



# *Climate Mischief and Ecological Misfortune*



## **Casualties in Oregon's Nearshore Marine and Estuarine Habitats and Communities**

**Steve Rumrill**

Shellfish Program  
ODFW Marine Resources  
Newport, OR



**Oregon Ocean Science Trust / Nov 2023**



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# Climate Mischief: Persistent Marine Heatwave & Ocean Warming along the Pacific West Coast

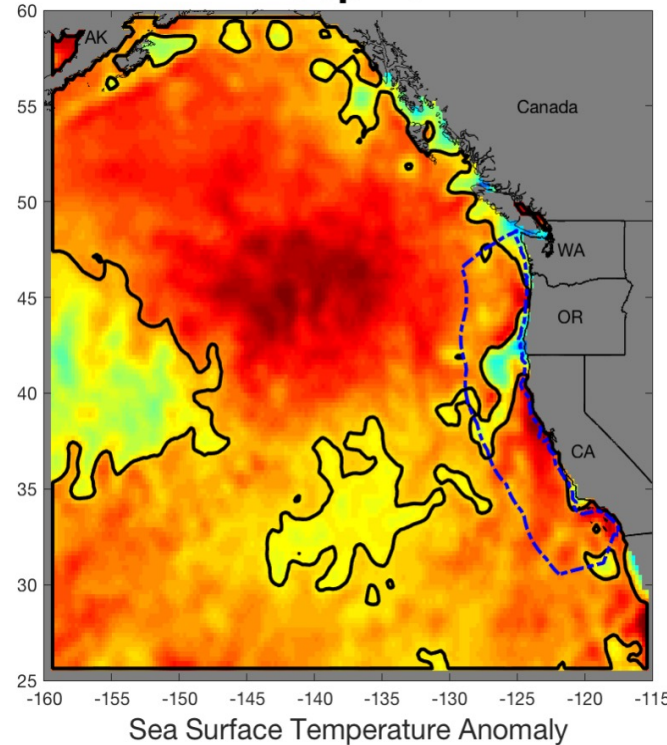
## Marine Heatwaves Disrupt Nearshore Marine Ecosystems

### Reported impacts:

- ✓ altered primary productivity
- ✓ proliferation of harmful algal blooms
- ✓ displacement of ocean habitats
- ✓ changes to populations of marine species
- ✓ disruption of commercial and recreational fisheries

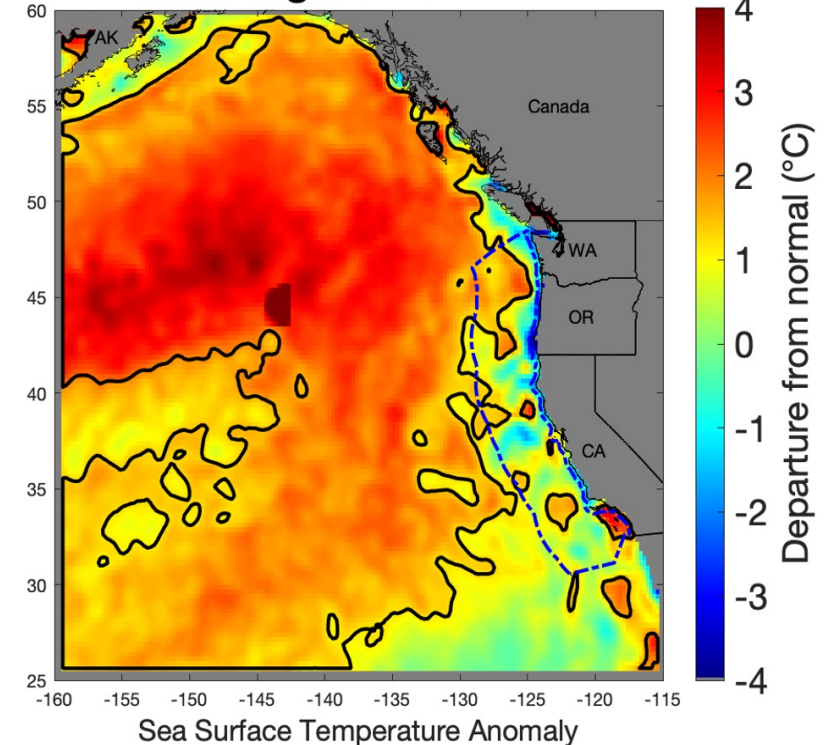
### Formation

22-Sep-2014



### Persistence

Aug-30-2022



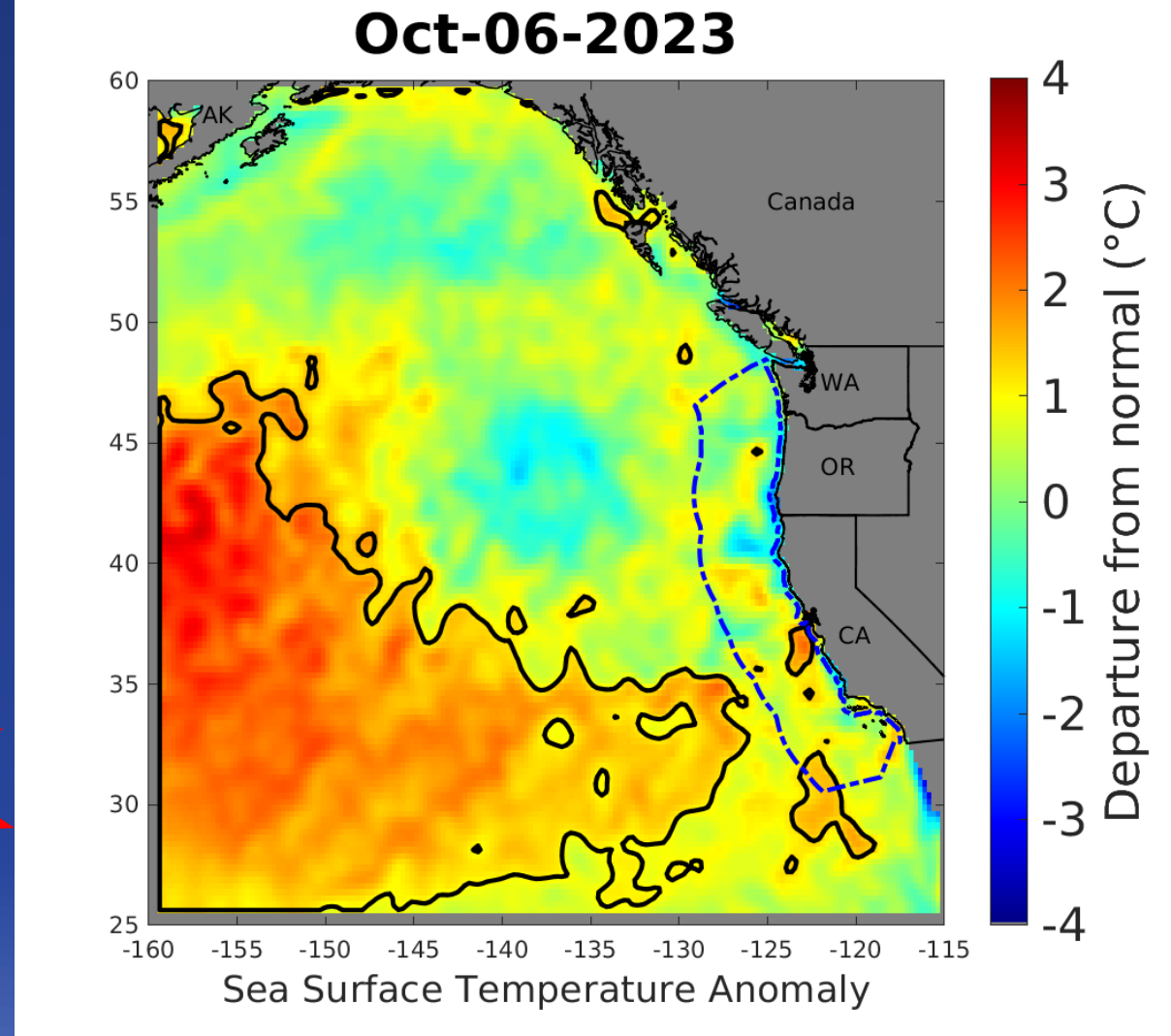
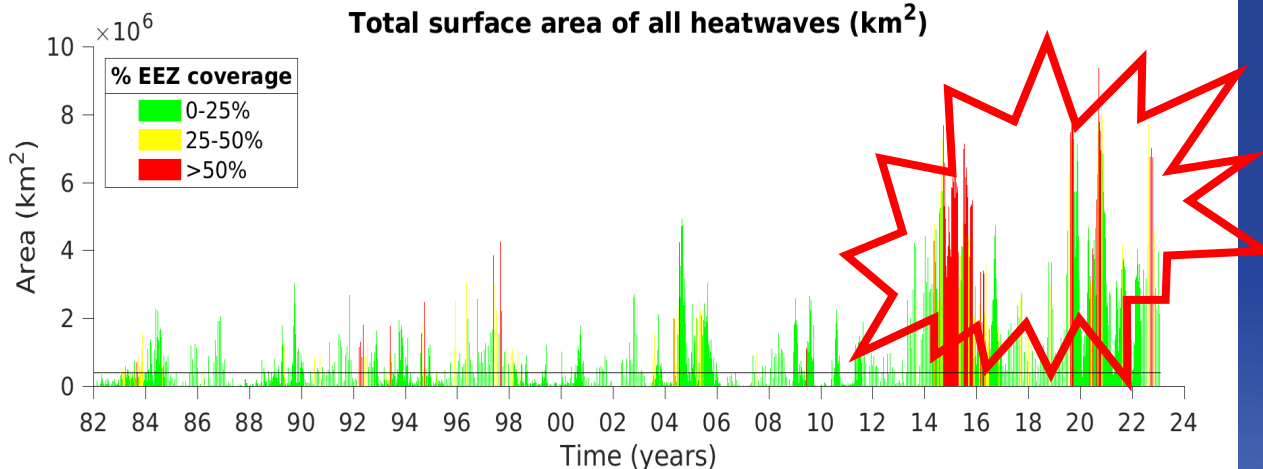


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# NOAA – IEA: The California Current Marine Heatwave Tracker – “Blobtracker”

## Observations & Forecast:

- Unusually warm ocean waters (2013-2023)
- Large marine heatwaves (2013-2016 & 2019-2022)
- Current heatwave expected to remain offshore, coastal waters will cool through winter 2023-24, with coastal warming in spring 2024
- “*El Niño Advisory*” with a 95% chance that warm conditions will persist into 2024





