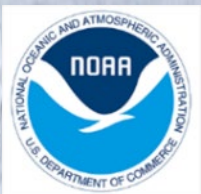


Salmon distributions and marine heat waves: potential changes to survival and distributions

Laurie Weitkamp
NOAA Fisheries

Northwest Fisheries Science Center
Newport, OR

Laurie.Weitkamp@noaa.gov



Today's talk

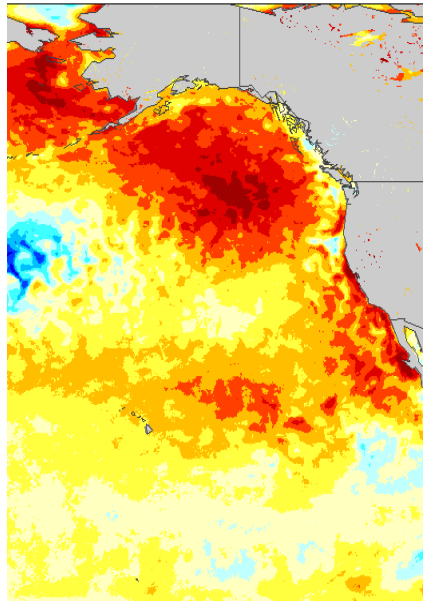
1. Species-specific ocean distributions affect salmon's exposure to recent marine heat waves
2. Observed distributional changes in salmon
 - Examples that salmon do (or don't) change distributions



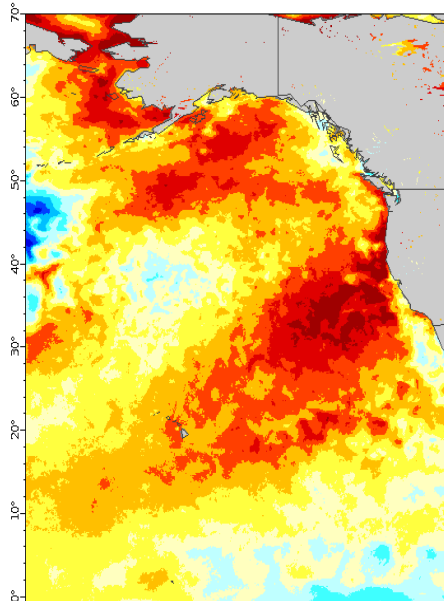
Recent NE Pacific marine heat waves

Sea surface temperature (SST) anomalies in September

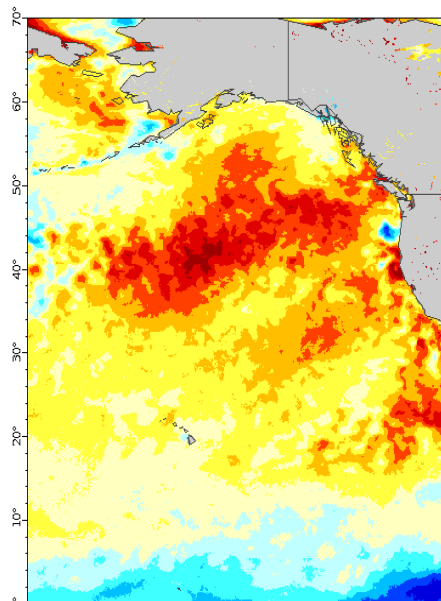
2014-16
"The blob"



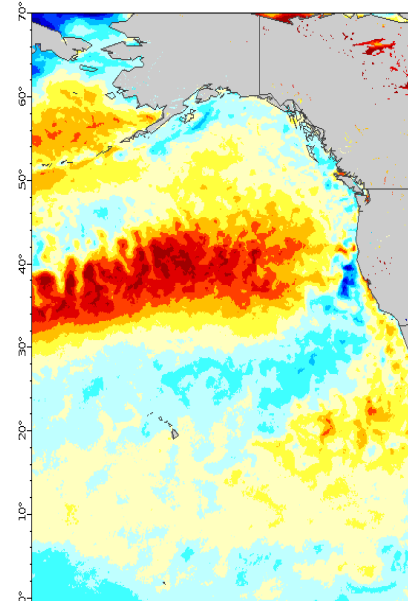
2019



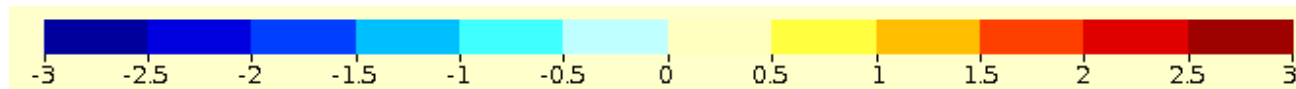
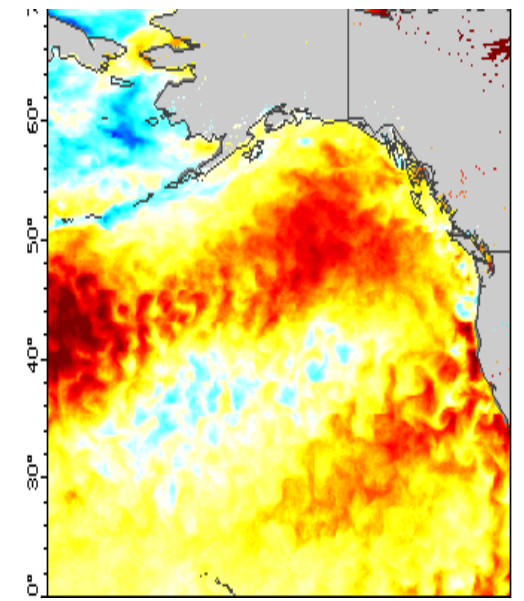
2020



2021



2022



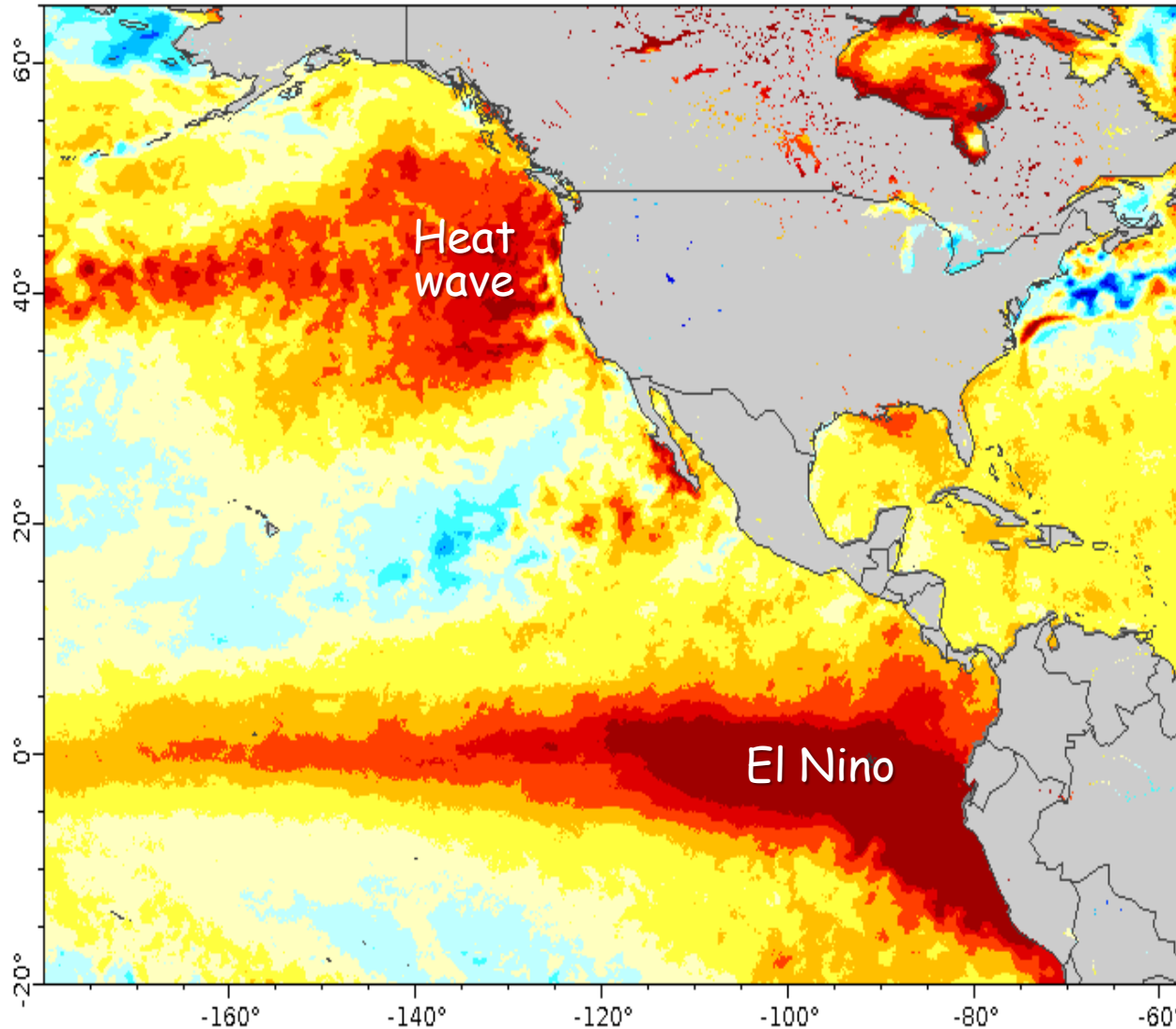
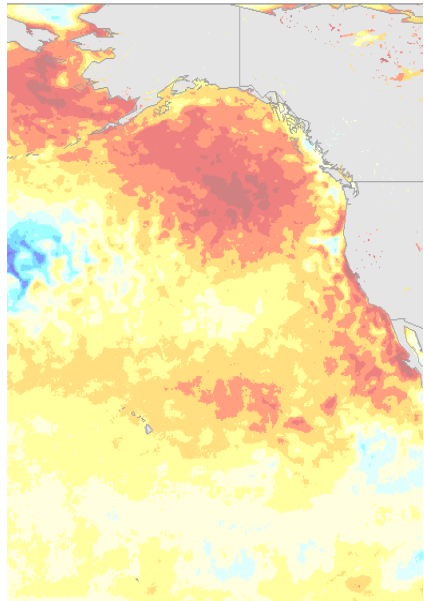
<https://www.integratedecosystemassessment.noaa.gov/regions/california-current/cc-projects/blobtracker>

