# Status of Pacific salmon stocks in the summer Bering Sea based on long monitoring survey by Japanese research cruises in 2007-2021

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A general conceptual model of seasonal distribution and migration of Pacific Salmon
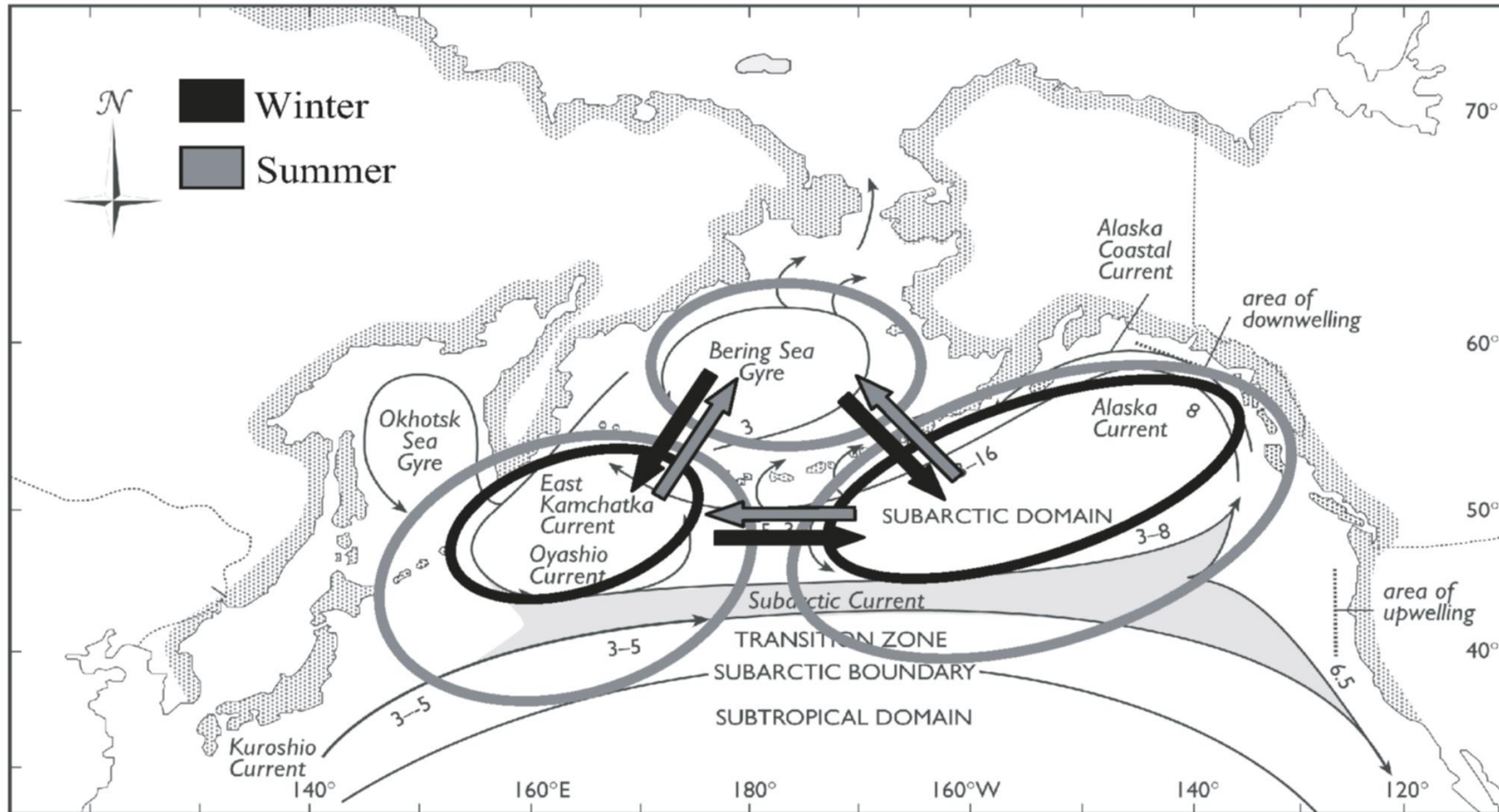
(Myers et al. 2007)

Movement patterns of immature fish
- Summer: To the North and West
- Winter: To the South and East

Summer Bering Sea is an important growth area of Pacific salmon

Long monitoring salmon survey:
Japanese salmon research cruise in the summer Bering Sea

- Periods: 2007-2021 (except for 2010)

- Season: late July-early August
     (2008: late August-early September)

- Survey area: Central Bering Sea

- Collected data/samples
    - Seawater temperature/salinity
    - Catch numbers
    - Biological data (FL, BW, GW, sex)
    - Scales, otoliths, adipose fins, stomachs
    - Zooplankton and micronekton etc…

- Data/sample analyses
    - Comparison of seawater temperature
    - Distribution patterns of Pacific salmon
    - Trends of Pacific salmon CPUE etc…
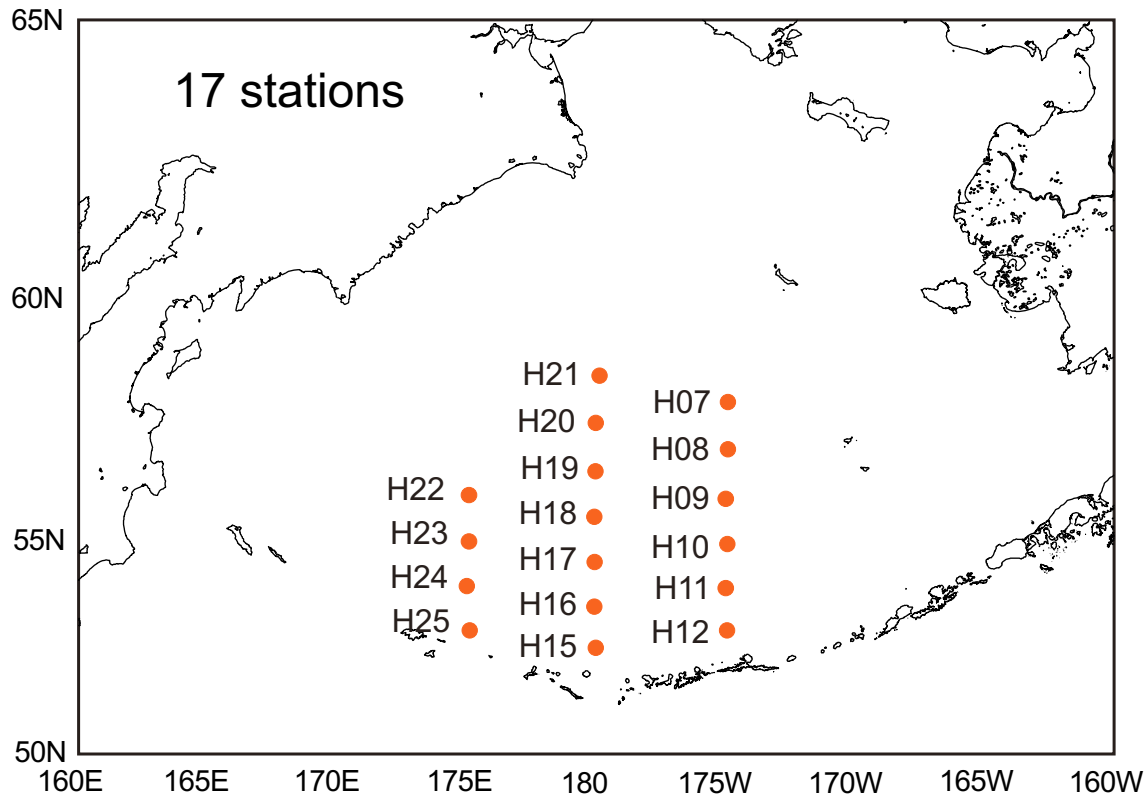
R/V *Hokko maru*

