Spawning migration strategies of Chum salmon (*Oncorhynchus keta*) with marine environment change in the coastal water of Korea

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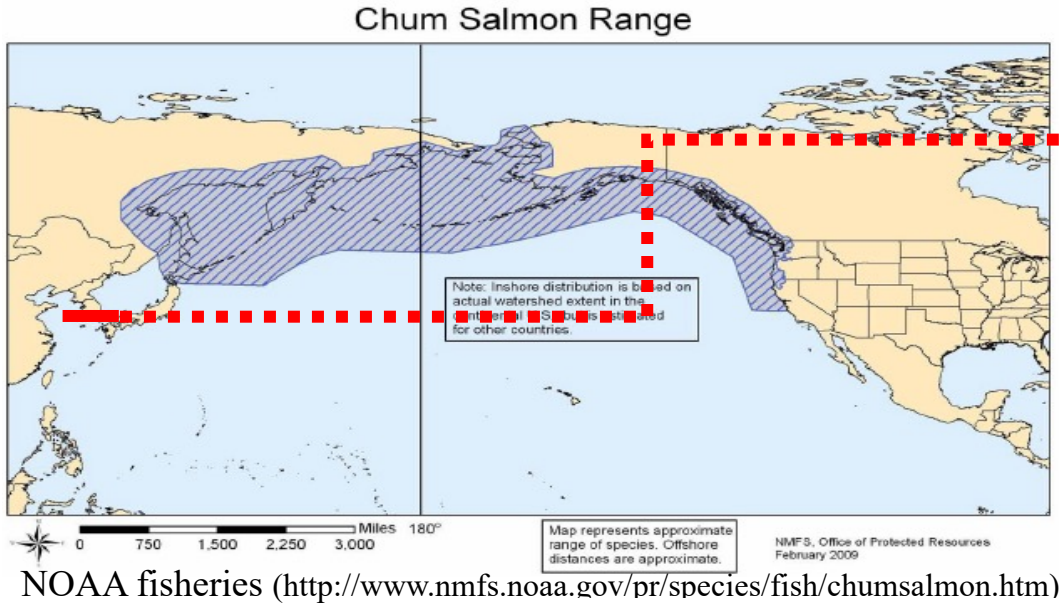
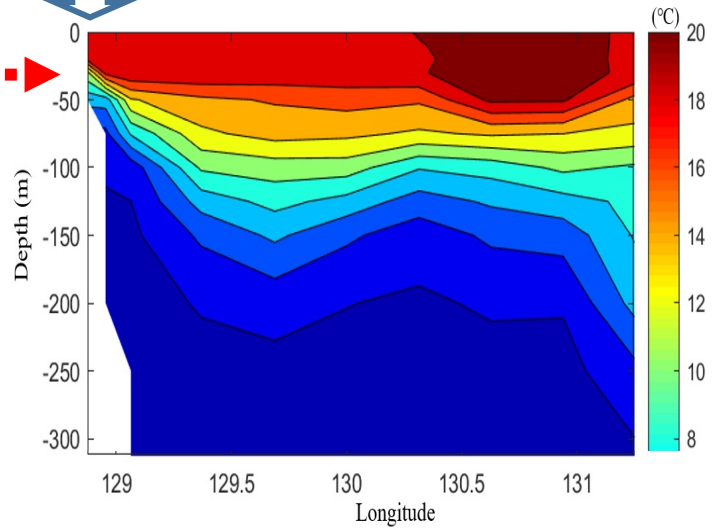
Introduction

Chum salmon range and migration

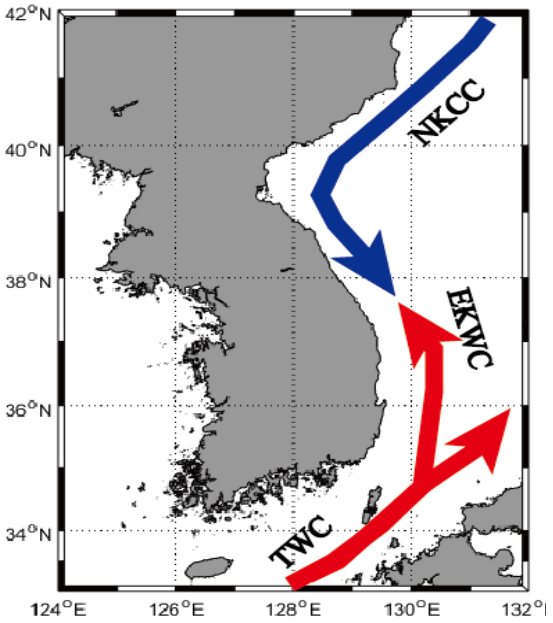


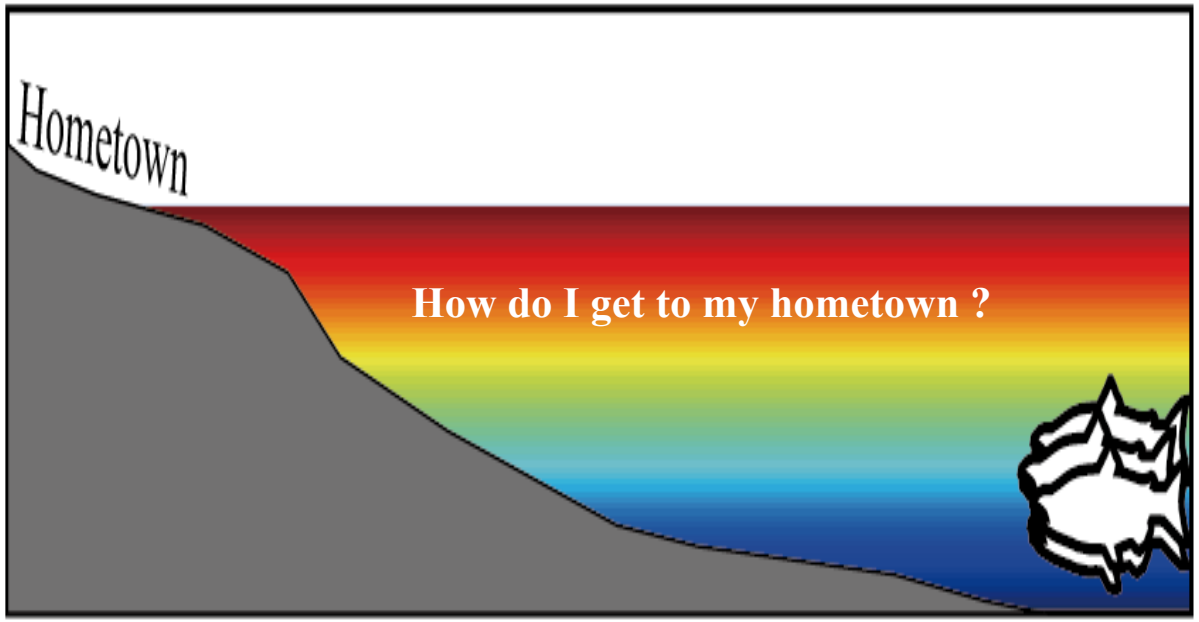
NOAA fisheries (http://www.nmfs.noaa.gov/pr/species/fish/chumsalmon.htm)

Eastern coast of Korea



In the subsurface layer, cold water mass (<14℃) is distributed throughout the year. This environment is one of the reasons salmon can be distributed at relatively lower latitude along the coast

