Impact of climate change on China's marine ecosystem and MPA

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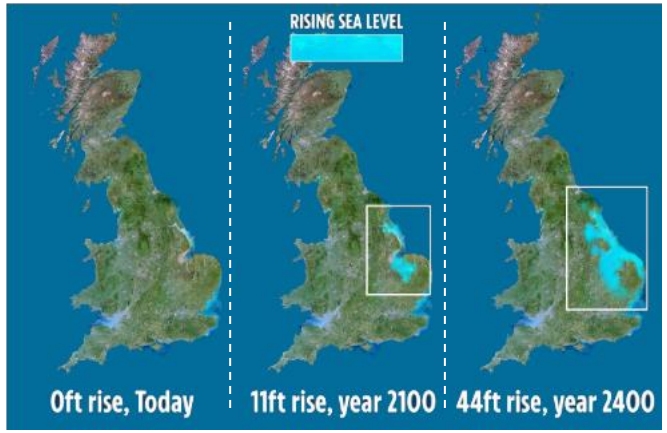
01 Impacts of climate change on the oceans

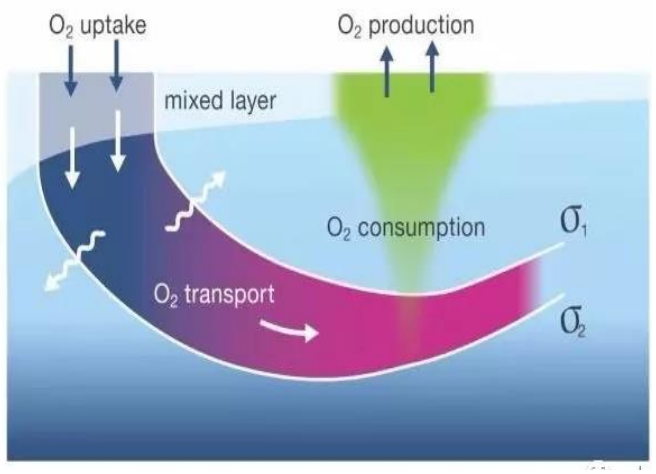
The marine environment is changing

Sea water warming

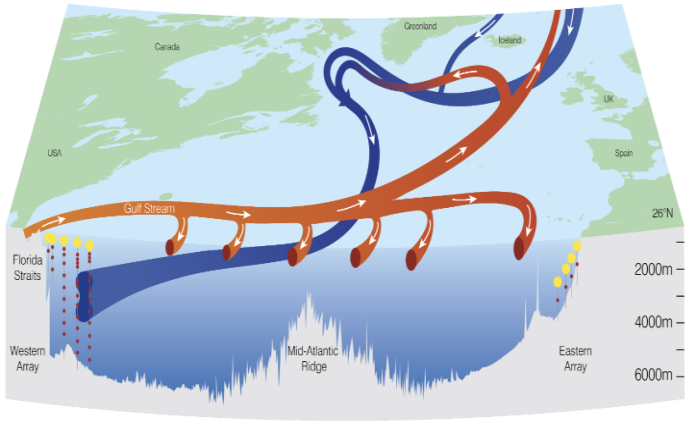
Ocean acidification



sea level rise



Worsening hypoxia



Ocean current changes

Intensified marine hazards

(Jones et al., 2014; Struve et al., 2020; IPCC, 2021)