1,246 gross tones

Summer Bering Sea monitoring data have been accumulated over 10 years

Objectives

Summarize our long monitoring data by Japanese research cruises to understand status of Pacific Salmon and their habitat environments in the summer Bering Sea
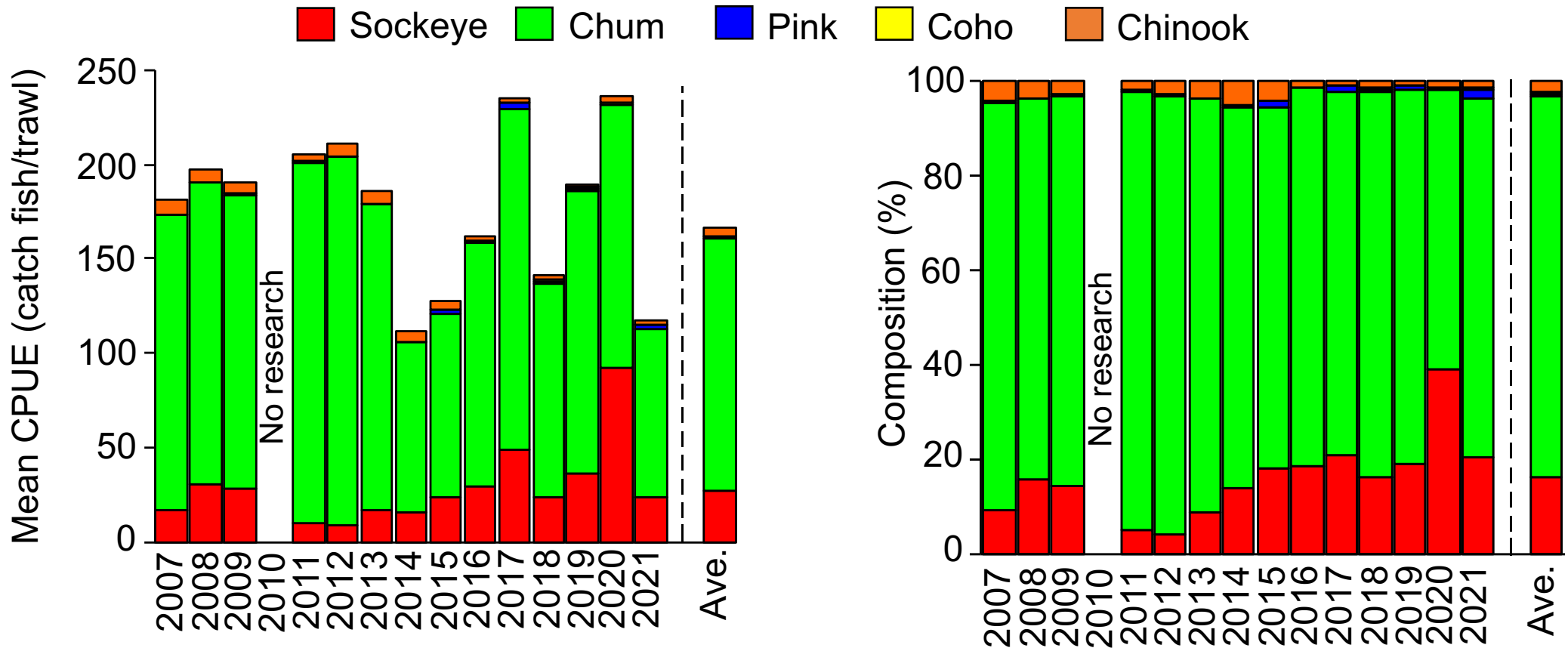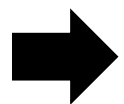
Sampling locations

Trawl survey

Status of Pacific salmon: Mean CPUE and compositions of collected Pacific salmon in the summer Bering Sea during 2007-2021
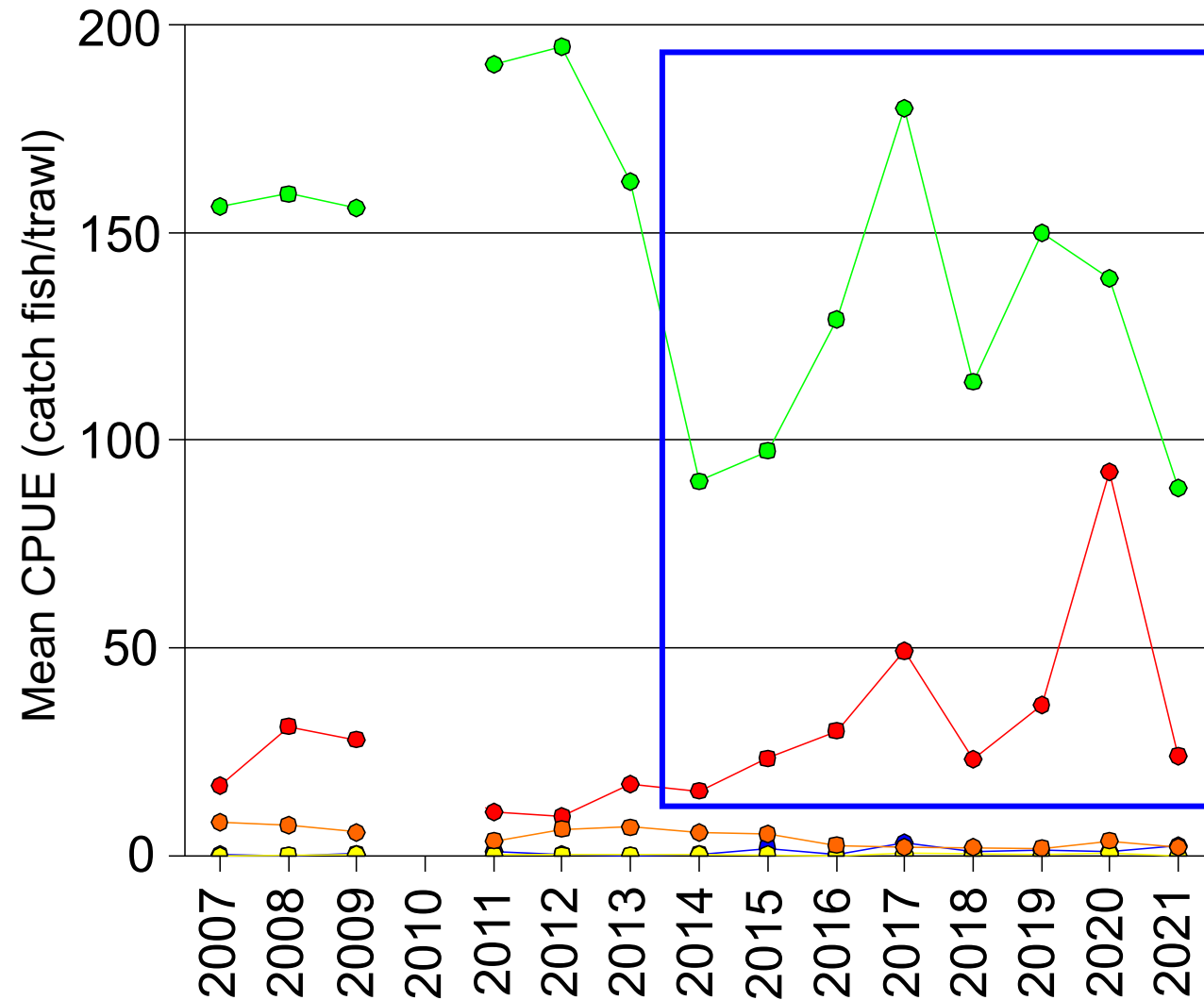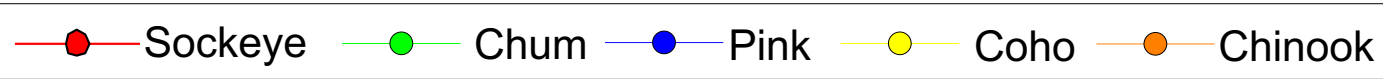

