April 7, 2020

MEMORANDUM

TO: **Fish and Wildlife Committee members**

FROM: **Mark Fritsch**

SUBJECT: **Recent Ocean Observations and Outlooks for Salmon Returns**

BACKGROUND:

Presenter: Brian Burke (Research Fishery Biologist at NOAA's NW Fisheries Science Center)

Summary: The Council will be briefed on the 2019 returns and NOAA's 2020 run forecasts of adult salmon and steelhead based on ocean conditions.

Brian Burke of NOAA's NW Fisheries Science Center in Seattle will present the outlook for Chinook and Coho returns to the Columbia River based on local and regional ocean conditions. This will be followed by a briefing from Oregon, Idaho and Washington on the Columbia River Basin salmon and steelhead returns for 2019 and run forecasts for 2020.

Relevance: This information is relevant to our high-level indicators by providing a preview for what is expected for adult returns in the current year.

Workplan: Fish and Wildlife Division preliminary work plan 2020; Program Implementation (2014 Program and 2020 addendum); Other program implementation.

More Info: Ocean conditions and return forecasts report from 2019

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

NOAA's Ocean Salmon Research

Northwest Power and Conservation Council Meeting

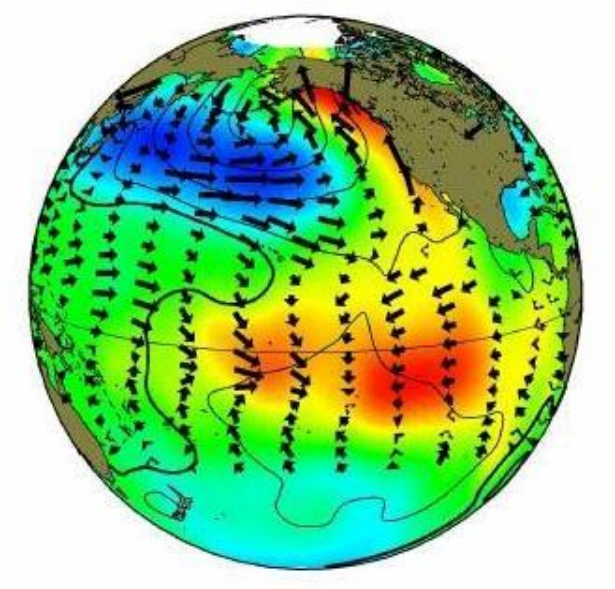
March 17th, 2020

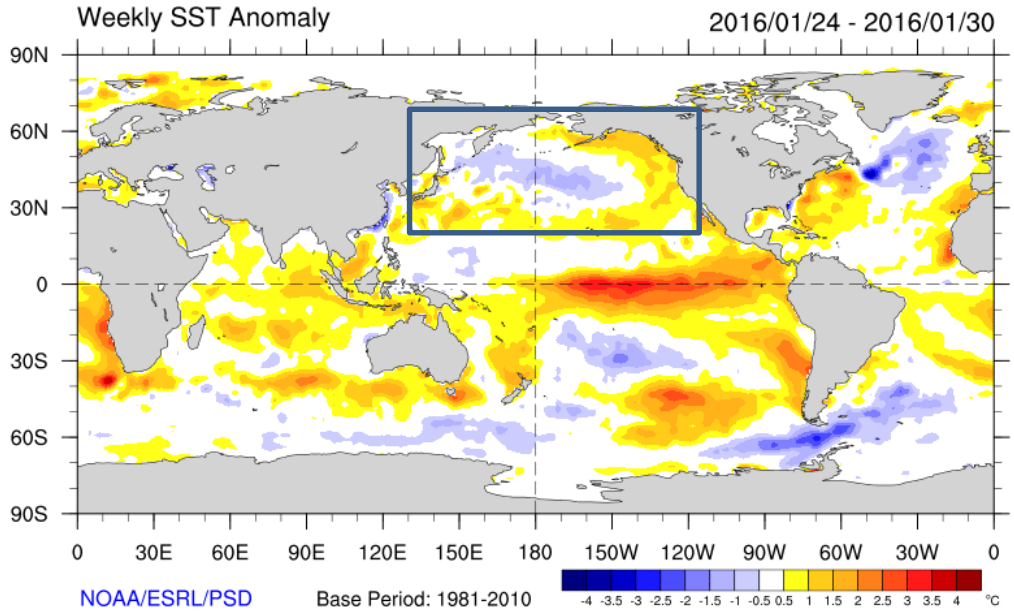
Presenter: Brian Burke
NOAA Fisheries, NWFSC

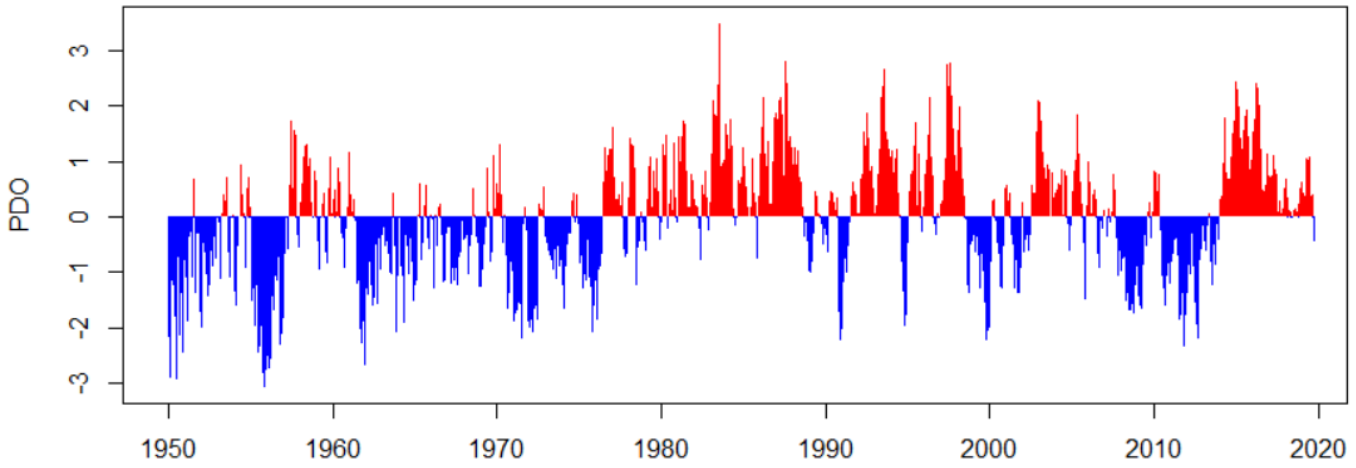
Supported by:

1. Background
2. Ocean Research
3. Modeling Survival

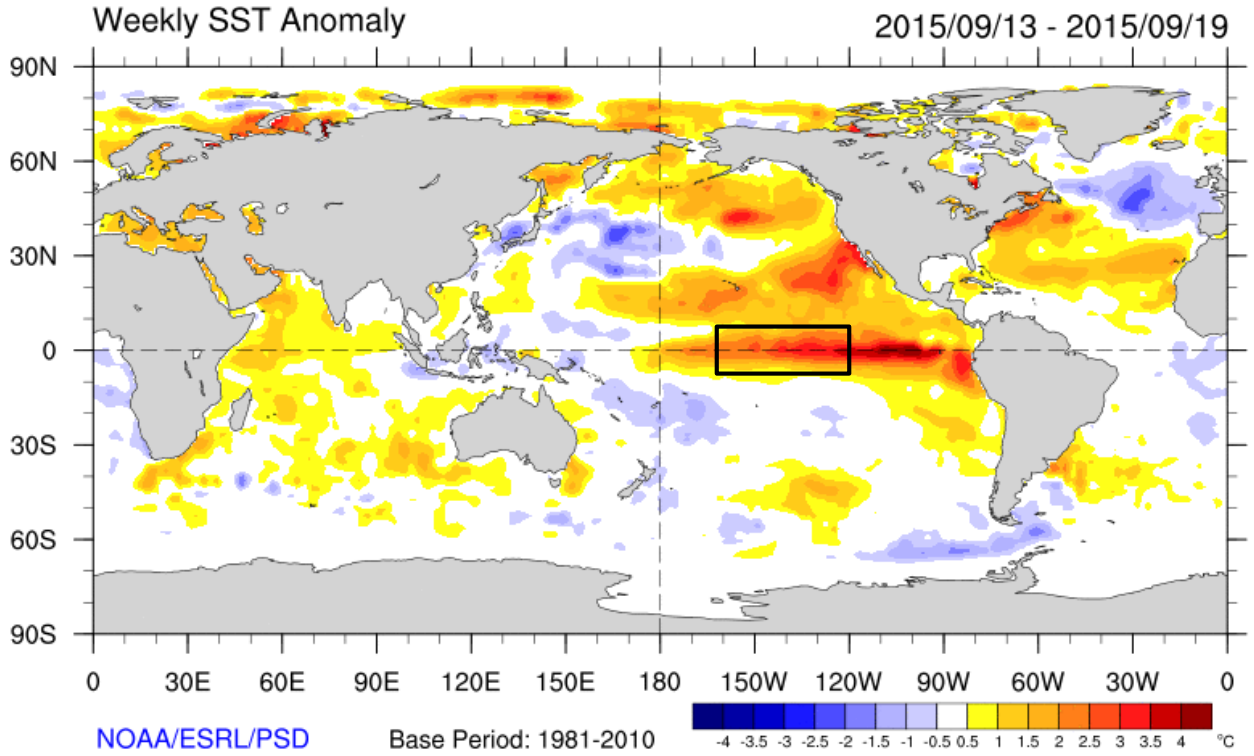
Pacific Decadal Oscillation (PDO)

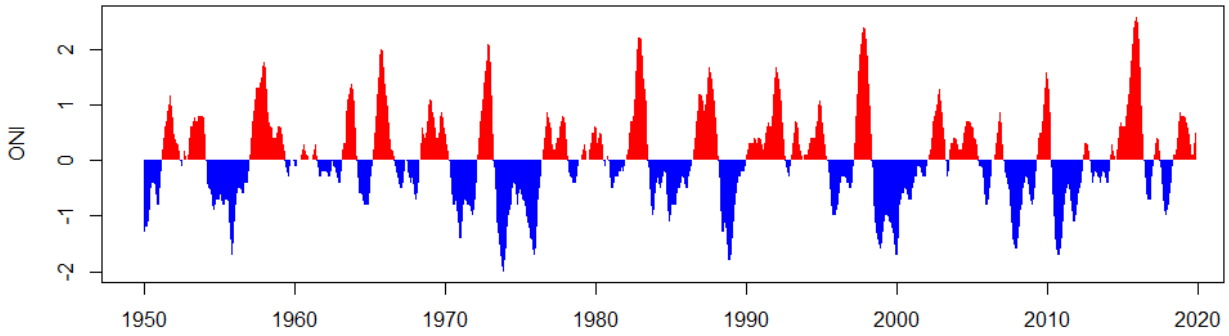




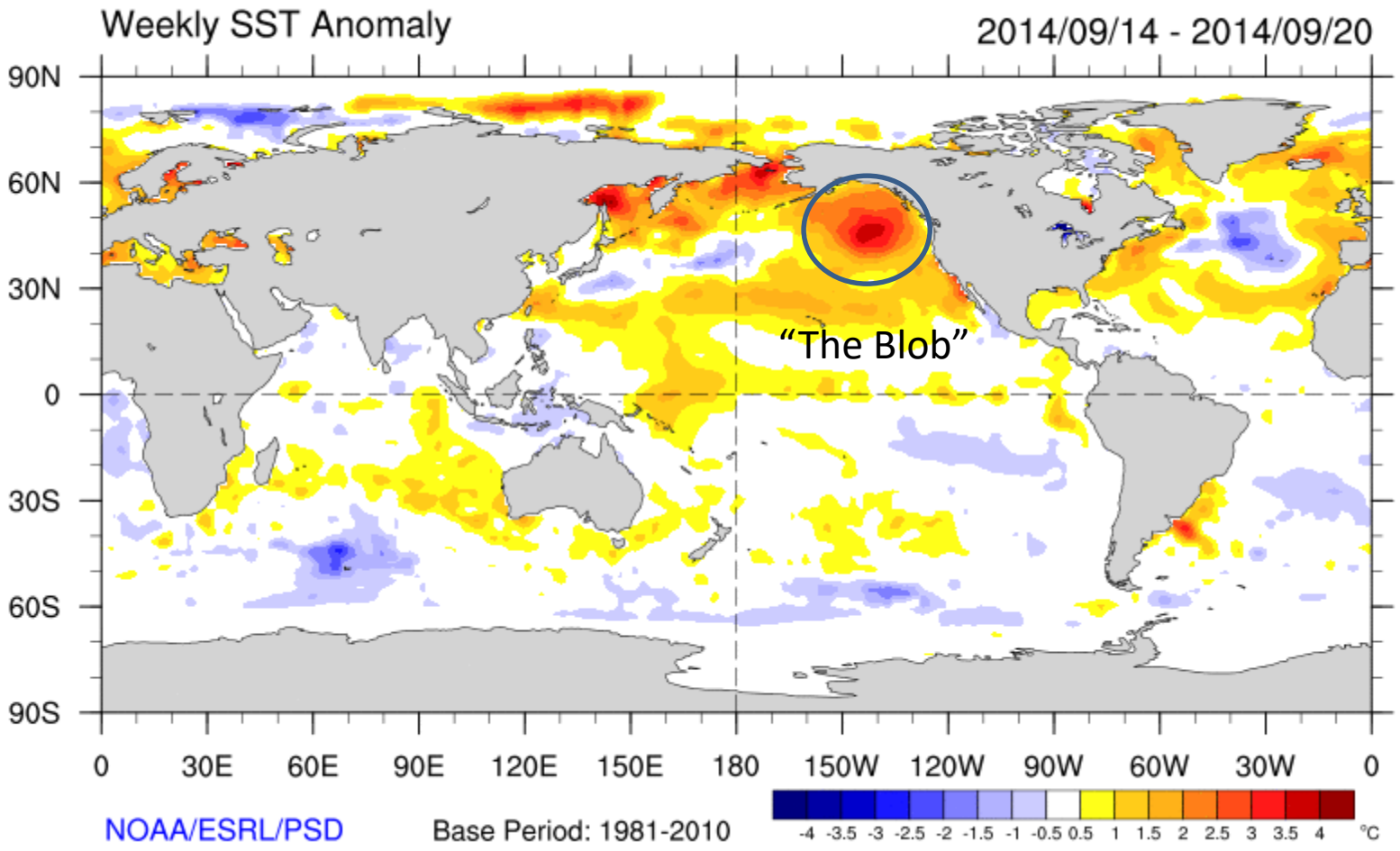


El Niño


Weekly SST Anomaly
2015/09/13 - 2015/09/19
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
NOAA/ESRL/PSD
Base Period: 1981-2010
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0.5 1 1.5 2 2.5 3 3.5 4
°C


ONI
2
1
0
-1
-2
1950
1960
1970
1980
1990
2000
2010
2020

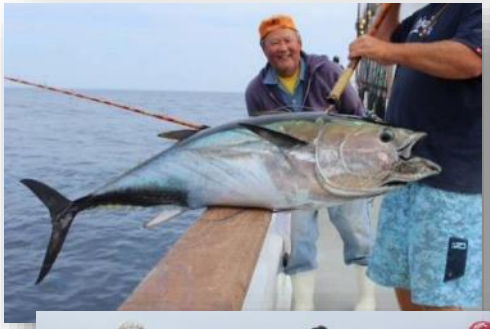
Marine Heat Wave



* High pressure reduces winter storms, resulting in less mixing with deep, cold water