# Ecological Misfortune: Recent Changes to Nearshore Rocky Reefs along the Southern Oregon Coast



Starved Urchins

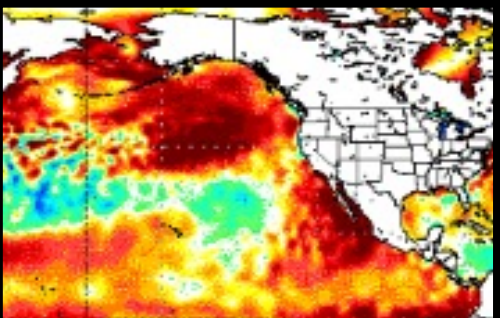


Sea Star Mortality



Decline in Red Abalone

Increased Abundance of Purple Urchins & Formation of Urchin Barrens



Marine Heatwave 2013-2017 (2023)

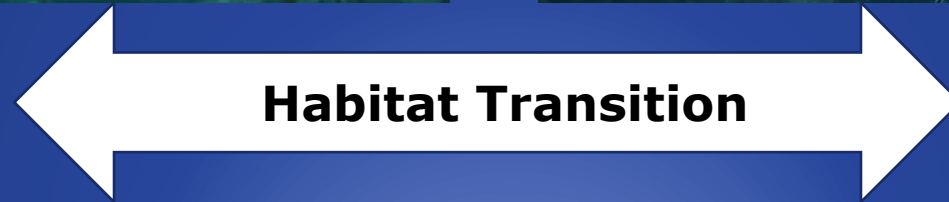
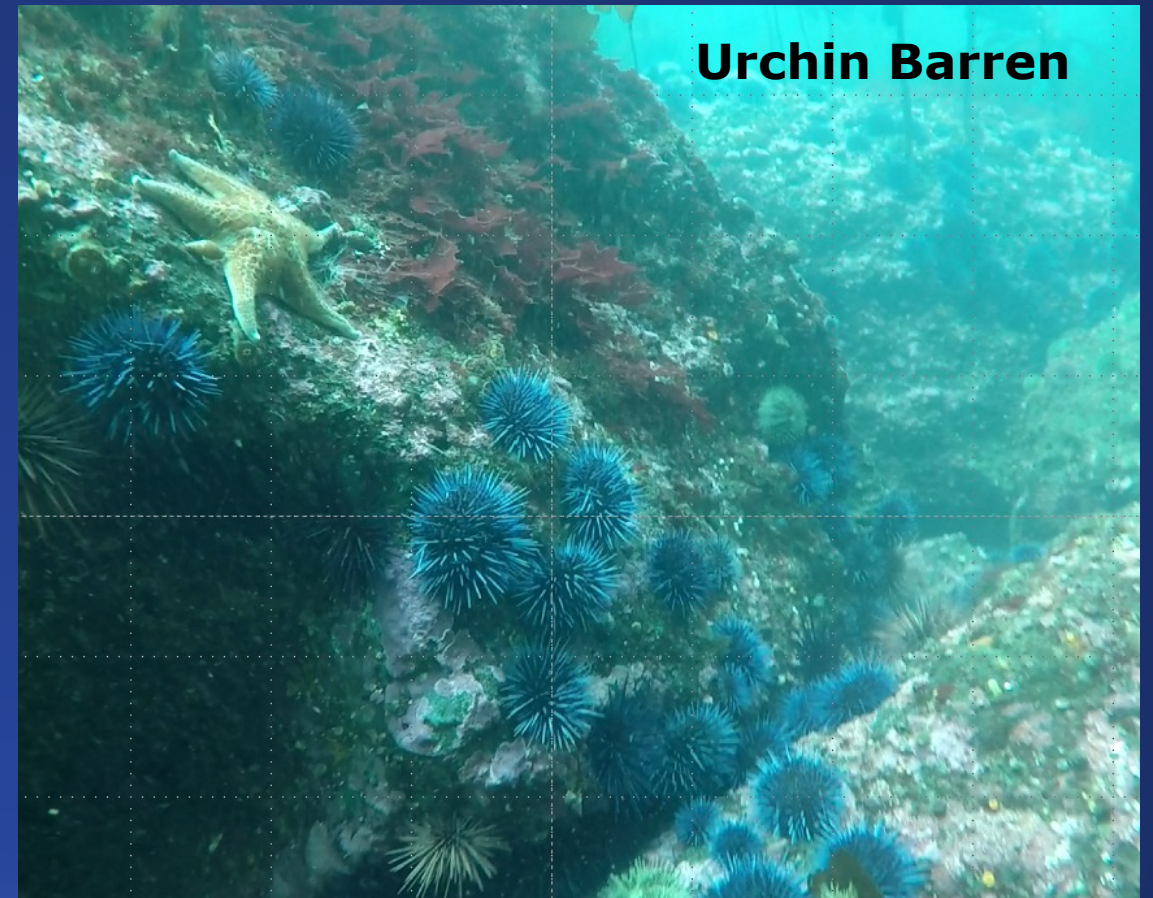


Patchy Demise of Bull Kelp

# Changes to Rocky Reef Communities and Kelp Habitat along the Southern Oregon Coast (2013-2023)



# Changes to Rocky reef Communities and Kelp Habitat along the Southern Oregon Coast (2013-2023)





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# Sea Star Wasting Disease (SSWD): Massive Mortality of Multiple Species of Sea Stars along the West Coast (2013 to present)

Sunflower stars (*Pycnopodia helianthoides*) are important predators that prey upon urchins and other organisms in rocky subtidal habitats.



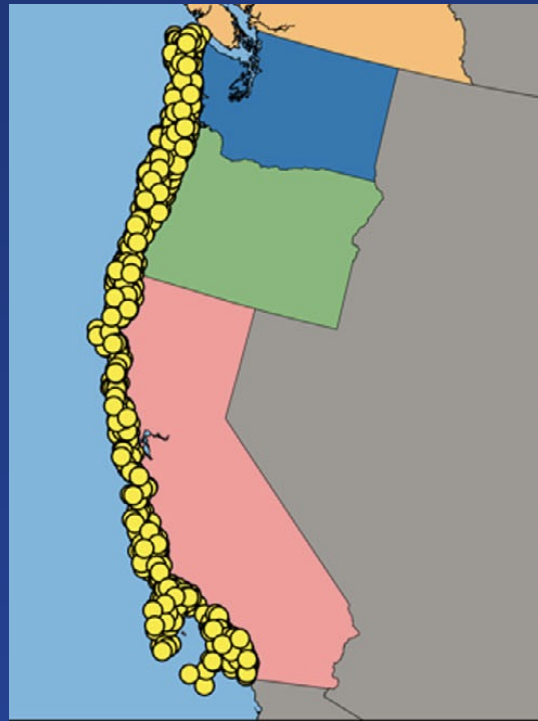
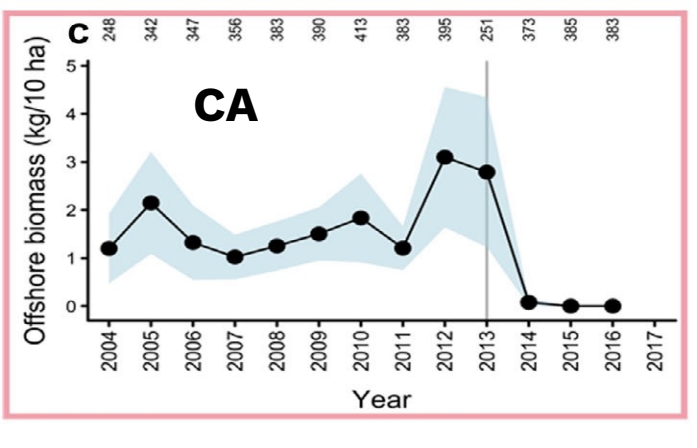
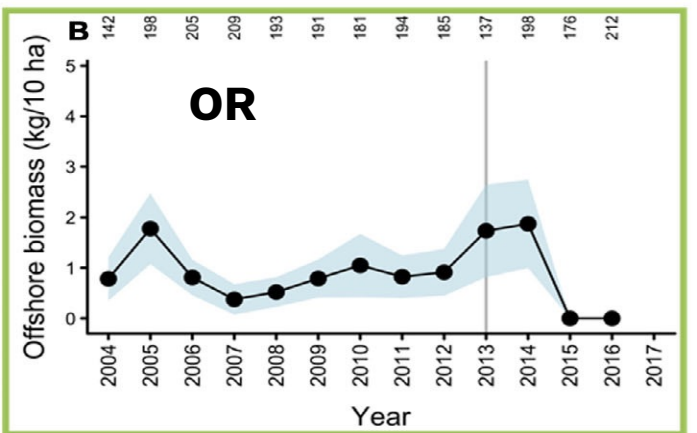
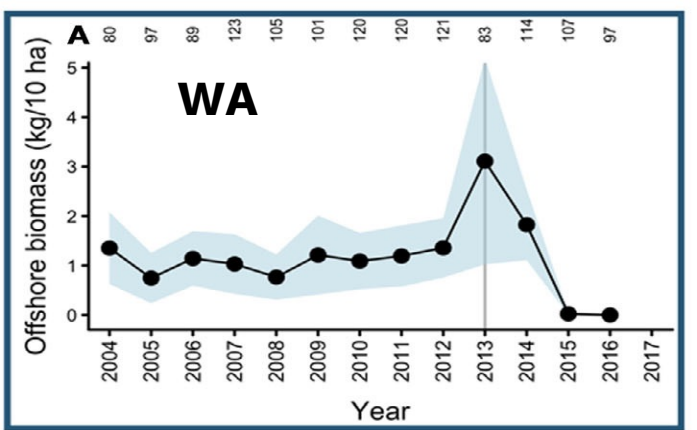
Healthy sunflower sea stars can consume 2 urchins every 3 days



