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Survivals of Japanese chum salmon during the early ocean life in 2011-2017

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Juvenile pink and chum salmon in the Okhotsk Sea

BACKGROUND

Status of Japanese chum salmon

- Adult returns of Japanese chum salmon have showed a trend of decreasing since a peak (76 million fish) in 2004, being less than 32 million fish in recent years (2016-2020)(Figure 1).
- It is an urgent issue to understand when and why the survival of Japanese chum salmon is decreasing for their sustainable management.

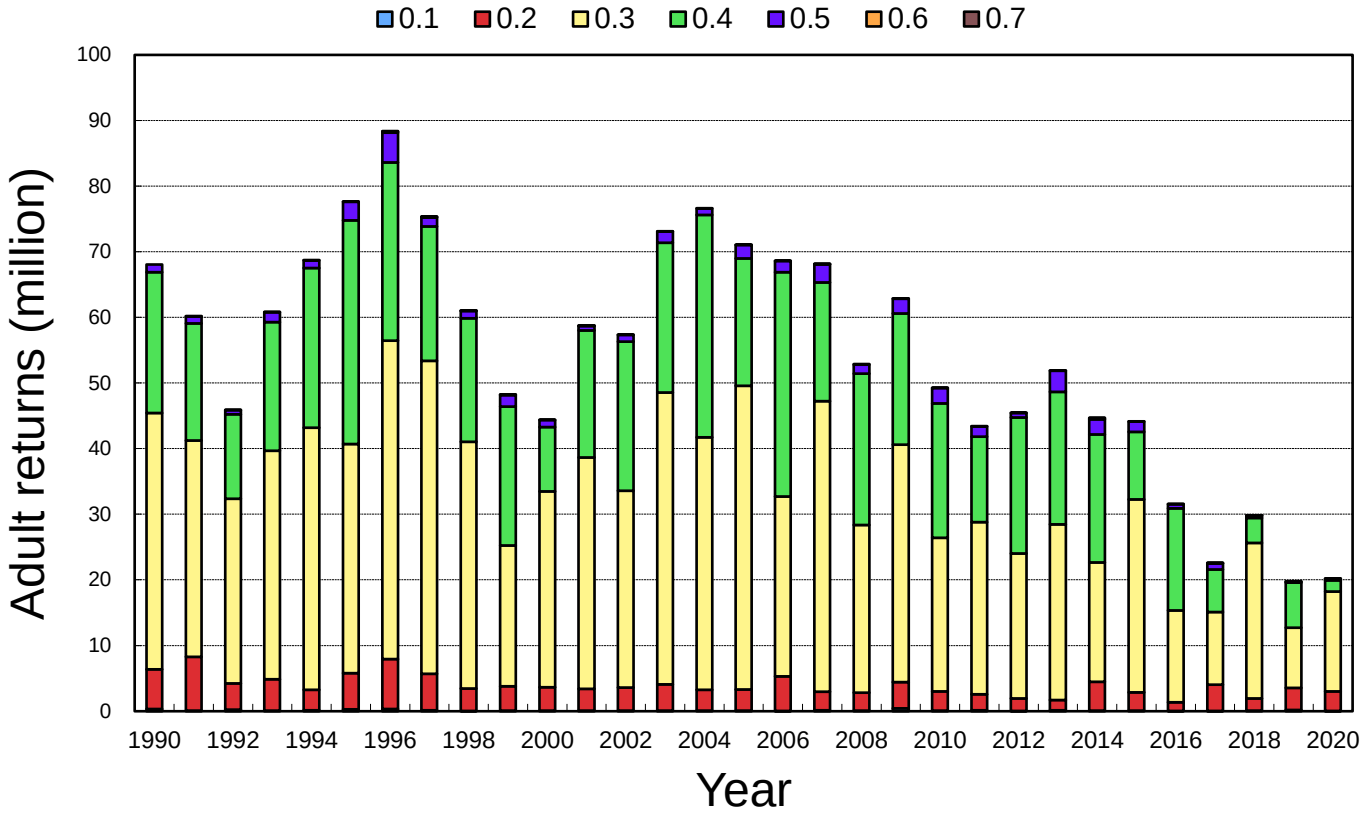

Figure 1. Adult returns of chum salmon by age in Japan, 1990-2020. Data source: Salmon Resources Research Department, FRA.

Migrations and distribution of juvenile chum salmon

- Juvenile chum salmon released from hatcheries migrate along the coastal shelf of northern Japan, heading for the Okhotsk Sea (Figure 2).
- Recent genetic and otolith mark studies have indicated that juvenile chum salmon of all regional populations in Japan are distributed in the Okhotsk Sea during the first summer and fall.