2023: Another big heat wave and El Niño

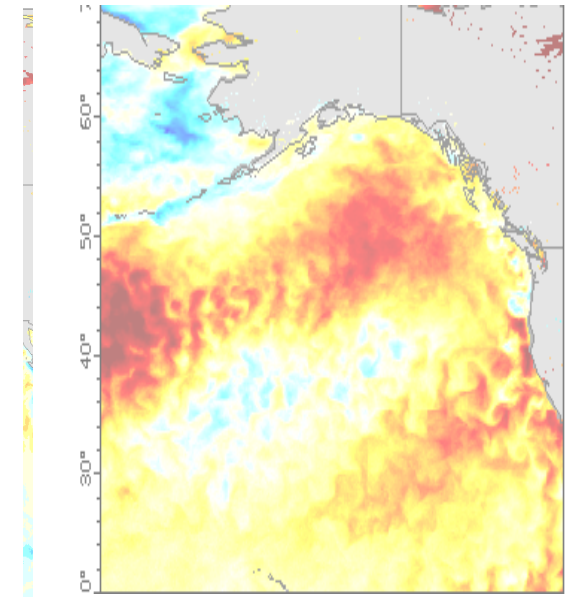
2023

iber

2014-16
"The blob"



2022



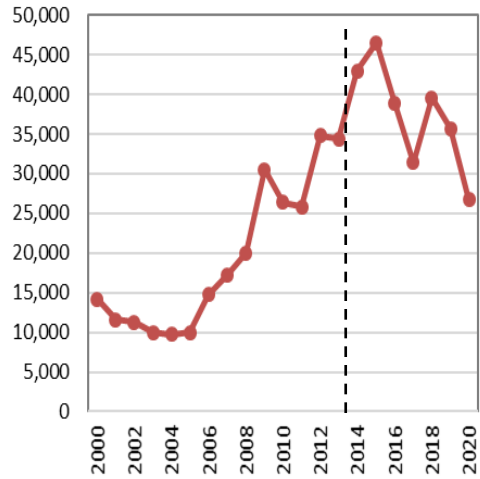
<https://www.in>

cc-projects-blobtracker

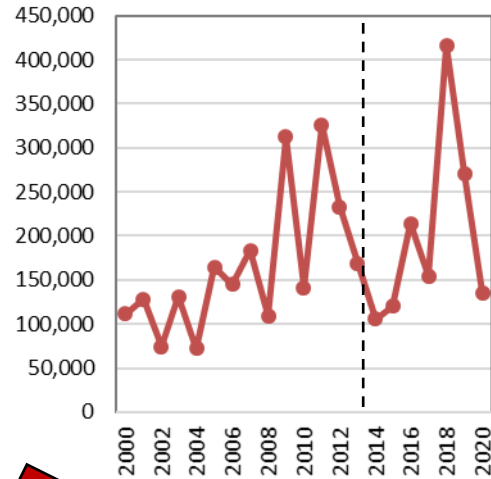
Catch by country/state shows diverse trends

(numbers of fish in 1,000s)

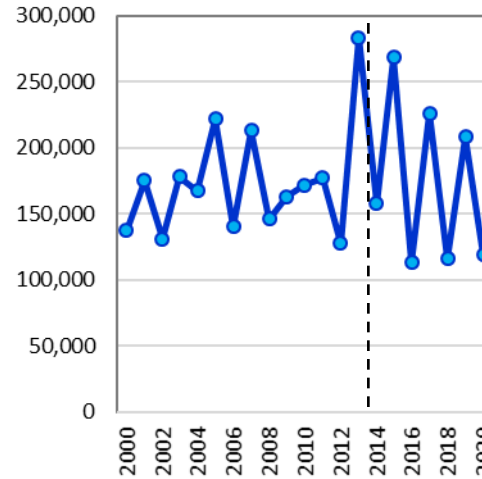
Russia chum



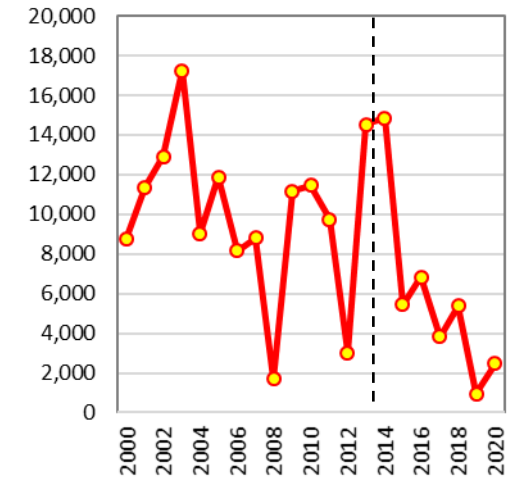
Russia pink



Alaska all spp



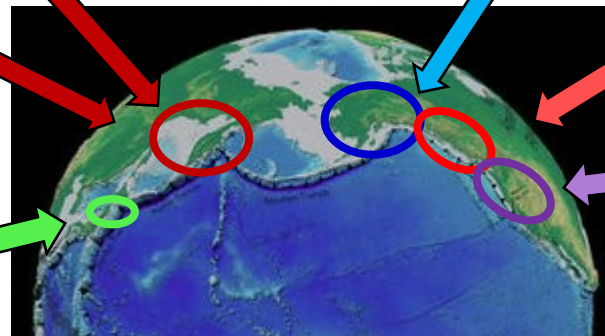
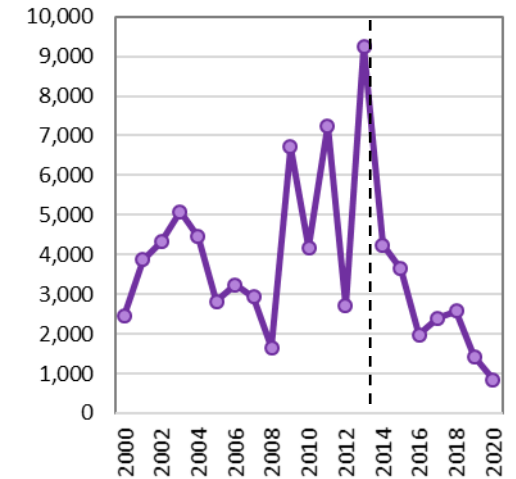
Canada all spp