Biological Response

Range Expansions

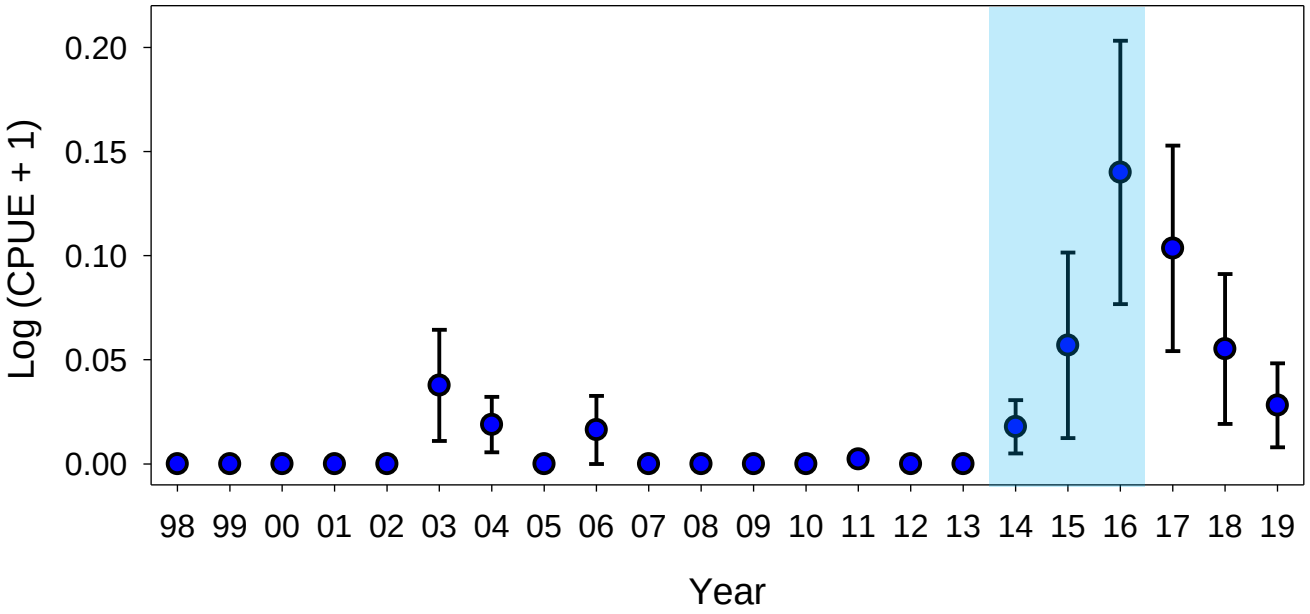






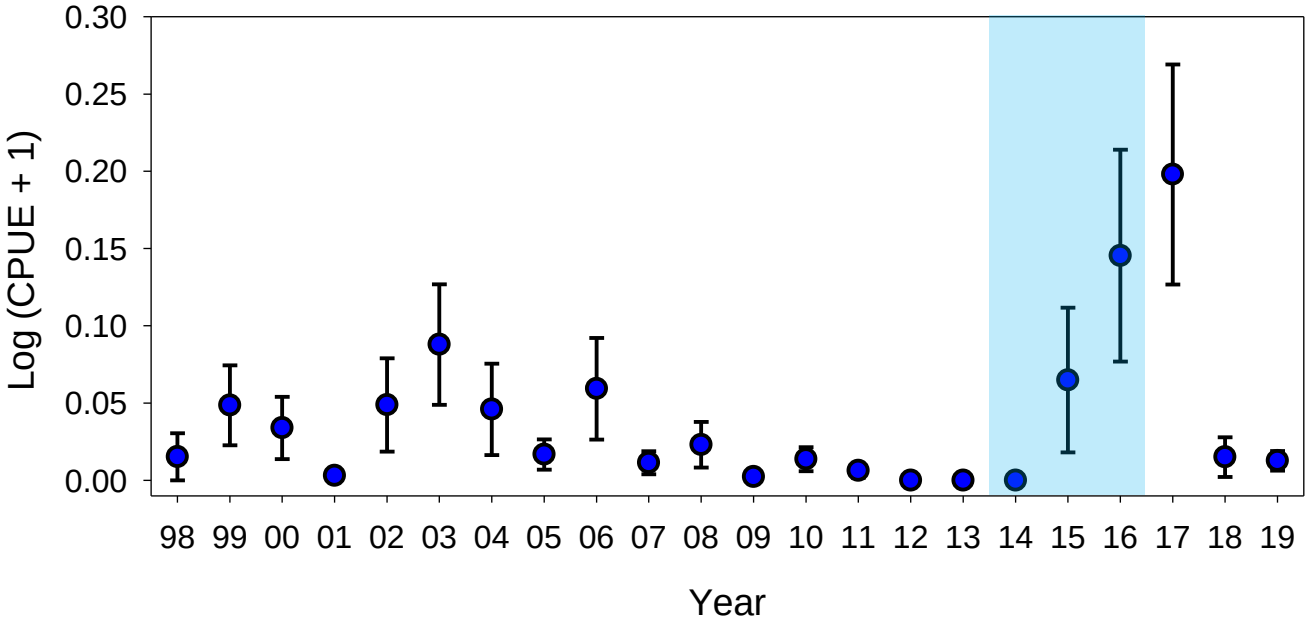



Pacific Pompano



Peprilus simillimus

Jack Mackerel

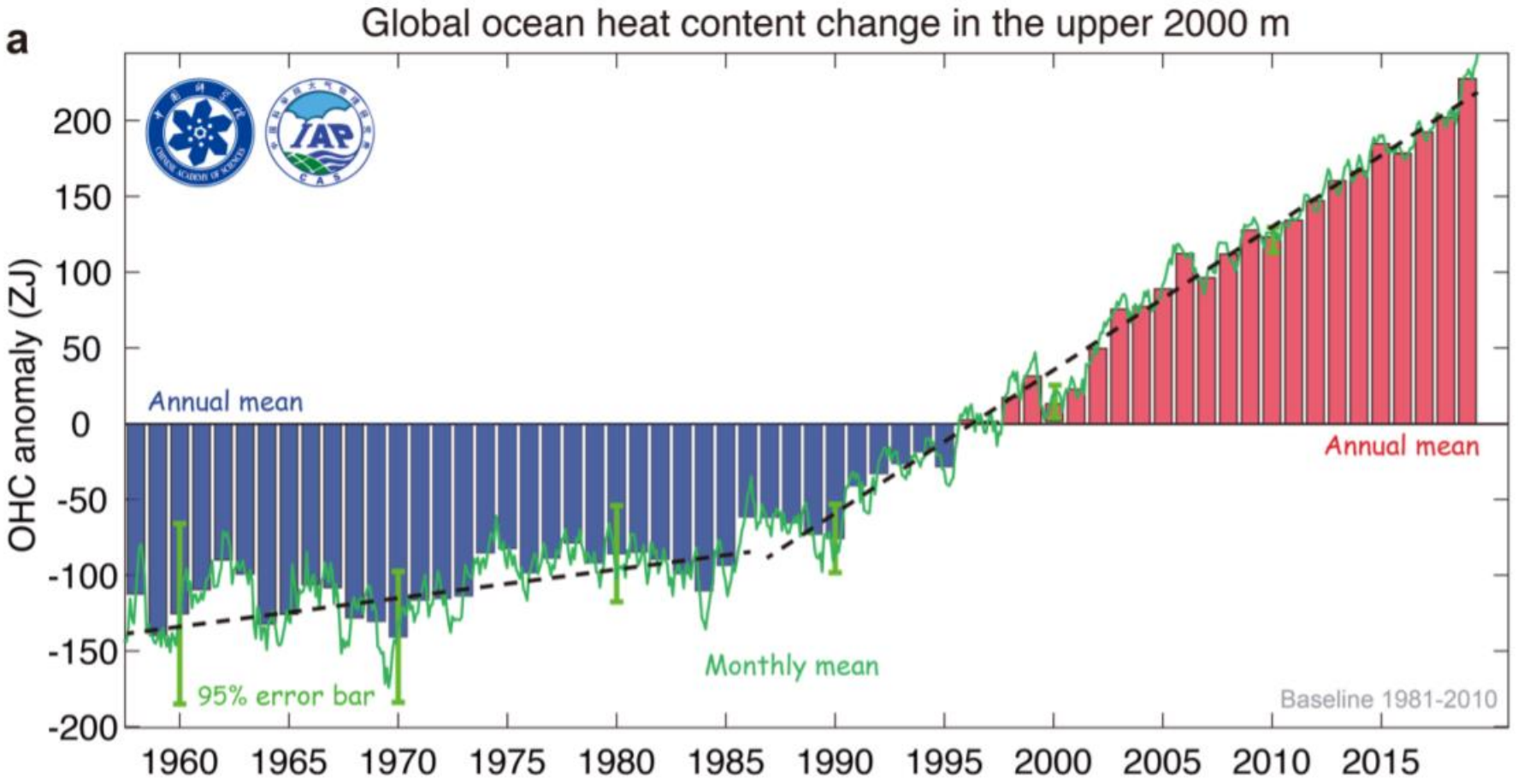


Trachurus symmetricus

Biological Response

Lack of Food and Disease

Unfortunately, I don't see it getting better any time soon

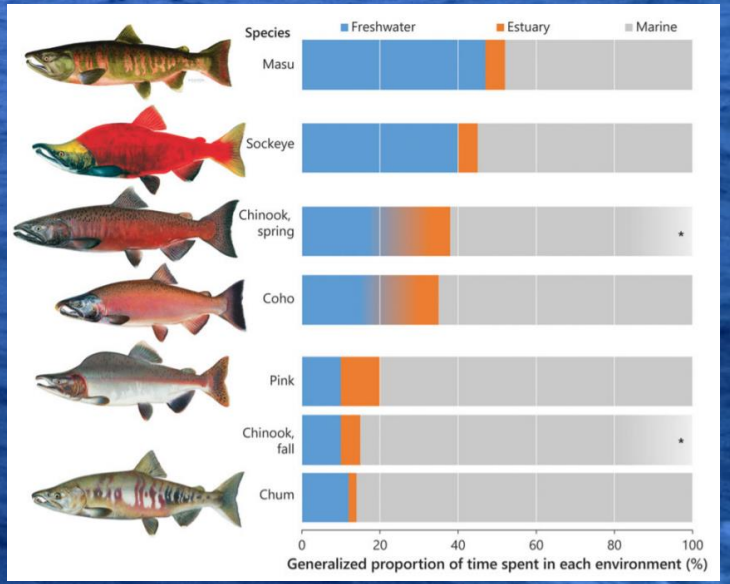


Cheng, *et al.* 2020. *Adv. Atmos. Sci.* **37,** 137–142. doi:10.1007/s00376-020-9283-7

Why study salmon in the ocean?

The ocean is where:

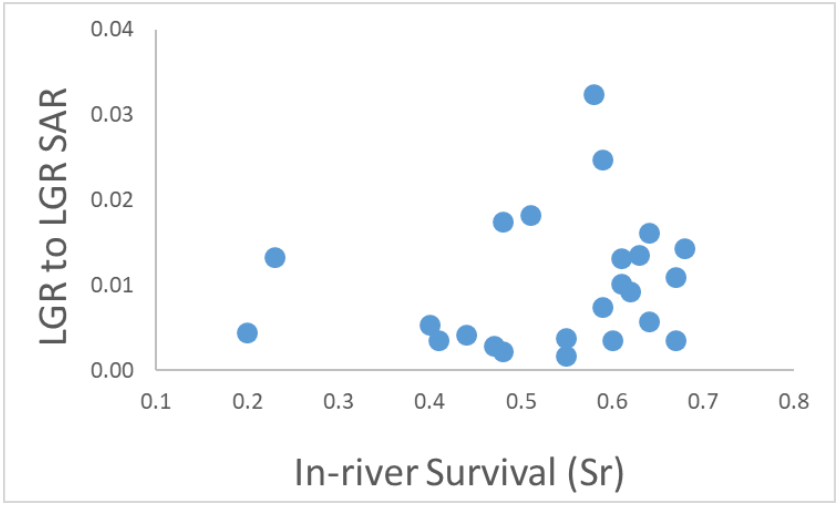
- salmon spend most of their life
- they gain most of their adult size
- adult abundance is largely determined
- each species behaves differently
- we understand the least

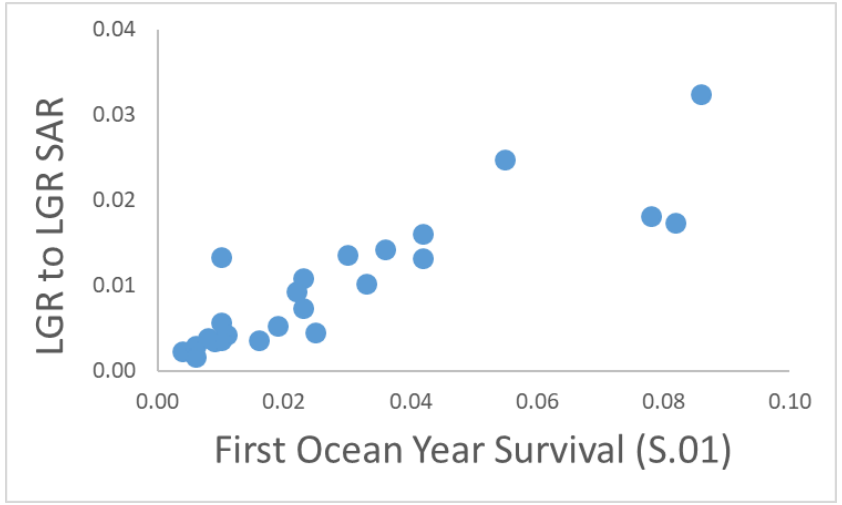


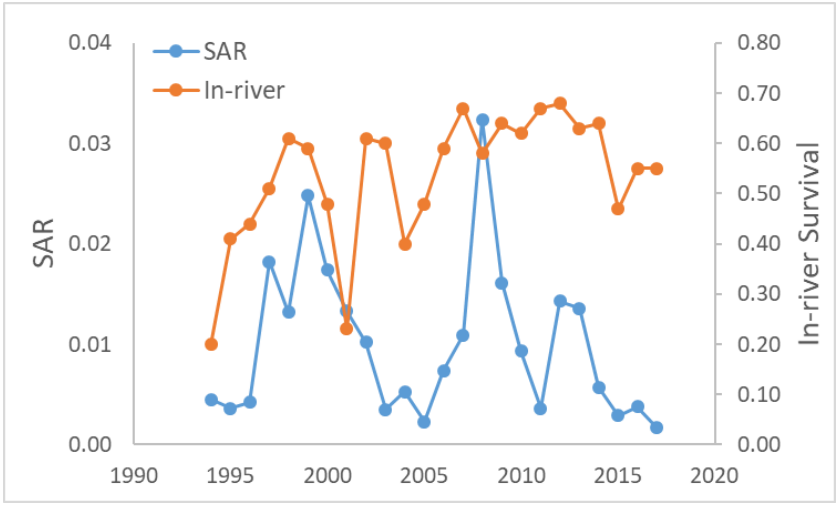
Flitcroft et al. 2018
https://doi.org/10.1111/1752-1688.12708

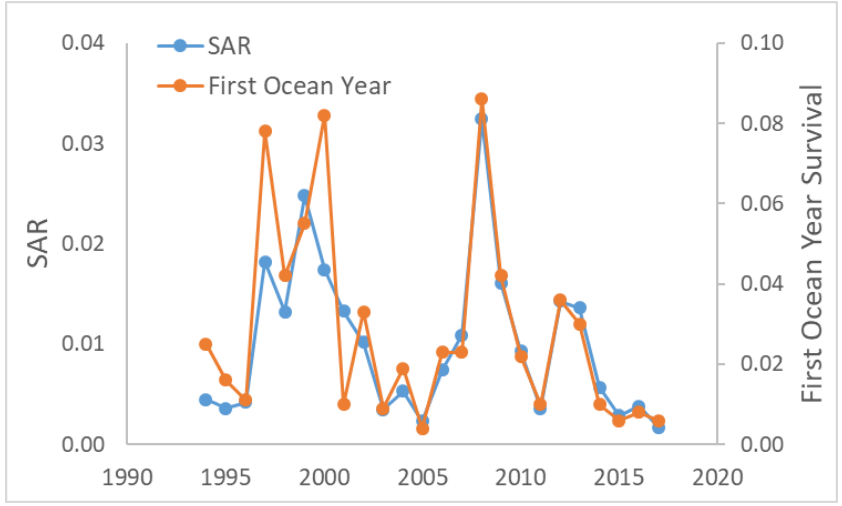
Where is Variability in Survival Occurring?

Wild Snake River spring/summer Chinook, 1994-2017







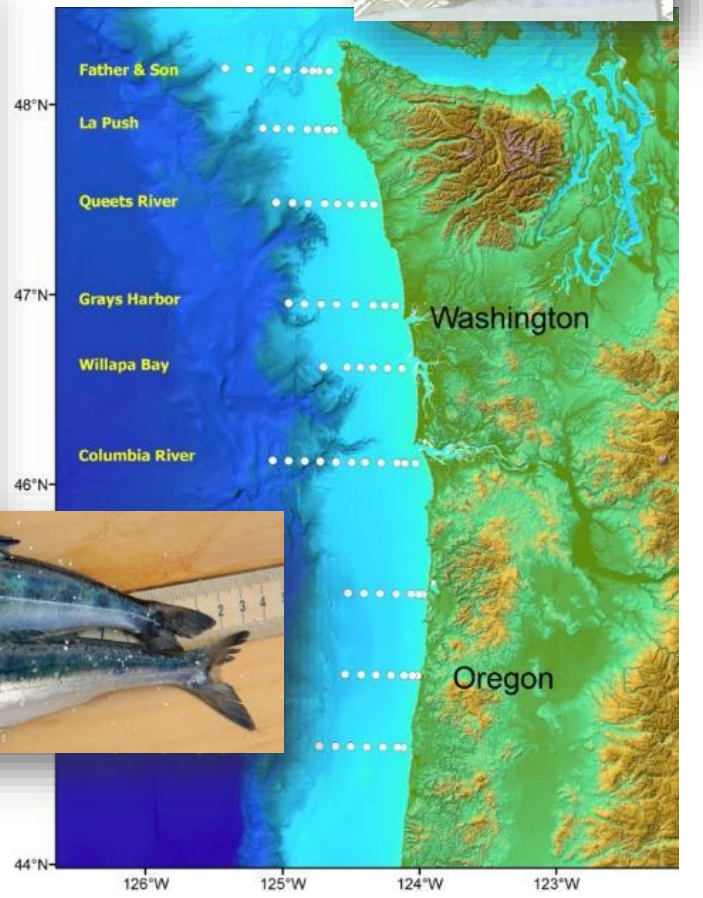


Data from Table B.126 in 2019 CSS report:
http://www.fpc.org/documents/CSS/2019CSSAnnualReport.pdf

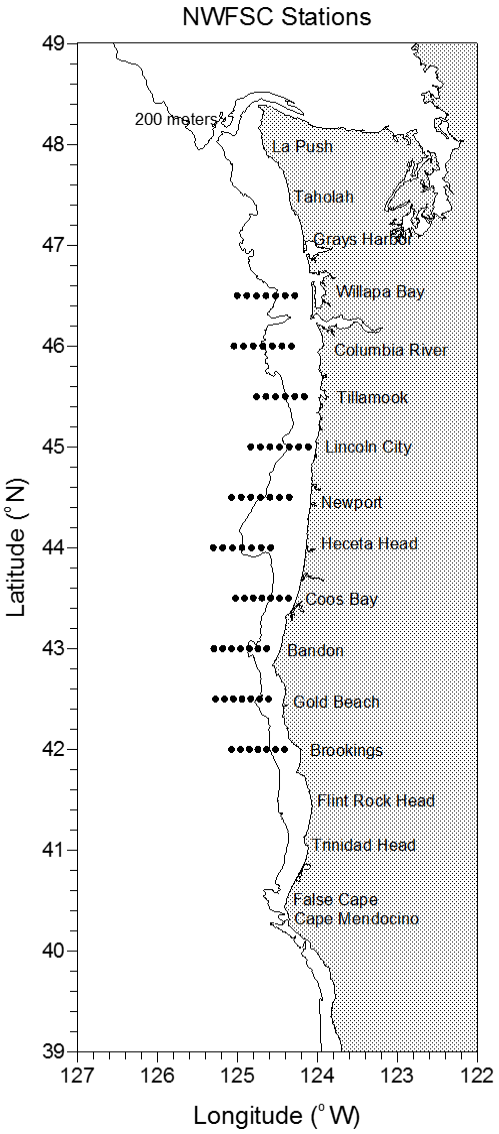
Juvenile Salmon and Ocean Ecosystem Survey (JSOES)

- May (2006 – 2012, 2015 - present)
- June (1998 – present)
- September (1998 – 2012, 2015)

Photo credit: Pacific Dror



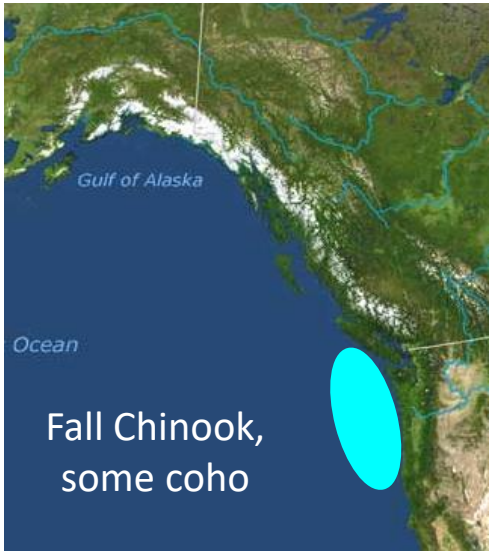
Newport Hydrographic Line and Pre-recruit Ecosystem Assessment Survey



