Fish IN
Fish OUT

Snohomish Forum

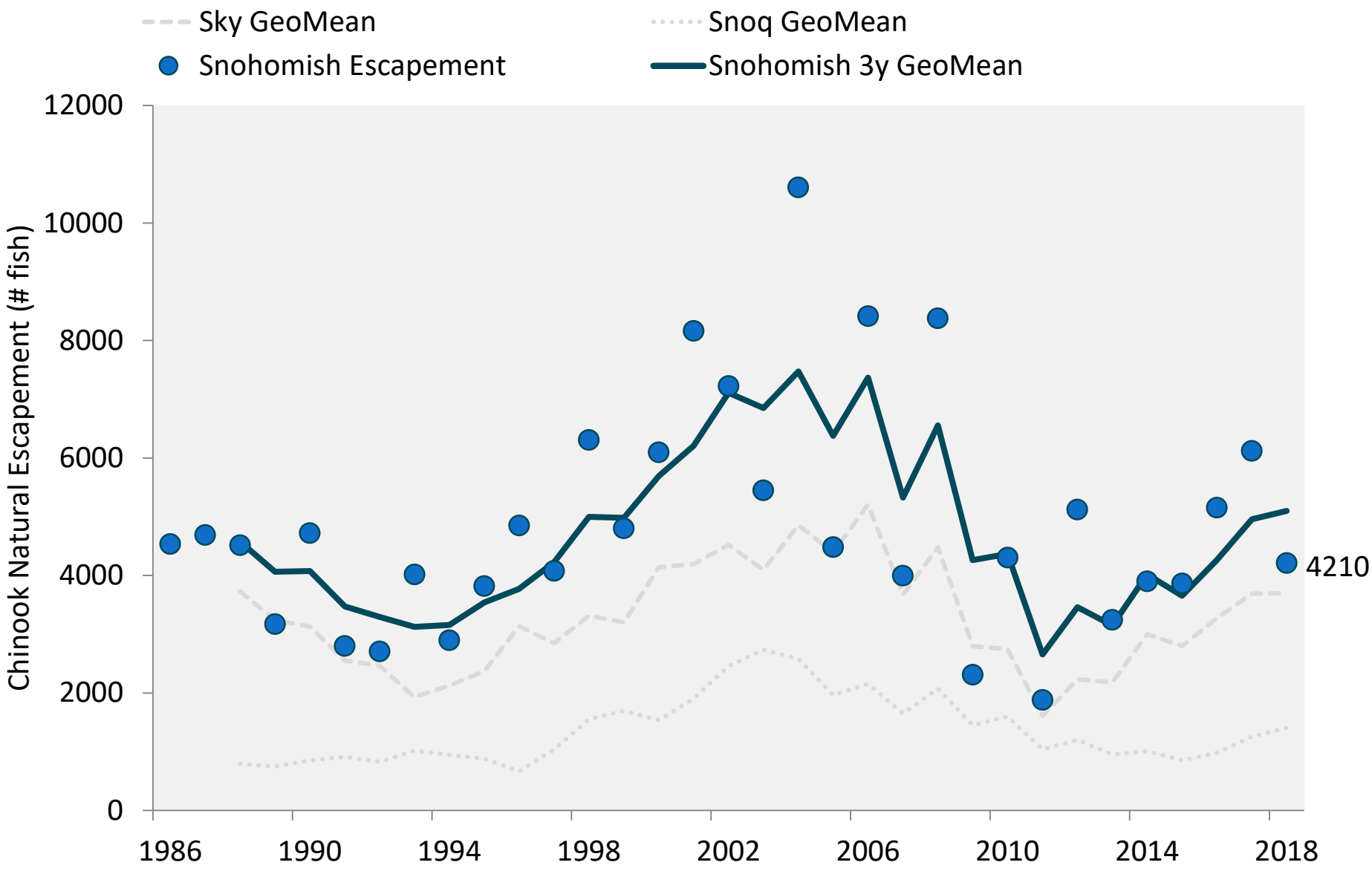
May 2, 2018

Colin Wahl

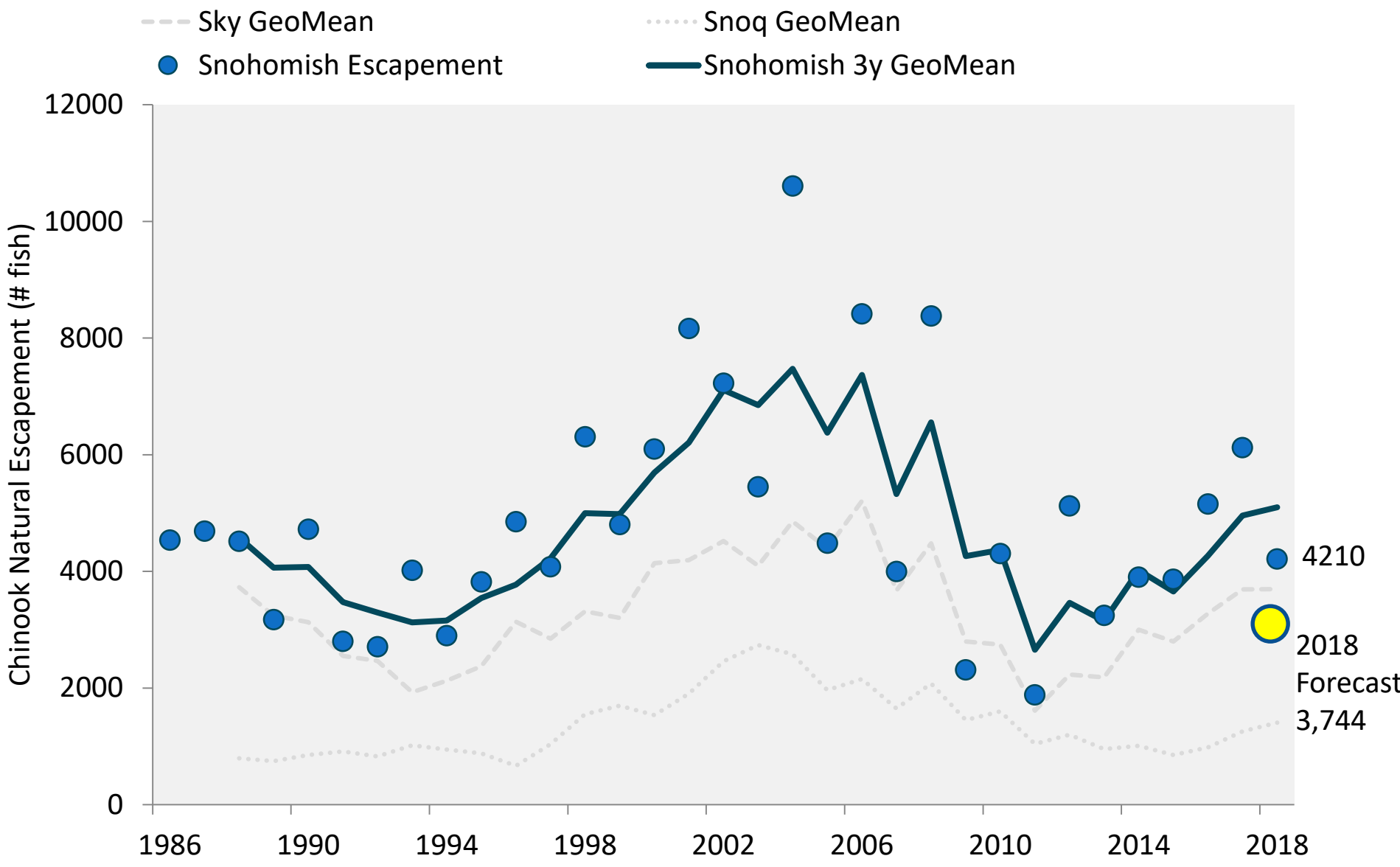
Tulalip Tribes

- Escapements and forecasts
- Trap numbers
- Productivity
- Ocean conditions

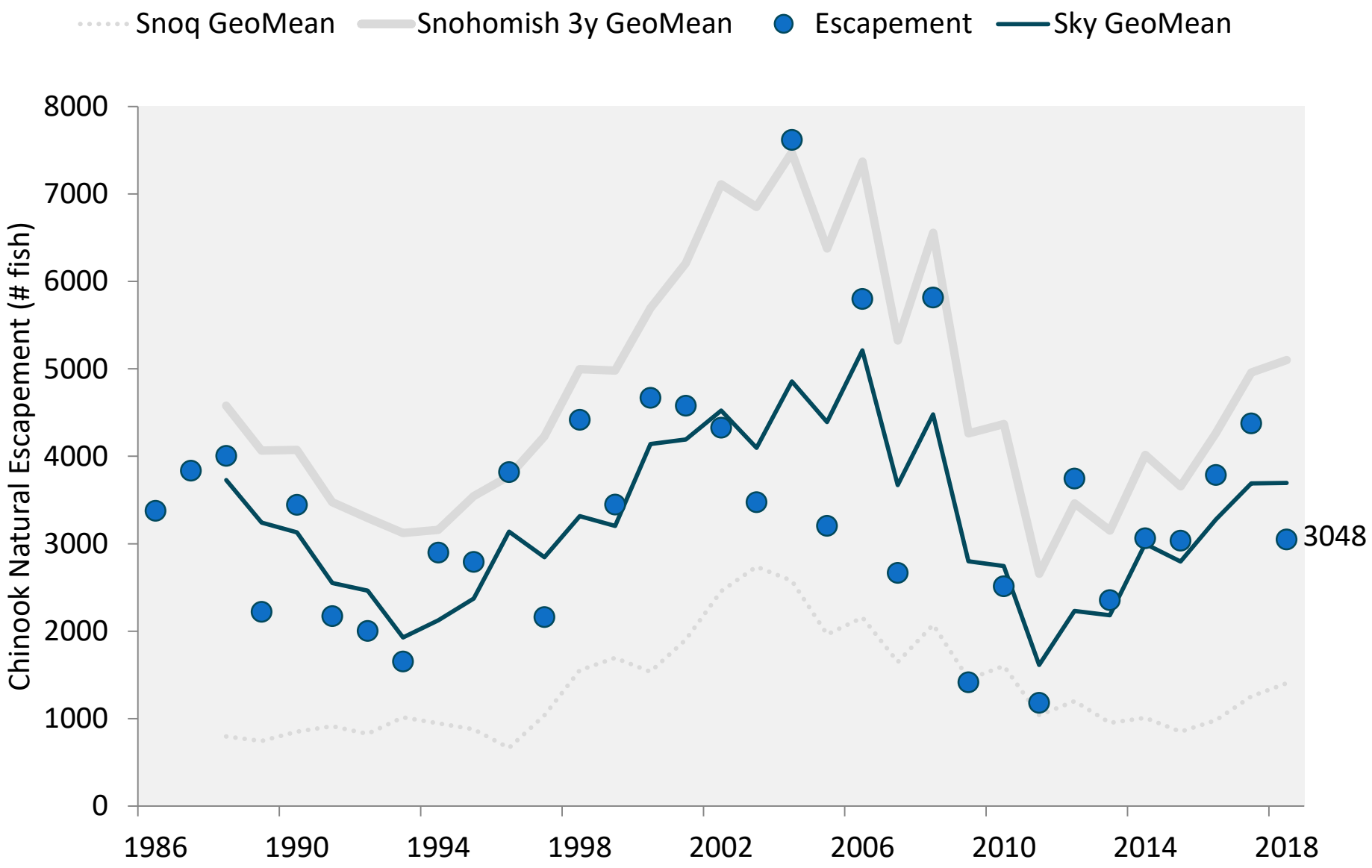
Snohomish Chinook 1986-2018



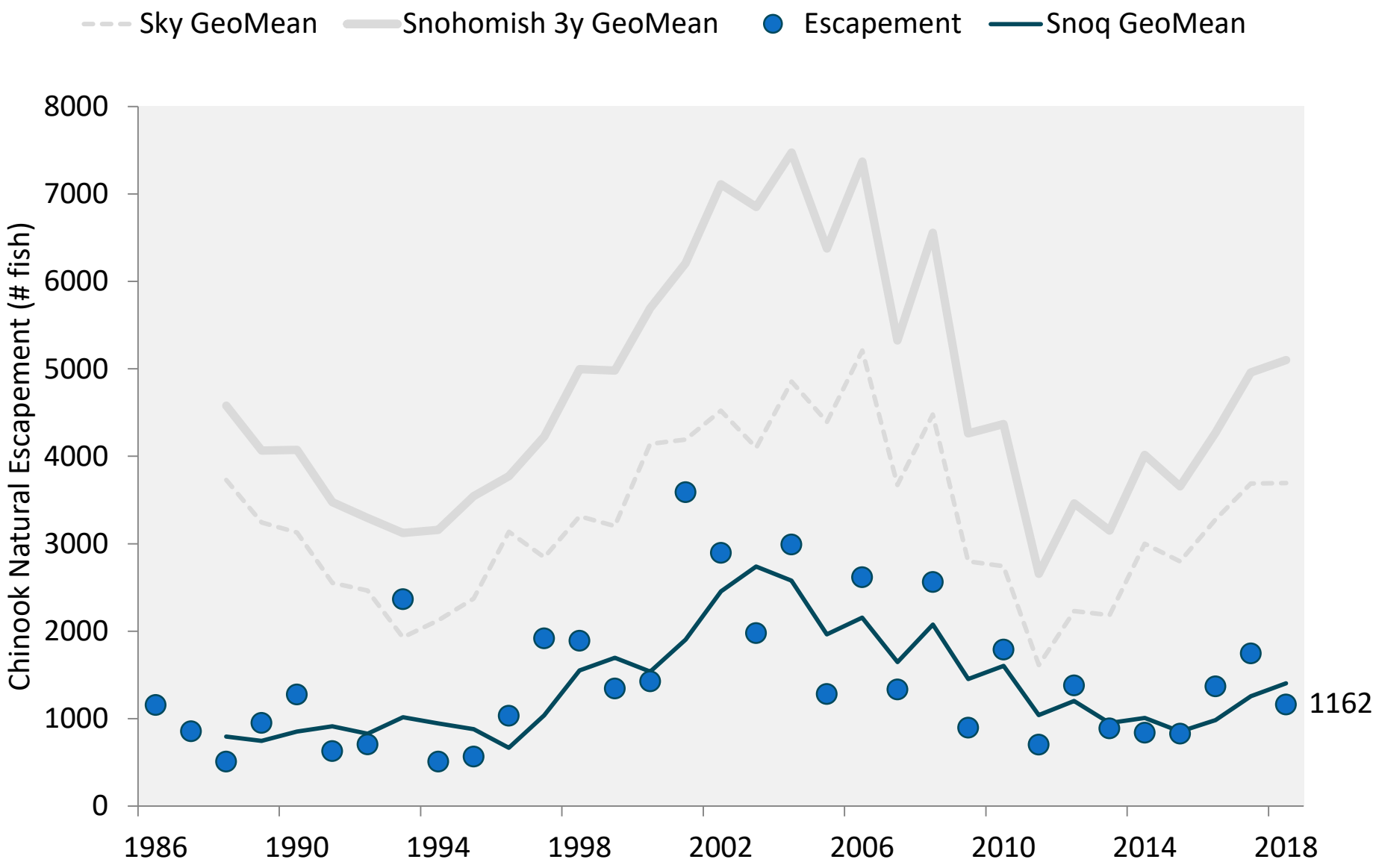
Snohomish Chinook 1986-2018



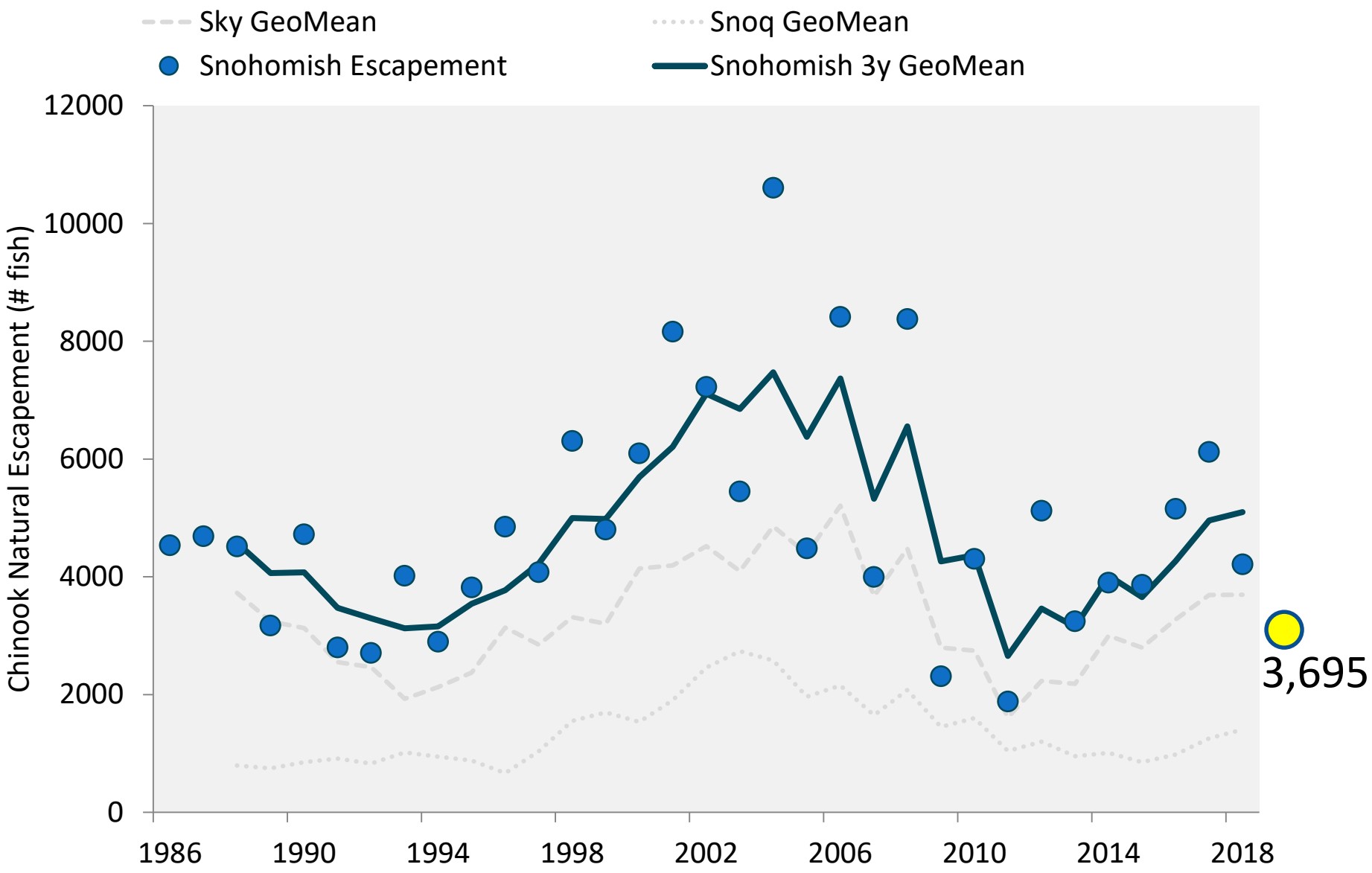