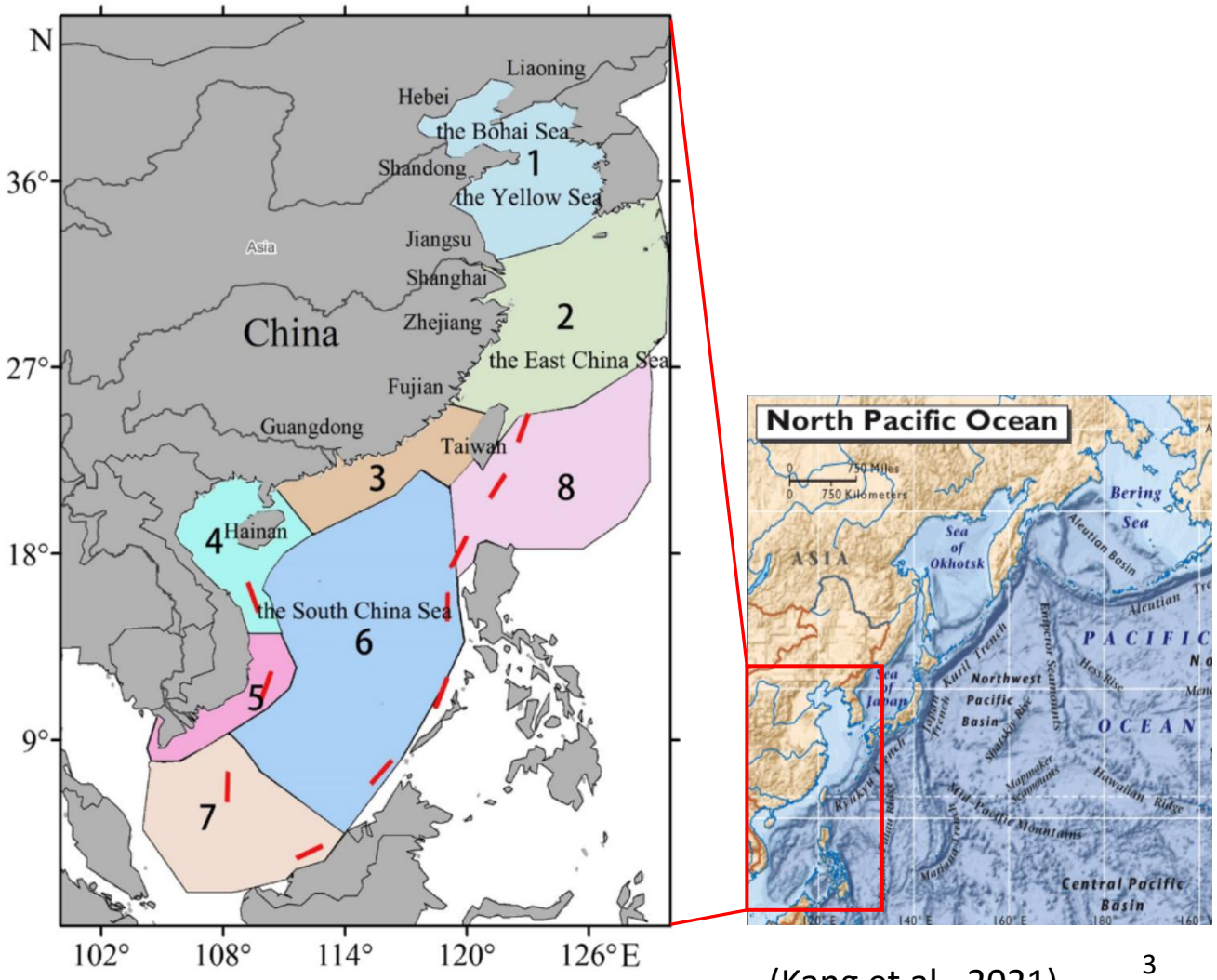
02 Impacts of climate change on the Chinese Sea

Chinese Sea

The Chinese sea is located between the Asian continent and the Pacific Ocean, divided into the Bohai Sea, Yellow Sea, East China Sea, South China Sea, and the Pacific Ocean east of Taiwan, spanning from tropical to warm temperate climate zones, covering 8 ecological zones.

Biogeographic ecoregions in the China Sea:. 1: Yellow Sea; 2: East China Sea, 3: South China Sea, 4: Beibu Gulf, 5: Southern Vietnam, 6: South China Sea Oceanic Islands, 7: Sunda Shelf/ Java Sea, 8: South Kuroshio.

climate change have physical, biological, and ecological perspectives impact.