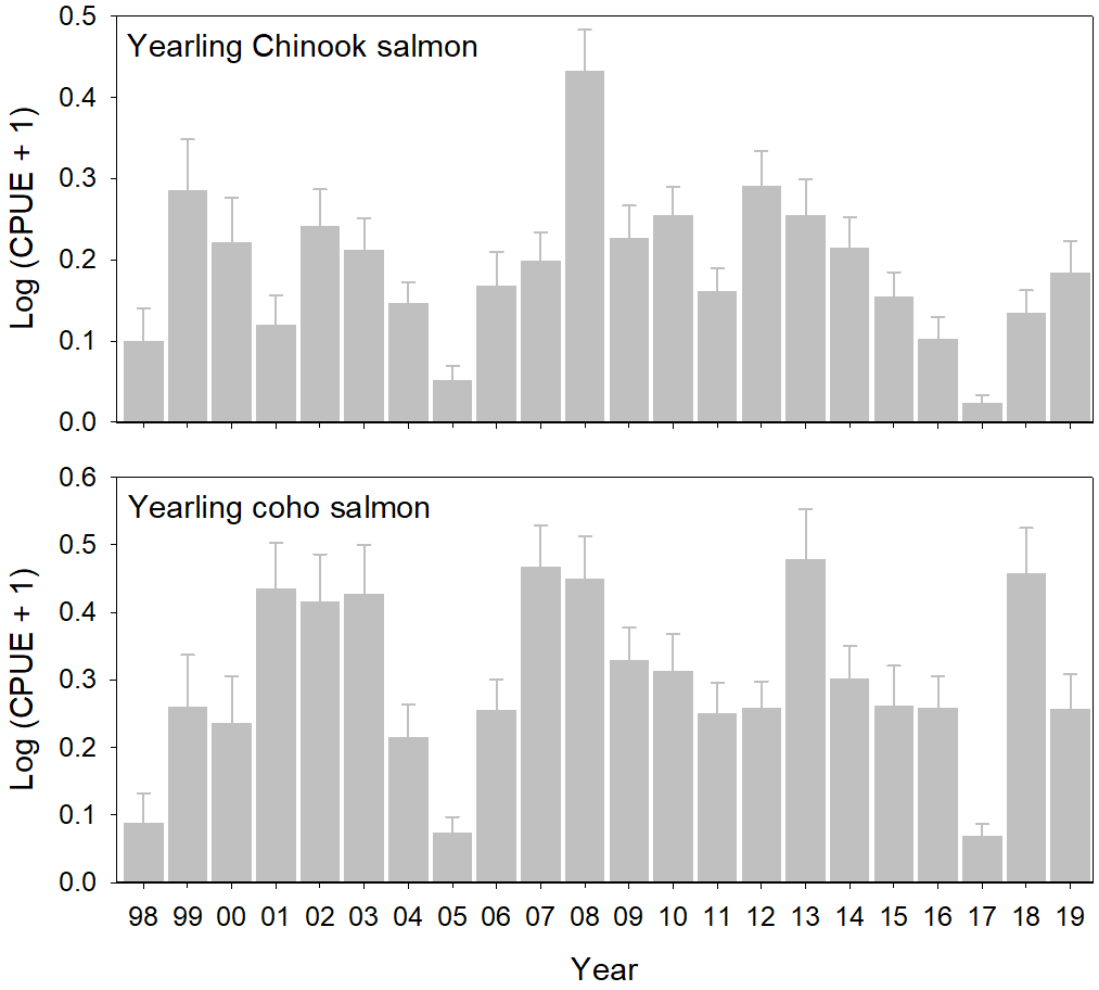
NH Line: Sampled biweekly for 25 years (1996 – present); CTD, nutrients, chl-*a*, phytoplankton and HABs, zooplankton, ichthyoplankton

Pre-recruit: May-June (2011, 2013-2019); night trawls at 30 m depth, plankton, CTD, acoustic, seabird and mammal surveys

Columbia River Salmon Migration Patterns



Chinook and Coho CPUE was about average in 2019

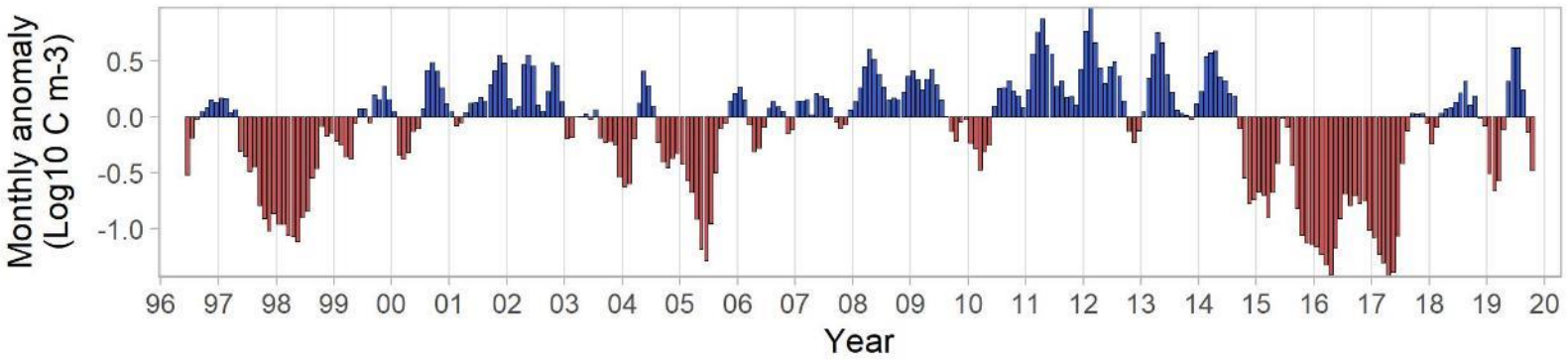


Juvenile Salmon and Ocean Ecosystem Survey

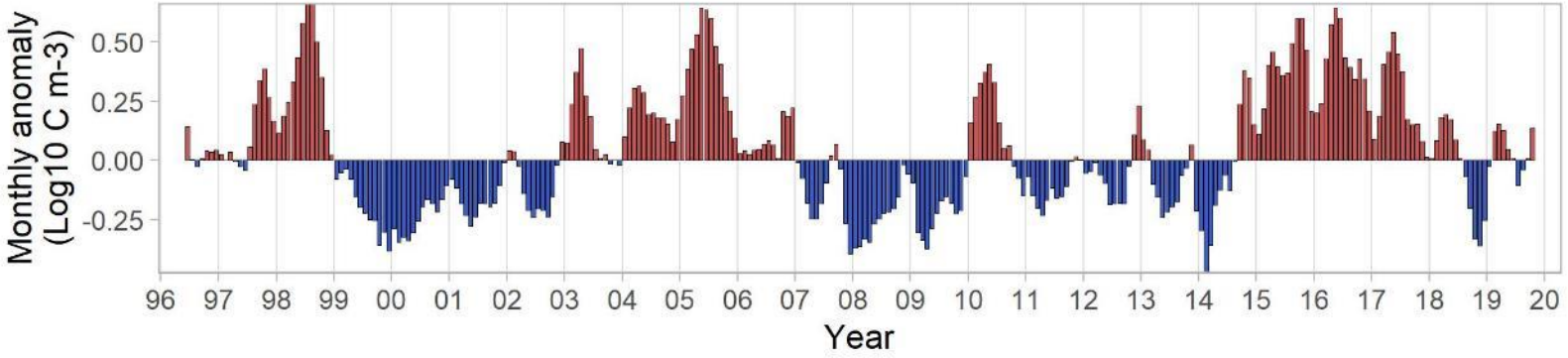
Results from June surveys 1998-2019

Copepod Biomass was high this summer

Northern Copepod Biomass



Southern Copepod Biomass

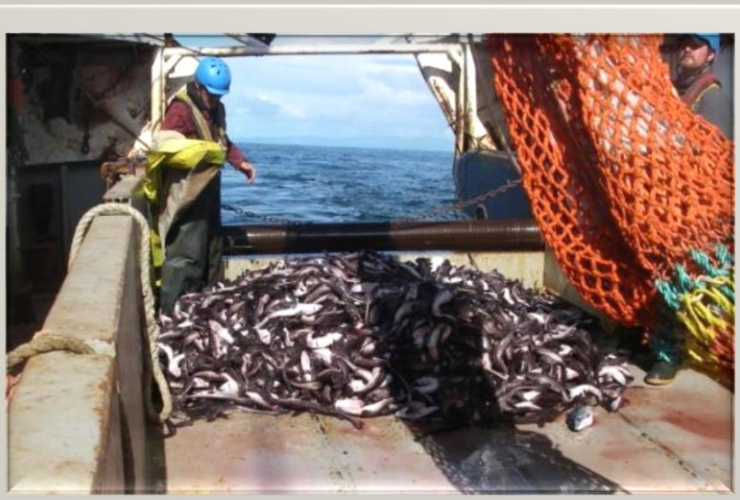


Good – Fair – Poor

	Year																					
Ecosystem Indicators	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Basin-scale physical indices																						
PDO (Sum Dec-March)	19	6	3	13	7	21	12	17	14	9	5	1	16	4	2	8	10	22	20	18	11	15
PDO (Sum May-Sept)	10	4	6	5	11	17	16	18	12	14	2	9	7	3	1	8	20	22	21	15	13	19
ONI (Average Jan-June)	21	1	1	7	14	16	15	17	9	12	3	11	18	4	6	8	10	19	22	13	5	20
Regional physical indices																						
SST NDBC buoys (°C; May-Sept)	17	6	8	4	5	11	22	12	2	14	1	10	3	7	9	16	20	19	18	13	15	21
Upper 20 m T (°C; Nov-Mar)	21	11	8	10	6	15	16	13	12	5	1	9	18	4	3	7	2	22	20	19	14	17
Upper 20 m T (°C; May-Sept)	16	11	13	4	1	3	22	19	8	10	2	5	17	7	6	18	20	9	14	12	15	21
Deep temperature (°C; May-Sept)	22	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	21	19	13	18	20	17
Deep salinity (May-Sept)	21	3	11	4	5	18	19	12	7	1	2	16	20	15	14	13	22	17	9	8	6	10
Regional biological indices																						
Copepod richness anom. (no. species; May-Sept)	20	2	1	7	6	15	14	19	16	10	8	9	18	4	5	3	11	21	22	17	13	12
N. copepod biomass anom. (mg C m^{-3}; May-Sept)	20	15	11	12	4	17	14	21	16	13	7	10	9	1	3	5	6	18	22	19	8	2
S. copepod biomass anom. (mg C m^{-3}; May-Sept)	22	2	5	4	3	15	16	21	14	10	1	7	17	9	8	6	11	19	20	18	13	12
Biological transition (day of year)	19	11	6	7	8	15	12	20	14	3	1	2	17	4	9	5	10	21	21	18	13	15
Nearshore Ichthyoplankton Log(mg C 1,000 m^{-3}; Jan-Mar)	17	4	11	6	1	21	22	16	8	18	3	13	2	7	5	10	19	14	15	12	9	20
Nearshore & offshore Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	11	6	5	9	8	13	16	20	1	14	3	12	15	4	2	7	10	18	21	22	17	19
Chinook salmon juvenile catches (no. km^{-1}; June)	20	4	5	17	8	12	18	21	13	11	1	6	7	16	2	3	10	14	19	22	15	9
Coho salmon juvenile catches (no. km^{-1}; June)	20	8	14	6	7	3	17	21	18	4	5	10	11	16	19	1	13	9	15	22	2	12
Mean of ranks	18.5	6.3	7.3	7.4	5.9	13.9	16.4	17.7	10.9	9.6	2.9	8.6	13.1	7.1	6.1	8.3	13.4	17.7	18.3	16.6	11.8	15.1
Rank of the mean rank	22	4	6	7	2	15	17	19	11	10	1	9	13	5	3	8	14	19	21	18	12	16

http://www.nwfsc.noaa.gov/oceanconditions

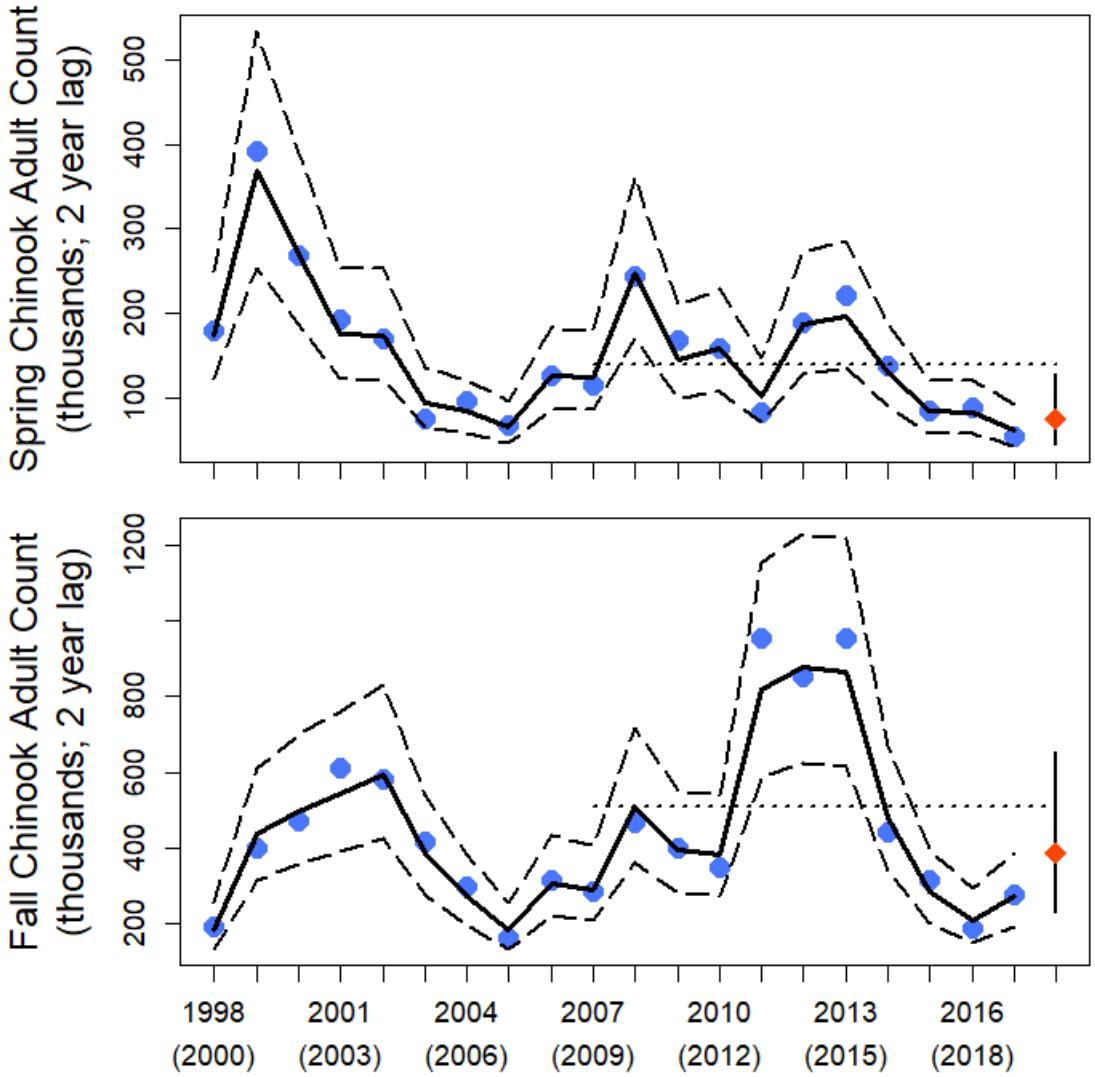
Ocean predation impacts remain a data gap




1. Background
2. Ocean Research
3. Modeling Salmon Survival
Pacific Drone

Model 1: Chinook at Bonneville Dam

Dynamic Linear Models



Spring Chinook in 2020

(March 15 – May 31)

75K (44K - 128K)

54% of 10-year mean

Fall Chinook in 2020

388K (229K - 656K)