**Onset of SSWD for sunflower sea stars was coincident with initiation of marine heatwave (2013-2017)**

**Unhealthy *Pycnopodia* with wasting disease**

# Mass Mortality of Sunflower Stars along the US West Coast (2016)



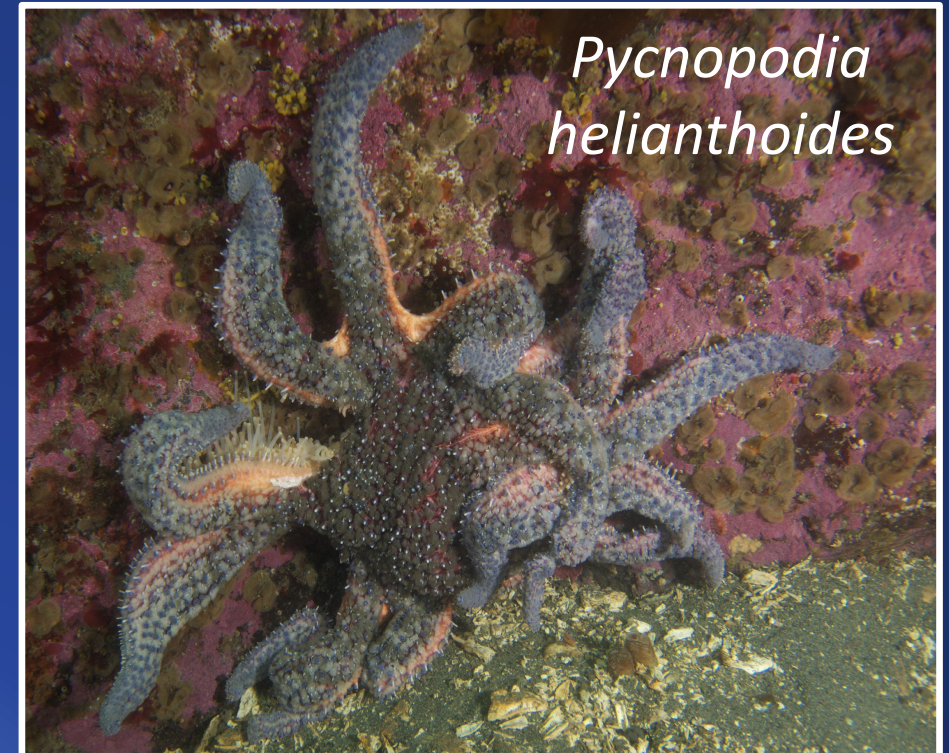
0 250 500 750 1000 km

**Jurisdictions**

- British Columbia
- Washington
- Oregon
- California

Sunflower stars:

- *ca.* 100% declines in CA and OR
- *ca.* 99% decline in WA
- None observed in 692 trawls in 2016





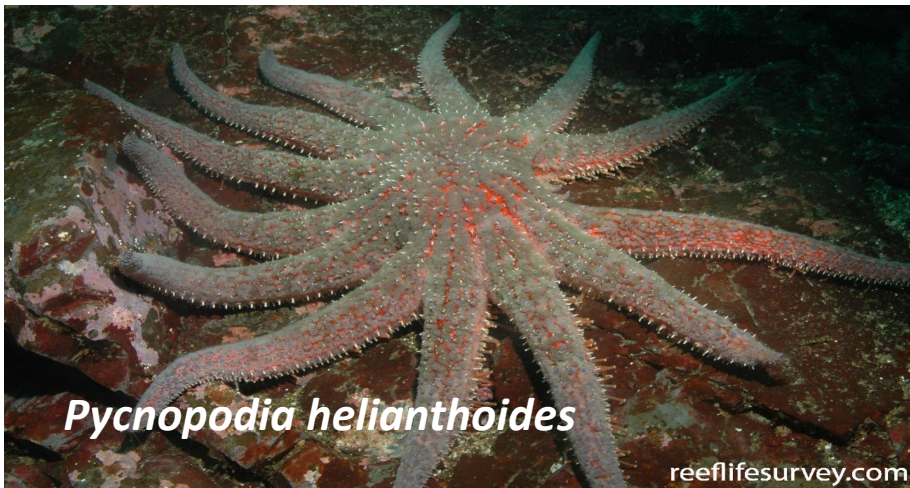


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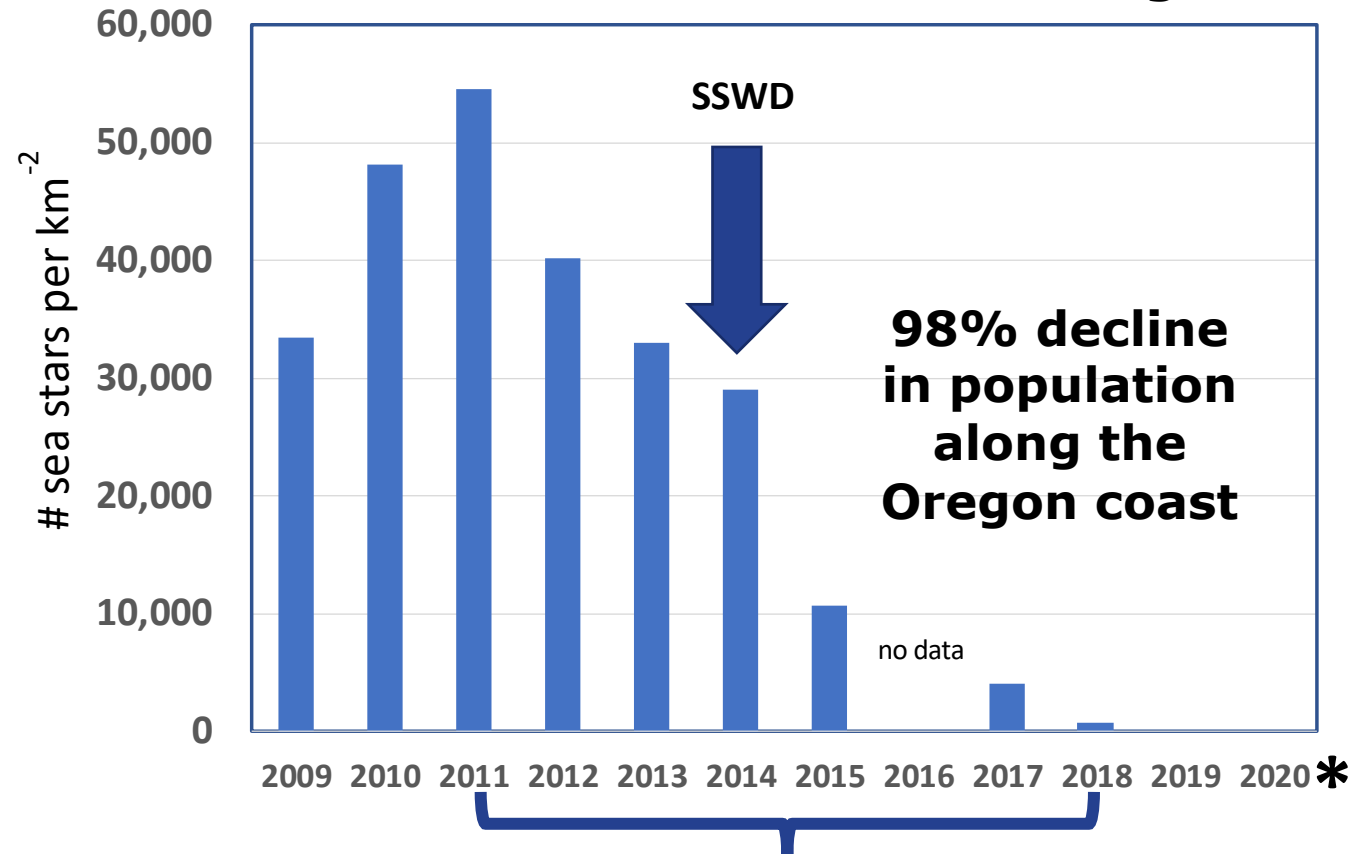
# Mass Mortality of Sunflower Sea Stars (*Pycnopodia*)

## Coastwide Decline of Sunflower Sea Stars:

- 90% coastwide (AK-Baja CA) decline after Sea Star Wasting Disease (SSWD)
- IUCN Red List as “critically endangered” in 2019 / urgent action needed
- Currently under consideration by NOAA for ESA listing (pending March 2024)