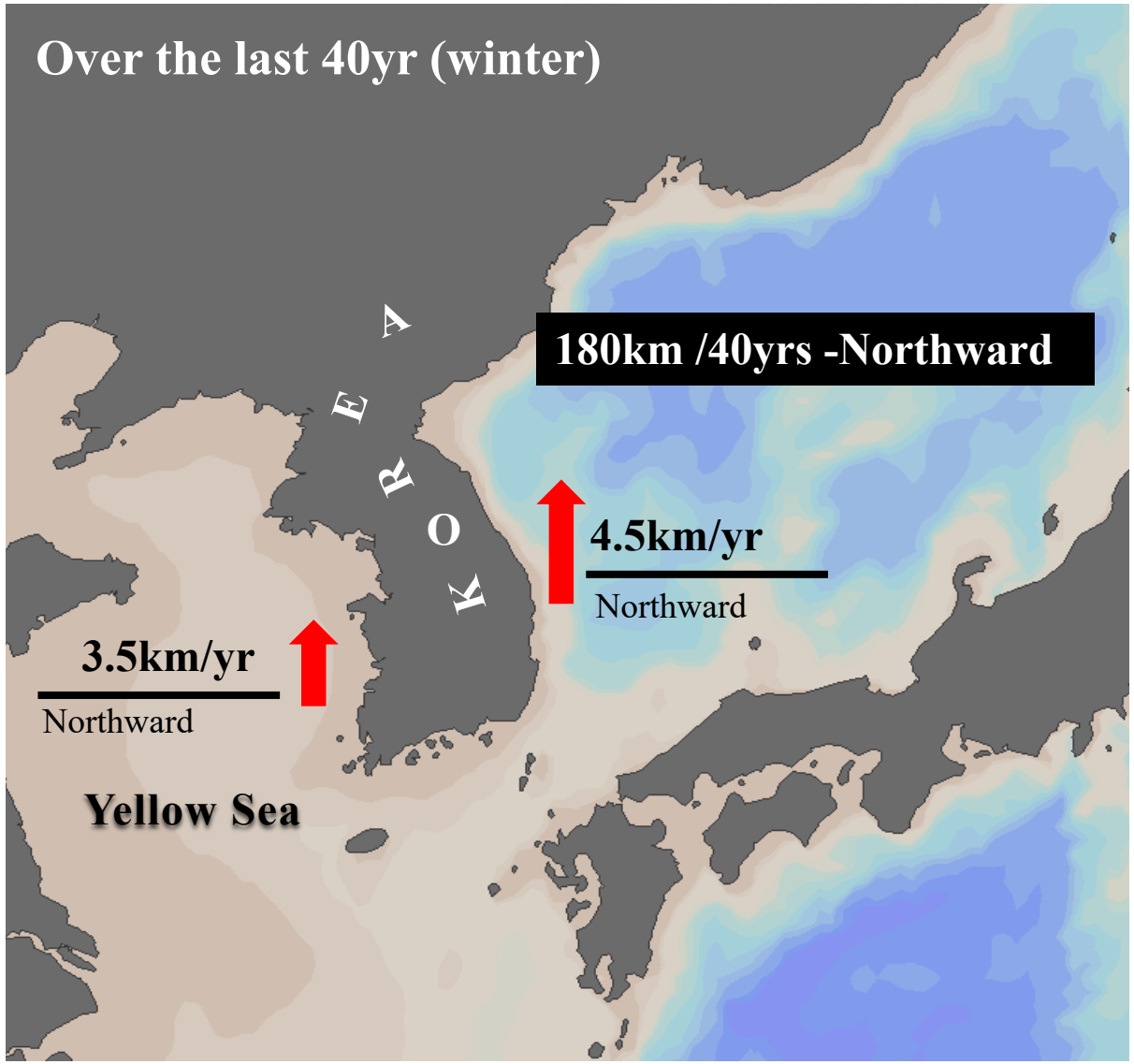




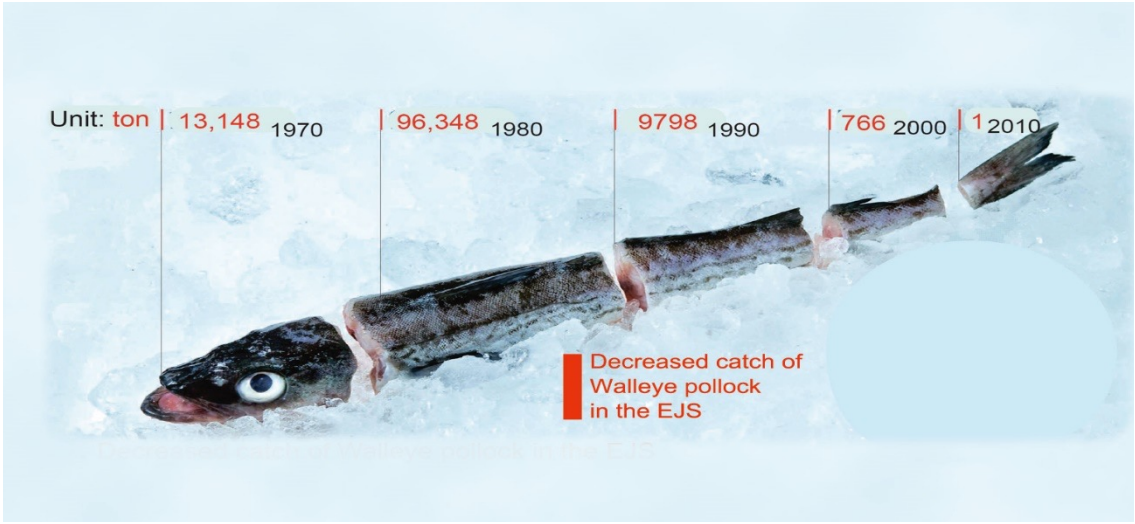
The surface layer is affected by warm water mass originating from the Kuroshio, and salmon must pass through this high temperature layer to migrate to the river to spawn. The process is very interesting.