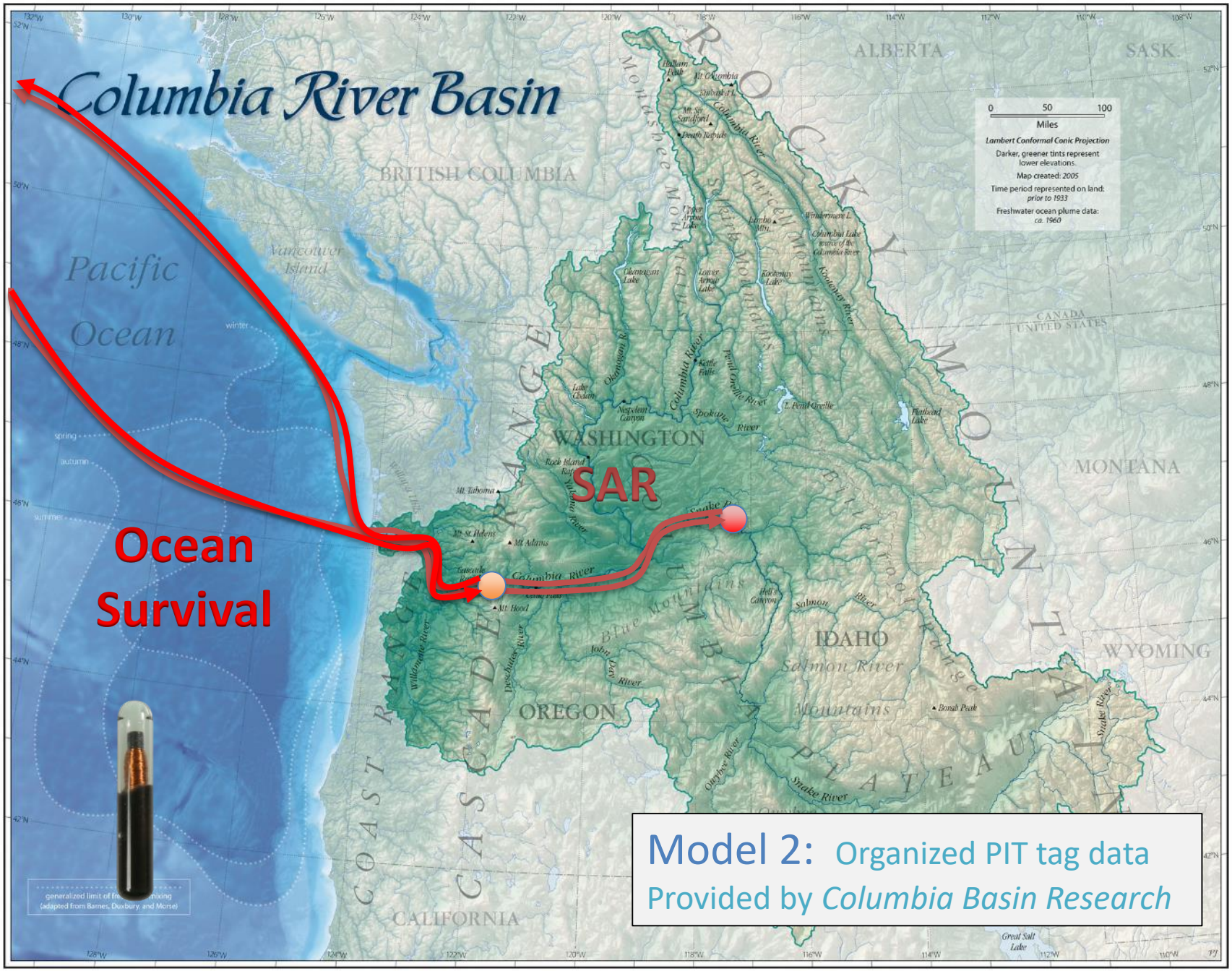
76% of 10-year mean

Return data from Columbia Basin Research, DART

Model 2: Snake River Spring-Summer Chinook

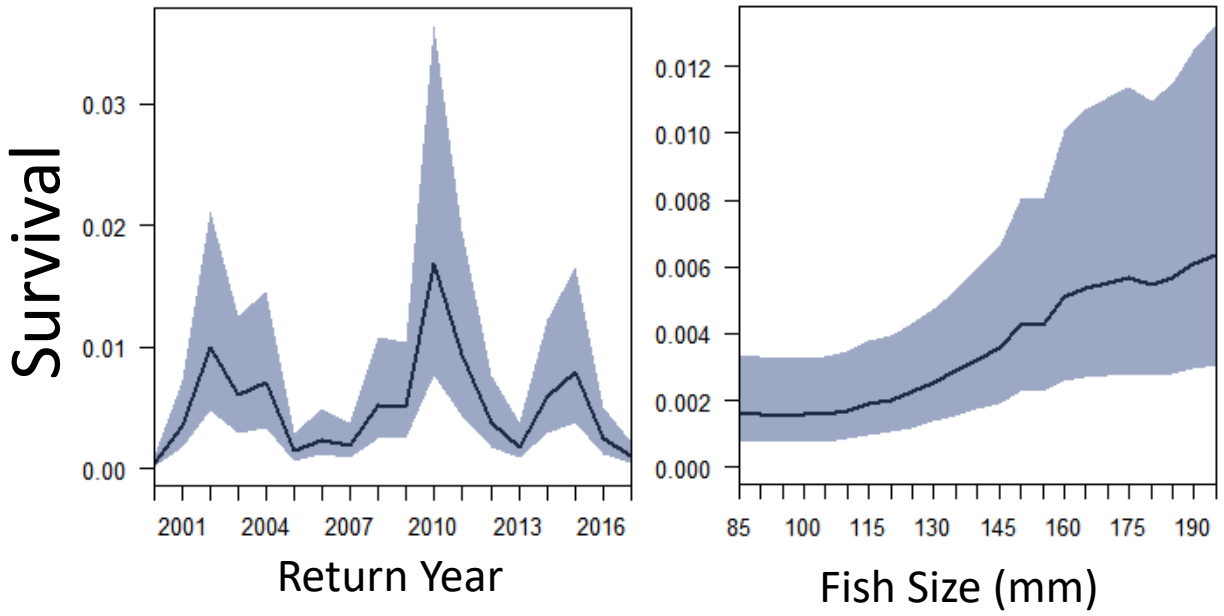
Juvenile migration years 2000-2015

Population	Hatchery	Wild
Clearwater	88,895	4,512
Grande Rhonde and Wallowa	16,956	5,636
Late (Imnaha, Pahsimeroi, South Fork Salmon)	60,215	14,622
Little Salmon	69,016	8
Lower Snake and Tucannon	11,125	988
Middle Fork Salmon	0	3,714
Upper Salmon and Lemhi	5,589	4,384
Total	**251,796**	**33,864**

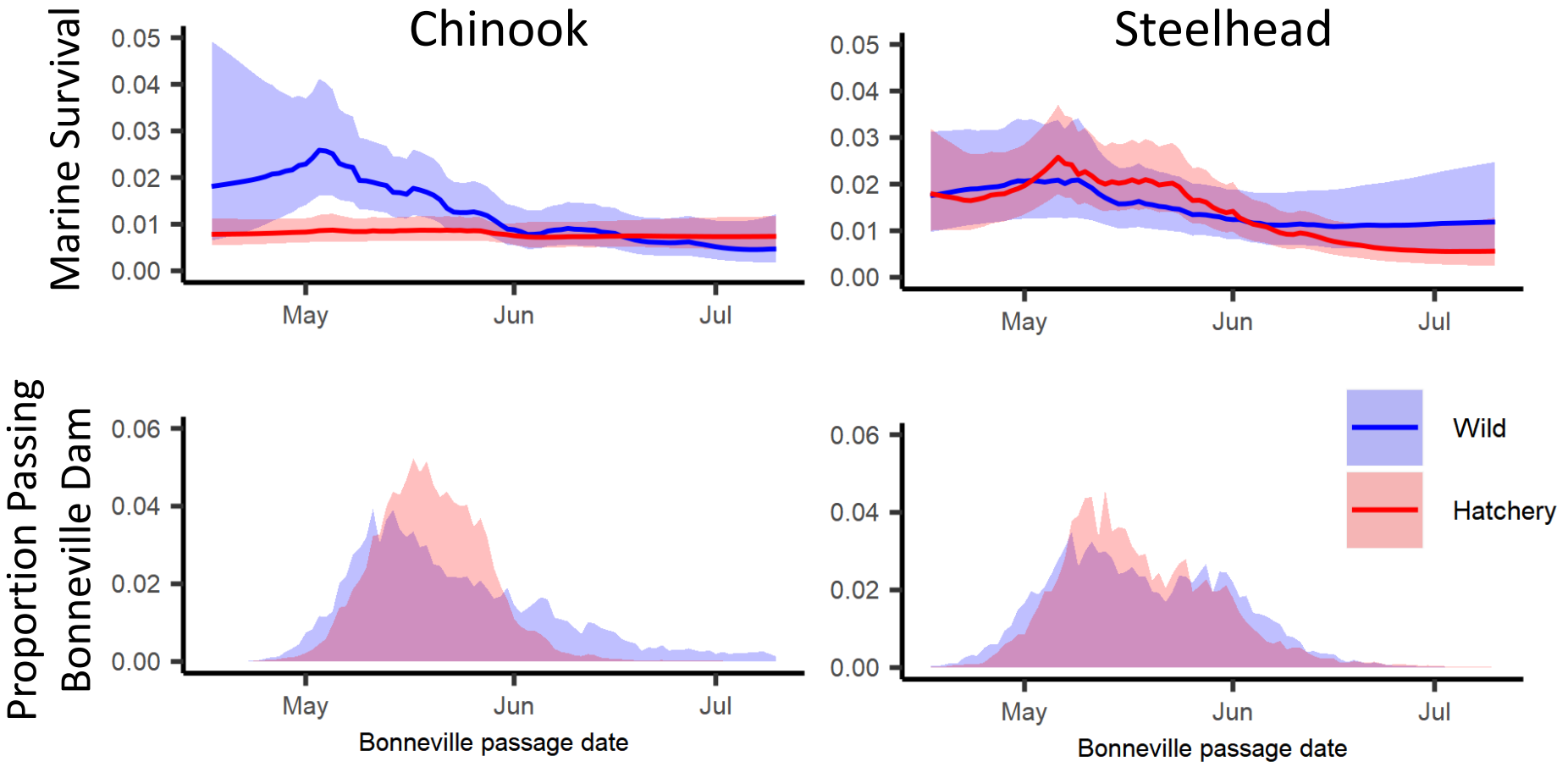


Bigger is Better

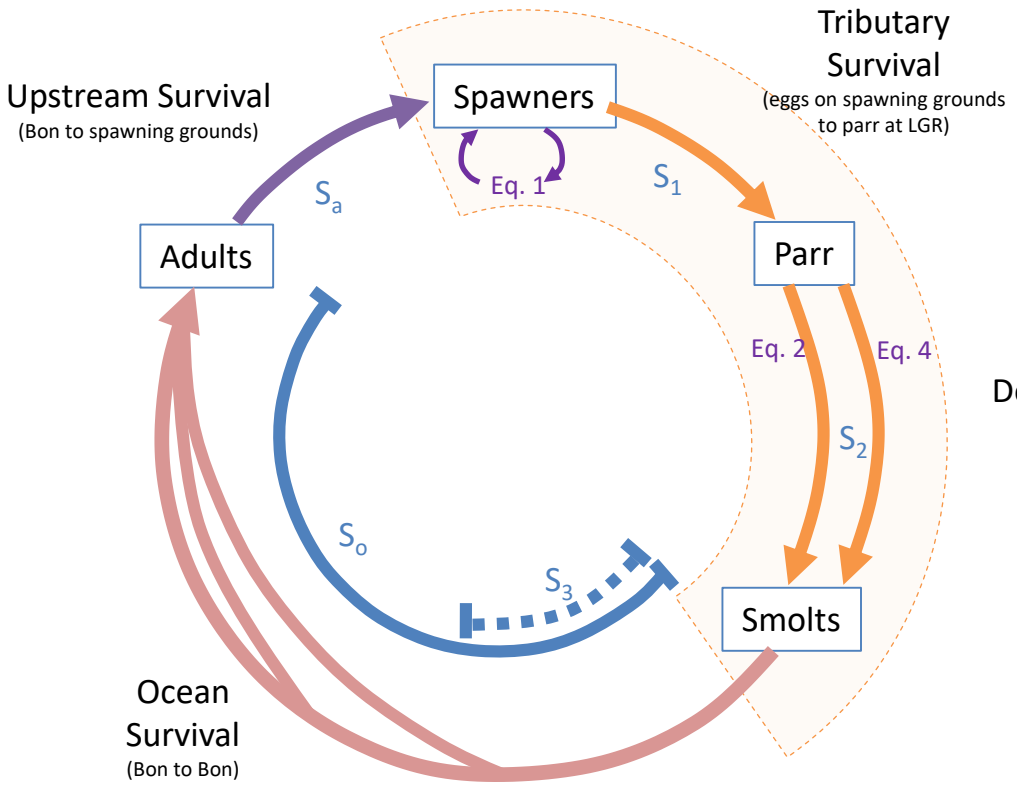
Wild Snake River spring/summer Chinook, 2000-2017



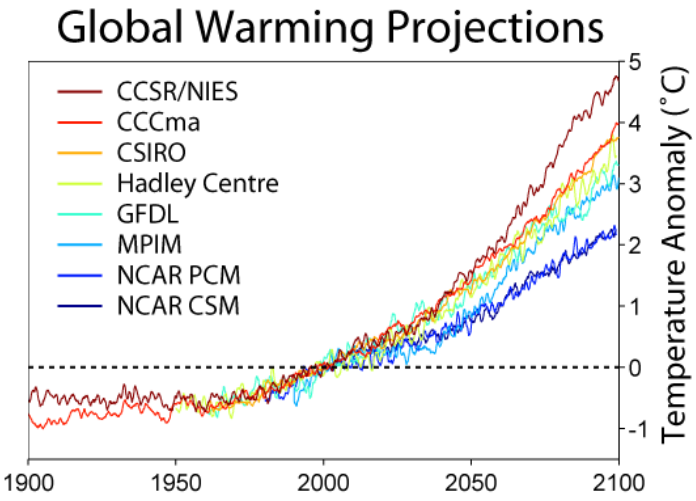
Survival Depends on *When* Fish Leave the River



Life Cycle Models and Climate Effects

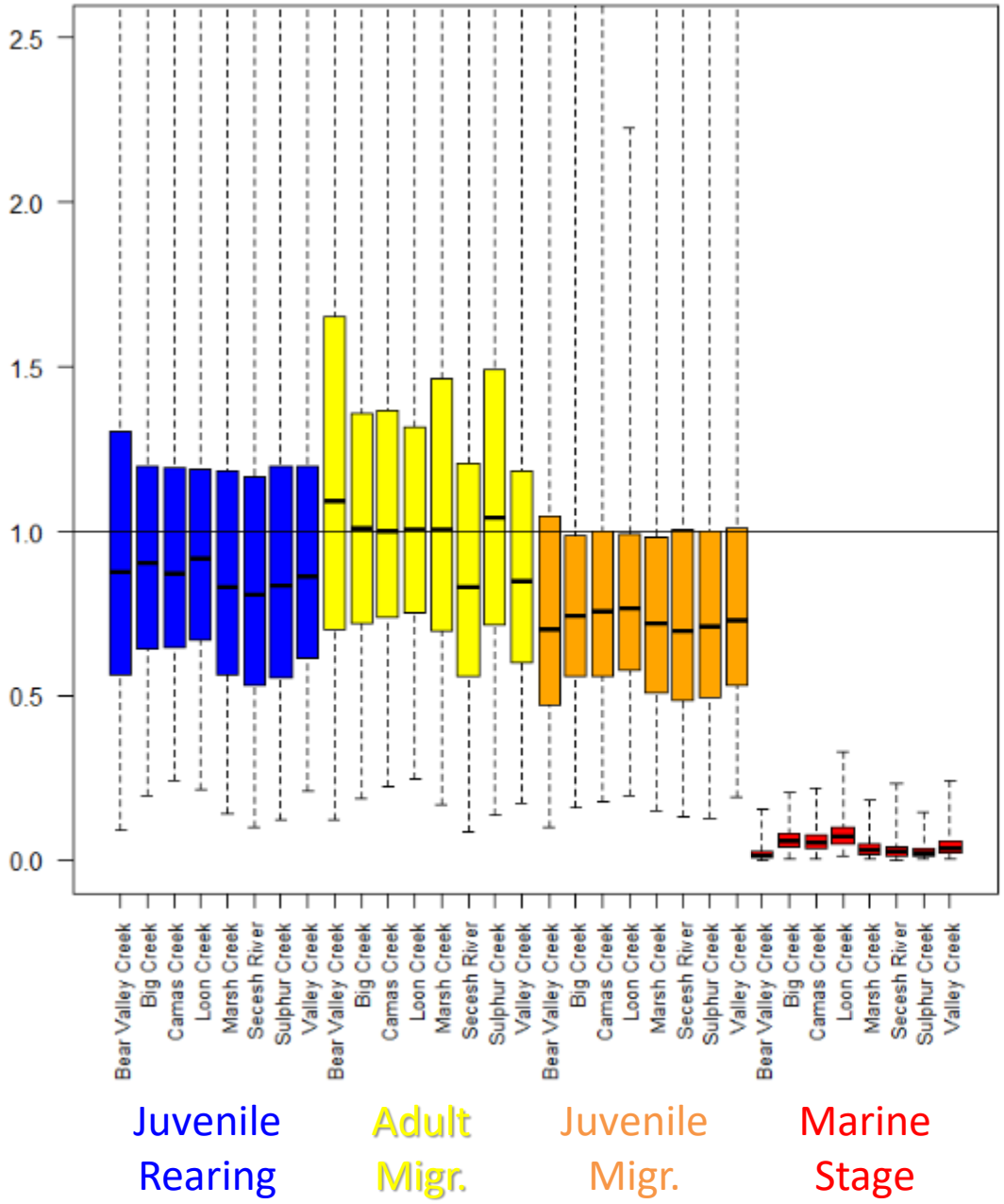


Downstream
Survival
(LGR to Bon)

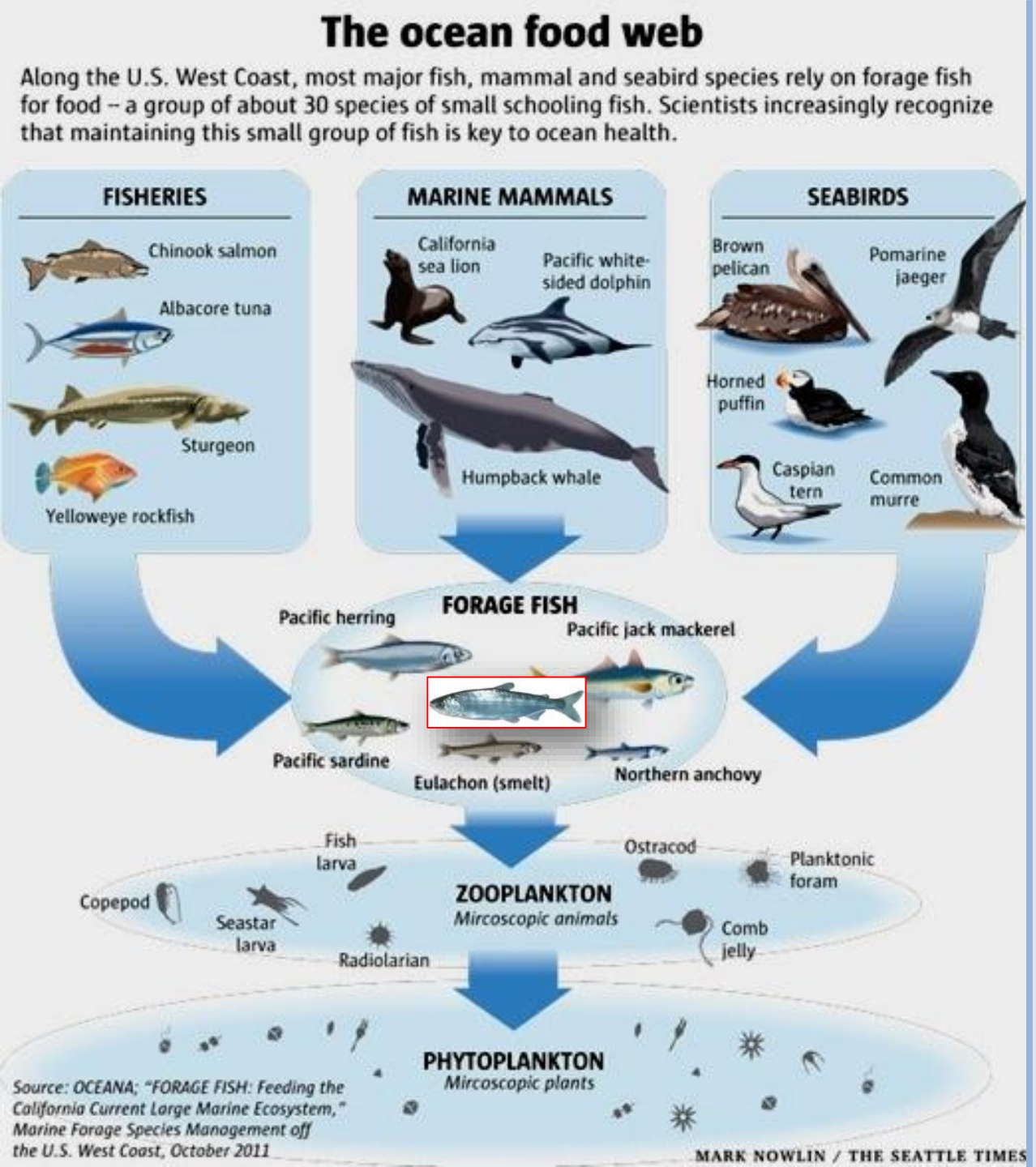


Climate Change and Global Warming
Ashwini S. Jajda, P. V. Khandve, Mangesh L. Gulhane

Change in # Spawners
(2080s / 2020s)