Skykomish Chinook 1986-2018



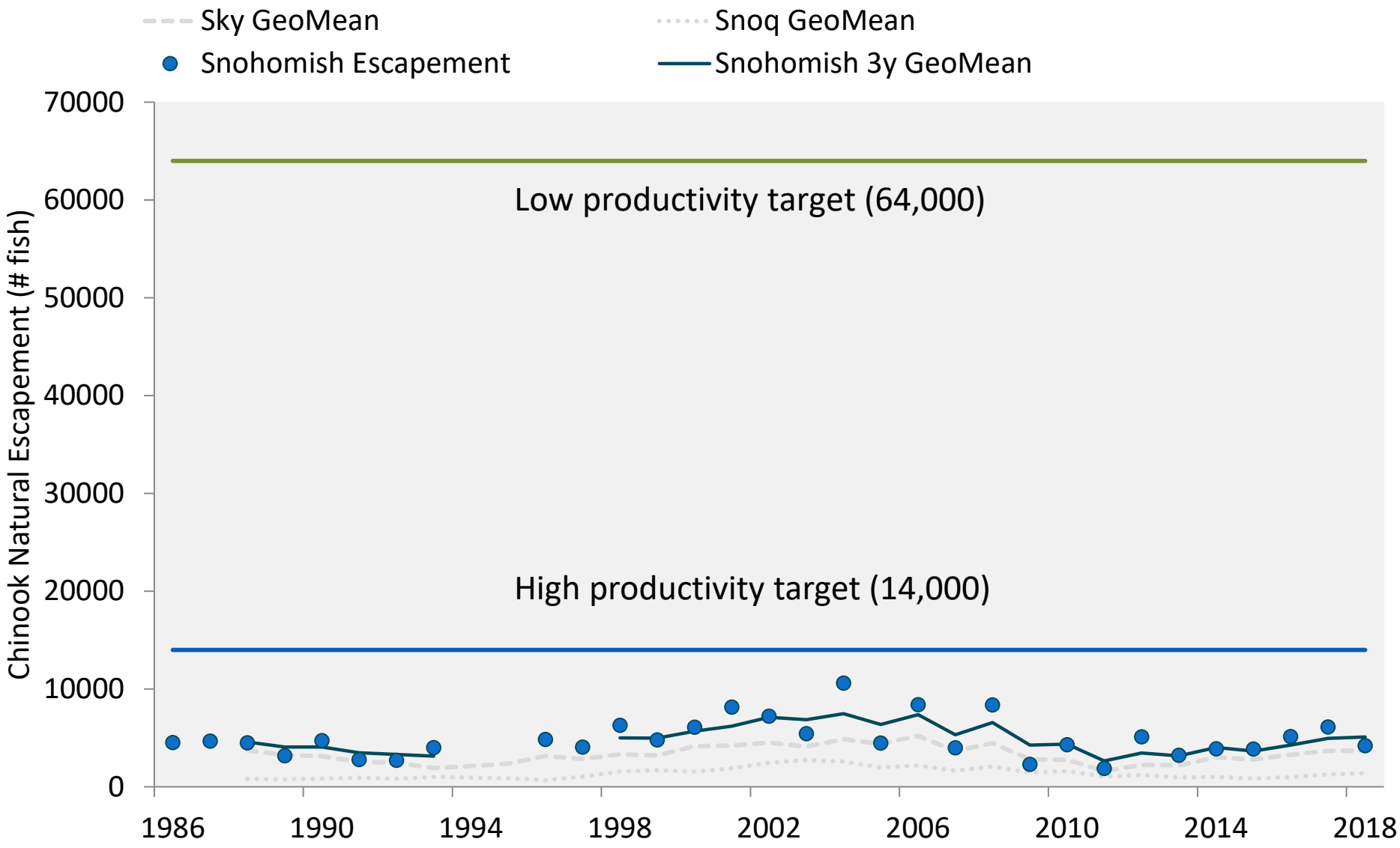
Snoqualmie Chinook 1986-2018



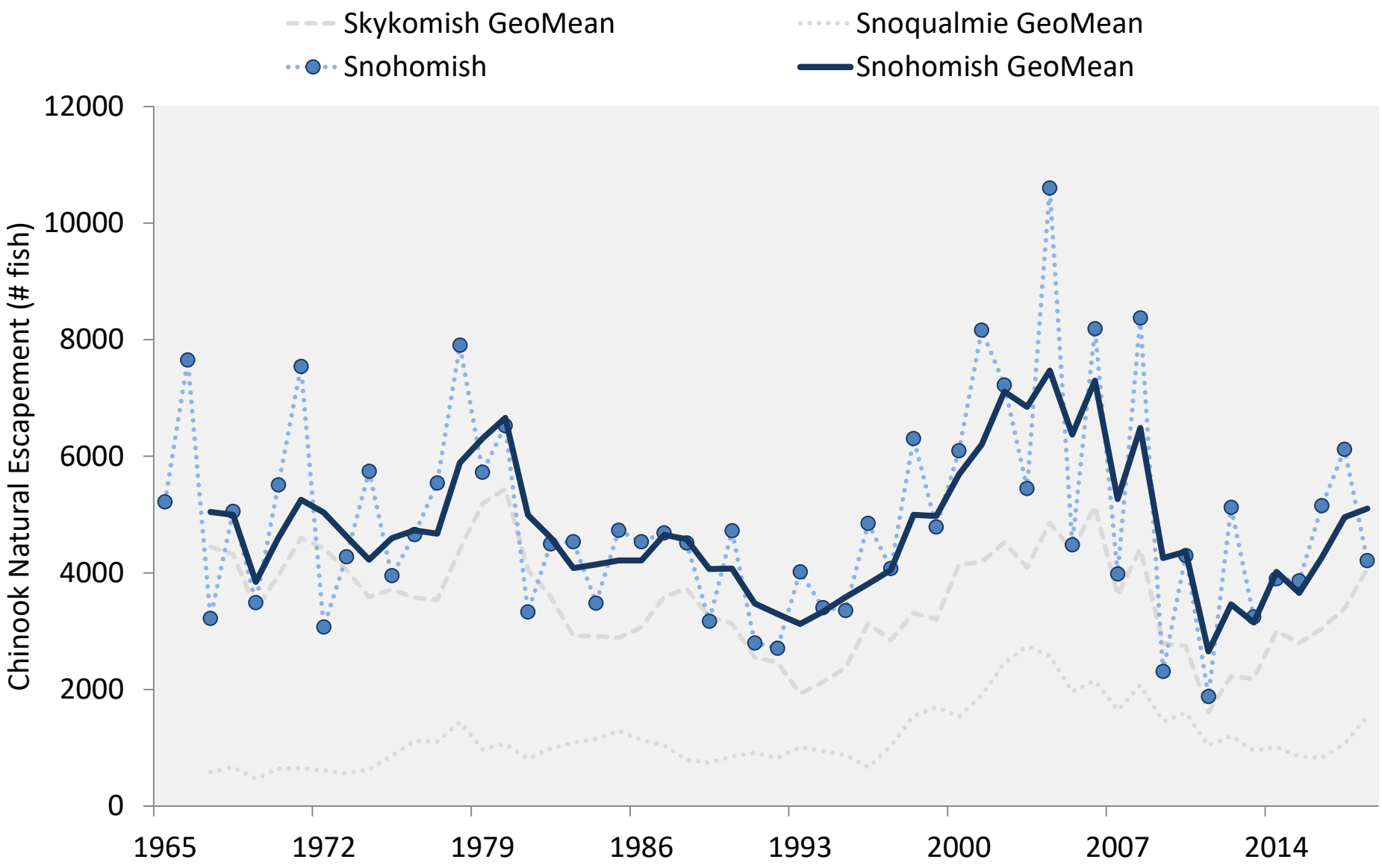
Snohomish Chinook 2019 Forecast



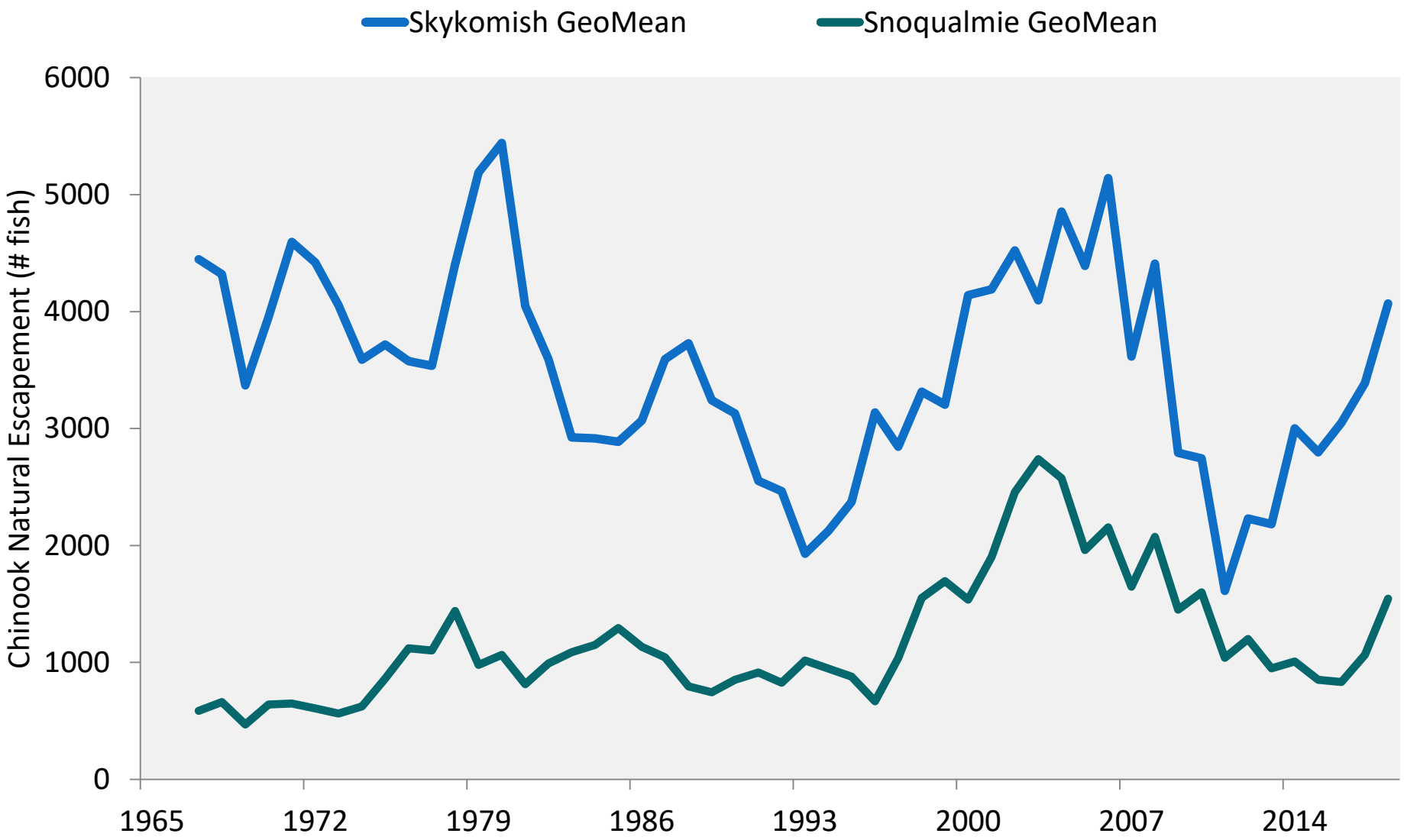
Chinook recovery goals



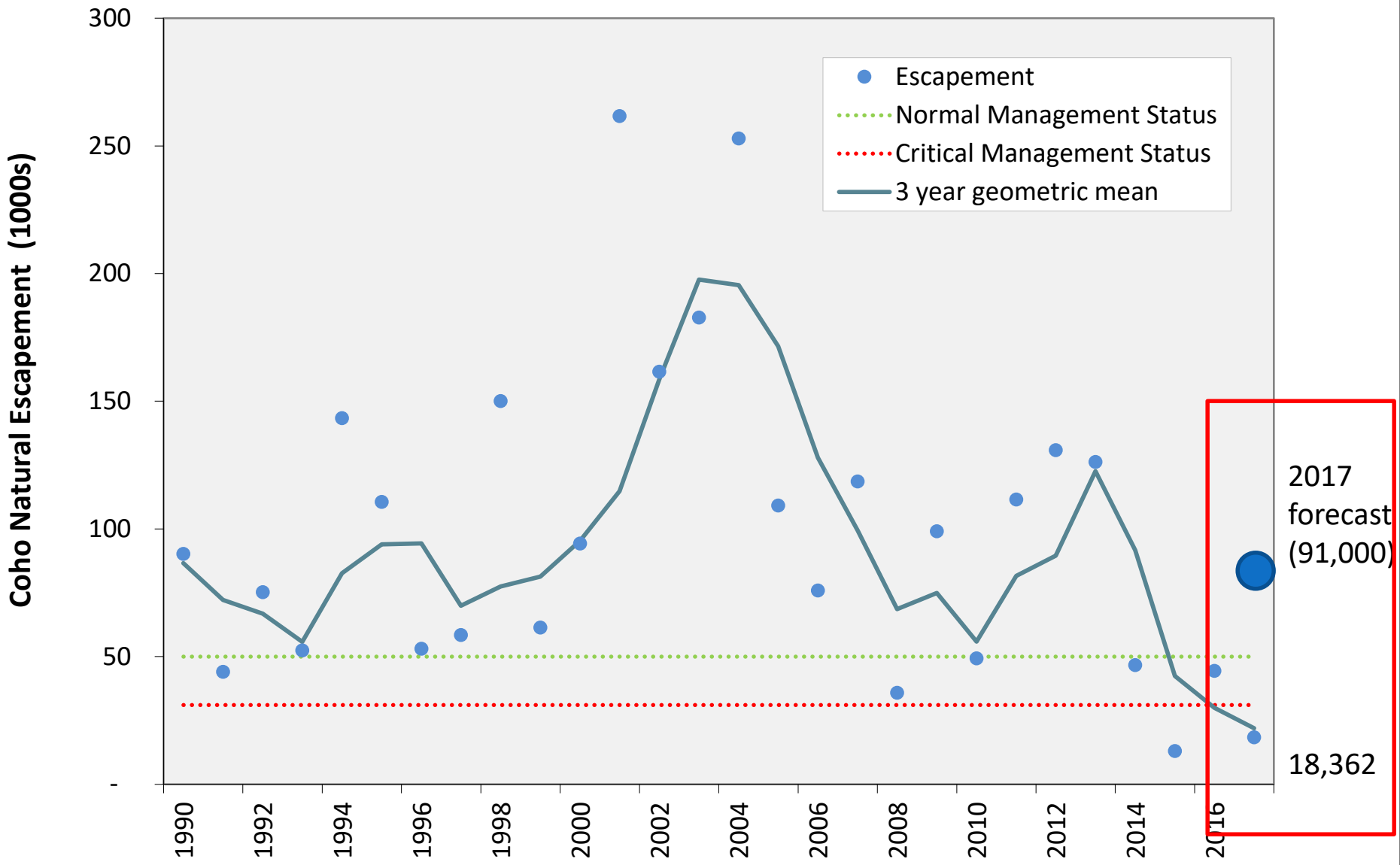
Chinook 1965-2018



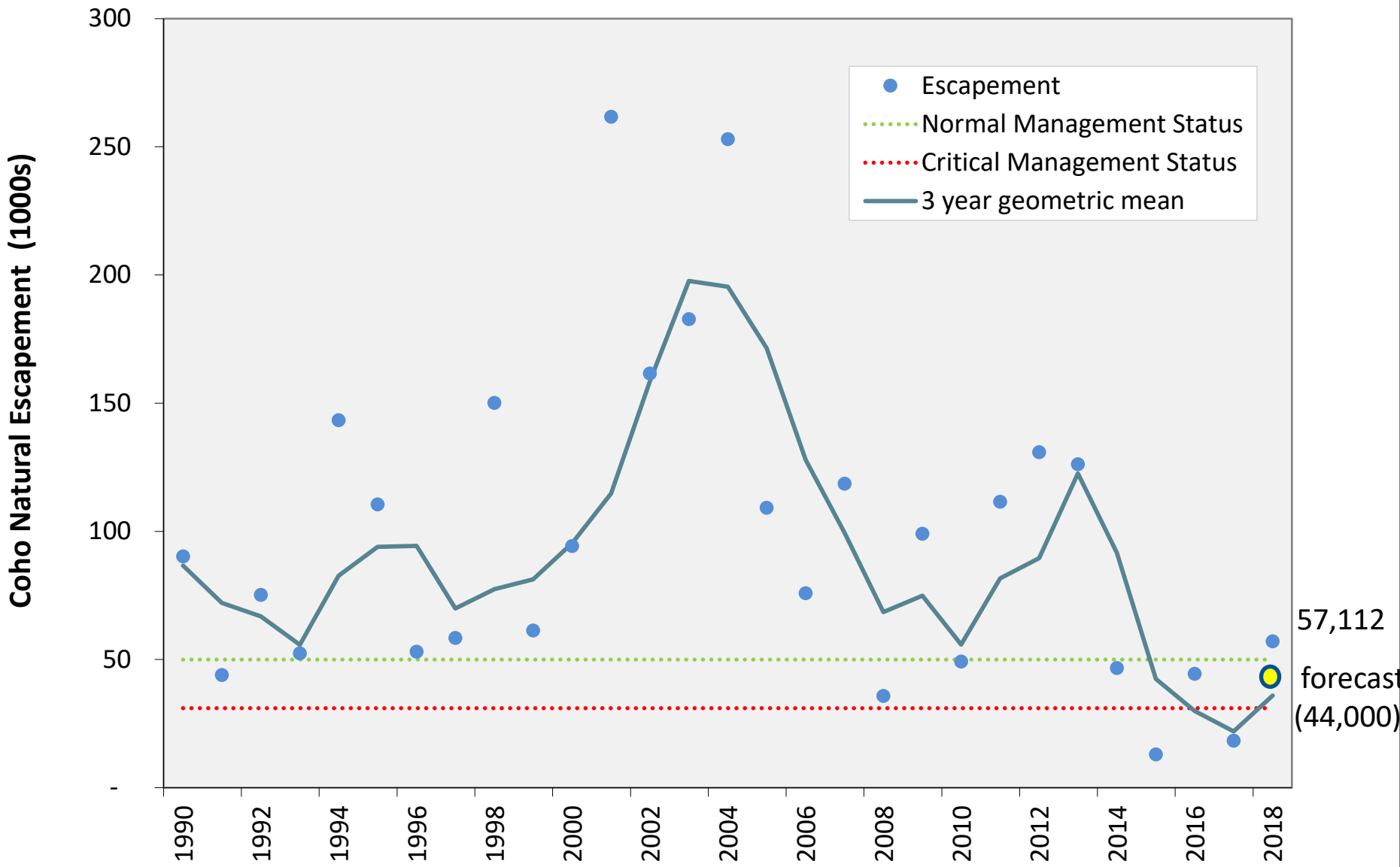
Skykomish vs Snoqualmie Chinook 1965-2018