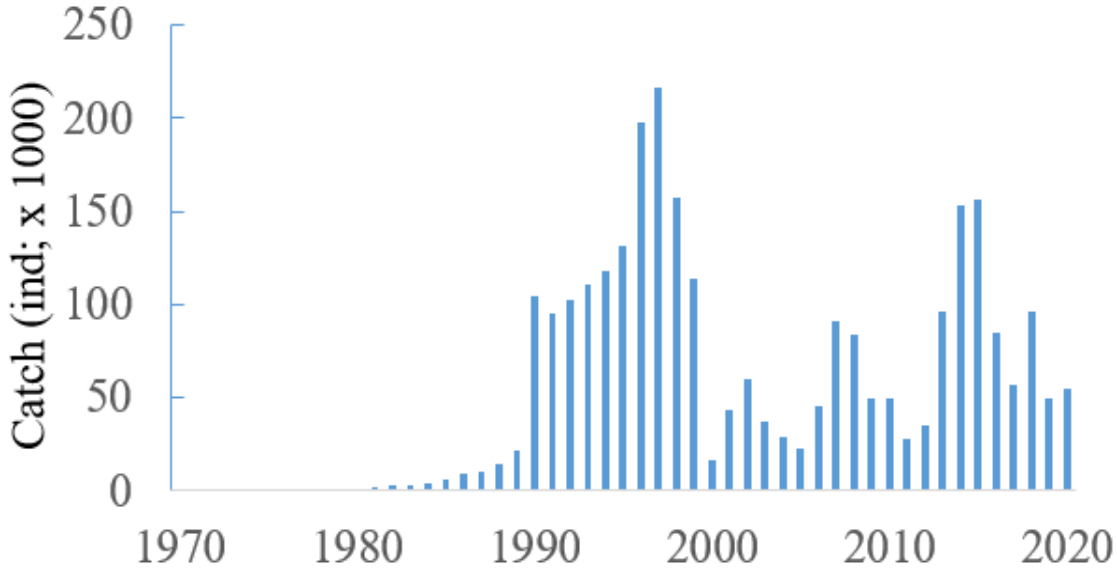
Introduction

Ocean Warming On Speed

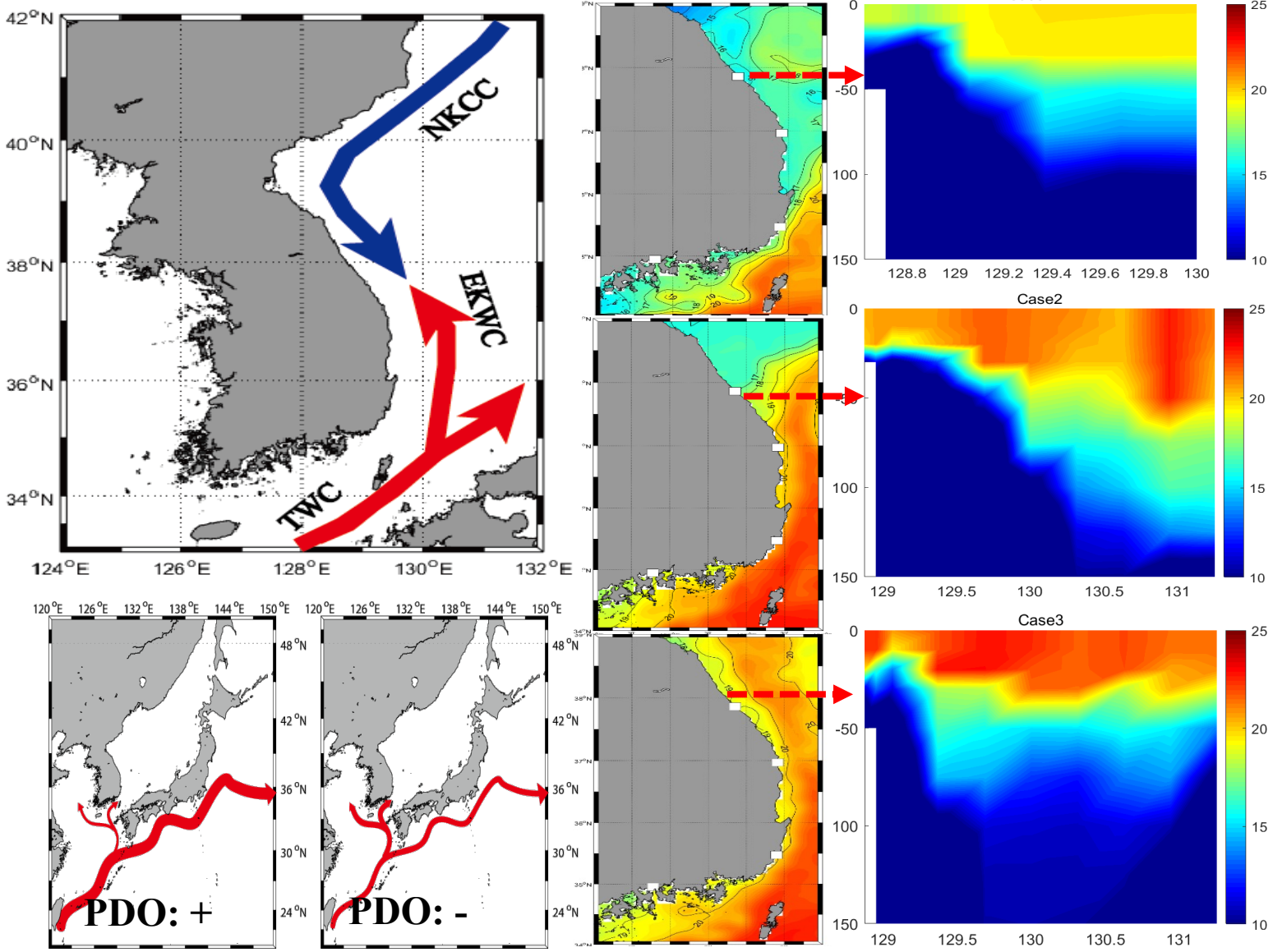


Catches in Walleye Pollock (top) and salmon (bottom) in the eastern coastal water of Korea





Introduction



The eastern coast of Korea

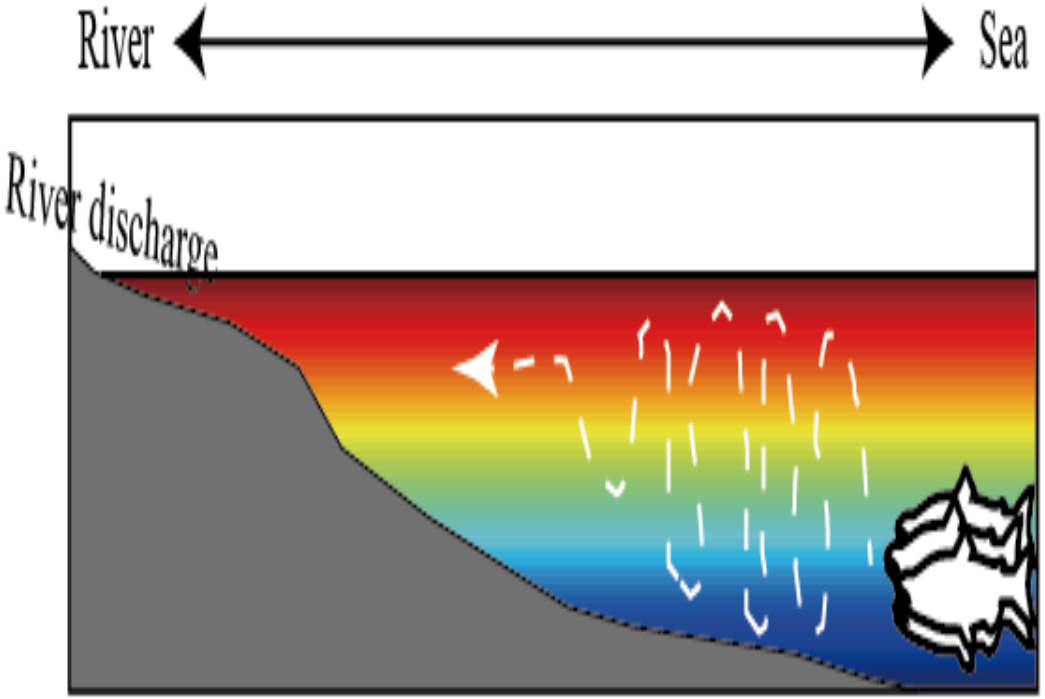
1) is the boundary where the cold and warm currents meet,
2) and as a result in change of PDO mode and the influence by various environmental factors, there are three major types of environmental changes.

These environmental changes could

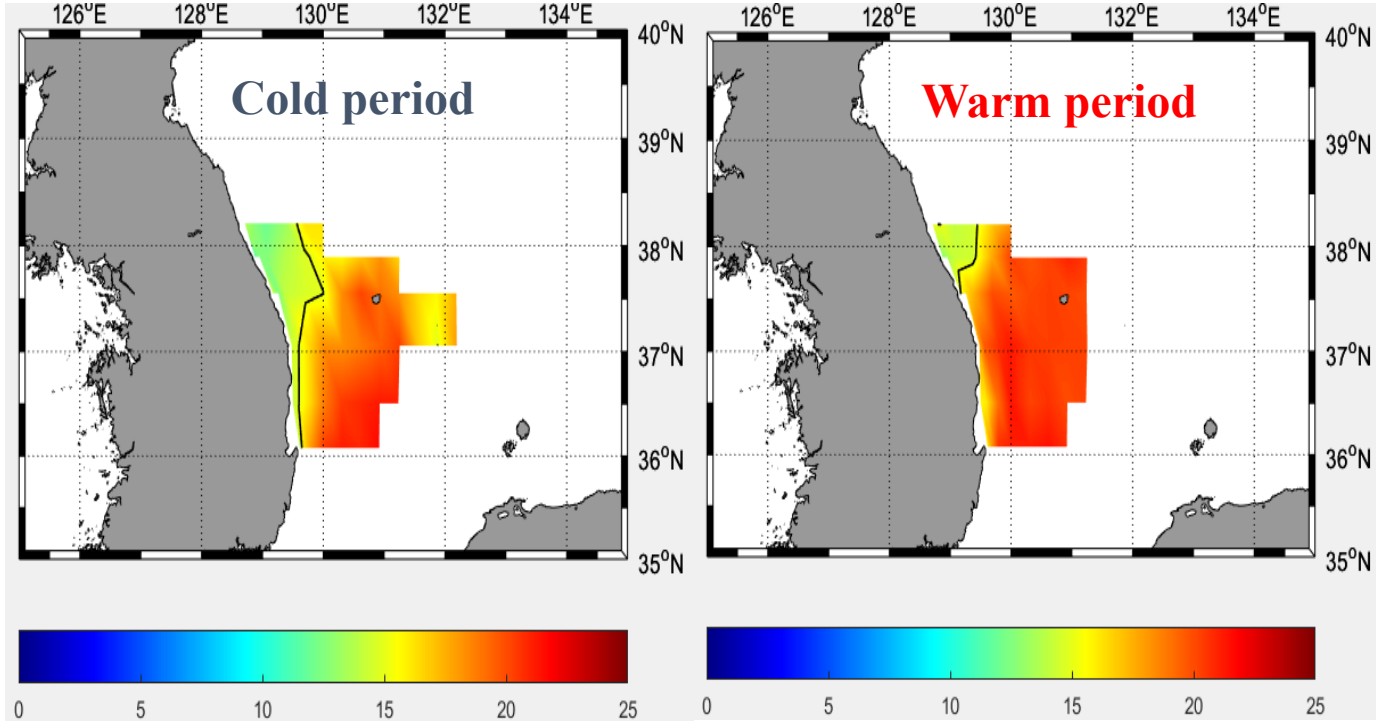
1) affect the distribution of salmon migrating to the rivers where they were born for spawning migratory.

Introduction

The aim of this study is to understand the spawning migration strategies of Chum salmon (*Oncorhynchus keta*) with marine environment change in the coastal water of Korea, and two major topic were covered as follows;



First, a strategy that uses environmental conditions when salmon migrate from the coast to the river for spawning.

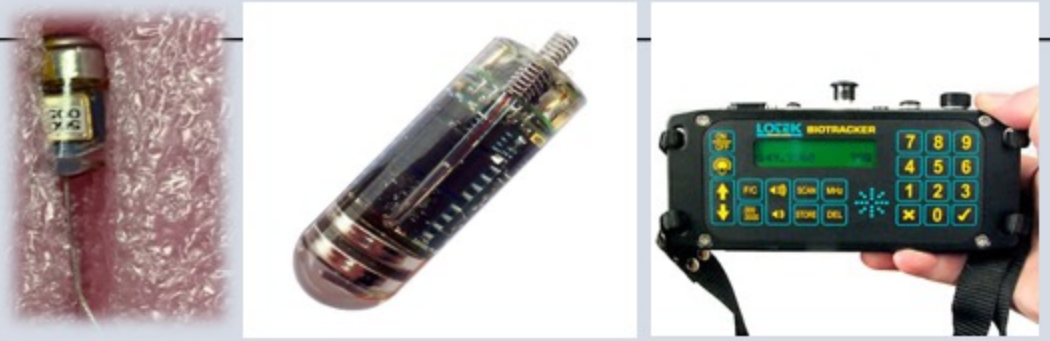


Second, changes in the distribution of salmon with the coastal environment change.