Japan chum

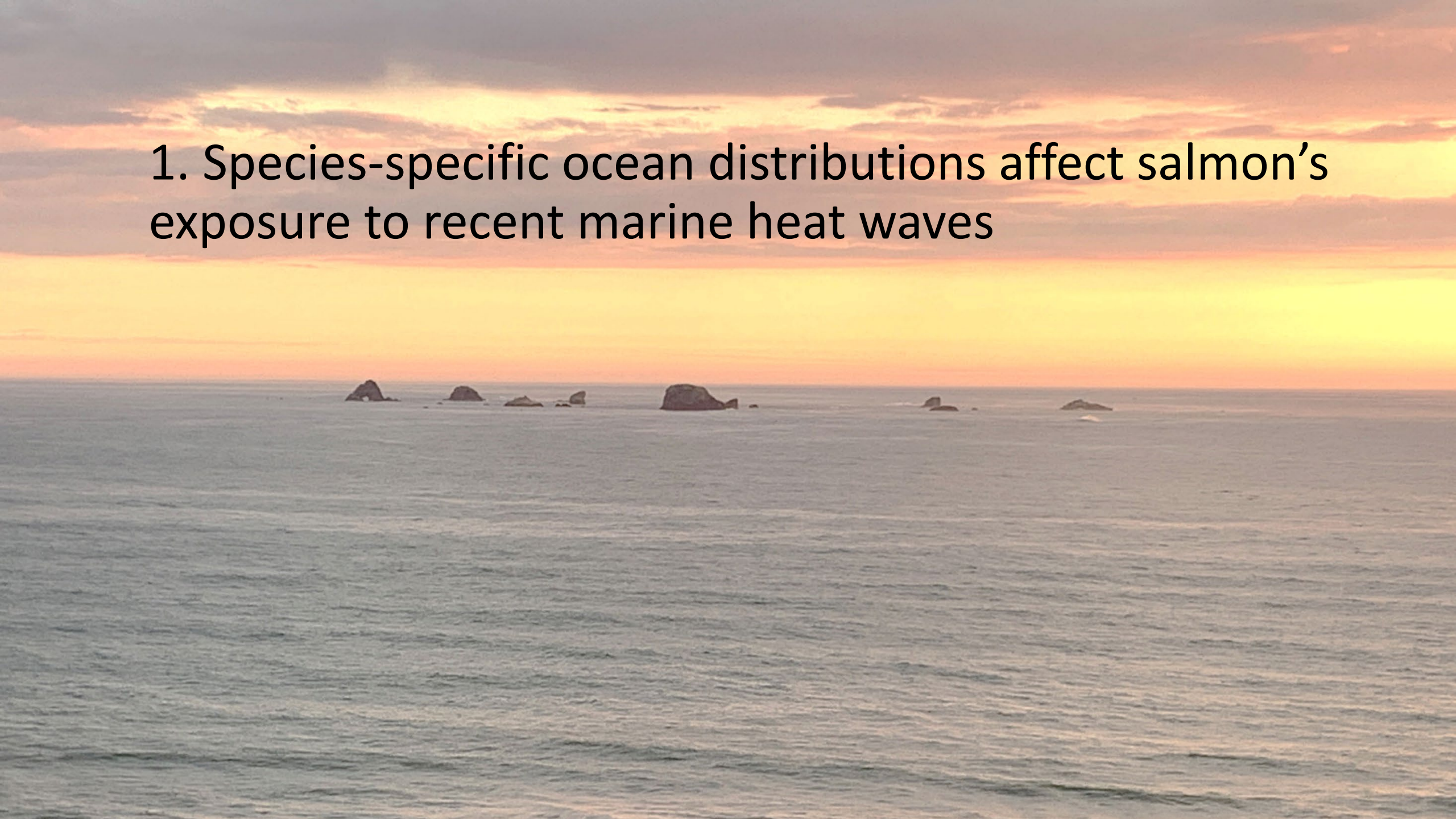


WA-OR-CA all spp



Data from NPAFC.org

1. Species-specific ocean distributions affect salmon's exposure to recent marine heat waves



First summer in the ocean: 3 patterns for Columbia River salmon

Pattern 1: Rapid north-
wards movement on shelf
to Gulf of Alaska

Which: Spring Chinook,
chum, sockeye, some coho

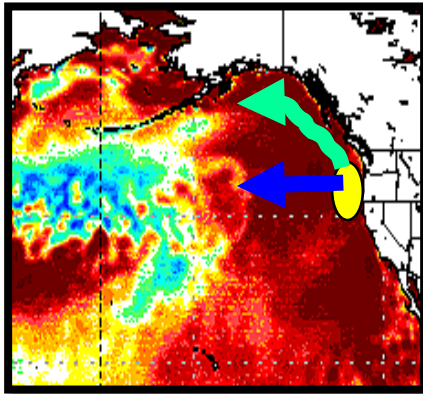


**This is when most marine
mortality is thought to occur**

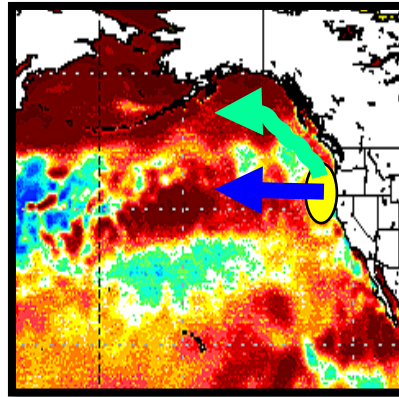
Initial ocean migrations of Columbia River salmon in recent Julys

(shading = sea surface temperature anomalies)

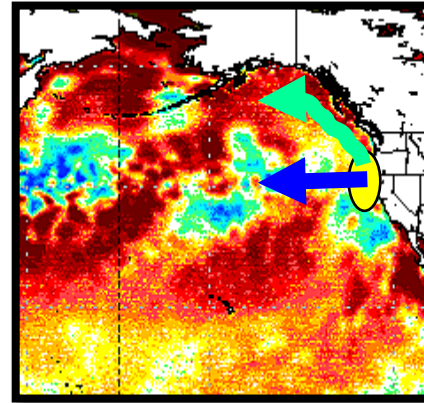
July 2015



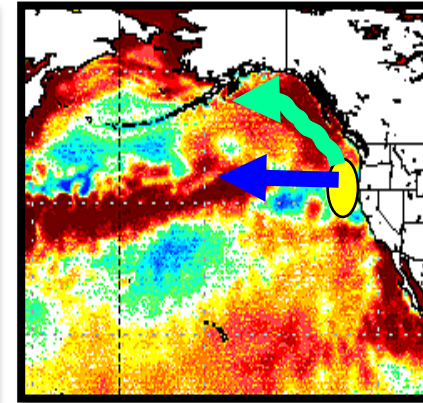
July 2016



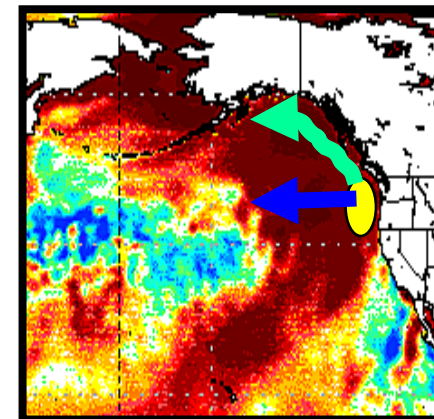
July 2017



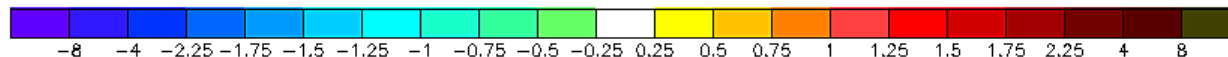
July 2018



July 2019



- ← Spring Chinook, sockeye
- ← Steelhead
- Fall Chinook, coho



degrees C

Columbia River high seas distributions



Adults returning to the Columbia: 3 general migration patterns

Pattern 1: **Southwards
movement along shelf**

Which: Fall Chinook,
Chum (?), sockeye (?)



Pattern 2: **Northwards
along California &
Oregon Coasts**

Which: Coho



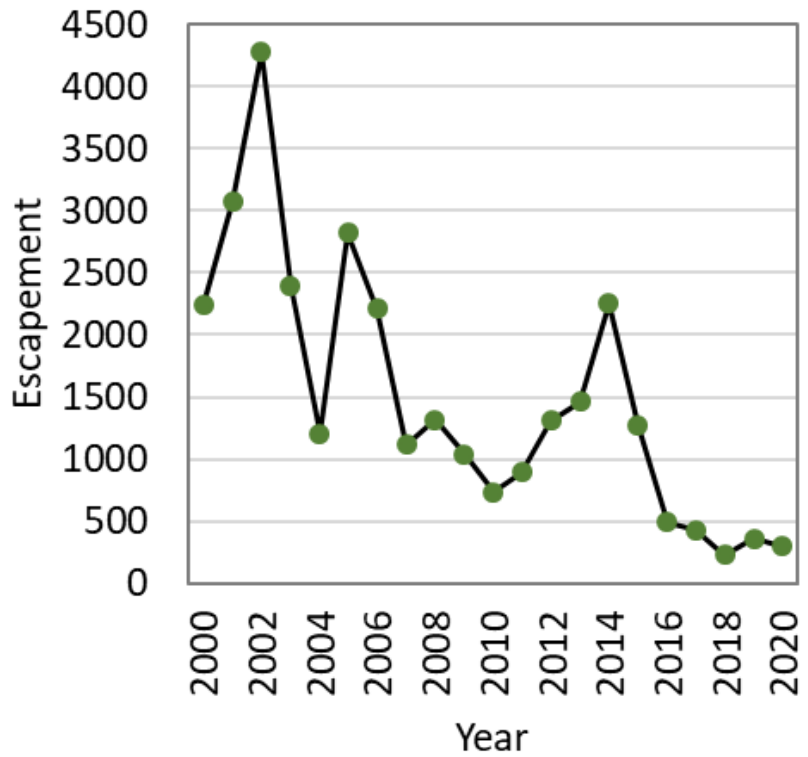
Pattern 3: **Move rapidly
onshore (or unknown)**