Conclusions



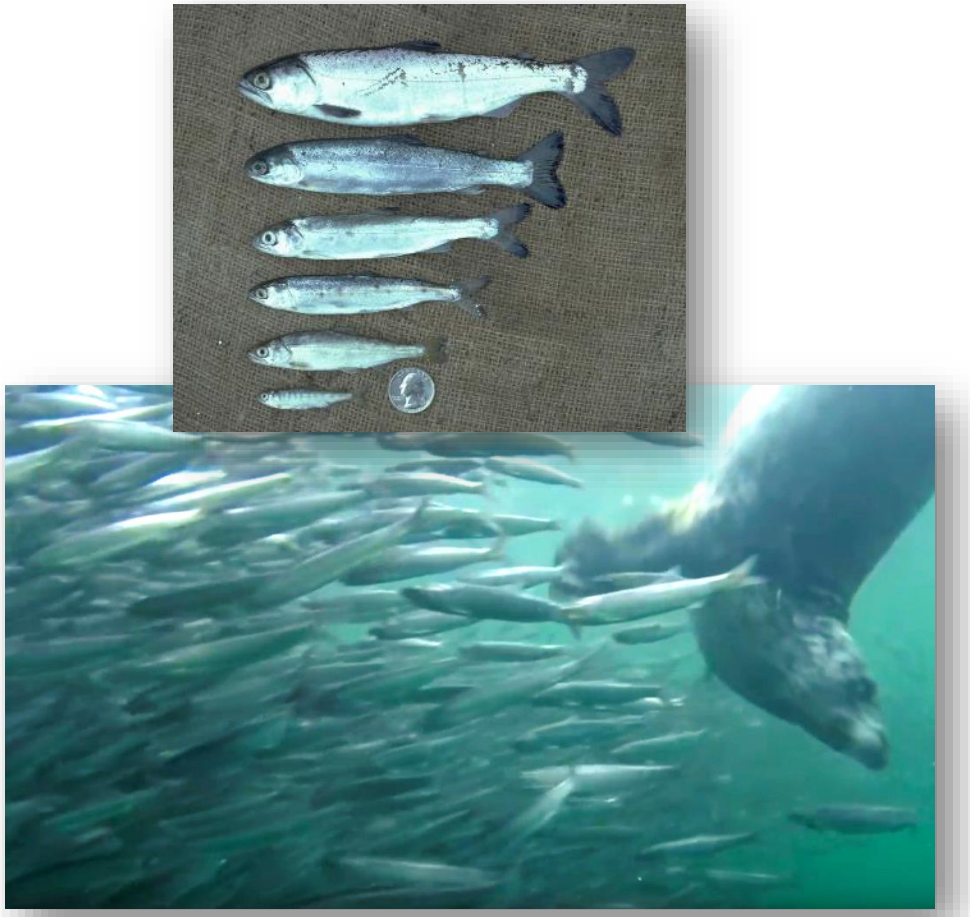
The Future of Salmon Science:

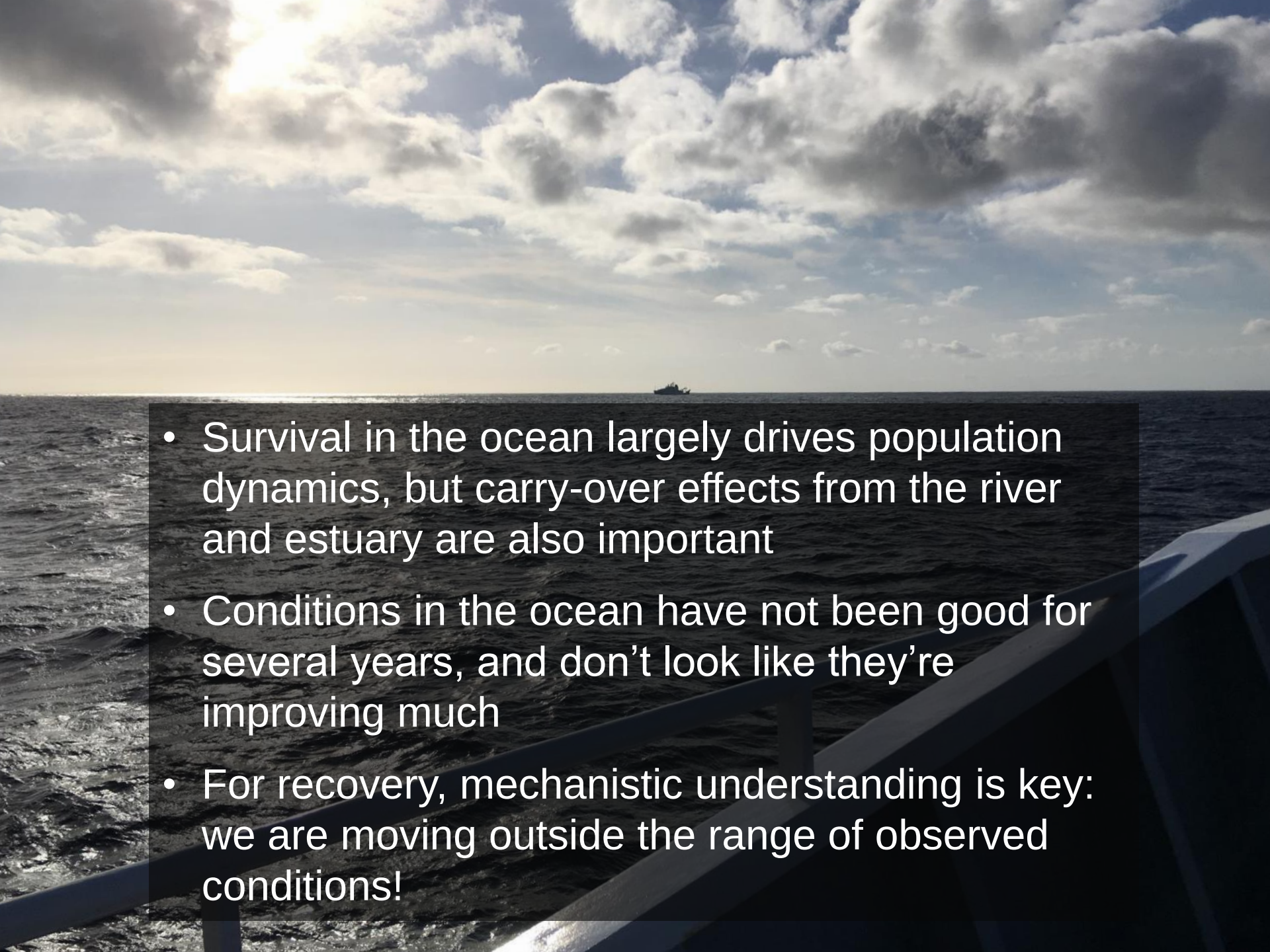
Ecosystem-Based Fisheries Management

“We can’t manage the ocean”

But we can manage:

- Fish size
- Outmigration timing
- Smolt abundance
- Forage fish
- Predator abundance





- Survival in the ocean largely drives population dynamics, but carry-over effects from the river and estuary are also important
- Conditions in the ocean have not been good for several years, and don’t look like they’re improving much
- For recovery, mechanistic understanding is key: we are moving outside the range of observed conditions!

NOAA's Ocean Salmon Research

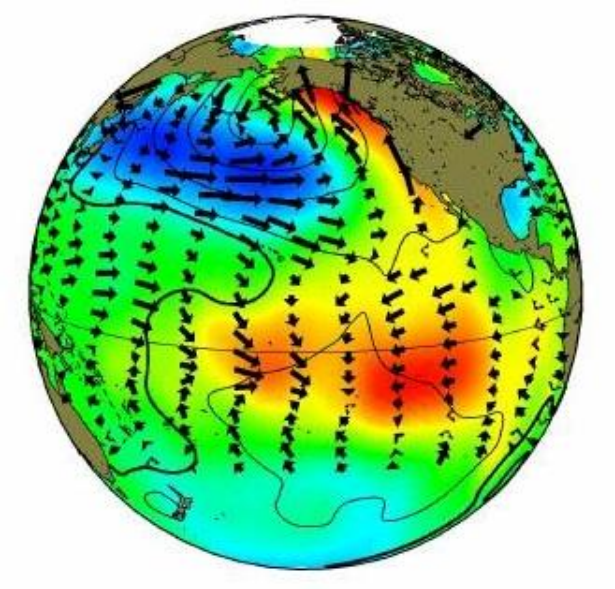
Northwest Power and Conservation Council Meeting
April 14th, 2020

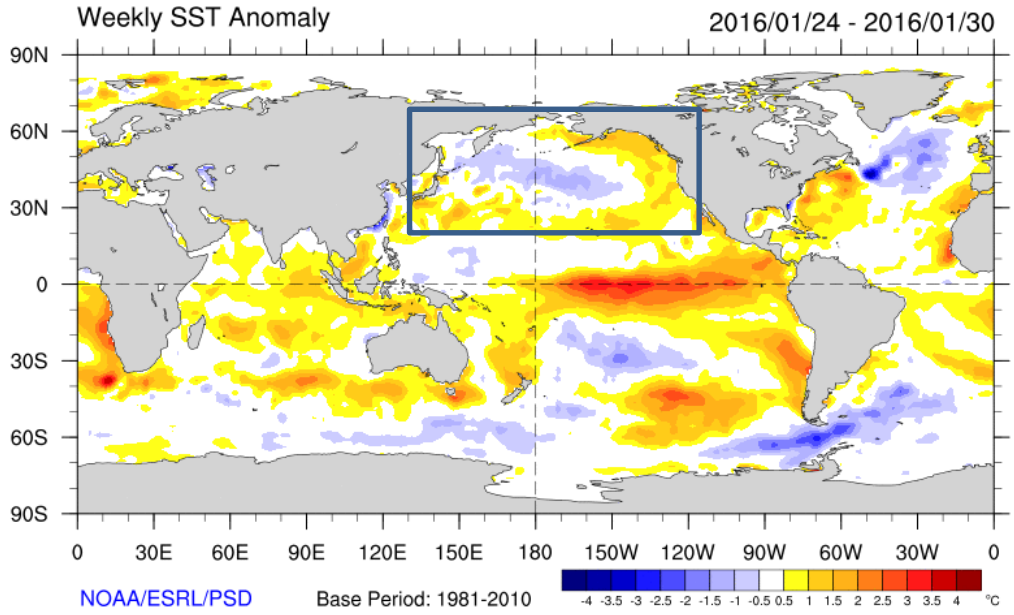
Presenter: Brian Burke
NOAA Fisheries, NWFSC

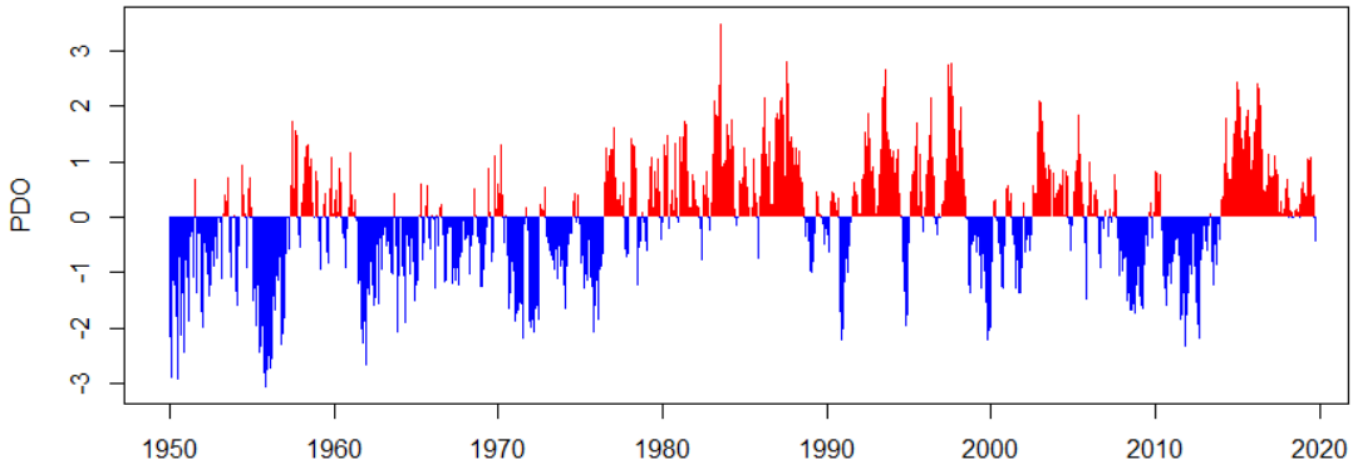
Supported by:


1. Background
2. Ocean Research
3. Modeling Survival
FROSTI
PH 229

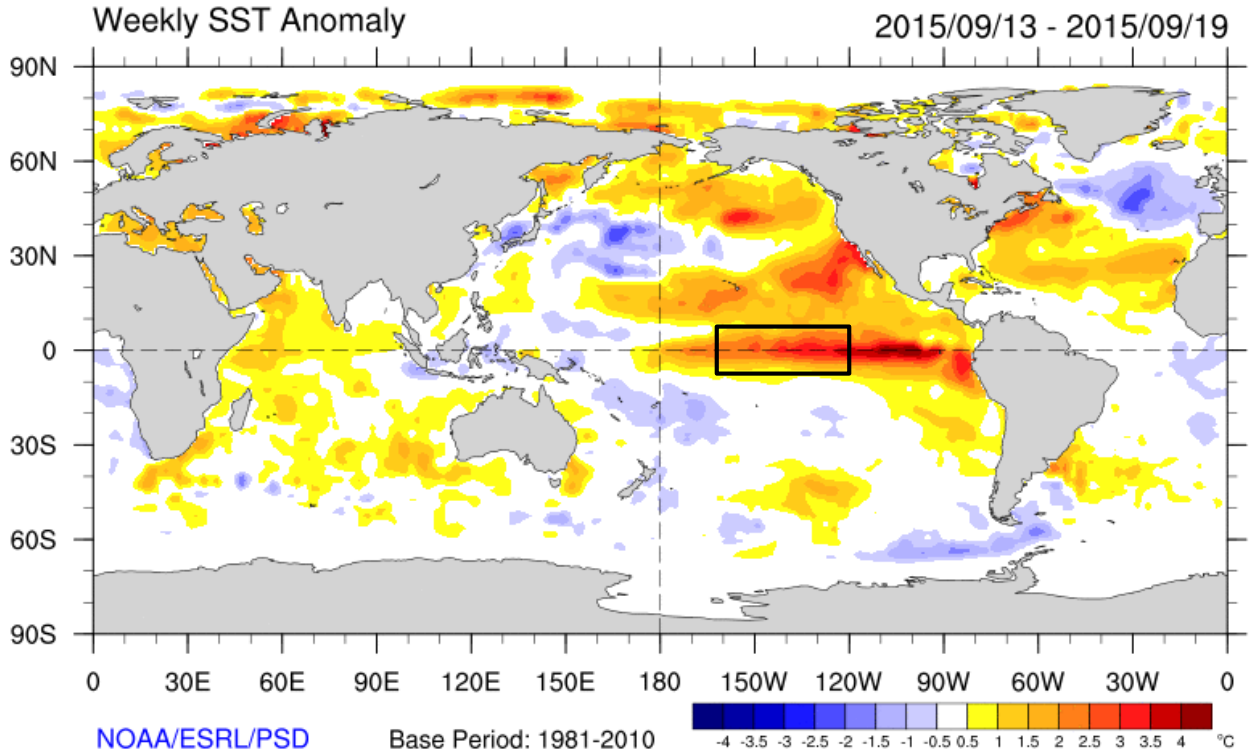
Pacific Decadal Oscillation (PDO)

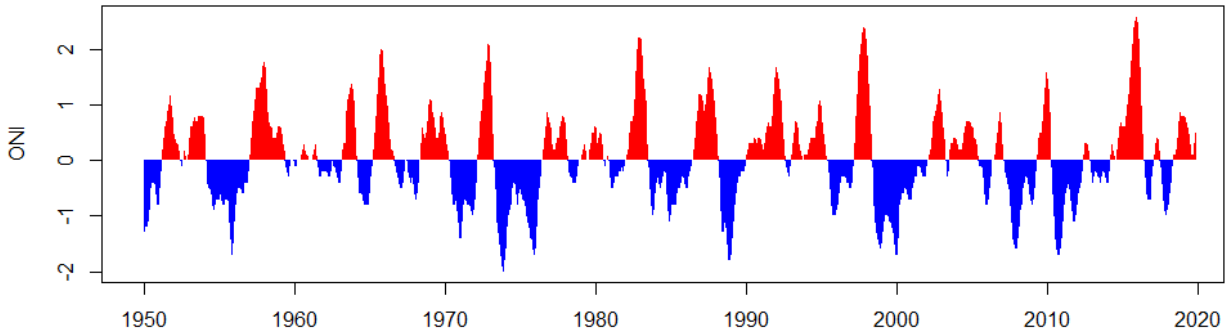




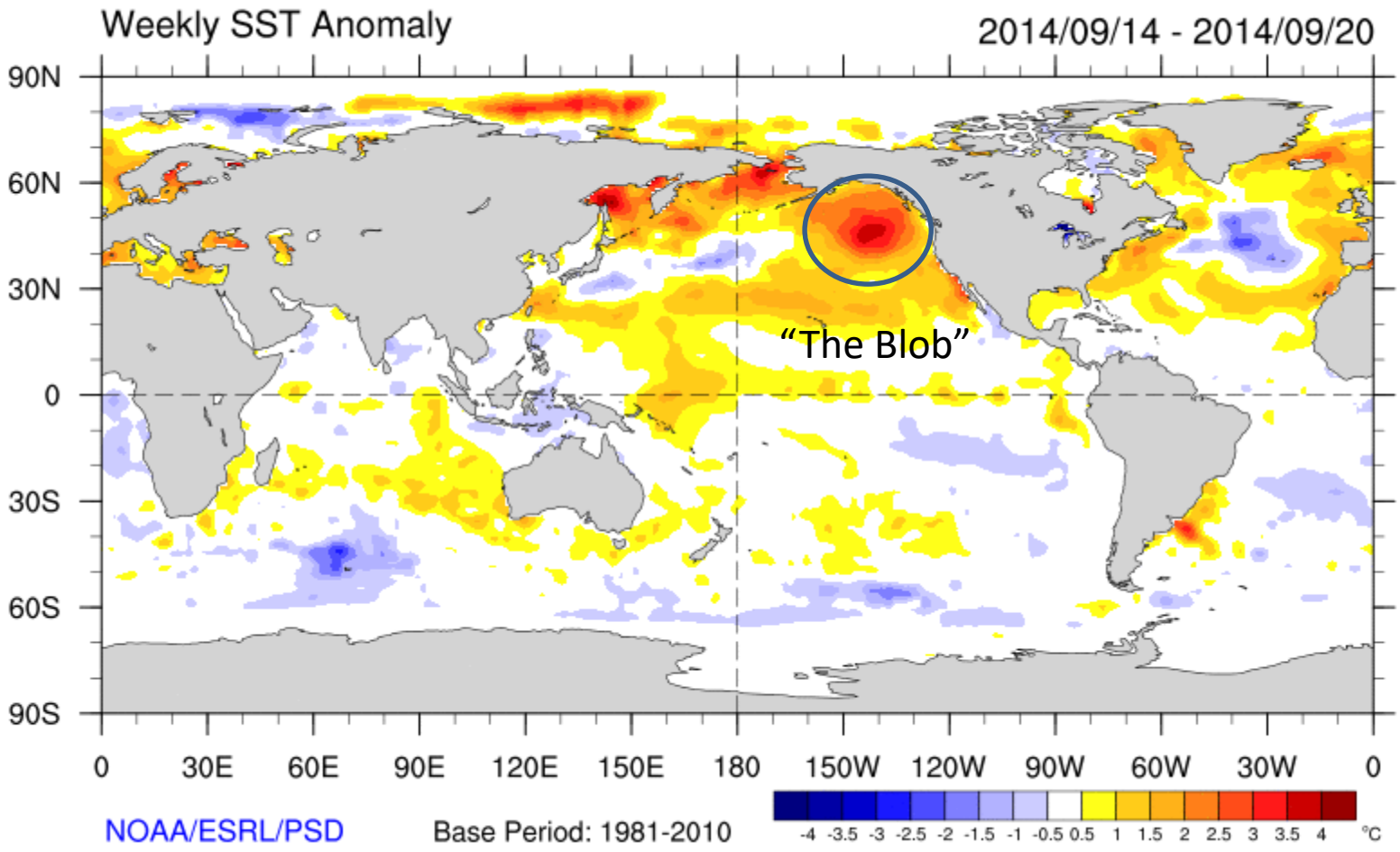


El Niño


Weekly SST Anomaly
2015/09/13 - 2015/09/19
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
NOAA/ESRL/PSD
Base Period: 1981-2010
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0.5 1 1.5 2 2.5 3 3.5 4
°C