## Decreased Abundance in Oregon

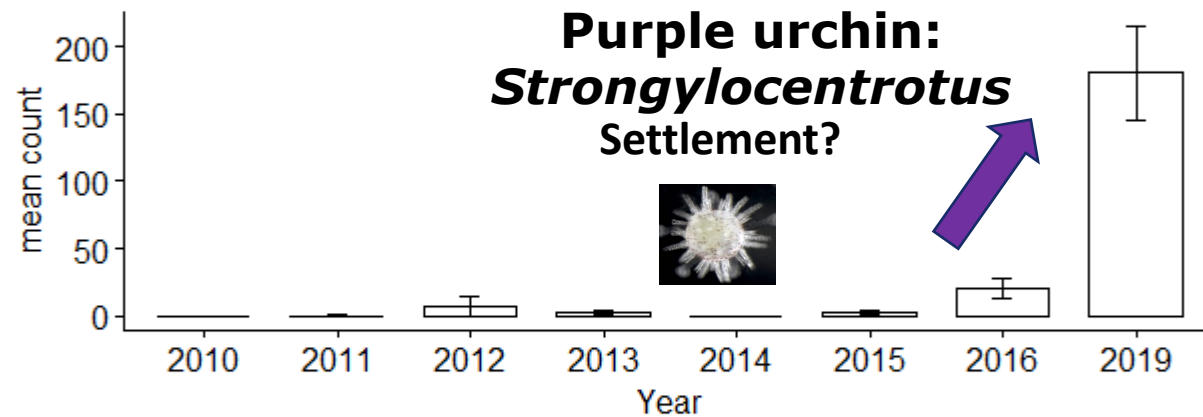
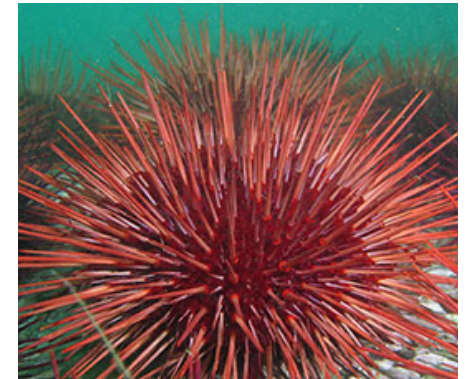
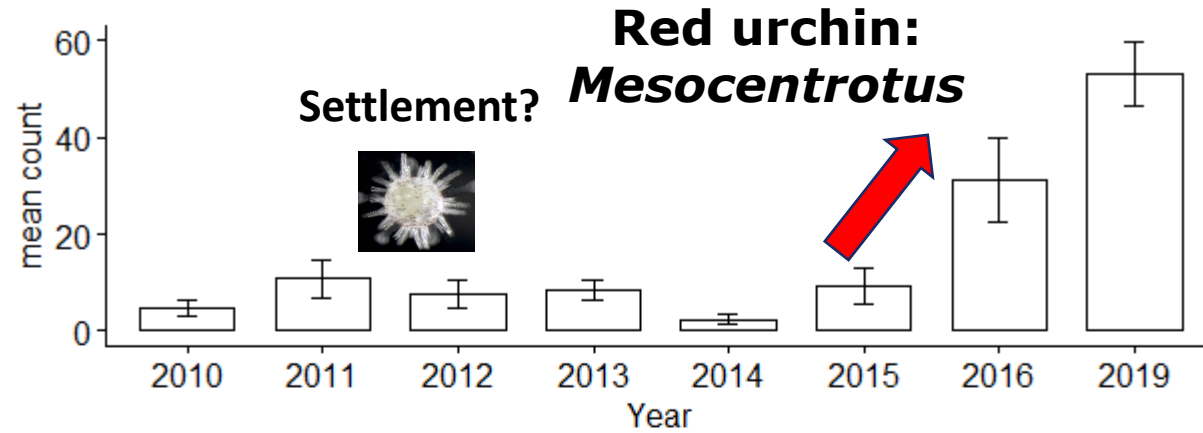
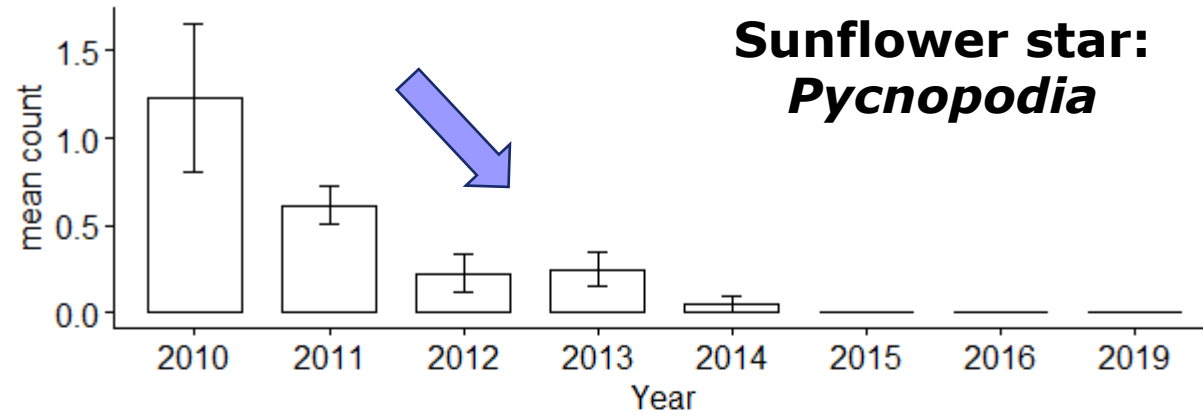
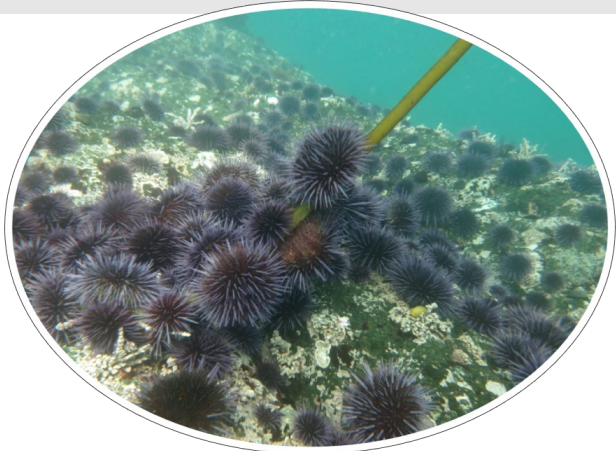


**Note 1: multi-year decline 2012-2018**

**Note 2\*: numerous juveniles observed in 2023**

# Changes in abundance of echinoderms in Oregon subtidal habitats

ODFW SCUBA surveys estimate 350 million new purple sea urchins at Orford Reef (2019)





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# Variability in Bull Kelp along the Oregon Coast

**Bull kelp beds are naturally highly variable in space and time along the OR coast:**

- Substantial Reduction at some sites after marine heatwave 2014-15
- *i.e.*, Orford Reef, Blanco, Humbug, Brookings



**Orford Reef 2014, abundant bull kelp**



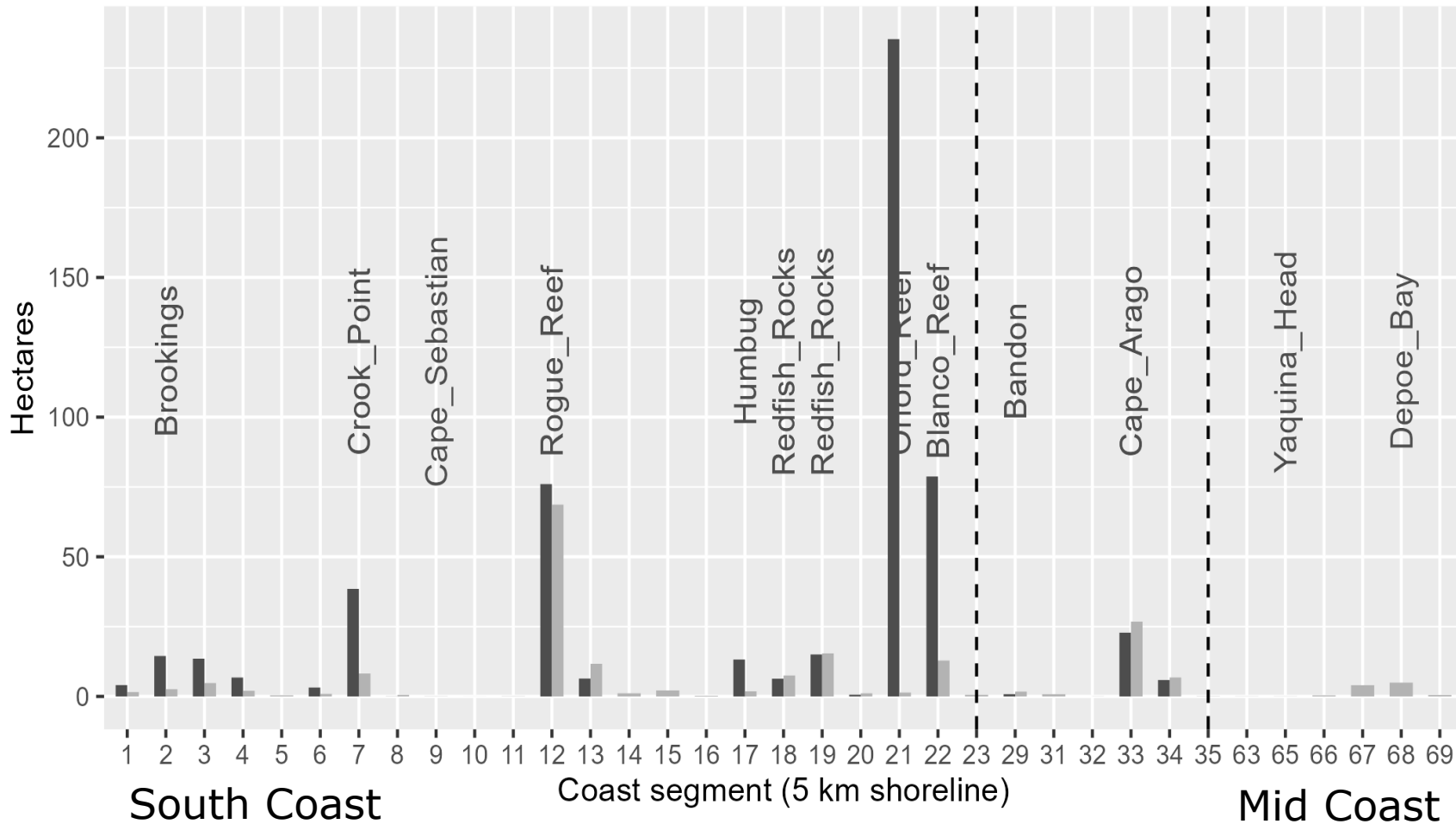
**Orford Reef 2016, little bull kelp**



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# Spatial Variability and Decline in Bull Kelp along the Oregon Coast (2010-2022)

Classified kelp coverage (surface + subsurface) in ODFW aerial surveys

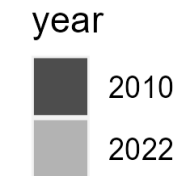


## Total canopy area (CA to Cape Arago)

2010: 536 hectares

2022: 182 hectares

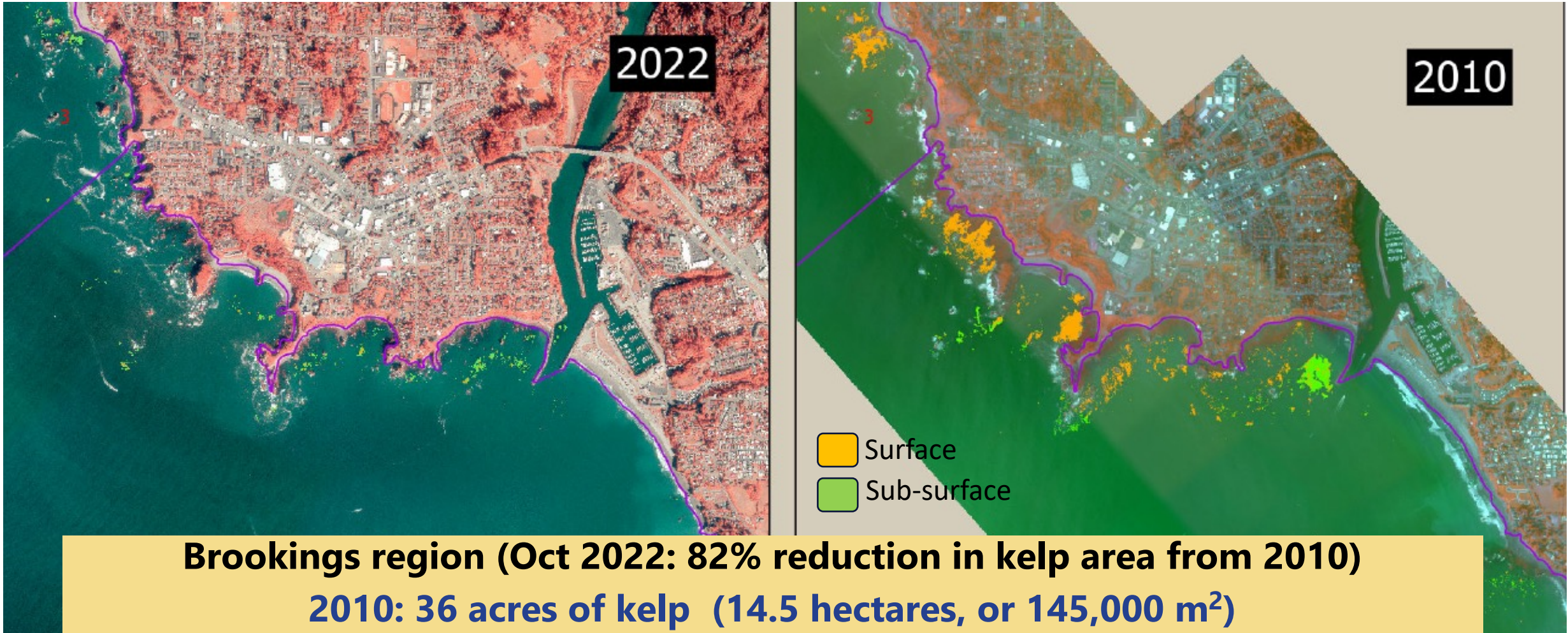
*Overall ~ 66% reduction from 2010*





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# Spatial Variability and Decline in Bull Kelp along the Oregon Coast (2010-2022)