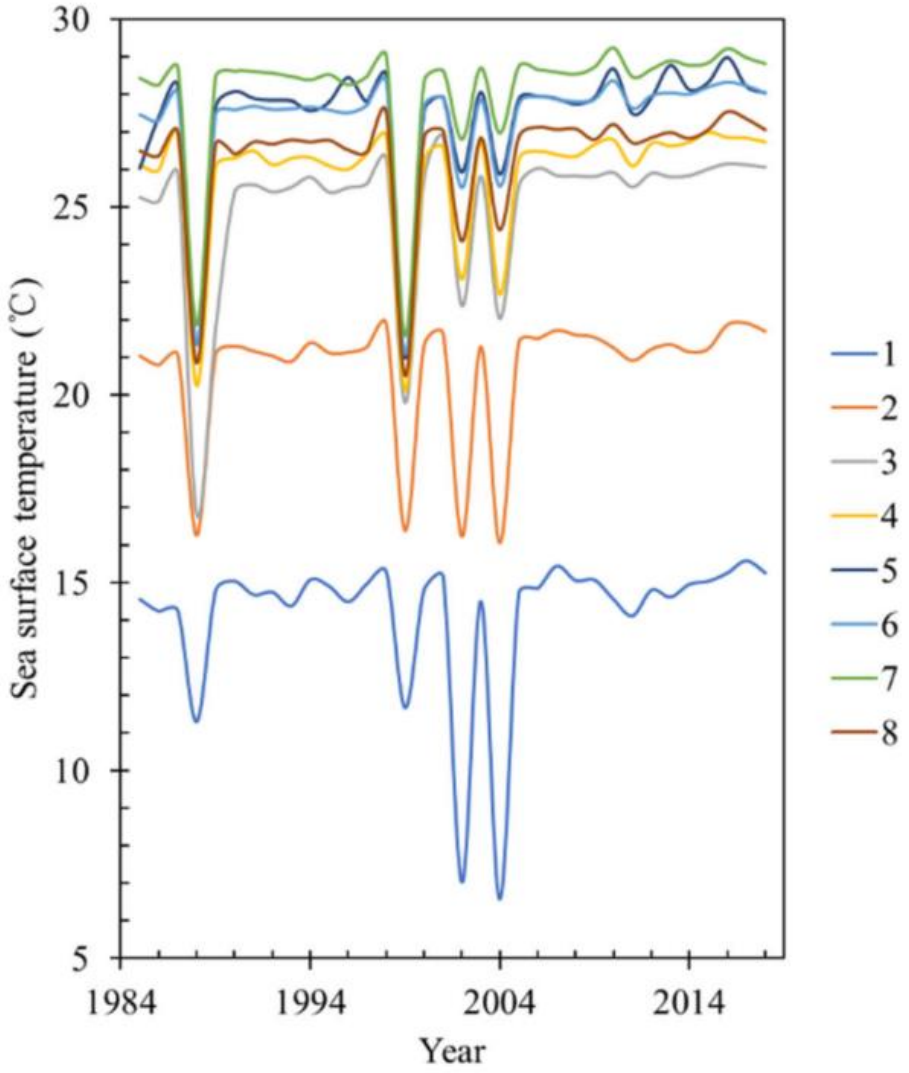


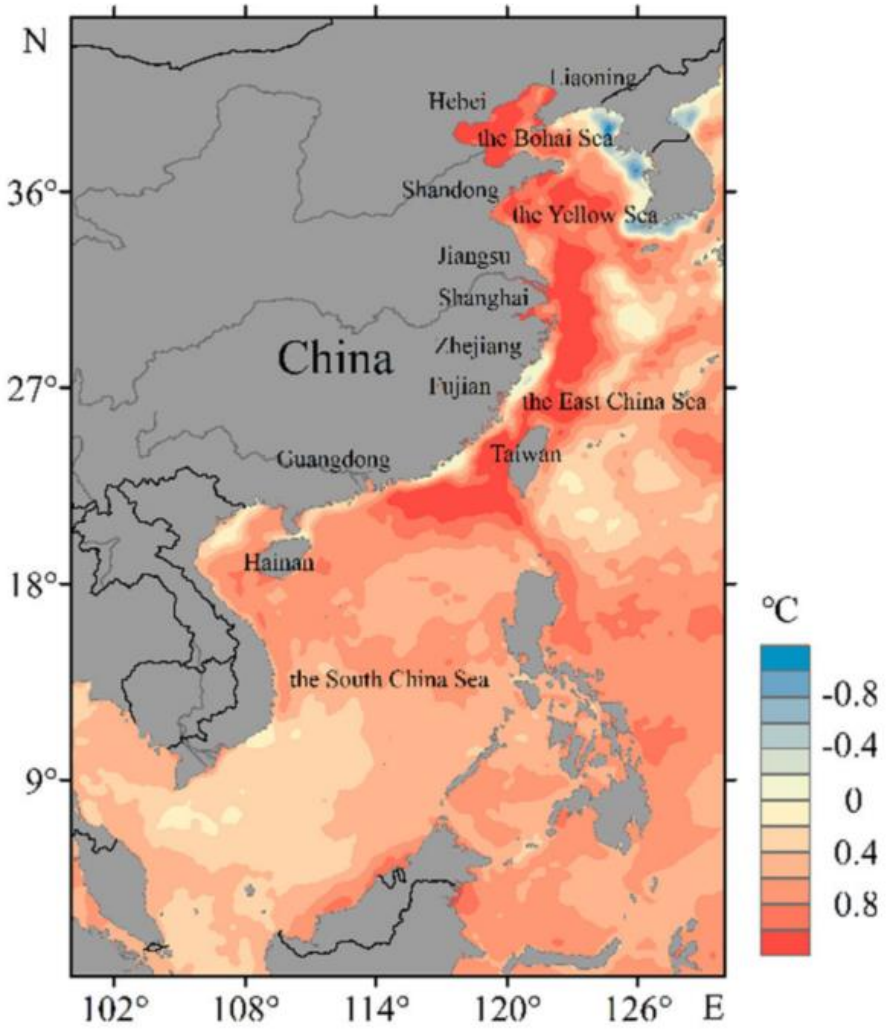
(Kang et al., 2021)

02 Impacts of climate change on the Chinese Sea

sea surface temperature increase

from 1985 to 2018





(Kang et al., 2021)

02 Impacts of climate change on the Chinese Sea

Impacts of climate change on marine ecosystems in China

In the seas of China, multi-decadal climate variability has driven obvious changes in the abundance and distribution of dominant species.