- Mean CPUE: chum>>sockeye>Chinook>pink>coho
- Compositions: chum is highest, but sockeye is increased since 2013

➡ Chum and sockeye salmon are dominant species in our monitoring survey

Annual CPUE of Pacific salmon in the summer Bering Sea during 2007-2021

- CPUE of chum salmon was highest but fluctuated during survey years

- CPUE levels of sockeye salmon tend to increase since 2013

- CPUE trends of chum and sockeye salmon seem to indicate same pattern between 2014 and 2021 without 2020

Annual age specific CPUE of chum salmon during 2007-2021
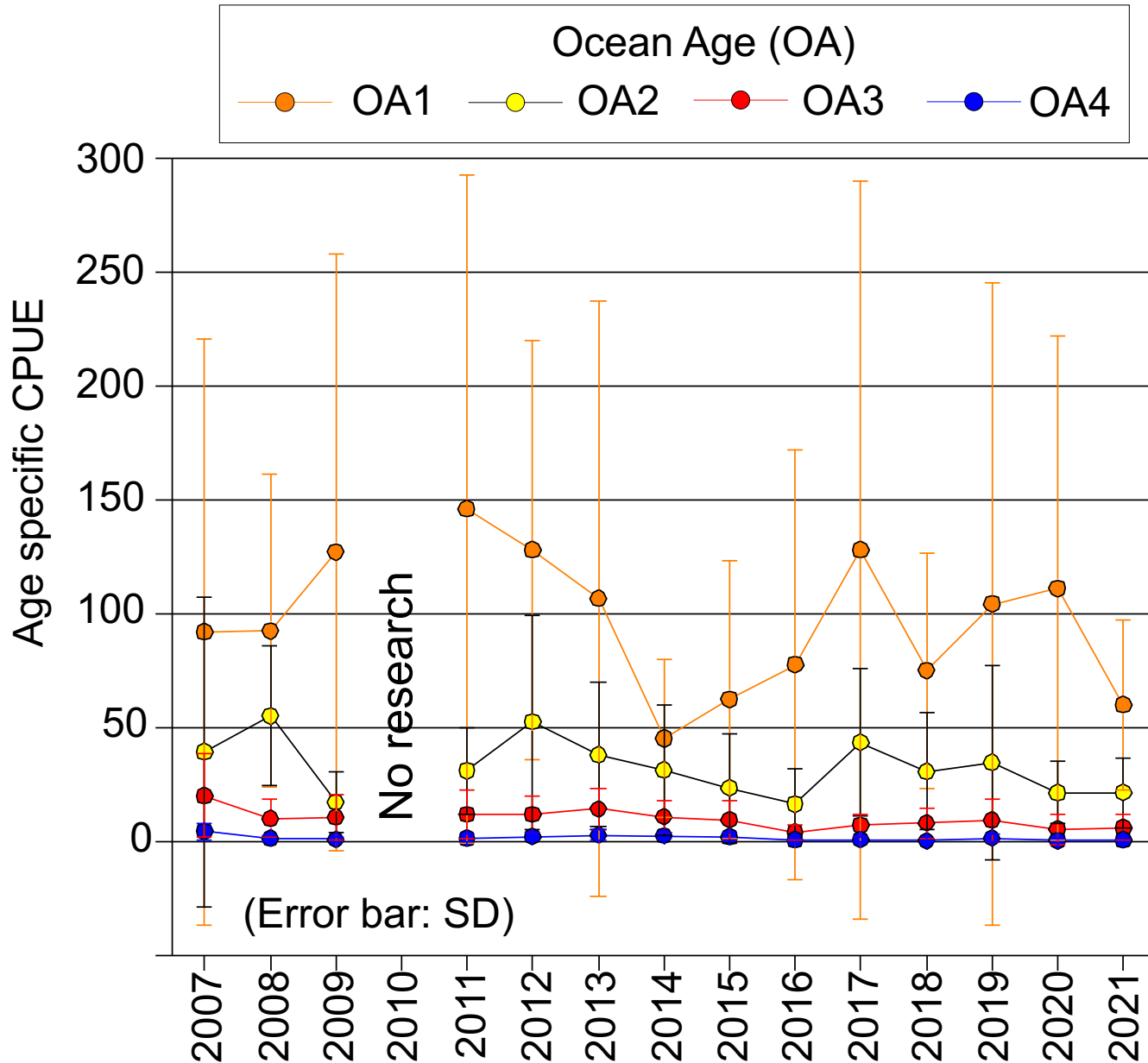
All age fish:
- Show large SD, particularly OA1 fish