ONI
2
1
0
-1
-2
1950
1960
1970
1980
1990
2000
2010
2020

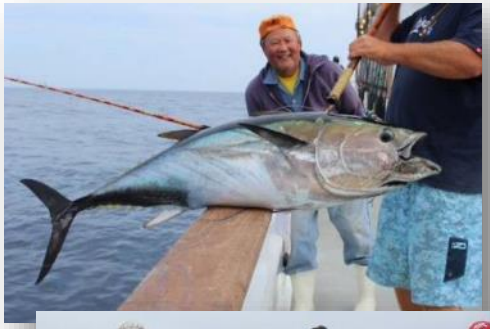
Marine Heat Wave



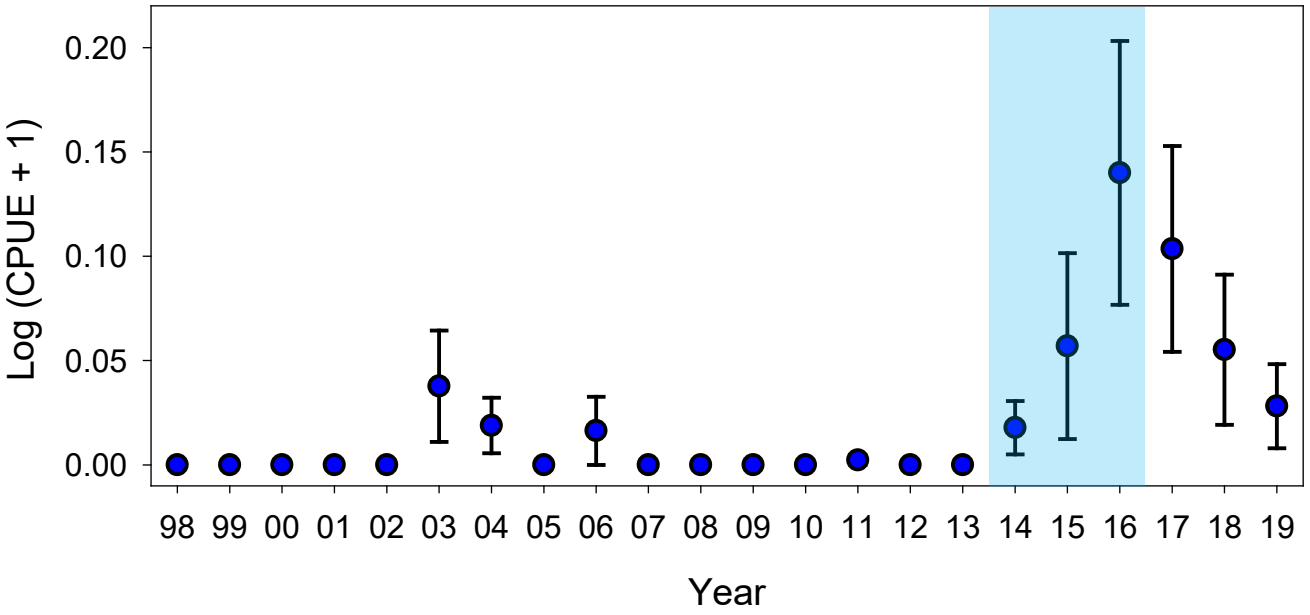
* High pressure reduces winter storms, resulting in less mixing with deep, cold water

Biological Response

Range Expansions

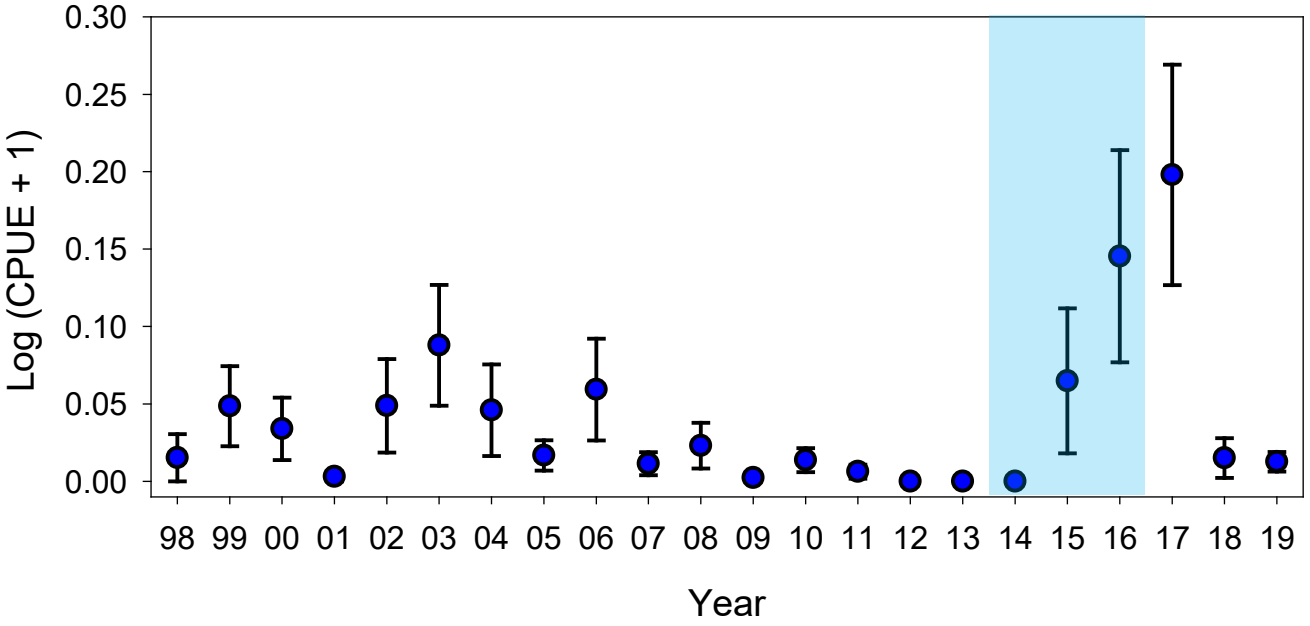


Pacific Pompano



Peprilus simillimus

Jack Mackerel

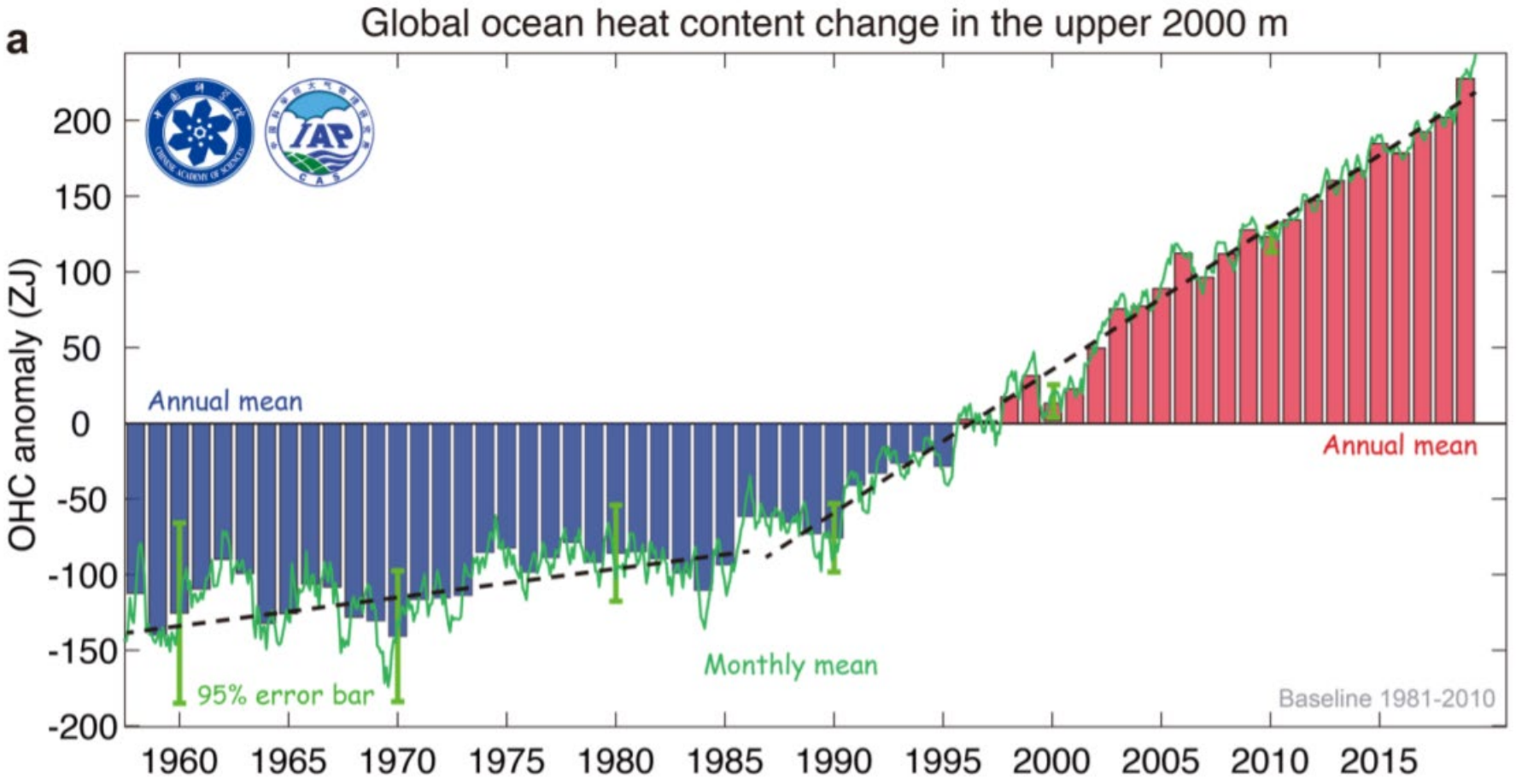


Trachurus symmetricus

Biological Response

Lack of Food and Disease

Unfortunately, I don't see it getting better any time soon

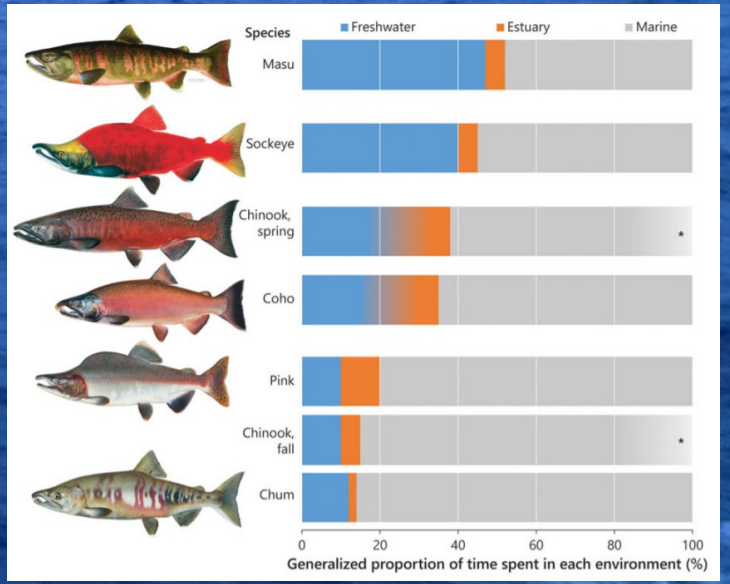


Cheng, *et al.* 2020. *Adv. Atmos. Sci.* **37,** 137–142. doi:10.1007/s00376-020-9283-7

Why study salmon in the ocean?

The ocean is where:

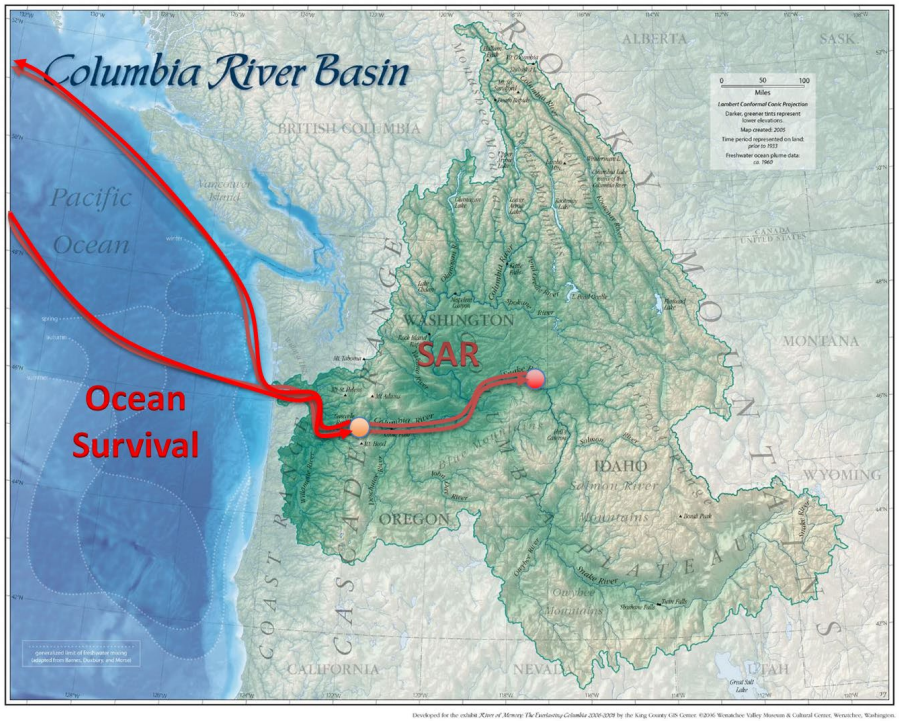
- salmon spend most of their life
- they gain most of their adult size
- adult abundance is largely determined
- each species behaves differently
- we understand the least

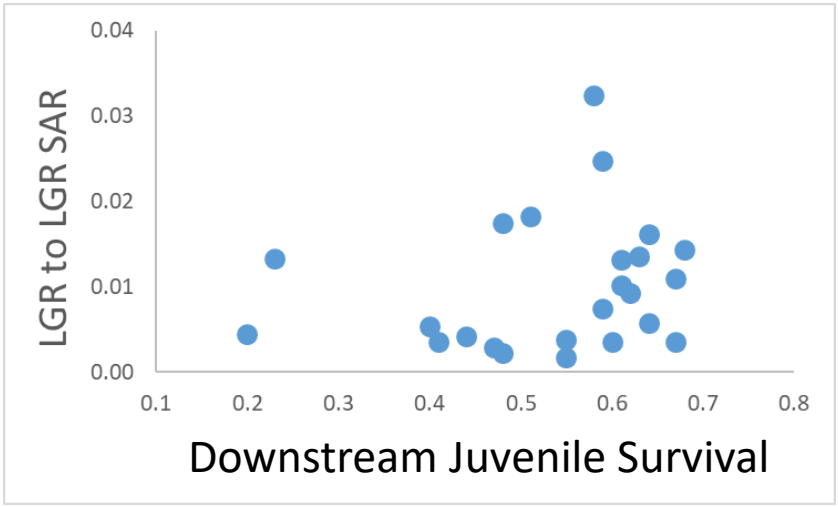


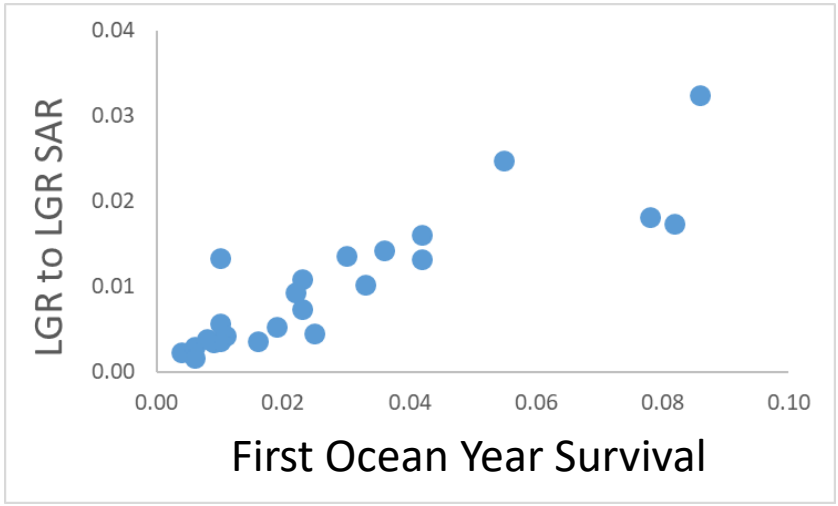
Flitcroft et al. 2018
https://doi.org/10.1111/1752-1688.12708

Where is Variability in Survival Occurring?