- Yellow Sea: **poleward expansion** of warm-water zooplankton species;
- East China Sea: **increasing proportion** of warm water species and temperate species, from plankton to fish;
- South China Sea: **degradation** of coral reefs and mangroves.

Impacts of climate change on marine ecosystems in China

	Bohai Sea	Yellow Sea	East China Sea	South China Sea	East of Taiwan
Climate change drivers	Increasing temperature Acidification	Increasing temperature Acidification Hypoxia	Change in temperature regime Hypoxia Precipitation anomalies Heatwaves Acidification Sea level rise	Attribution of severe typhoons to climate change Sea level rise	Change in current system Increasing temperature Attribution of severe typhoons to climate change
Phytoplankton	Macroalgal blooms, *Noctiluca scientillans*, Aureococcus *anophagefferens*, etc. (Guo et al. 2015b, a)	*Blooms of Noctiluca scientillans, Skeletonema costatum, Enteromorpha prolifera* (Guo et al. 2015b, a; Zuo et al. 2011)	Frequent occurrences of red tides, e.g., *Prorocentrum donghaiense*, *Noctiluca scintikkans*, etc. (Guo et al. 2015b, a)	*Noctiluca scintillans* or *Pyrodinium bahamense* blooms (Guo et al. 2015b, a)	*Trichodesmium* abundance increase Fauna simplified, dominated by *Pseudonitzschia delicatissima* and *Thalassiosira subtilis* (Li et al. 2006a, b)
Zooplankton	Decrease in large sized copepods such as *Labidocera euchaeta* and *Calanus sinicus*; Northward expansion in distribution & increase in abundance of small-sized copepods such as *Acartia pacifica* & *Centropages dorsispinatus* (Yang et al. 2018)	Northward migration of large-size species such as *Calanus sinicus*, *Euphausia pacifica*, and *Sagitta crassa* (Shi et al. 2016)	Species turnover: sharp decrease of *Sagitta crassa* in winter and *Euphausia pacifica* in spring; blooms of Jellyfish and *Thaliacea* (Xu et al. 2006)	Abundance increase, e.g. *Oncaea conifer* (Gong et al. 2017) Diversity increase from 510 species in 1960, 586 species in 1979, 709 species in 2000 to 1135 species in 2008 (Wang et al. 2014)	Decline in abundance of hyperthermal and hypersaline species Decrease in species diversity Increase in biomass in northern section (Cai et al. 1995)
Fish species	Collapse of stocks: CPUE of 193 kg h^{-1} in 1959 to 18 kg h^{-1} in 2010 (Liang and Pauly 2020) Decline in diversity measures such as Margalef's Index and Shannon–Wiener Index (Shan and Jin 2016)	Change in dominant species, from small yellow croaker, hairtail, & flatfishes in 1950s-1960s, *Clupea pallasii* and *Scomber japonicas* in 1970s-1980s, to *Lophius litulon* and *Liparis tanakae* in 2000s-2010s (Chen et al. 2018) Increasing fish vulnerability, e.g. *Miichthys miiuy*, *Scomberomorus niphonius* (Chen et al. 2019)	Change in dominant species from higher economic value to lower trophic level species Poleward extensions of fishes (northward movement), e.g. *Thamnaconus septentrionalis* (Chang et al. 2012) New records of warm water species, e.g. *Paratrachichthys prosthemius* (Lin et al. 2007)	Decrease in density of pelagic fishes, e.g. Sardine, Konosirus punctatus,;Decline in biomass of demersal species, e.g., *Acropoma japonicum*, *Lutjanus sanguineus* (Cai et al. 2018) New records of tropical species, e.g., *Deveximentum megalolepis* (Ju et al. 2017b, a)	Poleward extensions of fishes (northward movement), e.g. *Teixeirichthys jordani, Lepidotrigla japonica* (Chen et al. 2014,) New records of 13 warm-water fishes, e.g. *Plagiopsetta glossa*, *Raja porosa* (Chen et al. 2009a, b, c)
Habitats	Destruction of spawning grounds, from increased temperatures, coastal erosion, water quality degradation, deoxygenation	Decline in seagrass abundance, e.g. *Zostera marina* (Zhang et al. 2016)	Destruction of spawning grounds,, from increased temperatures, coastal erosion, water quality degradation, deoxygenation	Decline in mangrove distribution and abundance; Coral bleaching Coastal erosion	

