Experiences in climate change fisheries adaptation policies

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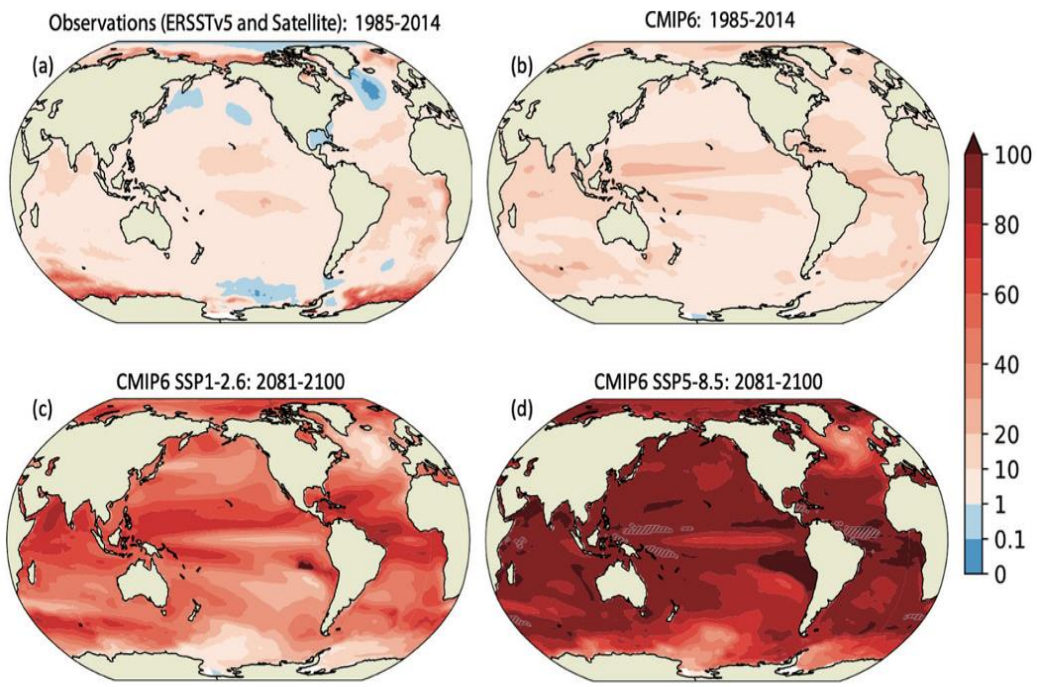
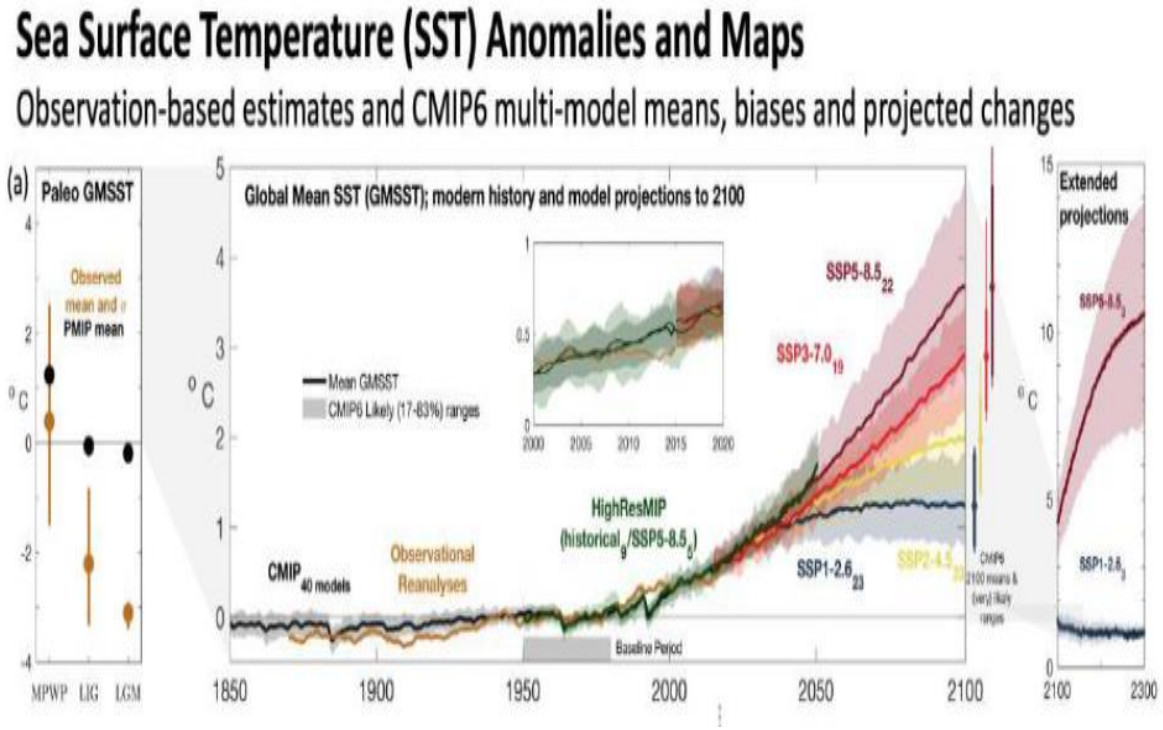
1. Introduction

1 Global warming

- Human activities have caused global warming of about 1.0℃ compared to pre-industrial times, and according to trends, 1.5℃ is expected to rise by 2040 at the latest (IPCC, 2021)
- Sea temperature rose 0.91℃ between 1901 and 2020, and sea level rose 0.2m between 1901 and 2018