Which: Steelhead, Spring
Chinook

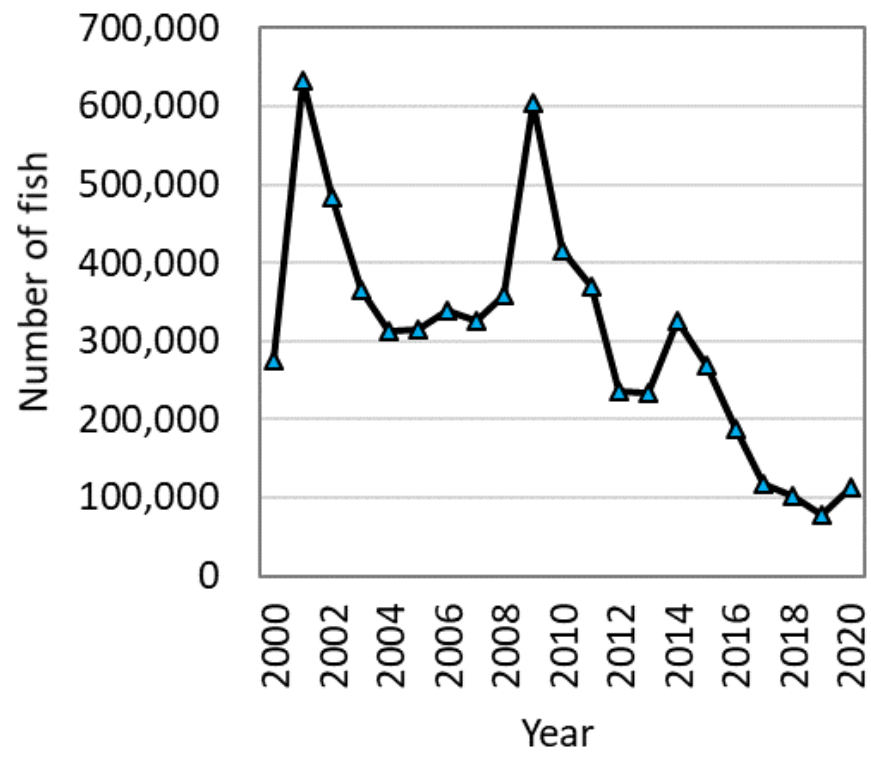


Expect that recent regional steelhead declines due to rapid movement offshore into worst of heat waves

Fraser River
(Thompson-Chilcotin)

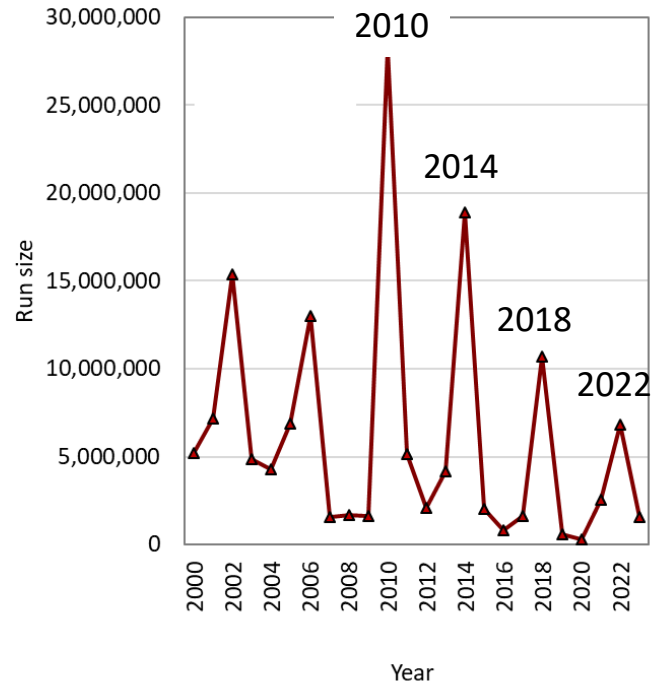


Columbia (dam counts)

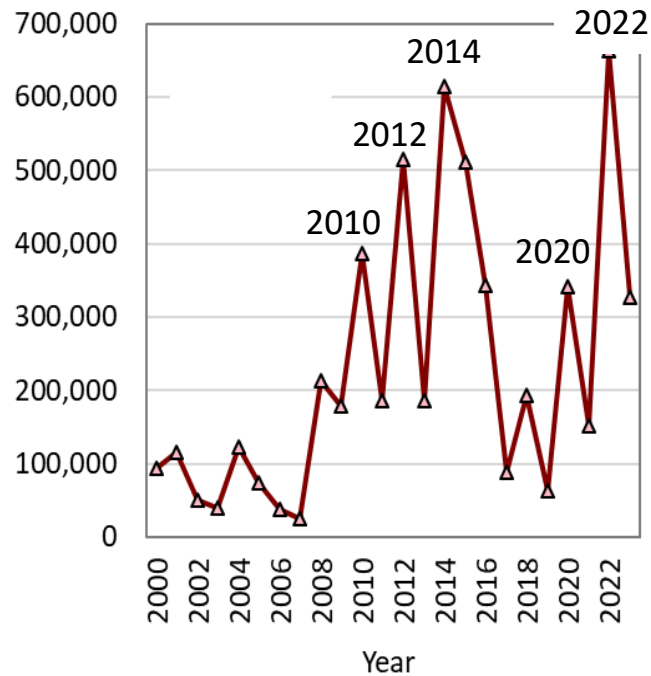


Surprisingly, Fraser and Columbia sockeye trends have diverged

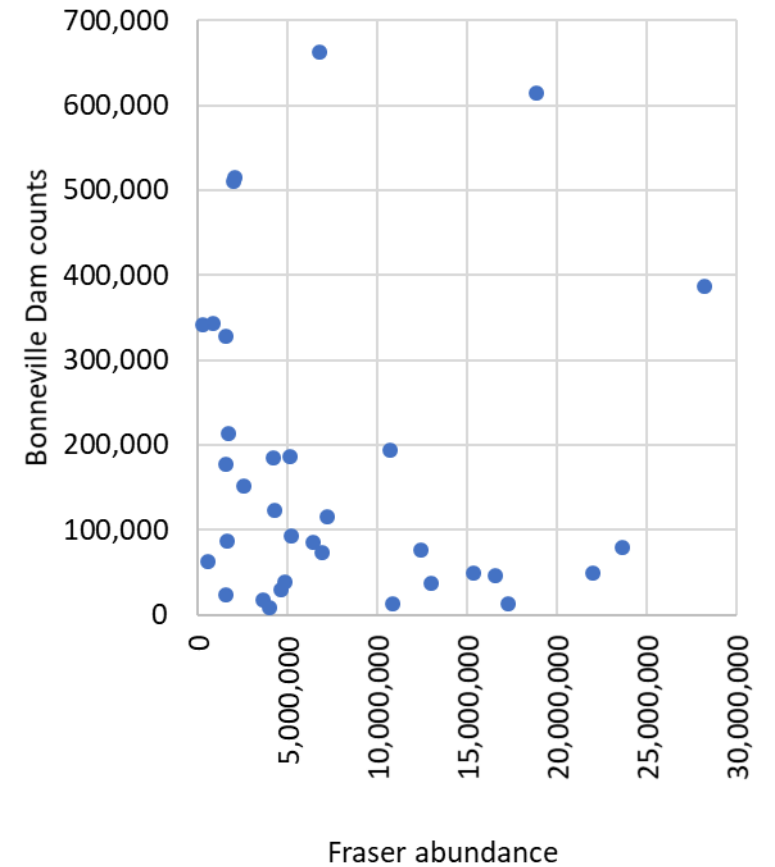
Fraser River



Columbia River (BON counts)