(Kang et al., 2021)

02 Impacts of climate change on the Chinese Sea

China's actions

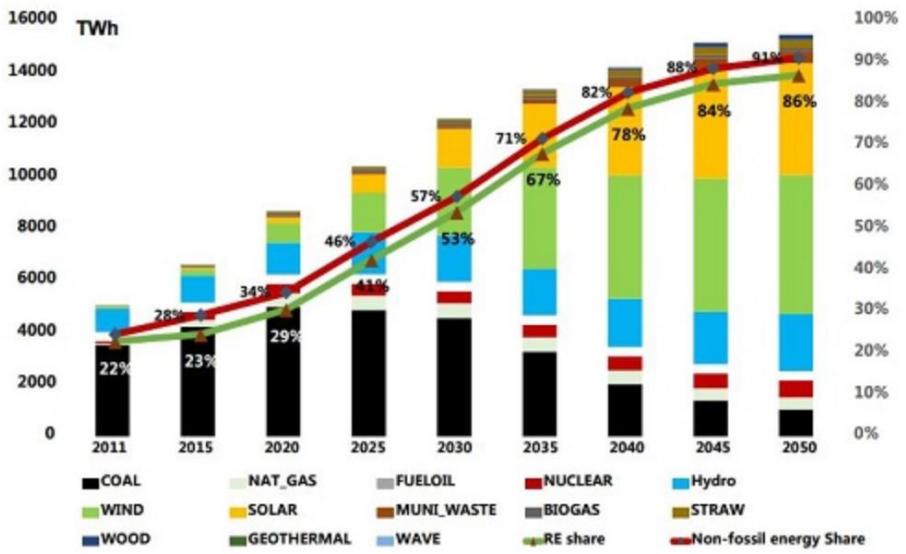
1. Introduce Policies to tackle climate change

- **2007《China's National Plan on Climate Change》:** To cope with climate change and promote sustainable development, the Chinese government has implemented measures such as adjusting the economic structure, improving energy efficiency, exploiting and utilizing hydropower and other renewable energy sources, and strengthening ecological construction.
- **2021《China's policies and actions to address climate change》**: Climate change is a common challenge for all humanity. China is actively responding, committing to achieve carbon peak before 2030 and carbon neutrality before 2060, contributing to global climate governance.
- **2022《The '14th Five-Year' Plan for Marine Ecological Environmental Protection》**: Enhance coordination, improve the ability of the ocean to cope with climate change.

02 Impacts of climate change on the Chinese Sea

China's actions

2. Promote the development of renewable energy



The proportion and development trend of renewable energy in China

Solar energy

Hydroelectricity

Wind power

Nuclear power

02 Impacts of climate change on the Chinese Sea

China's actions

3. Protection and restoration of marine ecosystems

Fig. 1 **Seagrass restoration** located in the northeast of Weihai, Shandong Province (3720’18’’–3721’32’’ N, 12233’18’’–12234’45’’ E), a typical lagoon in north China. Left, before planting 2012. middle, 2017; right, 2019.

Damaged

Restored

Fig. 2 **Mangrove restoration** south of the Oujiang estuary (27°54’–28°10’ N, 120°42’–129°51’ N), an area 3.2 degrees north of their natural distribution limit. Left, before transplanting in 2010; middle, 2014; right, 2016.

Figure 3. **Coral reef restoration** in Wuzhizhou Island waters (18°19’ N, 109°45’ N), an area of 3 ha was selected for planting hermatypic corals on circular attachments placed in the seafloor. Left, before planting in 2013; middle, 2014; right, 2016.