**Brookings region (Oct 2022: 82% reduction in kelp area from 2010)**

**2010: 36 acres of kelp (14.5 hectares, or 145,000 m<sup>2</sup>)**

**2022: 6.4 acres of kelp (2.6 hectares, or 26,000 m<sup>2</sup>)**



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# Low Densities of Red Abalone in Oregon



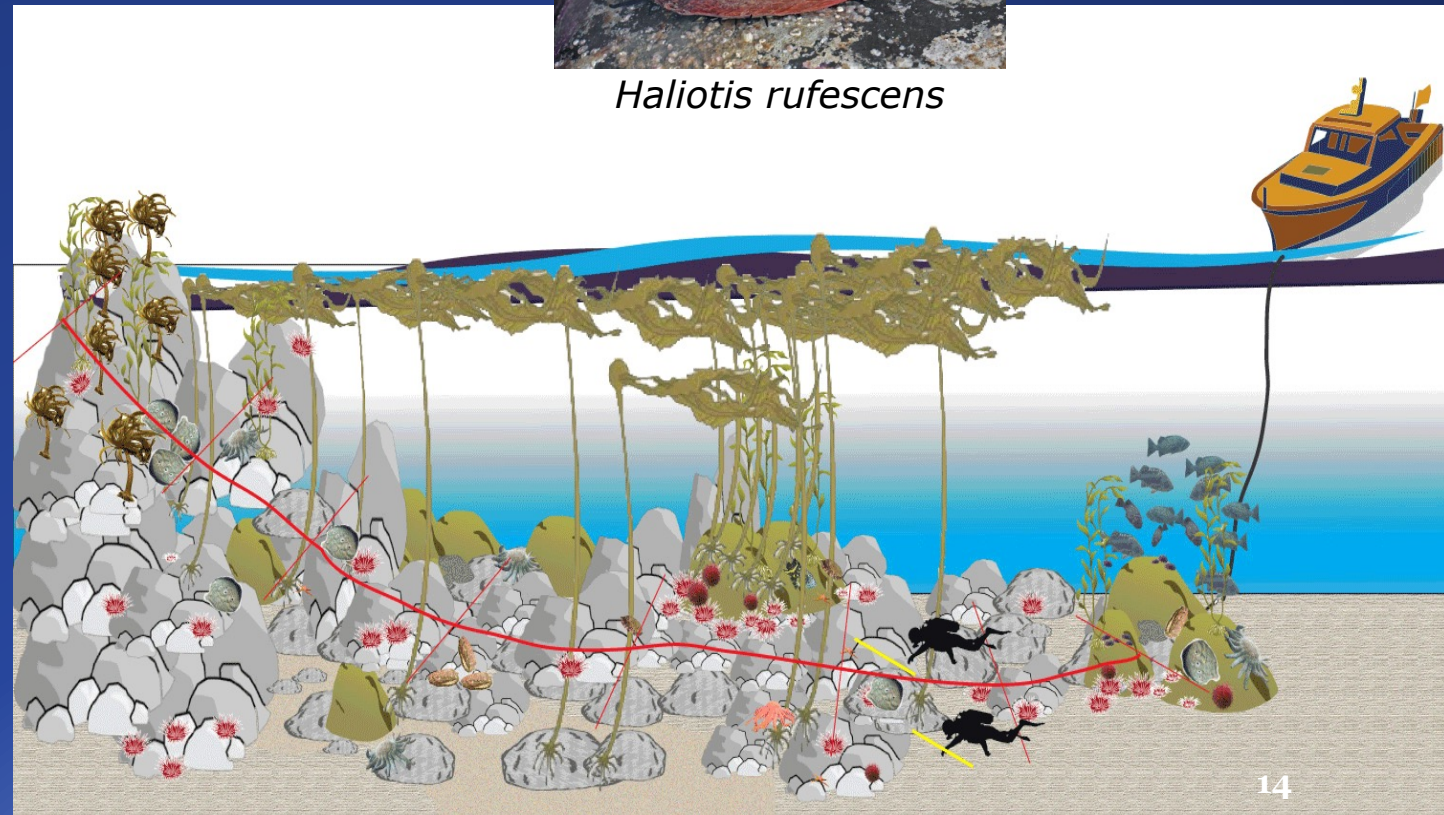
- Naturally occur at very low densities at northern limit of their biogeographic range
- Low densities below critical threshold for reproduction
- Environmental conditions are currently poor in rocky reef habitats
- OFWC suspended sport harvest 2018-2024 (recommend indefinite closure in Dec 2023)
- ODFW Conservation and Fishery Management Plan for Red Abalone (draft 2023)

**ODFW  
Surveys:  
2015 & 2022**



*Haliotis rufescens*

**85%  
decline**

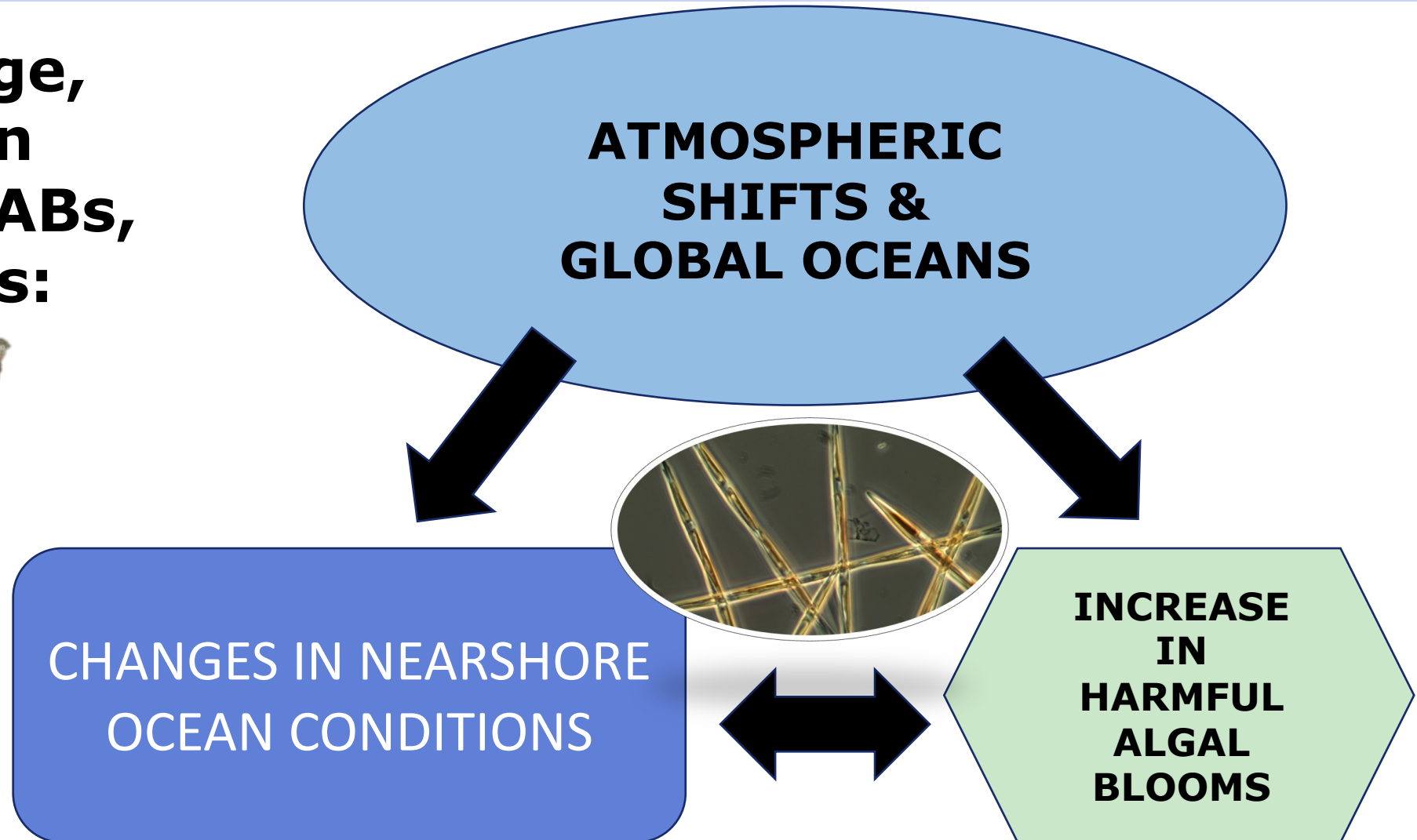




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# Harmful Algal Blooms and Oregon's Shellfish Fisheries

**Climate Change,  
Shifting Ocean  
Conditions, HABs,  
& Razor Clams:**





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# Ocean Drivers, Harmful Algal Blooms, Marine Biotoxins, & Shellfish Fishery Closures