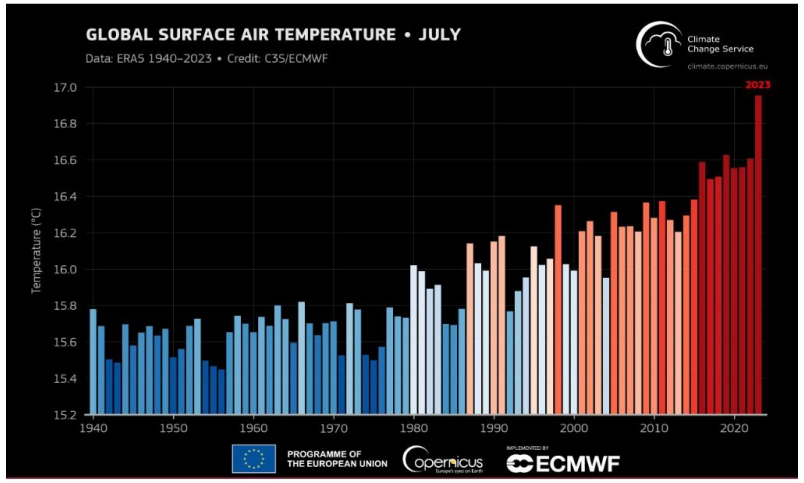


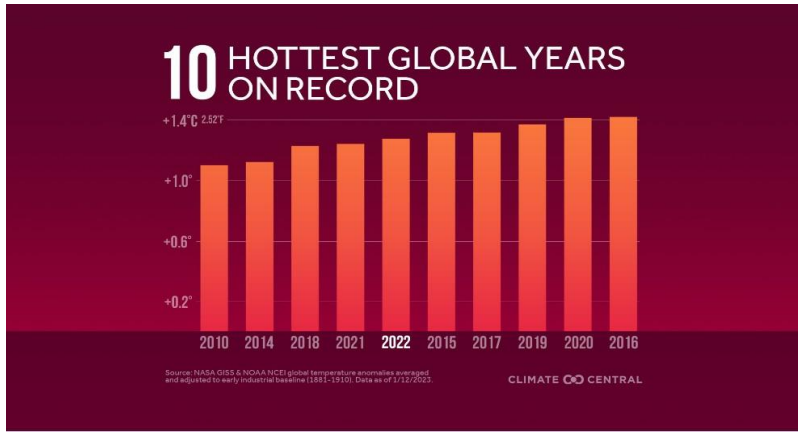
Source: IPCC

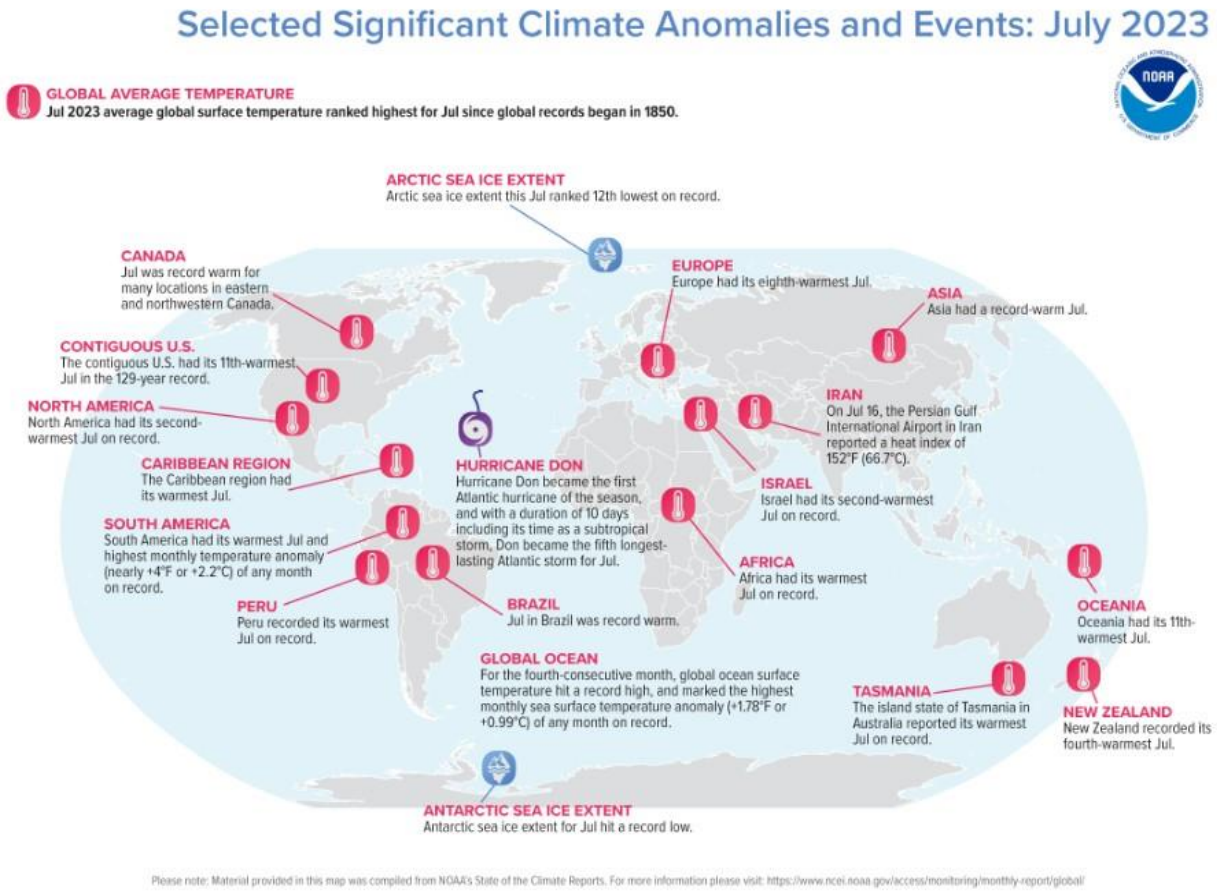
1. Introduction

1 Global warming

- 2023 is the hottest year ever observed??







Source: NIFS

1. Introduction

2 Current Status and Prospects of Climate Change in Korea

Temperature	The average annual temperature in the last 30 years (1991~2020) has increased by 1.6℃ compared to the past (1912~1940) and 0.2℃ every 10 years
Seasonal change	Due to the change in seasonal length, summer length increased by 20 days, winter length decreased by 22 days, and spring and summer start dates decreased by 17 and 11 days, respectively
Heavy rain and typhoon	'20-year longest rainy season (54 days in the middle) and '22-year super strong typhoon 'Hinnamno' broke precipitation record (212.3mm in Gyeongju, 342.4mm in Pohang)
Heatwave	The average annual temperature in 2016 (13.6℃), and the extreme heat wave and tropical night occurrence in the summer of 2018 (the average temperature in summer is the highest ever, and the average number of heat waves nationwide is 31.No. 1 in history with 4 days)
Prospect	By the second half of the future*, the average annual temperature on the Korean Peninsula is expected to rise 2.6~7℃ from the present depending on the degree of greenhouse gas emissions

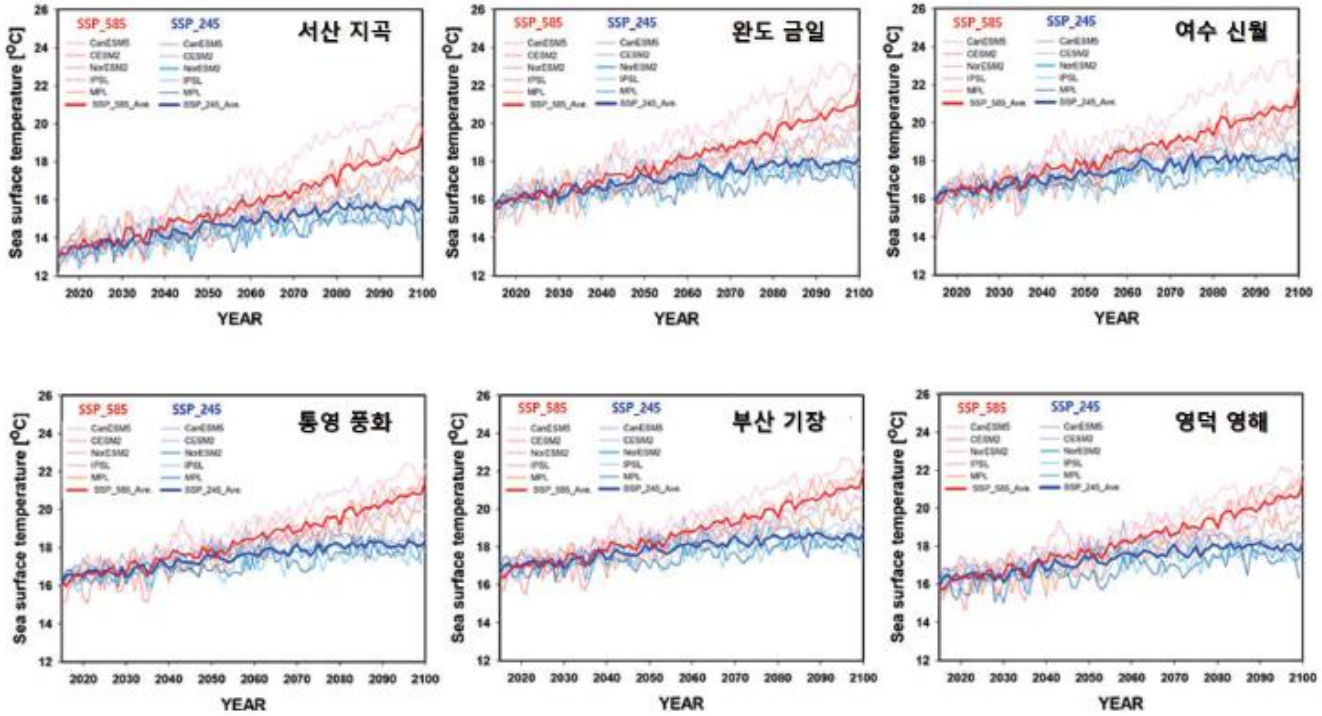
* First half of the future (2021-2040), second half of the future (2041-2060), and second half of the future (2081-2100)

1. Introduction

2 Current Status and Prospects of Climate Change in Korea

- The NIFS predicts the future water temperature of Korea by applying a detailed technique based on the prediction data of RCP and SSP scenarios.
- In the SSP2-4.5 scenario, the water temperature of about 2℃ is expected to rise by 2100, and in the SSP5-8.5 scenario, the water temperature of around 4~5℃ is expected to rise by 2100