OA1 fish:
- Highest CPUE in each survey year, but fluctuated annually

OA2 fish:
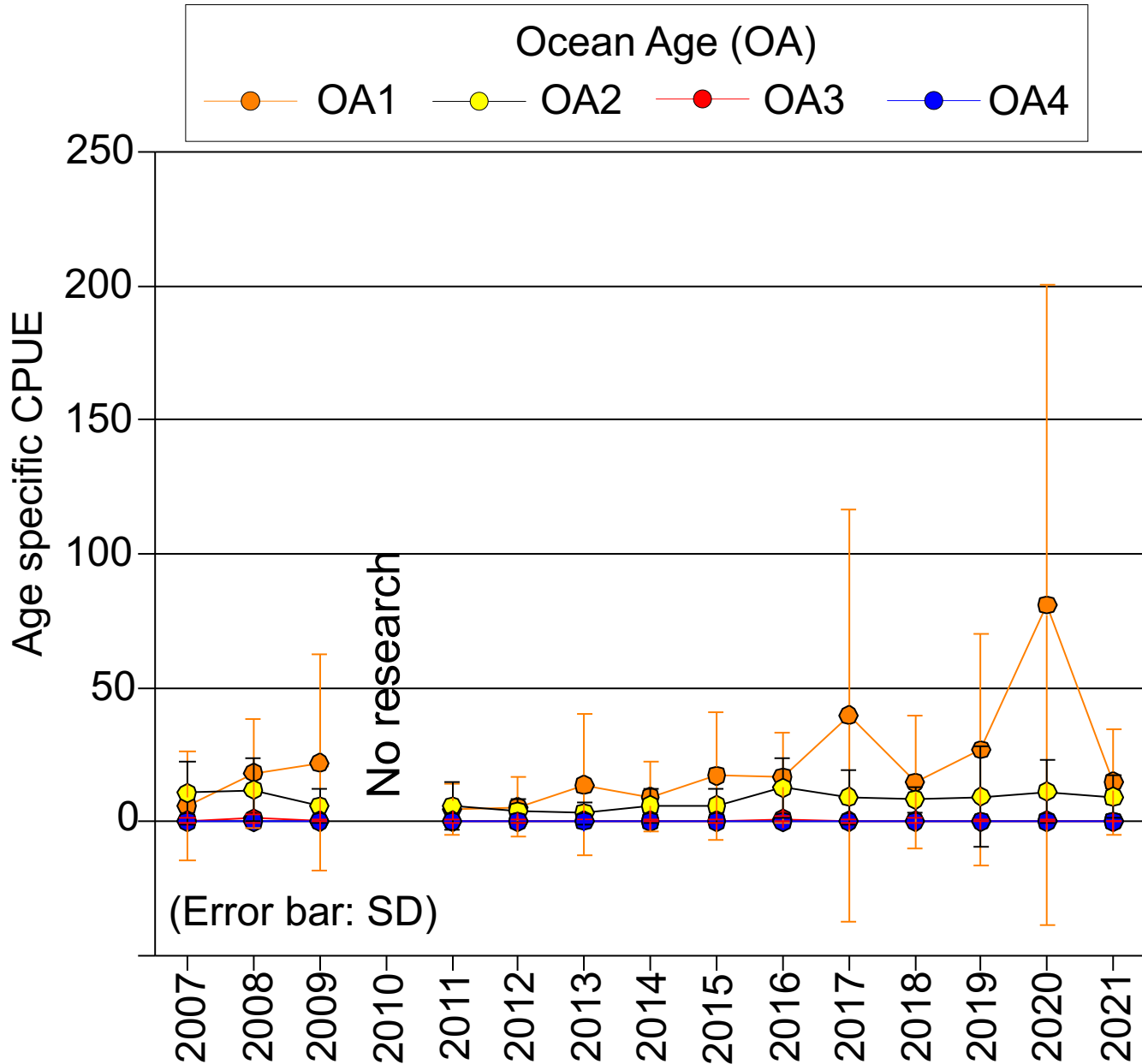- CPUE fluctuated, but that range was smaller than OA1 fish

OA3-4 fish:
- CPUE was low level and stable

CPUE variations of OA1 fish is influenced in total CPUE for the year

Annual age specific CPUE of sockeye salmon during 2007-2021

OA1 fish:
- Show large SD
- CPUE was stable between 2007-2016
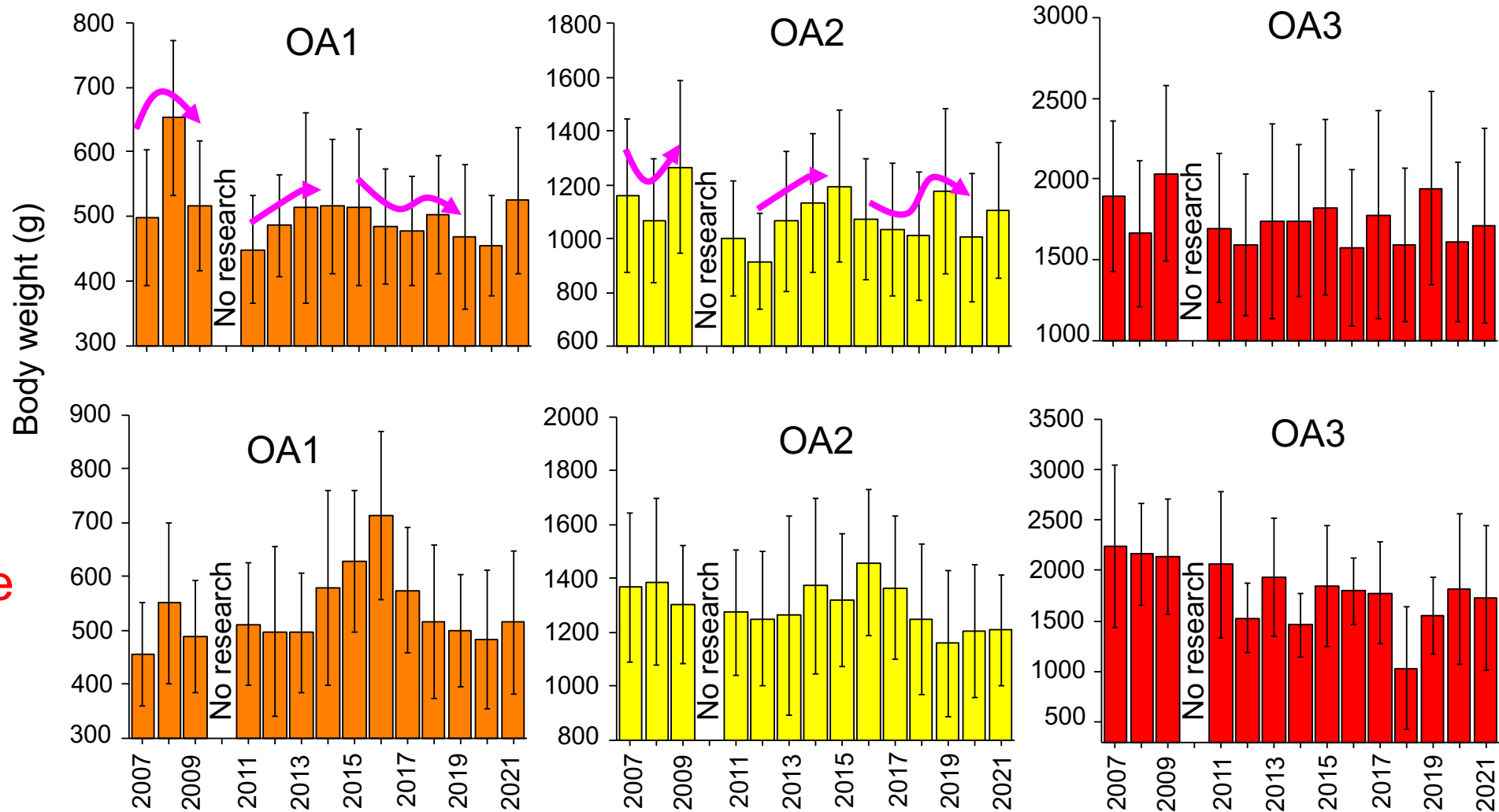- CPUE fluctuated after 2017
- CPUE was highest in 2020

