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PUKYONG NATIONAL UNIVERSITY

Better understanding of socioeconomic impacts of climate change in ocean and fisheries

- *Importance of integrated research and relation with the public* -

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Issues

- **Connecting Science and Communities in a changing North Pacific**

  - ✓ **Understanding the interactions among climate change, ecosystems, human activities (fisheries and coastal communities, etc.)**

  - ✓ **Effective communication among scientists, policy makers, fishers, the public**

  - ✓ **Based on scientific knowledges (*by scientists*), through effective management and responsive strategies on climate change (*by policy makers*), gaining benefits for the human and society (*industry and the public*)**

Issues

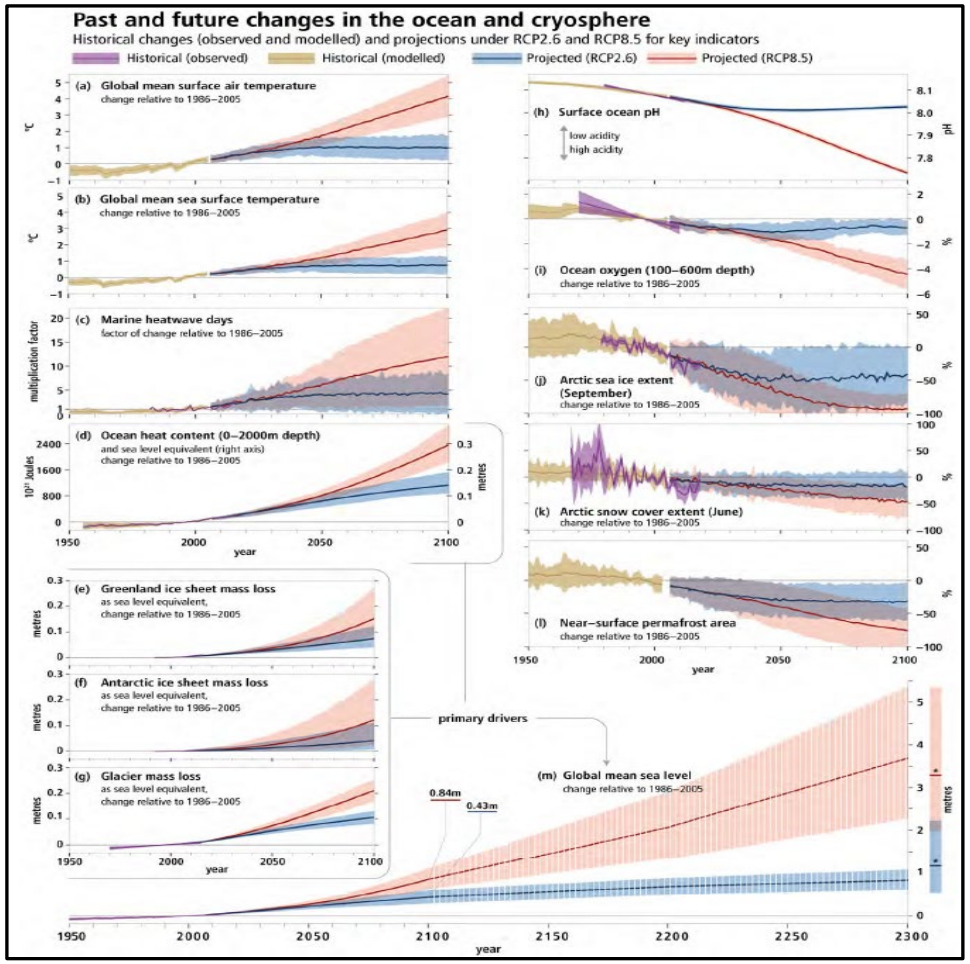
- **Many efforts have been already done so far,**
  - ✓ **Long-term observations of physical and biological properties collected around the North Pacific,**
  - ✓ **Researched patterns of climate variability at international and regional scales / at decadal to multi-decadal scales**
  - ✓ **SEES (Social-Ecological-Environmental Systems) framework was developed for understanding climate-ecosystem-human interactions by experts in PICES and it has been implemented within the PICES**
- ***However*, integrated researches on climate change issues are *still* limited**

Issues

- **Understanding *GAPS* on climate change between;**
  - ✓ **Scientists and Policy makers**
  - ✓ **Scientists and Industry (fisheries, aquaculture, marine-related, etc.)**
  - ✓ **Scientists and The public**
- **Different Interests and languages among scientists, policy makers, industry, and the public exist**

Issues

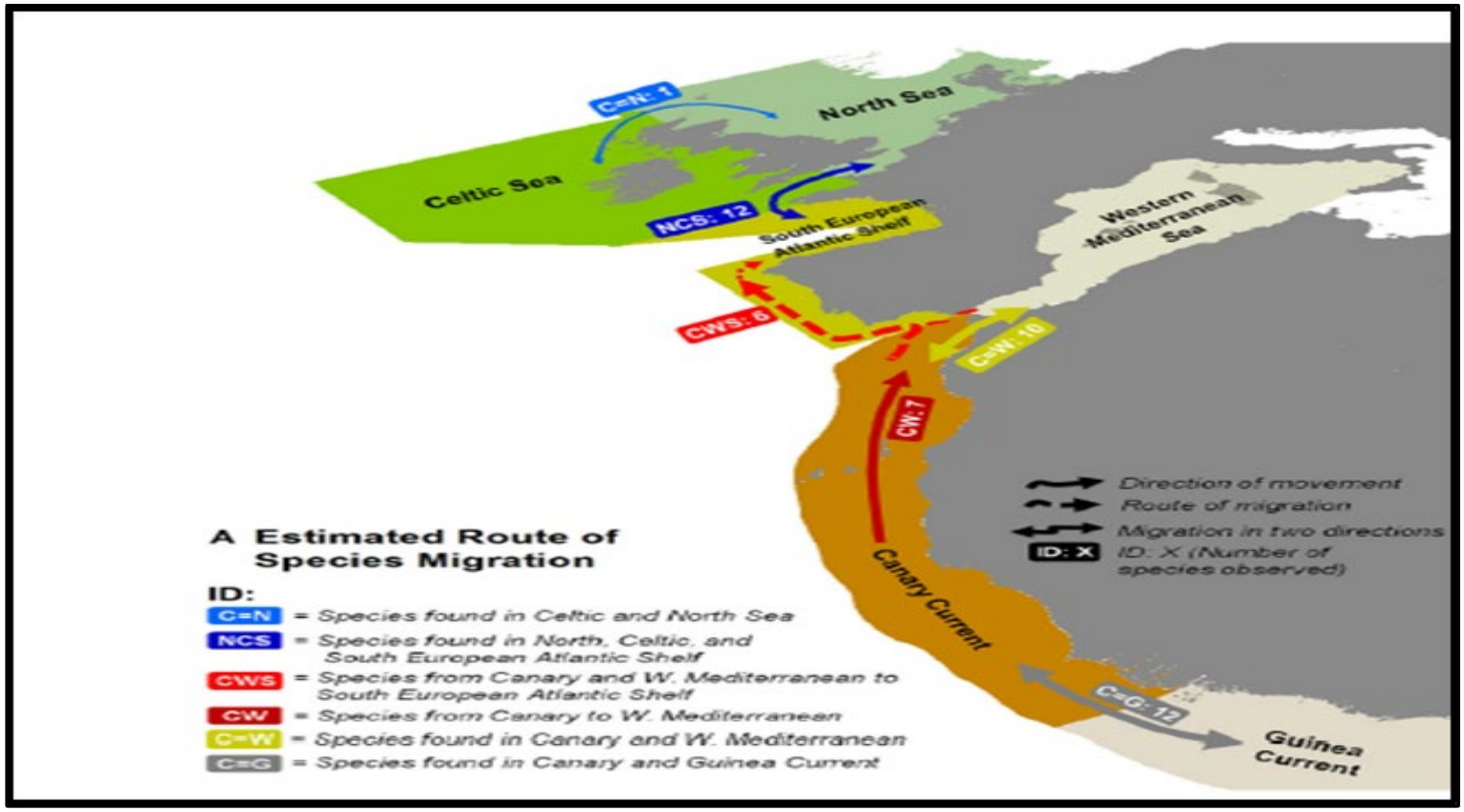
- **Sea temperature is rapidly rising**
- **Sea level is expected to be significantly increasing**
  → 0.4m~1.1m increase by 2100
- **Surface ocean pH is decreasing**
  → Ocean oxygen will be decreased
- **Greenland and Antarctic ice mass will be lost**