Wild Snake River spring/summer Chinook, 1994-2017







Data from Table B.126 in 2019 CSS report:
http://www.fpc.org/documents/CSS/2019CSSAnnualReport.pdf

Juvenile Salmon and Ocean Ecosystem Survey (JSOES)

- May (2006 – 2012, 2015 - present)
- June (1998 – present)
- September (1998 – 2012, 2015)

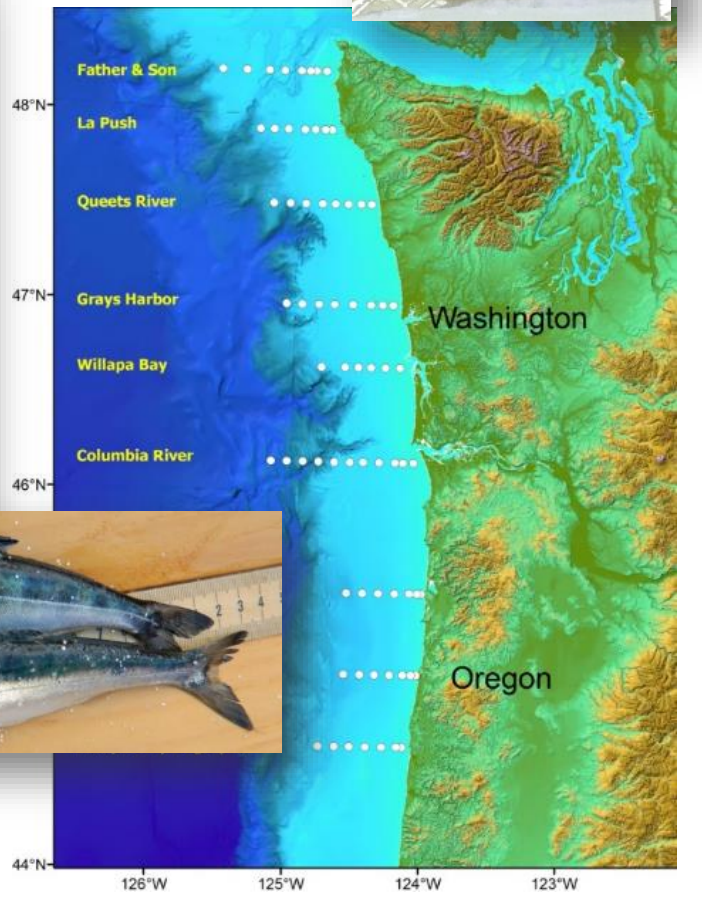
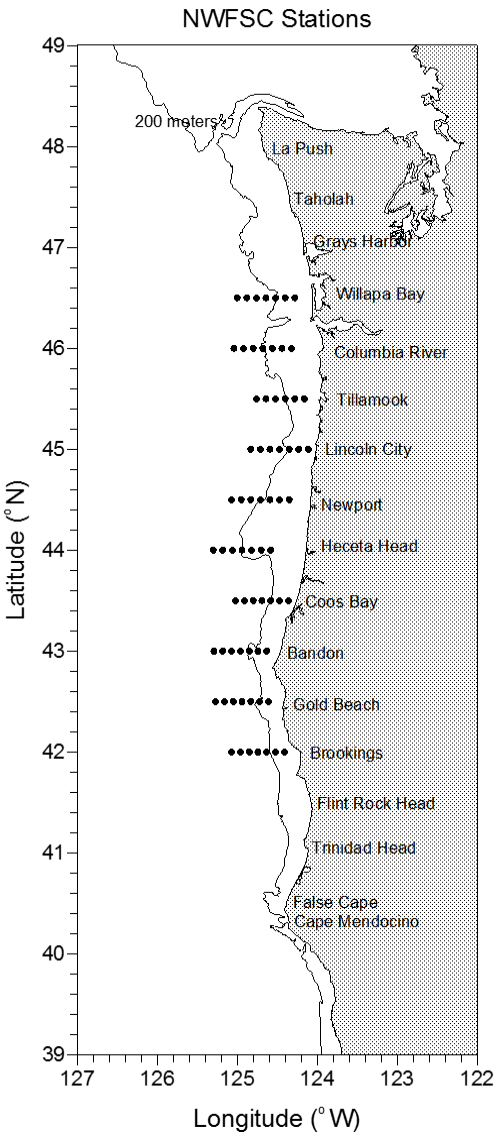


Photo credit: Pacific Dror

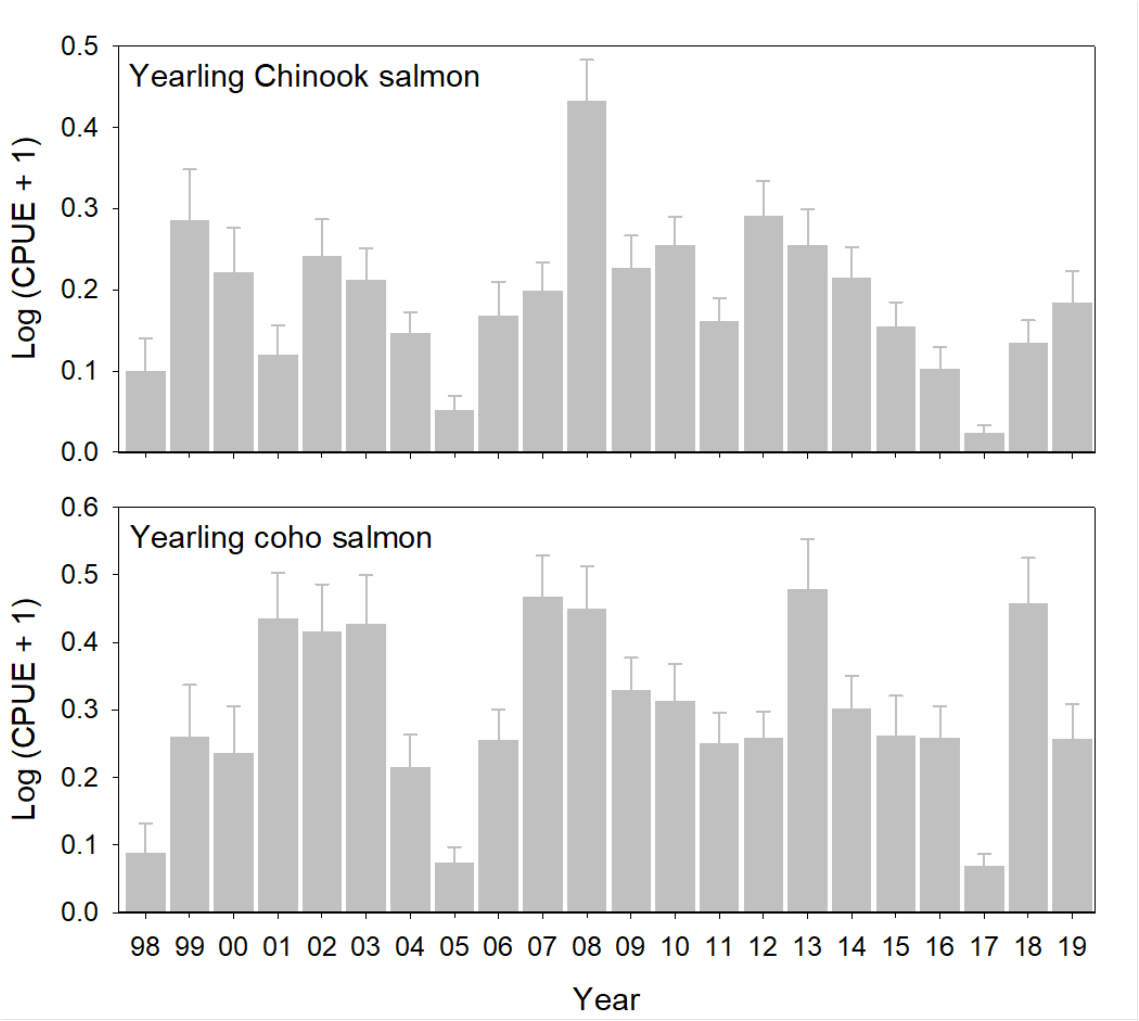
Newport Hydrographic Line and Pre-recruit Ecosystem Assessment Survey



NH Line: Sampled biweekly for 25 years (1996 – present); CTD, nutrients, chl-*a*, phytoplankton and HABs, zooplankton, ichthyoplankton

Pre-recruit: May-June (2011, 2013-2019); night trawls at 30 m depth, plankton, CTD, acoustic, seabird and mammal surveys

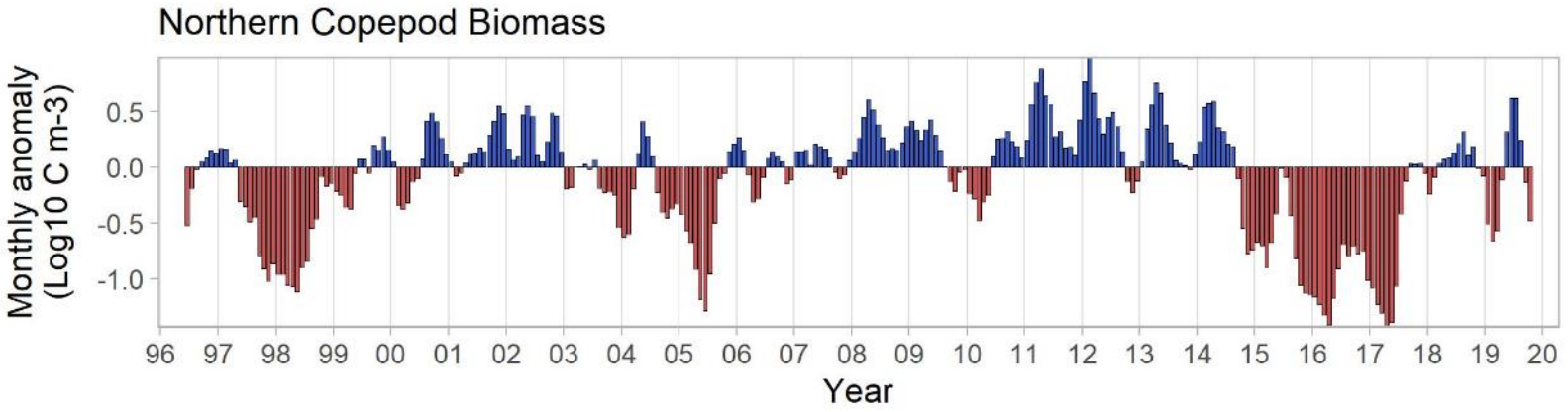
Chinook and Coho CPUE was about average in 2019

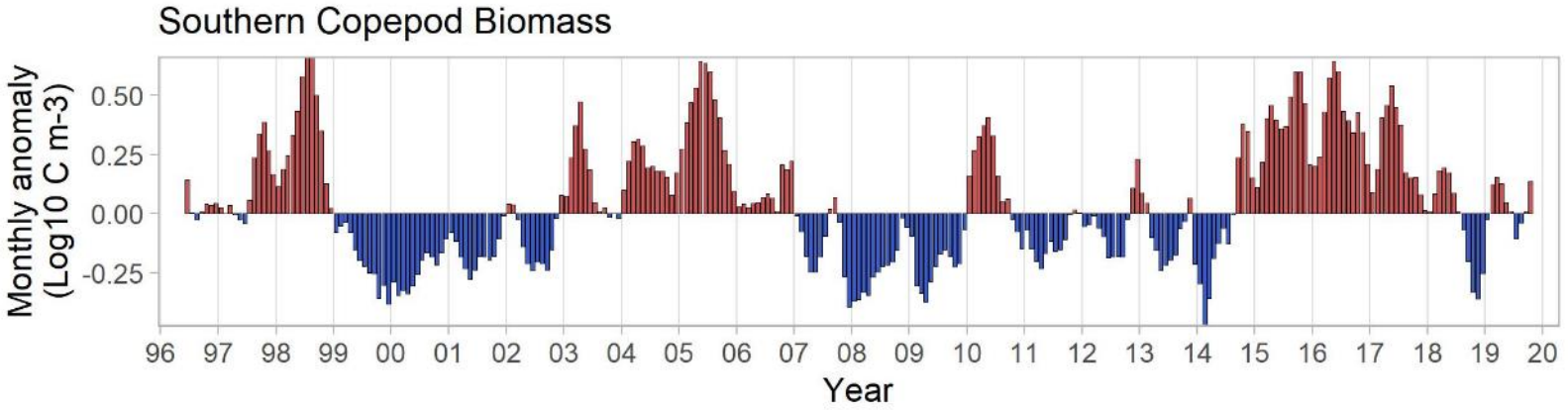


Juvenile Salmon and Ocean Ecosystem Survey

Results from June surveys 1998-2019

Copepod Biomass was high this summer





Good – Fair – Poor

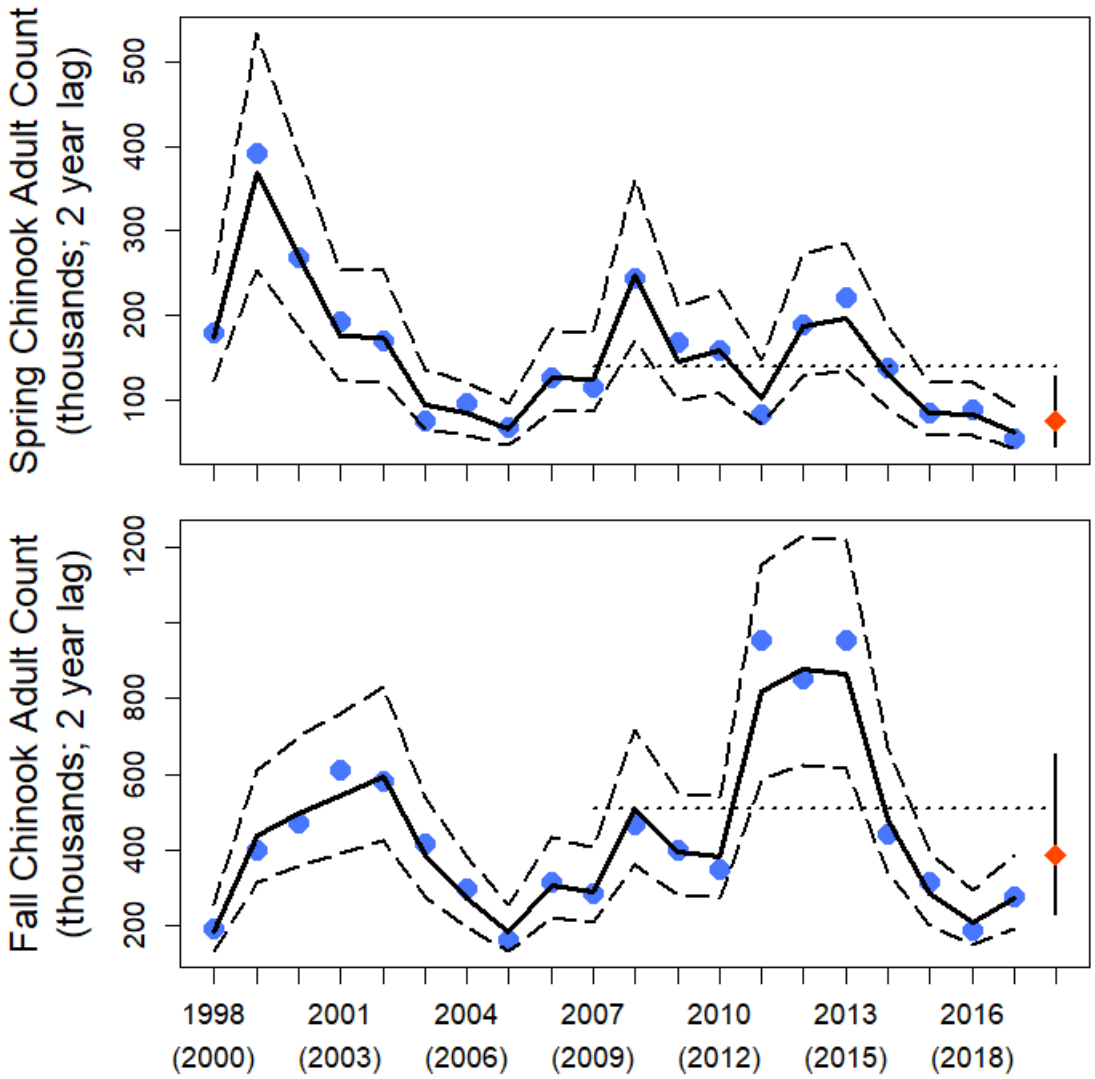
		Year																					
	Ecosystem Indicators	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Basin-scale physical indices	PDO (Sum Dec-March)	19	6	3	13	7	21	12	17	14	9	5	1	16	4	2	8	10	22	20	18	11	15
	PDO (Sum May-Sept)	10	4	6	5	11	17	16	18	12	14	2	9	7	3	1	8	20	22	21	15	13	19
	ONI (Average Jan-June)	21	1	1	7	14	16	15	17	9	12	3	11	18	4	6	8	10	19	22	13	5	20
Regional physical indices	SST NDBC buoys (°C; May-Sept)	17	6	8	4	5	11	22	12	2	14	1	10	3	7	9	16	20	19	18	13	15	21
	Upper 20 m T (°C; Nov-Mar)	21	11	8	10	6	15	16	13	12	5	1	9	18	4	3	7	2	22	20	19	14	17
	Upper 20 m T (°C; May-Sept)	16	11	13	4	1	3	22	19	8	10	2	5	17	7	6	18	20	9	14	12	15	21
	Deep temperature (°C; May-Sept)	22	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	21	19	13	18	20	17
	Deep salinity (May-Sept)	21	3	11	4	5	18	19	12	7	1	2	16	20	15	14	13	22	17	9	8	6	10
Regional biological indices	Copepod richness anom. (no. species; May-Sept)	20	2	1	7	6	15	14	19	16	10	8	9	18	4	5	3	11	21	22	17	13	12
	N. copepod biomass anom. (mg C m^{-3}; May-Sept)	20	15	11	12	4	17	14	21	16	13	7	10	9	1	3	5	6	18	22	19	8	2
	S. copepod biomass anom. (mg C m^{-3}; May-Sept)	22	2	5	4	3	15	16	21	14	10	1	7	17	9	8	6	11	19	20	18	13	12
	Biological transition (day of year)	19	11	6	7	8	15	12	20	14	3	1	2	17	4	9	5	10	21	21	18	13	15
	Nearshore Ichthyoplankton Log(mg C 1,000 m^{-3}; Jan-Mar)	17	4	11	6	1	21	22	16	8	18	3	13	2	7	5	10	19	14	15	12	9	20
	Nearshore & offshore Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	11	6	5	9	8	13	16	20	1	14	3	12	15	4	2	7	10	18	21	22	17	19
	Chinook salmon juvenile catches (no. km^{-1}; June)	20	4	5	17	8	12	18	21	13	11	1	6	7	16	2	3	10	14	19	22	15	9
	Coho salmon juvenile catches (no. km^{-1}; June)	20	8	14	6	7	3	17	21	18	4	5	10	11	16	19	1	13	9	15	22	2	12
	Mean of ranks	18.5	6.3	7.3	7.4	5.9	13.9	16.4	17.7	10.9	9.6	2.9	8.6	13.1	7.1	6.1	8.3	13.4	17.7	18.3	16.6	11.8	15.1
	Rank of the mean rank	22	4	6	7	2	15	17	19	11	10	1	9	13	5	3	8	14	19	21	18	12	16

http://www.nwfsc.noaa.gov/oceanconditions

Ocean predation impacts remain a data gap

Chinook at Bonneville Dam

Dynamic Linear Models



Spring Chinook in 2020

(March 15 – May 31)

75K (44K - 128K)