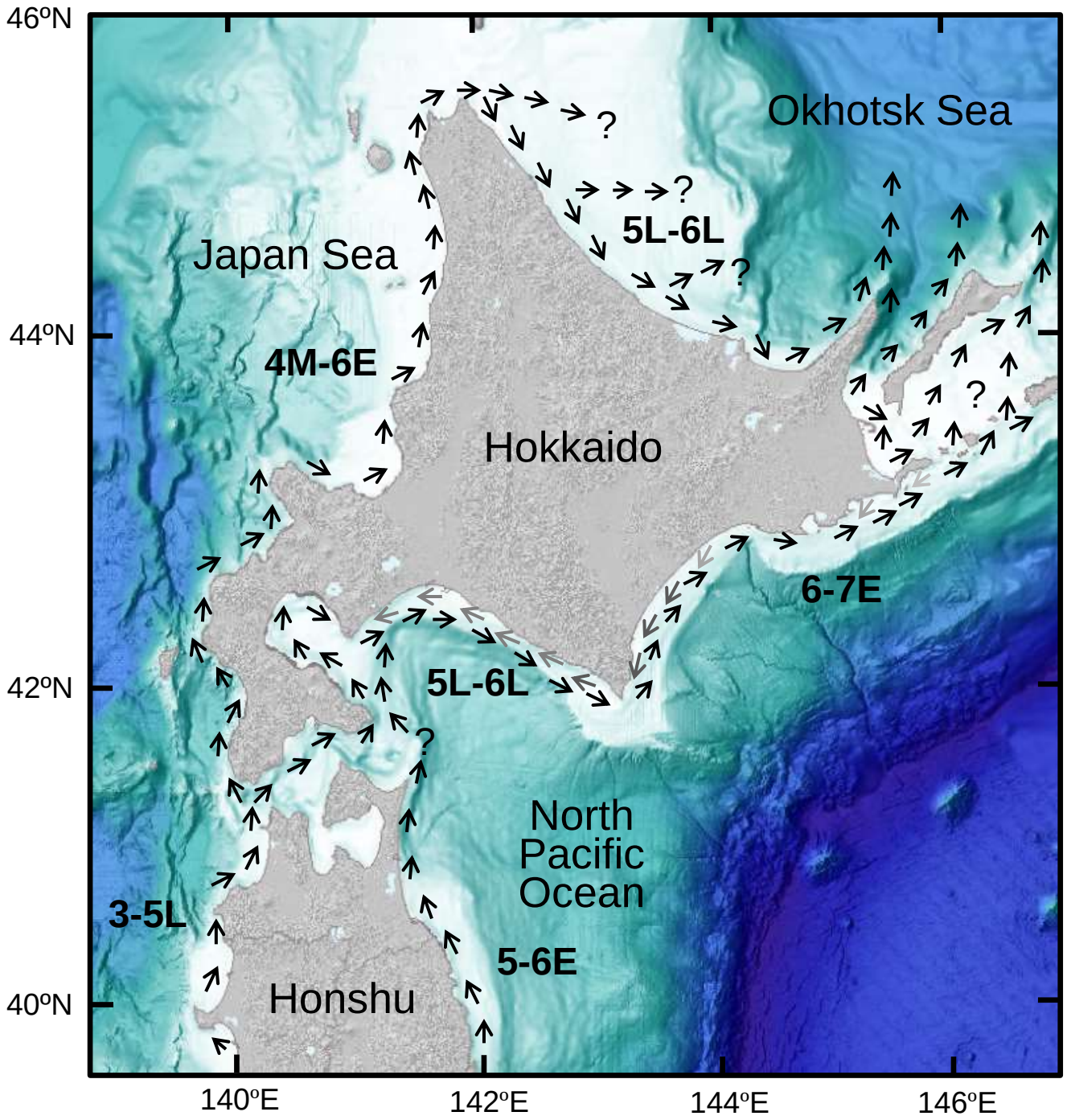

Figure 2. Estimated migration routes of juvenile chum salmon along the costal waters of northern Japan during March through July. Numerals indicate estimated migration period (month). E, early; L, late; M, middle. (Urawa et al. 2018).