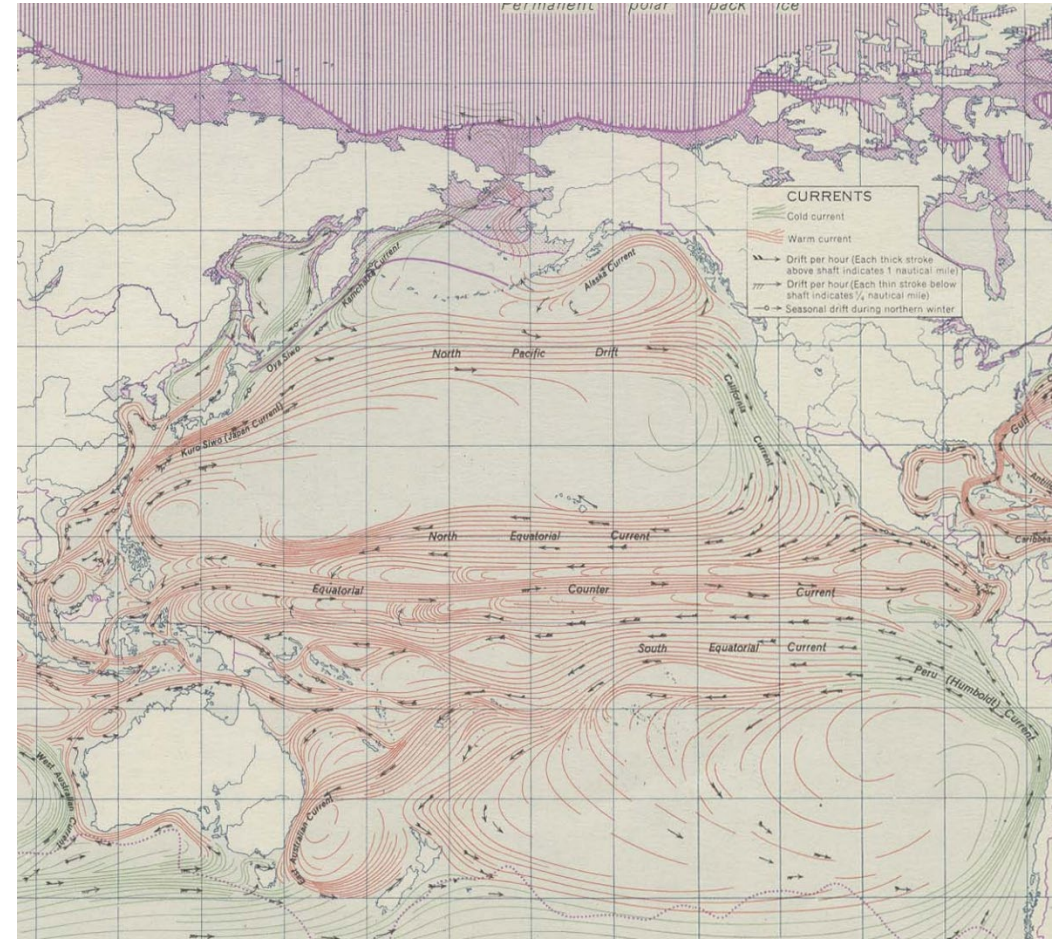
Fraser vs. Columbia abundances, 1990-2023



2. Observed distributional changes in salmon

Examples

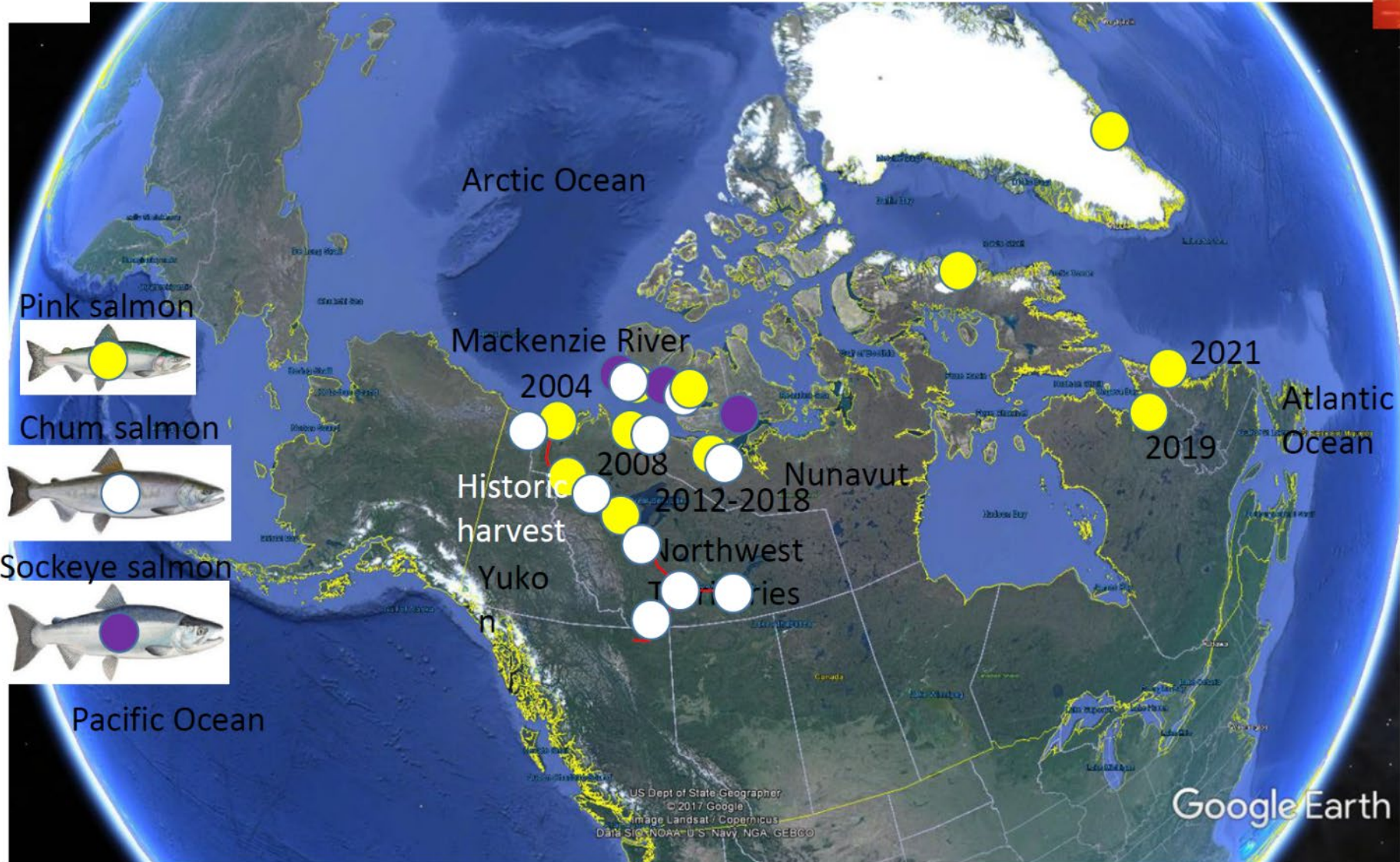
1. Salmon in the Arctic
2. Juvenile salmon in Chukchi Sea
3. Expected future Chinook salmon distributions