Data & method

1. Tagging experiment

Tag	NTF-6-1	LAT1410
Size	9 mm x 22 mm	11 mm x 35 mm
Weight	2.8 g (in air)	5.2 g (in air)
Type	Radio telemetry	Temperature, Depth logger
Life time	232 days (interval 5 s)	1 year (interval 1 m)

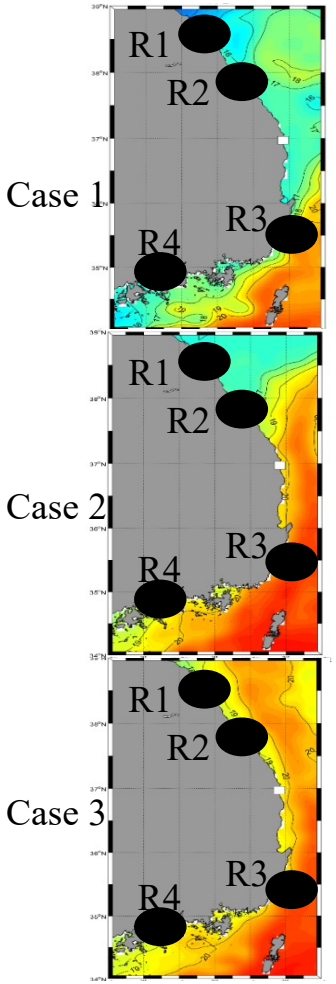


Electronic tagging experiments have been conducted to track salmon migration in coastal and stream.

- Using sensors that can track location and measure temperature and depth

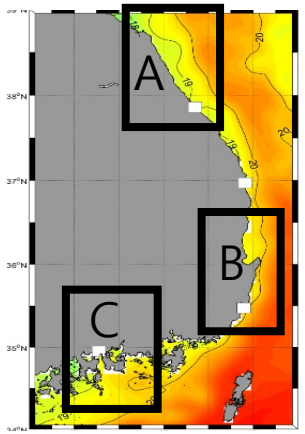
Data & method

2. Salmon distribution with coastal environmental change during spawning season



- The coastal environment is divided into three types according to the SST distribution
  - Case 1: Lower SST (< 20℃) is distributed from the eastern coast to the southern coast of Korea
  - Case 2: Lower SST and higher SST area is separated by the central region of eastern coast of Korea
  - Case 3: Higher SST (> 20℃) is distributed from the eastern coast to the southern coast of Korea

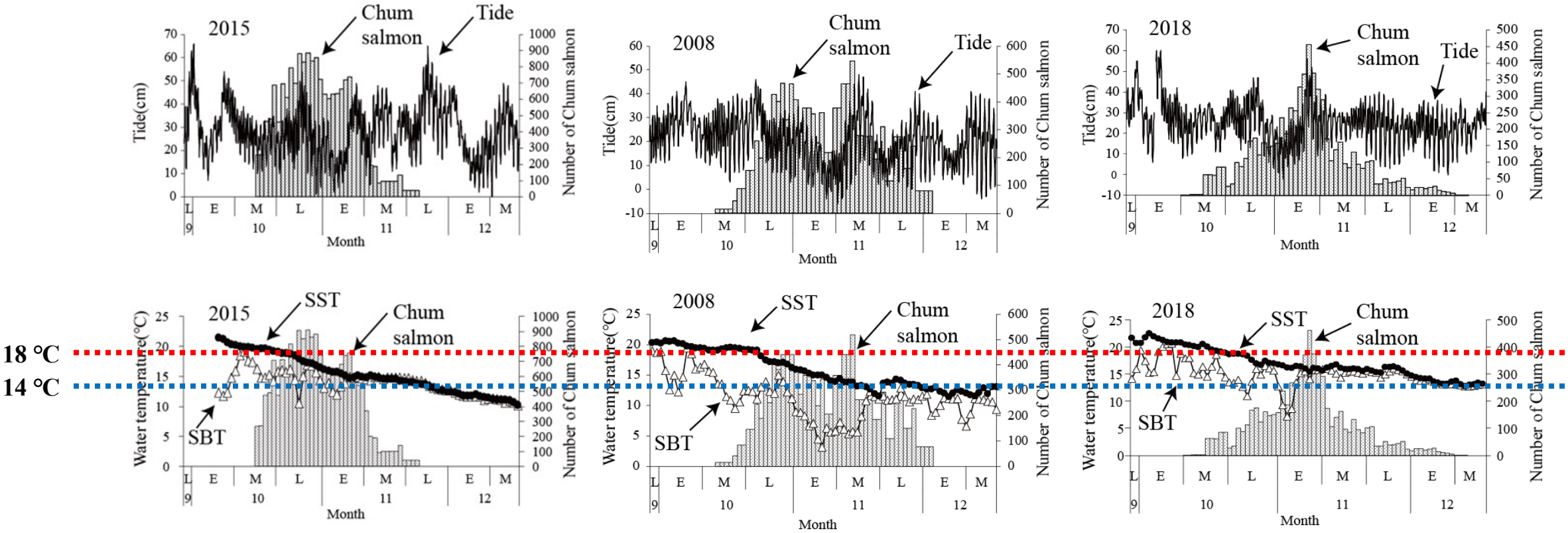
- Characteristics of salmon distribution in coastal area and stream by each type.
  - Change in salmon distribution along the coast by each type
  - timing entering river by each type



- Changes in return rates of salmon move to streams by each type.
  - Compare return rate with environmental change

Result and Discussion

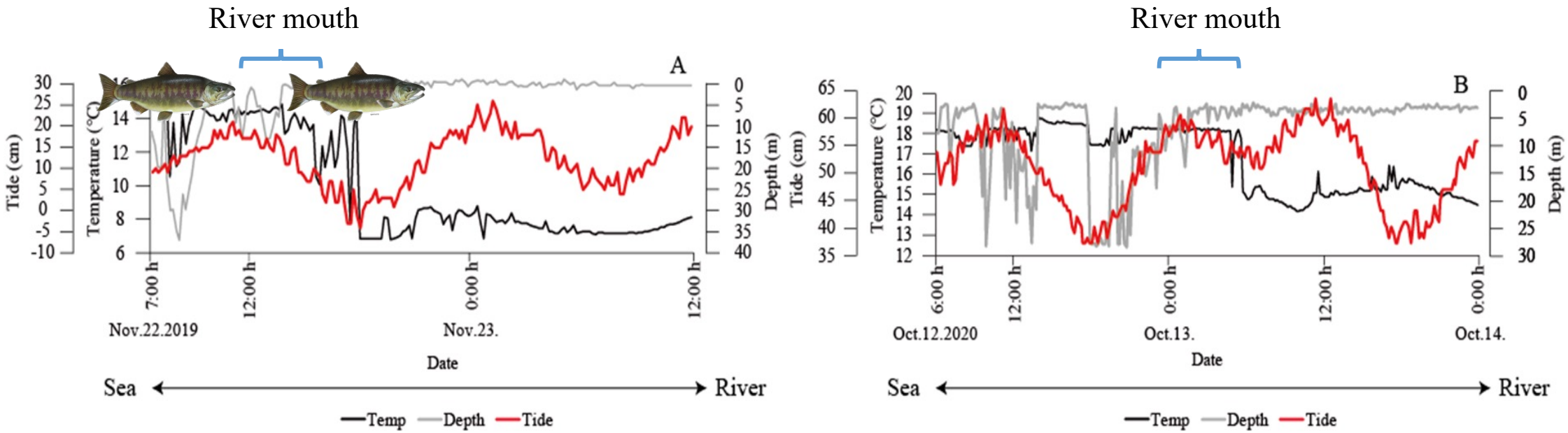
1. Change in tide, surface and bottom water temperatures in the coast, and the number of salmon migrating into rivers



- Salmon migrate from coast to river between 20 ℃ and 12 ℃ in coastal waters.
- When the coastal SST drops below 18 ℃, the individual of salmon migration to rivers increases.
- During the spring tide, when the temperature difference between the surface and the bottom is reduced by mixing, the individual of salmon migrating to the river is maximum.
- When the SST and SBT drops below 14 ℃, individual of salmon moving to rivers decreases sharply