PURPOSE

- The Okhotsk Sea is the most important feeding area for juvenile chum salmon of Asian origins including all regional populations in Japan.
- A long-term trawl survey has been conducted by Russian research vessels to estimate the abundance of chum and pink salmon in the Okhotsk Sea during fall season (mainly October).
- To evaluate the early survivals of Japanese chum salmon, their abundance in the Okhotsk Sea is estimated by using otolith marks.

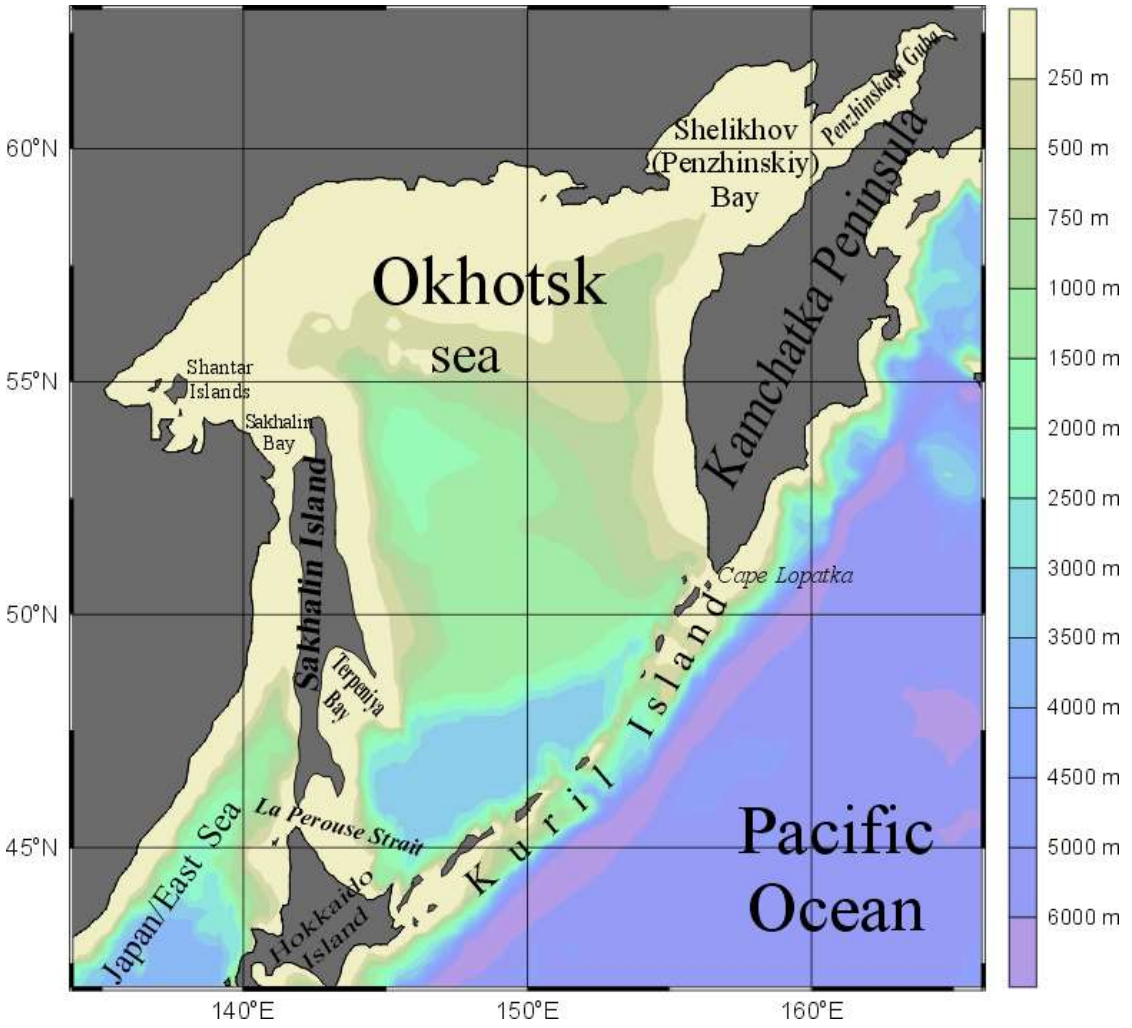

Figure 3. A bathymetric map of the Okhotsk Sea.

METHODS

- The abundance and otolith marks of juvenile chum salmon caught in the Okhotsk Sea during the fall of 2011–2017 were reported by Bugaev et al. (2019, 2020)(Figure 4).
- A total of 9,870 juvenile chum salmon were examined for otolith marks, and 347 otolith-marked fish released from hatcheries in Japan were detected with the NPAFC otolith mark release database (http://npafc.taglab.org).
- We estimated the abundance of hatchery-released juvenile chum salmon in the Okhotsk Sea by using the NPAFC otolith mark release database and the recovery data reported by Bugaev et al. (2019, 2020).