Sources: IPCC (2019) The Ocean and Cryosphere in a Changing Climate

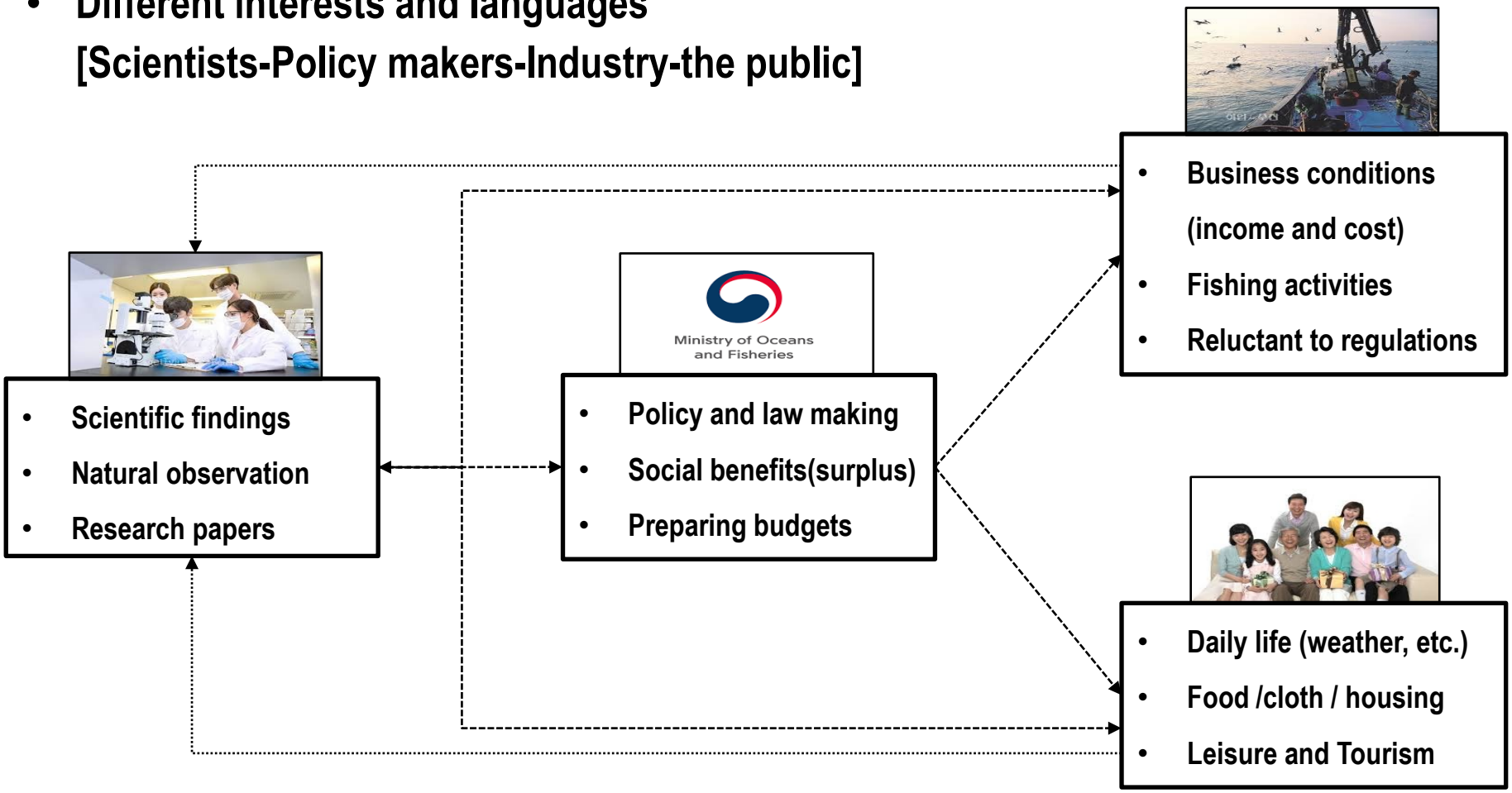
Issues

- **Scientist's interest and language**



Issues

- **Different interests and languages**
  [Scientists-Policy makers-Industry-the public]

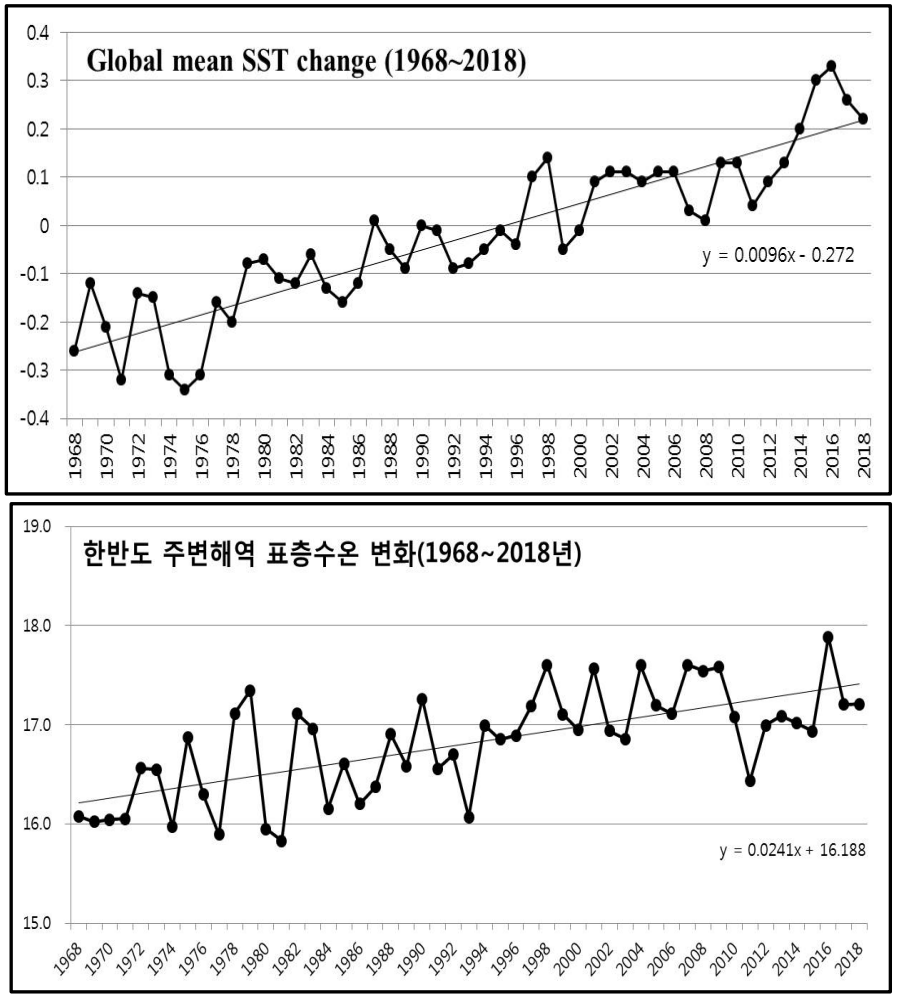


Case 1: Anchovy fishery in Korea [Scientist's interest and language]