〈 Water temperature predictions by scenario 〉

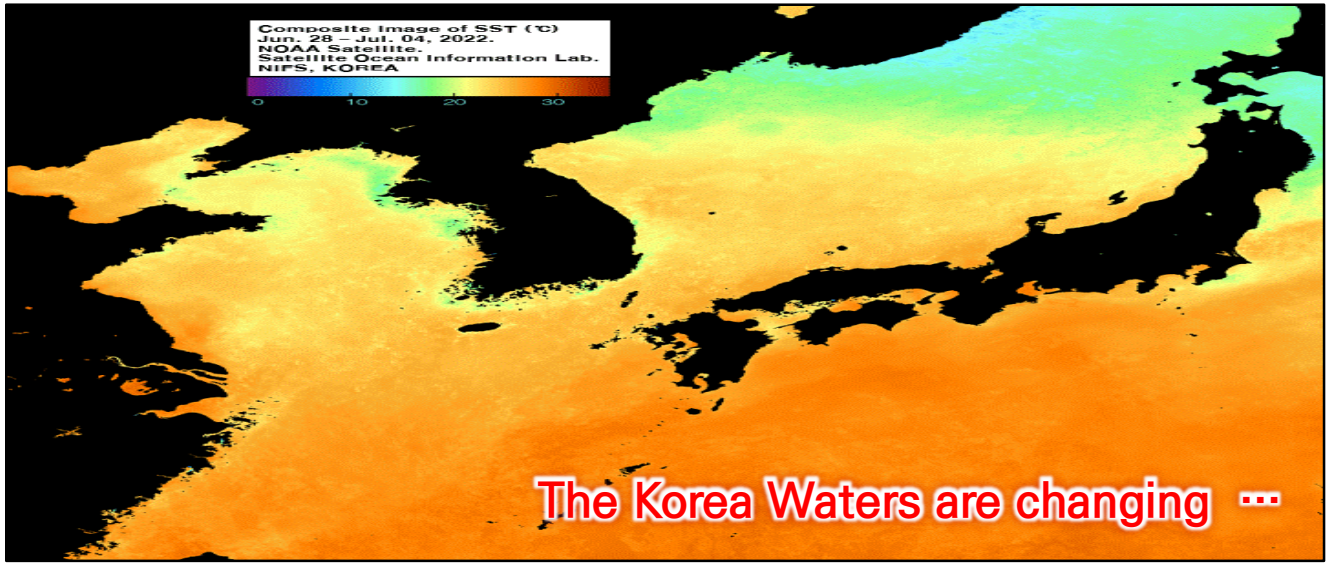


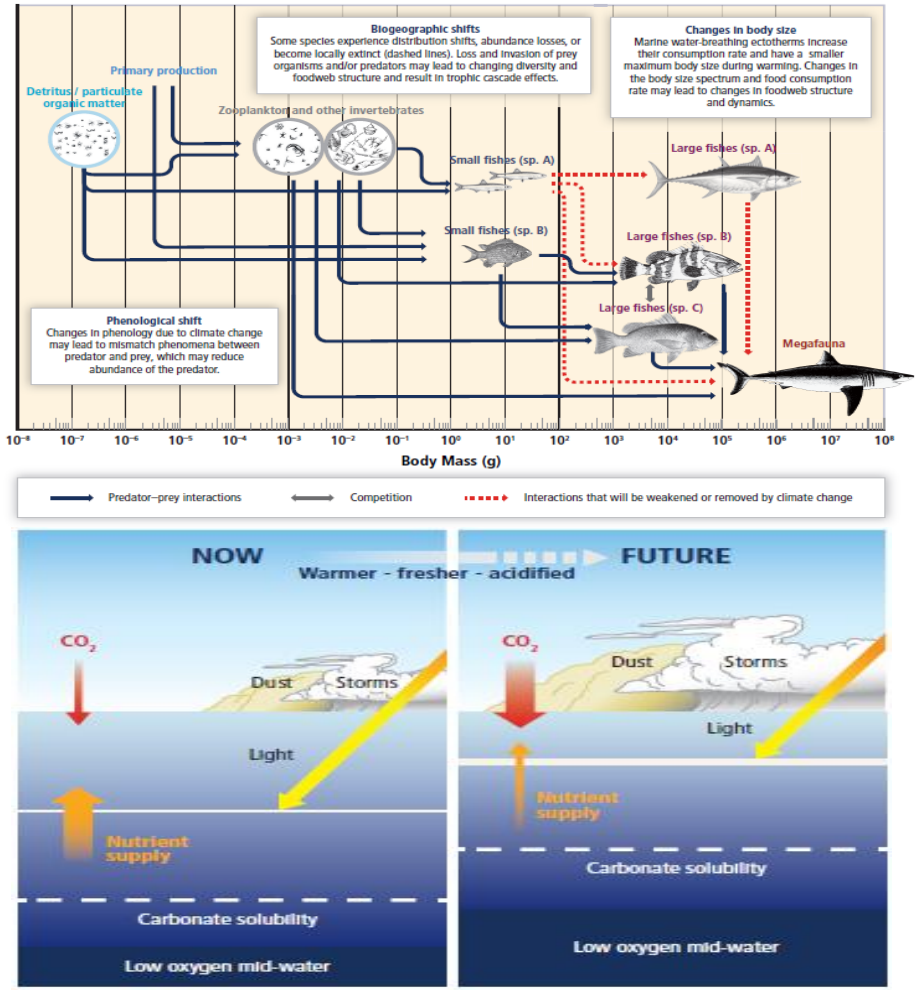
Source: NIFS

2. The Impact of Climate Change on Fisheries

1 Changes in the marine environment

- Our oceans and ecosystems change rapidly





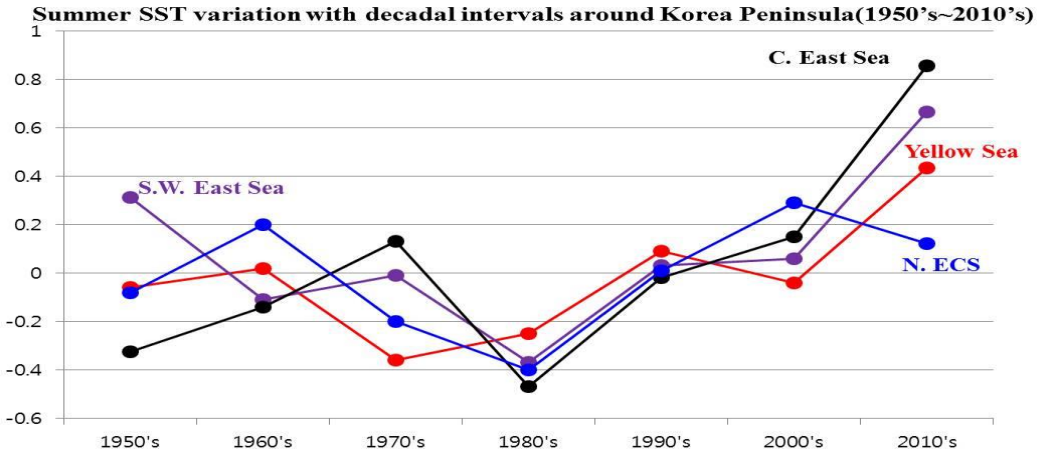
(Warming) Surface water temperature rises, stratification strengthening, Seasonal Pattern Changes in Water Temperature

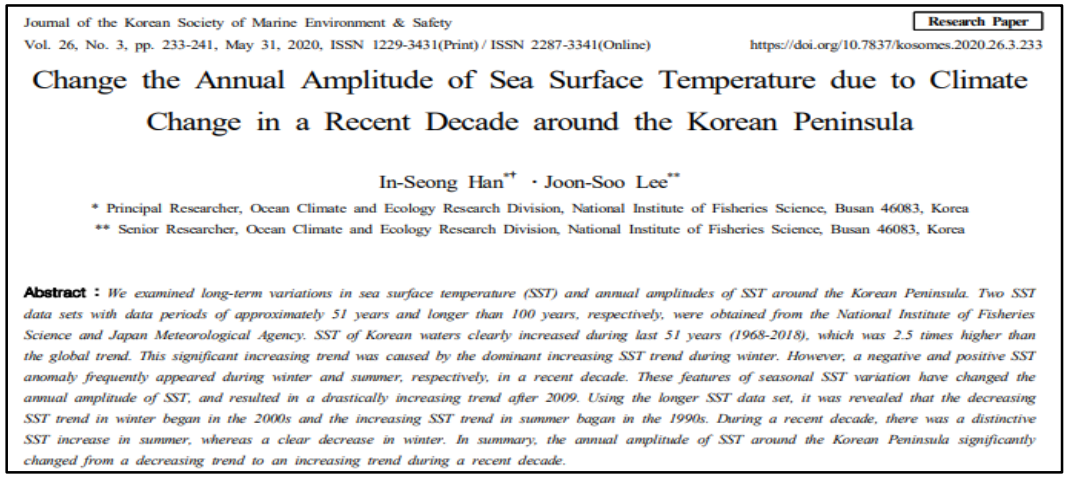
(biological and chemical) reducing the concentration of surface nutrients, a decline in basic productivity, Small Plant Plank Tone Superiority

2. The Impact of Climate Change on Fisheries

1 Changes in the marine environment

- Frequent abnormal water temperature phenomena





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Change the Annual Amplitude of Sea Surface Temperature due to Climate Change in a Recent Decade around the Korean Peninsula