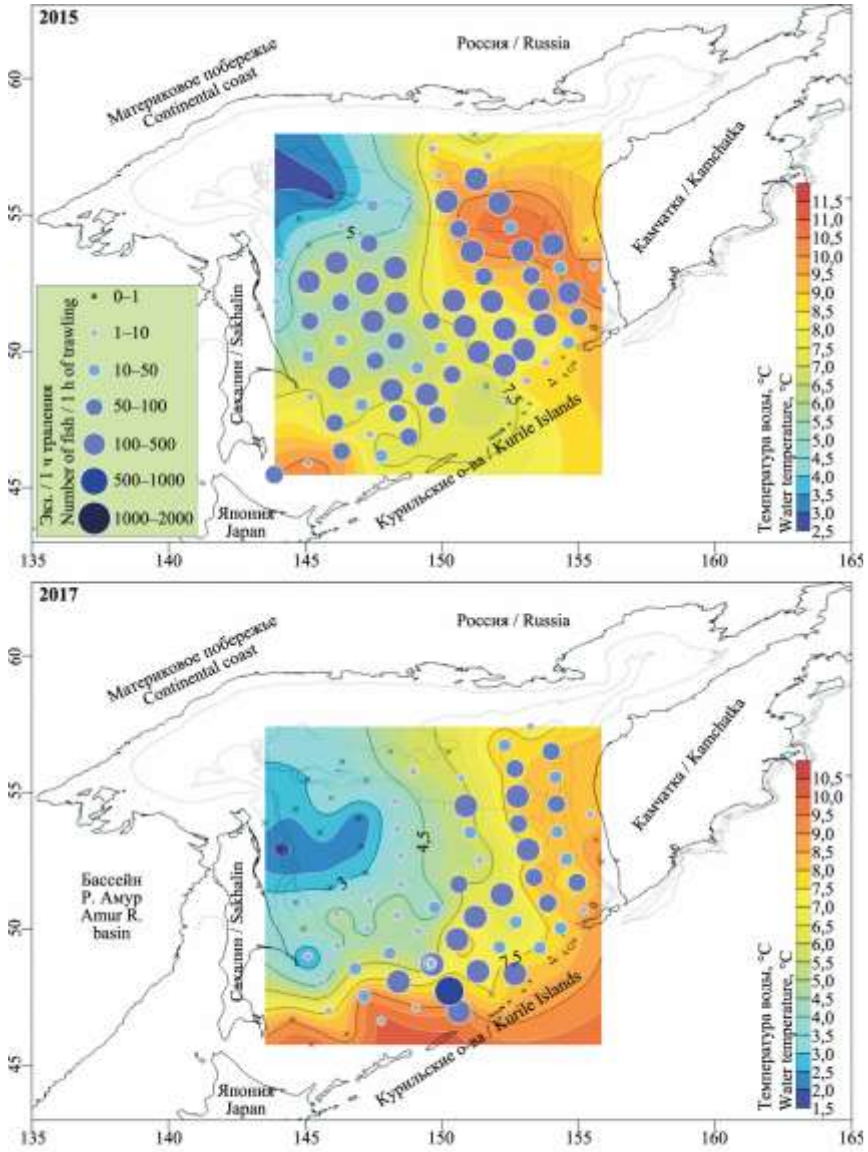

Figure 4. CPUE distributions of juvenile chum salmon and SST in the fall of 2015 and 2017 (Bugaev et al. 2020).

RESULTS & DISCUSSION

Estimated abundance of wild and hatchery chum salmon juveniles in the Okhotsk Sea during the fall season

- The total abundance of juvenile chum salmon was variable among brood year (BY) stocks: 164-553 million fish (Figure 5).
- Wild fish were prevailing (131-431 million fish). Although the origins were unknown, they might be dominated by Russian populations.
- The abundance of Japanese hatchery fish was 247 million in BY 2011 stock, while it decreased less than 80 million in BY 2012-2016 stocks.