OA2-4 fish:
- CPUE was low level and stable between 2007 and 2021

CPUE variations of OA1 fish is influenced in total sockeye CPUE after 2017

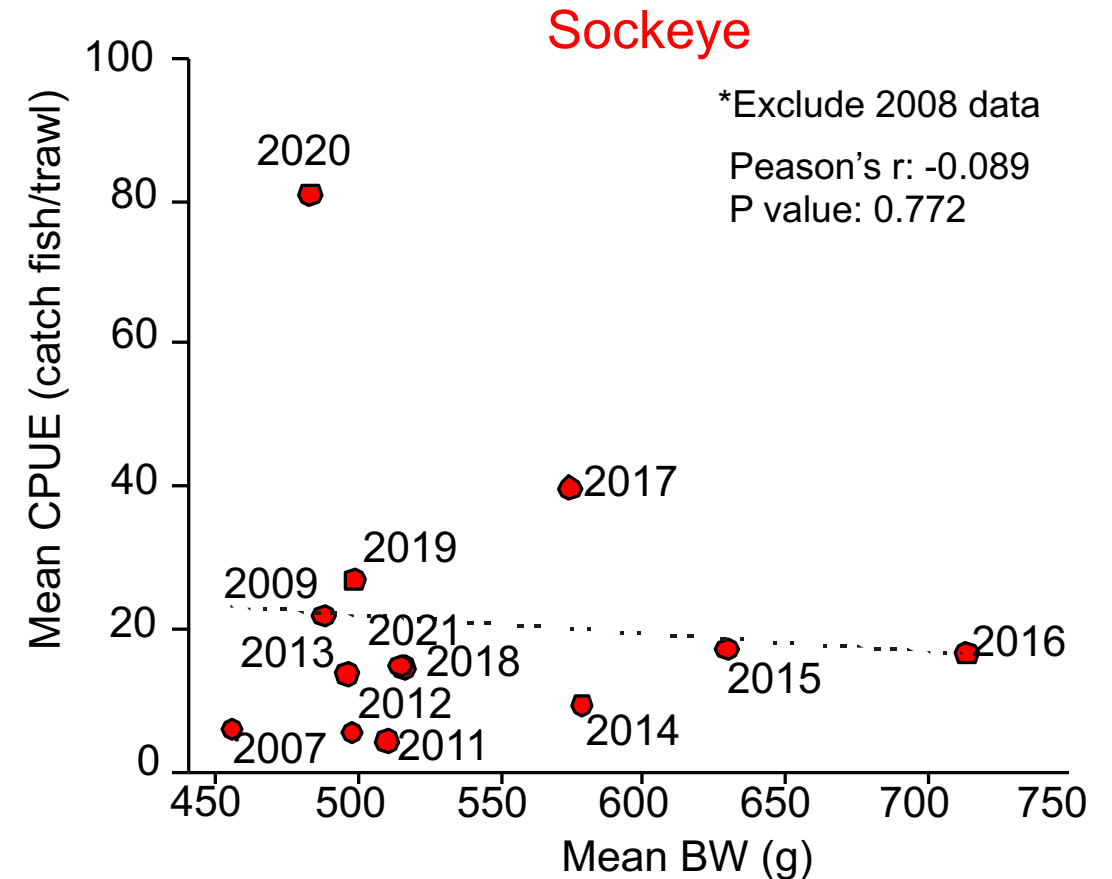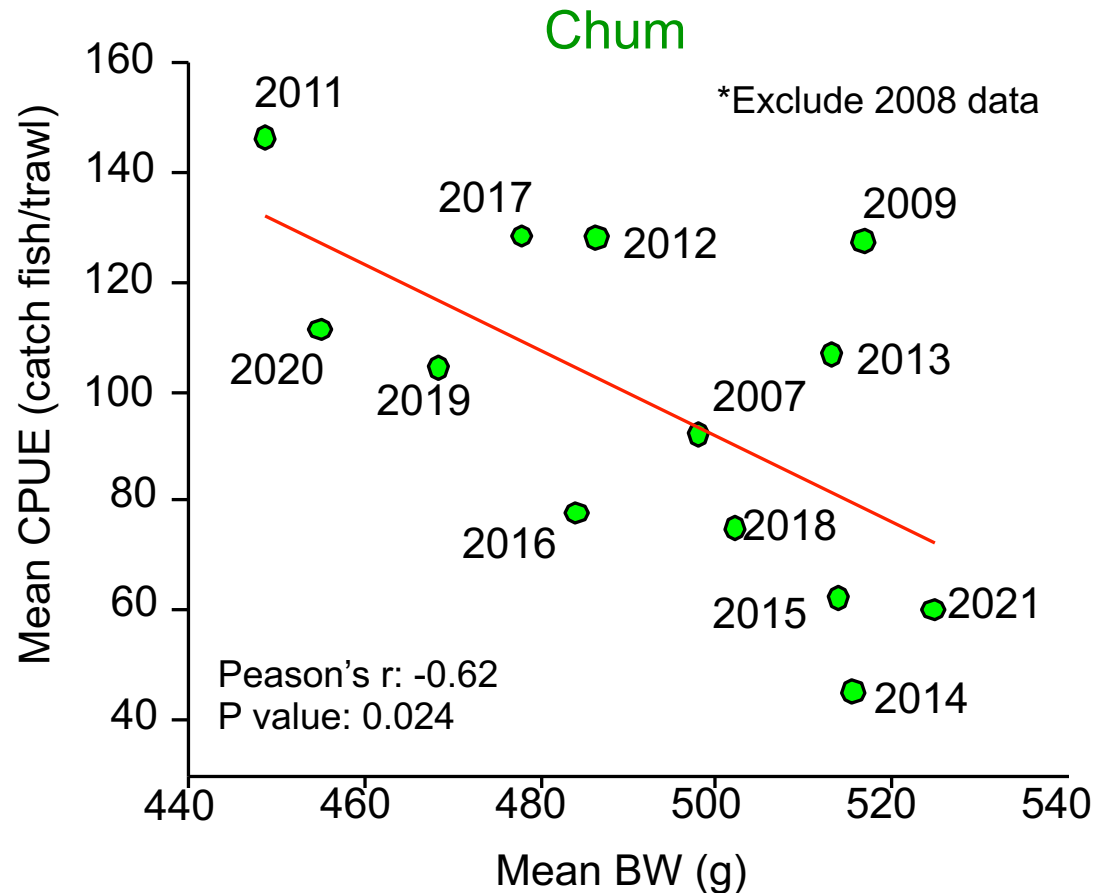# Annual mean BW in each OA of chum and sockeye salmon in the summer Bering Sea