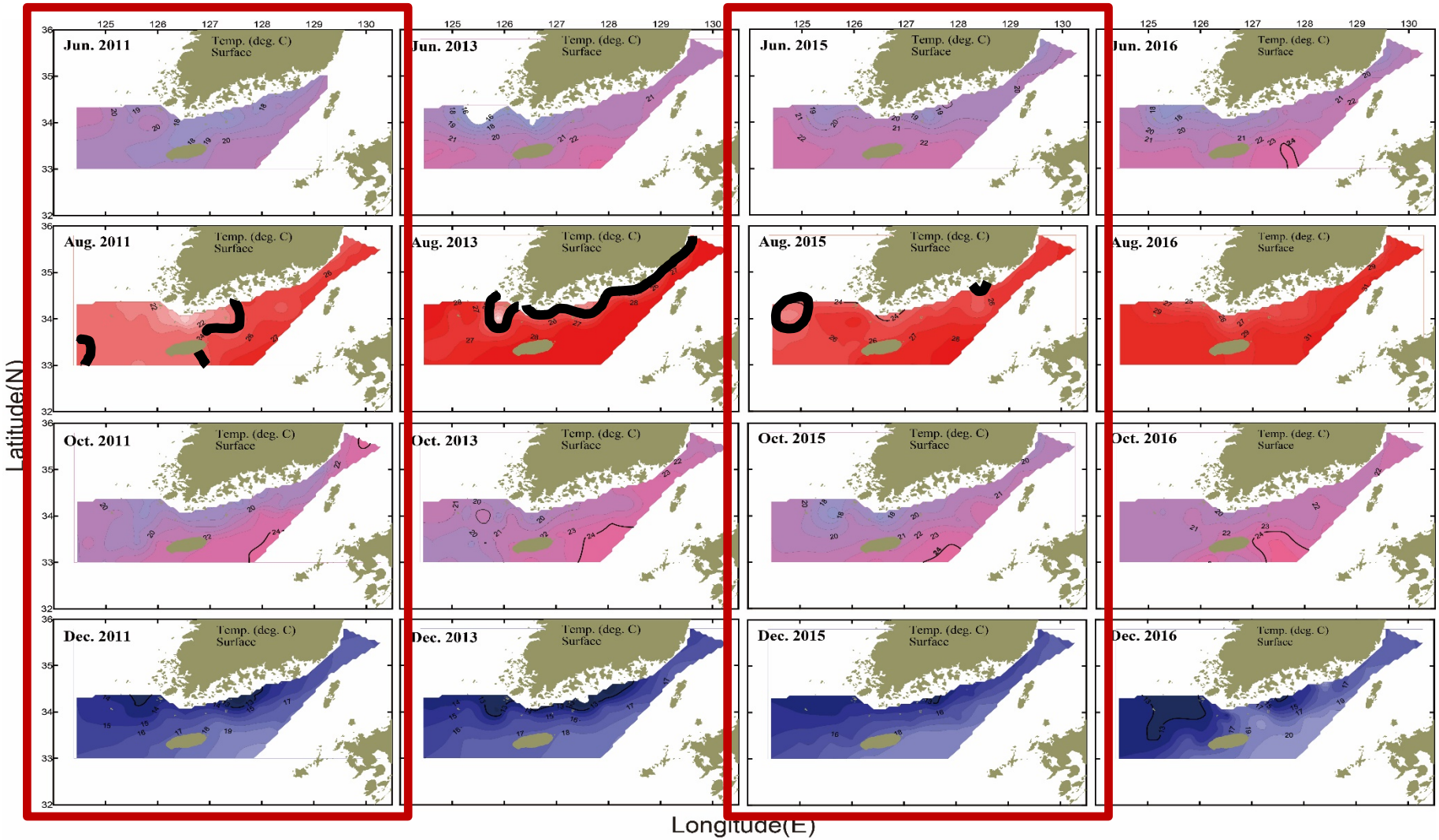
- **Water temperatures in East, West, and South Seas of Korea have been increasing**

  → Increased by 1.2ºC during last 50 years

  → More than 2 times faster increase than global average increase (increased by 0.5ºC)

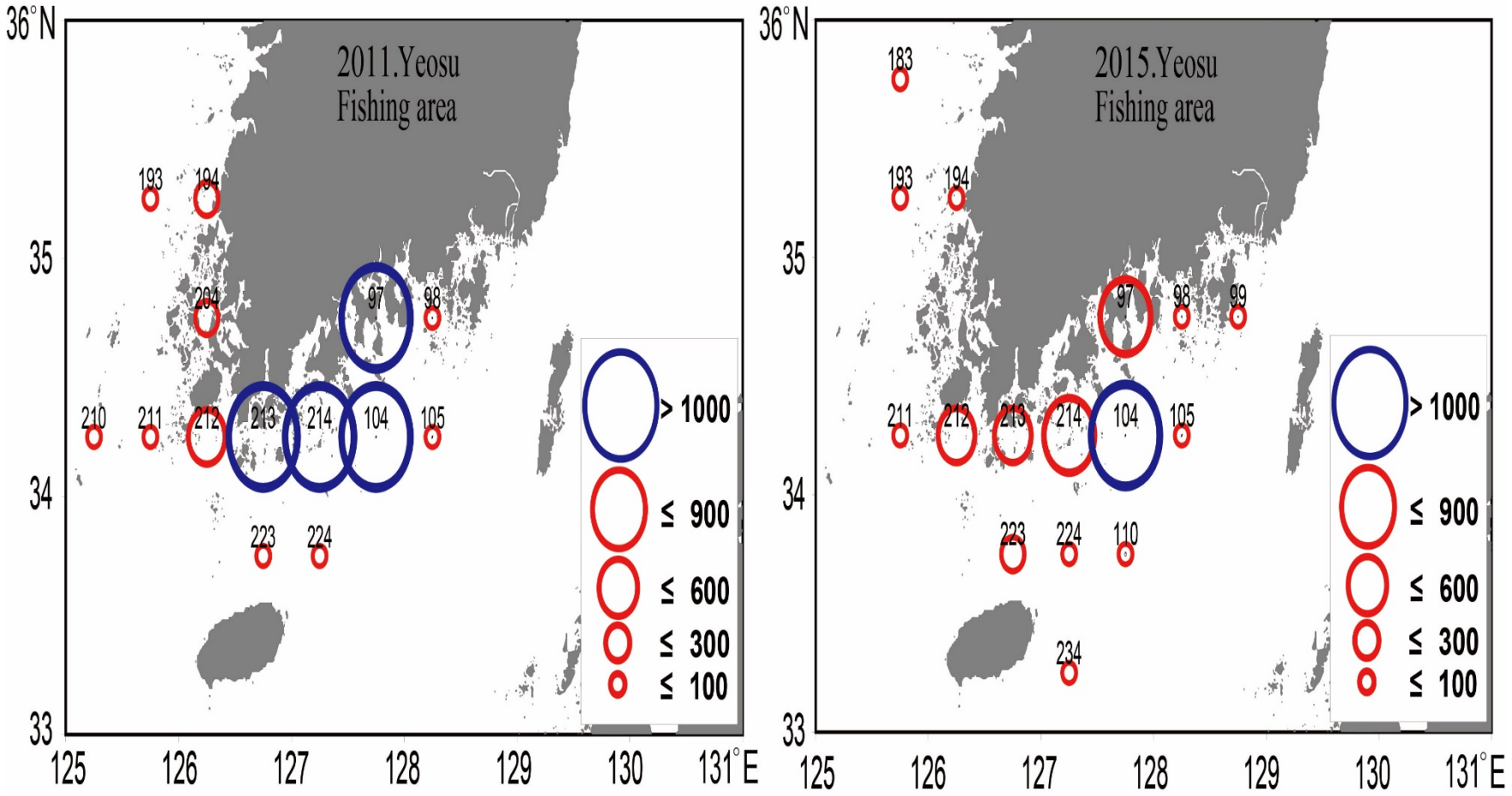


Case 1: Anchovy fishery in Korea [Scientist's interest and language]