Result and Discussion

2. Electronic tagging experiments on the northern coast of Korea



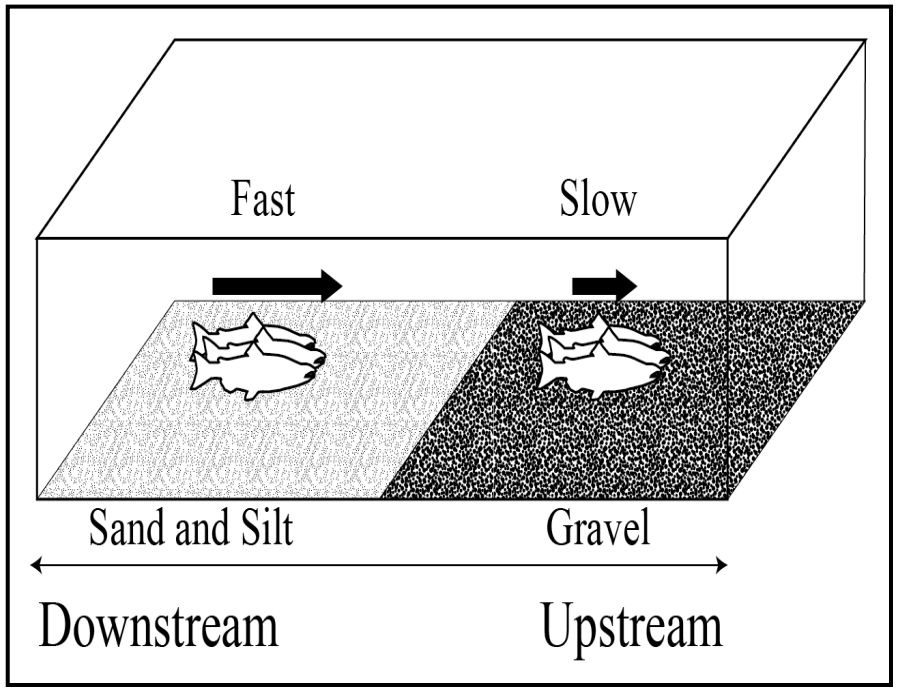
- When the sea level rises during high tide

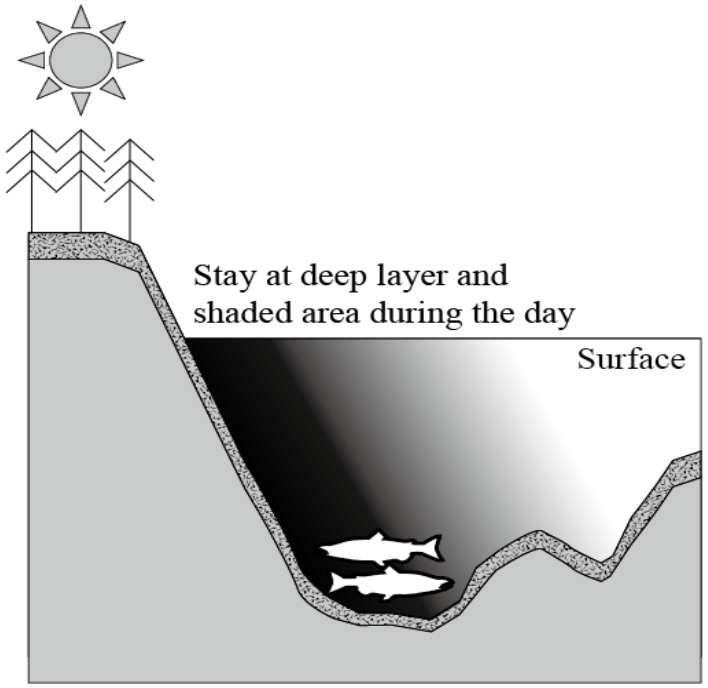
- the SST falls below 20 ℃ due to vertical mixing and sea surface cooling, salmon moves through the surface to the river.
- Sea level rise by tide helps salmon migrate from the coast to the river with less energy and less stress

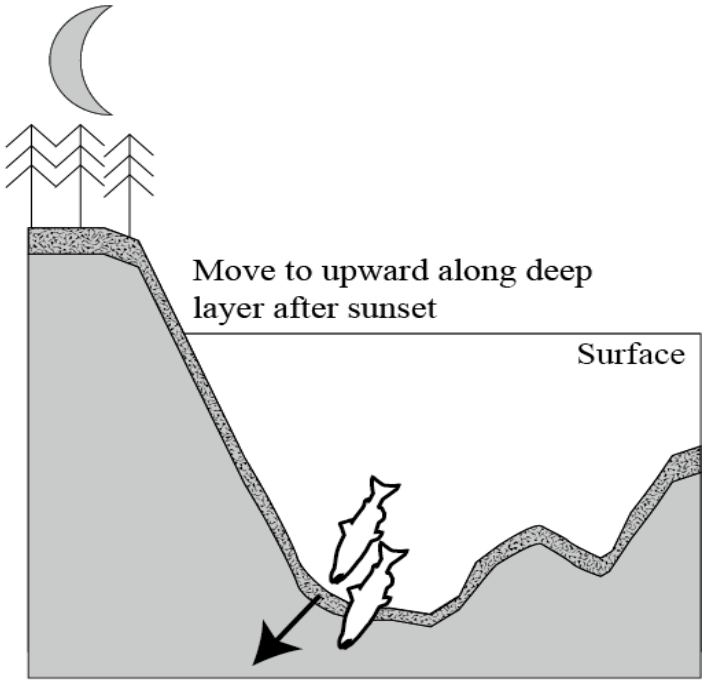
Result and Discussion

3. Tracking salmon migration characteristics in rivers

This experiment was repeated 9 times in different streams, and the results were summarized.





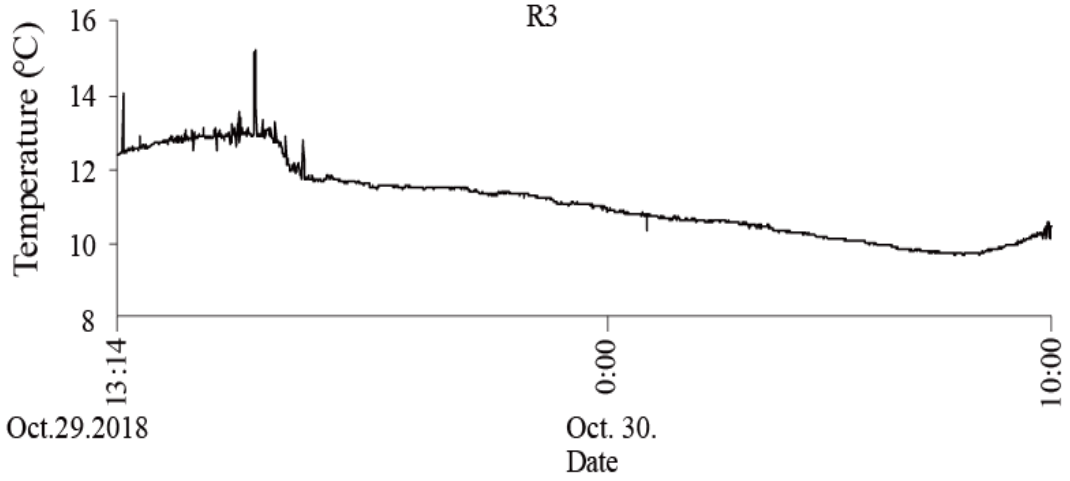


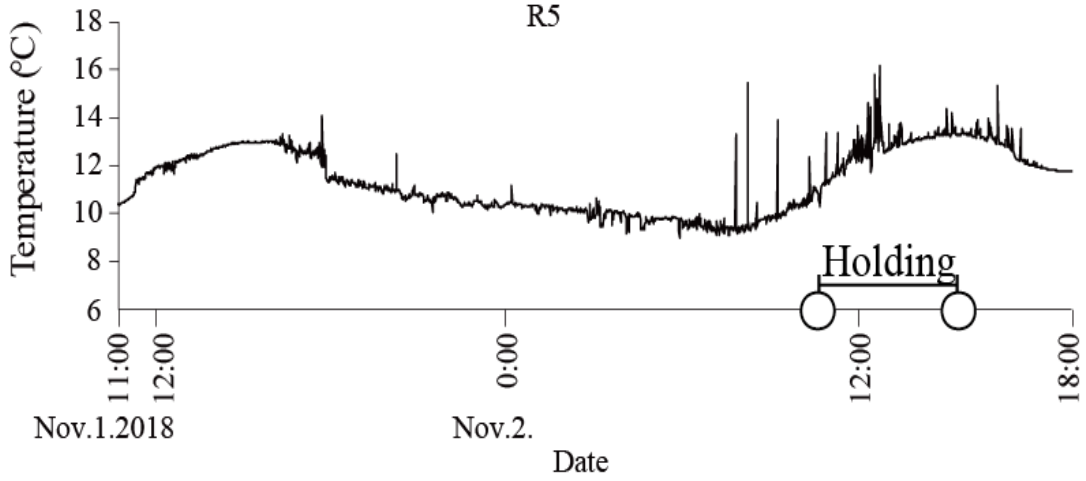
In the rivers, the salmon migration became slower in riverbed areas with gravel than with sand/mud substrates.
The salmon remained in deep-water and shaded areas of the river during the day and progressed upstream movement at night