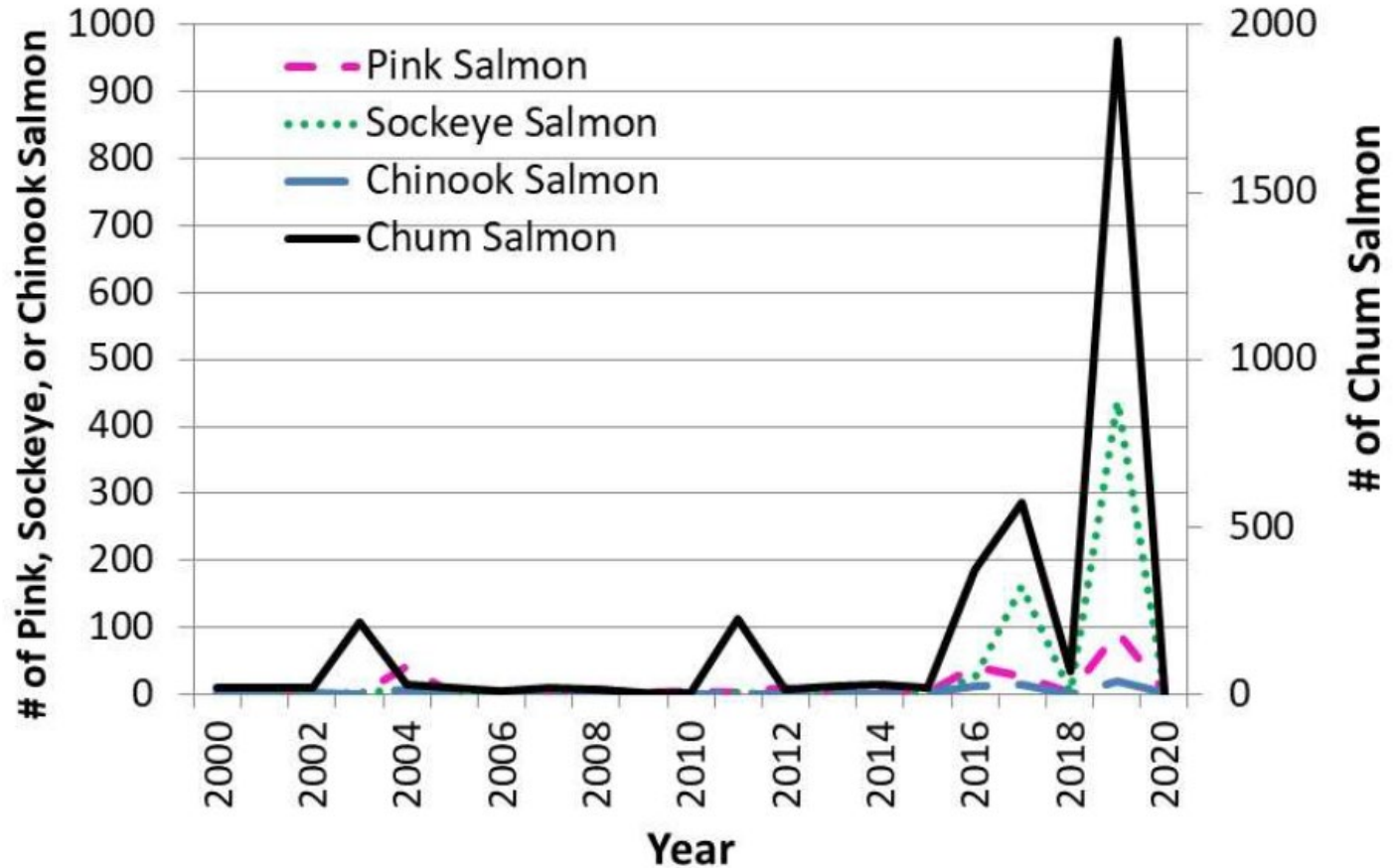


1. Arctic Salmon:

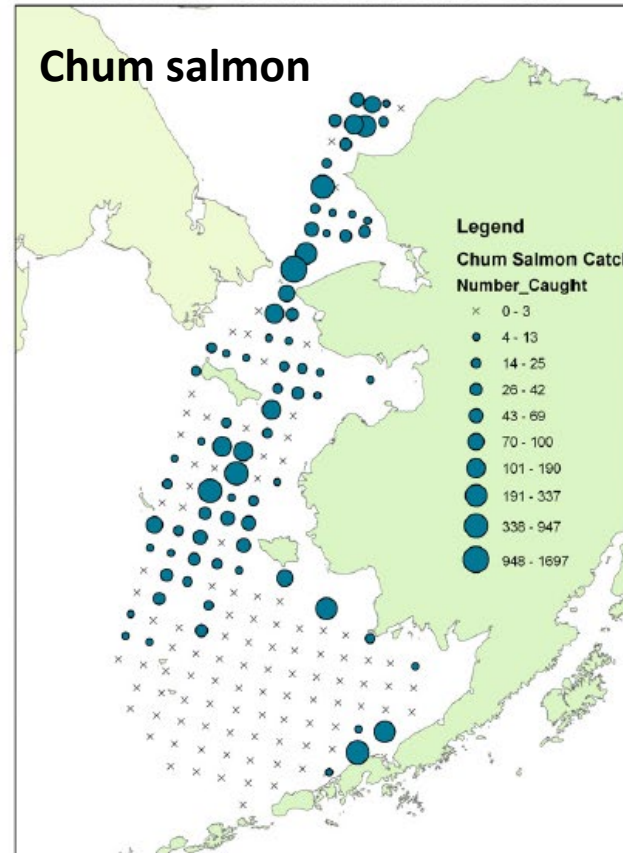
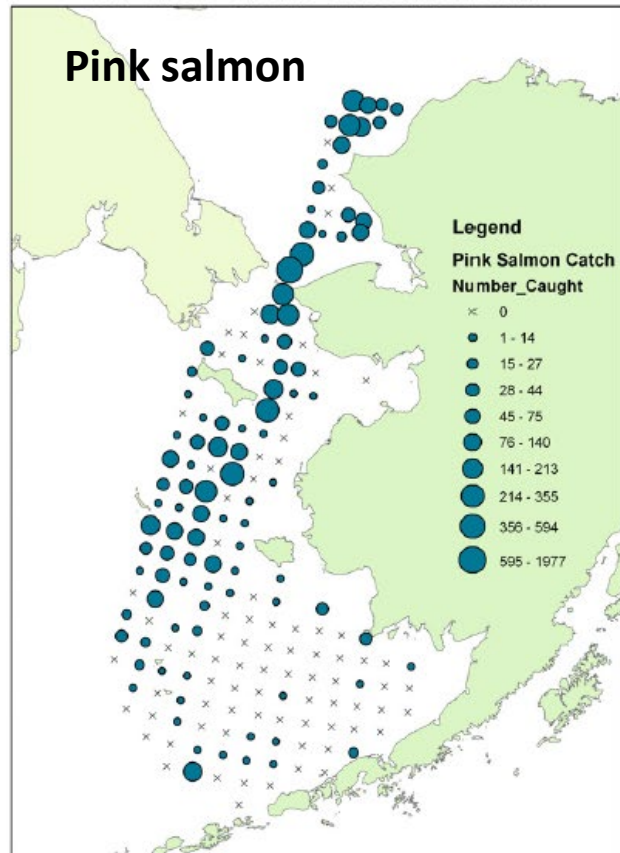
Community-led monitoring of
Arctic fish biodiversity change



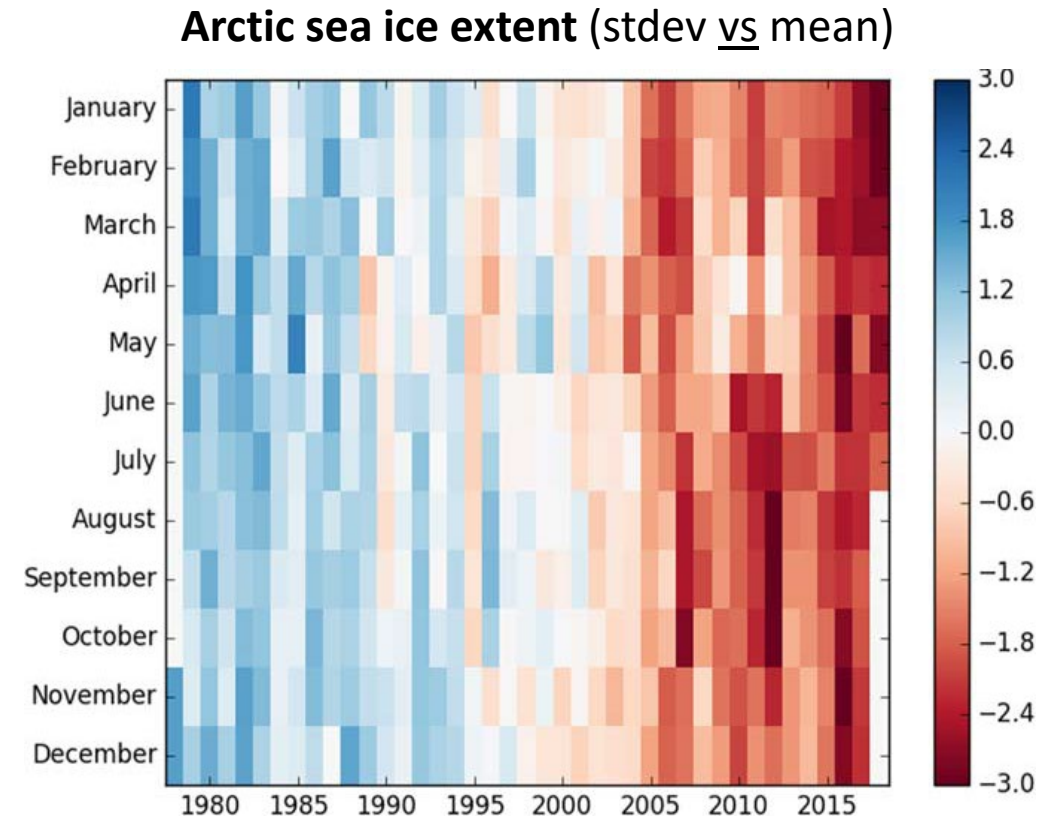
Increasing number of salmon observed across Arctic



