US West Coast *Pandalus jordani* Fishery

Zach Forster

WDFW, Coastal Shellfish Biologist

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Washington Department of FISH & WILDLIFE

ICWPF
INTERNATIONAL COLDWATER PRAWN FORUM

What we will cover

1. Fishery Introduction
2. Management
3. Fishery Sustainability
4. Environmental Drivers
5. Catch Modeling

Introduction

Species

Pink shrimp (*Pandalus jordani*)

- Range: Alaska to California
  - Depths of 40-150 fathoms
  - Inhabit mud or muddy sand bottoms
  - Short lived species, 3 years

Fishery Description

Offshore US West Coast: WA, OR, CA

- Season: April-October
- Trawl caught by double rigged vessels
- Landings: 59M Pounds (10 yr avg)
- MSC Certified Sustainable



WA Commercial Pink Shrimp Percent Catch by Area, 2023-25

Information Highlight

Annual Newsletters

- General fishery information
- Harvest Trends
  - Landings/ex-vessel value
  - Catch per unit effort (CPUE)
  - Catch distribution
- Biological and stock status
  - Age composition
- Gear innovation and bycatch mitigation
  - History of actions
  - New research
- Environmental outlooks and season forecasts
  - ENSO forecast
  - Environmental and biological catch models



Current Management

State managed, subject to federal restrictions under the Pacific States Management Council (PFMC) Fishery Management Plan including:

- Groundfish limits
- Essential fish habitat (EFH)
- Vessel Monitoring System (VMS) requirements

State Management Structure

- Departments of Fish and Wildlife (WDFW, ODFW, CDFW)
  - Primary agencies oversee daily management, research and enforcement
    - Logbook programs
    - Biological Sampling
    - Coordination between states
  - Guided by State Fishery Management Plans (FMP's)
    - Focus on fishery sustainability
- Respective States Fish and Wildlife Commissions
  - Legislative authority to adopt regulations including:
    - Season, size, area and gear
    - Permits and licenses
    - Sale and transport of shellfish

PINK SHRIMP MANAGEMENT HISTORY

1952 TO 2026

1952-57
FISHERY ESTABLISHED

STATE MANAGEMENT
Seasons, gear, logbooks, catch quotas, incidental catch limits, licenses