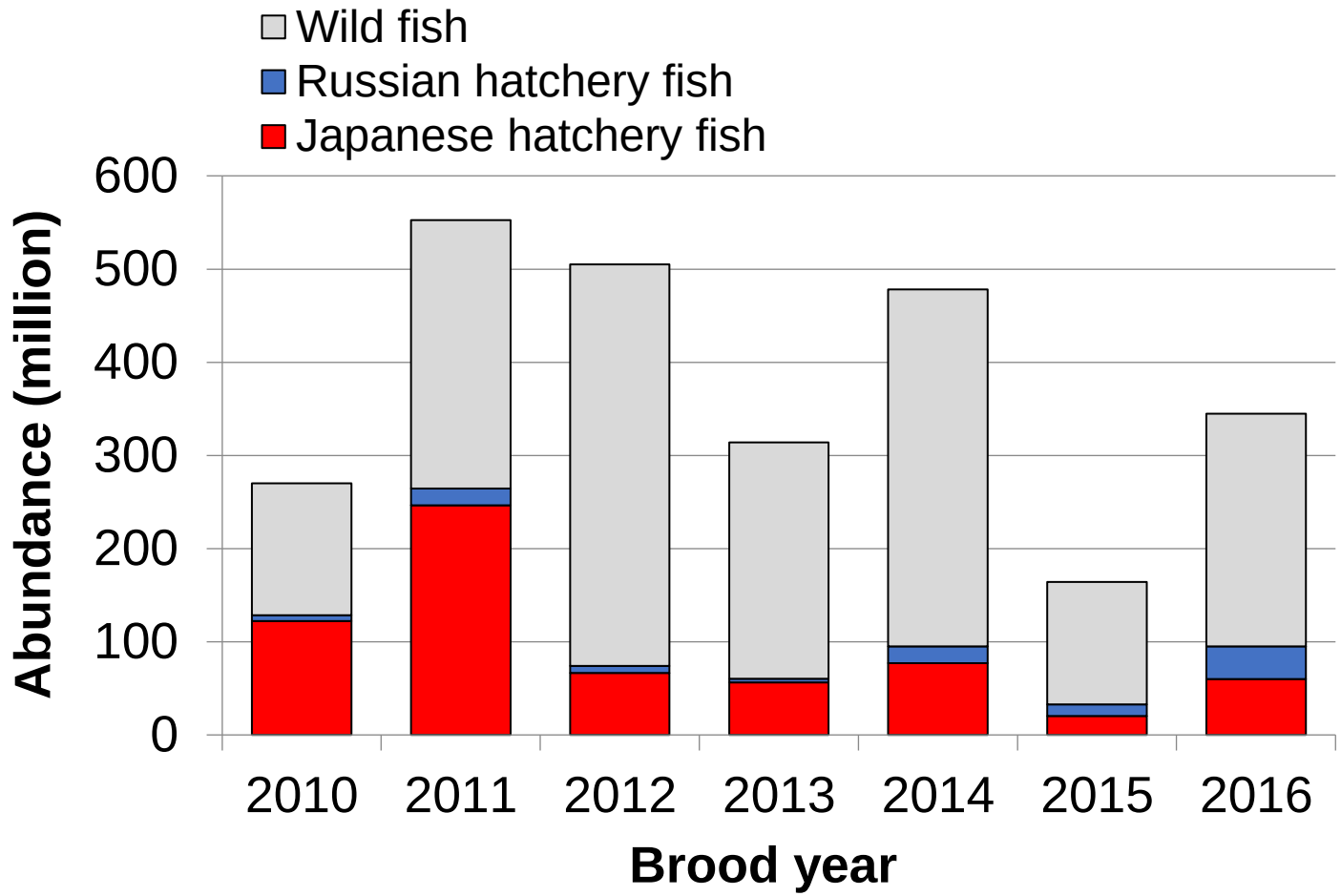

Figure 5. Abundance of wild and hatchery chum salmon juveniles in the Okhotsk Sea during fall (mainly October), estimated by otolith marks.

Survival rates of Japanese chum salmon

- Survival rate of hatchery-released chum salmon during the early life in the coastal waters and Okhotsk Sea was variable among brood year stocks:15% in BY 2011, 1.2-4.1% in BY 2012-2015 (Figure 6).
- Number of adult returns was 50 million fish in BY 2011, while it decreased to13-35 million fish in BY 2012-2015 stocks.
- Survival rate of juveniles in the Okhotsk Sea is estimated 20-62% in the following ocean life, showing no correlation with adult returns.