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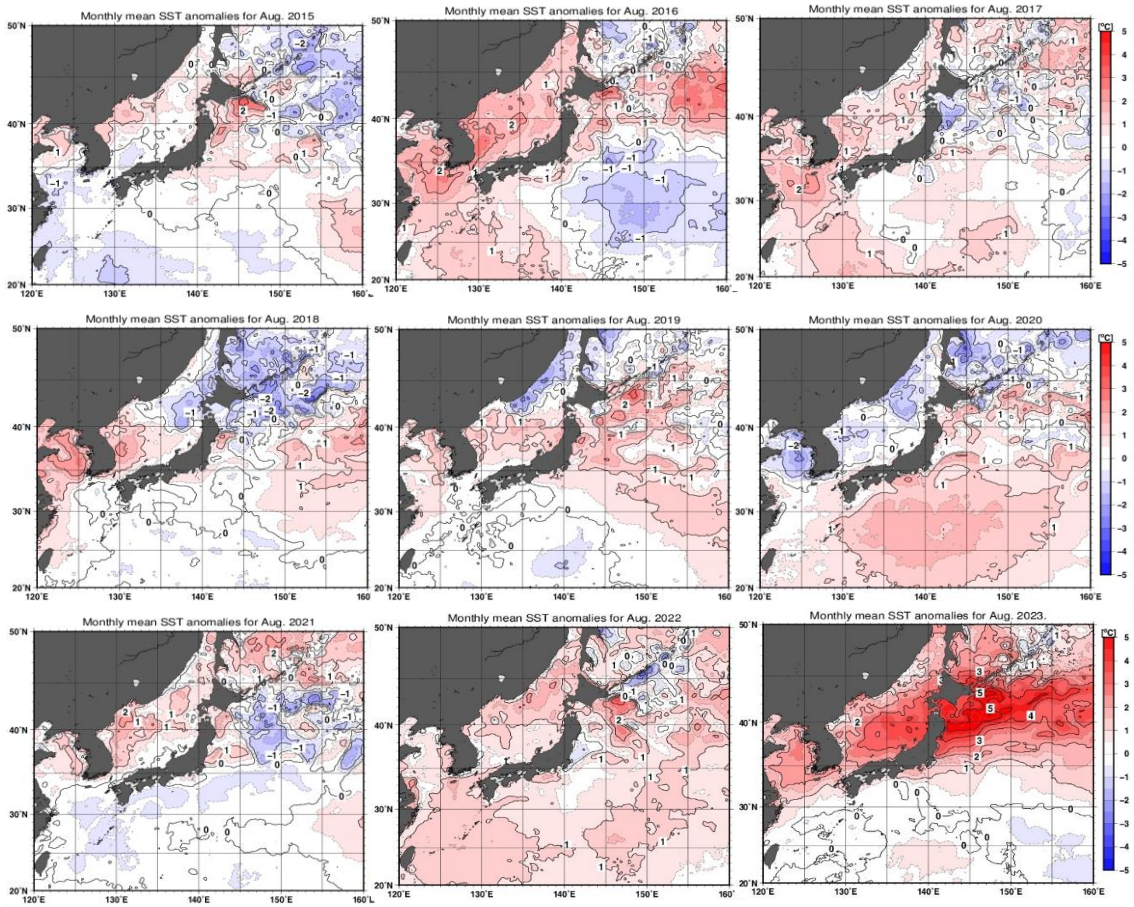
Abstract : *We examined long-term variations in sea surface temperature (SST) and annual amplitudes of SST around the Korean Peninsula. Two SST data sets with data periods of approximately 51 years and longer than 100 years, respectively, were obtained from the National Institute of Fisheries Science and Japan Meteorological Agency. SST of Korean waters clearly increased during last 51 years (1968-2018), which was 2.5 times higher than the global trend. This significant increasing trend was caused by the dominant increasing SST trend during winter. However, a negative and positive SST anomaly frequently appeared during winter and summer, respectively, in a recent decade. These features of seasonal SST variation have changed the annual amplitude of SST, and resulted in a drastically increasing trend after 2009. Using the longer SST data set, it was revealed that the decreasing SST trend in winter began in the 2000s and the increasing SST trend in summer bagan in the 1990s. During a recent decade, there was a distinctive SST increase in summer, whereas a clear decrease in winter. In summary, the annual amplitude of SST around the Korean Peninsula significantly changed from a decreasing trend to an increasing trend during a recent decade.*

〈 Monthly mean SST in August around the Korea Peninsula during recent 9years(2015~2023) 〉

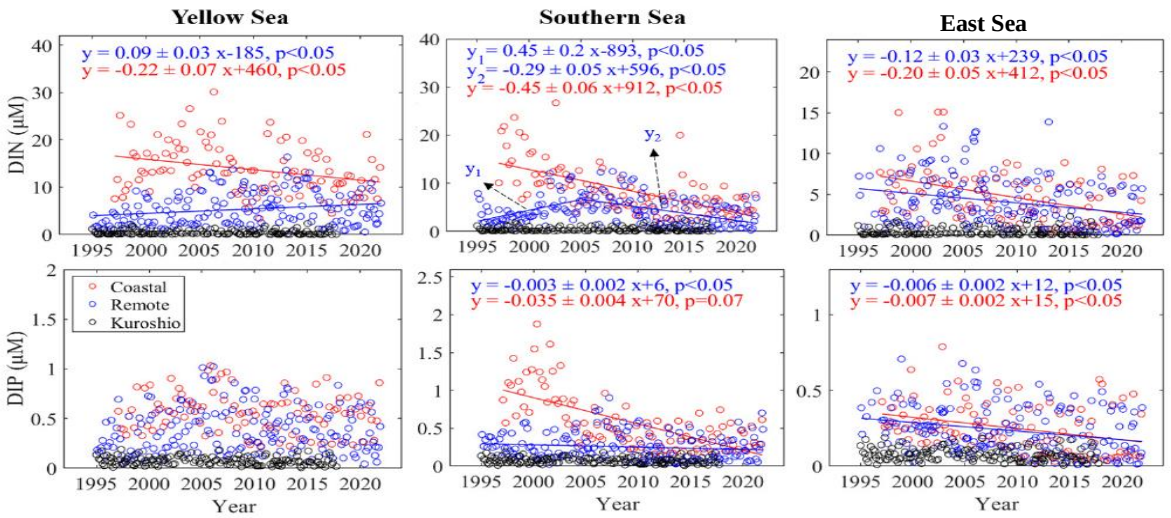


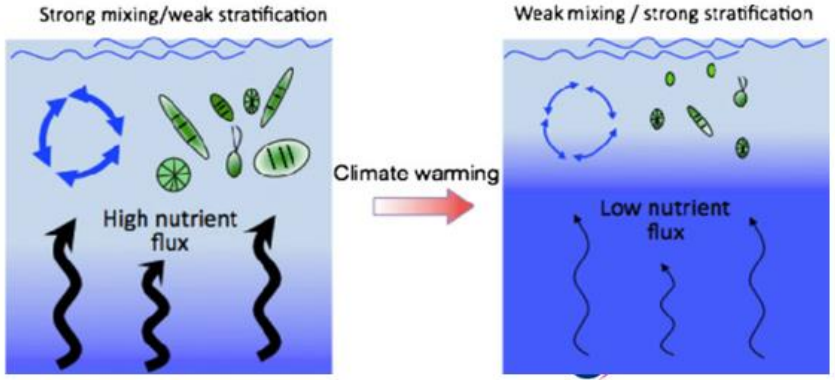
Source: NIFS

2. The Impact of Climate Change on Fisheries

1 Changes in the marine environment

- Reduced nutritional / basic productivity





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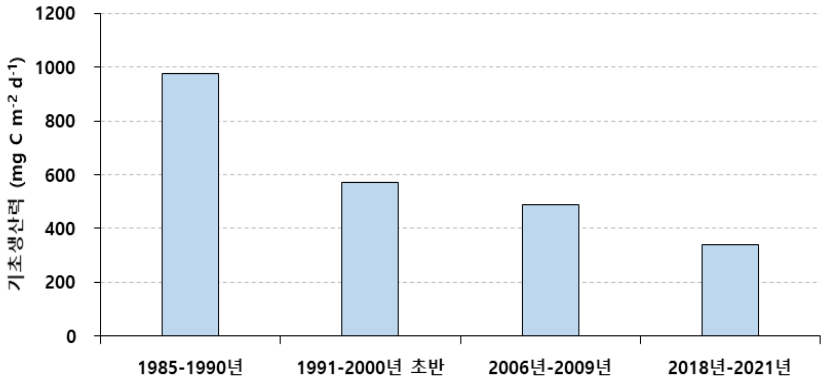


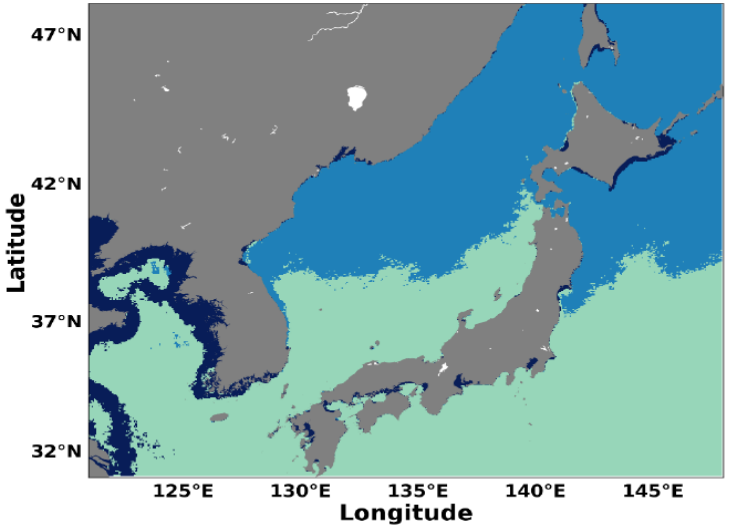
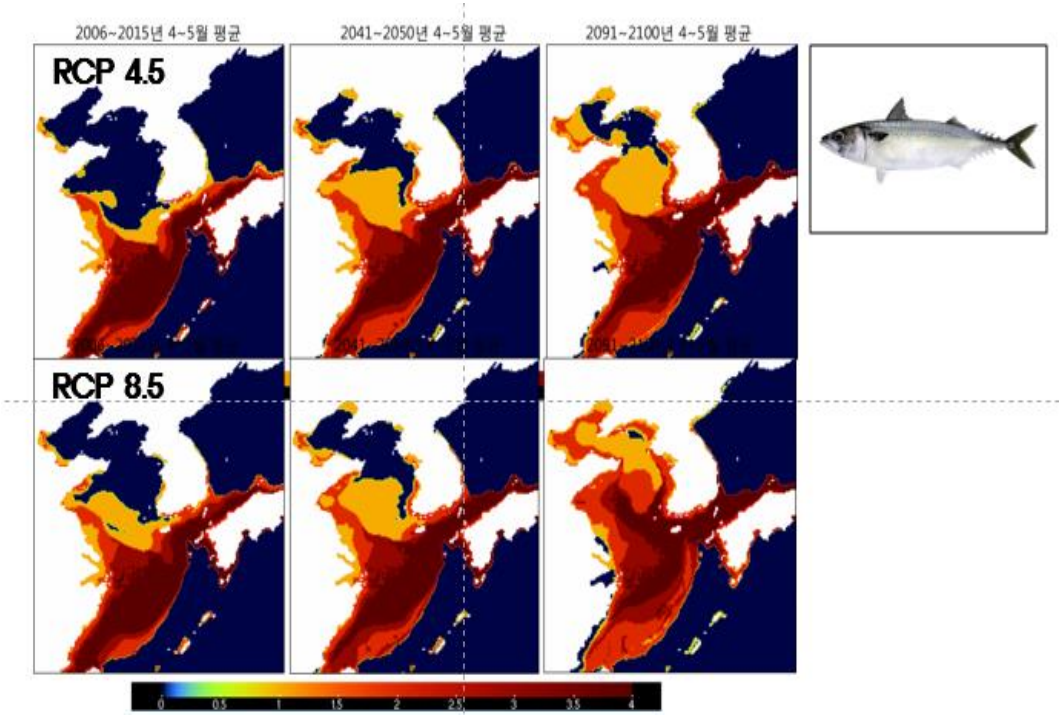