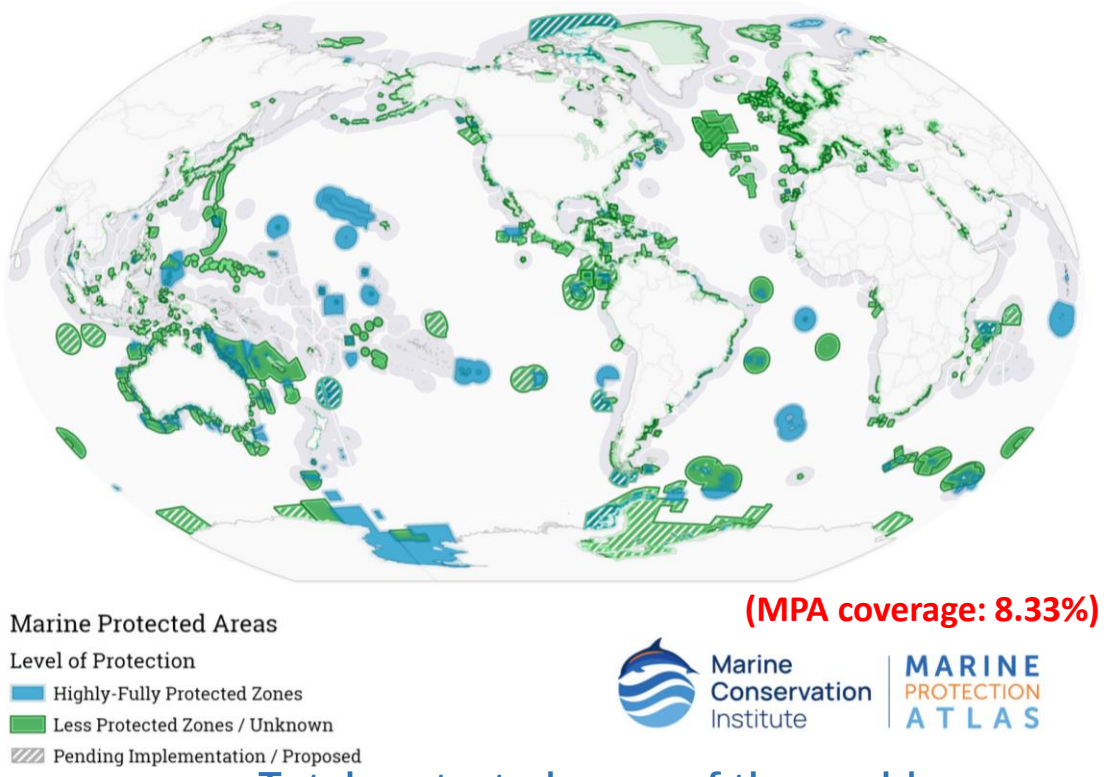
Habitat restoration support abundant benthos, fish, and feeding grounds for birds.

(Kang et al., 2021)

03 Role of marine protected areas

Marine protected areas (MPAs)

MPAs are designated regions aimed at protecting marine ecosystems and biodiversity. By restricting or prohibiting certain human activities, MPAs work to restore and protect the marine environment, ensure ecosystem health and stability, and support the sustainable use of fisheries and other marine resources.



(MPA coverage: 8.33%)

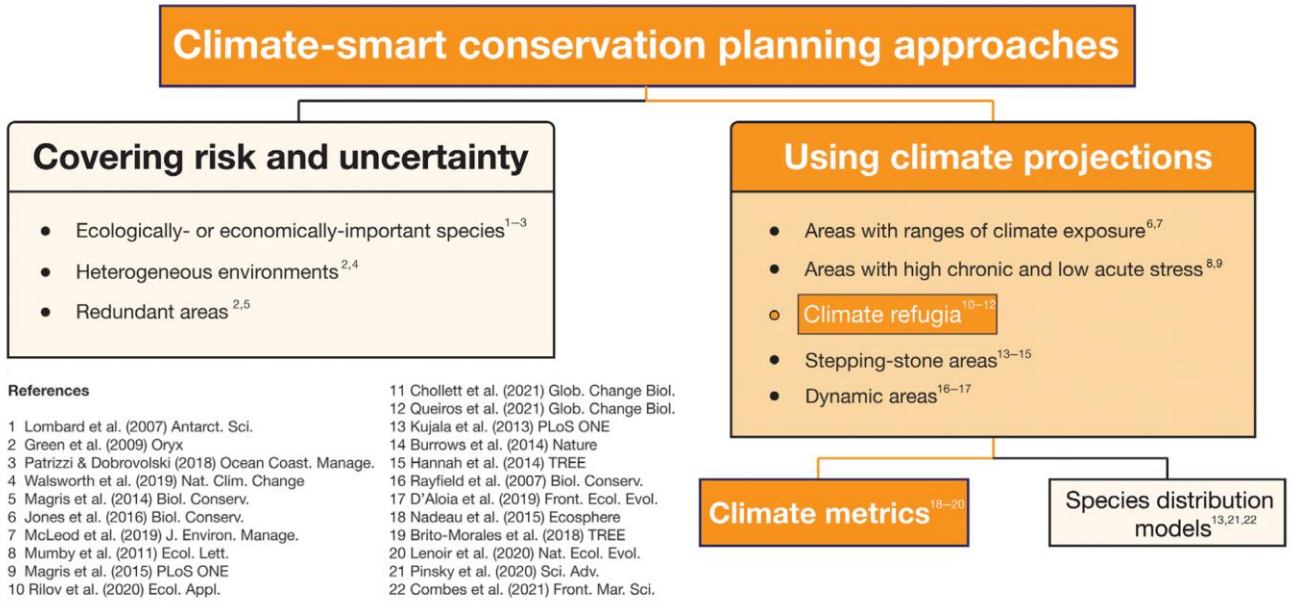
Total protected areas of the world

(Wikipedia; MPAtlas, 2022; IUCN, 2024)