[Figure] Changes of SST in South Sea, Korea (2011-2016)

Case 1: Anchovy fishery in Korea [Industry's interest and language]



[Figure] Comparison of catch amounts in South Sea region (2011 vs. 2015)

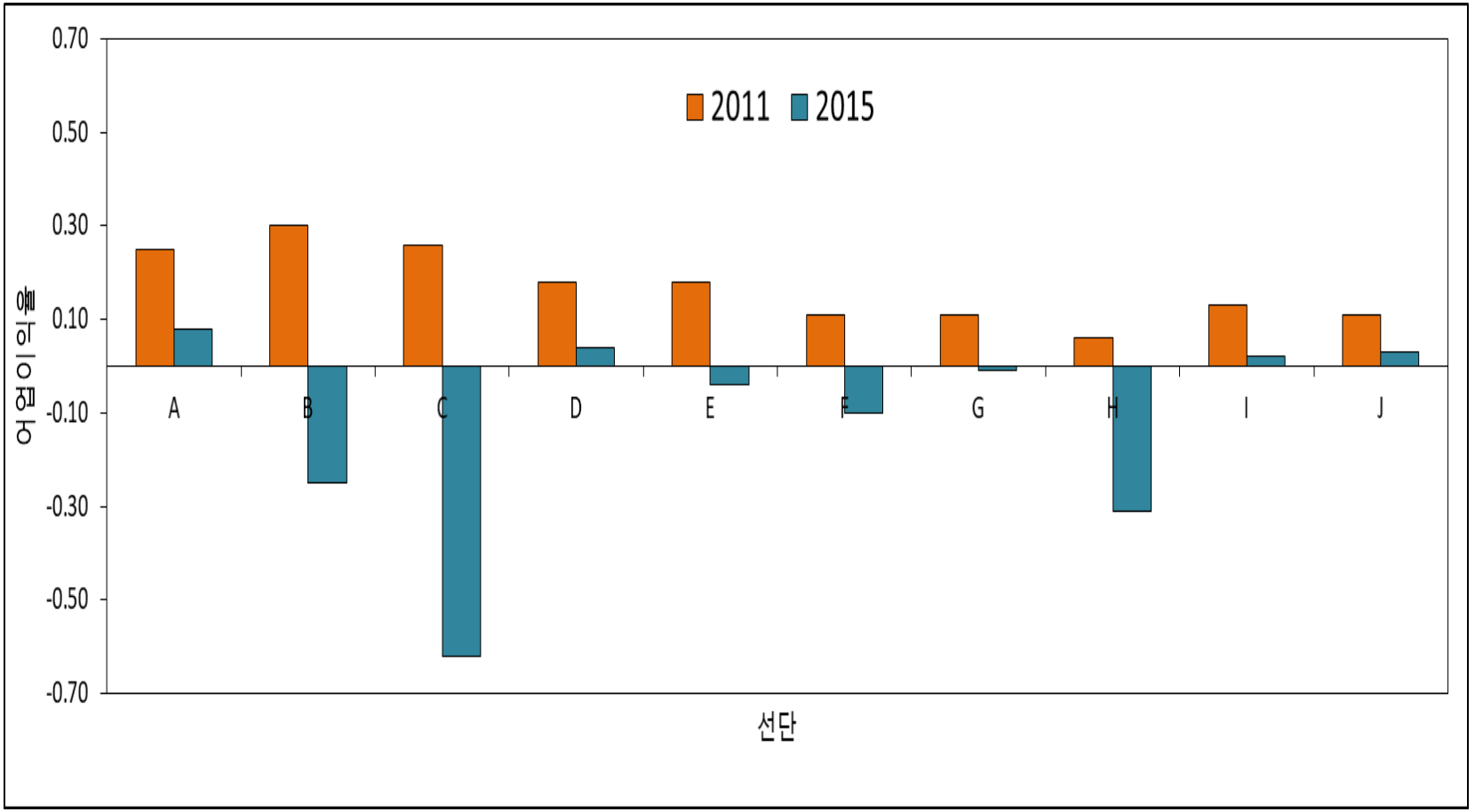
Case 1: Anchovy fishery in Korea [Industry's interest and language]

지역	선단	항목	연도				
			2011	2012	2013	2014	2015
전남	A	출어비 (%)	60.64	55.95	56.86	55.11	51.37
		임금 및 일반관리비 (%)	36.01	42.03	41.57	42.98	46.42
		어업이익률 **(ROS)**	**0.25**	**0.17**	**0.16**	**0.17**	**0.08**
	B	출어비 (%)	58.28	57.55	60.16	54.82	51.31
		임금 및 일반관리비 (%)	39.72	39.41	38.30	43.36	46.36
		어업이익률 **(ROS)**	**0.26**	**0.39**	**0.48**	**-0.25**	**-0.62**
	C	출어비 (%)	61.24	55.61	57.56	56.36	51.63
		임금 및 일반관리비 (%)	36.76	42.12	40.58	41.54	46.05
		어업이익률 **(ROS)**	**0.18**	**-0.13**	**-0.02**	**0.19**	**0.04**
	D	출어비 (%)	61.83	54.62	56.67	54.88	51.96
		임금 및 일반관리비 (%)	36.09	42.53	41.12	42.69	45.30
		어업이익률 **(ROS)**	**0.30**	**0.08**	**0.20**	**0.02**	**-0.25**
	E	출어비 (%)	60.33	56.90	55.60	53.33	52.07
		임금 및 일반관리비 (%)	37.45	40.83	42.00	44.36	45.28
		어업이익률 **(ROS)**	**0.18**	**0.01**	**-0.08**	**-0.23**	**-0.04**

지역	선단	항목	연도				
			2011	2012	2013	2014	2015
경남	A	출어비 (%)	72.24	69.37	66.79	68.81	66.62
		임금 및 일반관리비 (%)	22.09	27.33	31.31	31.19	33.38
		어업이익률**(ROS)**	**0.11**	**0.09**	**0.17**	**-0.03**	**-0.10**
	B	출어비 (%)	63.35	61.40	60.84	67.25	62.00
		임금 및 일반관리비 (%)	30.00	34.39	37.65	32.75	38.00
		어업이익률**(ROS)**	**0.06**	**0.01**	**-0.58**	**-0.35**	**-0.31**
	C	출어비 (%)	71.22	70.81	70.00	72.77	68.12
		임금 및 일반관리비 (%)	19.81	24.83	28.07	27.23	31.88
		어업이익률**(ROS)**	**0.11**	**0.14**	**0.07**	**0.20**	**0.03**
	D	출어비 (%)	79.20	66.12	70.30	67.94	64.40
		임금 및 일반관리비 (%)	19.93	29.78	27.53	32.06	35.60
		어업이익률**(ROS)**	**0.11**	**0.01**	**0.14**	**0.33**	**-0.01**
	E	출어비 (%)	73.27	68.28	70.28	68.39	66.89
		임금 및 일반관리비 (%)	22.44	27.04	28.31	29.67	33.11
		어업이익률**(ROS)**	**0.13**	**0.09**	**0.02**	**0.17**	**0.02**

[Figure] Changes of fishing profits by vessel (2011-2015)

Case 1: Anchovy fishery in Korea [Industry's interest and language]



[Figure] Changes of fishing profitability (ROS) by vessel (2011 vs. 2015)