Figure 6. Dominant area of each class. Indigo, blue, and green colors indicate micro-size phytoplankton, nano-size phytoplankton, and pico-size phytoplankton, respectively.

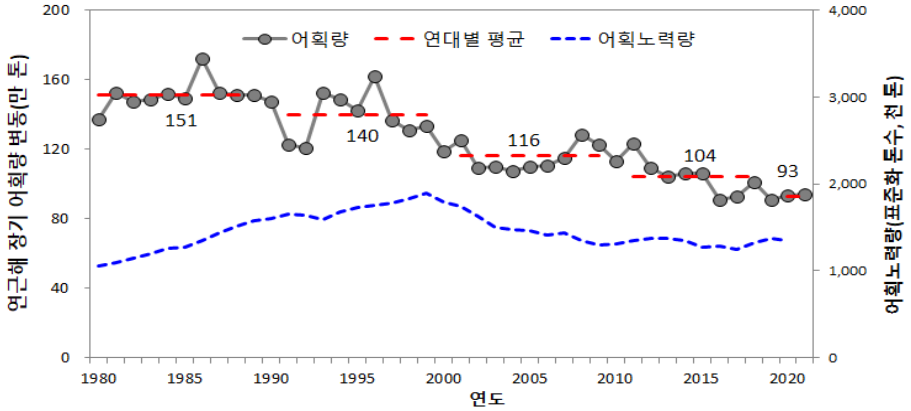
2. The Impact of Climate Change on Fisheries

② Decreased offshore catch and changes in the distribution of fisheries resources

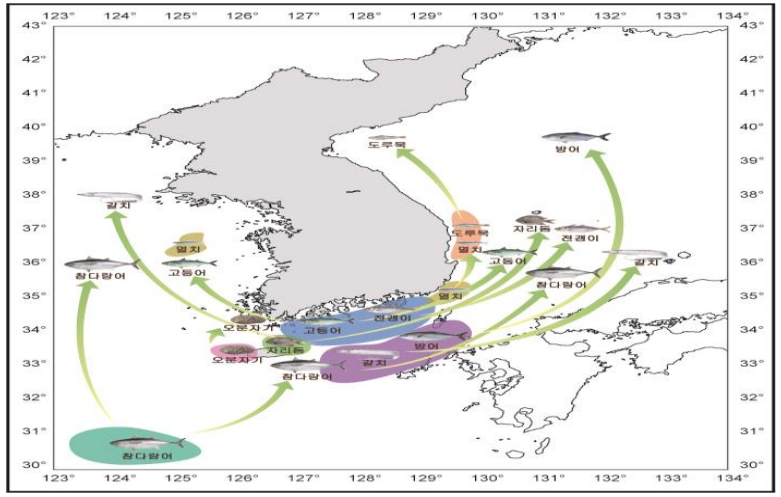
〈 Prediction of changes in spawning fields of major fish species according to IPCC RCP scenario 〉



〈Changes in the catch of coastal waters in Korea〉



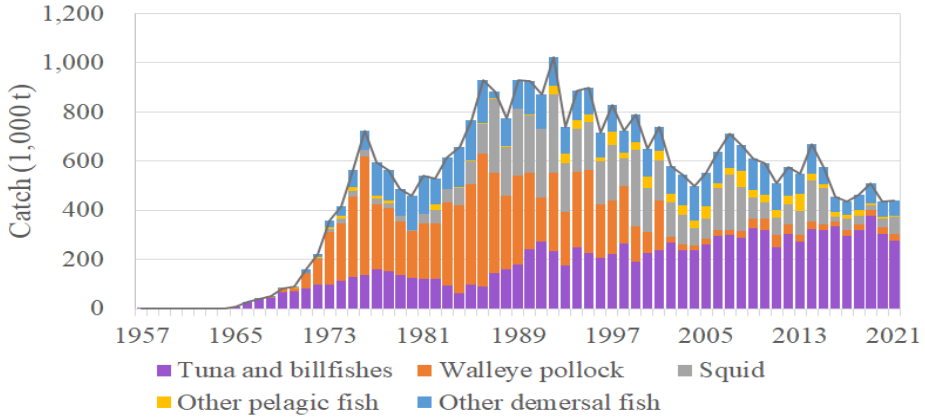
〈 Changes in the distribution of major fish species in Korea 〉



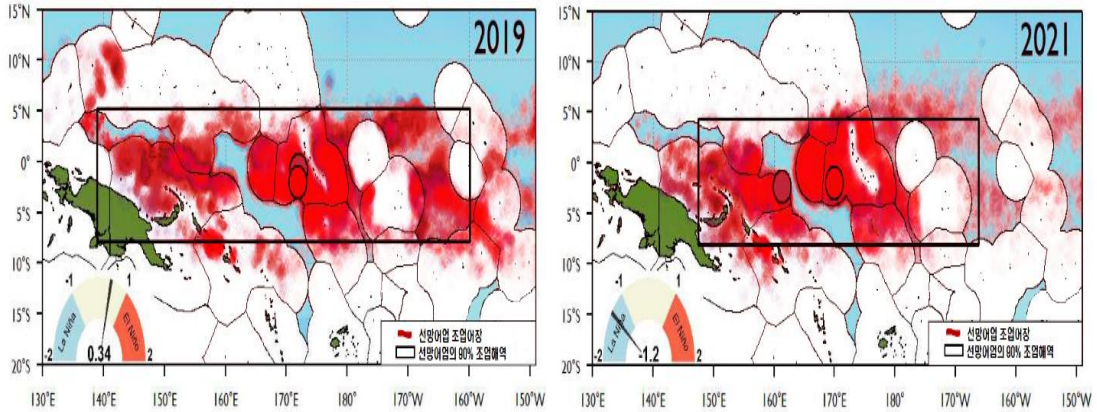
2. The Impact of Climate Change on Fisheries

3 Impact of Distant water fisheries

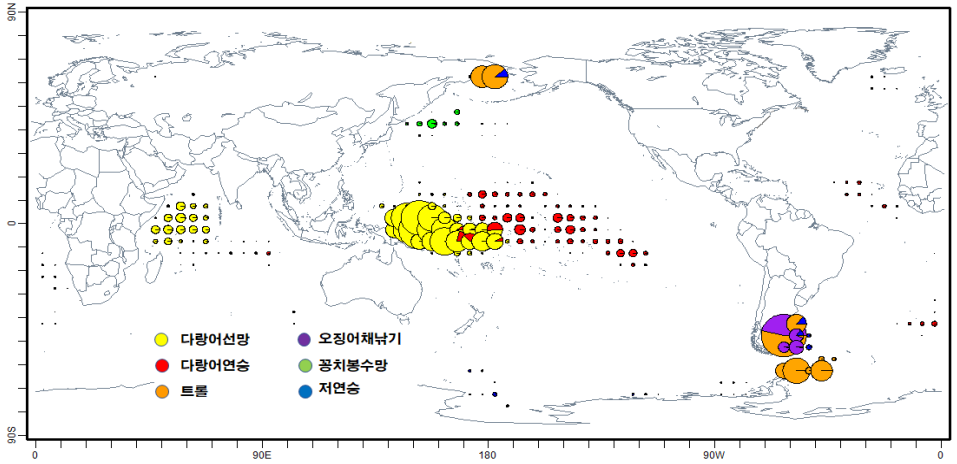
〈 Change of production by fish species in Distant water fisheries 〉