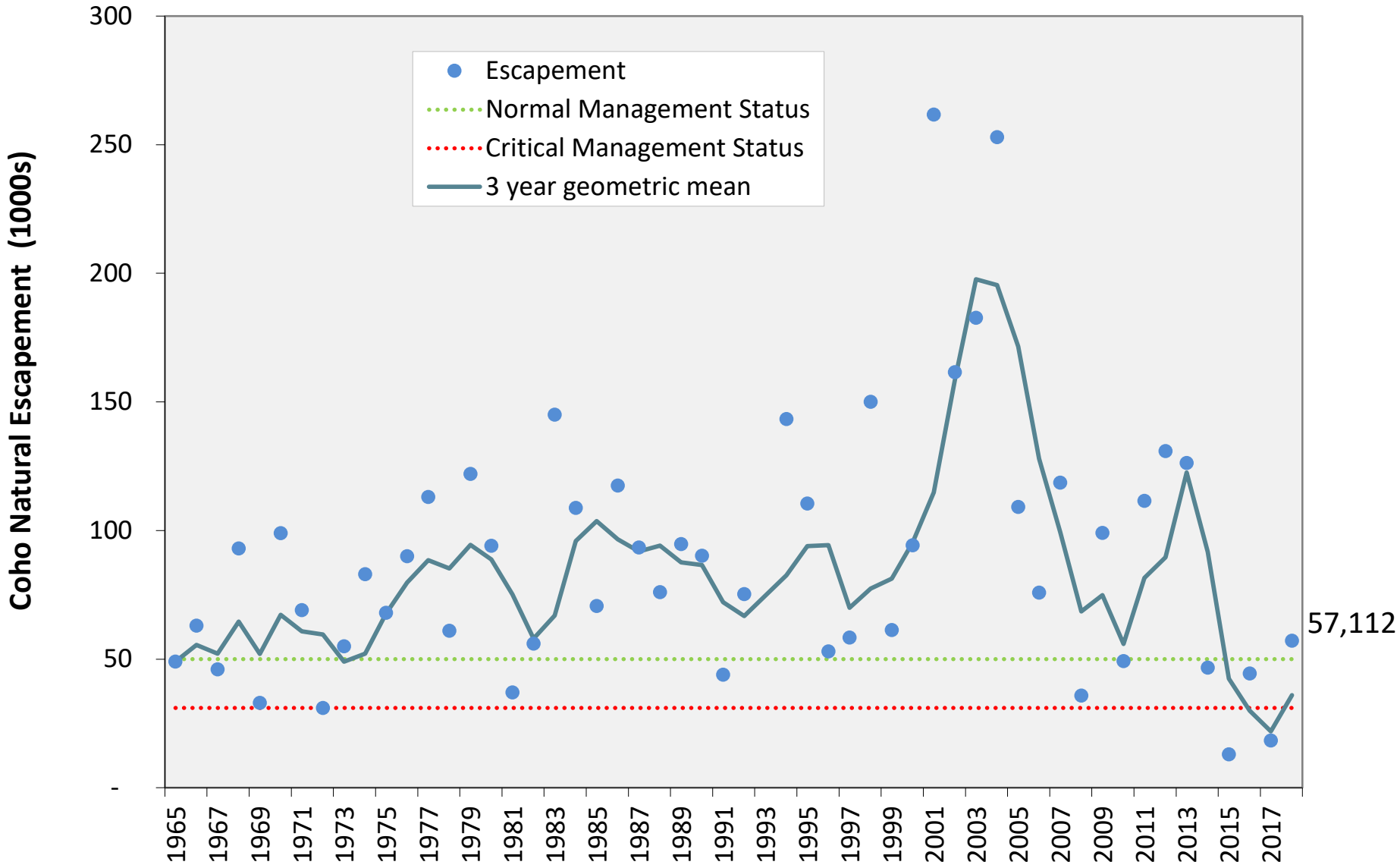
Coho 2017 over-forecast



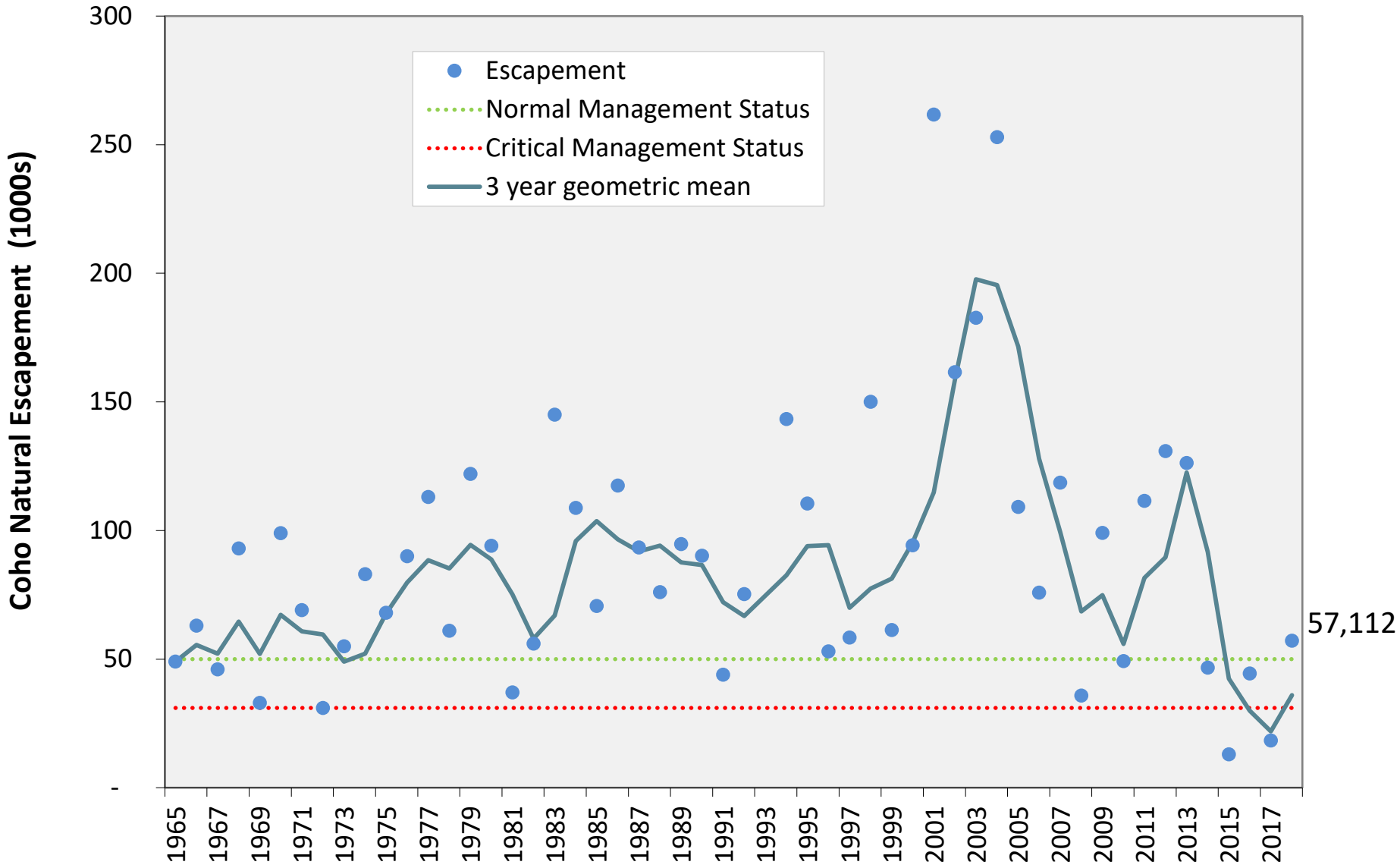
Coho 1990 – 2018



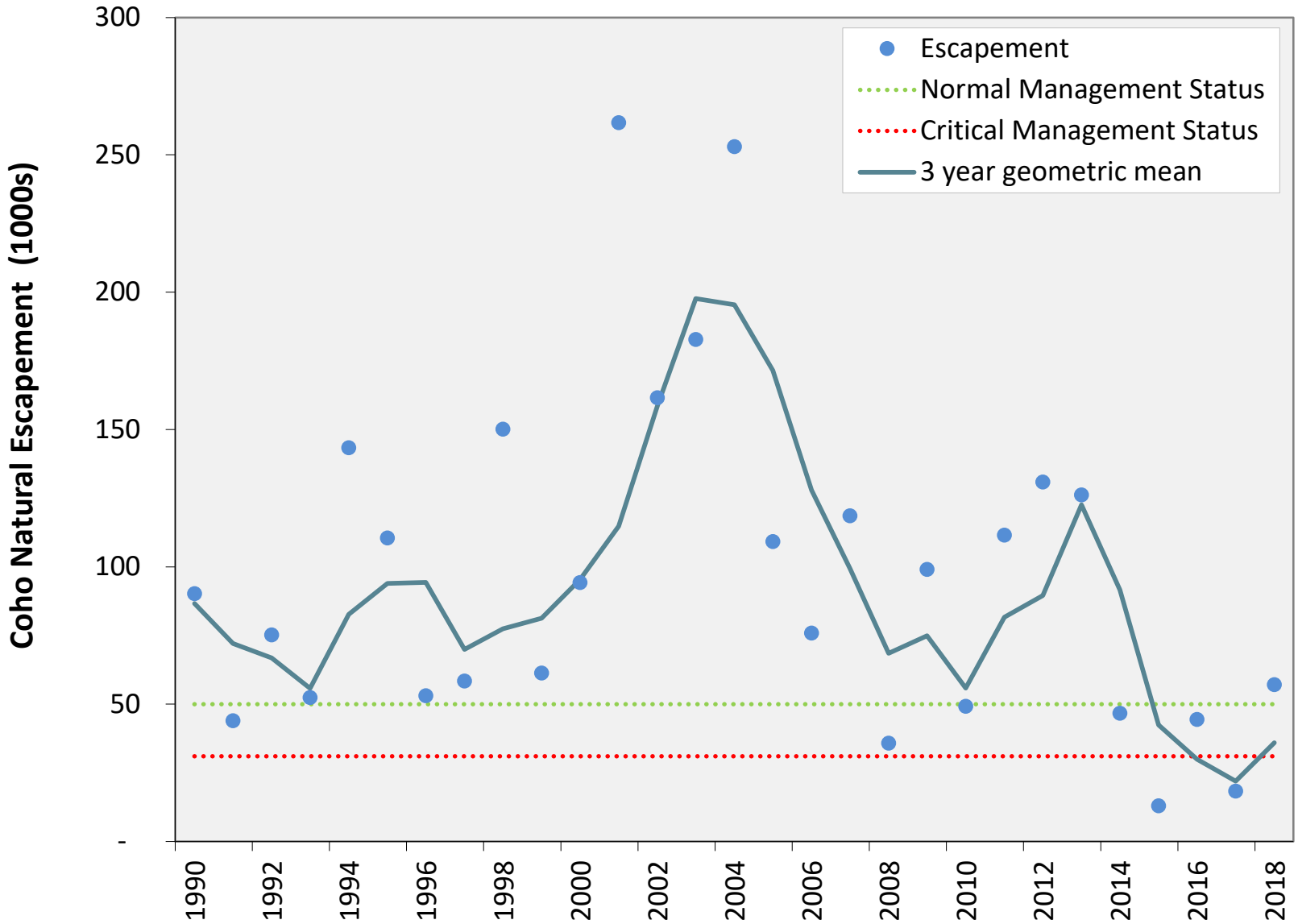
Coho 1965-2018



Coho still in critical status

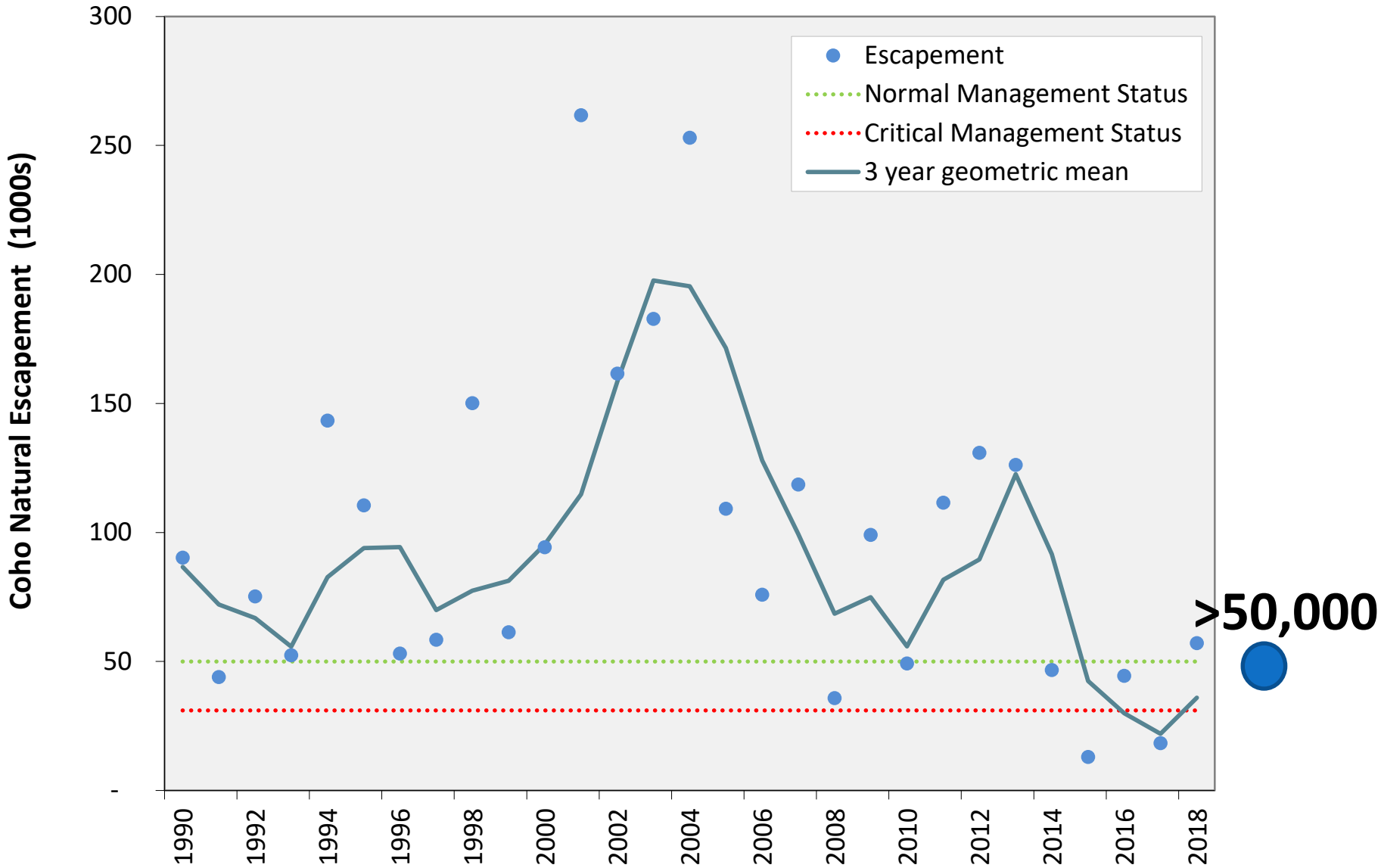


Coho 2019 OA3 forecast

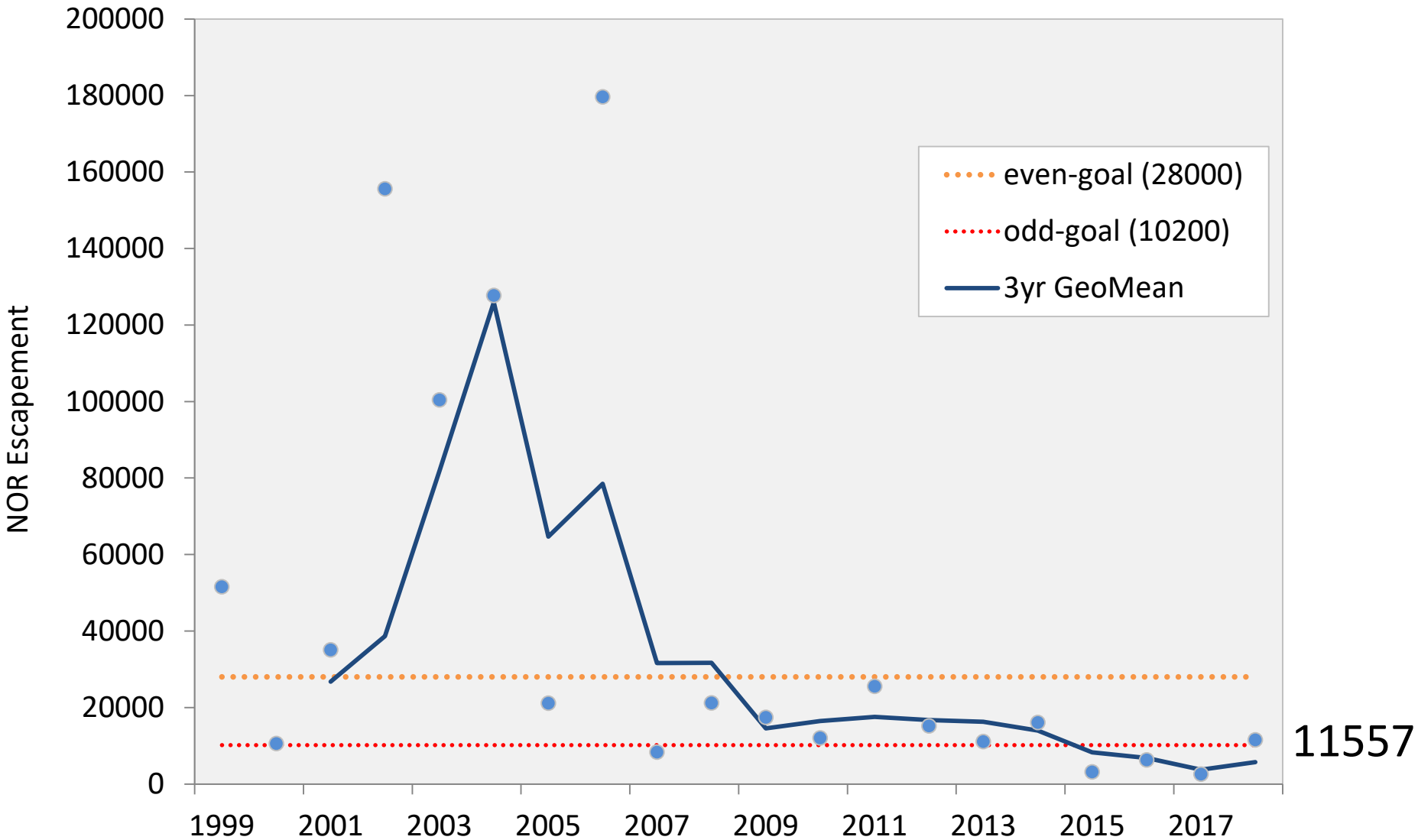


62,600

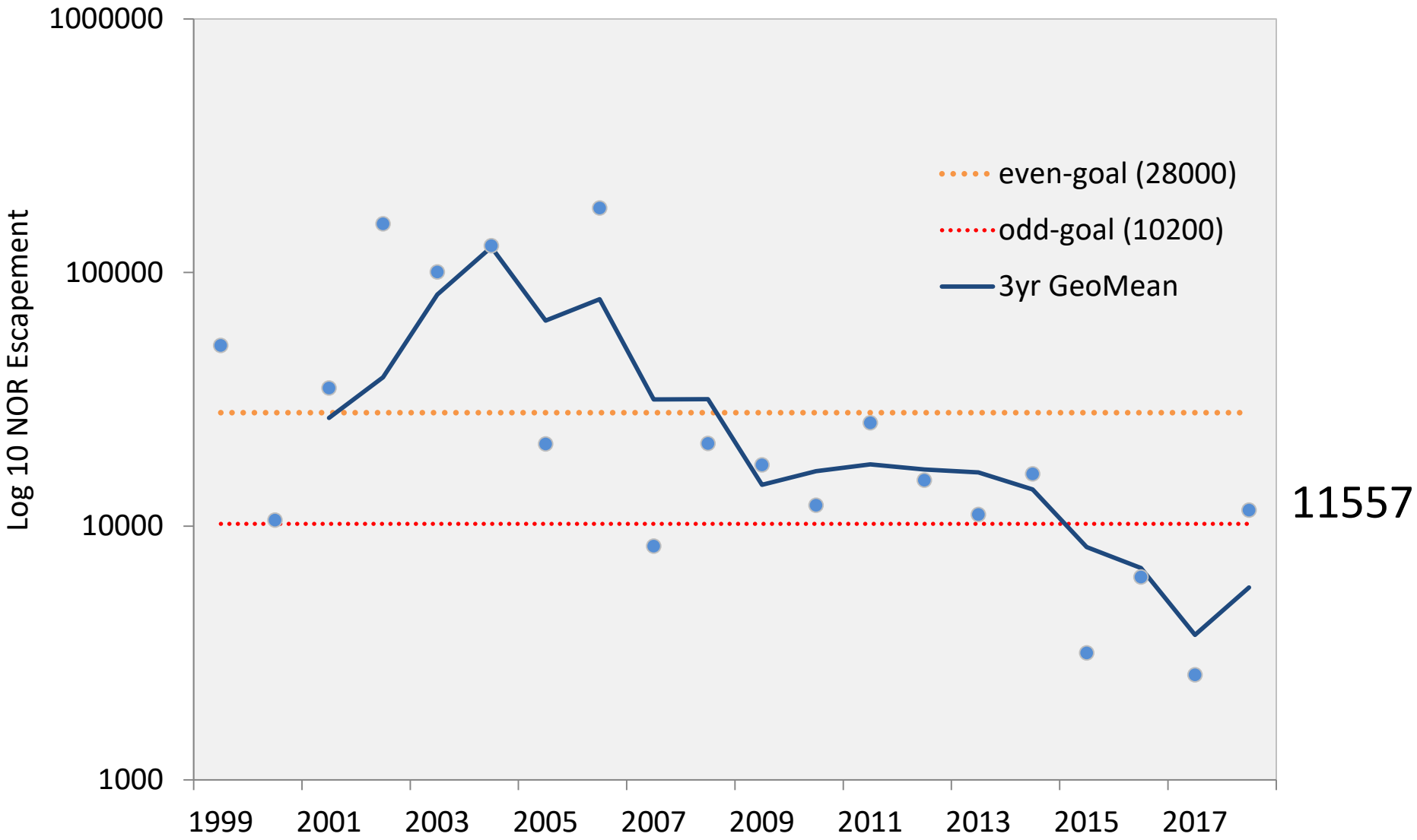
Coho 2019 escapement target



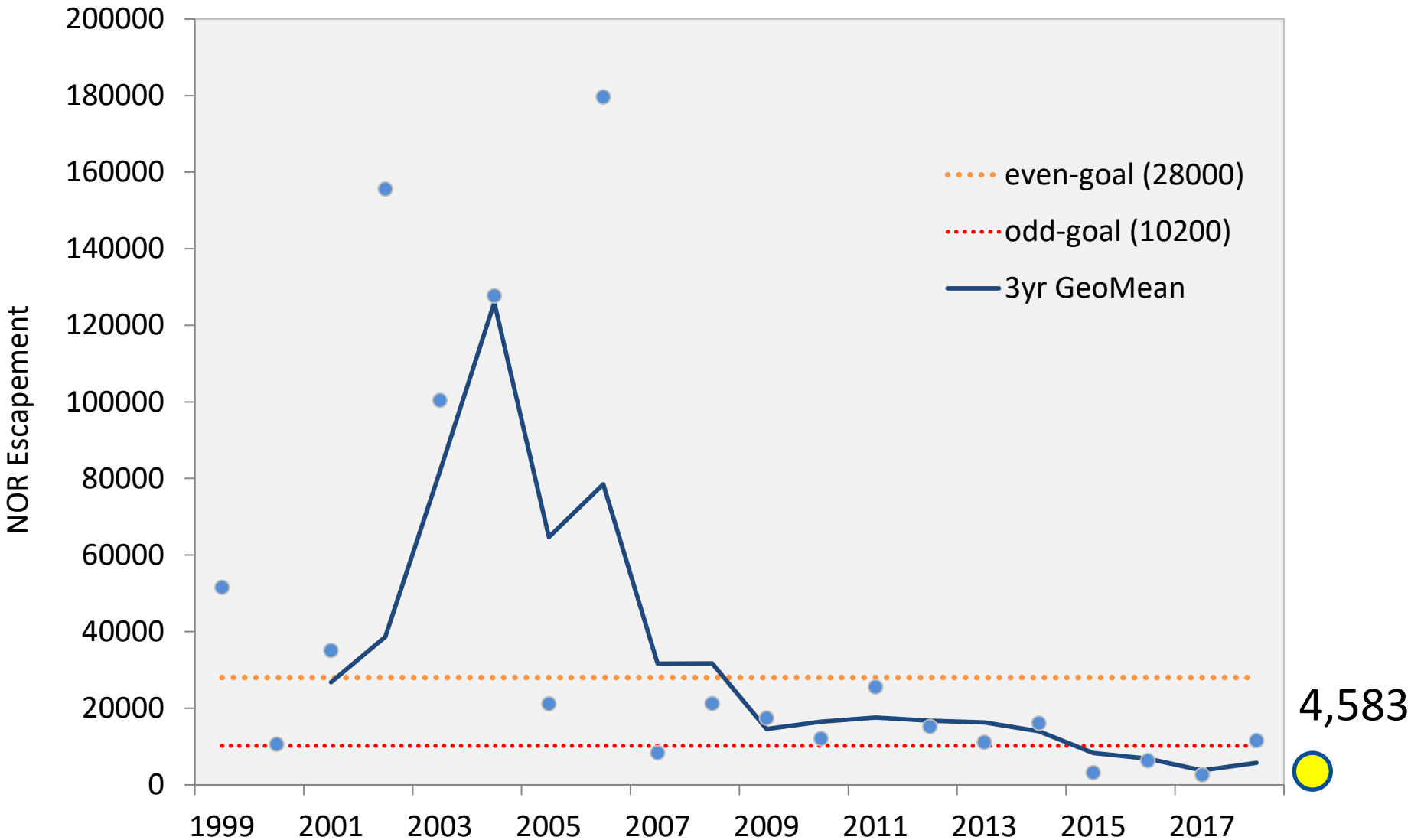
Chum (2018 escapement)



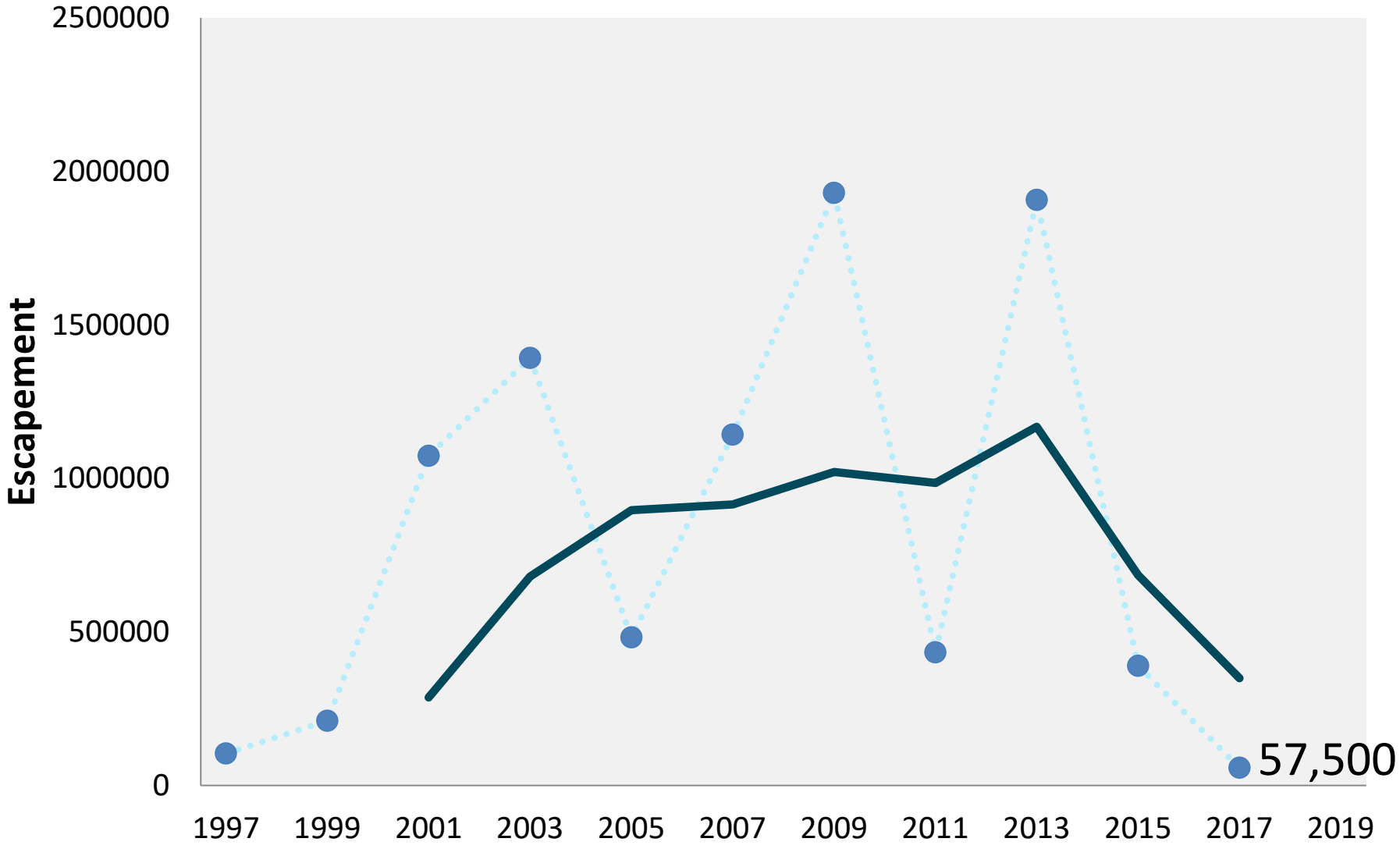
Chum (2018 escapement)