Result and Discussion

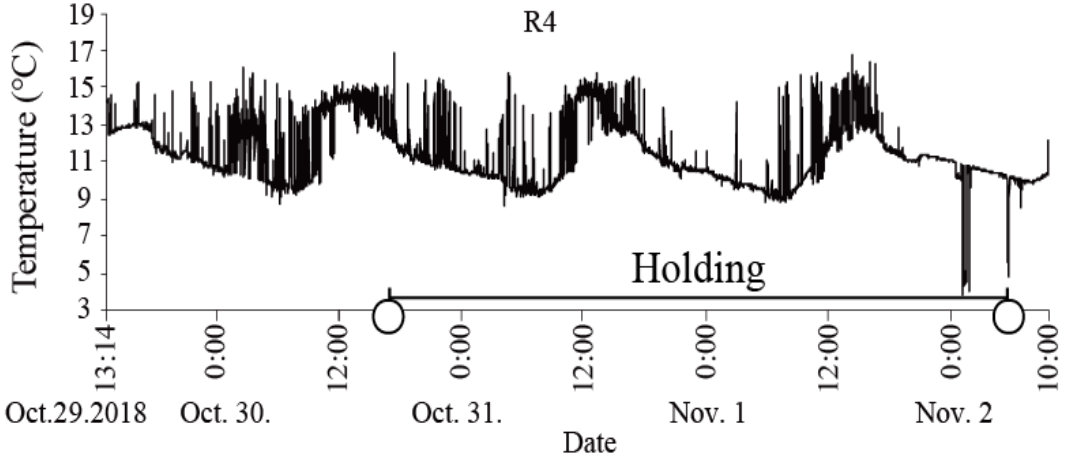
3. Tracking salmon migration characteristics in rivers

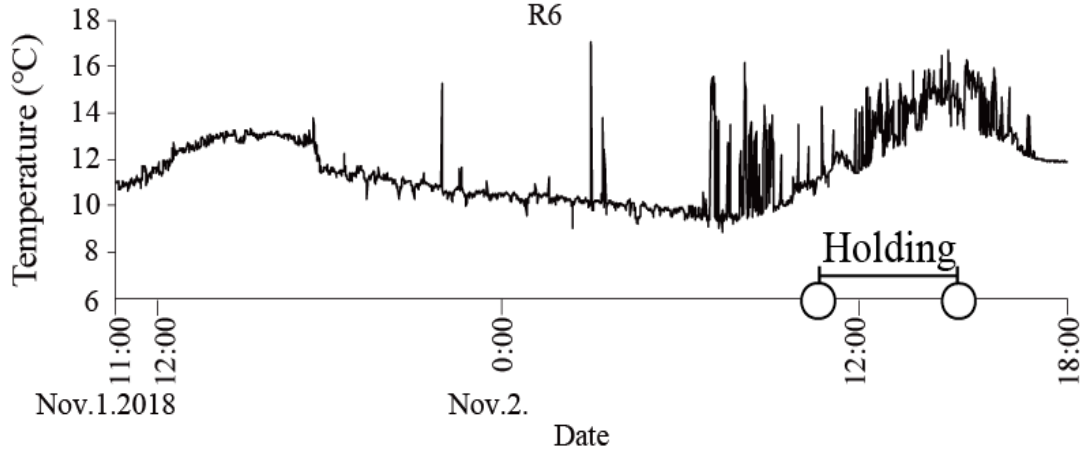
Male





Female

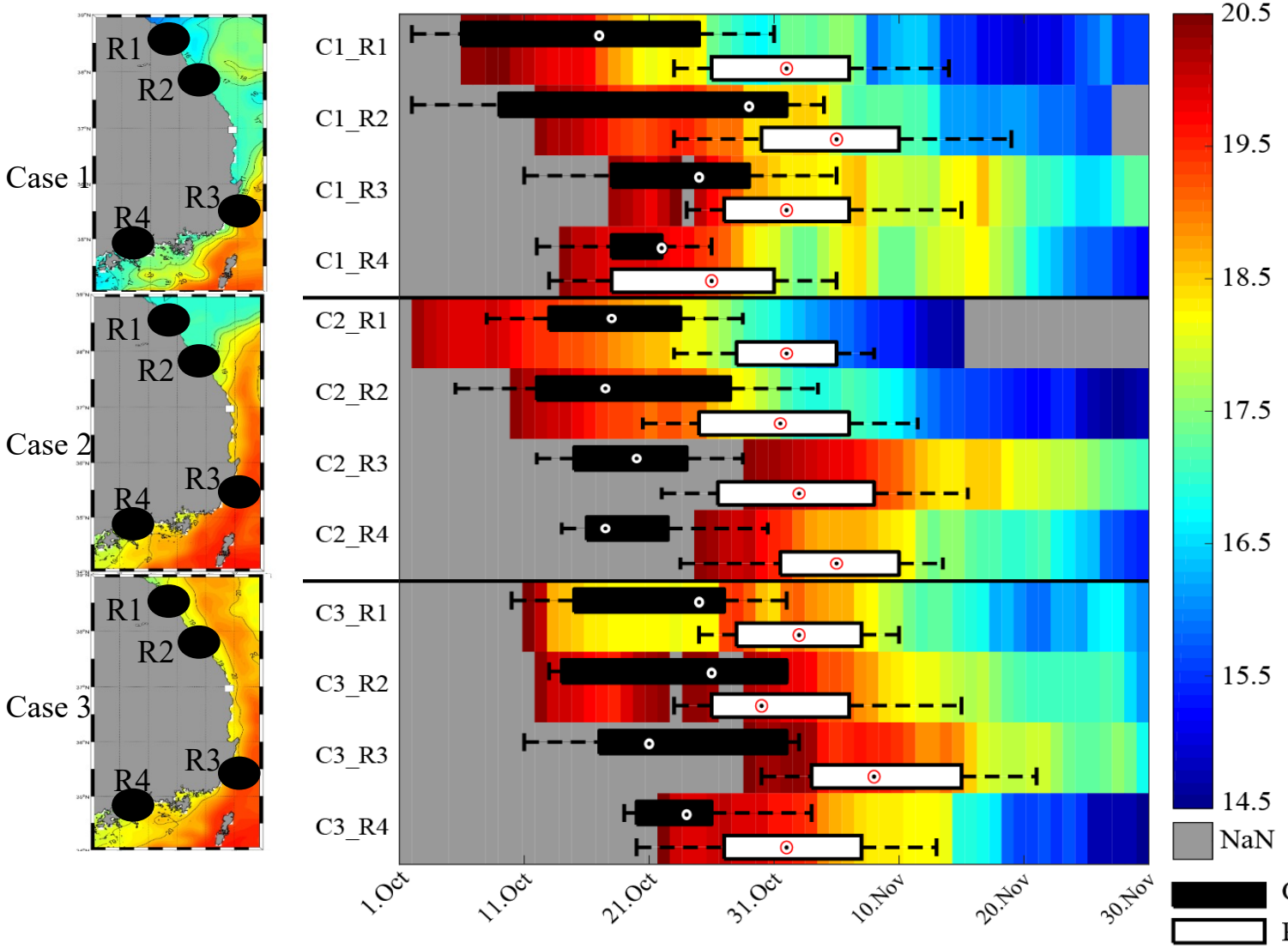




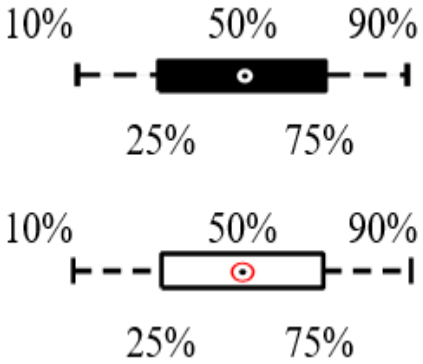
- Water temperature recorded in the female fluctuated greater than those in the male
- Different migratory patterns between male and female salmon. Females migrated upstream at a slower speed than males because they make more vertical movements during migration to find optimal spawning ground.