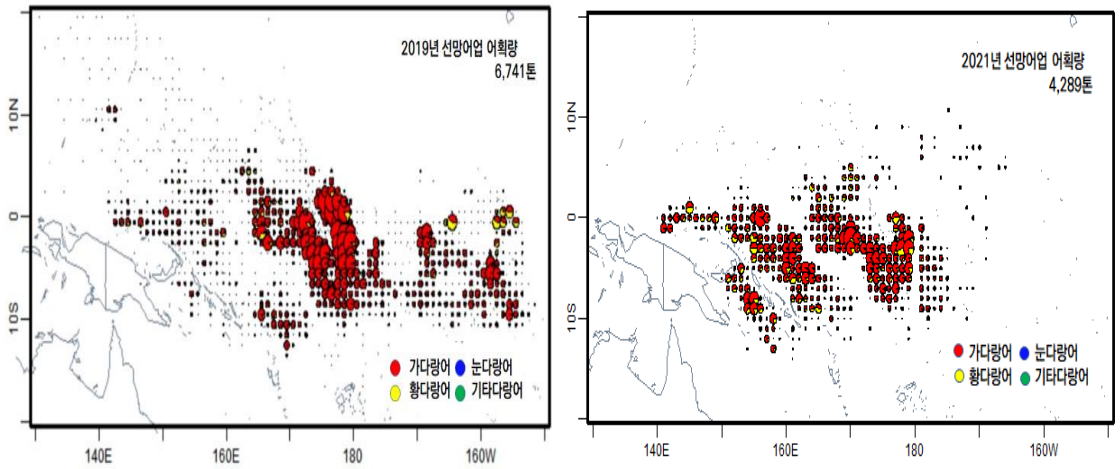
〈 Change in the fishing ground of large purse seine in WCPFC 〉



〈 Distribution of Fishing Sites in Korea's Distant water fisheries 〉



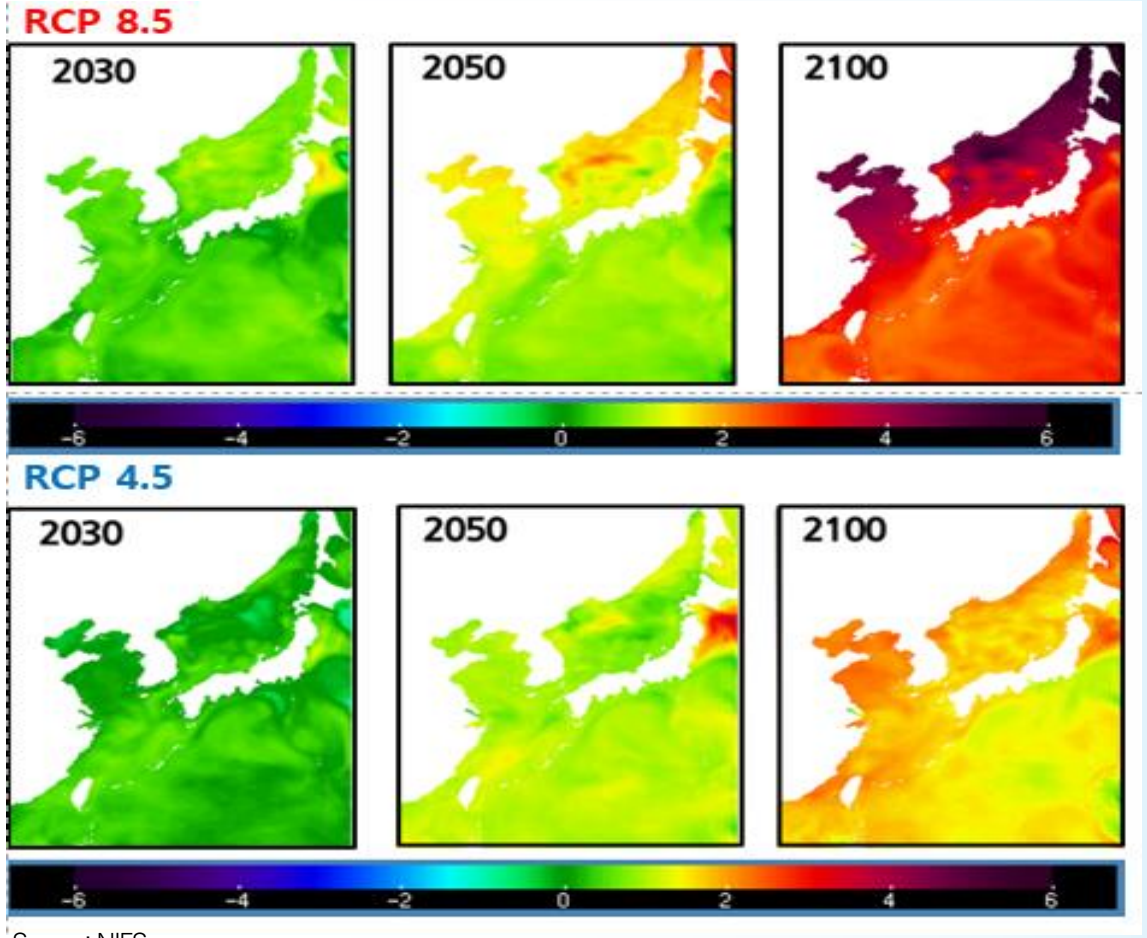
〈 Change in the catch species type of large purse seine in WCPFC 〉



2. The Impact of Climate Change on Fisheries

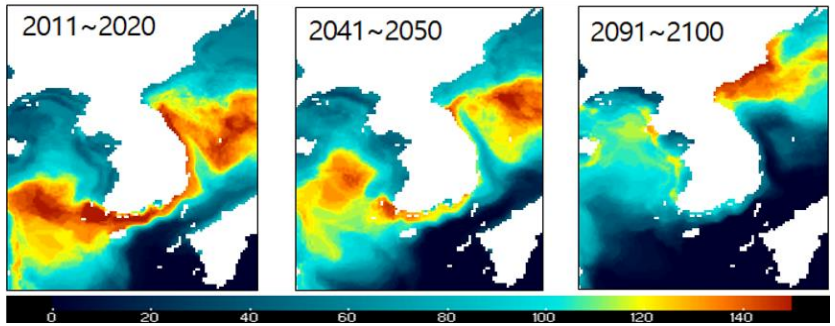
4 Impact of aquaculture industry

〈 Providing information on marine climate models based on IPCC scenarios 〉



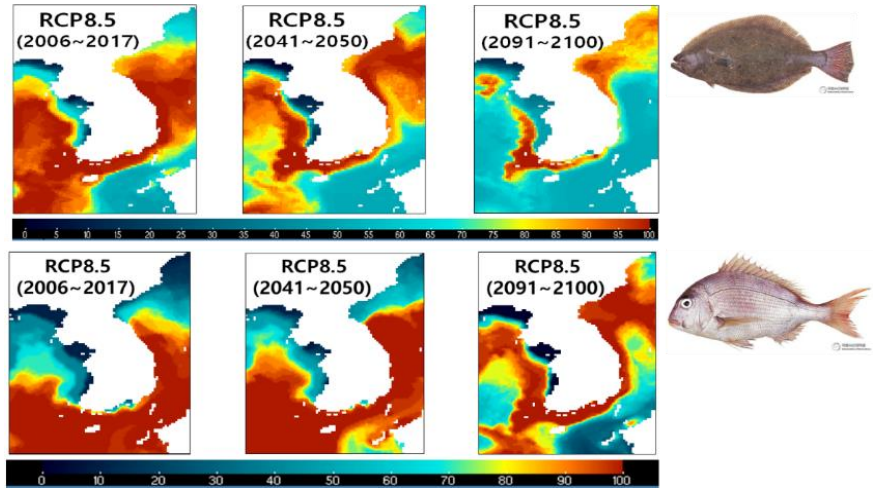
Source: NIFS

〈 Prediction of changes in the timing of laver production 〉



Source: NIFS

〈 Prediction of Future Site of Aquaculture Species according to Water Temperature Change 〉