Annual HABs are highly variable but increasing in frequency and severity

Impacts to razor clam fisheries

- Domoic Acid → shellfish closures

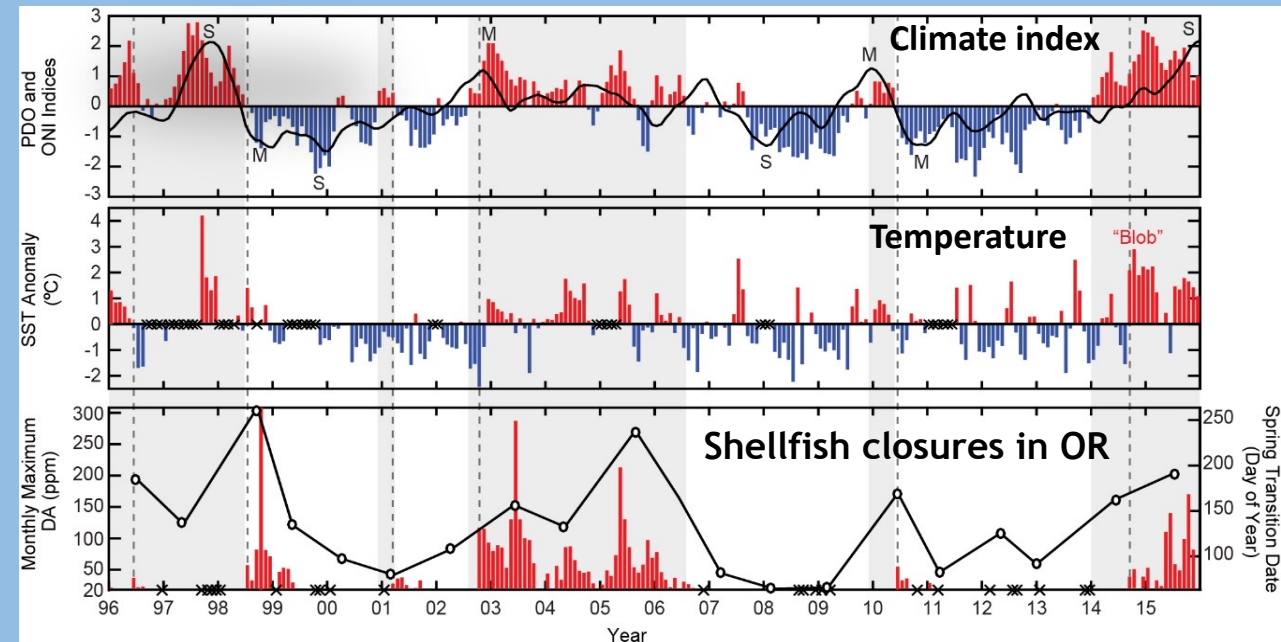
Unprecedented coast wide closure in 2015-2017

- Clatsop Beach closed for 21 months

Clatsop Beach razor clam closure had a \$7.5M impact to local communities in 2021

Trophic accumulation of marine biotoxins

- Impacts to other fisheries = Dungeness crab



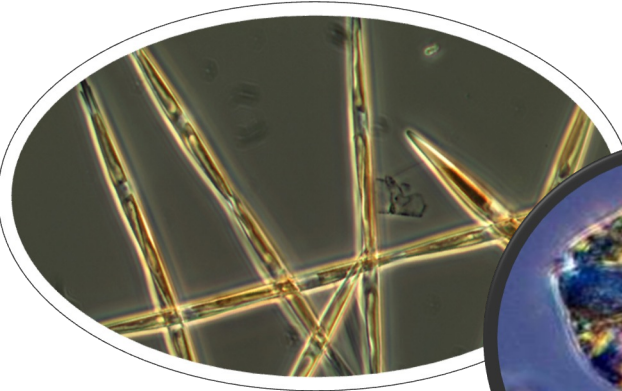


# Increased frequency and duration of HABs, domoic acid maxima, & biotoxin closures

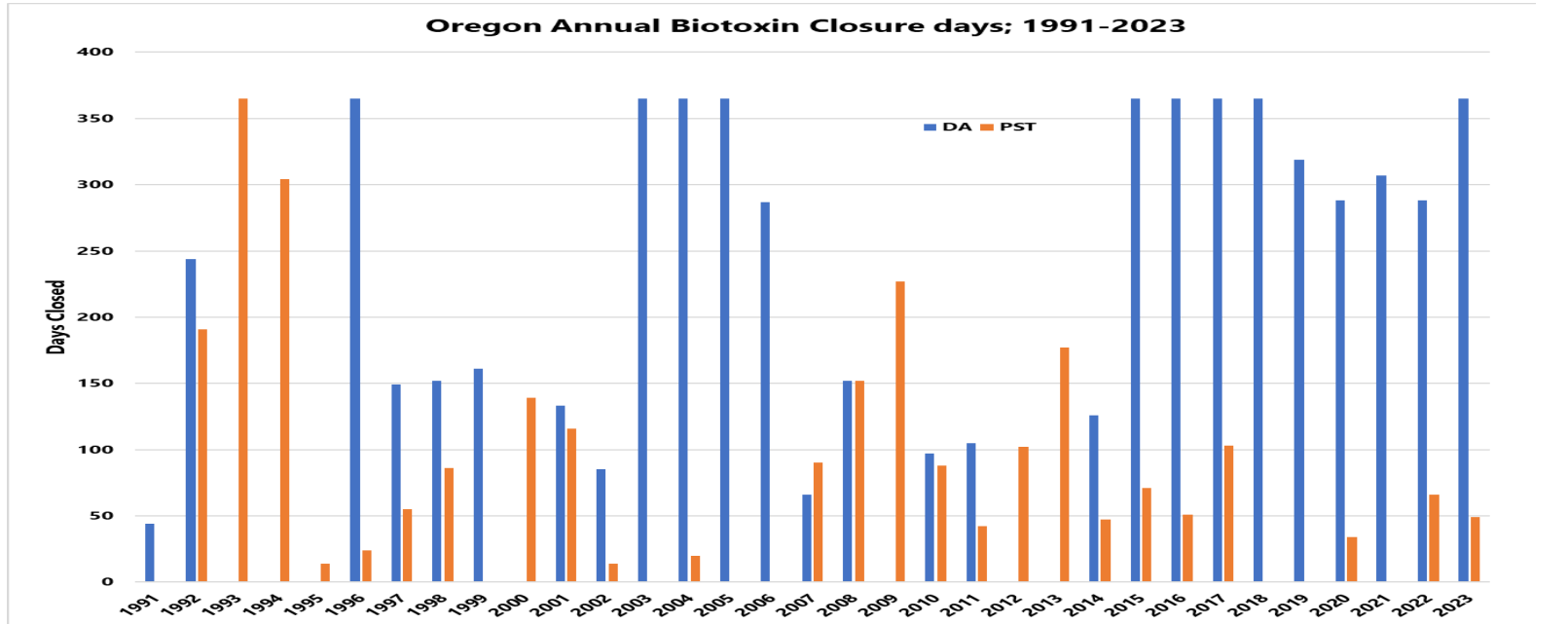
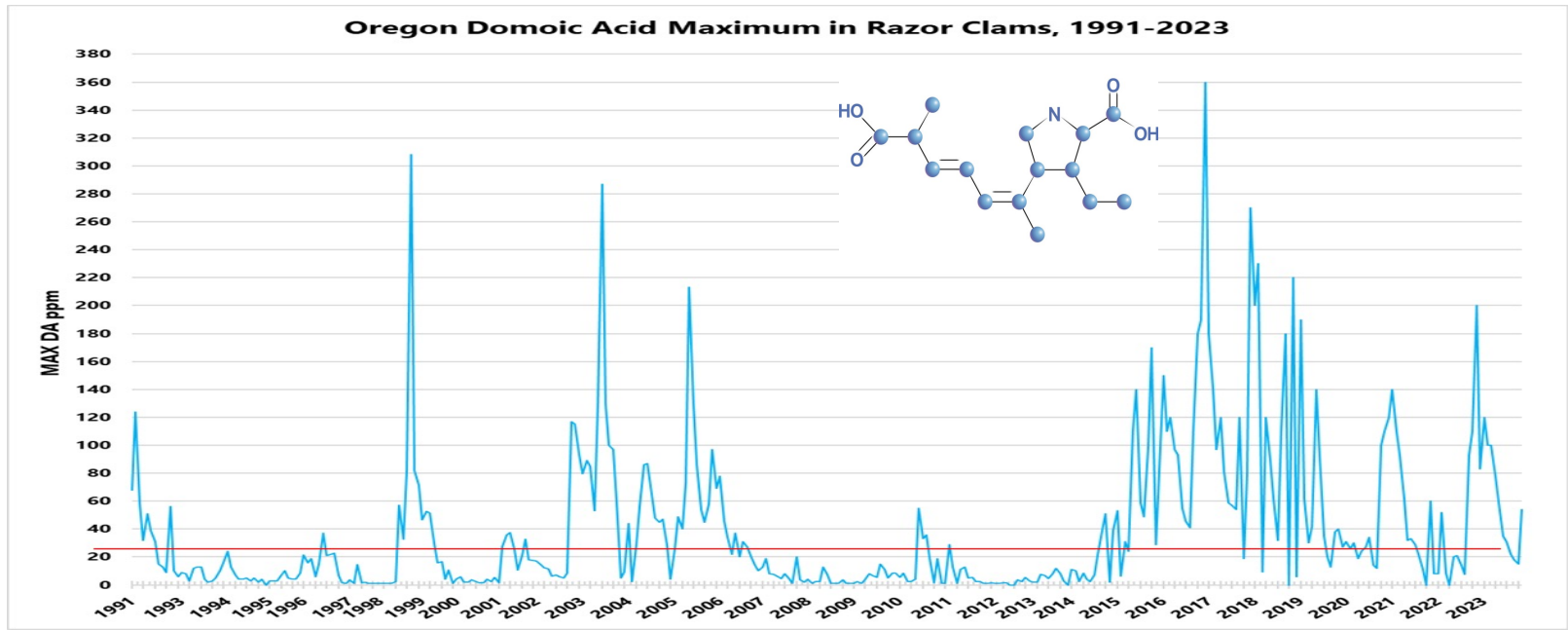
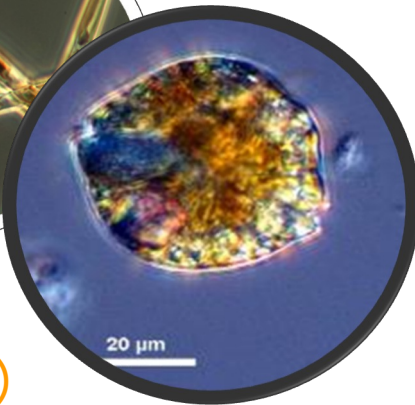