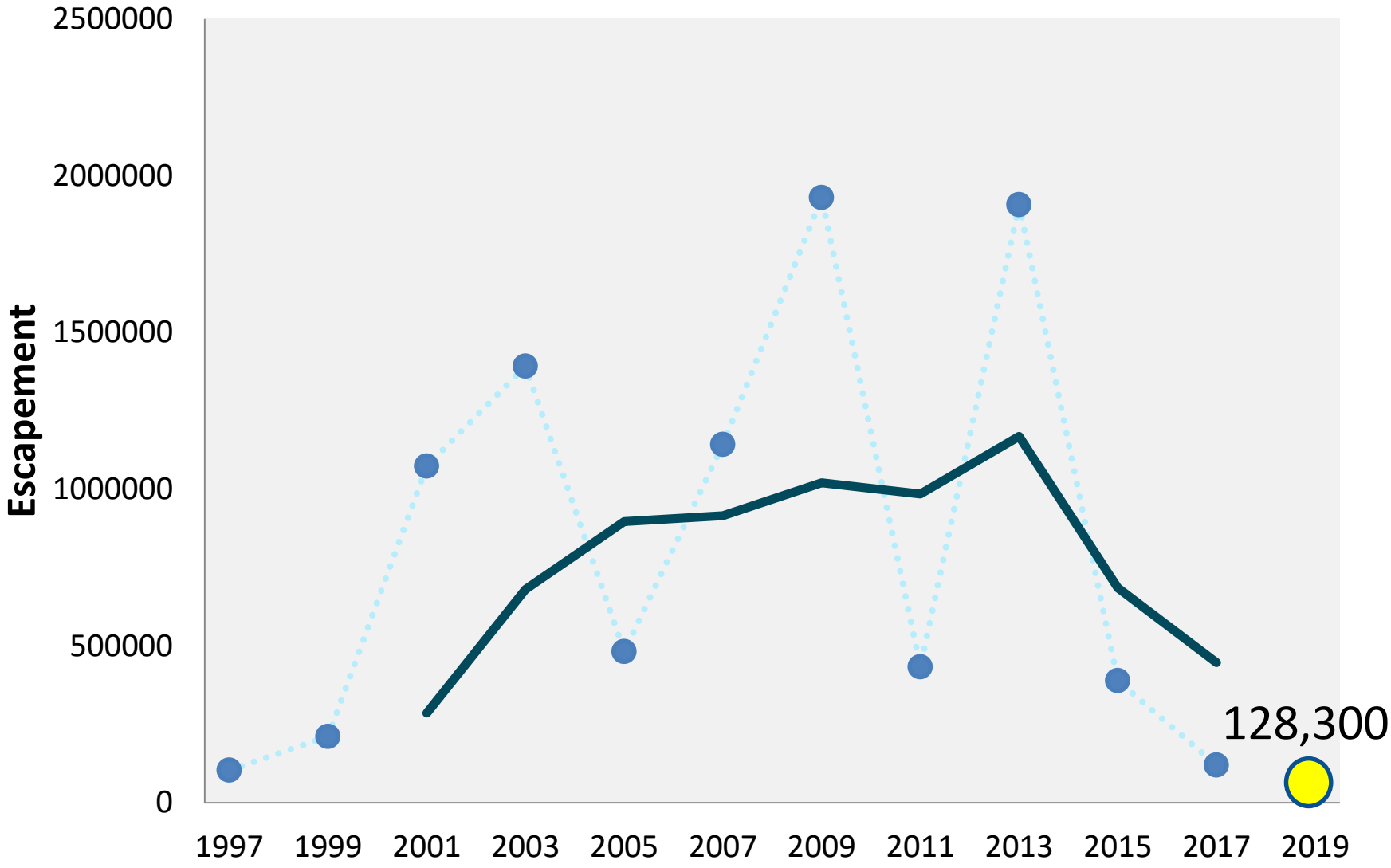
Chum 4B forecast



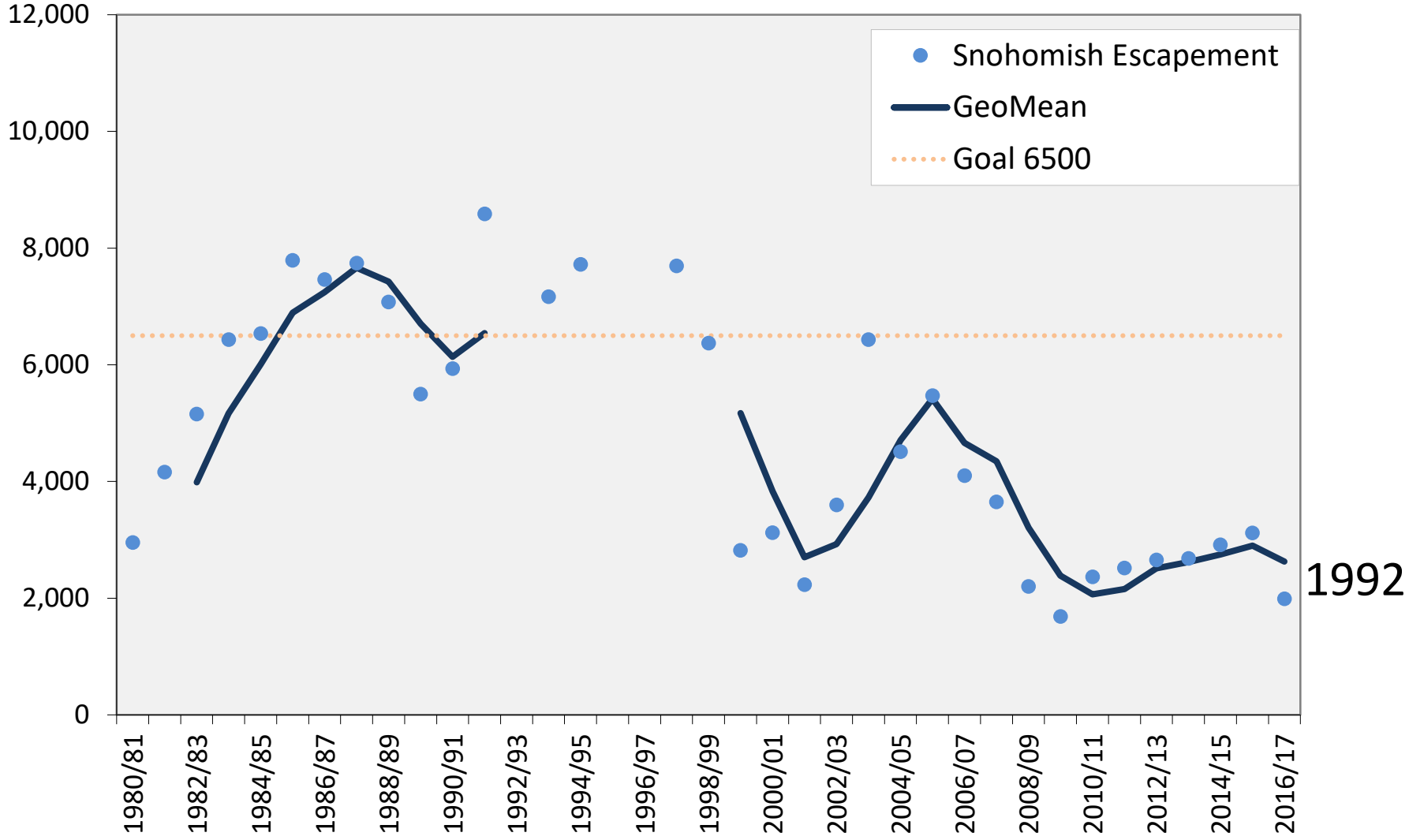
Pink (2018 escapement)



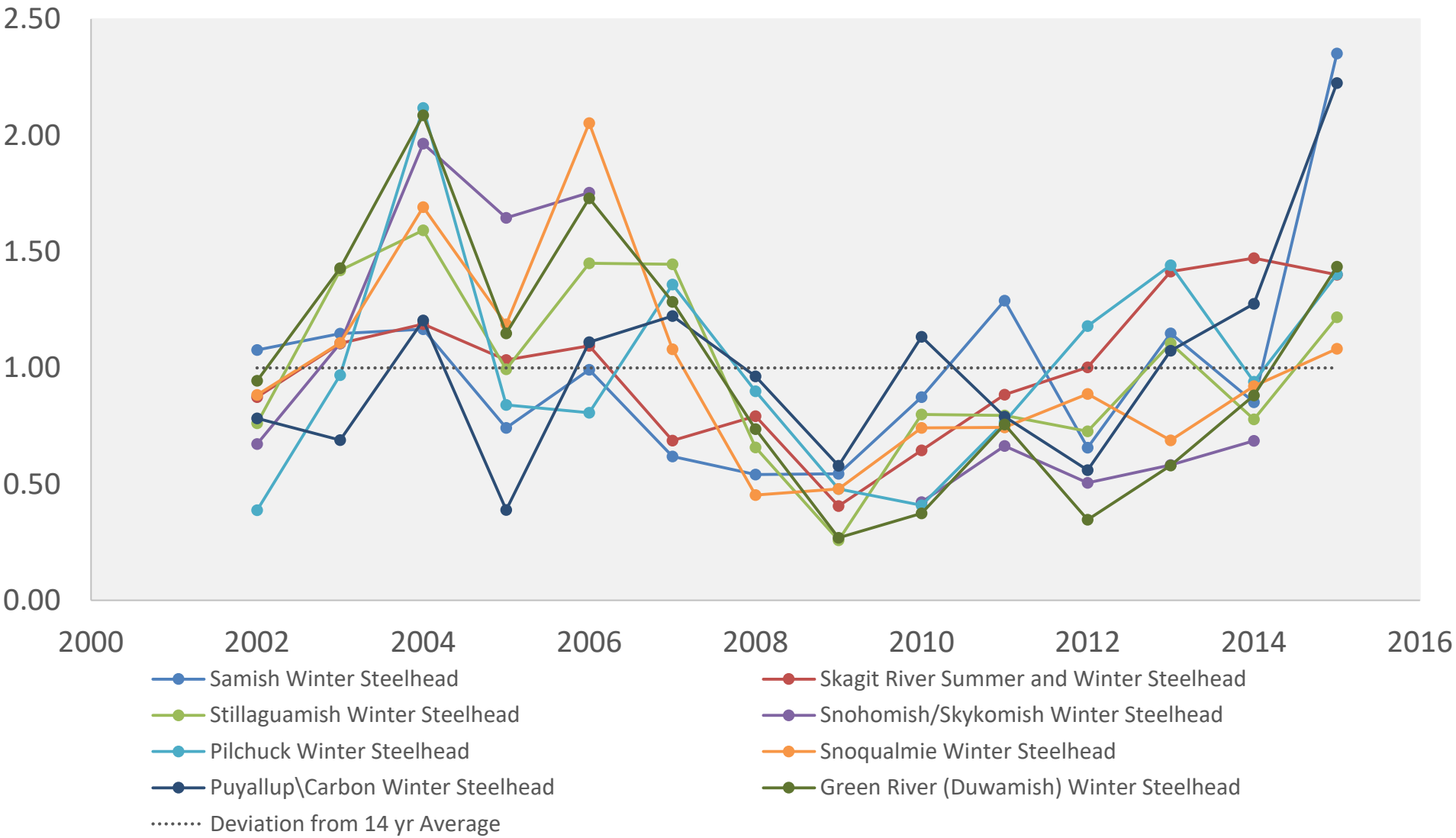
Pink 2019 4B forecast



Snohomish Winter Steelhead (2018)

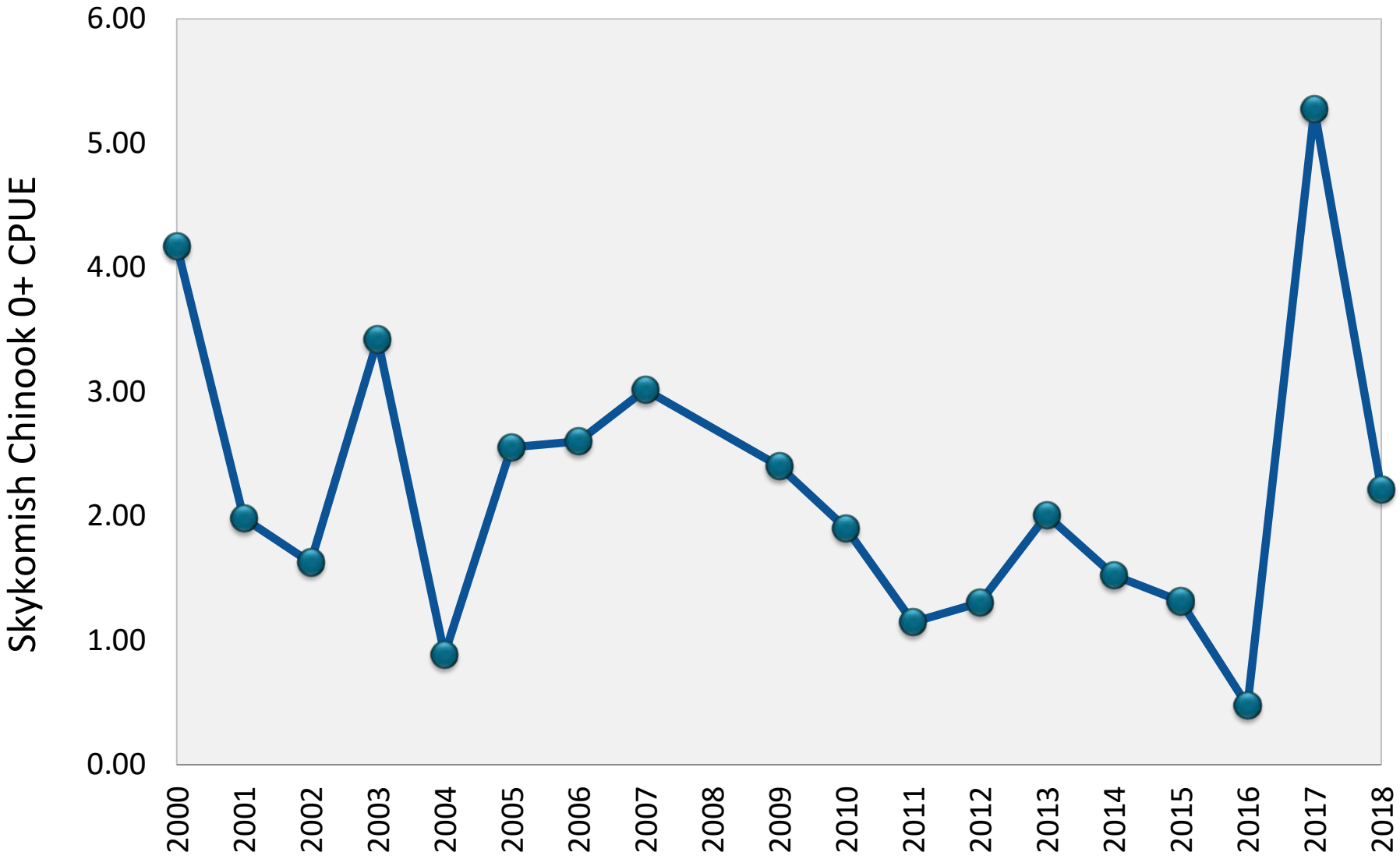


Snohomish Winter Steelhead

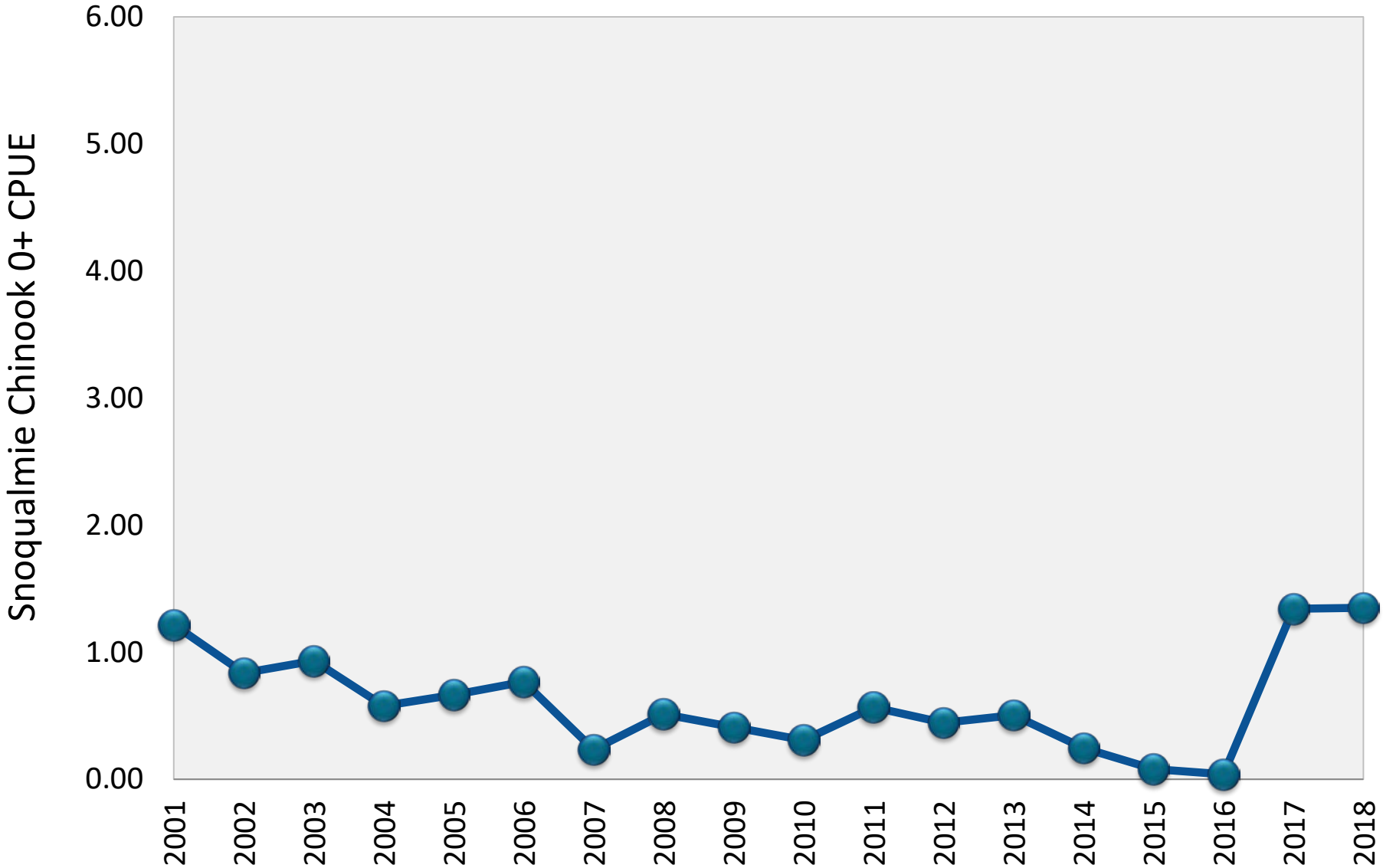


Out-migration

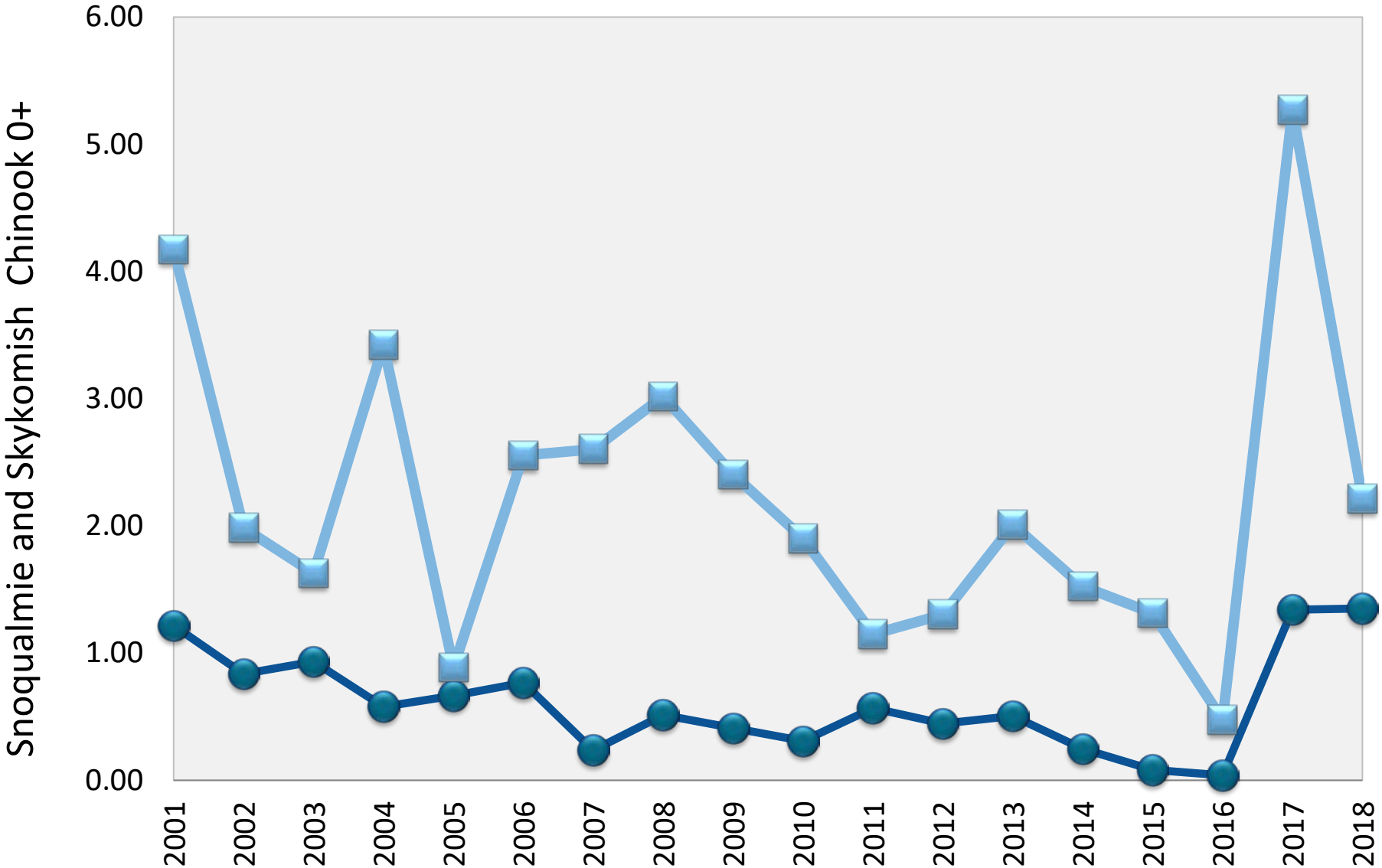
Skykomish Chinook (CPUE)



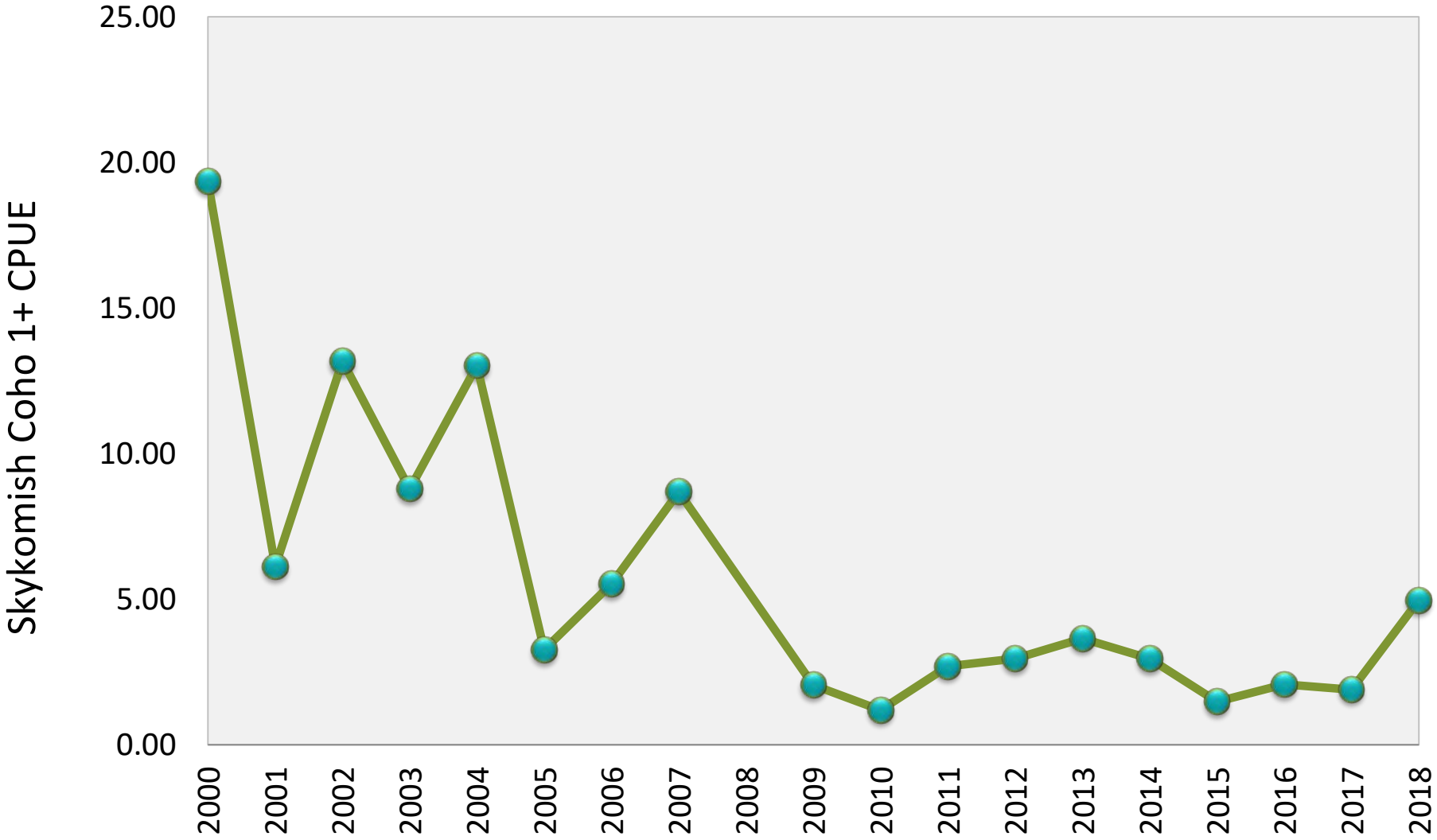
Snoqualmie Chinook (CPUE)