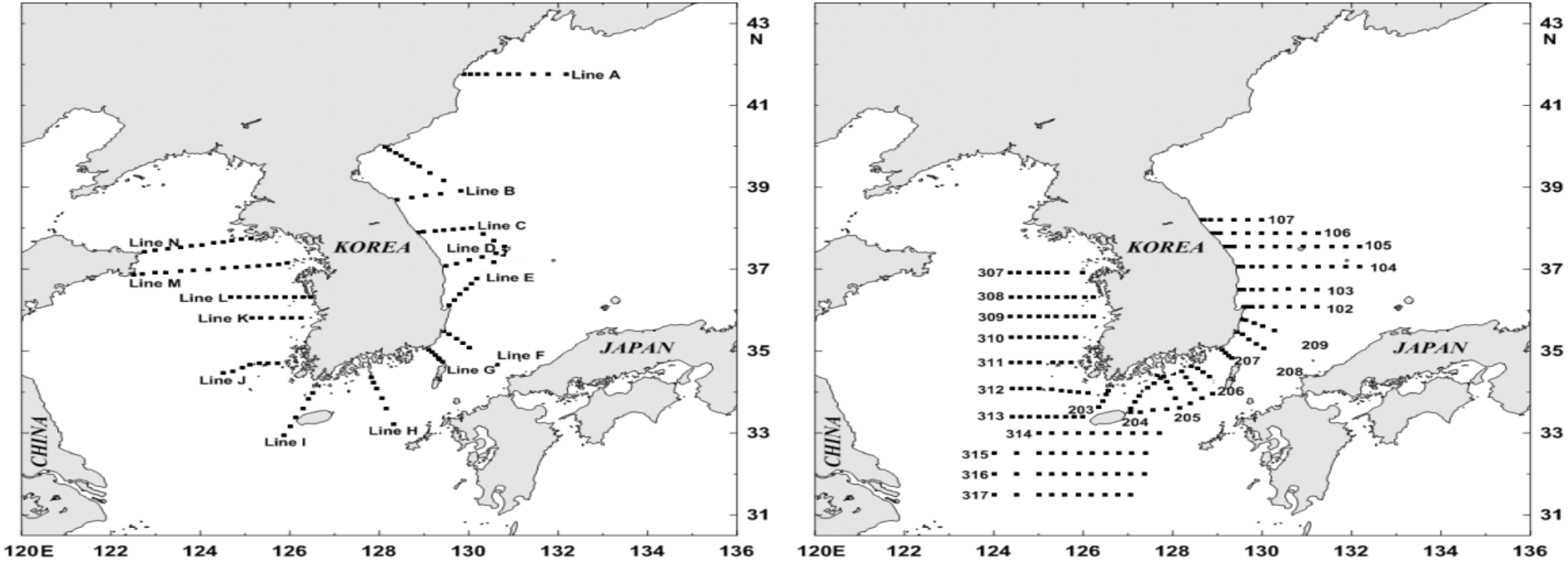
Source: NIFS

3. Experiences in climate change fisheries adaption policies

1 Forecasting and providing information based on climate change data

a. Identifying the impact of climate change in the waters surrounding the Korean Peninsula based on a long-term monitoring system

〈 Location of the serial oceanographic observation station before 1960 (left) and after 1961 (right) 〉



Source: NIFS

3. Experiences in climate change fisheries adaption policies

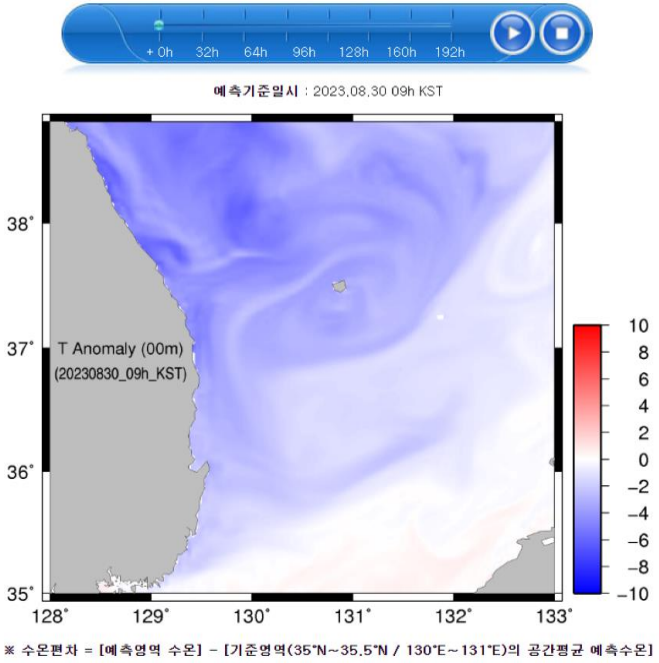
1 Forecasting and providing information based on climate change data

b. Response to fishery disaster due to extreme weather

〈 A map of stations for the NIFS real-time information system for the aquaculture environment (180 stations, as of May 2023) 〉

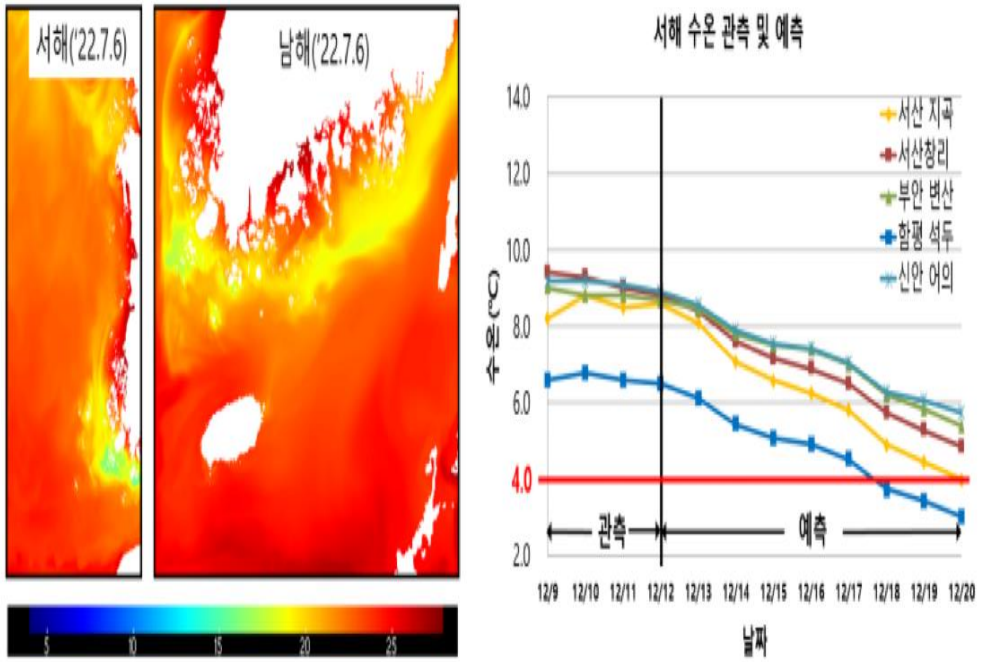
Source: NIFS

〈 NIFS forecast system for the coastal cold water in the East Sea 〉



Source: NIFS

〈 Prediction of heatwave occurrence represented by the temperature distribution (left) and prediction of low water temperature occurrence by station (right) 〉



Source: NIFS

3. Experiences in climate change fisheries adaption policies

1 Forecasting and providing information based on climate change data

c. Activation of special warnings for water temperature anomalies and implementation of comprehensive measures

〈 Special warning criteria for the high and low water temperature 〉

Levels	High water temperature	Low water temperature
Watch	- 7 days before or after the water temperature is expected to reach 28℃	- 7 days before or after the water temperature is expected to reach 4℃
Advisory	- Sea areas where water temperature is predicted to reach 28℃ - Sea areas where water temperature rises by more than 3℃ compared to the previous day - Sea areas with rapid temperature fluctuations of more than 2℃ compared to the average year	- Sea areas where water temperature is predicted to reach 4℃ - Sea areas where water temperature drops by more than 3℃ compared to the previous day - Sea areas with rapid temperature fluctuations of more than 2℃ compared to the average year
Warning	- Sea areas where water temperature above 28℃ lasts for more than 3 days, or is expected to continue - Sea areas where water temperature rises by more than 5℃ compared to the previous day - Sea areas with rapid temperature fluctuations of more than 3℃ compared to the average year	- Sea areas where water temperature above 4℃ lasts for more than 3 days, or is expected to continue - Sea areas where water temperature drops by more than 5℃ compared to the previous day - Sea areas with rapid temperature fluctuations of more than 4℃ compared to the average year

Source: NIFS

〈 An example of a high temperature warning issued 〉

Source: NIFS

3. Experiences in climate change fisheries adaption policies

1 Forecasting and providing information based on climate change data

d. Assessment of the fishing industry's vulnerability to climate change

- **Definition of Vulnerability**

Climate change vulnerability (V) is a function of climate exposure (E), sensitivity (S), and adaptive capacity (AC), according to the IPCC's third assessment report. It can be defined as the difference between potential impact of climate change, which is the sum of exposure and sensitivity (E+S), and the adaptive capacity.

$$V = f(E, S, AC) = (E+S) - AC$$

〈 Result of climate change vulnerability assessment of the Korean fishing industry 〉

Level of vulnerability	Coastal fisheries	Aquaculture
High	Coastal stow net, coastal gill net, offshore stow net, offshore eel trap etc.	Laver, sea mustard, clam
Medium	Coastal trap, offshore gill net, coastal composite, large pair trawl, large otter trawl, offshore longline, large Danish seine etc.	Rockfish, oyster, mussel, sea squirt
Low	Anchovy boat seine, offshore jigging, offshore trap, large purse seine	Olive flounder, striped beakfish, flathead grey mullet, red snapper, shrimp, abalone