2. Juvenile pink and chum salmon expanding northwards in Bering and Chukchi Seas as ice retreats

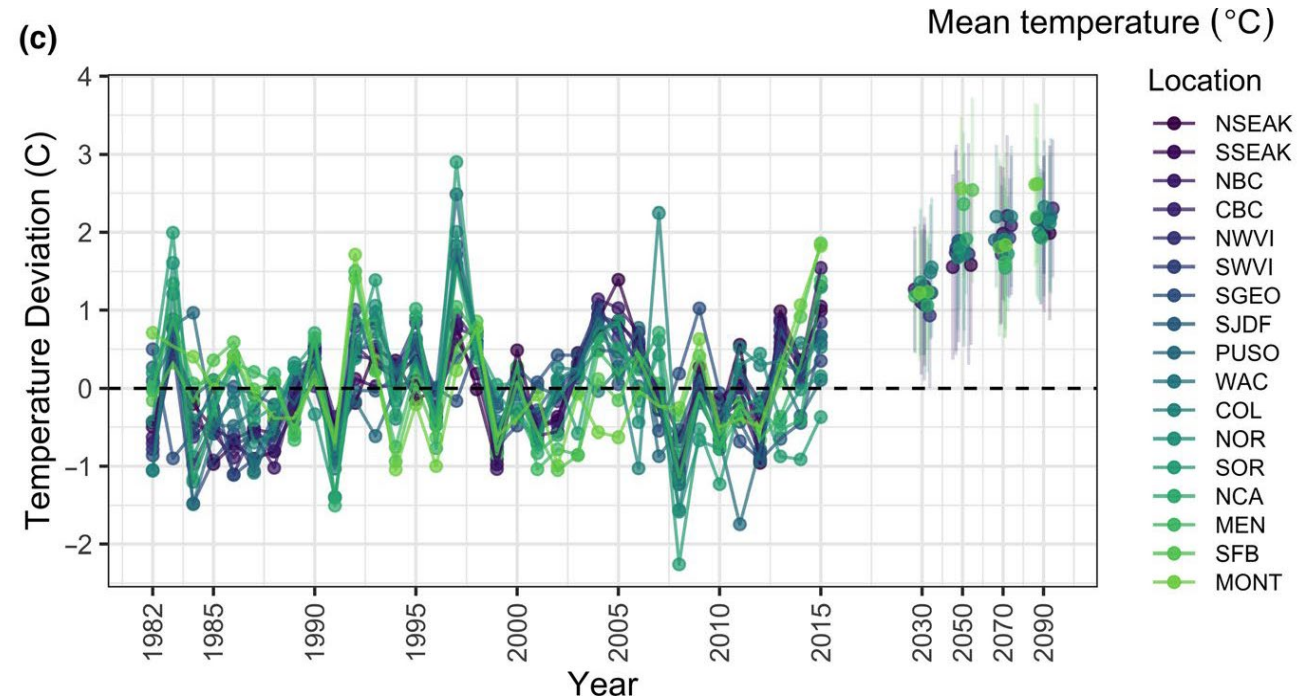
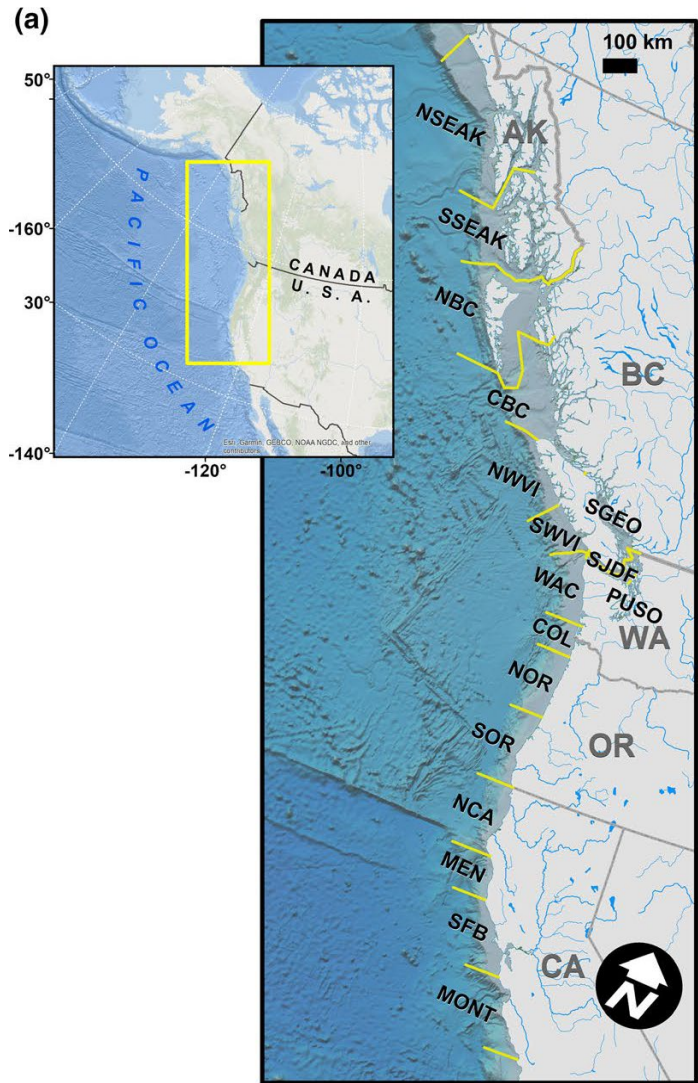