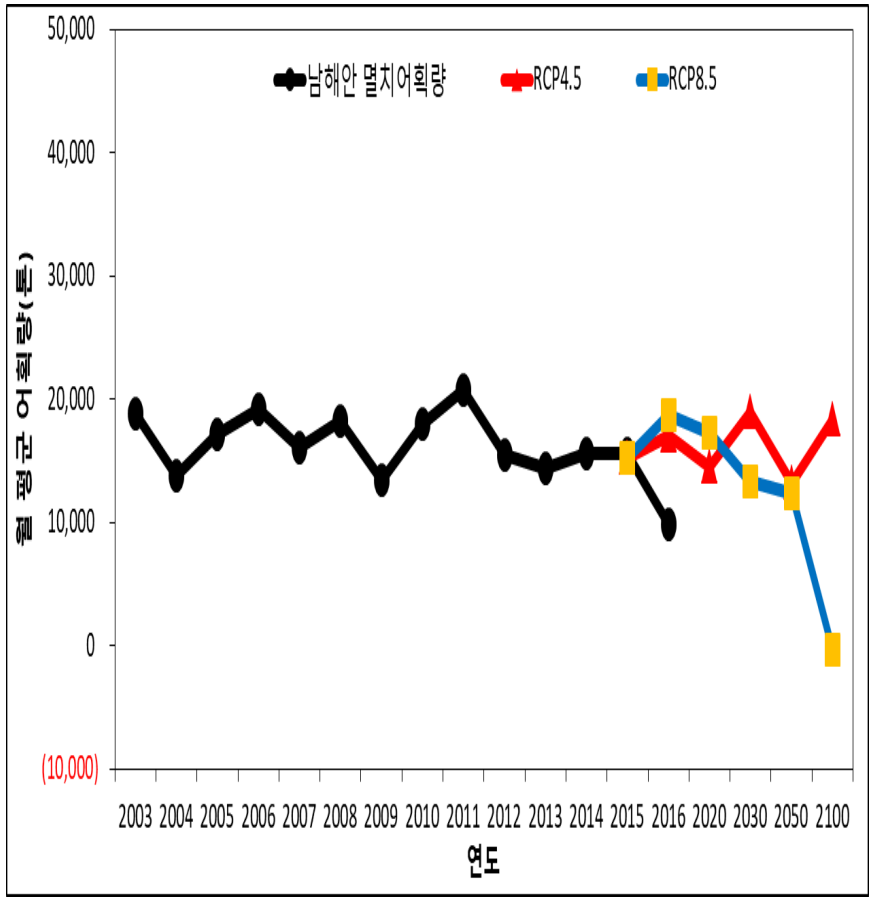
Case 1: Anchovy fishery in Korea [Policy maker's interest and language]

- **Decision making about future anchovy production and management of fishery**

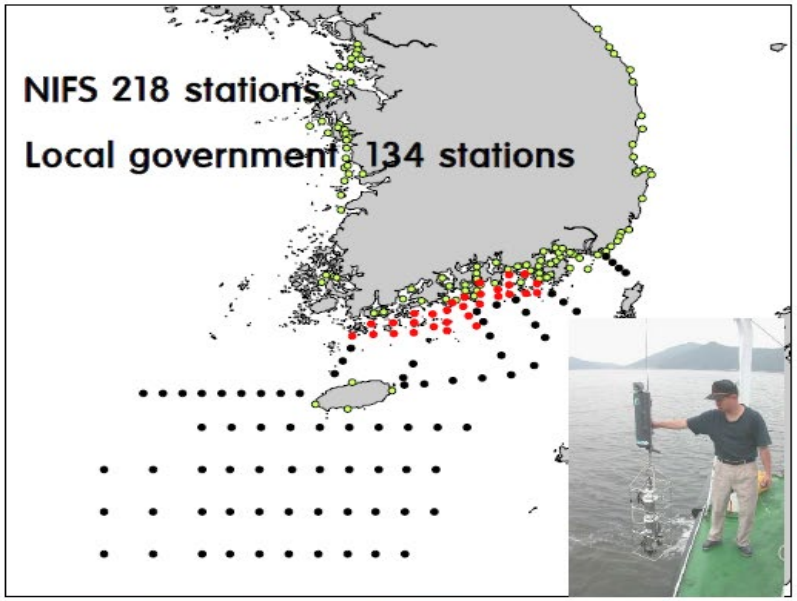
  → Change regulations for the Anchovy Drag net fishery and allow them to fish in West and East Seas???

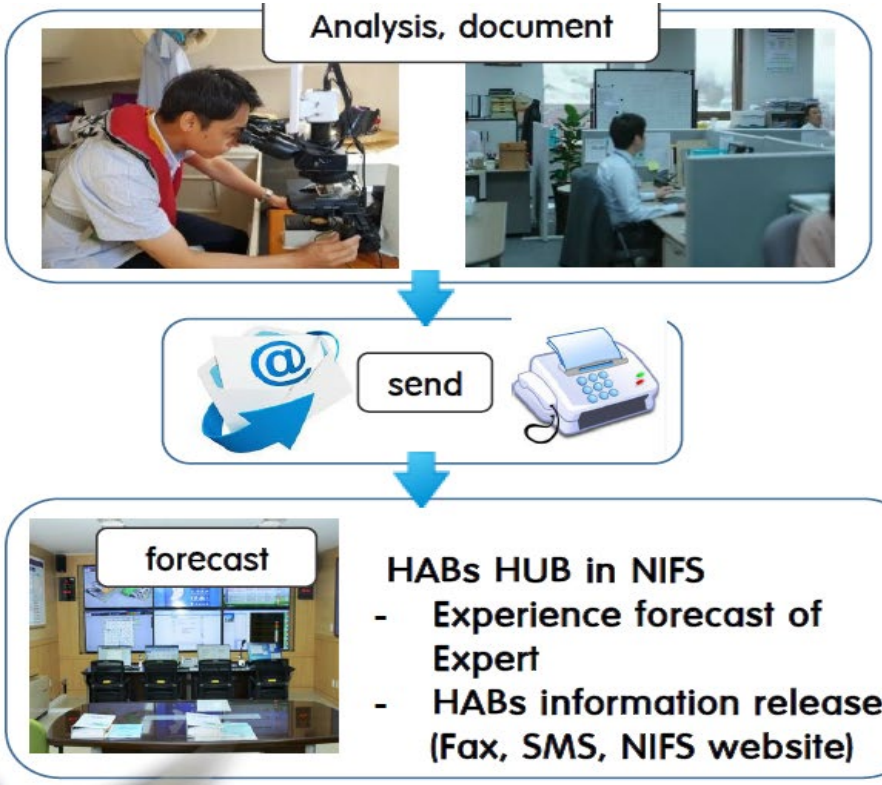
  → Expand buyback program for Anchovy Drag net fishing vessels???

  → Recommend Anchovy fishers to change their jobs???