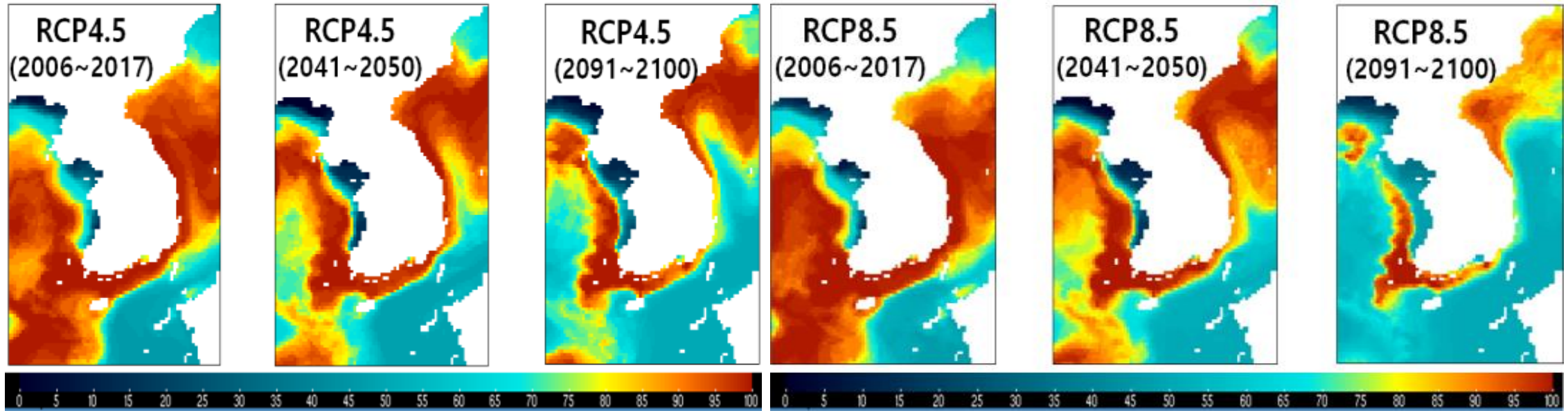
Source: NIFS

3. Experiences in climate change fisheries adaption policies

② Adaptation to Climate Change

a. Predicting impacts on the aquaculture fisheries industry using future ocean forecast data

〈 Distribution average of olive flounder farming suitability by the period under the RCP 4.5 (left) and 8.5 (right) scenarios 〉

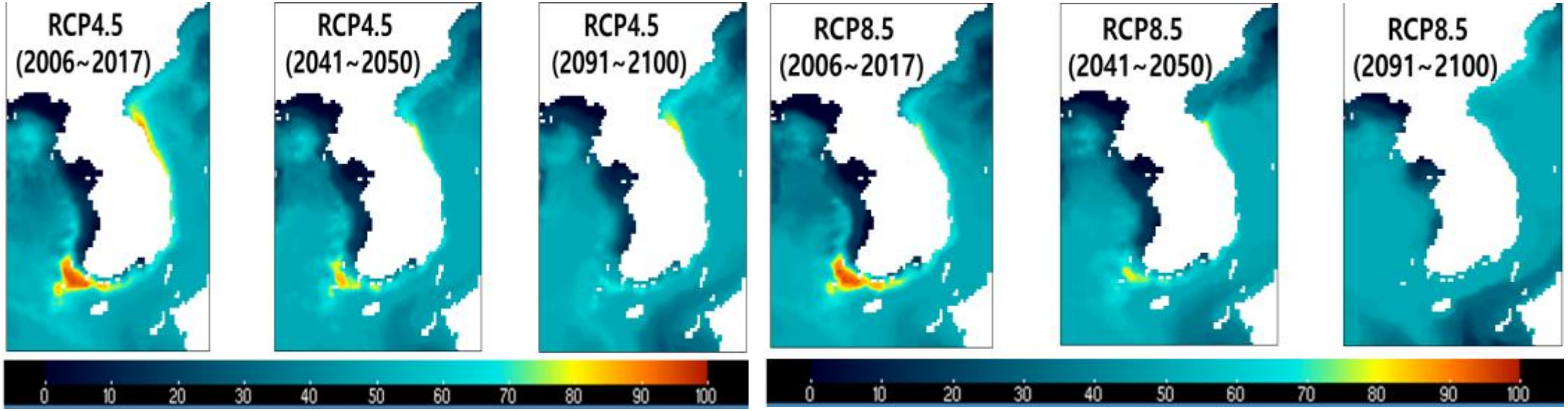


3. Experiences in climate change fisheries adaption policies

② Adaptation to Climate Change

a. Predicting impacts on the aquaculture fisheries industry using future ocean forecast data

〈 Distribution average of abalone farming suitability by the period under the RCP 4.5 (left) and 8.5 (right) scenarios 〉



3. Experiences in climate change fisheries adaption policies

2 Adaptation to Climate Change

b. Development of new aquaculture species and technologies to respond to climate change

〈 Distribution average of abalone farming suitability by the period under the RCP 4.5 (left) and 8.5 (right) scenarios 〉

Source: NIFS

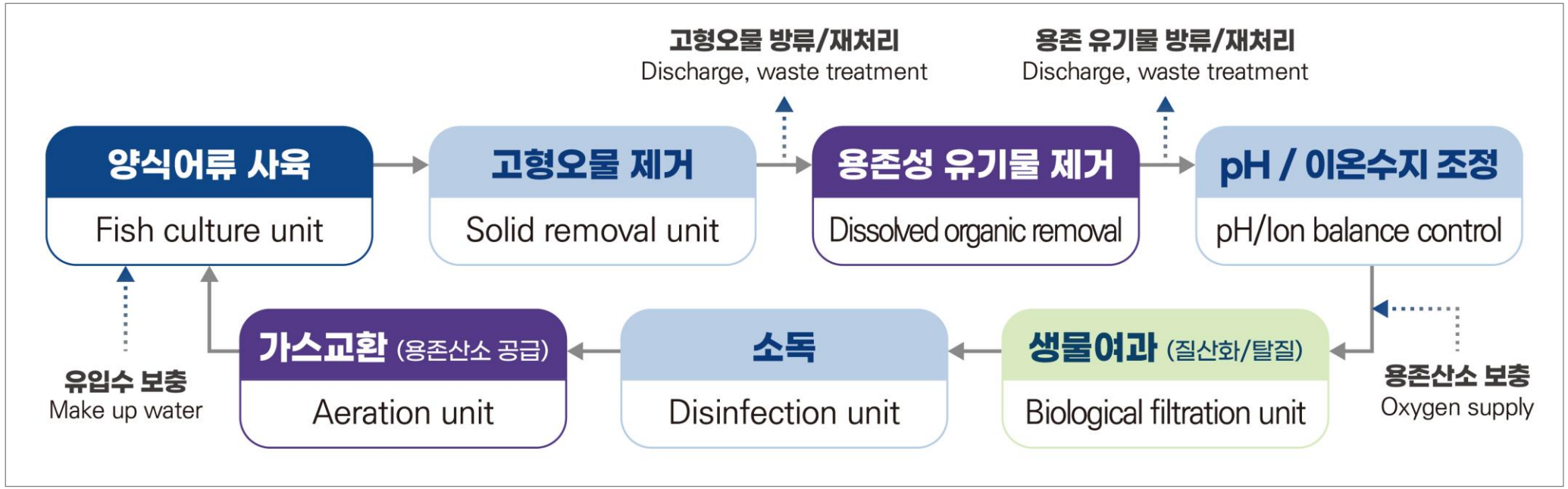
Source: NIFS

3. Experiences in climate change fisheries adaption policies

2 Adaptation to Climate Change

b. Development of new aquaculture species and technologies to respond to climate change

〈 Structural diagram of a recirculating aquaculture system 〉



4. Future tasks (Response to worldwide fisheries and role of OECD)

Fishing

Mitigation	Development and dissemination of electric propulsion or hybrid engine technology to reduce greenhouse gas emissions
Adaptation	Development and Application of Stock assessment model Considering Conduction Paths and Fish Distribution according to Climate Change (Water Temperature Change – Feeding Biological Change)

- Implementation of reducing greenhouse gas emissions through the entire process by increasing the size of fishing boats, increasing the size, and innovating the distribution structure

4. Future tasks (Response to worldwide fisheries and role of OECD)

Aquaculture industry

Mitigation	Need to develop aquaculture technology to reduce greenhouse gas emissions
Adaptation	Development of high-temperature adaptive seeds, development and distribution of RAS systems capable of environmental control, and development of high-temperature varieties

- Reducing greenhouse gas emissions through the whole process by scaling up the aquaculture industry, expanding the size, and innovating the distribution structure
  (Enhancement of environmental monitoring to prevent marine environmental pollutants in scale fish farms)

4. Future tasks (Response to worldwide fisheries and role of OECD)

OECD

- Securing nationwide statistical data through the establishment of water temperature data and catch monitoring system for each credible sea area such as NOAA and Global Fishing Watch (matching with existing fisheries statistics data)

Check the trend of changes in the output (amount) of fisheries by country according to climate change (water temperature change)

→ A comprehensive perspective on the impact of climate change on fisheries through joint research between countries