• Chum: mean BW of OA2 was relative to that of OA1 in year before
• Sockeye: no relationship between BW of OA1 and OA2 as seen in chum

Correlation between mean CPUE and mean BW in OA1 fish of chum and sockeye salmon in the summer Bering Sea

- Chum: significant negative correlation between mean CPUE and BW
- Sockeye: no correlation between CPUE and BW

➡ Chum may indicate density-dependent growth consequences (Morita and Fukuwaka, 2020)

# Status of ocean conditions: Mean sea surface temperature (SST) in the summer Bering Sea during 2007-2021
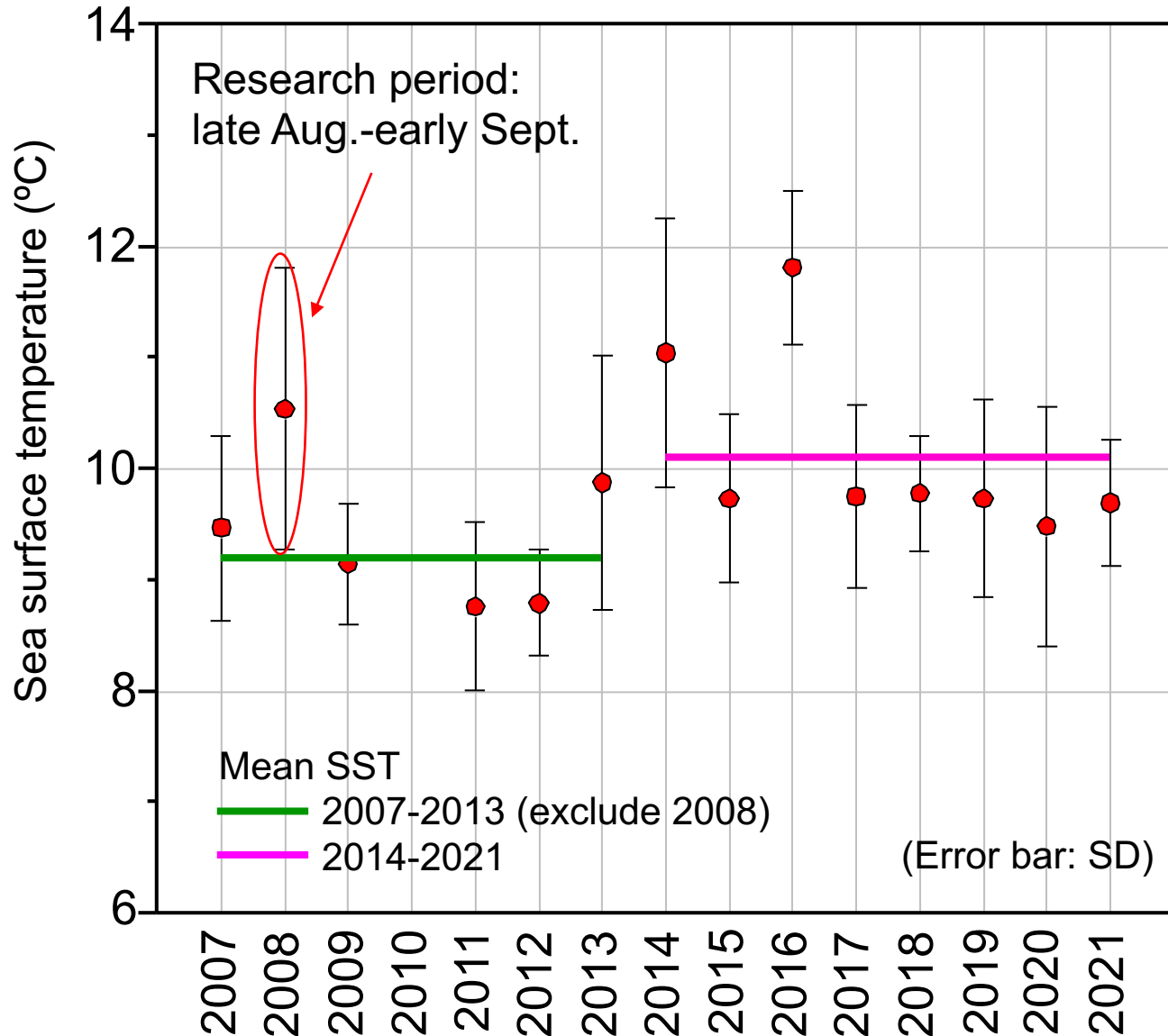
SST trends in the summer Bering Sea

- Mean SST through survey periods (exclude 2008): 9.8 ± 0.8°C (range: 8.8-11.8°C)

- Mean SST treads:
  2007-2013 (exclude 2008): 9.2°C
  2014-2021: 10.1°C

- Abnormal SSTs were shown in 2014 (11.1°C) and 2016 (11.8°C
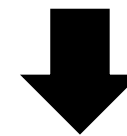
SST has been increased in the summer Bering Sea since 2014