54% of 10-year mean

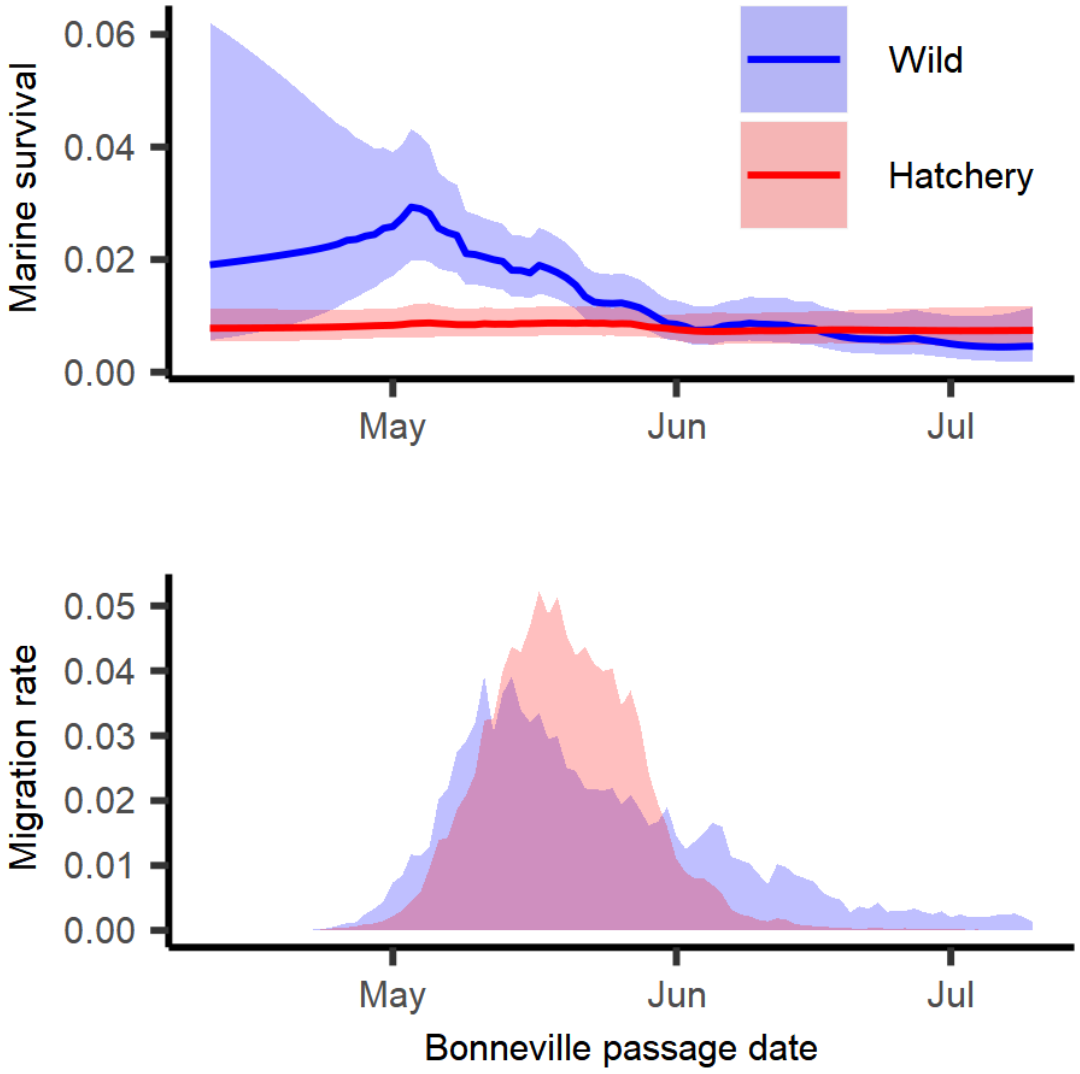
Fall Chinook in 2020

388K (229K - 656K)

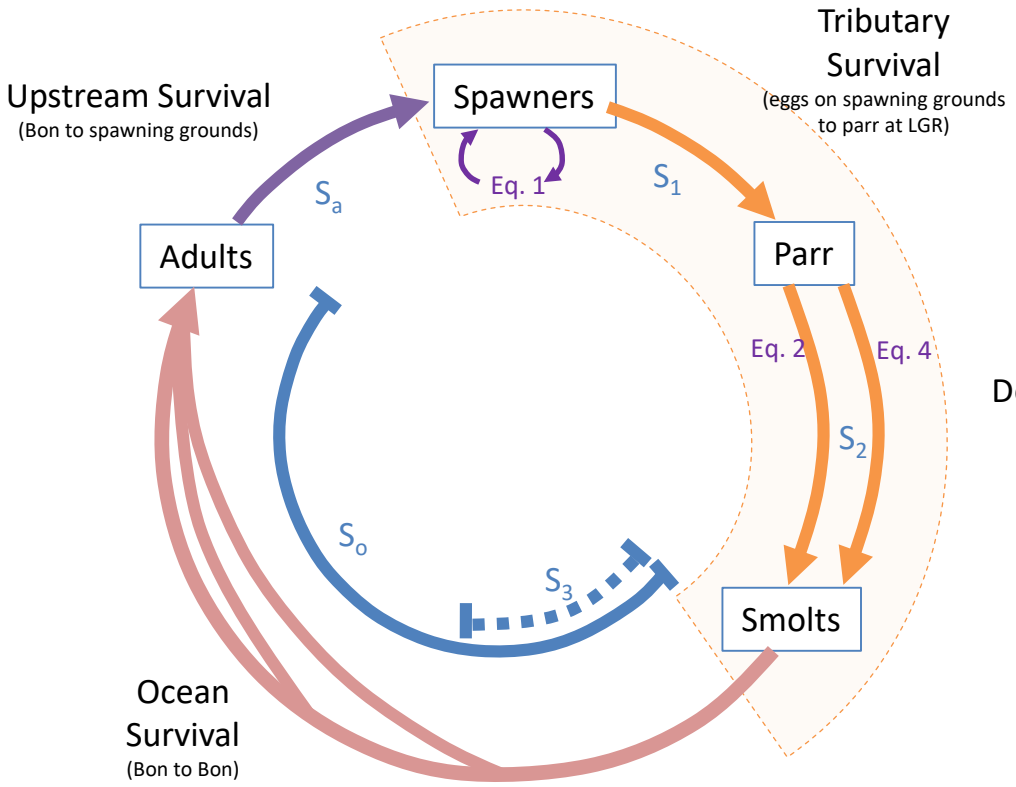
76% of 10-year mean

Return data from Columbia Basin Research, DART

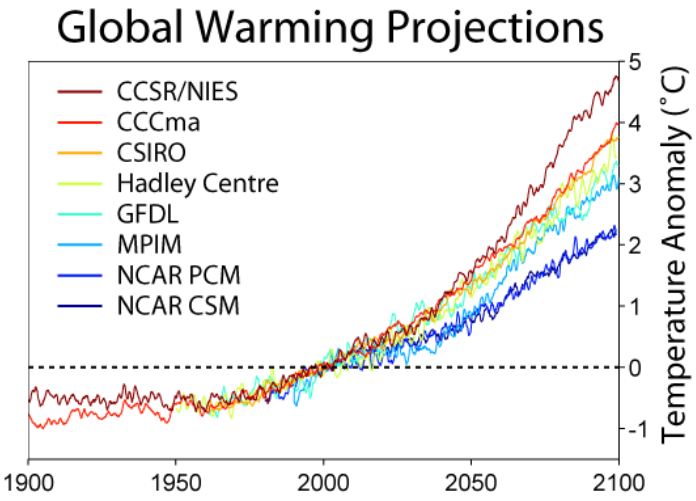
Survival Depends on *Migration Timing*



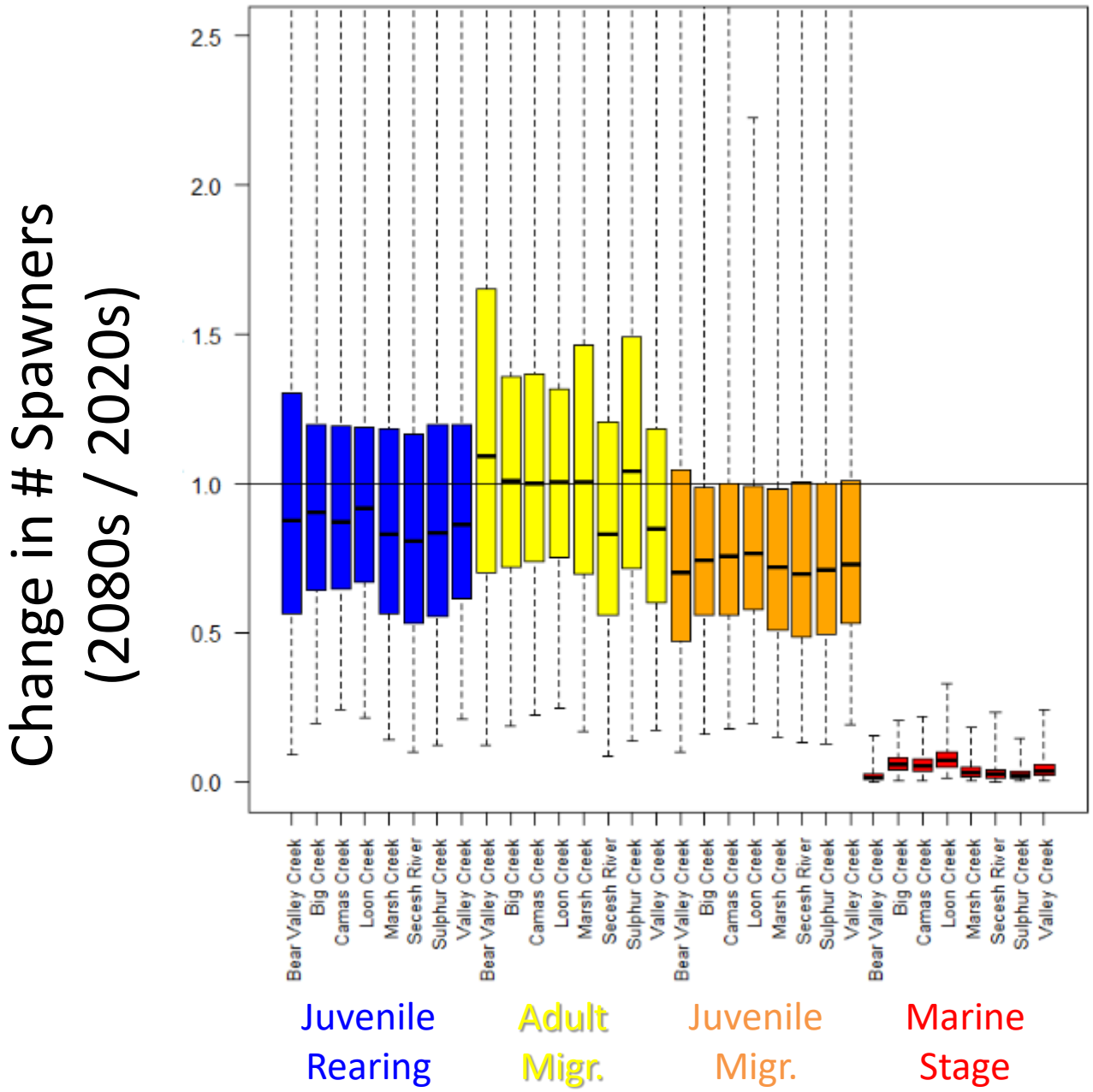
Life Cycle Models and Climate Effects



Downstream Survival
(LGR to Bon)

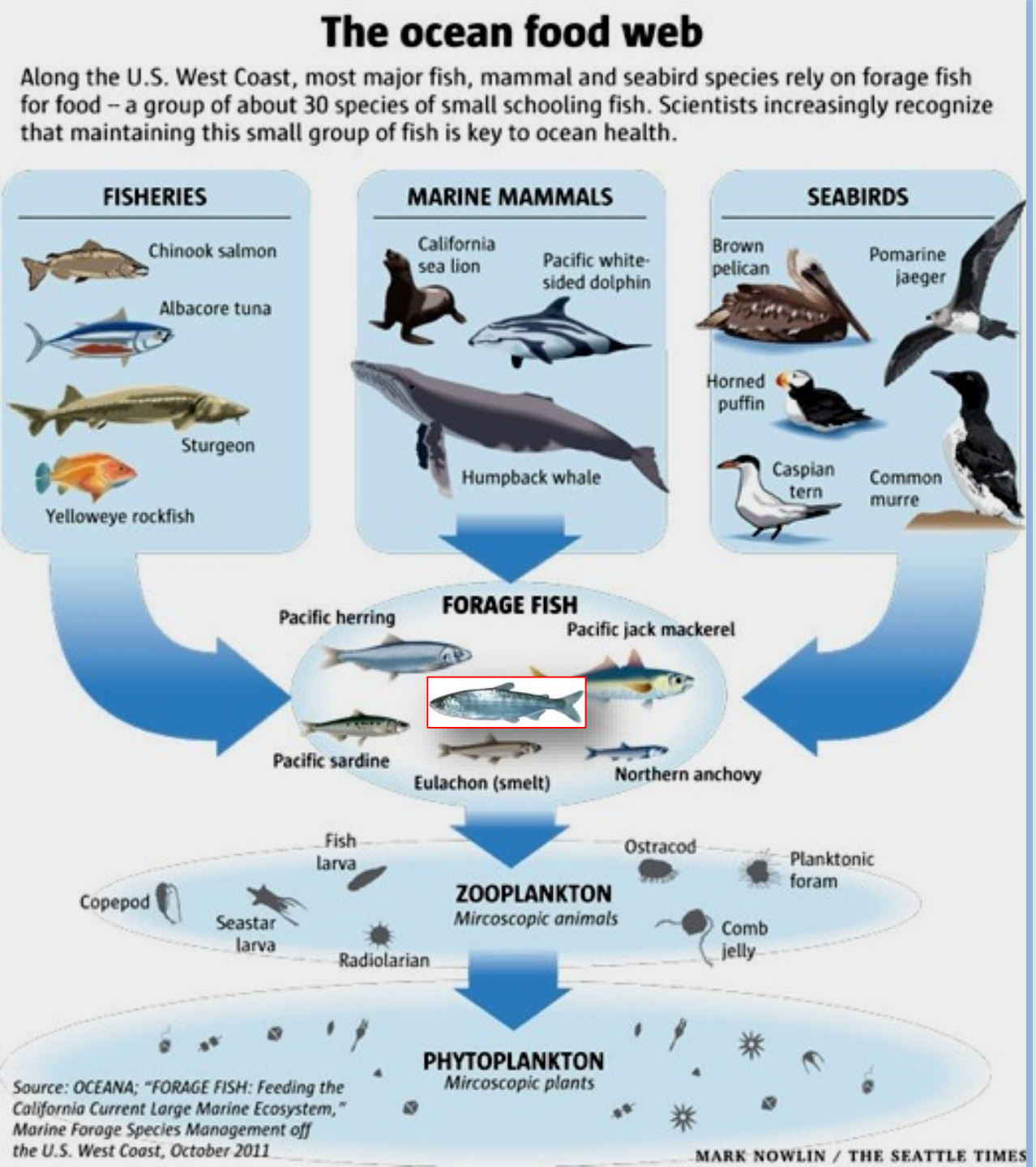


Climate Change and Global Warming
Ashwini S. Jajda, P. V. Khandve, Mangesh L. Gulhane



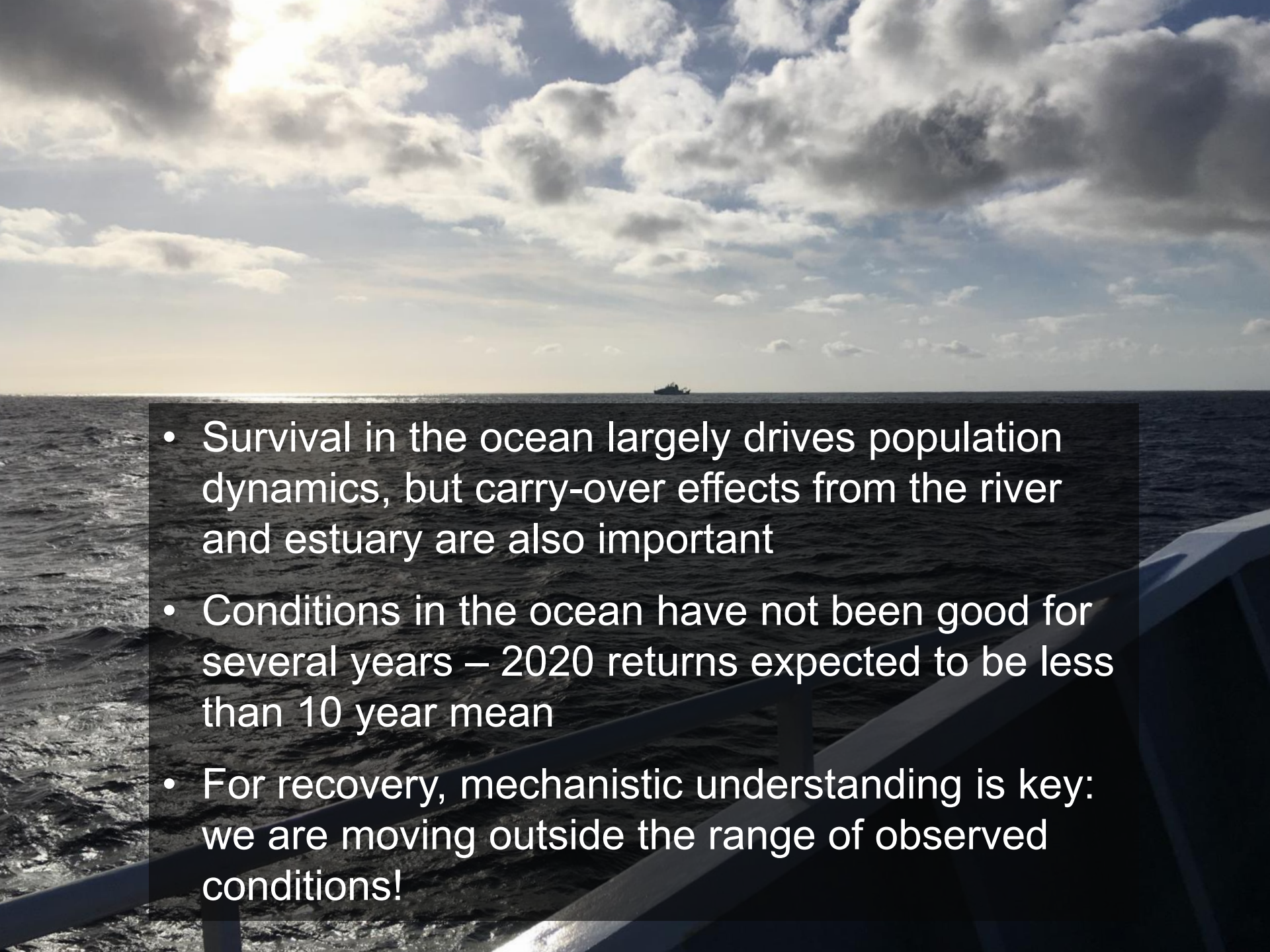
Crozier et al.
In Review

Conclusions



The Future of Salmon Science:

Ecosystem-Based Fisheries Management



- Survival in the ocean largely drives population dynamics, but carry-over effects from the river and estuary are also important
- Conditions in the ocean have not been good for several years – 2020 returns expected to be less than 10 year mean
- For recovery, mechanistic understanding is key: we are moving outside the range of observed conditions!