1981
ODFW FISHERY RESEARCH Program Established

PFMC REFER MANAGEMENT TO STATES
OR,WA,CA

OR,WA,CA; SEASON AND SIZE REGUALTIONS
April 1- October 31, 160/LB

1982

1994
WA ADOPTS NEW RULES
LIMITED ENTRY, MINIMUM CODEND MESH SIZE

FISHERY RESEARCH

VOLUNTARY USE OF EXCLUDERS

1998

2003
MANDATORY BRD's
Finfish excluder 2-inch max

VOLUANTARY VMS

2004

2006
NMFS DESIGNATES EFH & HAPC's

MANDATORY VMS

2008

WA OPS PERMIT, MANDATORY OBSERVERS

2010
ESA listing of Eulachon

2011
WA Logbook Reinstated

EXCLUDER ADJUSTMENT
Rigid panel .75-inch max

2012

2015 Biological sampling program reestablished

2015 Voluntary LED use

2018
OR, WA- FMP's, ESTABLISH HCR'S MANDATORY LED USE

NMFS Drops Observer Coverage

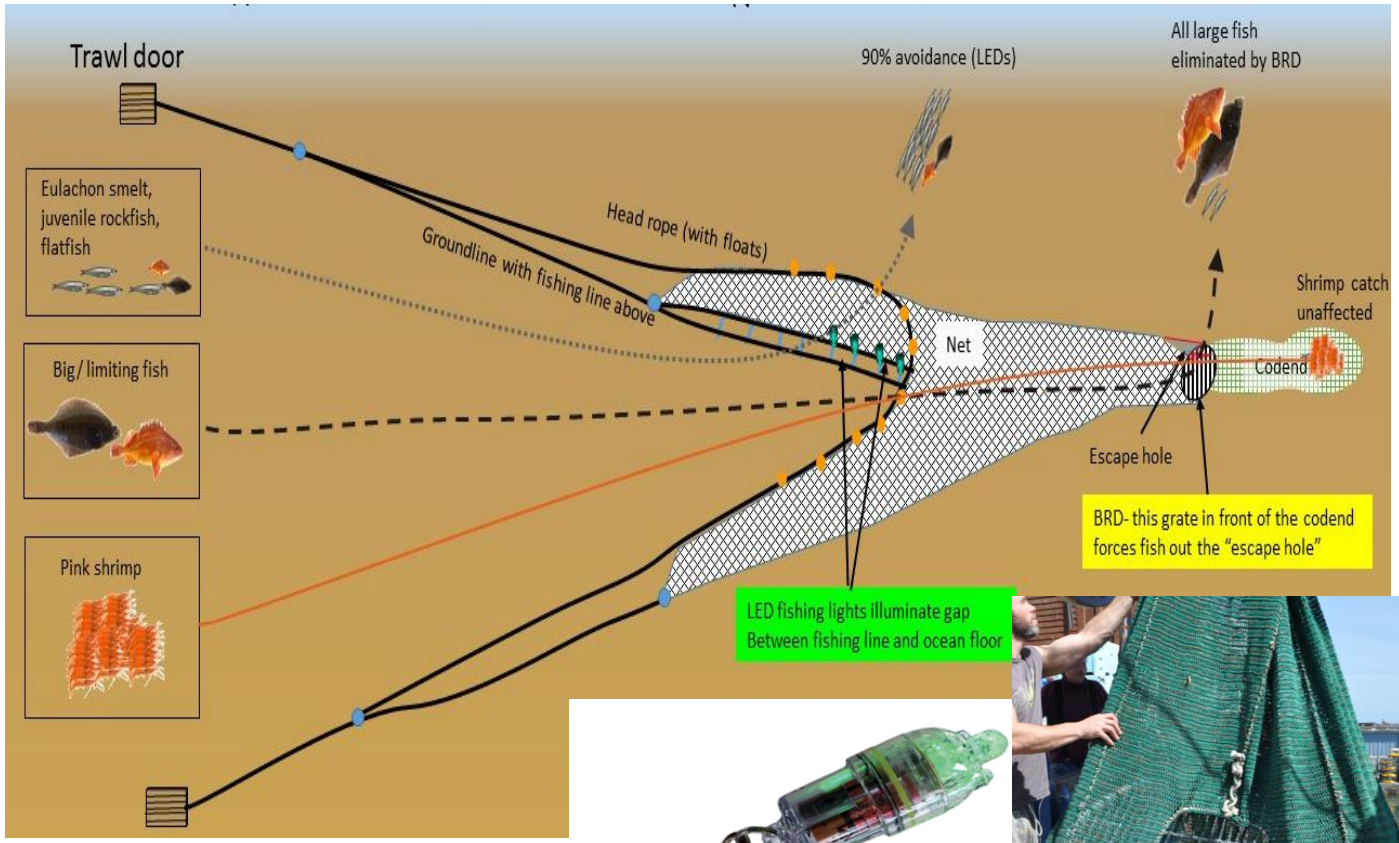
FMP's Up for Review

2026 TO PRESENT

Fishery Milestones

Bycatch Reduction Devices (BRD's)

- Ridged grate fish excluders (2003)
  - Installed in front of the cod end to fish to escape
  - 0.75-inch maximum bar spacing
  - Escape hole at least 100 sq inches
  - Reduces time sorting bycatch while maintaining production
- LED lights (2018)
  - Installed on groundline
  - Minimum of 5 approved lighting devices
  - Spaced four feet apart in the center 16 feet of the net





Sustainability

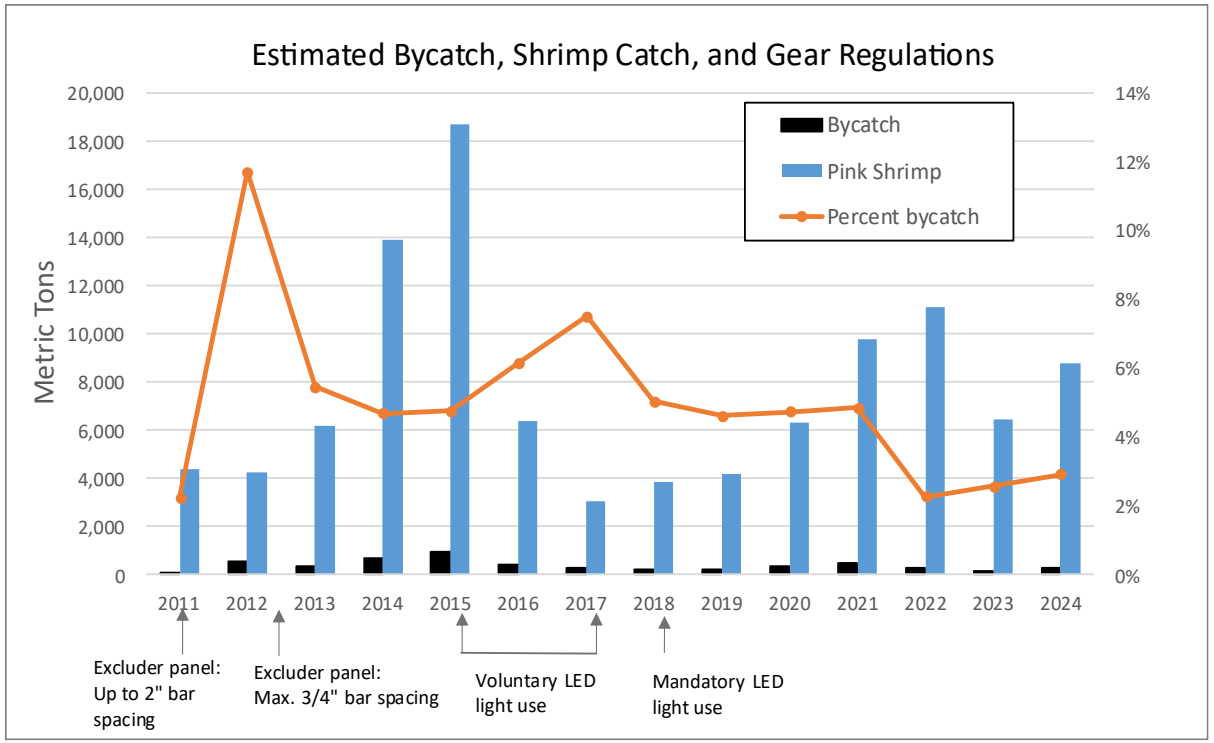
Fishery Interactions

On Board Observer Data

- Consistent across years
- <5% non-target catch
- No documented bird/marine mammal mortalities or serious injuries



BRDs WORK!