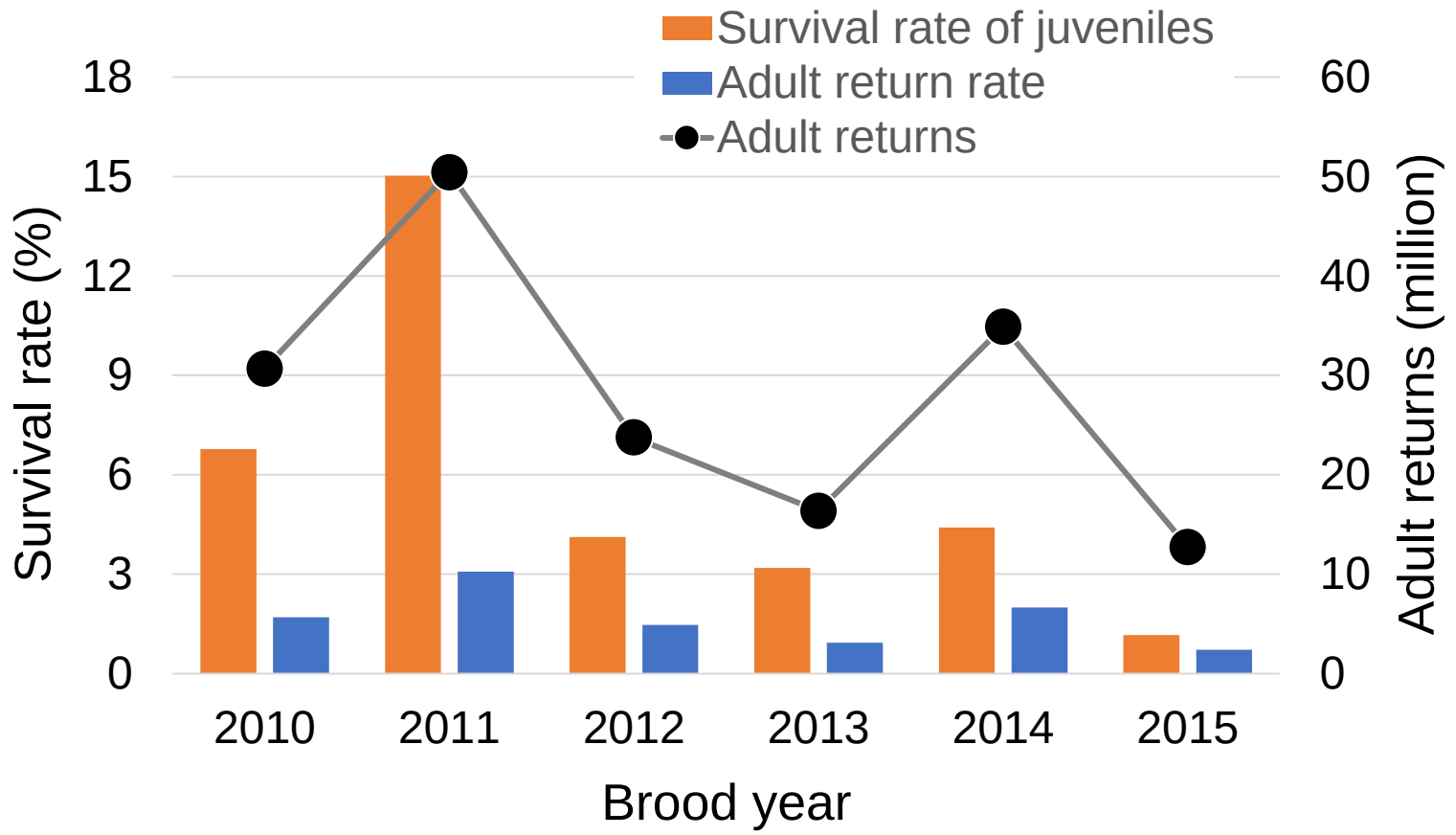

Figure 6. Survival rates and adult returns of chum salmon released from Japanese hatcheries. The survival rates of juvenile fish were estimated from their abundance in the Okhotsk Sea. The adult return rates might be over-estimated, because adult returns included wild fish.

When is the brood year strength of Japanese chum salmon determined?

- There was a significant positive correlation between abundance of Japanese hatchery-released chum salmon juveniles in the Okhotsk Sea and adult returns (Figure 7).
- This indicates the brood year strength of Japanese chum salmon is determined in the early life stage during the coastal and offshore migrations to the Okhotsk Sea.