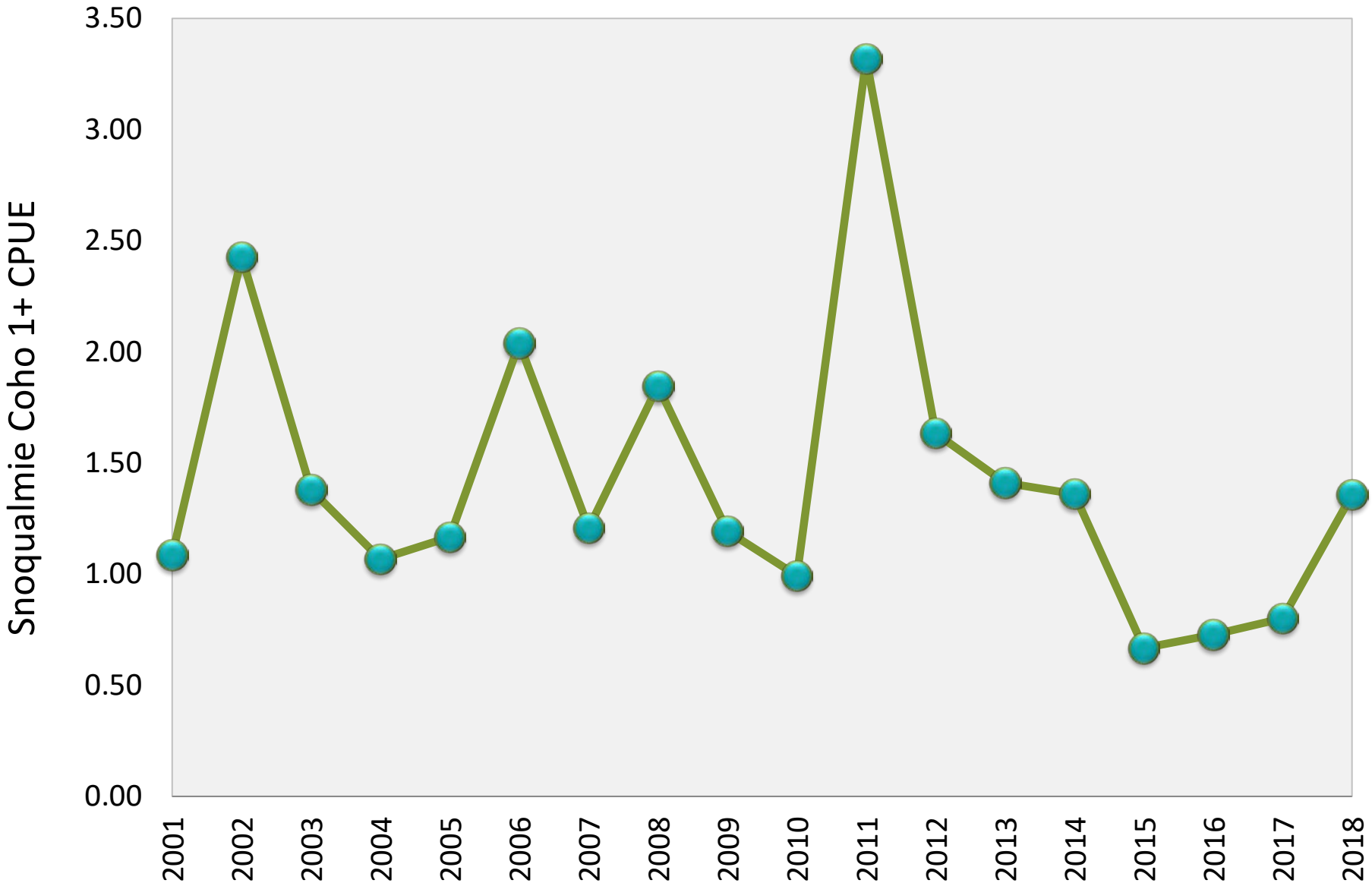
Snoqualmie Chinook (CPUE)



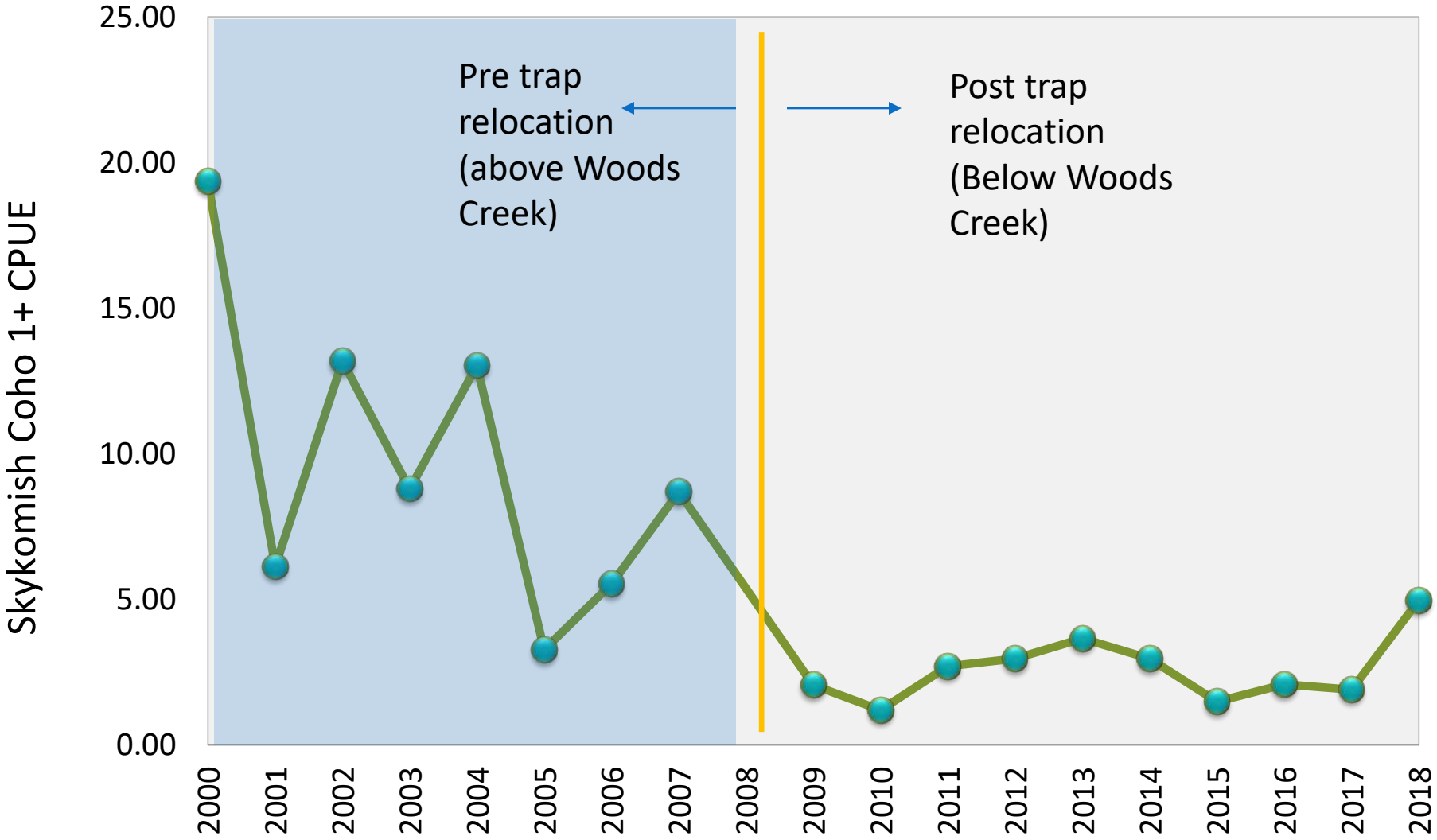
Skykomish Coho (CPUE)



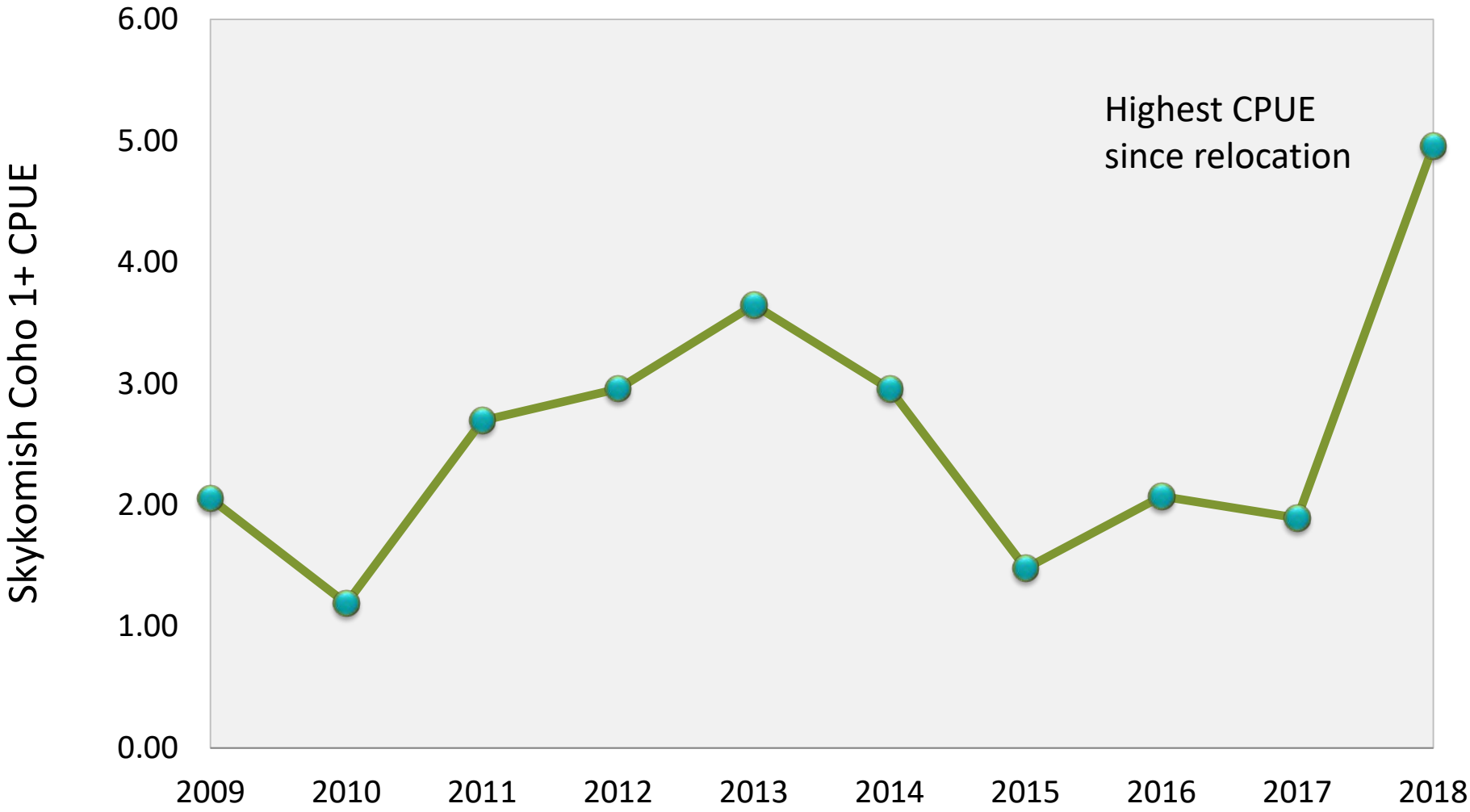
Snoqualmie Coho (CPUE)



Skykomish trap relocated in 2008

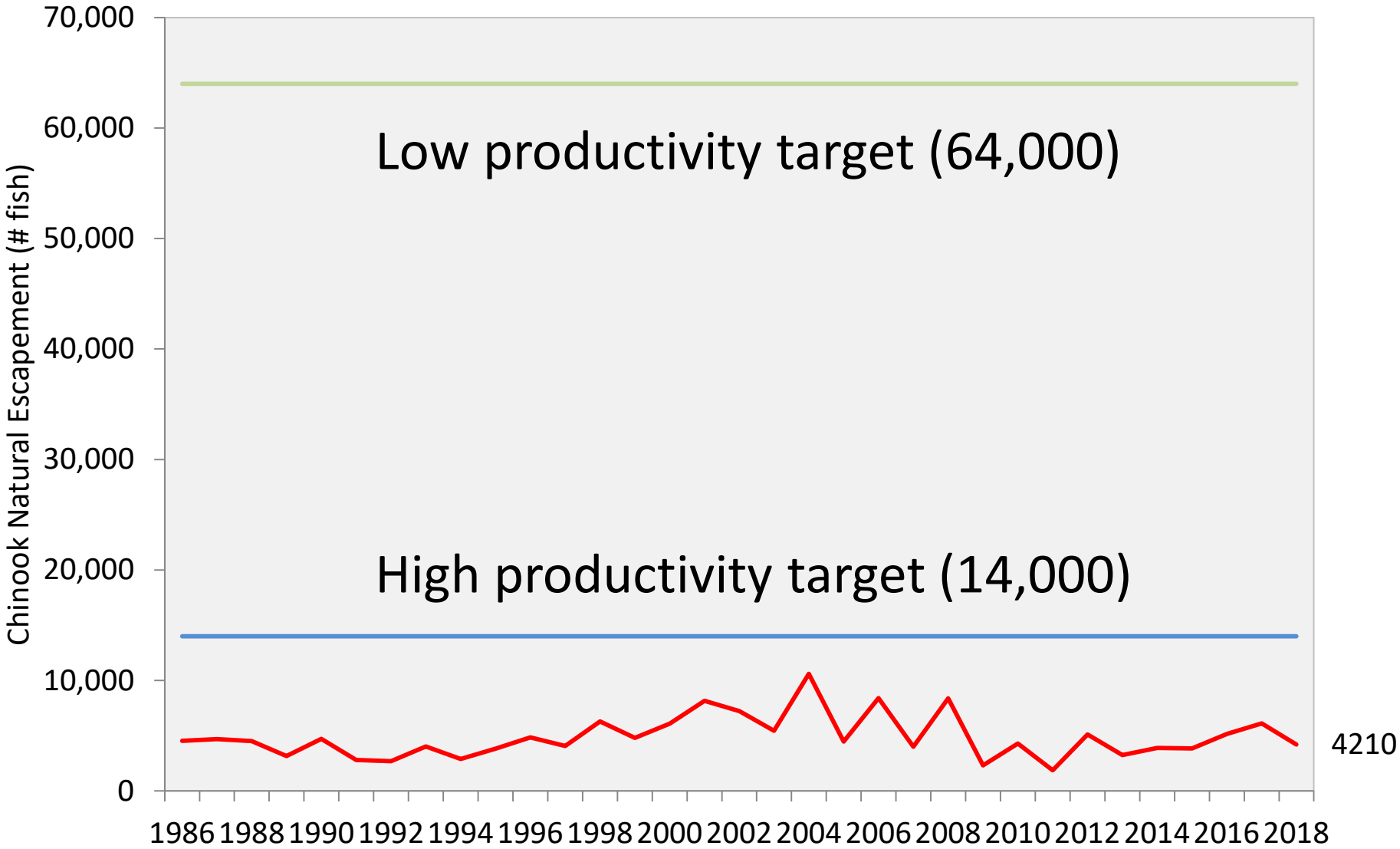


2009 – 2018 Coho (post relocation)