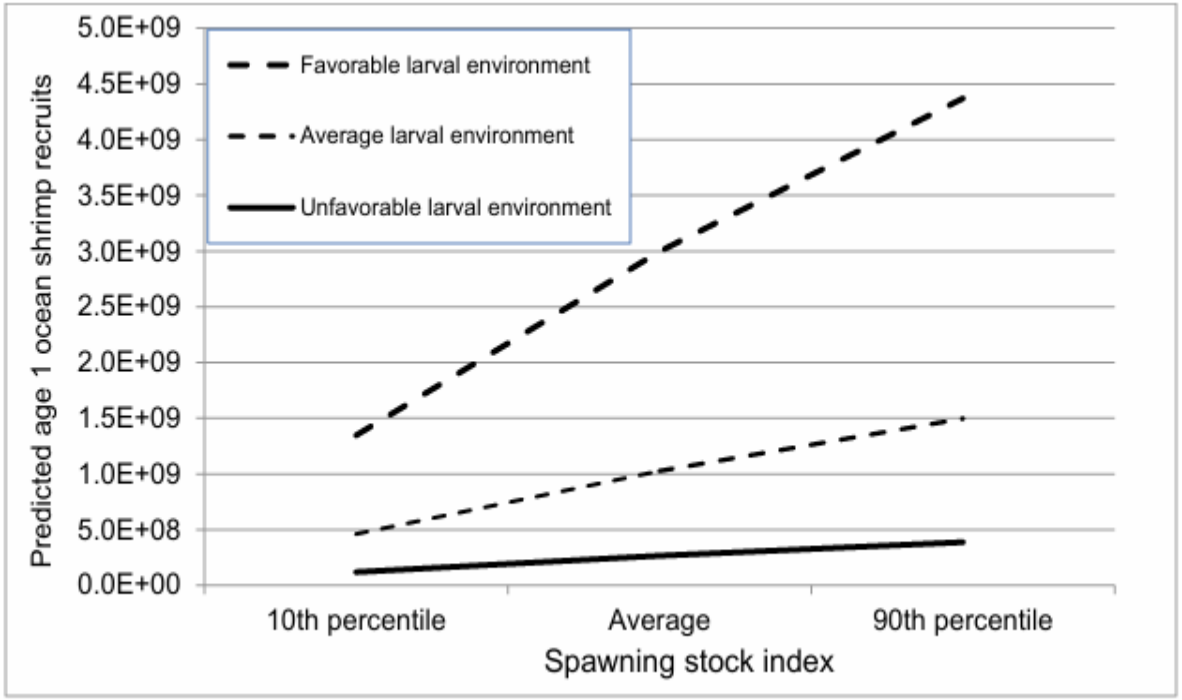
Sustainability

Shrimp Ecology

- Short lived species
- Recruitment driven population

Research to support current management:

"Results remain consistent with the characterization of recruitment in ocean shrimp as being primarily **driven by environmental conditions** during the pelagic larval phase and **not strongly influenced by fishery harvest.**" *(Scott D. Groth, Robert W. Hannah- ODFW Information Report)*



Predicted southern Oregon age 1 ocean shrimp recruitment using Log southern spawner index (t-2), April-Jan SLH (t-1), April-July Upwelling index at 42 ° N. Lat. *(Scott D. Groth, Robert W. Hannah- ODFW Information Report)*