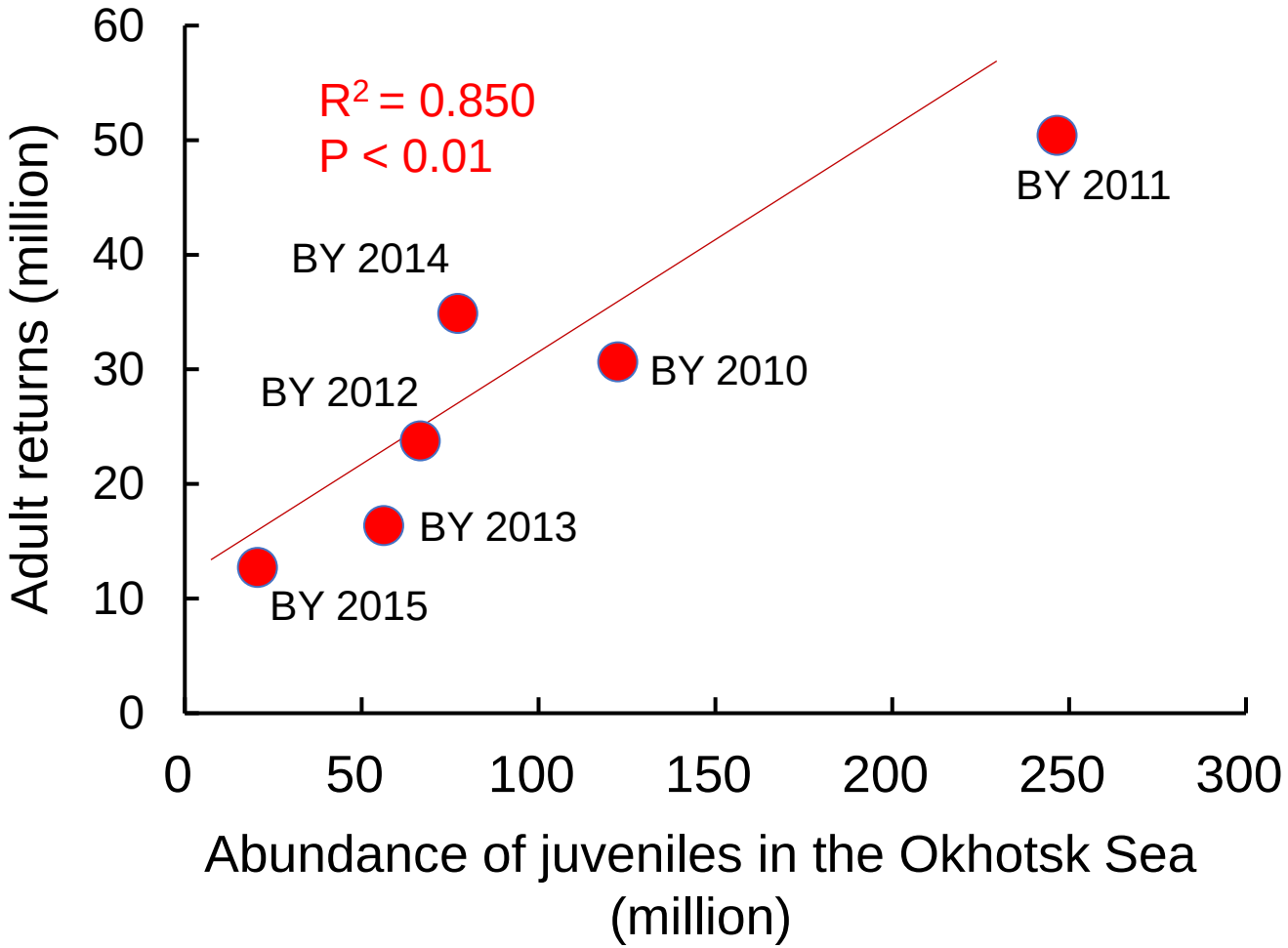

Figure 7. Relationship between estimated abundance of Japanese hatchery chum salmon juveniles in the Okhotsk Sea and adult returns by brood year (BY) stock.

Possible cause of variability in early ocean survival

- BY 2011 stock could stay longer in the favorable coastal environments (8-13°C) due to positive SST anomaly in spring and negative anomaly in early summer, which might result in better growth and survival of juvenile chum salmon (Figure 8).
- BY 2012-2015 stocks could not stay longer in the favorable environments due to low coastal SST in spring and/or high SST in early summer, which might result in the poor growth and survival.