Case 2: Red tide [Scientist's interest and language]





- **Researching on the relation between climate change and red tide bloom**
  → Sea level and water temperature rise would increase the red tide blooms

Case 2: Red tide [Recreational fisher's interest and language]

- **Due to the increase of red tide, recreational fishers would lose their surplus (fishing utility /satisfaction), which is one of important economic impacts by climate change**
- **Recreational fishers *worry* about the loss of fishing trip opportunity and *angry* about the climate change**

- Example of recreational fisheries in Yeosu region (N=263)

Variable	Poisson Model	Negative binomial model
Intercept	3.484 (0.000)	2.936 (0.000)
Travel cost	-0.108 (0.000)	-0.069 (0.000)
Catch	0.058 (0.000)	0.072 (0.012)
Income	0.001 (0.002)	0.0004 (0.521)
Marriage	-0.307 (0.000)	-0.160 (0.292)
Age	0.013 (0.000)	0.014 (0.107)
α	-	0.957 (0.000)
Log Likelihood	-2,982.420	-983.974

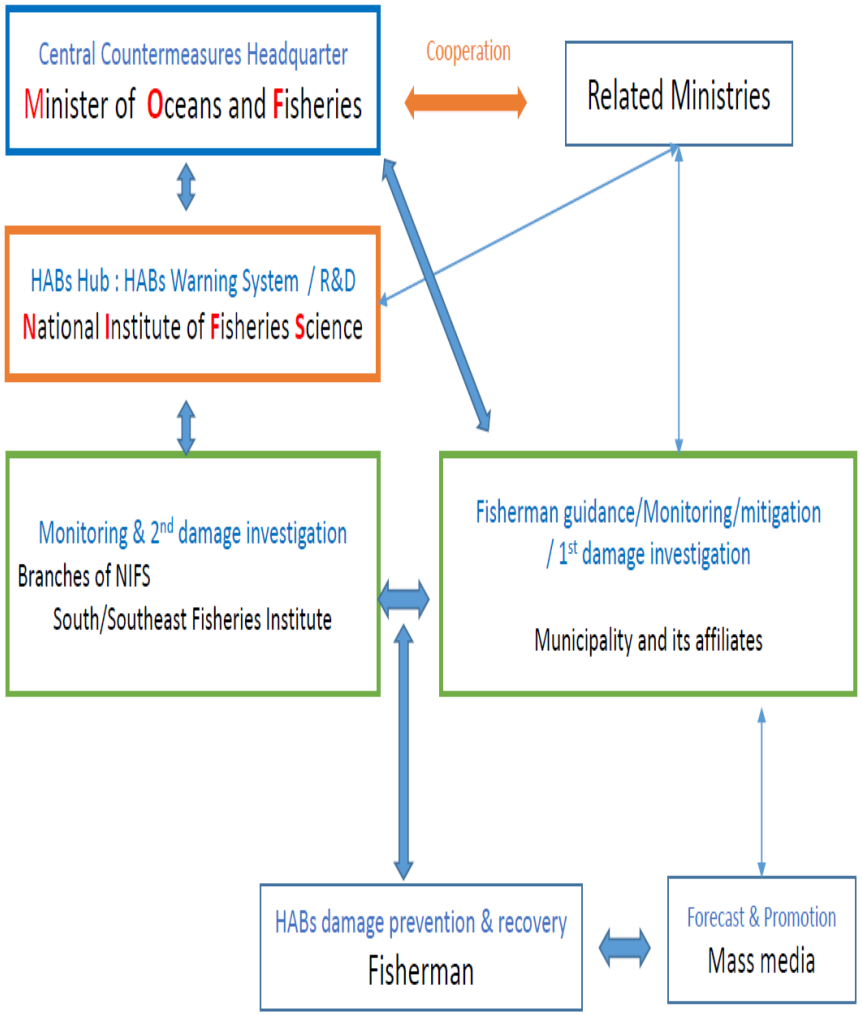
- The consumer surplus benefit received was estimated to be $122 per angler per trip based on the result of negative binomial model

Case 2: Red tide [Policy maker's interest and language]

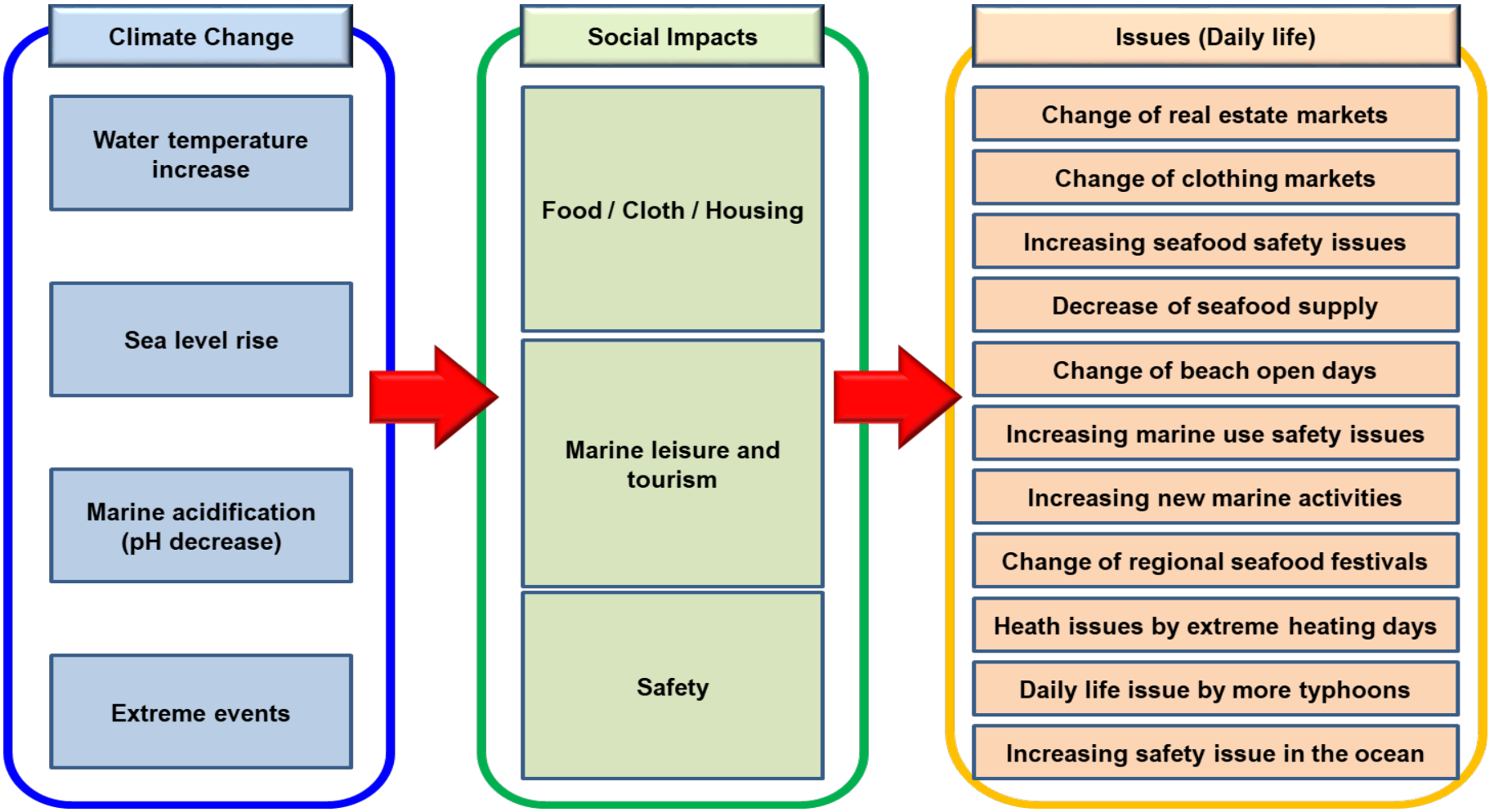
- **Decision making about monitoring and management on red tide blooms**
  - **→ Yellow cray control activities**
  - **→ Purchasing red tide removal equipment**

- **Decision making about R&D projects**
  - **→ Rapid monitoring and forecasting**
  - **→ Eco-friendly mitigation techniques**