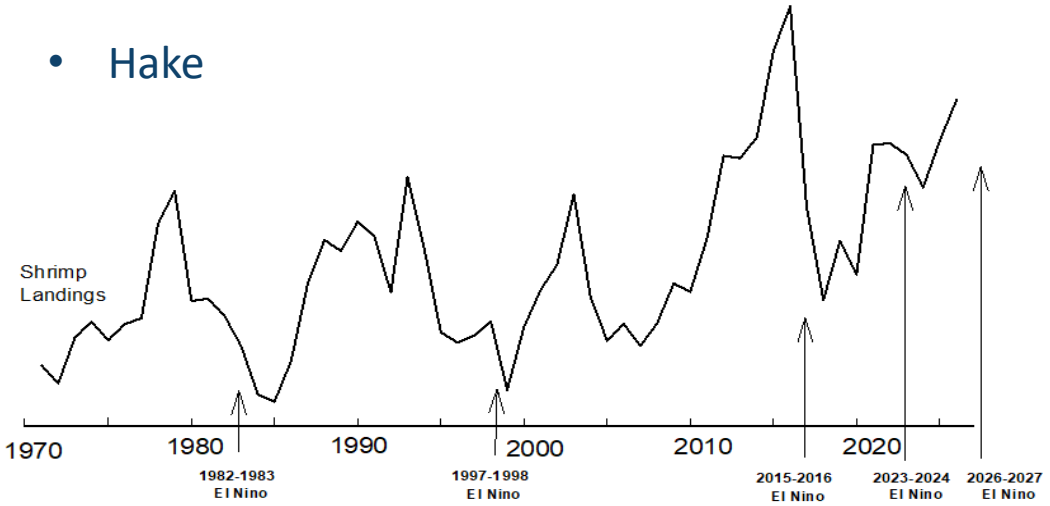
Environmental Conditions

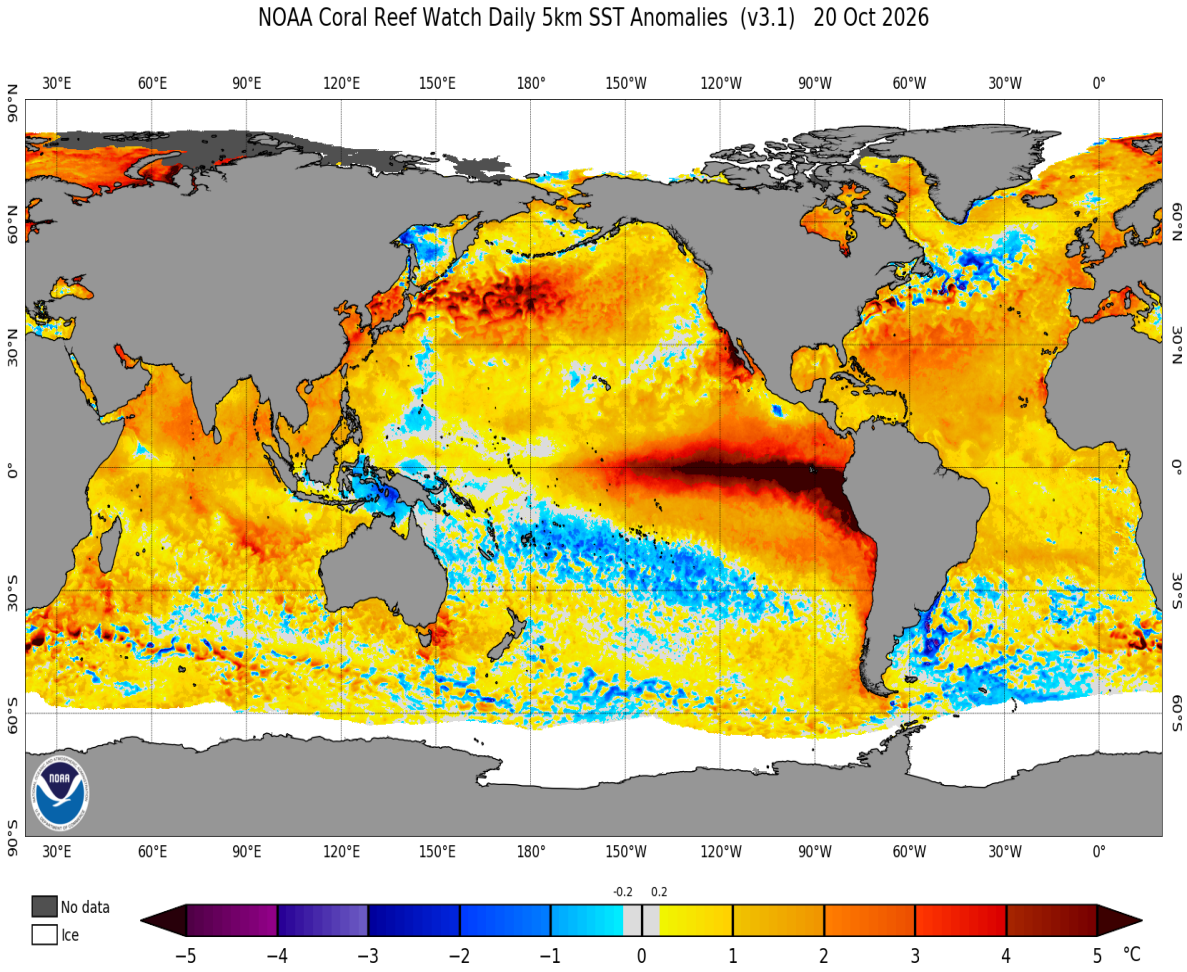
Sea Level Height at Crescent City California

- Warm waters expand increasing sea height
  - ENSO (El Nino/La Nina)
- Strength and timing of upwelling
  - Spring Transition