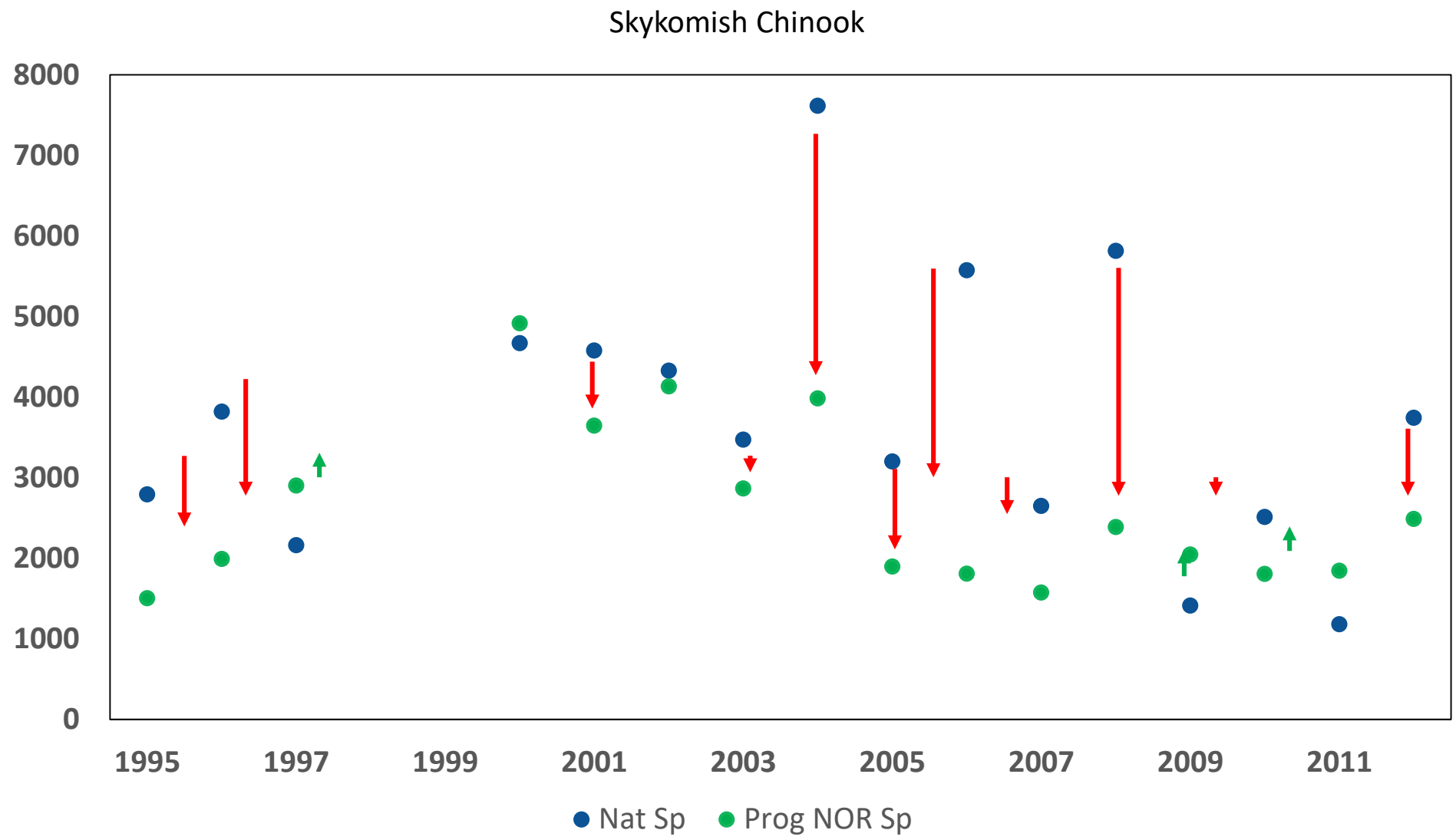


Productivity

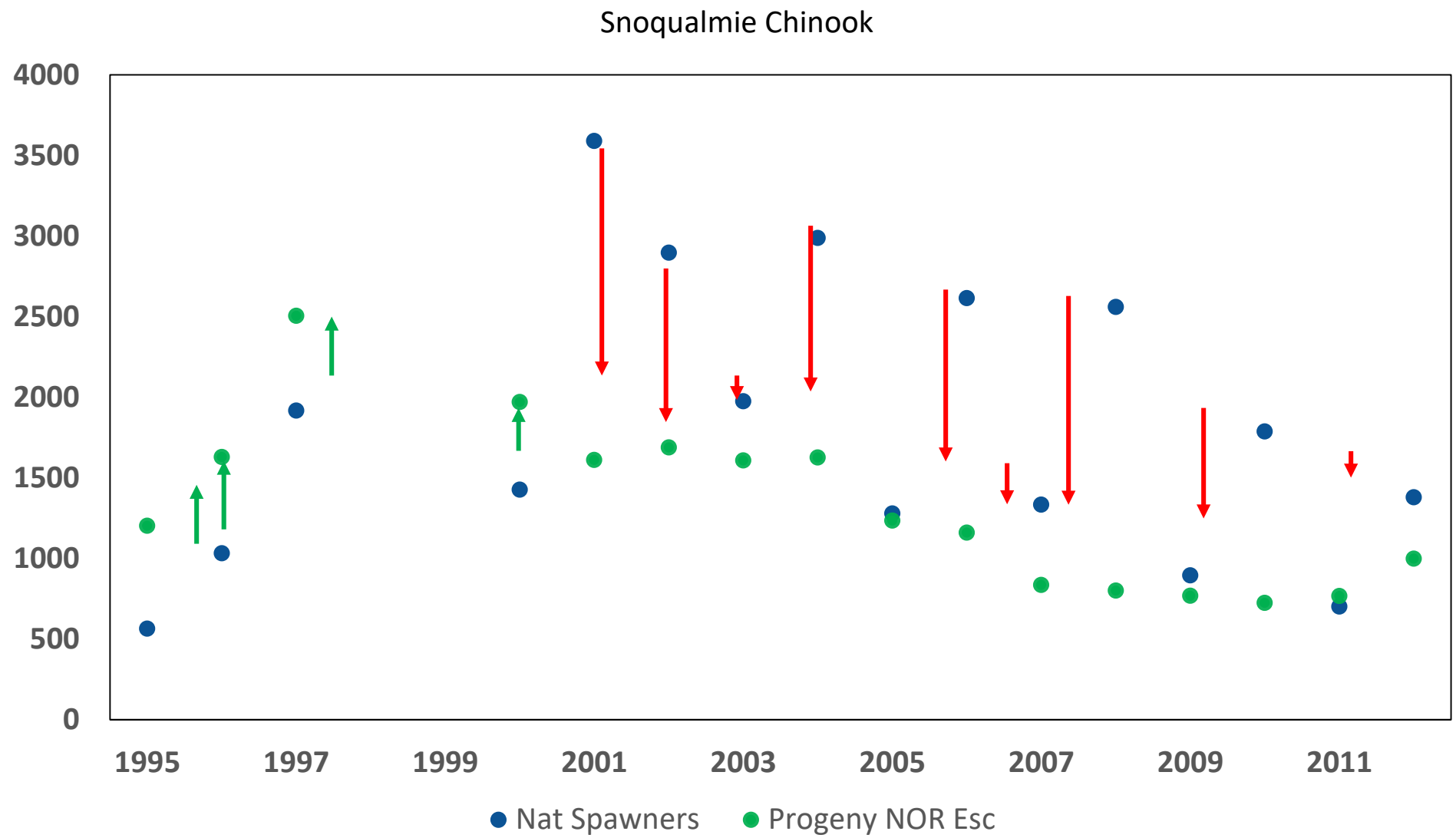
Recovery Goals defined by productivity



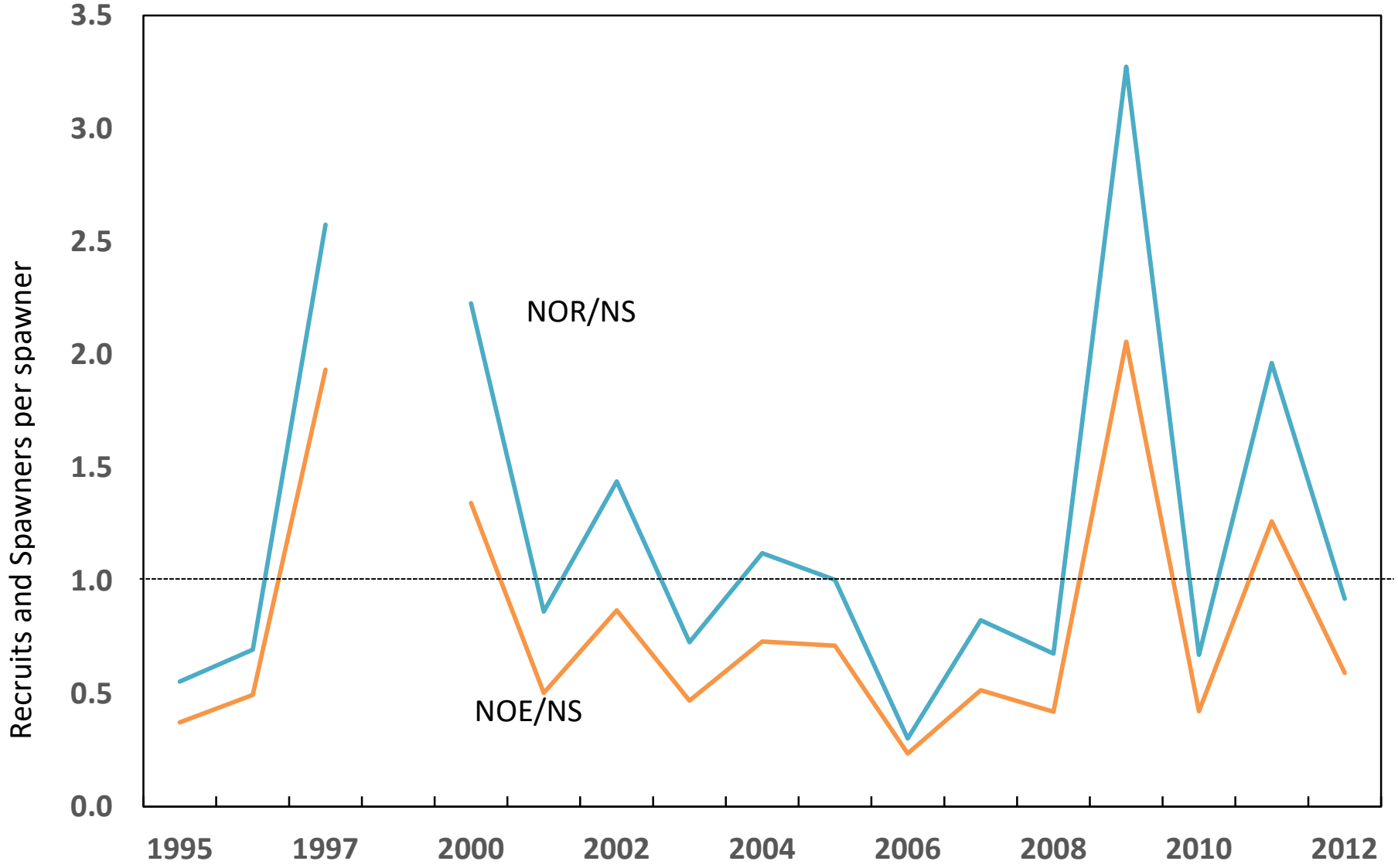
Chinook Productivity



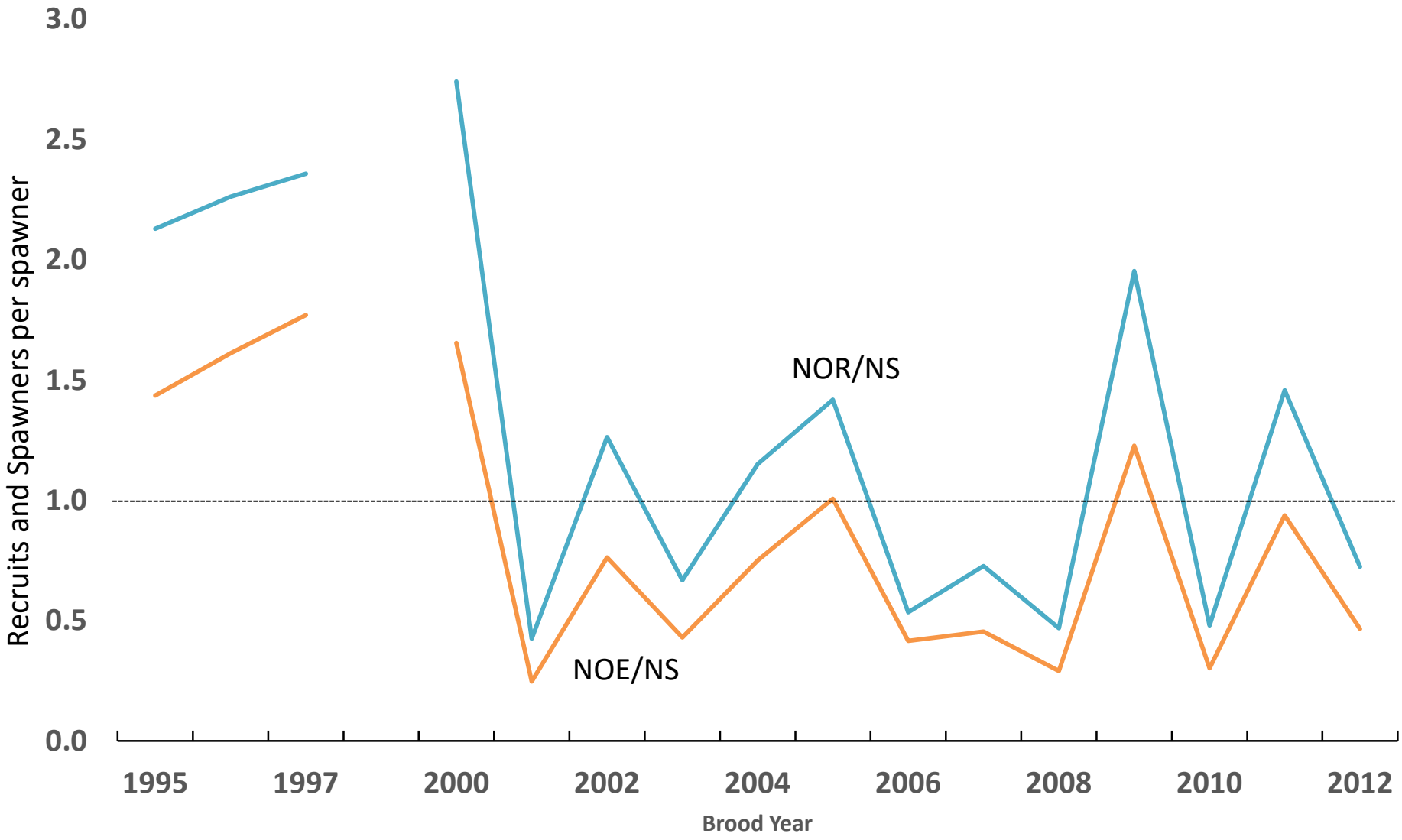
Chinook Productivity



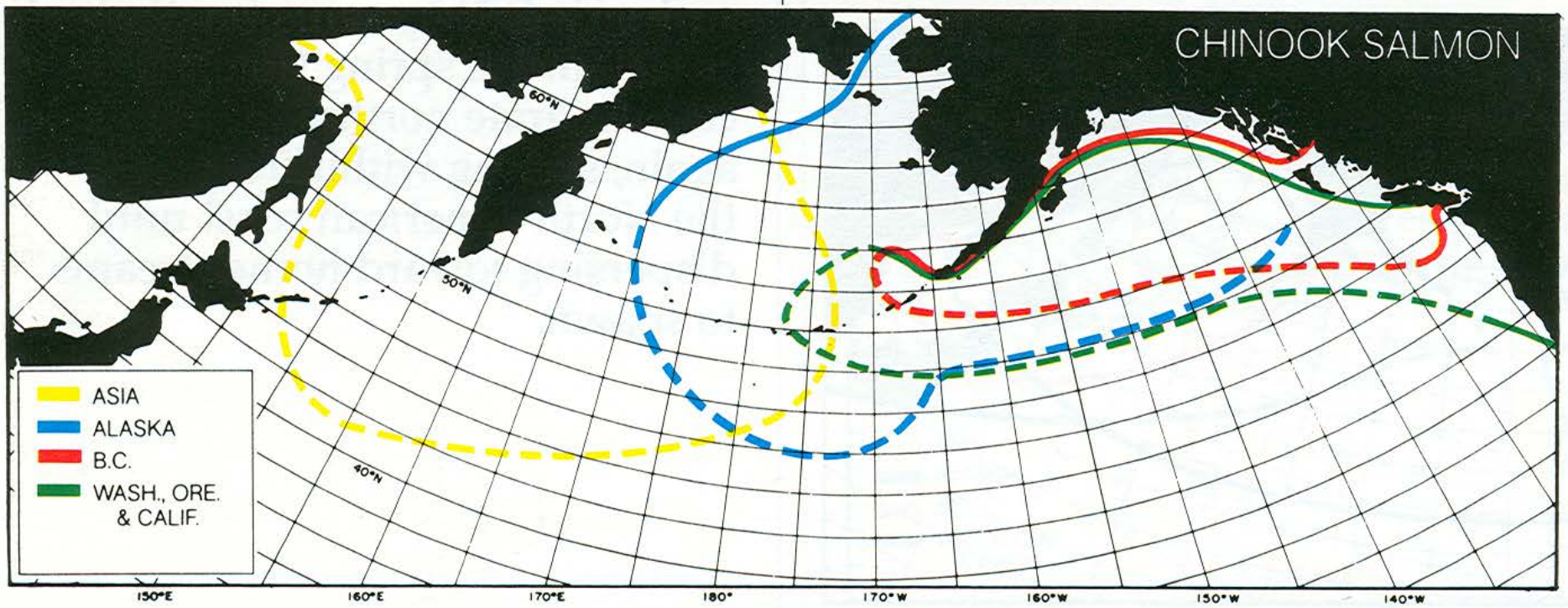
Chinook Productivity - Skykomish



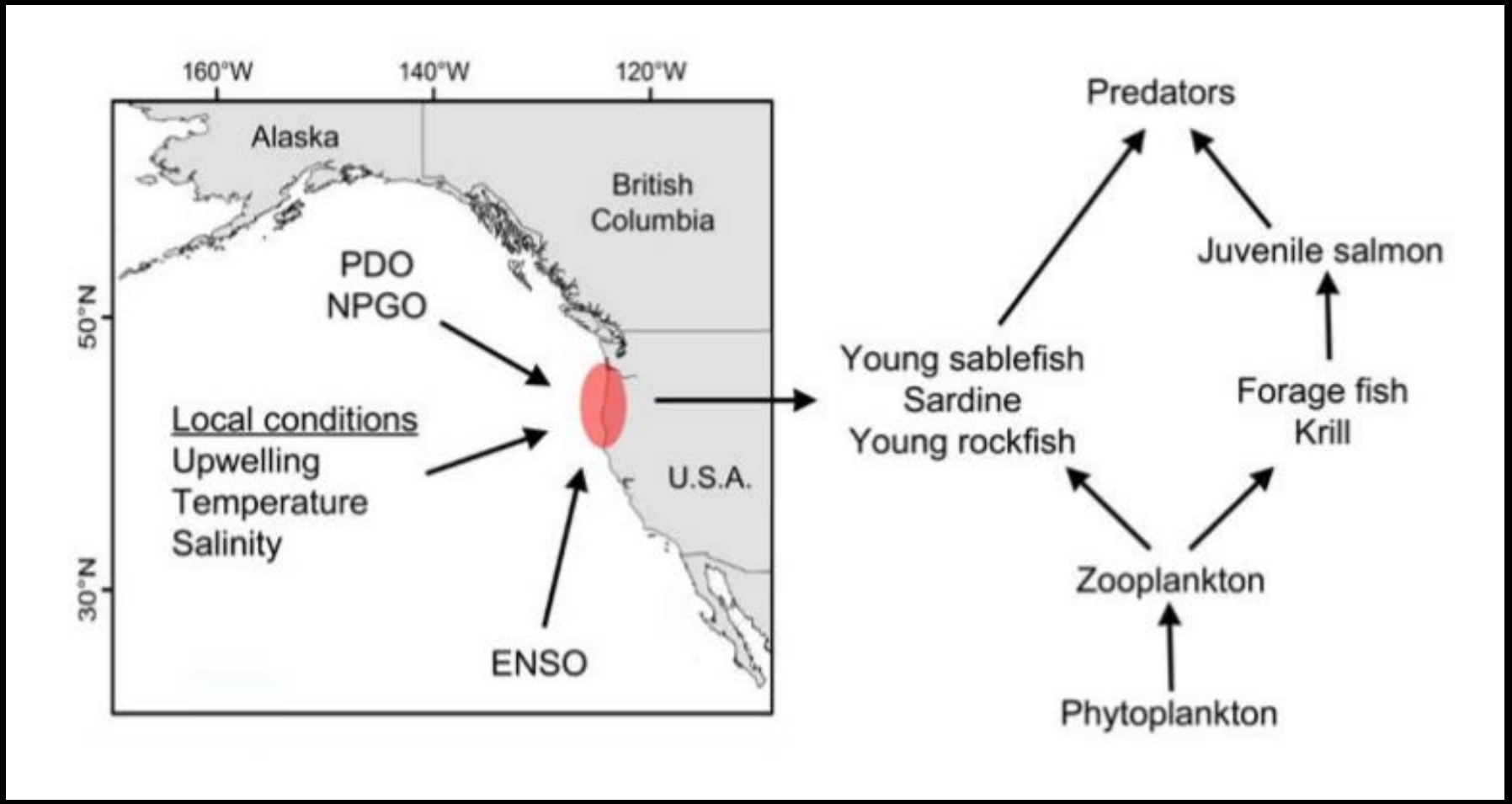
Chinook Productivity - Snoqualmie



Marine conditions



Subjected to a variety of marine phenomena



Ocean Conditions - PDO

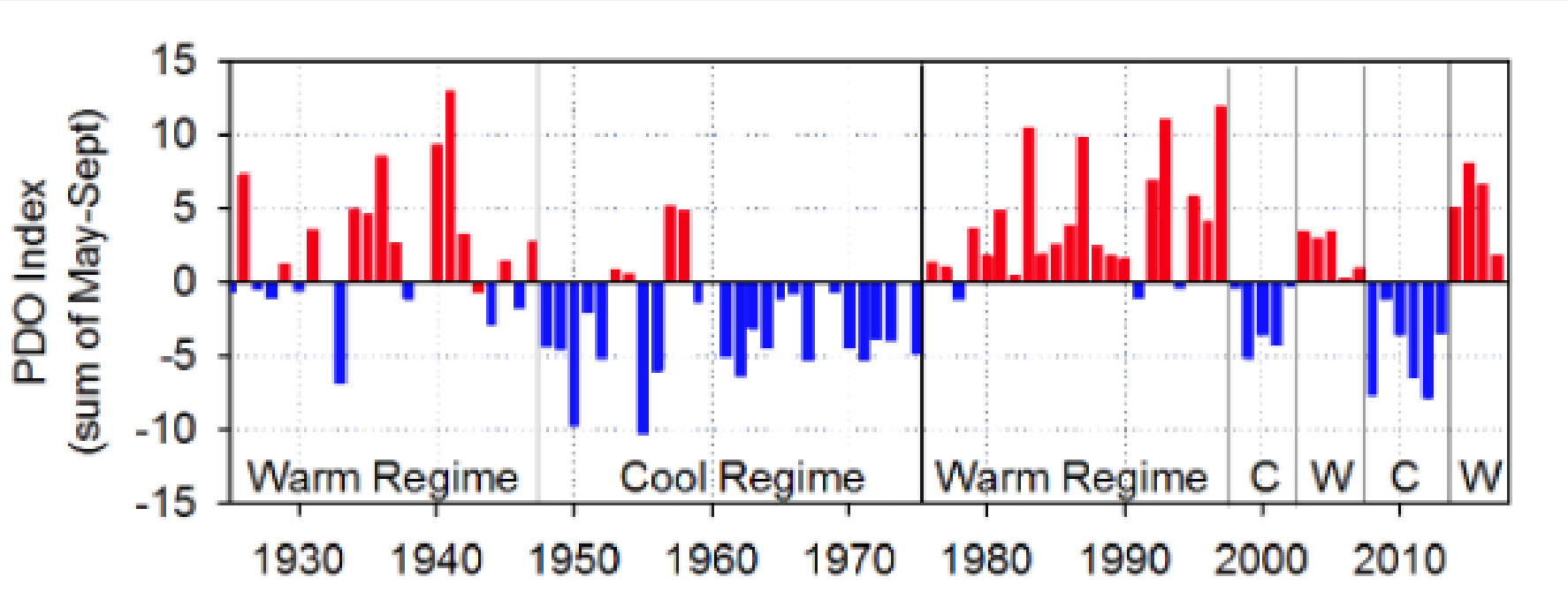


Figure PDO-01. Time series of shifts in sign of the Pacific Decadal Oscillation (PDO), 1925 to present. Values are summed over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years. Note that 2008 and 2012 were the most negative values recorded since 1956.

www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm

Ocean Conditions – ONI (El Nino)

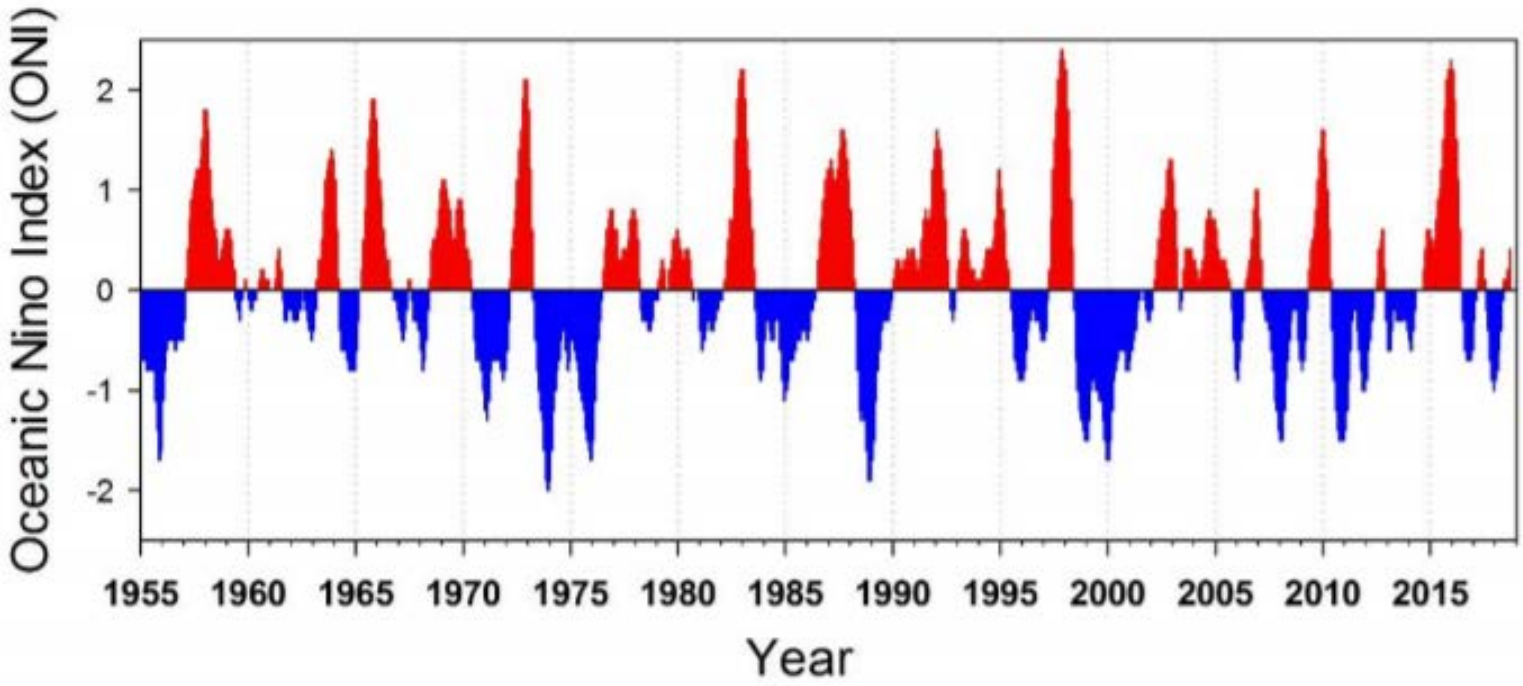


Figure ONI-01. Values of the ONI, 1955 - present. Red bars indicate warm conditions in the equatorial Pacific, blue bars indicate cool conditions in equatorial waters. Large and prolonged El Niño events are indicated by large, positive values of the index: note the >+2 value associated with the 1972, 1983, 1998, and recent strong even in 2015-2016. Recent cool anomalies (La Niña) were during 1999-2002, 2007-2009 and 2010-2012.