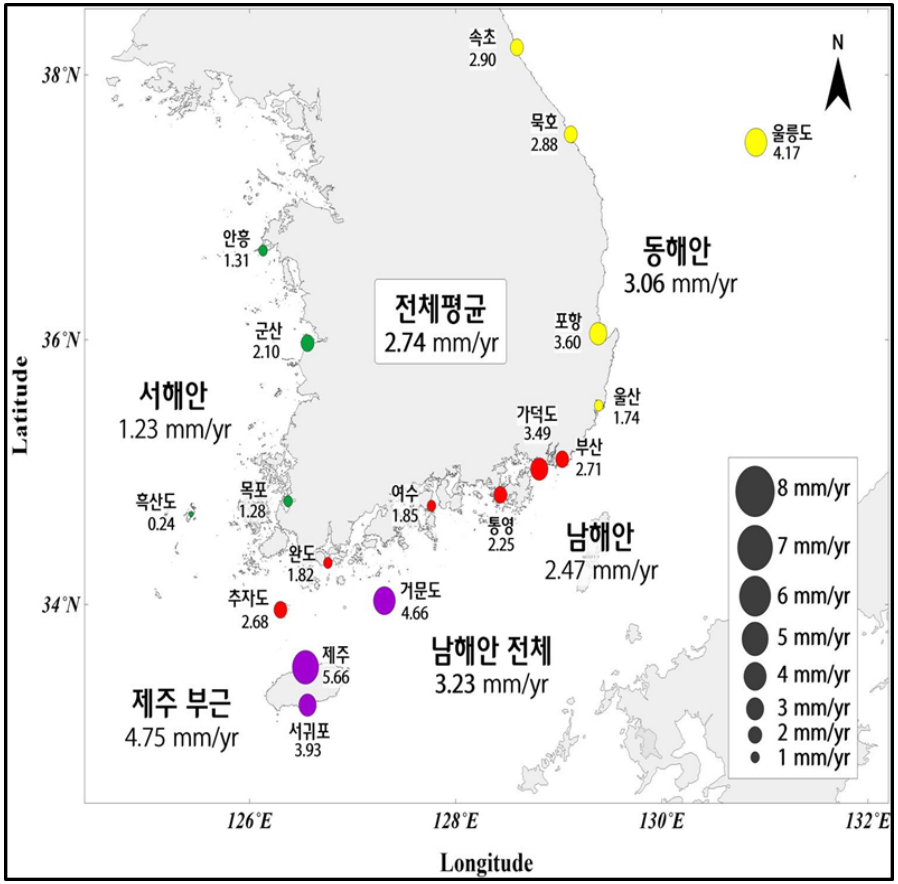
- **Providing red tide information to the public**
  - **→ Real-time information system**
  - **→ Information on recreational fishing activities**



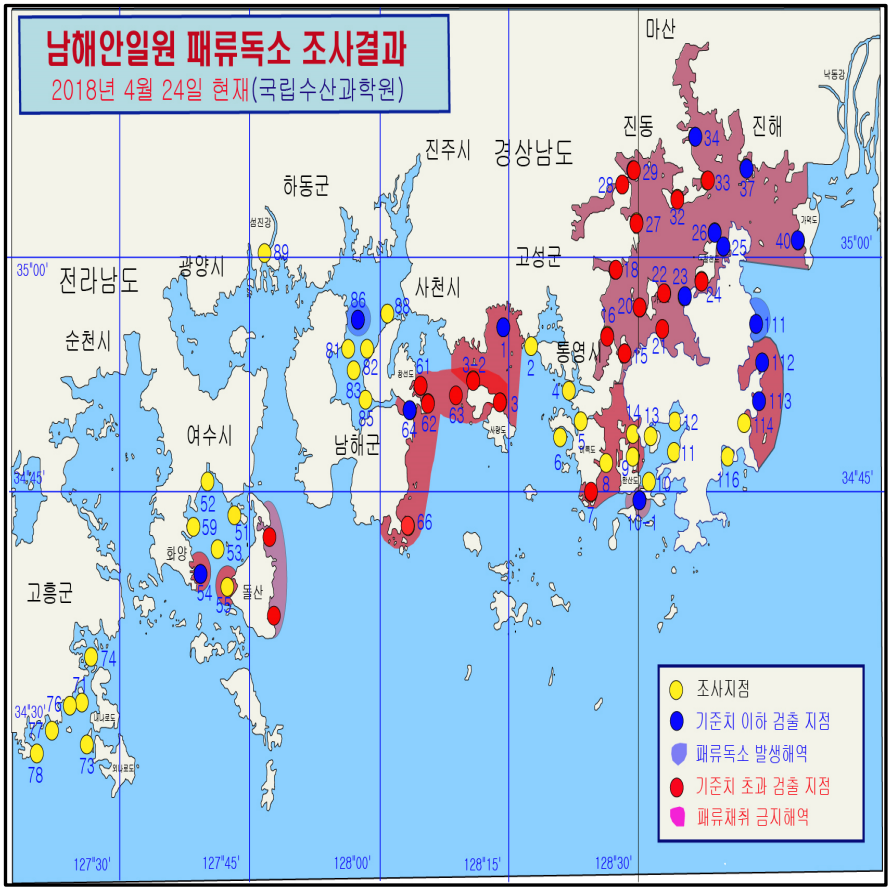
Connecting Science and The public (emphasizing public interest and language)



Connecting Science and The public

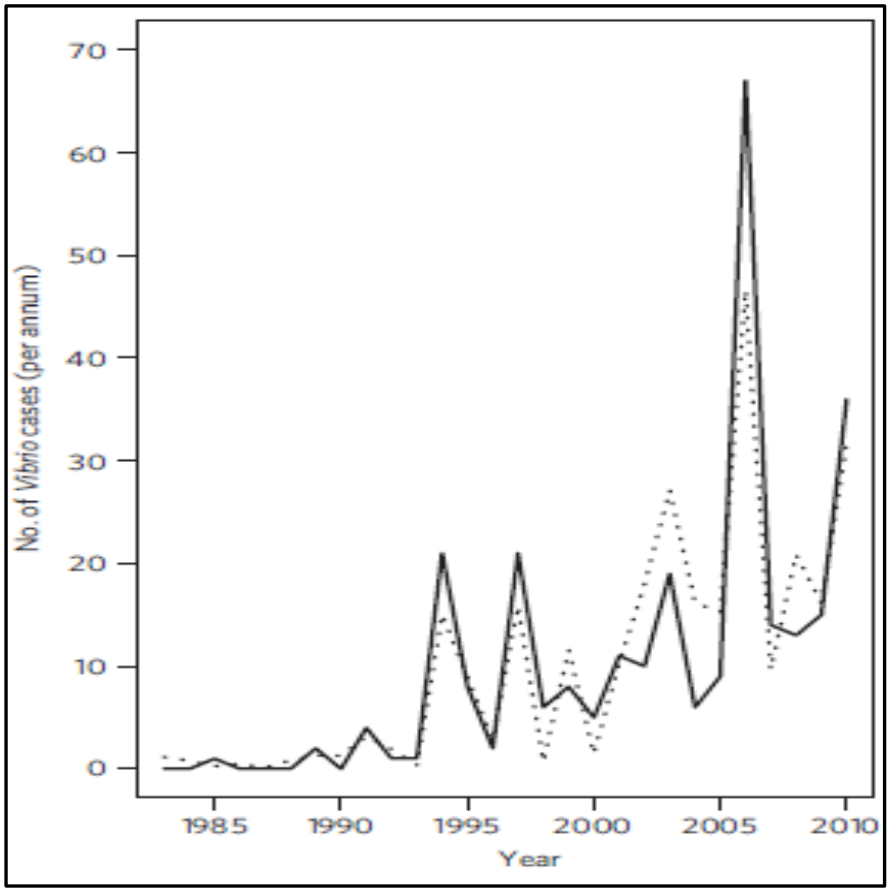


[Sea level rise in Korea → Change of real estate markets]