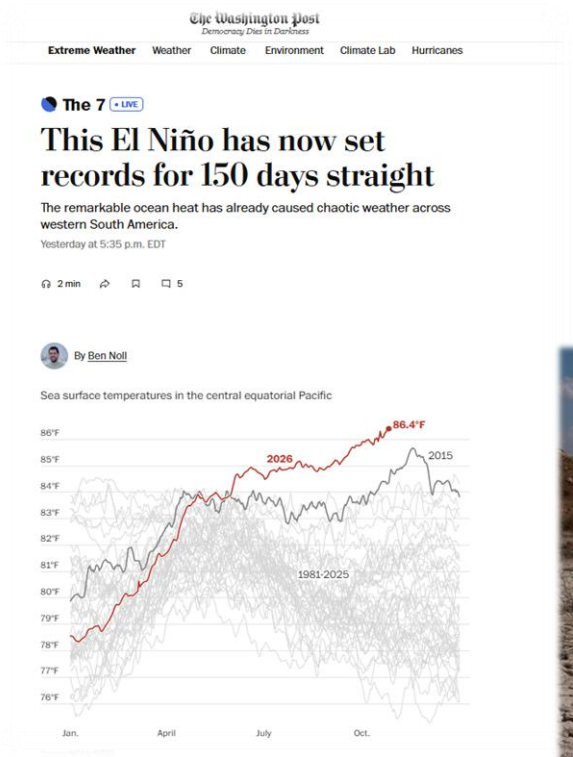
Predation

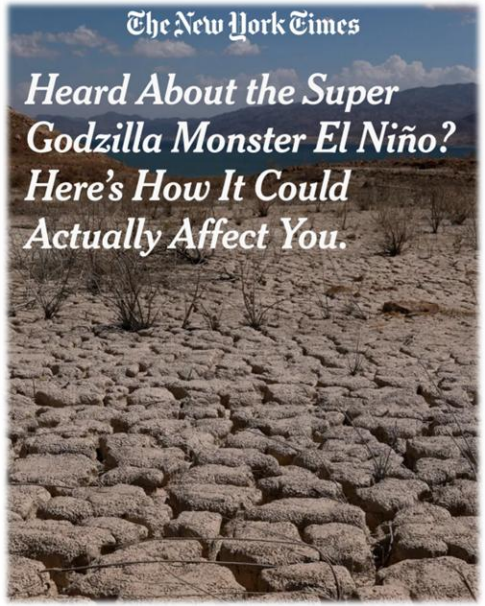
- Hake

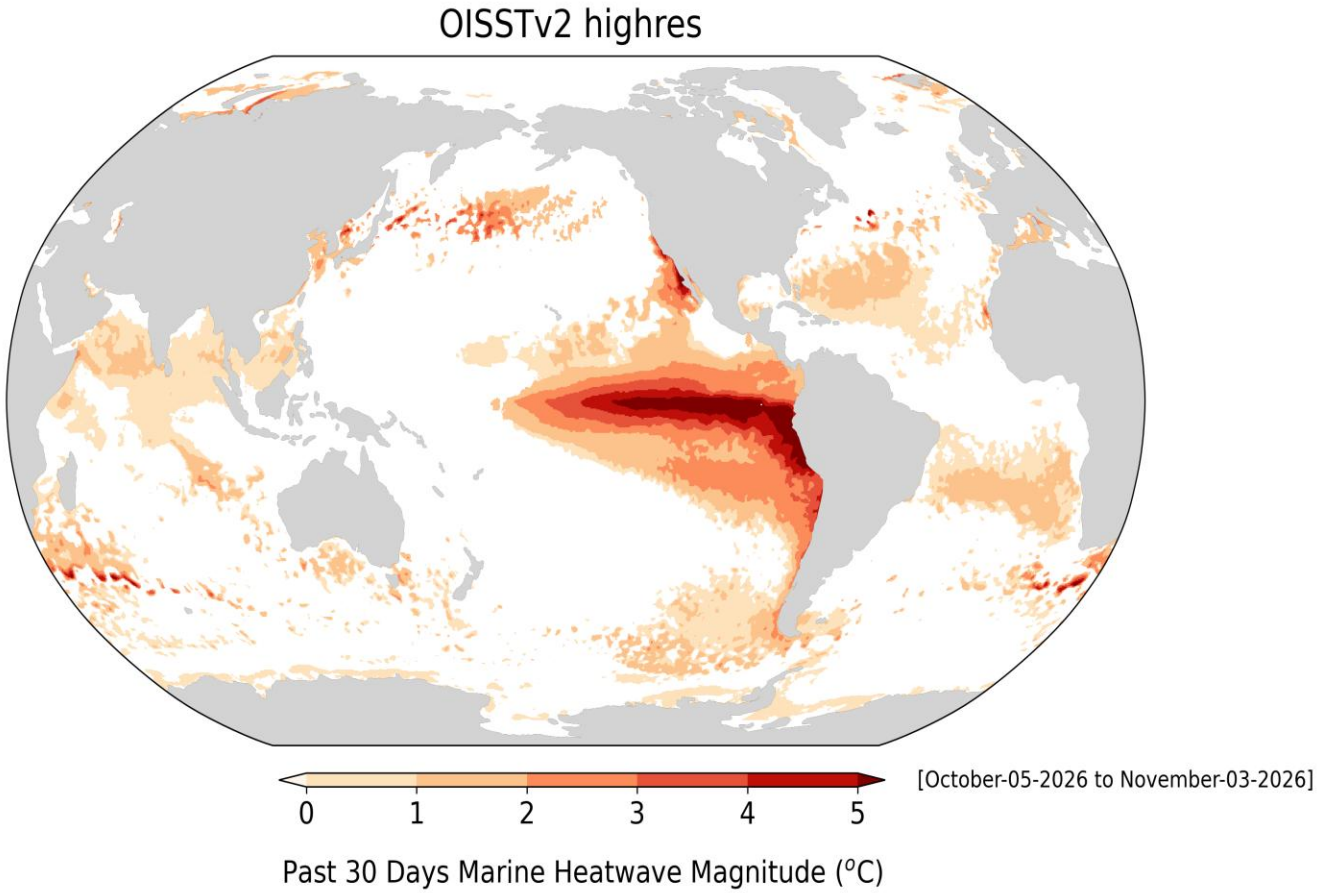




Environmental Outlook



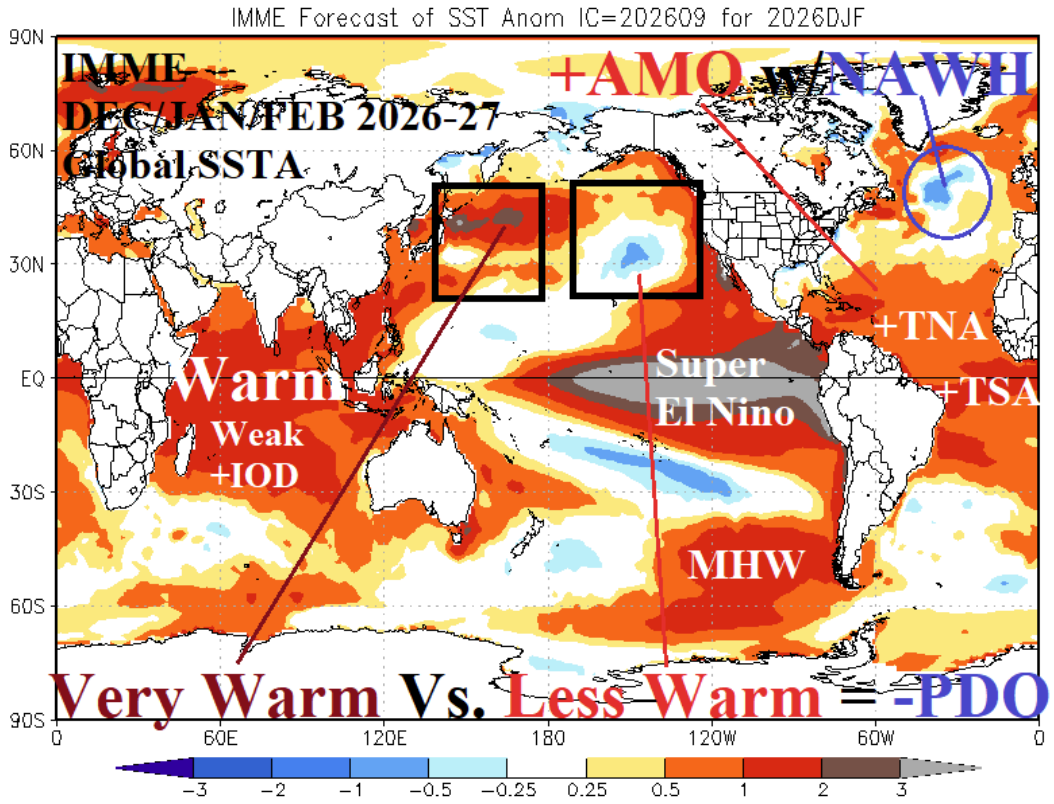


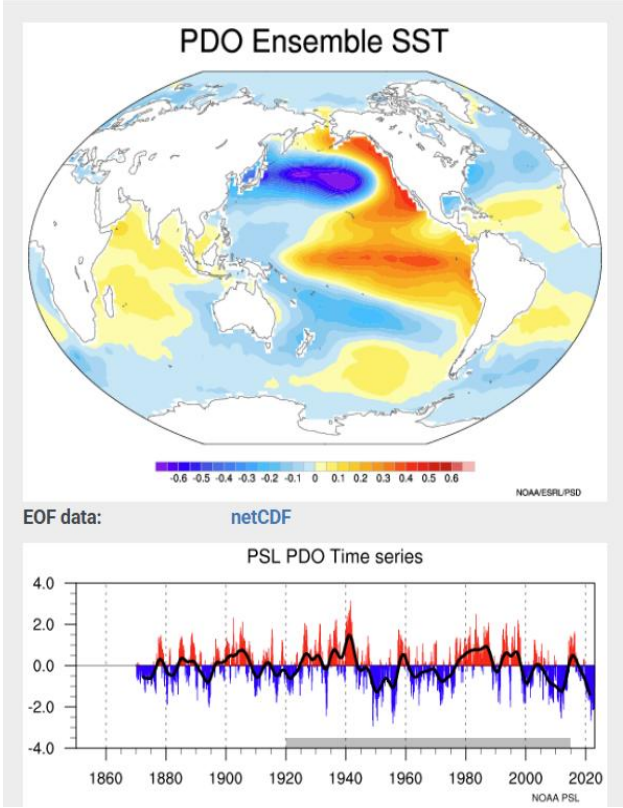


Environmental Outlook- Not All Bad?

Pacific Decadal Oscillation (PDO)

- Tracks sea surface temperate anomalies and atmospheric pressure in the North Pacific Ocean
- Broader, long-term climate pattern that interacts with shorter ENSO states