# Vertical distribution of seawater temperature anomalies in the summer Bering Sea during 2007-2021
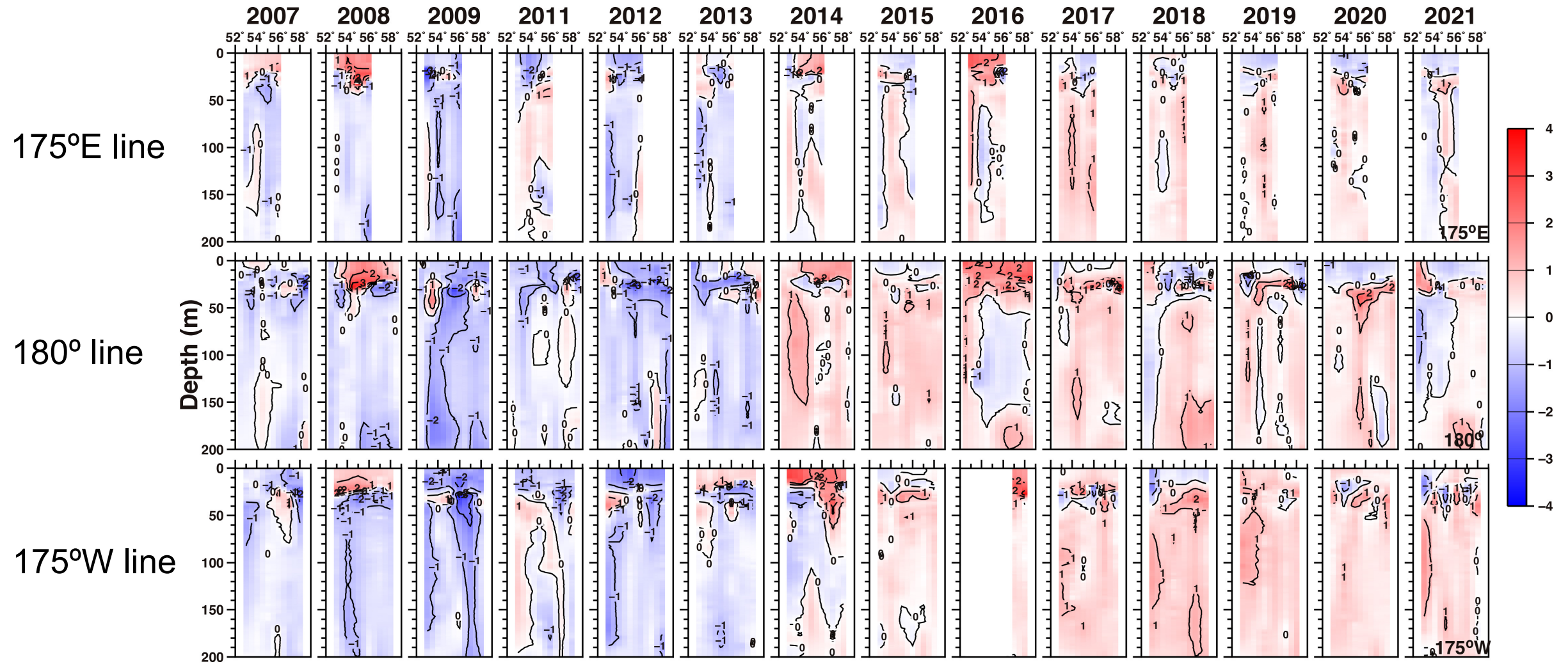
Continue to high seawater temperature conditions from surface to 200 m depth after 2014

Correlation between mean CPUE of chum and sockeye salmon and SST in the summer Bering Sea
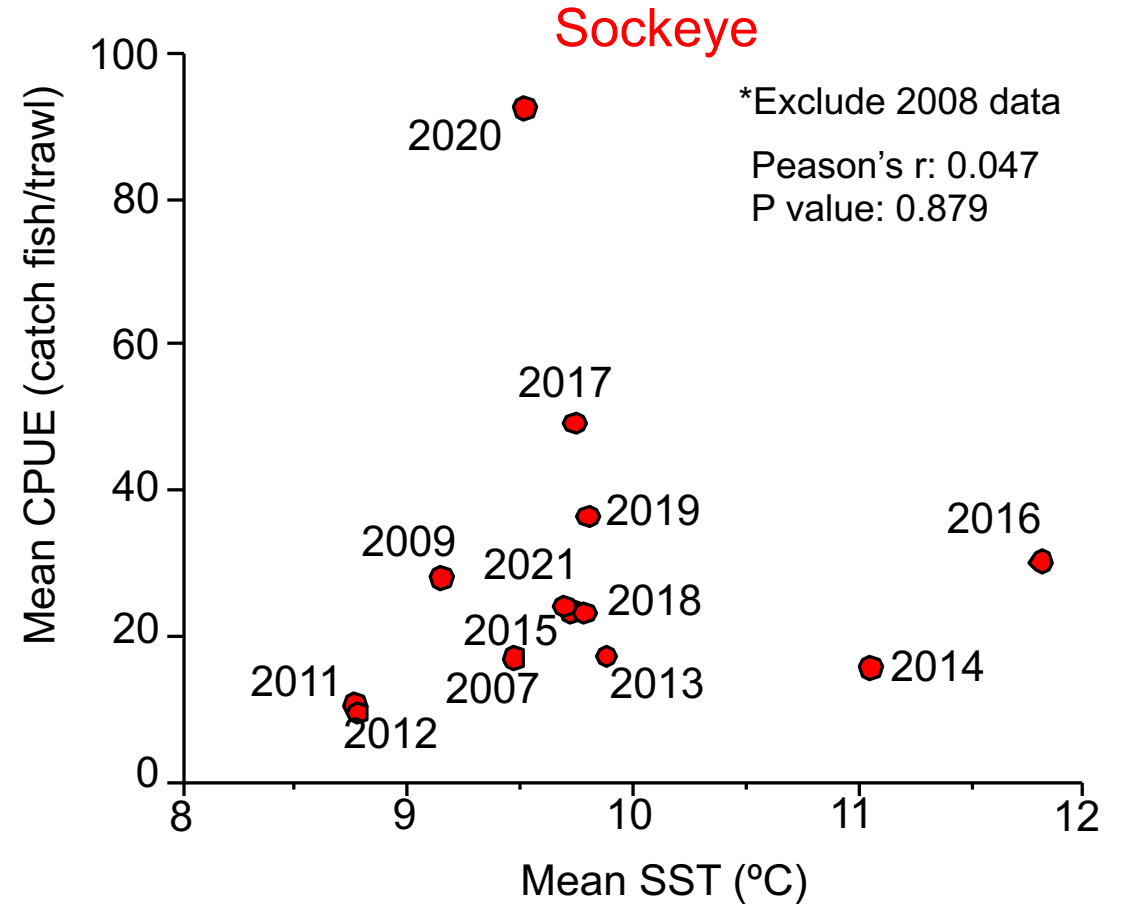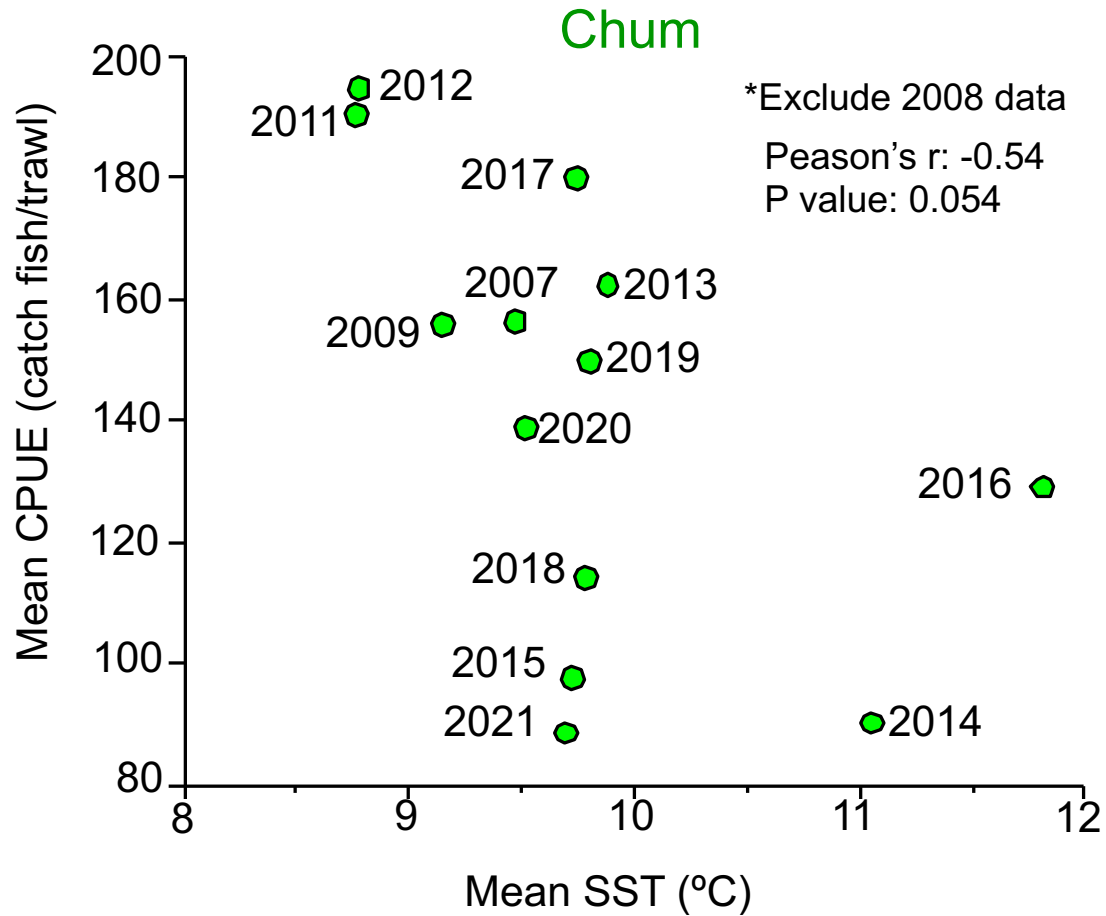
- Chum: no significant correlation between CPUE and SST, but they indicate negative trend
- Sockeye: no significant correlation between CPUE and SST