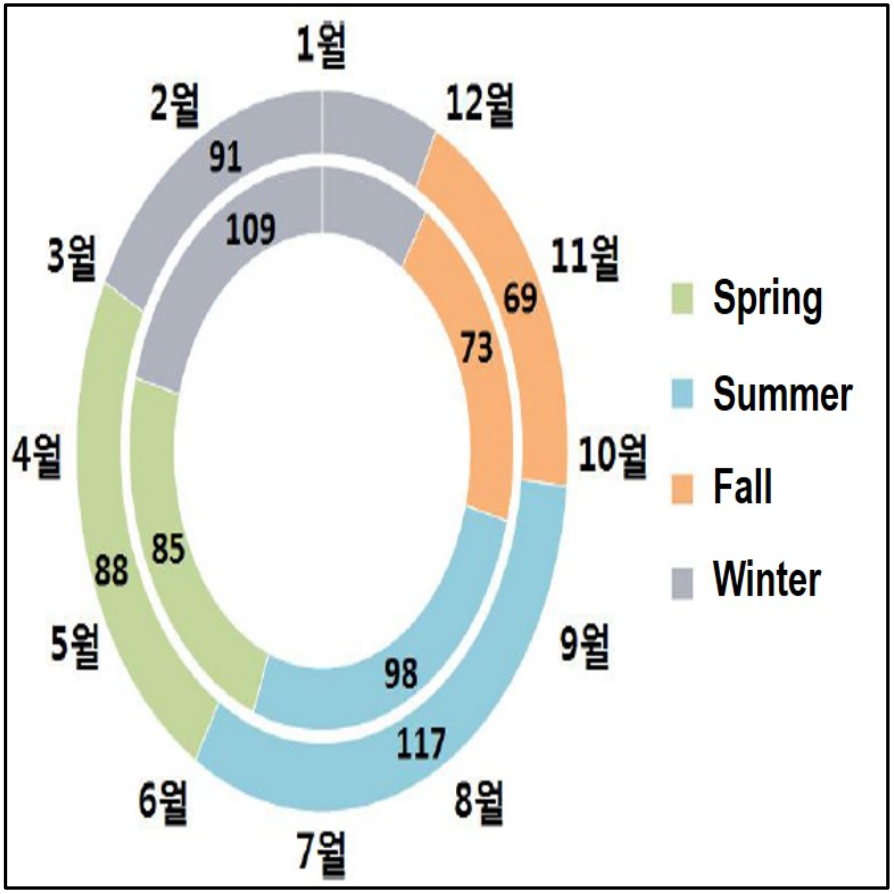


[(SST increase → HABs Increase) → shellfish poisoning increase]

Connecting Science and The public

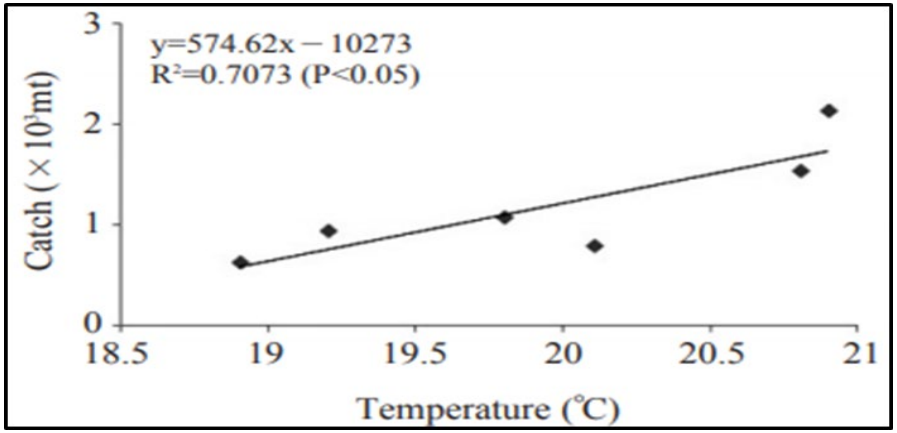


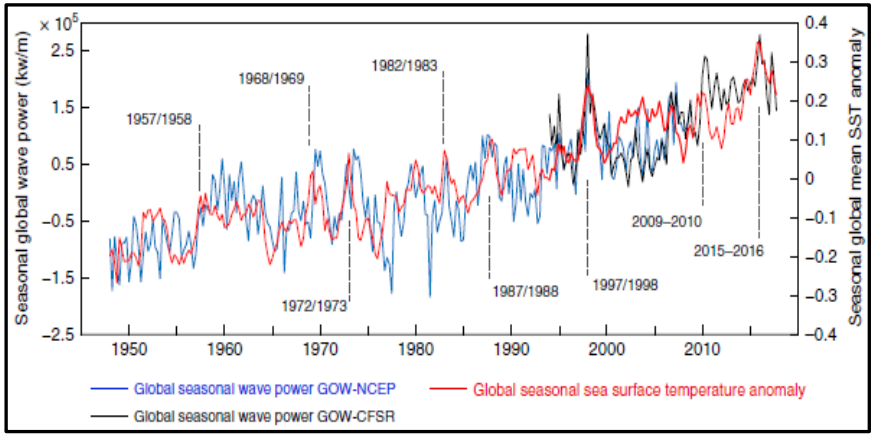
[SST increase → Increase of Vibrio cases (Baker-Austin et al., 2013)]



[Changes of seasonal length (NIMS,2018)→ early beach opening]

Connecting Science and The public

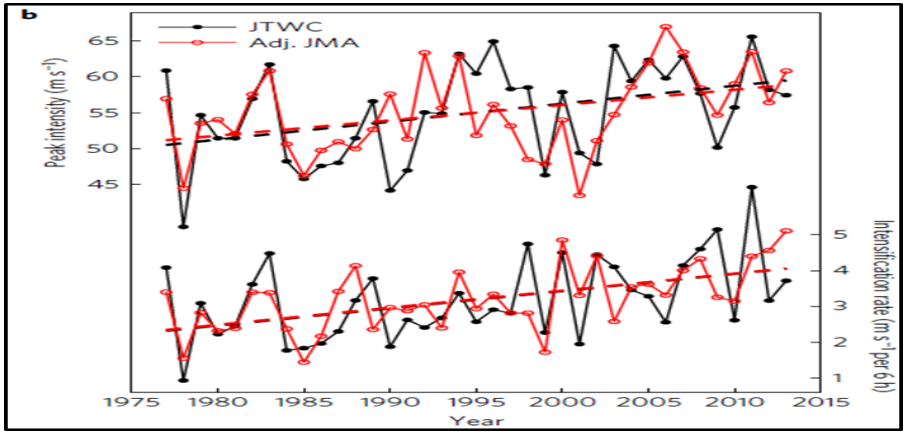




[WT increase → Increase of tropical fish species]

[Increase of wave power → Increase of new leisure opportunity]

Connecting Science and The public



[Increase of damages by typhoon]

[Increase of wave power → Increase of marine safety issues]

Conclusion and Suggestions

- **Connecting Science and Communities is very important**
  - ✓ **Better understanding and effective responsiveness to climate change impacts**
  - ✓ **Good example of SEES (Social-Ecological-Environmental Systems) approach**

- **Improving communication on climate change impacts**
  - ✓ **More researches those can understand different interests and languages**
  - ✓ **Providing information to the public for better understanding and responsiveness**
    [Information on recreational fishing (HABs, ocean conditions, etc.), beach conditions, seafood safe information, etc. using Smart phone Apps]

Conclusion and Suggestions

- **Economic impact analysis for better understanding on climate change impacts**

  - ✓ **Since products from ocean and fisheries are used as raw materials for other industries, changes of ocean and fisheries due to the climate change would have another impacts on other forward and backward linkage industries**

  - ✓ **For example, if coastal and offshore fishery production in Korea decreases by 30% due to the climate change, its direct impact on fisheries is about 986.4 million USD and impact on other related industries is about 1,816.9 million USD**

  - ✓ **This information would be useful to policy makers and industries for understanding climate change impacts and making plans and strategies**

THANK YOU