- Research linking Coho Salmon abundance:
  - Forage- Copepod richness
  - Predation- Hake
  - Recruitment and Survival





climateimpactcompany.com

Regional Buffering?

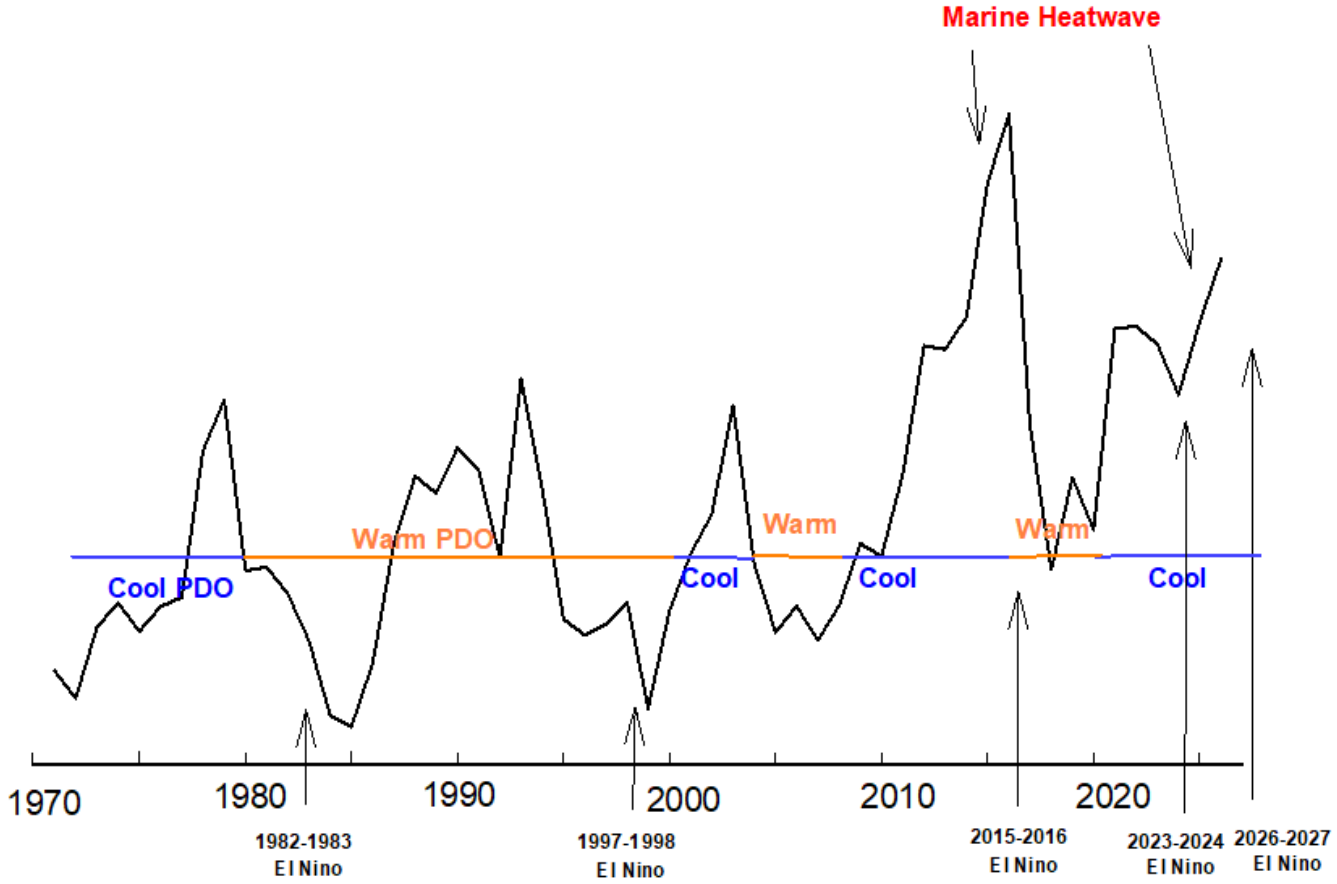
PDO remains firmly negative (cool)

- Currently in an out-of-phase year PDO negative, Ocean Nino Index (ONI) is warm (El Nino)
- Will the cool waters in the North Pacific buffer transport of warm equatorial waters?