www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm

Ocean Conditions – PDO, ONI and Temp anomalies

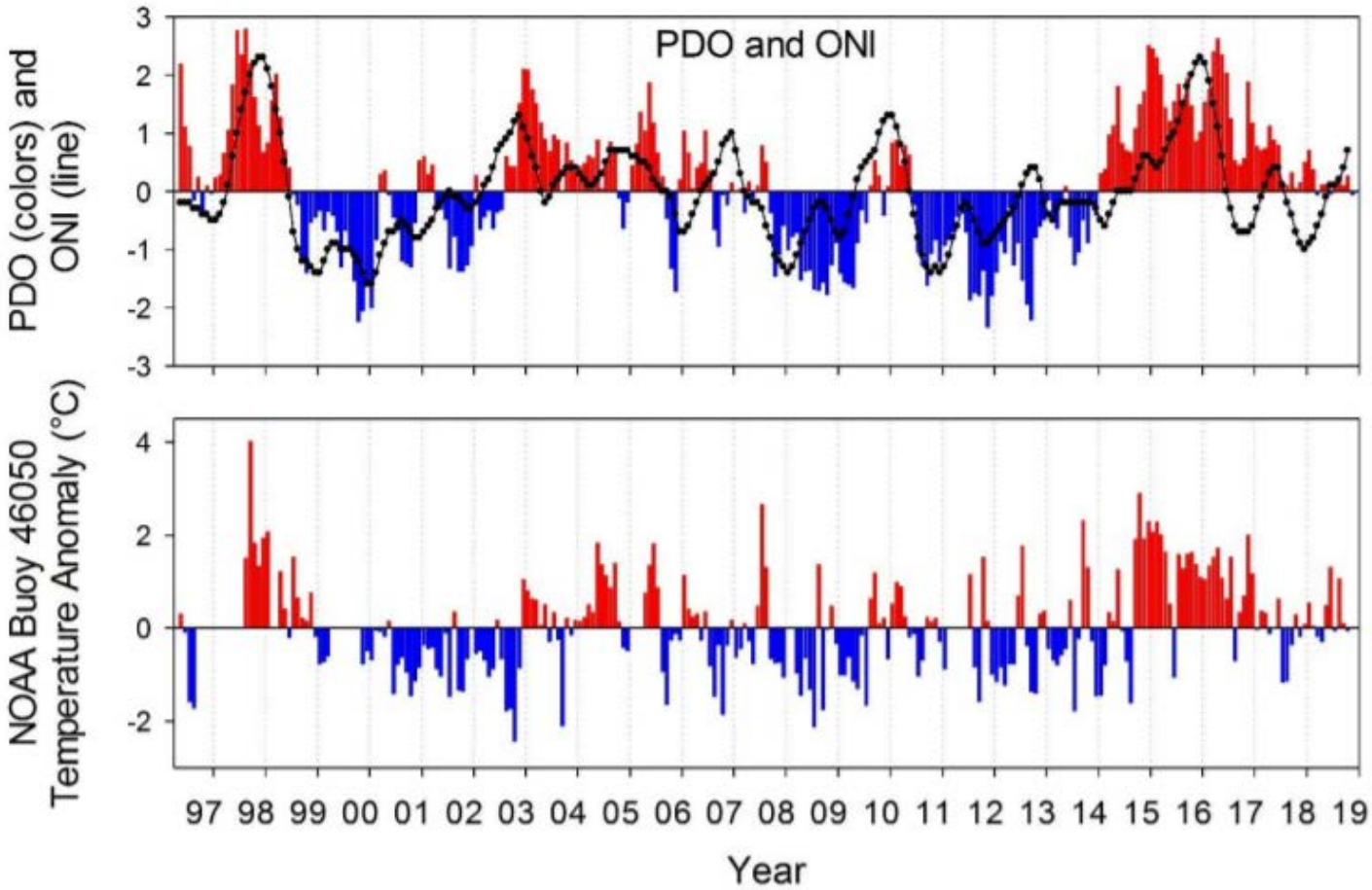
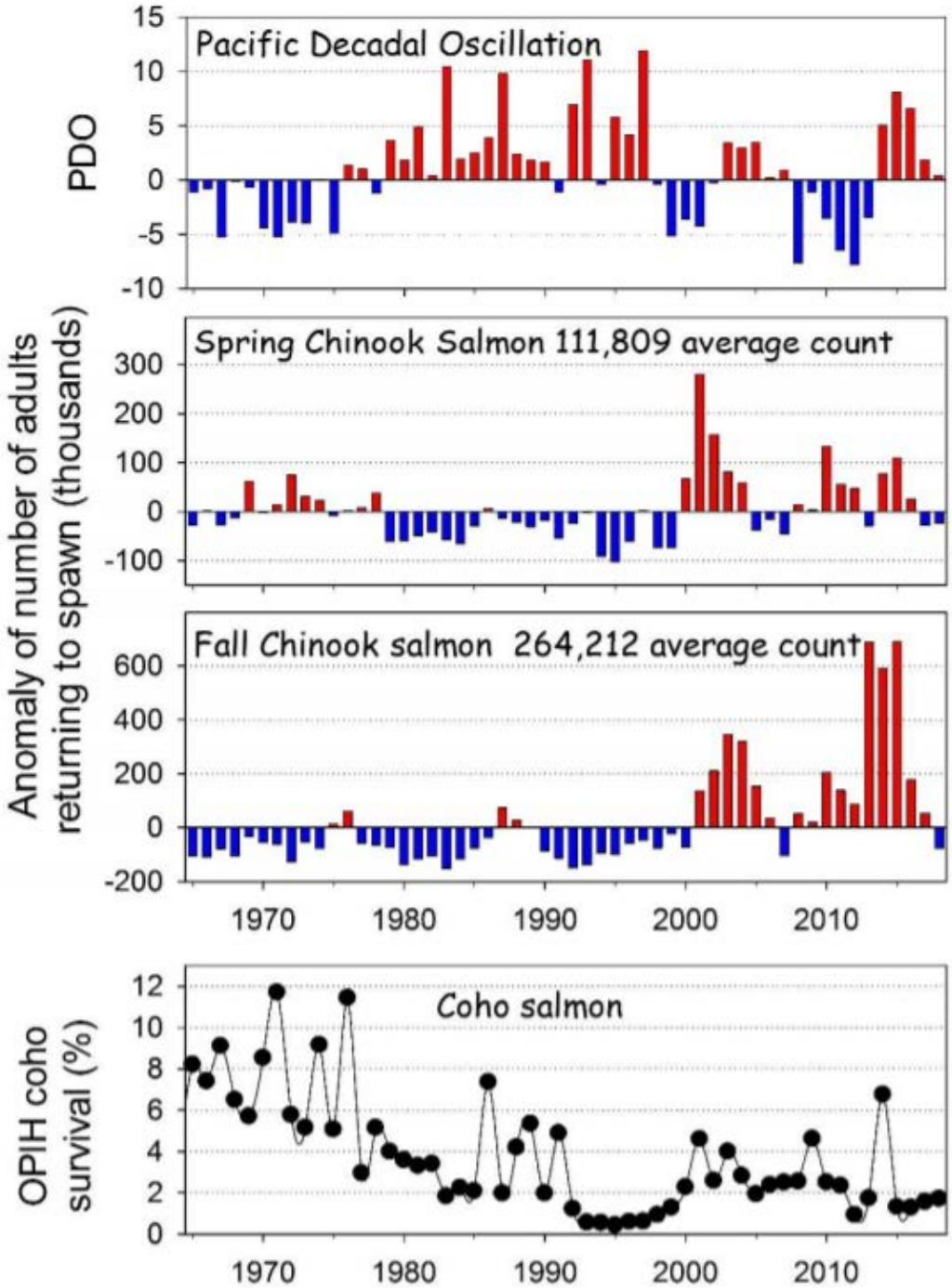


Figure TA-01. The PDO (upper panel, colored bars), ONI (upper panel, line) and monthly sea surface temperature (SST) anomalies at NOAA Buoy 46050, 20 miles west of Newport, OR (bottom panel).

https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/da-sea-surface-temp.cfm#TA-01

Ocean Conditions - PDO and correlations with salmon



https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm#PDO-02

Figure PDO-02. Upper panel shows summer PDO (sum of May–Sept), 1965—present; middle panels show anomalies in counts of adult spring and fall Chinook salmon passing Bonneville Dam from 1965—present; lower panel shows survival of hatchery coho salmon from 1965—present. Vertical lines indicate climate—shift points in 1977 and 1998.

Ocean Conditions – Coastal Upwelling

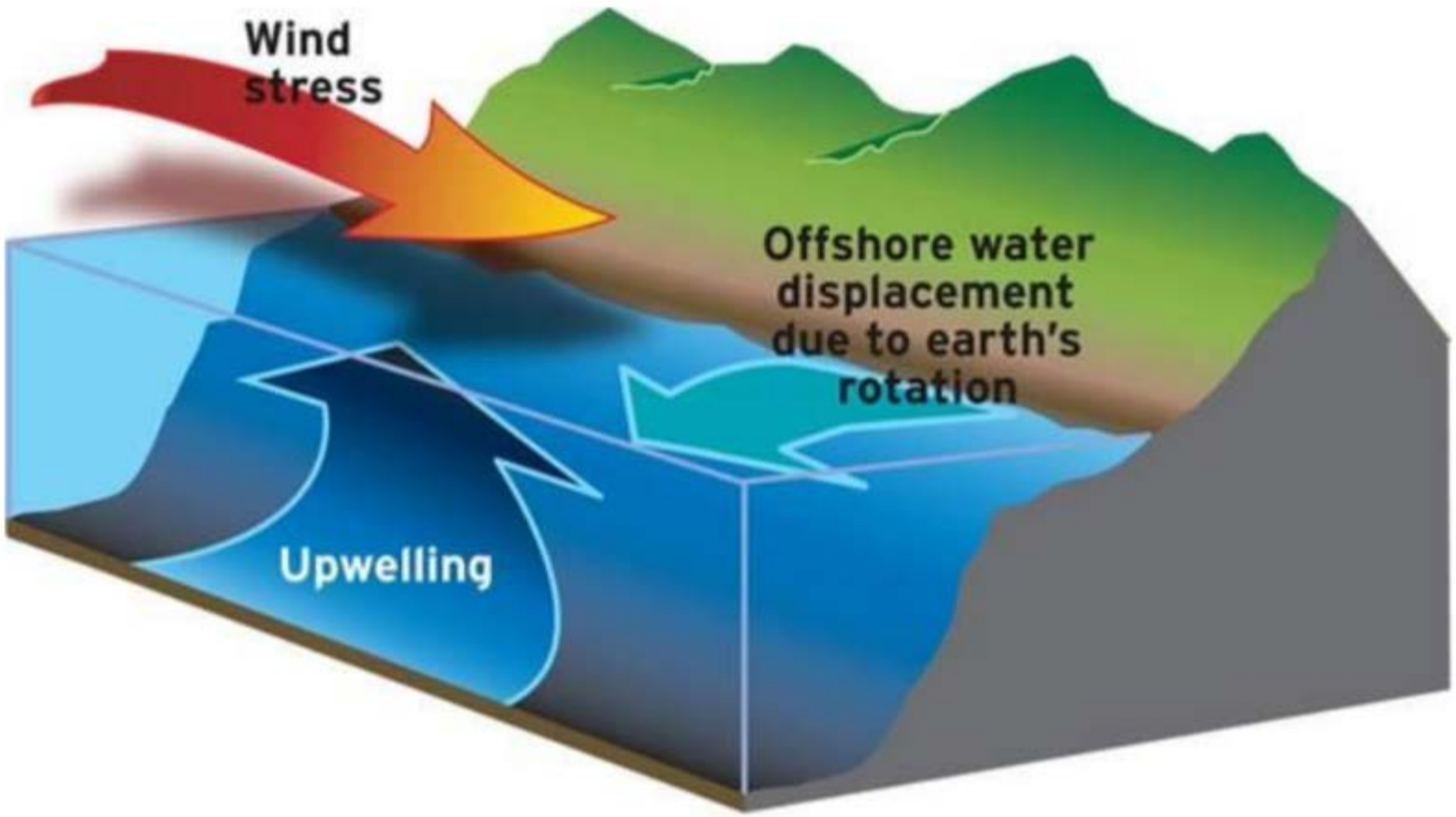


Figure CU-01. Forces affecting coastal upwelling.

https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/db-coastal-upwelling-index.cfm

Ocean Conditions – Coastal Upwelling

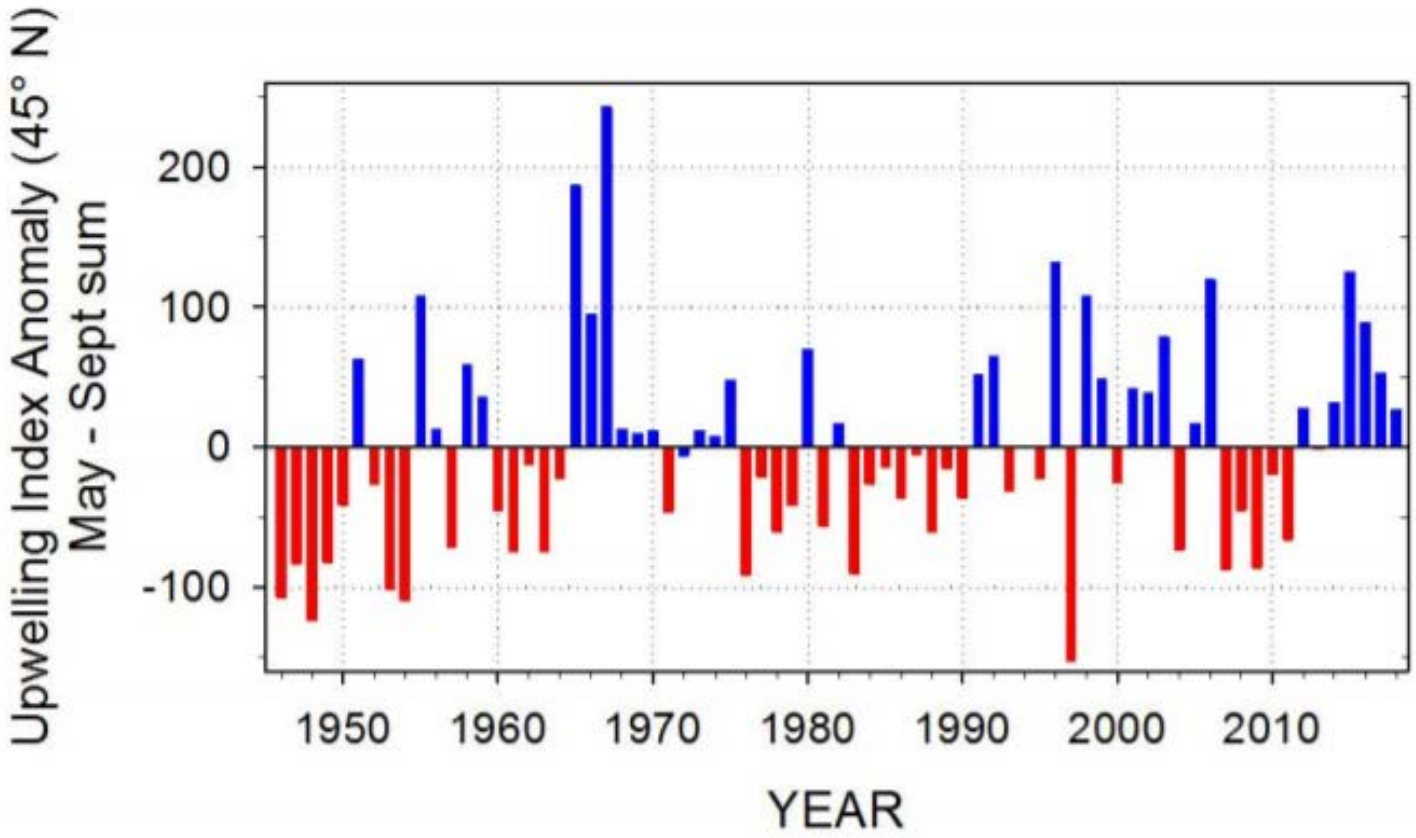
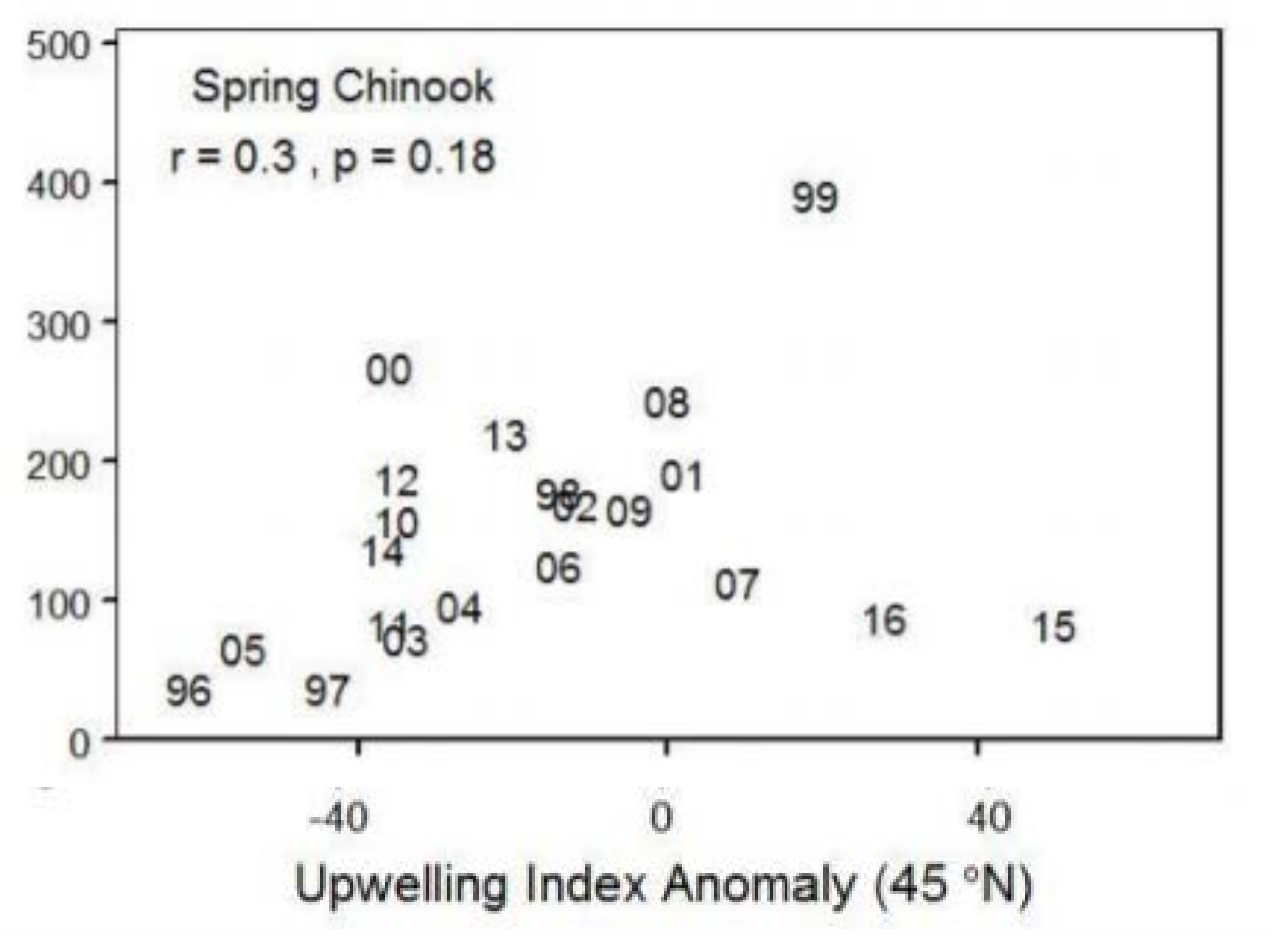


Figure CU-02. Anomalies of the coastal Upwelling Index during May to September each year, 1946 – present.

https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/db-coastal-upwelling-index.cfm

Ocean Conditions – Coastal Upwelling



https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/db-coastal-upwelling-index.cfm#CU-03

Ocean Conditions – Spring Transition

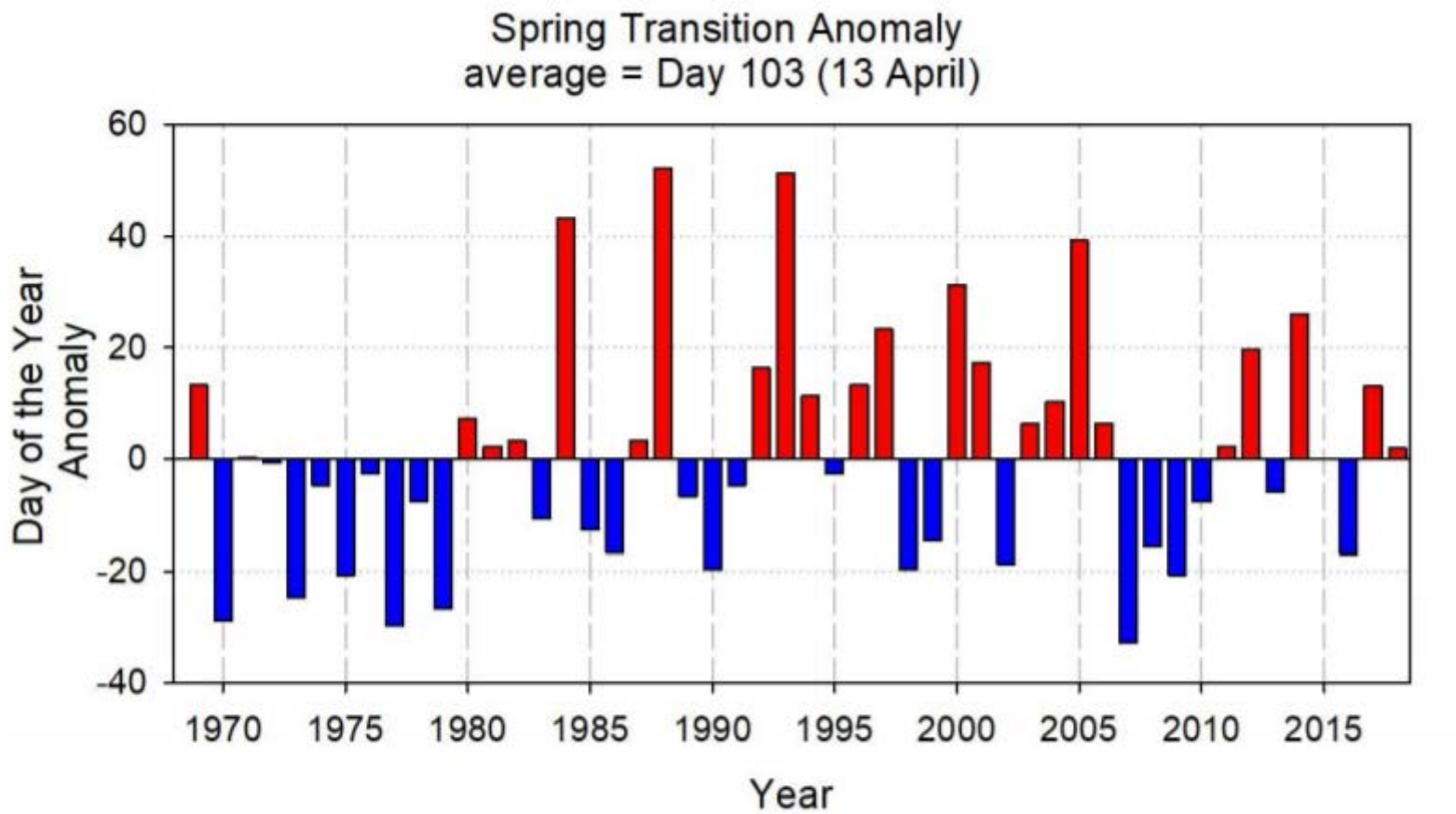


Figure PST-01. Anomalies in the date of the physical spring transition from 1969 to present. Anomaly is based on an average date of 13 April using the minimum cumulative upwelling index (CUI) climatology from 1969 – 2017.

https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/db-coastal-upwelling-index.cfm#CU-02