Cat	IUCN Protected Area Management Categories:
Ia	**Strict nature reserve** A marine reserve usually connotes "maximum protection", where all resource removals are strictly prohibited. In countries such as Kenya and Belize, marine reserves allow for low-risk removals to sustain local communities.
Ib	**Wilderness area**
II	**National park** Marine parks emphasize the protection of ecosystems but allow light human use. A marine park may prohibit fishing or extraction of resources, but allow recreation. Some marine parks, such as those in Tanzania, are zoned and allow activities such as fishing only in low risk areas.
III	**Natural monuments or features** Established to protect historical sites such as shipwrecks and cultural sites such as aboriginal fishing grounds.
IV	**Habitat/species management area** Established to protect a certain species, to benefit fisheries, rare habitat, as spawning/nursing grounds for fish, or to protect entire ecosystems.
V	**Protected seascape** Limited active management, as with protected landscapes.
VI	**Sustainable use of natural resources**

03 Role of marine protected areas

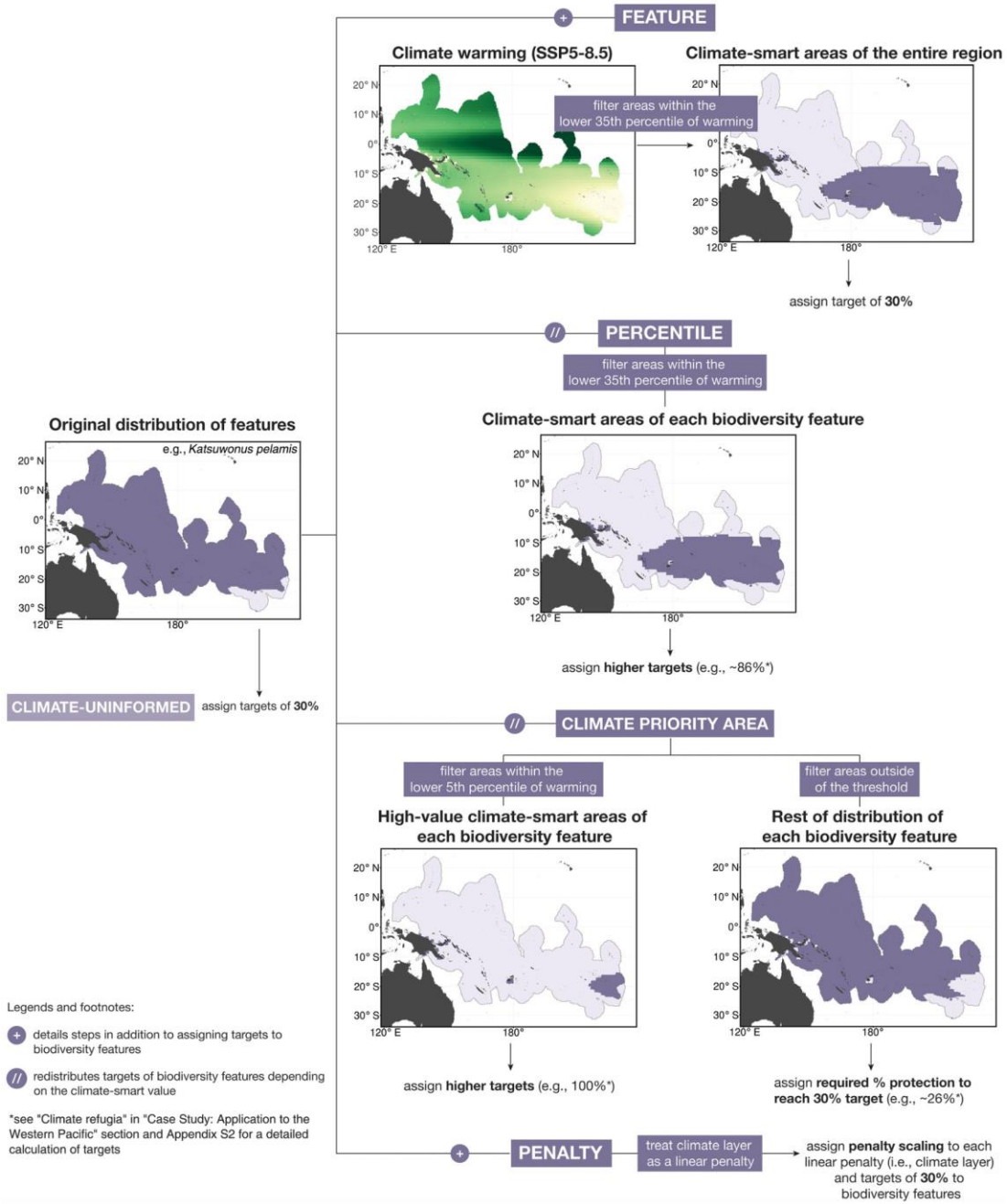
Consider climate change in MPAs building