Marine Heatwaves

- Large marine heatwaves have occurred each of the last seven years (2019 - 2025)

"current MHW off California has somewhat "preconditioned" the region with above-average water temperatures before we encounter additional warming this fall due to El Niño, the two features may ***not necessarily be additive****."*
(integratedecosystemassessment.noaa.gov)



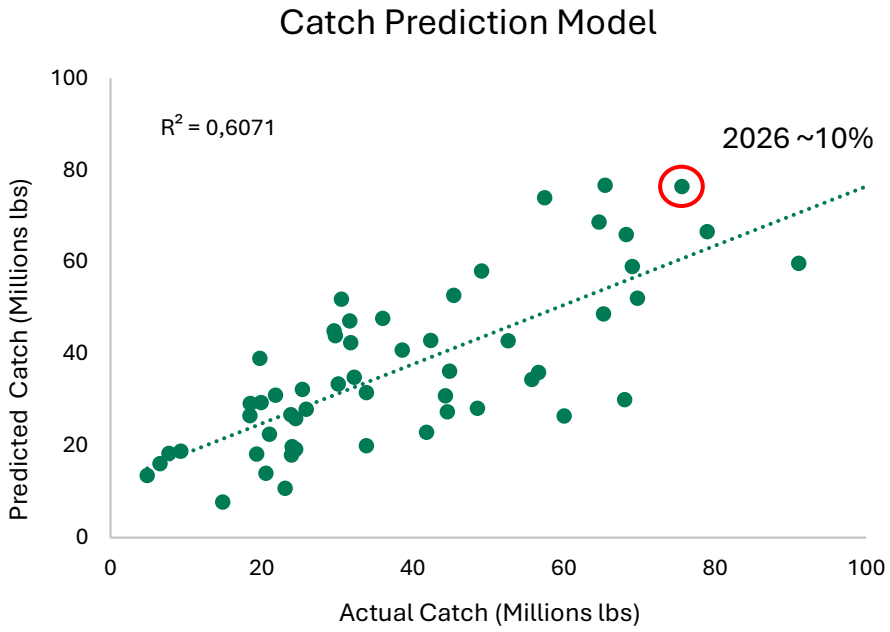
Can we build a catch model to capture these environmental conditions?



Photo credit: ChatGPT

Catch Prediction Model

- Multiple log-linear regression model
- 1971-2026 catch
- Leave-One-Out Cross Validation (LOOCV)
- Based on oceanographic indicators and stock carryover from previous year.
  - Catch ($\ln \text{Catch}_{t-1}$)
  - Relative Oceanic Nino Index- Yearly Avg. (RONI_{t-1})
  - Pacific Decadal Oscillation -April (PDO_{t-2})
  - Biological Spring Transition- Julian Date (ST $_{t-1}$)
  - Out of Phase Buffer (Buffer_t)