Ocean Conditions – Spring Transition

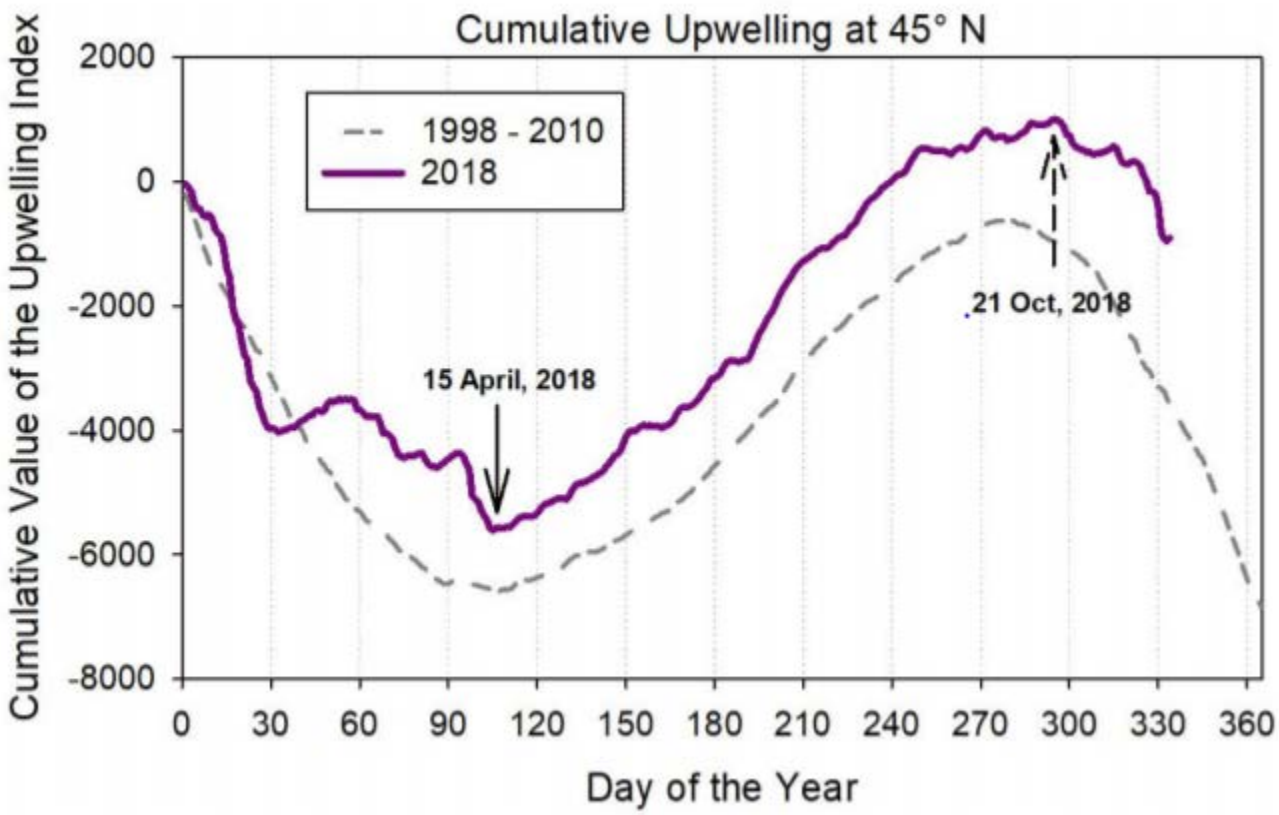
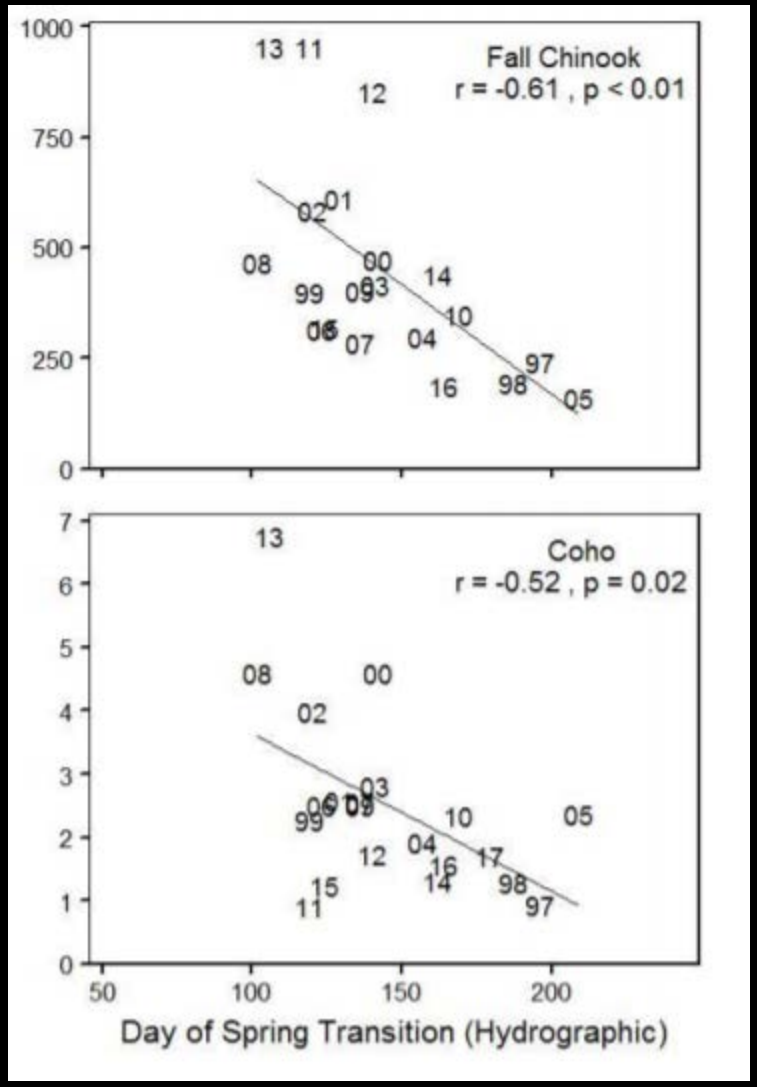


Figure CU-04. : Cumulative upwelling index. Vertical arrows indicate the date of physical spring transition (solid line) and fall transition (dashed line).

https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/db-coastal-upwelling-index.cfm#CU-04

Ocean Conditions – Spring Transition



https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm

Ocean Conditions – Copepod community

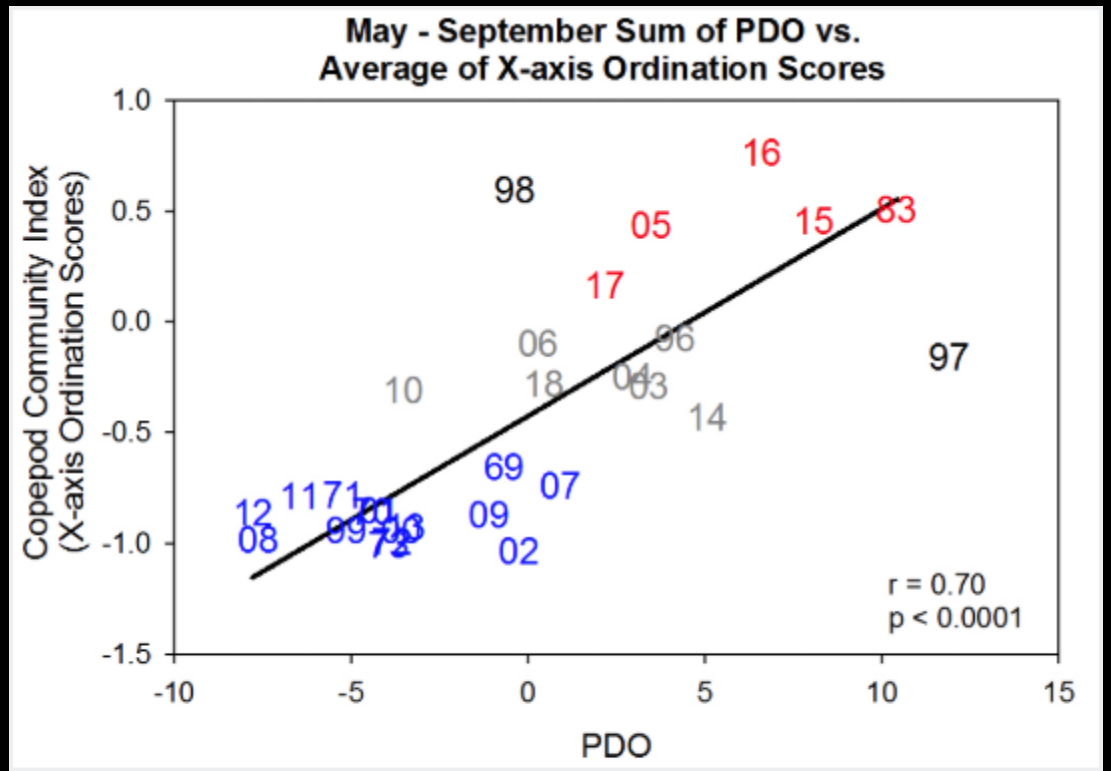
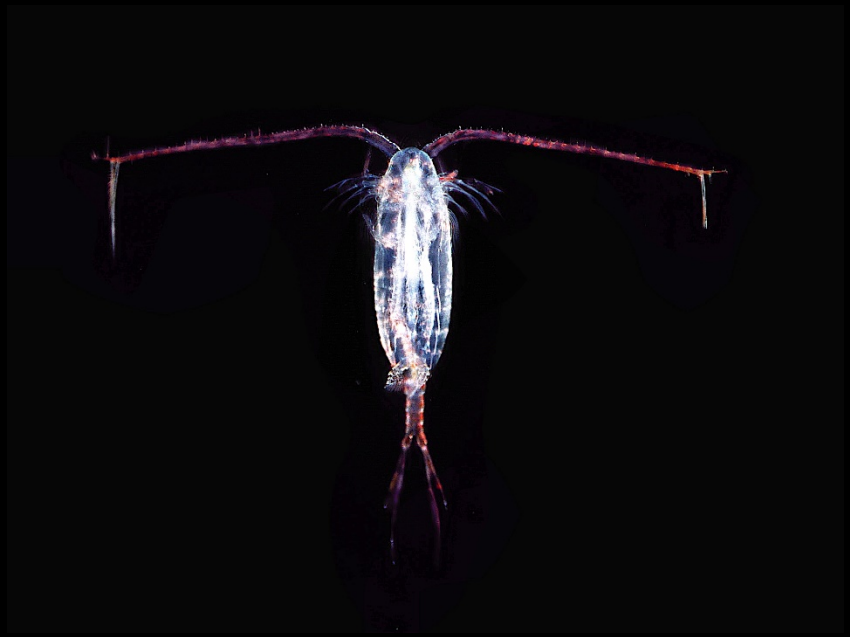


Figure CCI-02. Relationship between the PDO and X-axis ordination scores. A "cold-water zooplankton community" is associated with the negative (cold) phase of the PDO and vice versa. Number symbols indicate the warm (red) neutral (gray) and cold (blue) years. Years in black were outliers and were excluded from the regression.

https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm

Ocean Conditions – Copepod community



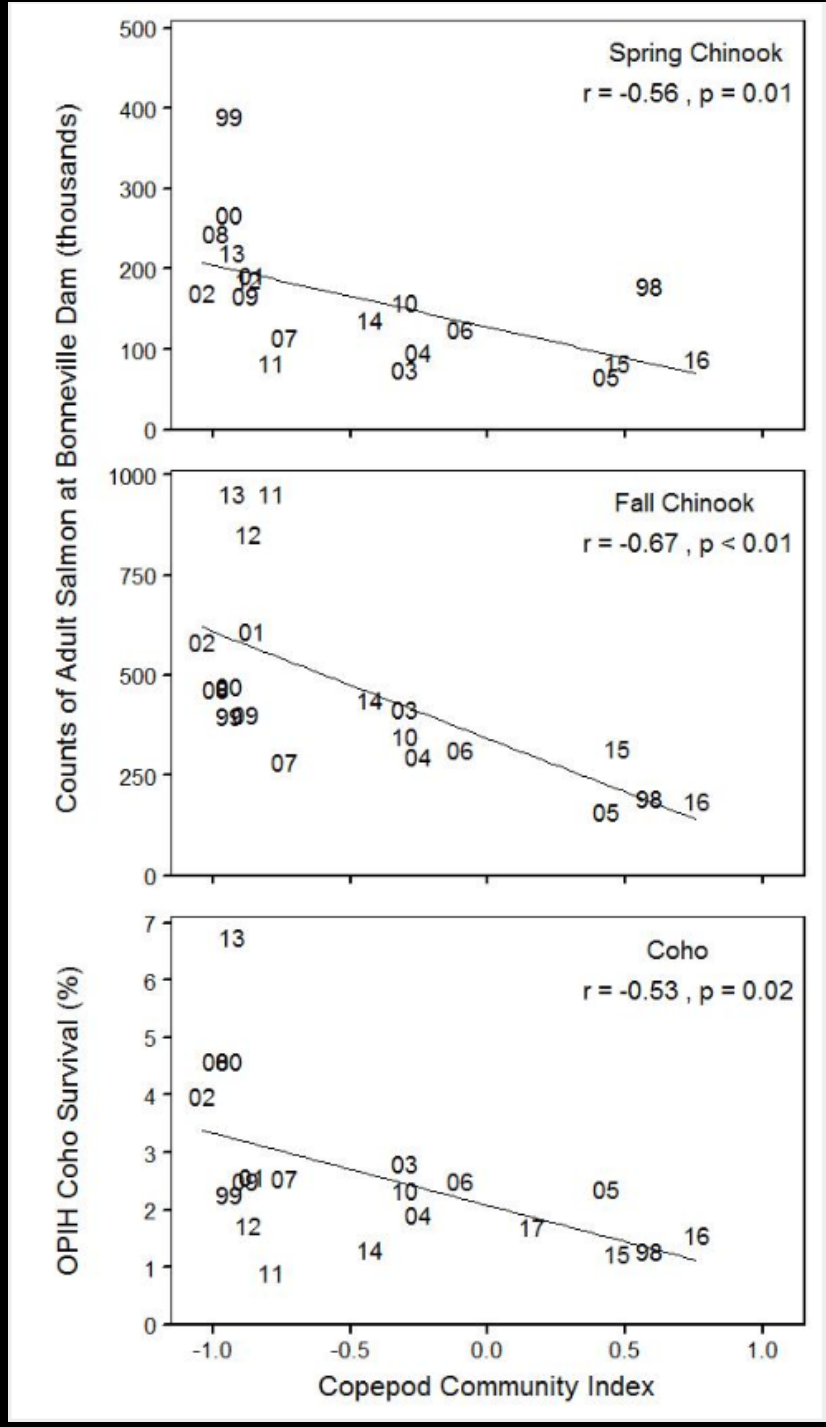


Figure CCI-03. Plot showing the relationship between spring Chinook salmon adult returns at Bonneville dam (lag 2 years, top panel), fall Chinook salmon adult returns at Bonneville dam (lag 2 years, middle panel), and coho salmon survival (OPIH, lag 1 year, bottom panel) versus the copepod community structure index (X-axis ordination score).The X-axis ordination score for May-September 2018 was -0.29, which indicates a transition back to more average salmon survival. Number symbols indicate the year of juvenile salmon outmigration.

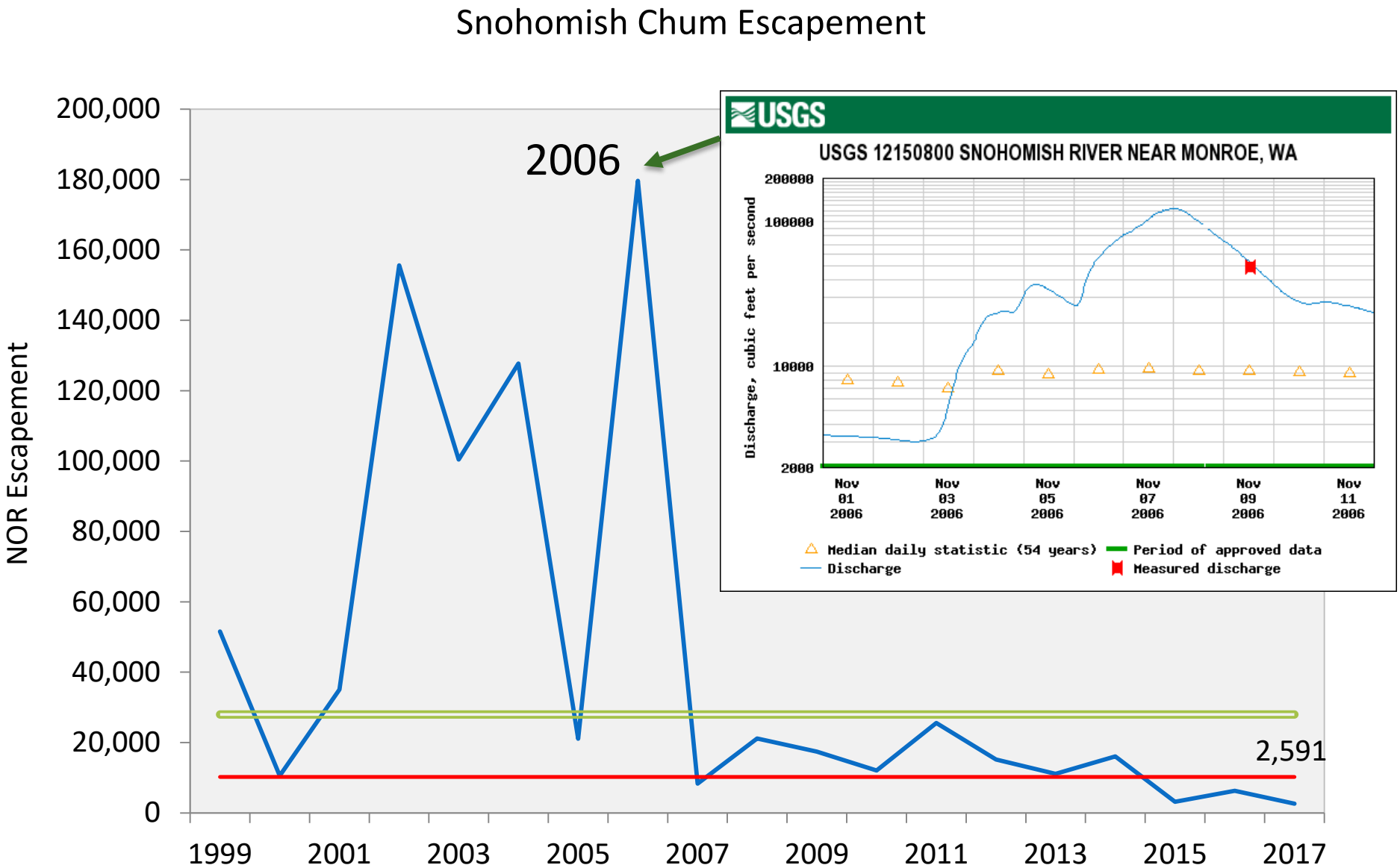
https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/he-copepod-comm-structure.cfm

Ecosystem Indicators	Year																				
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
PDO (Sum Dec-March)	18	6	3	13	7	20	12	16	14	9	5	1	15	4	2	8	10	21	19	17	11
PDO (Sum May-Sept)	10	4	6	5	11	17	16	18	12	14	2	9	7	3	1	8	19	21	20	15	13
ONI (Average Jan-June)	20	1	1	7	14	16	15	17	9	12	3	11	18	4	6	8	10	19	21	13	5
46050 SST (°C; May-Sept)	16	9	3	4	1	8	21	15	5	17	2	10	7	11	12	13	14	20	18	6	19
Upper 20 m T (°C; Nov-Mar)	20	11	8	10	6	15	16	12	13	5	1	9	17	4	3	7	2	21	19	18	14
Upper 20 m T (°C; May-Sept)	17	12	14	4	1	3	21	19	7	8	2	5	13	10	6	18	20	9	15	11	16
Deep temperature (°C; May-Sept)	21	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	20	18	13	17	19
Deep salinity (May-Sept)	19	3	9	4	5	16	17	10	6	1	2	14	18	13	12	11	20	15	8	7	6
Copepod richness anom. (no. species; May-Sept)	19	2	1	7	6	14	13	18	15	10	8	9	17	4	5	3	11	20	21	16	12
N. copepod biomass anom. (mg C m^{-3}; May-Sept)	19	14	10	11	3	16	13	20	15	12	6	9	8	1	2	4	5	17	21	18	7
S. copepod biomass anom. (mg C m^{-3}; May-Sept)	21	2	5	4	3	14	15	20	13	10	1	7	16	9	8	6	11	18	19	17	12
Biological transition (day of year)	18	8	5	7	9	14	13	19	12	2	1	3	16	6	10	4	11	21	21	17	15
Ichthyoplankton biomass (mg C 1,000 m^{-3}; Jan-Mar)	21	12	3	8	10	19	18	15	17	16	2	13	5	14	11	9	20	6	7	1	4
Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	10	13	2	7	5	11	20	18	3	12	1	14	15	8	4	6	9	19	21	17	16
Chinook salmon juvenile catches (no. km^{-1}; June)	19	4	5	16	8	12	17	20	11	9	1	6	7	15	3	2	10	13	18	21	14
Coho salmon juvenile catches (no. km^{-1}; June)	19	8	13	6	7	3	16	20	17	5	4	10	11	15	18	1	12	9	14	21	2
Mean of ranks	17.9	7.2	6.0	7.3	6.1	13.0	15.9	17.1	11.3	9.2	2.7	8.6	12.8	8.1	6.6	7.7	12.8	16.7	17.2	14.5	11.6
Rank of the mean rank	21	5	2	6	3	15	17	19	11	10	1	9	13	8	4	7	13	18	20	16	12
Ecosystem Indicators not included in the mean of ranks or statistical analyses																					
Physical Spring Trans. UI based (day of year)	3	7	20	17	4	13	15	21	13	1	6	2	8	11	18	9	19	10	5	16	11
Physical Spring Trans. Hydrographic (day of year)	20	3	13	8	5	12	14	21	6	9	1	9	18	3	11	2	16	7	17	19	14
Upwelling Anomaly (April-May)	10	3	17	6	9	14	13	21	10	4	7	8	15	17	15	12	19	1	2	20	5
Length of Upwelling Season UI based (days)	6	2	19	12	1	14	10	21	5	3	9	3	16	18	16	15	20	11	8	13	7
SST NH-5 (°C; May-Sept)	9	6	5	4	1	3	21	16	10	18	2	19	11	7	14	13	15	12	17	8	20
Copepod Community Index (MDS axis 1 scores)	20	3	4	8	1	13	15	18	16	10	2	6	12	9	7	5	11	19	21	17	14
Coho Juv Catches (no. fish km^{-1}; Sept)	11	2	1	4	3	6	12	14	8	9	7	15	13	5	10	NA	NA	NA	NA	NA	NA

Outlook for Coho and Chinook

Table SF-01. Ocean ecosystem indicators of the Northern California Current. Colored squares indicate positive (green), neutral (yellow), or negative (red) conditions for salmon entering the ocean each year. In the two columns to the far right, colored dots indicate the outlooks for adult returns based on ocean conditions in 2018 (coho salmon) and 2017 (Chinook salmon).

	Juvenile Migration Year				Adult Return Outlook	
	2015	2016	2017	2018	coho 2019	Chinook 2019
Large– scale ocean and atmospheric indicators						
PDO (May - Sept)	🟥	🟥	🟥	🟨	🟡	🔴
ONI (Jan - Jun)	🟥	🟥	🟨	🟩	🟢	🟡
Local and regional physical indicators						
Sea surface temperature	🟥	🟥	🟩	🟥	🔴	🟢
Deep water temperature	🟥	🟨	🟥	🟥	🔴	🔴
Deep water salinity	🟥	🟨	🟩	🟩	🟢	🟢
Local biological indicators						
Copepod biodiversity	🟥	🟥	🟥	🟨	🟡	🔴
Northern copepod anomalies	🟥	🟥	🟥	🟩	🟢	🔴
Biological spring transition	🟥	🟥	🟥	🟥	🔴	🔴
Winter ichthyoplankton biomass	🟩	🟩	🟩	🟩	🟢	🟢
Winter ichthyoplankton community	🟥	🟥	🟥	🟥	🔴	🔴
Juvenile Chinook salmon catch – June	🟨	🟥	🟥	🟨	🟡	🔴
Juvenile coho salmon catch – June	🟨	🟨	🟥	🟩	🟢	🔴

Questions?

4th highest peak flow on record