Result and Discussion

4. Salmon distribution by coastal area and timing of migration to rivers according to coastal environment

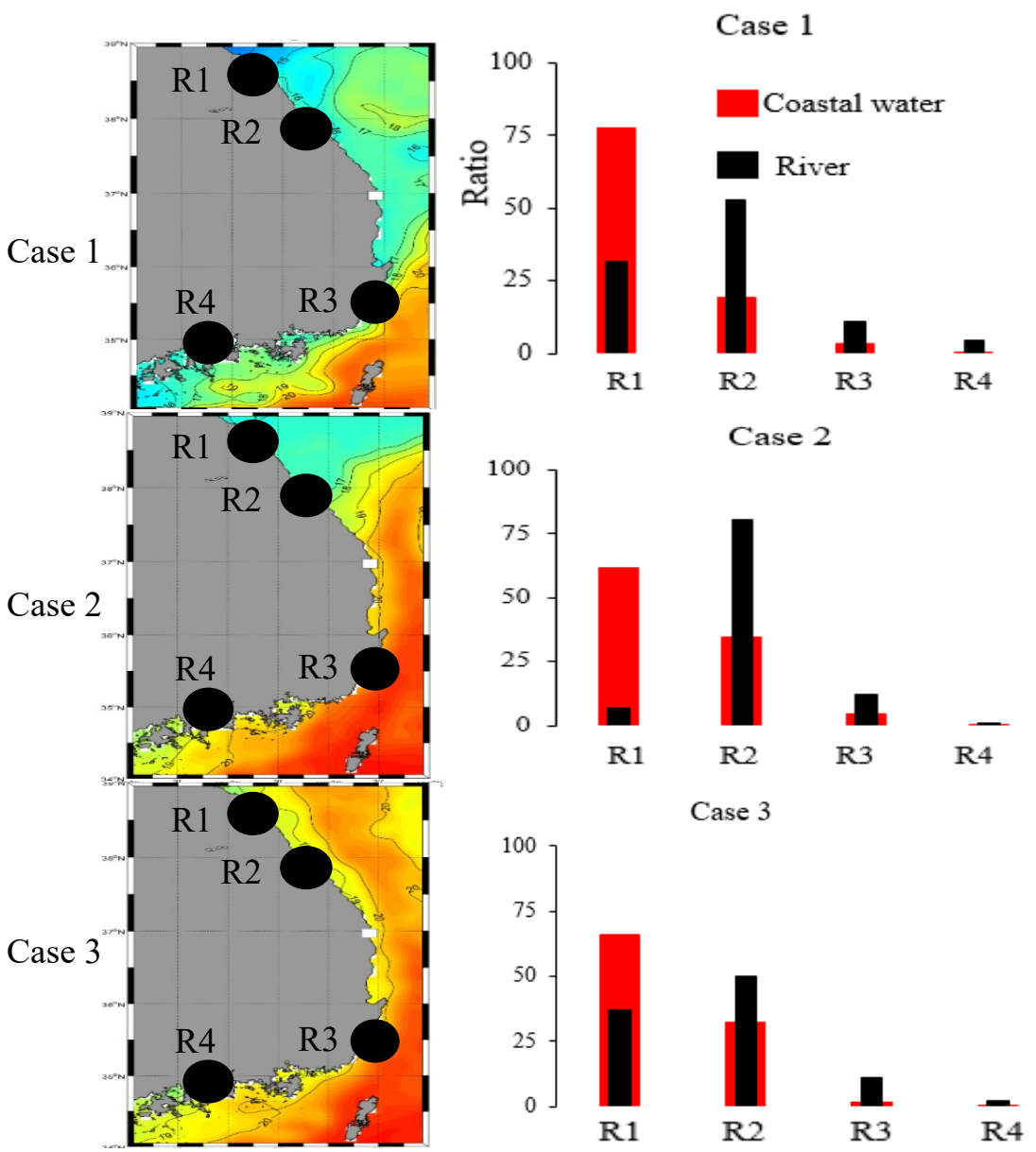


- Salmon is distributed sequentially from the northern part to the southern part along the eastern coast of Korea
- The time of movement to the river adjacent to the coast does not proceed sequentially from north to south, but appears differently depending on the coastal environment.



Result and Discussion

5. Catch ratio in coast and river with each environmental type.



1. In coastal waters

In all three types, catch ratio was high in R1.

However, in cases 2 and 3, the ratio in R2 relatively increased.

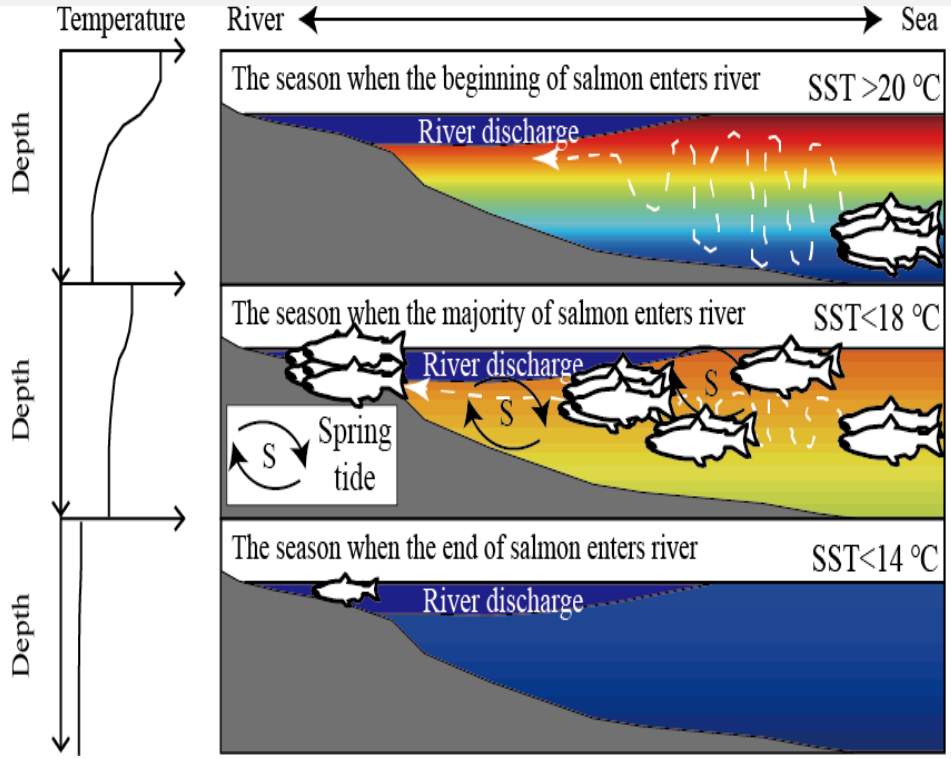
2. In streams

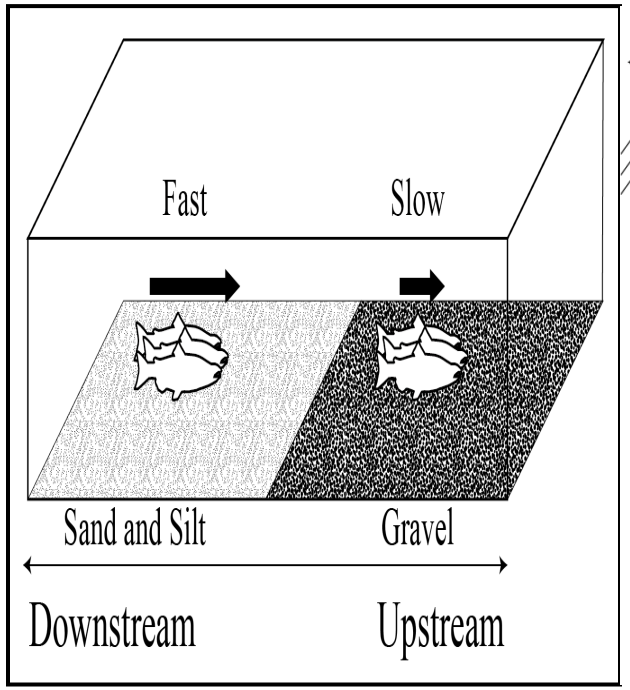
In all three types, catch ratio was high in R2.

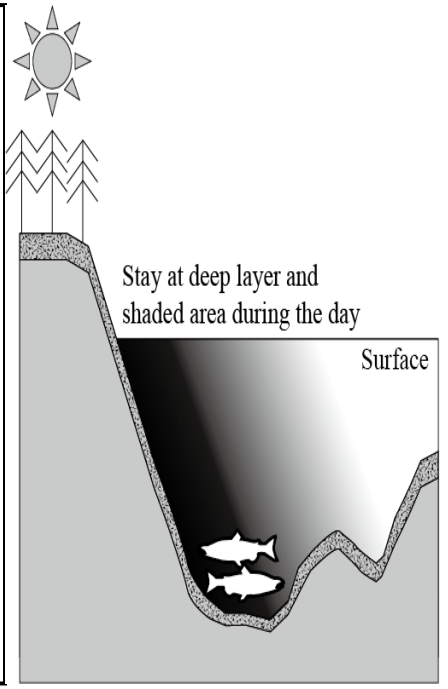
However, in cases 1 and 3, the ratio in R1 relatively increased.