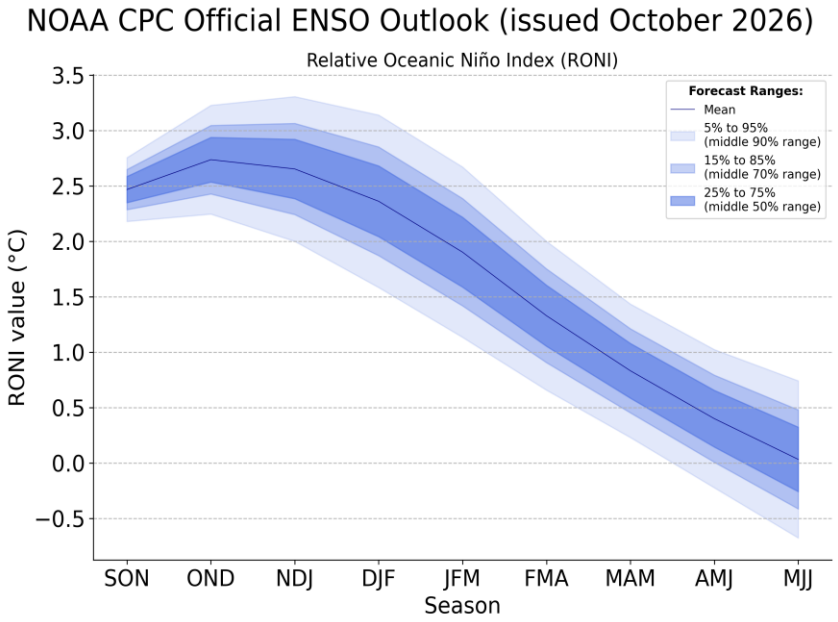


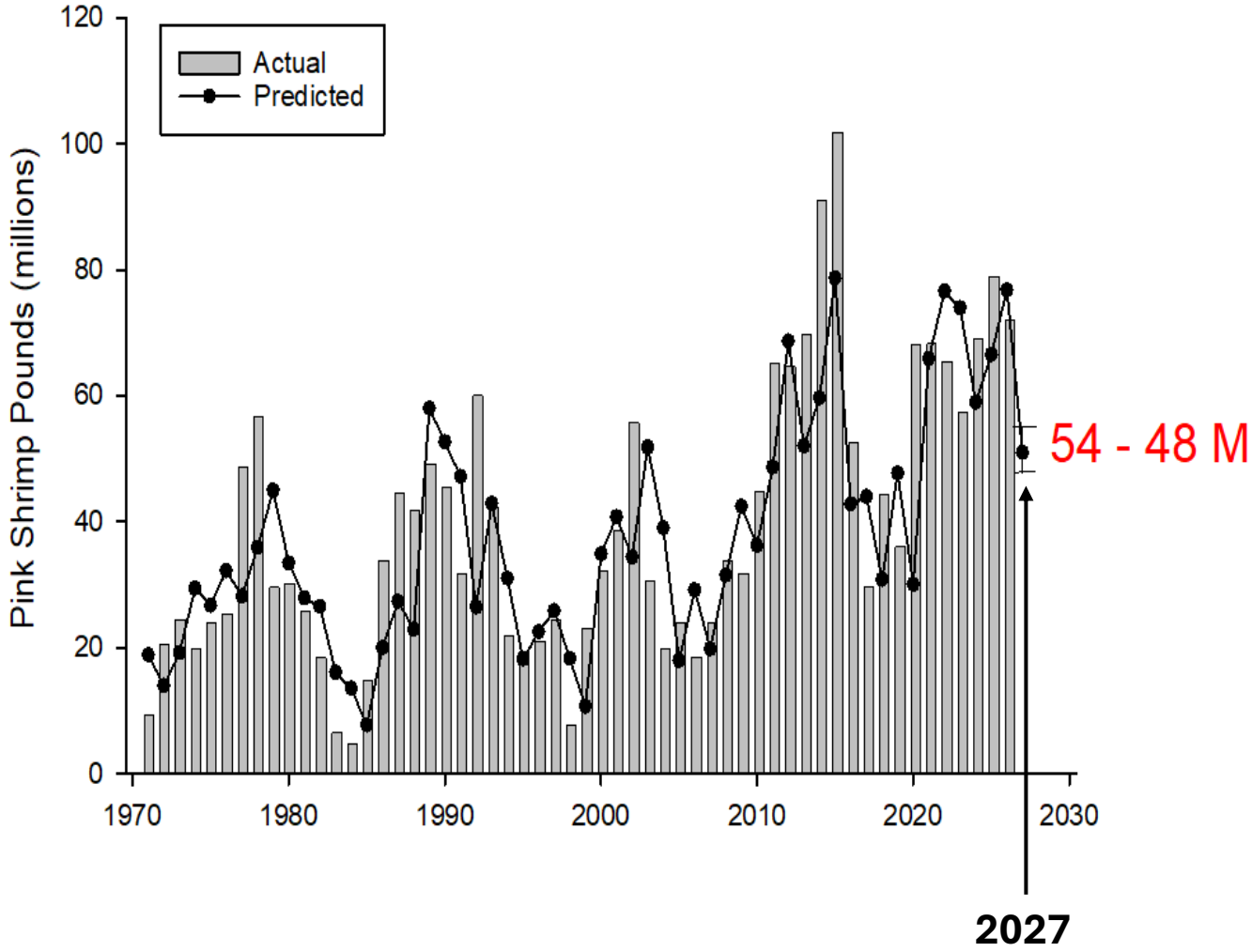
Catch and RONI are the most significant, however the PDO buffer acts a cushion during an El Nino and accounts for a slight increase in variance explained.

Forecast

2027 Model Inputs

- High-low range of predicted RONI values through the three-month forecast period of January/February/March (JFM)





Summary

Caveats with any fishery dependent model

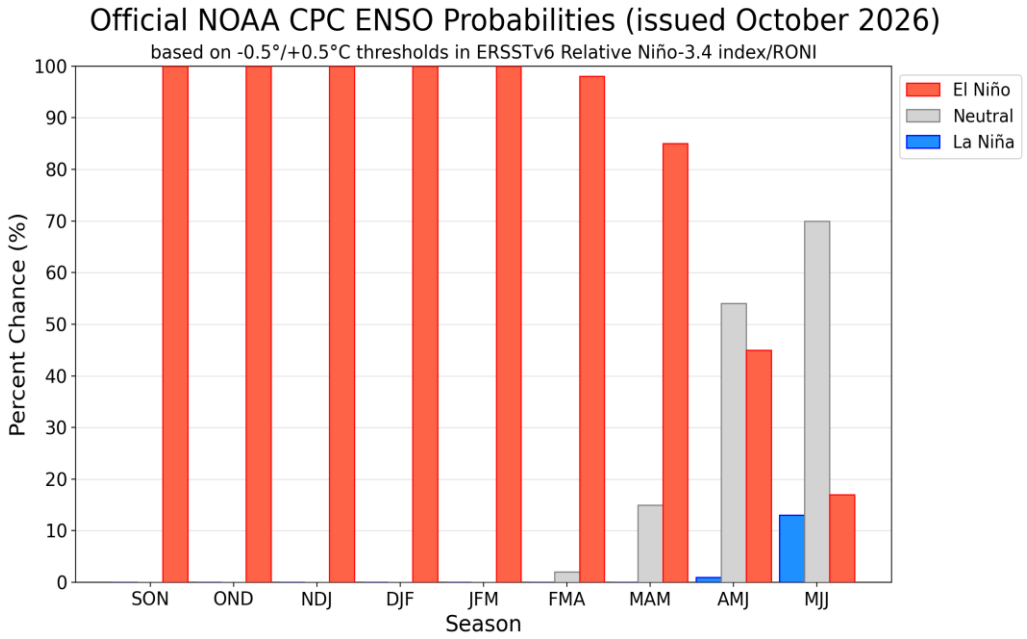
- Markets, processing capacity, fishing efficiency, weather
    - e.g. 2014-2015 higher than average fishing effort

2027 forecast represents a 28% - 36% reduction in catch.

- 2015 to 2016 catch reduction was 48%.

Good news! Strong El Nino years are typically followed by strong La Nina.

- If La Nina conditions return as predicted in 2027-2028, we could see a quick rebound in production.



A special thanks to the ICWPF and everyone for listening!

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