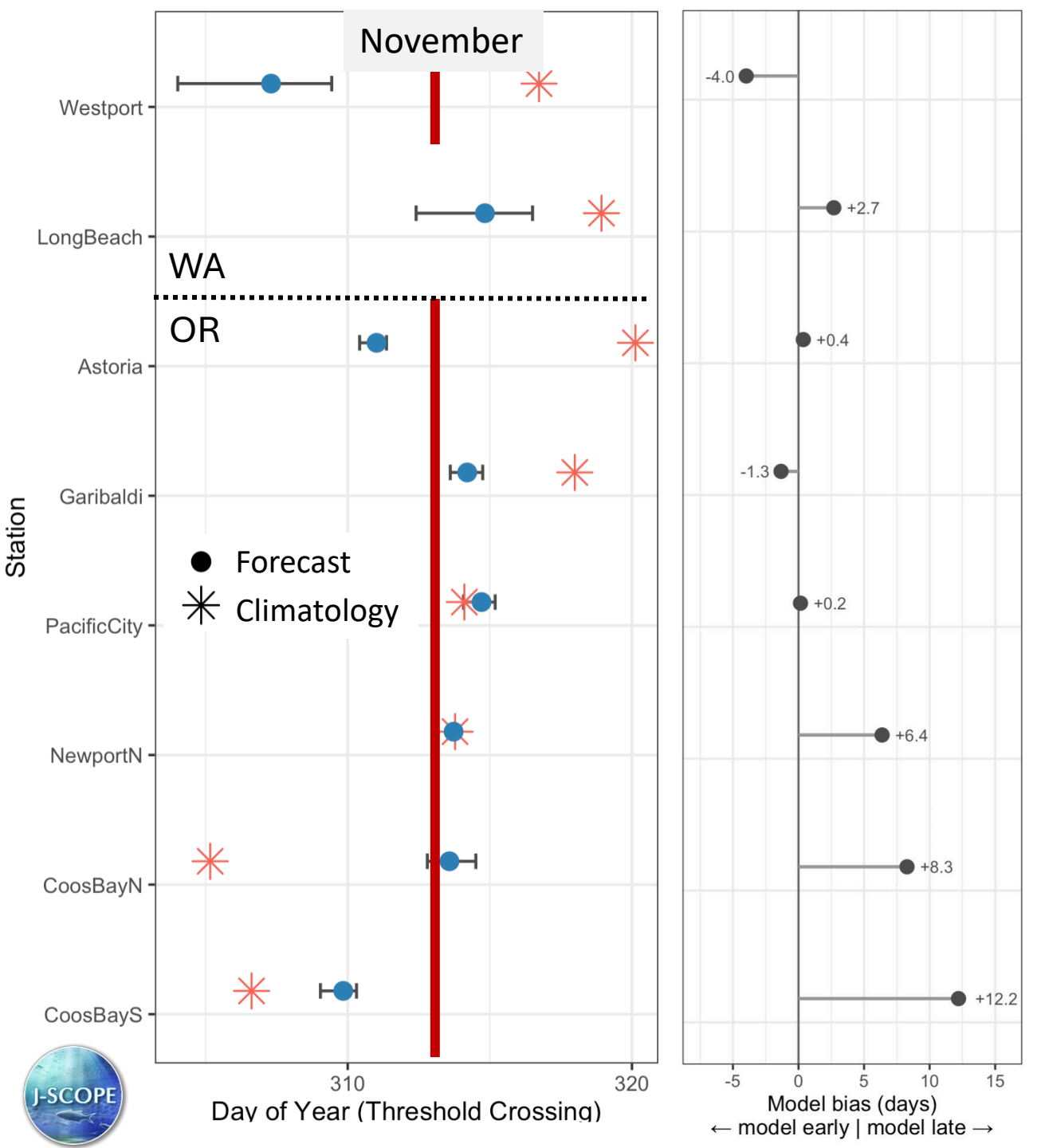


Co–Designed True Forecast 2025-26

All sites in OR and Westport were over the MQ threshold (0.23) by the Nov 9th test.

Long Beach crossed the threshold a month later (12/13). Which held back the opening until Dec 15th .

Tribes opened first and it was earlier than previous years.



Error bars = ensemble mean + earliest/latest DoY

Lara Navarrete et al., *in prep*

Key Takeaways

- A decision point that can be informed by seasonal forecasts has been identified – meat quality to support the opening of this co-managed fishery
- The MQ model performs well, which has allowed us to deliver our forecast as a soft launch to managers only (2025-26 and 2026-27).
- Manager input has been invaluable to improving the model by providing data, hypotheses for potential predictors and shaping how the results are communicated – building trust in the forecast
- O_2 during the upwelling season is a significant predictor of MQ; higher O2 in autumn promotes meat quality, but higher O2 in upwelling season does not.
- We are still exploring potential predictors, come talk to me if you have an ideas!

QUESTIONS?



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