*Siliqua*  
(bivalve)

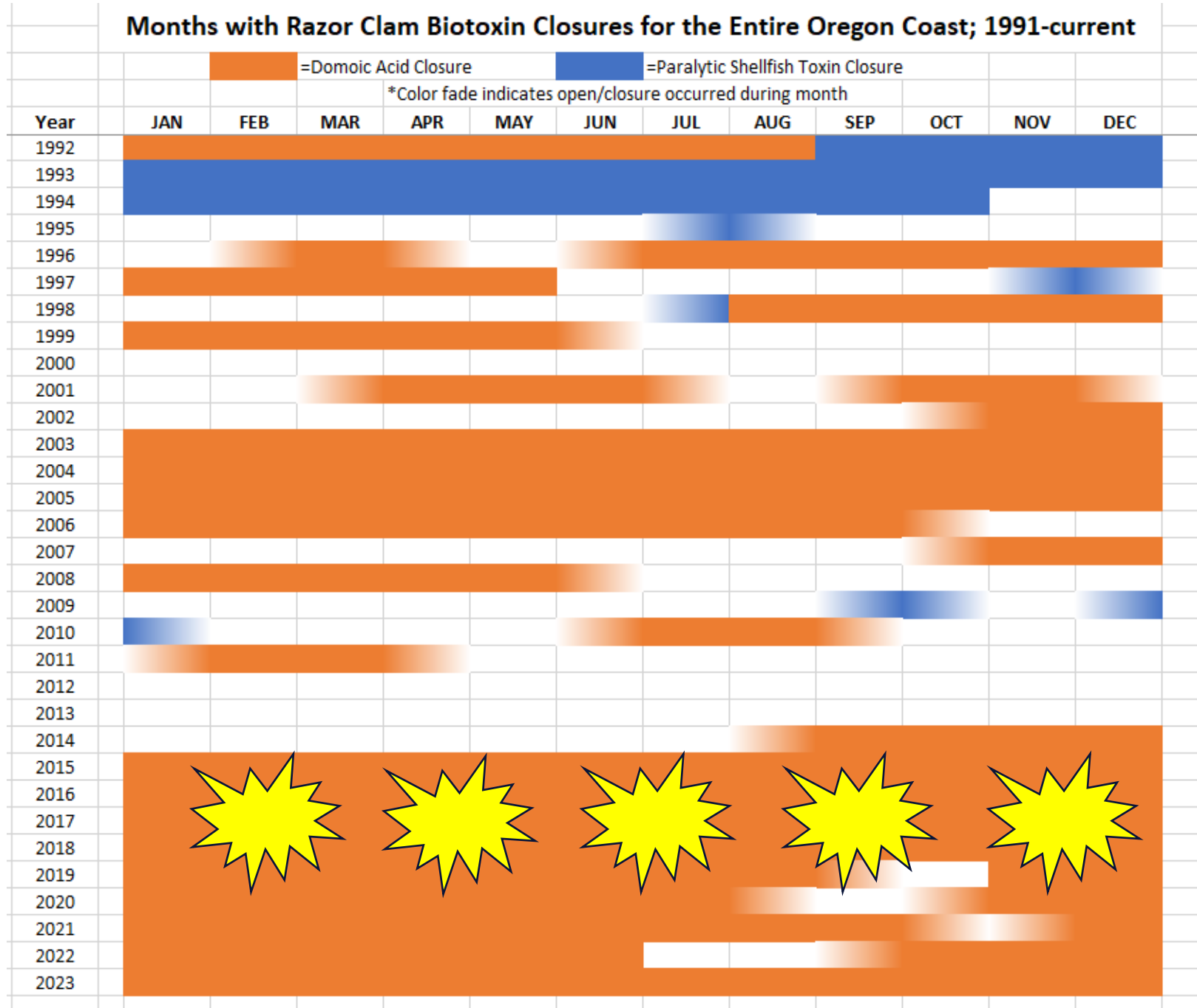
*Pseudo-nitzschia*  
(diatom)



*Alexandrium*  
(dinoflagellate)

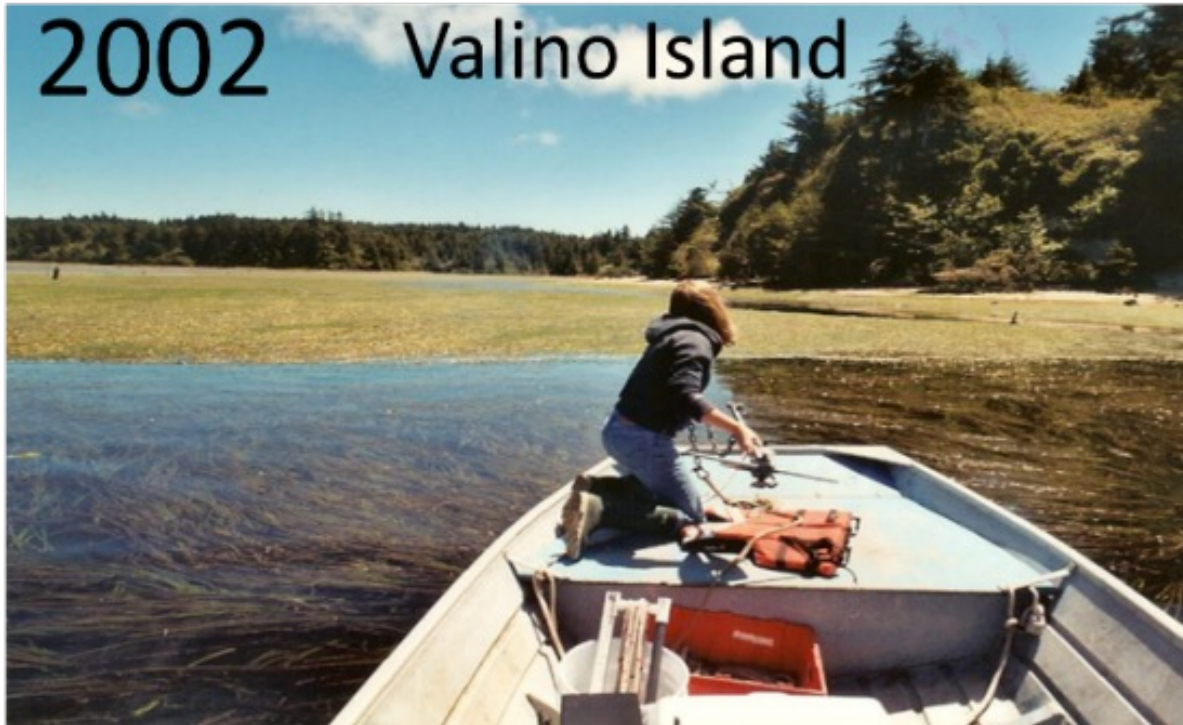


Razor clam biotoxin closures currently occur in all seasons and months, and extend for longer periods (2015-2023) 





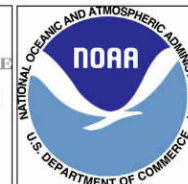
# Recent Declines in Eelgrass (*Zostera marina*) within the South Slough Estuary, OR