Moss et al. 2009. NPAFC Bull 5:191-196

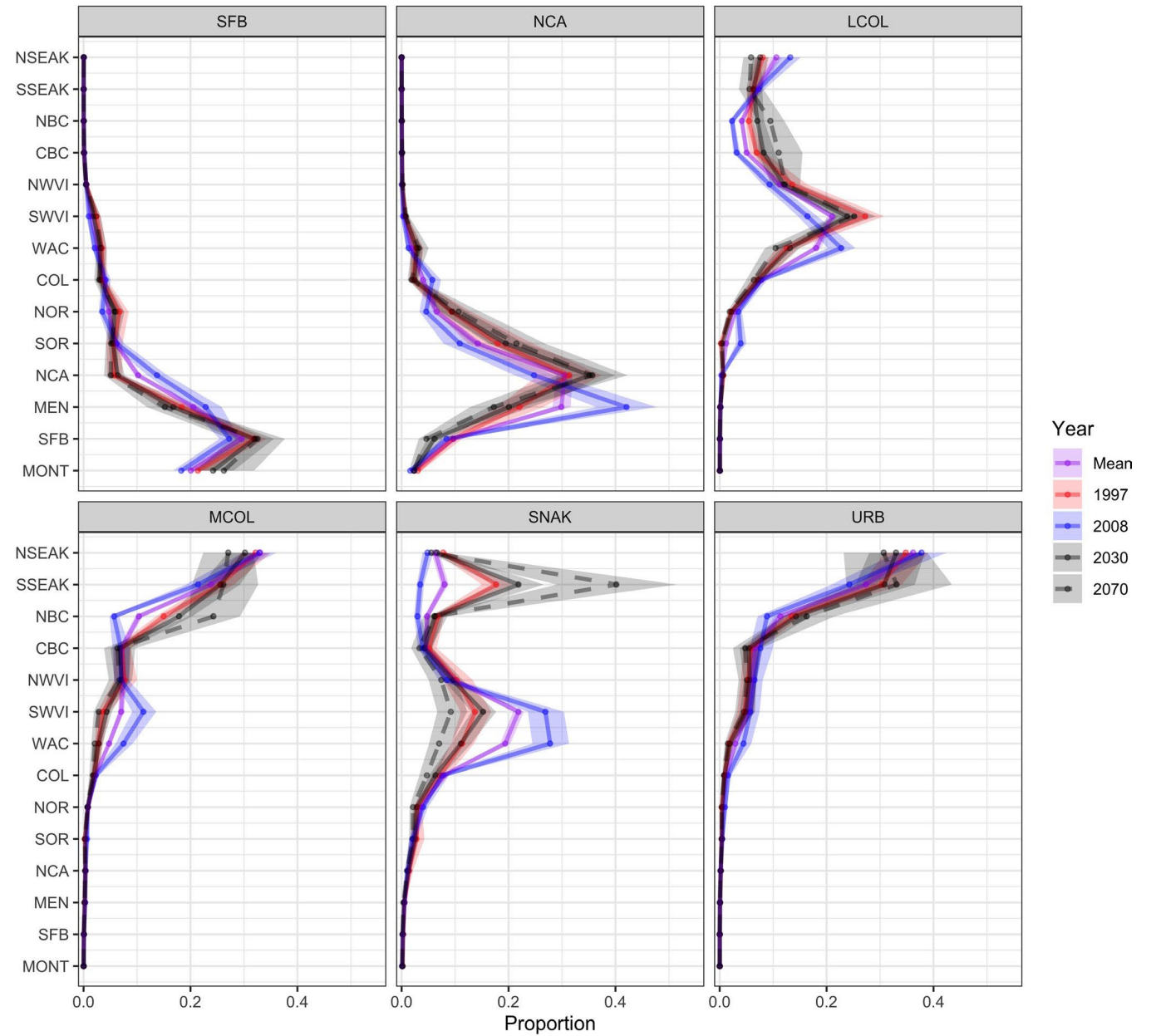


Stroeve & Notz 2018 Env Res Let 13

3. Expected fall Chinook distributions in a warming ocean (Shelton et al. 2021)



Distributions of focal stocks only slightly shifted northwards in future



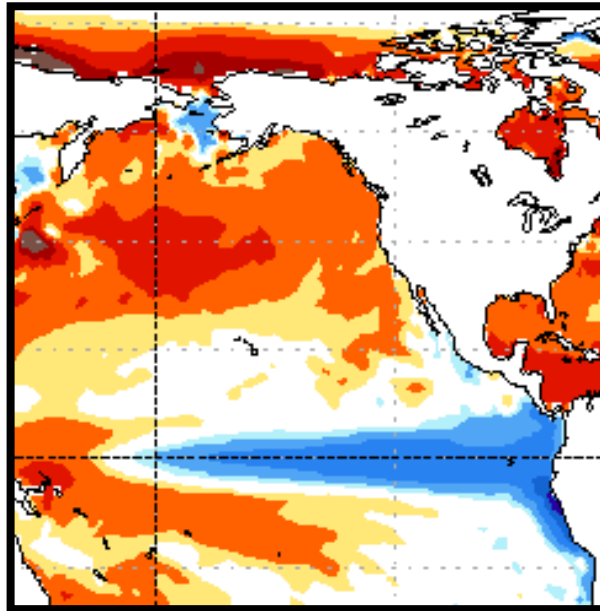
Summary and conclusions

- Expect recent species- or stock-specific changes in salmon abundance are due to ocean distributions relative to marine heat waves
 - Buffer provided by upwelling for species remaining near shore
 - Steelhead move straight offshore and into worst of heat waves
- Salmon expansion into Chukchi Sea (pink & chum juveniles) or Arctic (all species) indicates flexibility for some individuals
- Modeled small changes in fall Chinook distributions in future suggests reliance on “ancestral feeding routes” that may be slow to change.

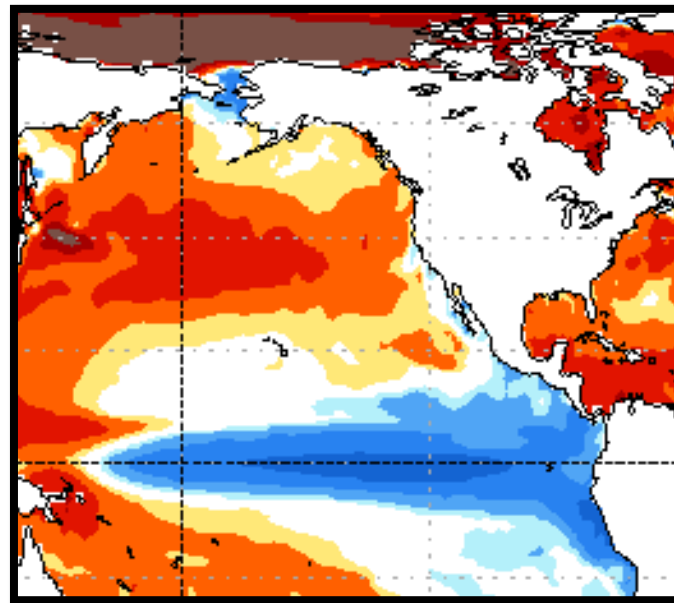
Forecast SST anomalies for this summer show lots of warm water across N Pacific but La Niña brewing at equator

CFSv2 forecast seasonal SST anomalies

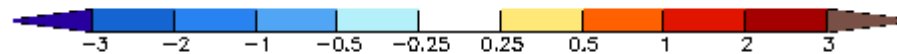
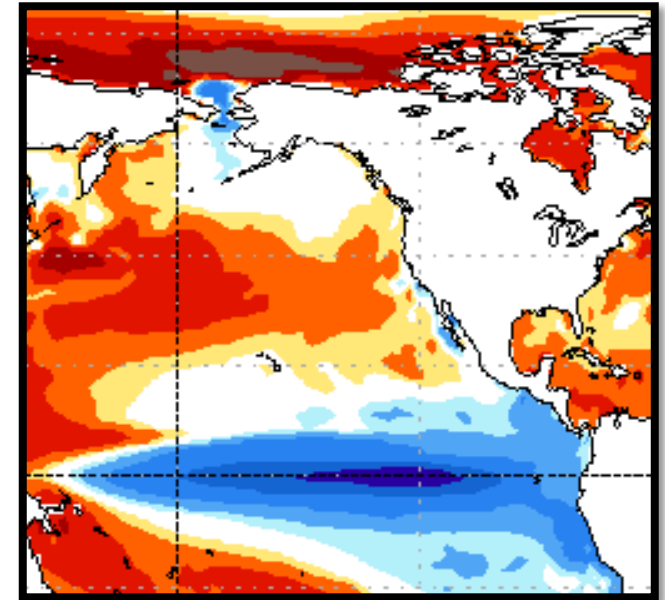
May-June-July



July-Aug-Sep



Sep-Oct-Nov



<https://www.cpc.ncep.noaa.gov/products/people/wwang/cfsv2fcst/>

Upwelling keeps heat waves offshore in N California Current in spring and early summer (monthly SST anomalies)

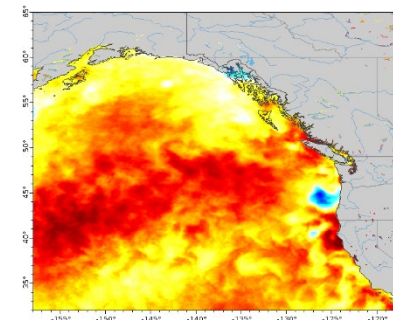
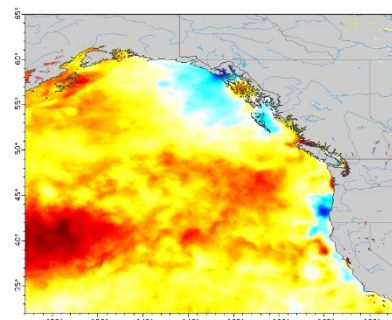
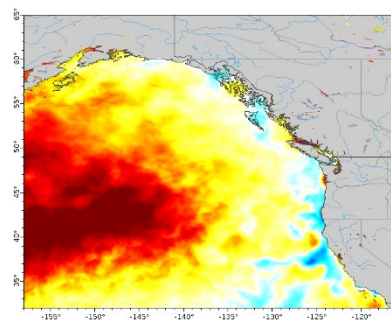
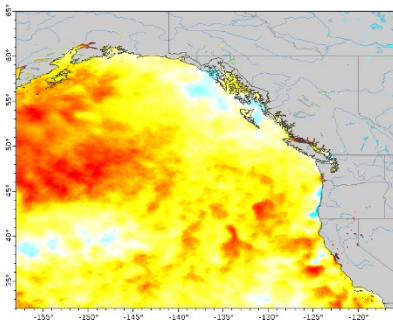
June

July

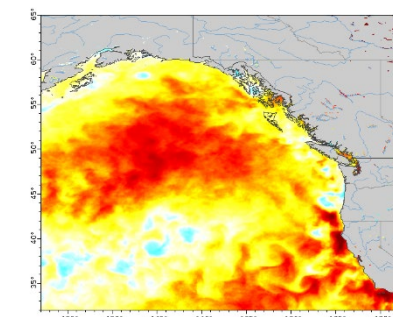
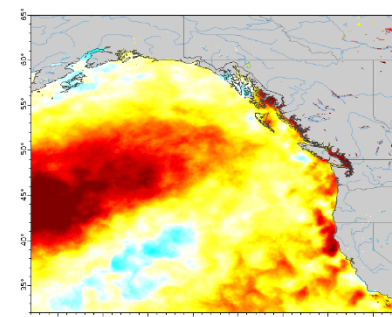
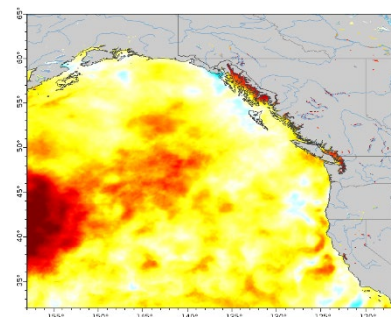
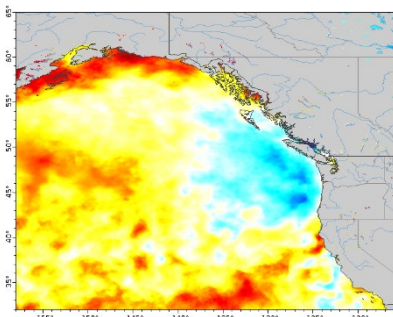
August

September

2021



2022



2023