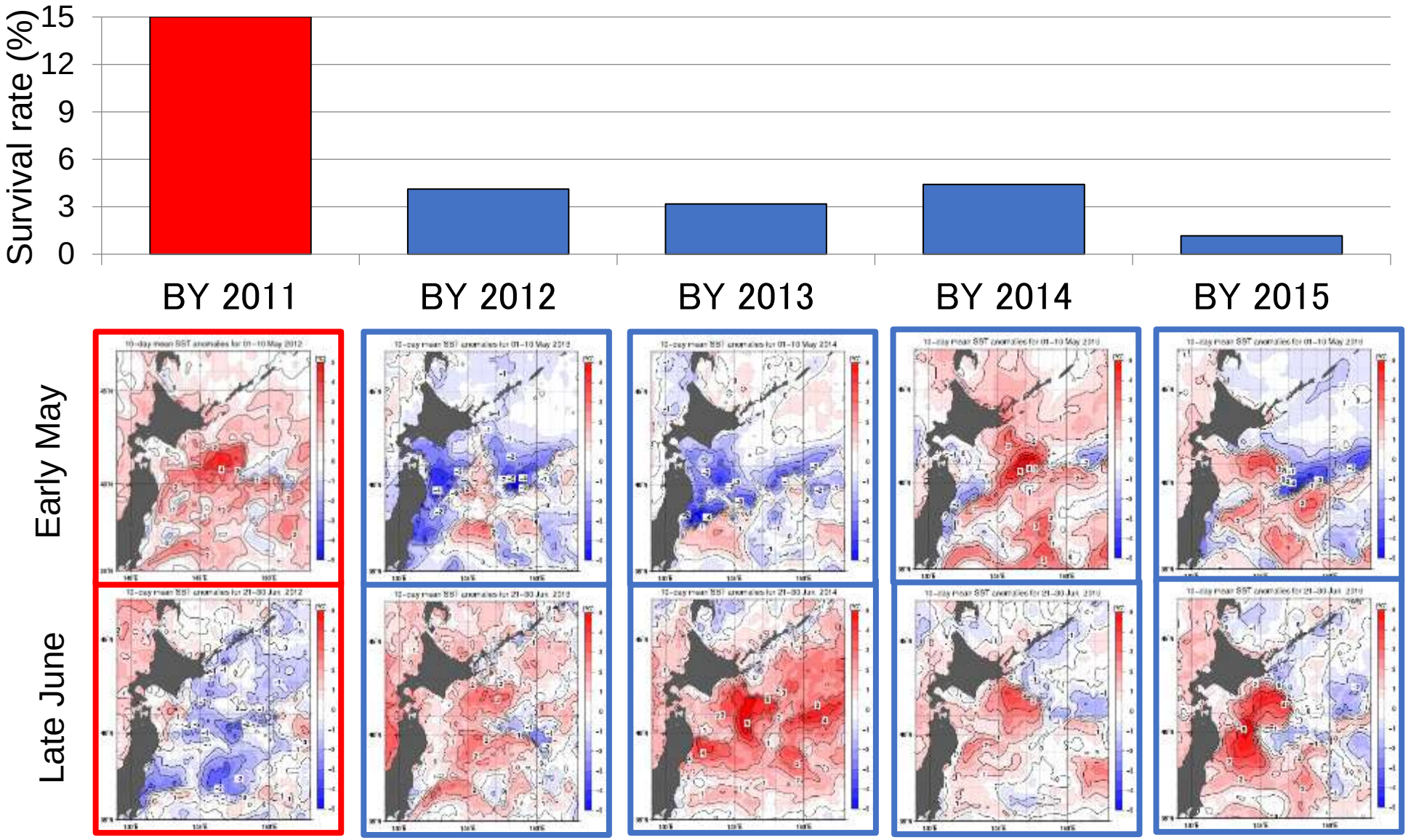

Figure 8. Early survival rates of juvenile chum salmon (upper) and coastal SST anomalies experienced by them in early May and late June (lower). Data source of SST anomalies: Japan Meteorological Agency.

SUMMARY & CONCLUSIONS

- The abundance of Japanese hatchery-released chum salmon juveniles in the Okhotsk Sea during the fall was variable among brood year (BY) stocks: 247 million fish in BY 2011 stock, but less than 80 million fish in BY 2012-2016 stocks.
- There was a significant positive correlation between abundance of Japanese chum salmon juveniles in the Okhotsk Sea and adult returns, suggesting the brood year strength of Japanese chum salmon is determined in the early life stage during the coastal and offshore migrations to the Okhotsk Sea.
- Recent decrease of early ocean survivals of juvenile cum salmon might be caused by the reduction of favorable coastal habitats (SST: 8-13^{o}C) due to a climate change.
- Further studies are required to clarify the survival mechanisms of juvenile chum salmon during the early ocean life for better management of Japanese populations.

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