**Dense eelgrass bed in intertidal and shallow subtidal zones**

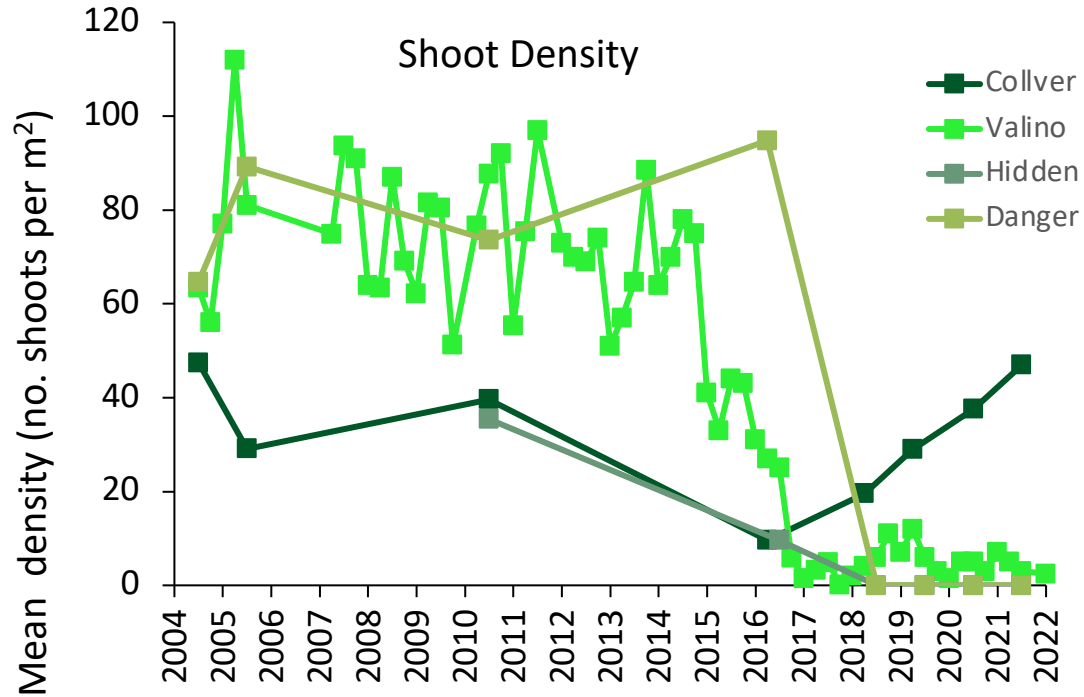


**Eelgrass missing and very patchy in intertidal and shallow subtidal zones**





# Recent Declines in Eelgrass (*Zostera marina*) within the South Slough Estuary, OR

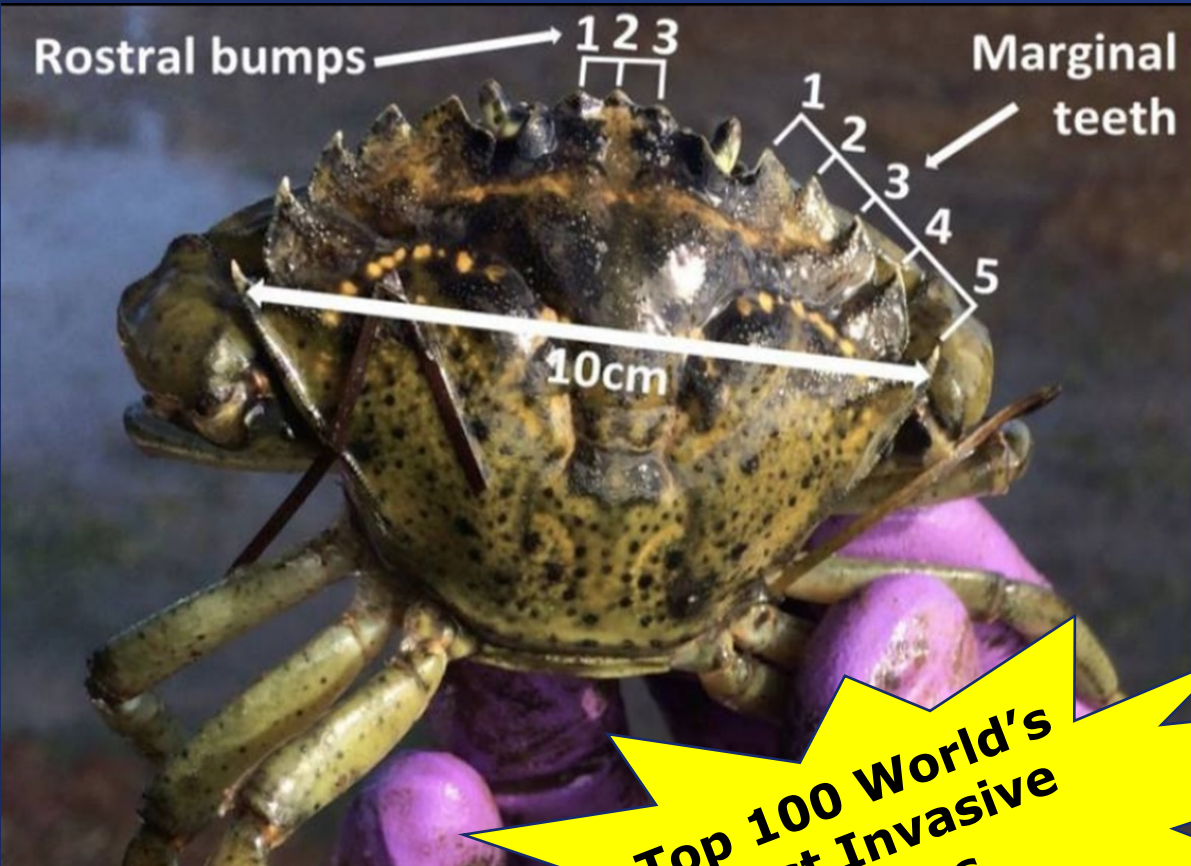


**Decline in eelgrass beds over 2015-2018 in mid and upper regions of South Slough**

**South Slough tidal inlet, and greater Coos Estuary (Charleston, OR).**



# Close Encounters: European Green Crab in Oregon Bays and Estuaries



## European green crab (*Carcinus maenas*)

- Mid-sized (3-4" adult) shore crab inhabit mid-region of estuaries
- 5 spines or marginal teeth / 3 bumps between eyes
- Variable coloration (green, brown, yellow, red, blue)
- High likelihood for mis-identification with native crab
- Predators that consume bivalves, oysters, clams, worms, crab, *etc.*

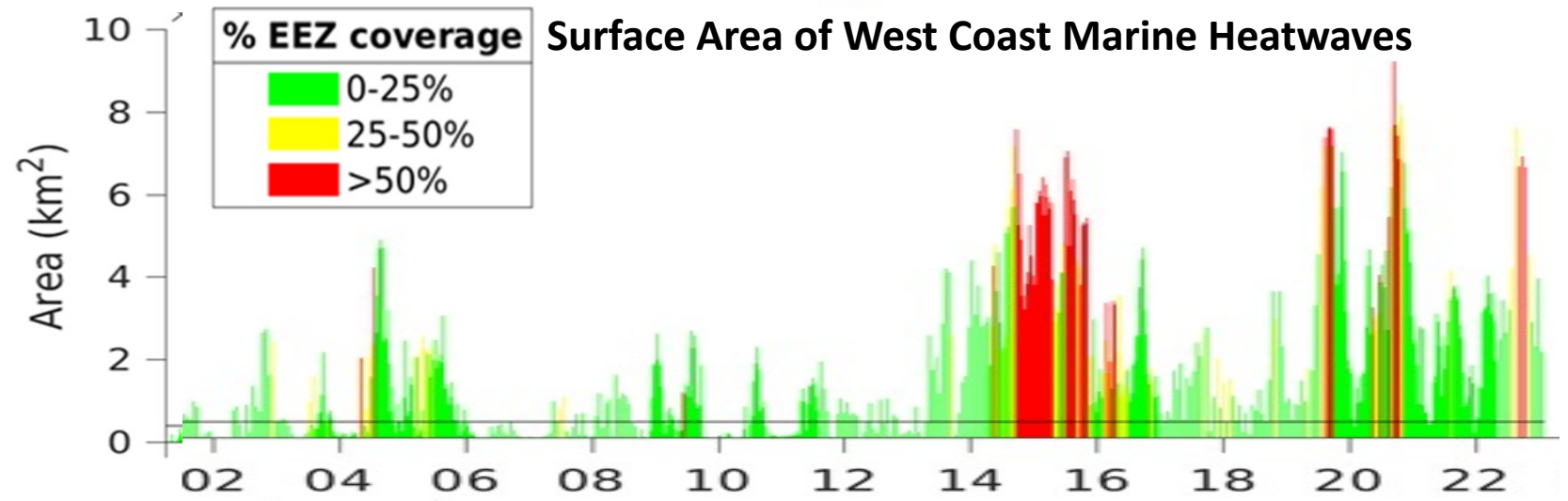
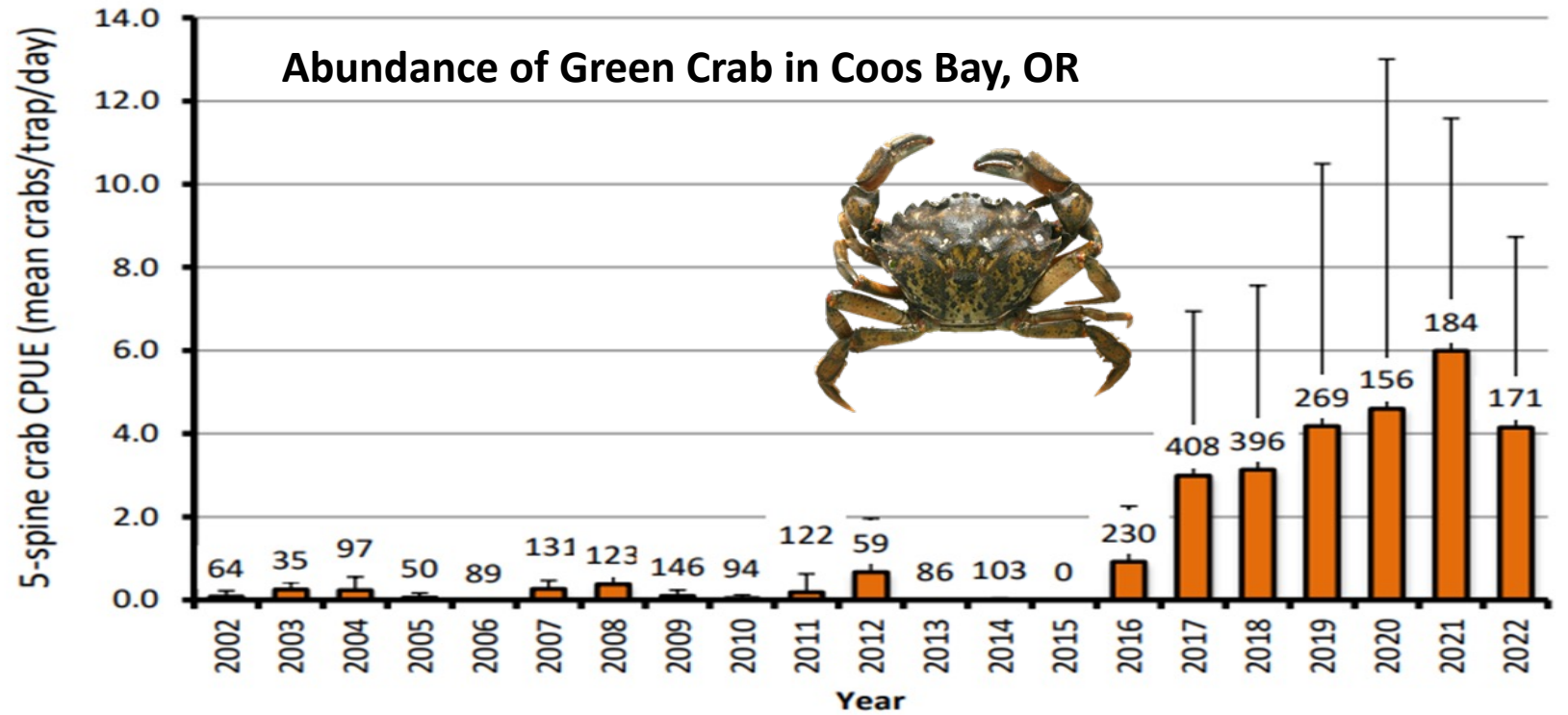
**Top 100 World's Worst Invasive Species**



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Temporal Correspondence between the Increased Abundance of European Green Crab and Persistence of Anomalously Warm Ocean Waters





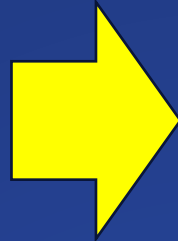
# Climate Mischief and Ecological Misfortune



## Final Thoughts

### Climate/Ocean Drivers:

- Persistent marine heatwaves and warming ocean waters are a regional manifestation of climate change
- Shifts in ocean drivers exert multiple stressors on marine habitats and communities along the Oregon coast



**Research and monitoring needed to determine mechanistic cause/effect relationships, impacts, & resilience**

### Some of the Casualties include:

- Alteration of marine and estuarine habitats and communities
- Massive loss of sea stars
- Increased abundance of sea urchins
- Decline in spatial extent of bull kelp
- Decline in abundance of abalone
- Increased HABs and closures of shellfish fisheries (razor clams & crab)
- Patchy declines in eelgrass beds
- Increased abundance of non-indigenous European green crab