Approaches to climate-smart conservation planning

Climate change will alter environmental conditions and species distributions, so protected area design must account for these changes to ensure ecosystems can adapt and maintain biodiversity and ensure the effectiveness of conservation measures.

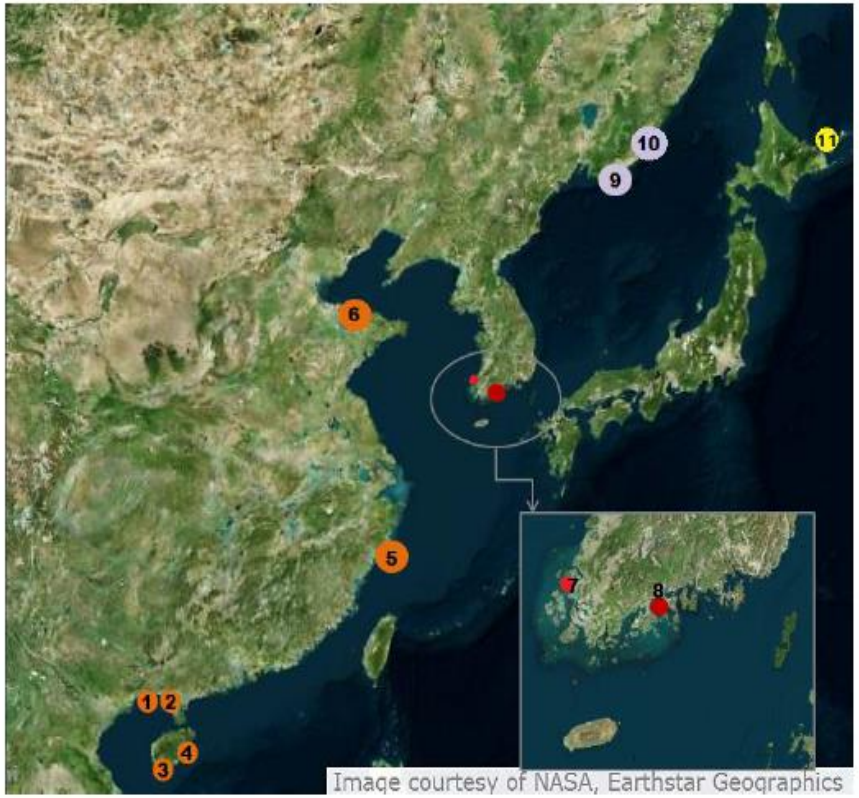
(Buenafe et al., 2022)



Workflows of identifying climate refugia

04 Impacts of climate change on the demonstration area

Chinese protected areas of Northeast Asia MPA Network



All protected areas of the Northeast Asia MPA Network

China	
1	Beilun Estuary National Marine Nature Reserve
2	Shankou Mangrove National Marine Nature Reserve
3	Sanya Coral Reef National Nature Reserve
4	National Nature Reserve of Dazhou Island Marine Ecosystems
5	Nanji Islands National Marine Nature Reserve
6	Changyi National Marine Ecology Special Protected Area
Republic of Korea	
7	Muan wetland Protected Area
8	Suncheon Bay wetland Protected Area
Russian Federation	
9	Far-Eastern State Marine Biosphere Reserve
10	Sikhote-Alin State Natural Biosphere Reserve
Japan	
11	Shiretoko National Park

Details of Protected areas in China

No.	Location	Area (hectares)	Protected Objects
1	Fangchenggang, Guangxi	30,000	Mangrove ecosystem
2	Hepu, Guangxi	8,000	Mangrove ecosystem
3	Sanya, Hainan	4,000	Coral reefs and their ecosystems
4	Wanning, Hainan	7,000	Swallows and their habitats, marine ecosystem
5	Pingyang, Zhejiang	19,600	Marine mollusks and their habitats
6	Changyi, Shandong	2,929	Various coastal wetland ecosystems dominated by tamarisk and marine life

Thanks for your listening

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