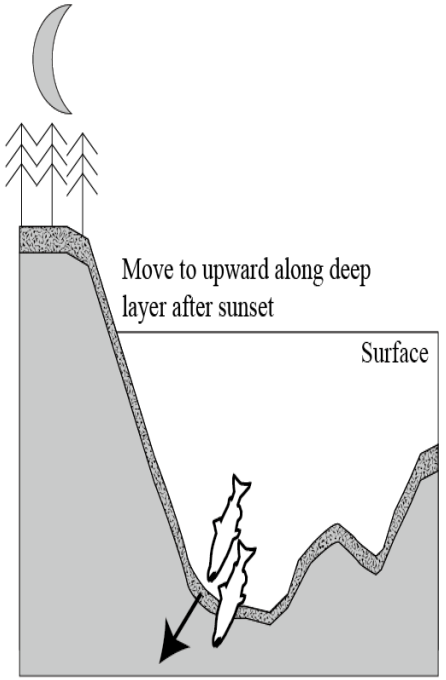
Conclusion

1. Salmon strategically use tidal period, riverbed, photoperiod for utilizing energy efficiently and increase survival rates









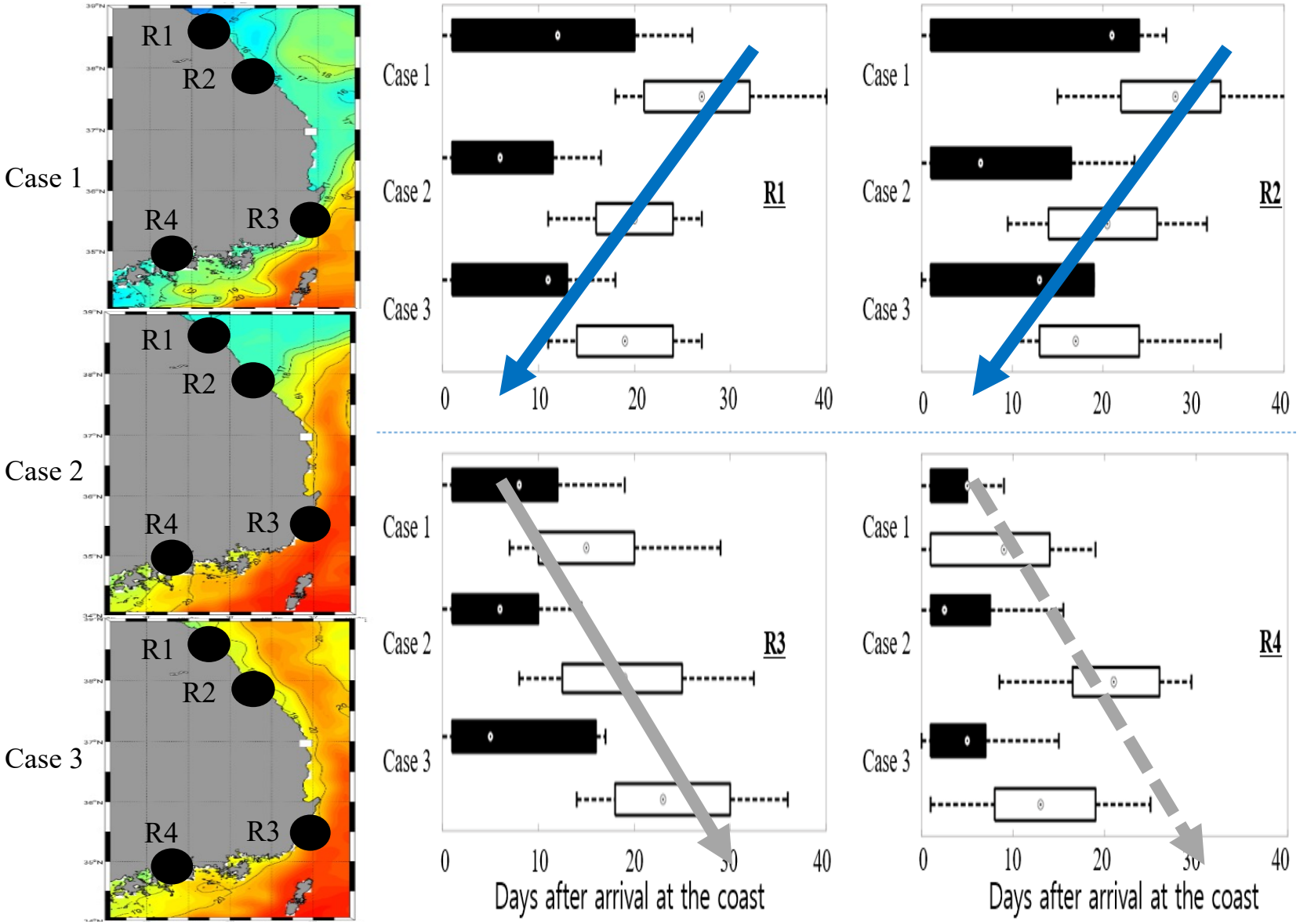
Salmon tend to stop feeding during spawning migration. When salmon migrate from coast to river, they rely primarily on energy accumulated in the ocean for sustenance. Therefore, it is essential for the salmon to utilize their accumulated energy efficiently to sustain their migration from the coast to riverine spawning grounds

1. Water temperature and tidal elevation are important physical factors to determine the vertical distribution of salmon in coastal waters and the timing entering rivers.

2. Riverbed structure, water depth, and photoperiod affect the speed and timing of upstream migration

Summary

2. Changes in the coastal environment affect the spatial-temporal distribution and return rate of salmon



In the northern coast (R1, R2)

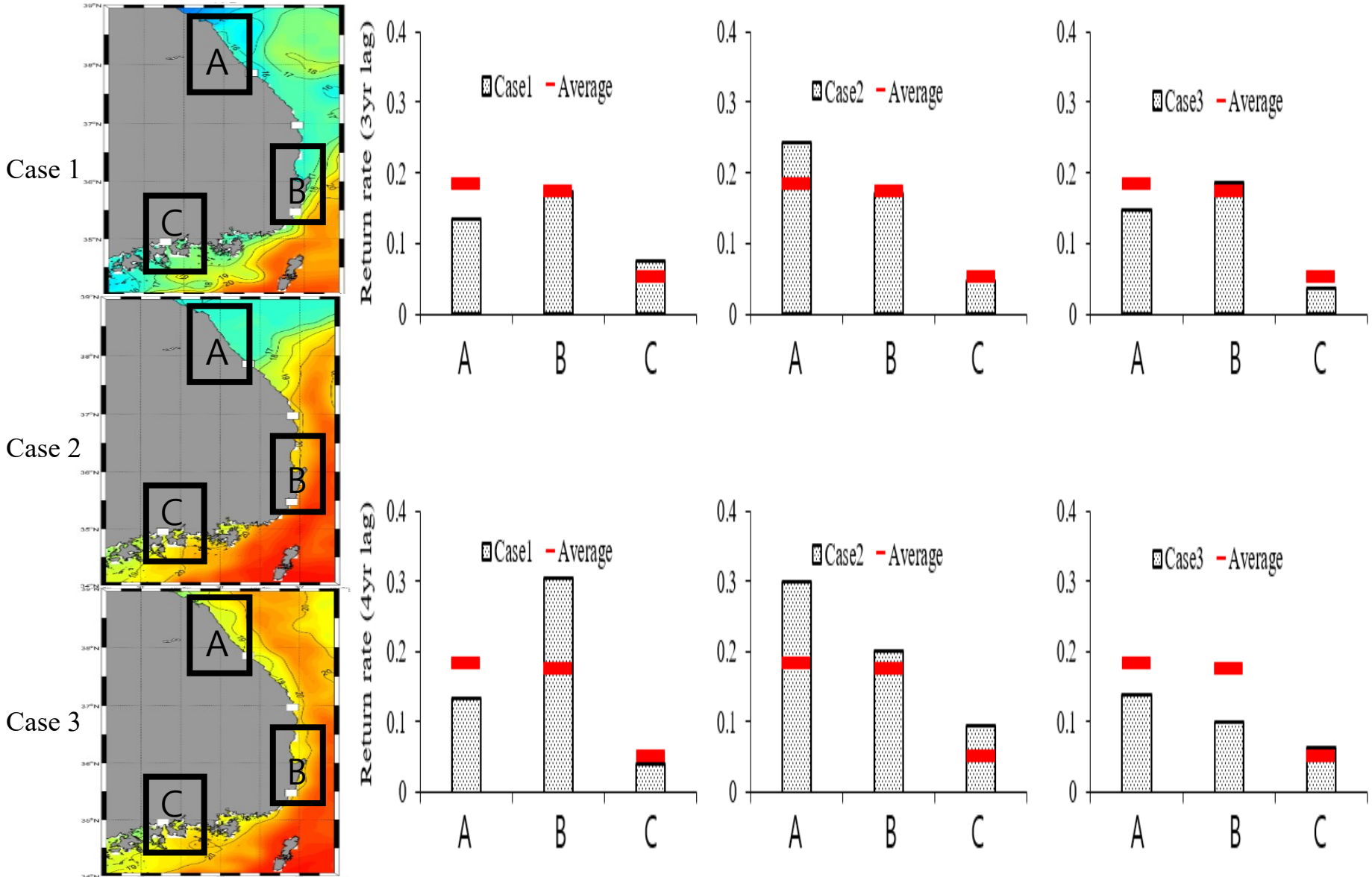
The colder(warmer) the coastal waters, the longer(shorter) the salmon distribute in the coast, and the later(earlier) salmon migrate to rivers.

In the southern coast (R3, R4(?))

The warmer(colder) the coastal waters, the longer(shorter) the salmon distribute in the coast, and the later(earlier) salmon migrate to rivers.

Summary

2. Changes in the coastal environment affect the spatial-temporal distribution and return rate of salmon



1. When the coastal environment of the eastern coast is bordered by a cold environment and a warm environment (case 2), the return rate is relatively high in the rivers of the northern coast.

2. To understand salmon return, it is necessary to understand the overall life cycle and changes in stream, coastal and open sea environment. On the other hand, changes in the coastal environment are important factors in controlling the timing of moving to rivers and return rate.

Thank you for listening