Status of prey environment: Mean biomass of each zooplankton and micro-nekton collected by BONGO net in the summer Bering Sea during 2007-2021

Red and blue lines indicate Regression lines
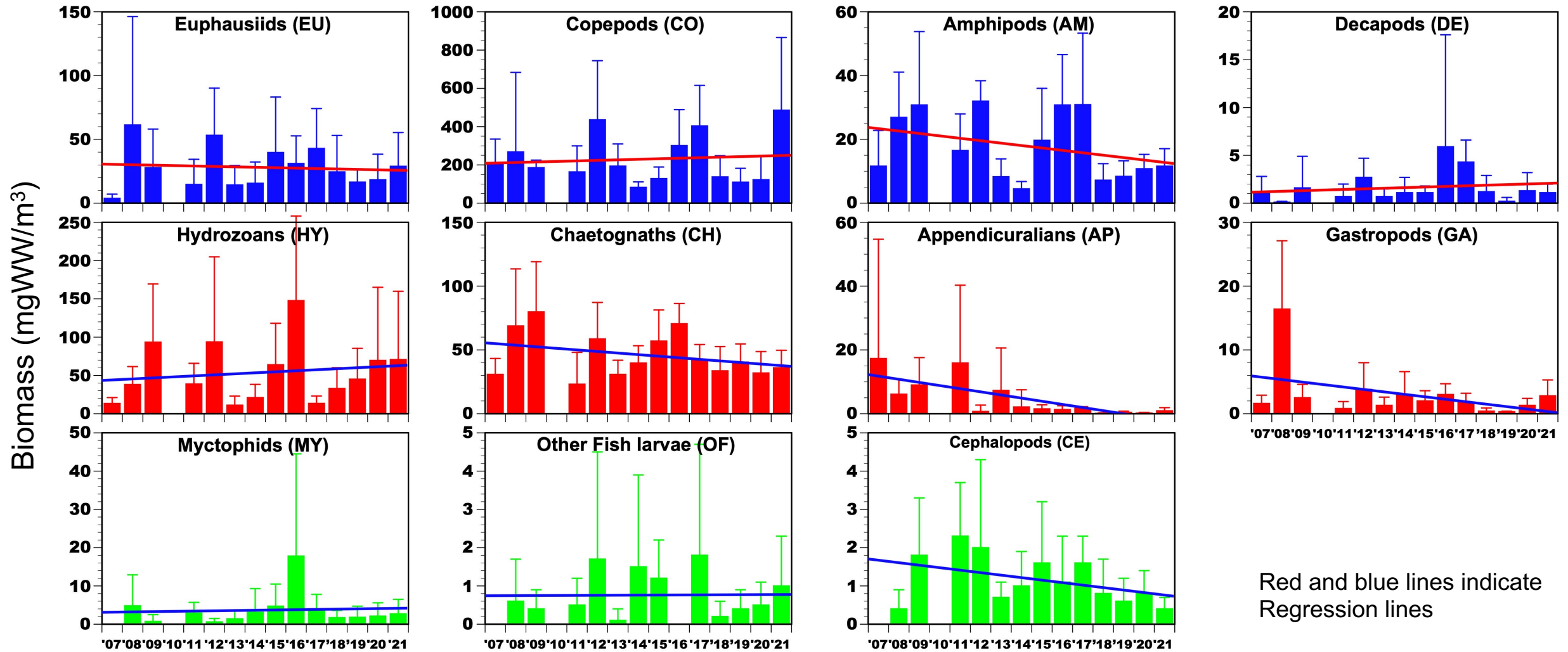
- Biomass of each zooplankton species fluctuated during survey years
- Trends: Increase… CO, DE, HY; Stable…EU, MY, OF; Decrease…AM, CH, AP, GA, CE,

Summary

Status of Pacific salmon stocks
- Chum and sockeye salmon are dominant species in our monitoring survey
- CPUE of chum is highest, while CPUE of sockeye increased since 2013
- Both chum and sockeye salmon, CPUE variations of OA1 fish were influenced in total CPUE for the year
- Chum: mean BW of OA2 was relative to that of OA1 in year before
- Significant negative correlation was indicated between mean chum CPUE and BW

Status of ocean conditions
- SST has been increased in the summer Bering Sea since 2014
- No significant correlation between mean CPUE of chum and sockeye and SST, but chum indicate negative trend between CPUE and SST
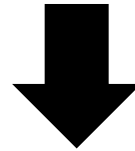
Status of prey environments
- Zooplankton biomass are fluctuated during survey years

Summary

Long monitoring salmon survey by Japanese research cruise demonstrates:

- Abundance of Pacific salmon
- Ocean conditions
- Prey environments

fluctuate in the summer Bering Sea in recent years

- Ocean conditions and prey environments will continue to change from year to year under climate change

- Pacific salmon stocks may be affected by unstable ocean condition and prey environments in their marine life stage

Our long monitoring survey will contribute continuously to understand status of Pacific salmon in a changing salmosphere

Acknowledgements