The change in the environment and fish community structure in an enclosed bay western Japan over the last five decades

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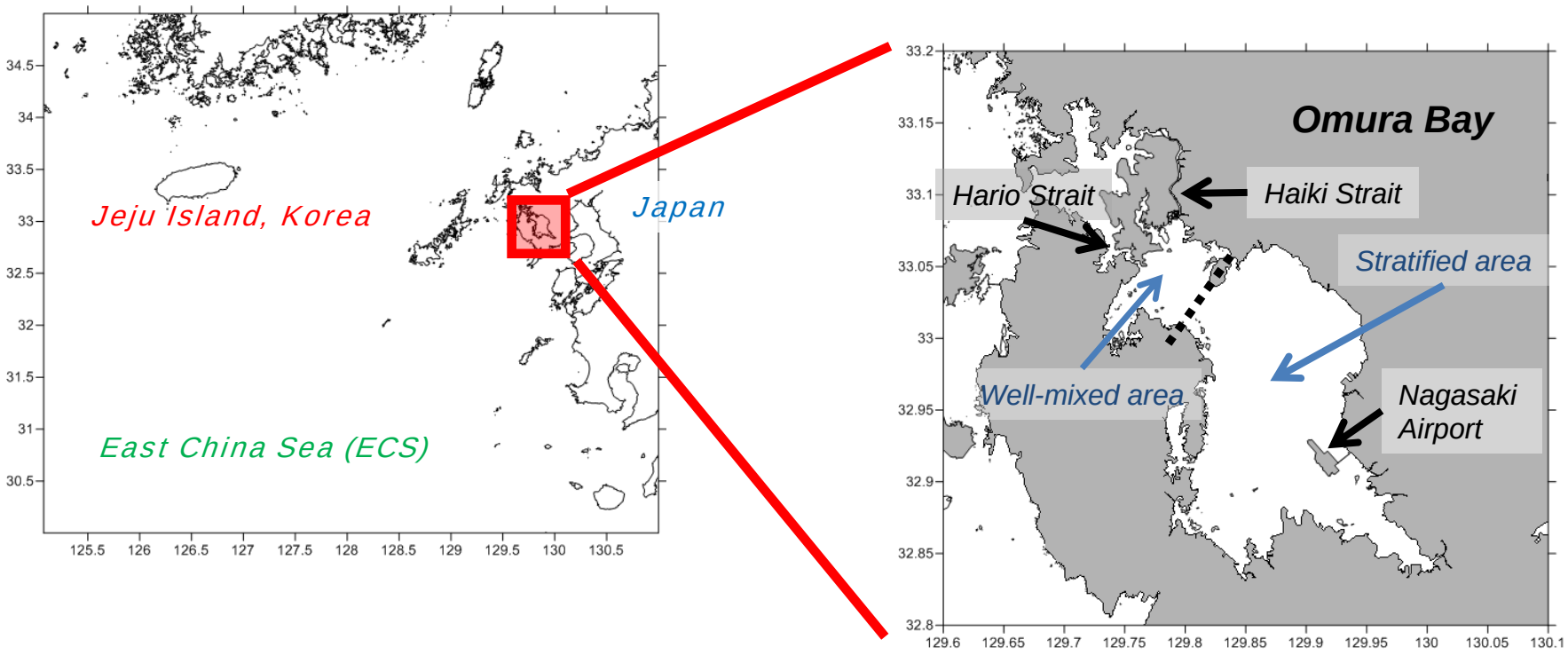
Geographical and physical features of the study area (1)



- *An enclosed bay connected to East China Sea (ECS) through very narrow straits*
- *Due to the enclosed feature, water exchange is extremely small*
- *Suffering from the problem of eutrophication such as hypoxia formation*

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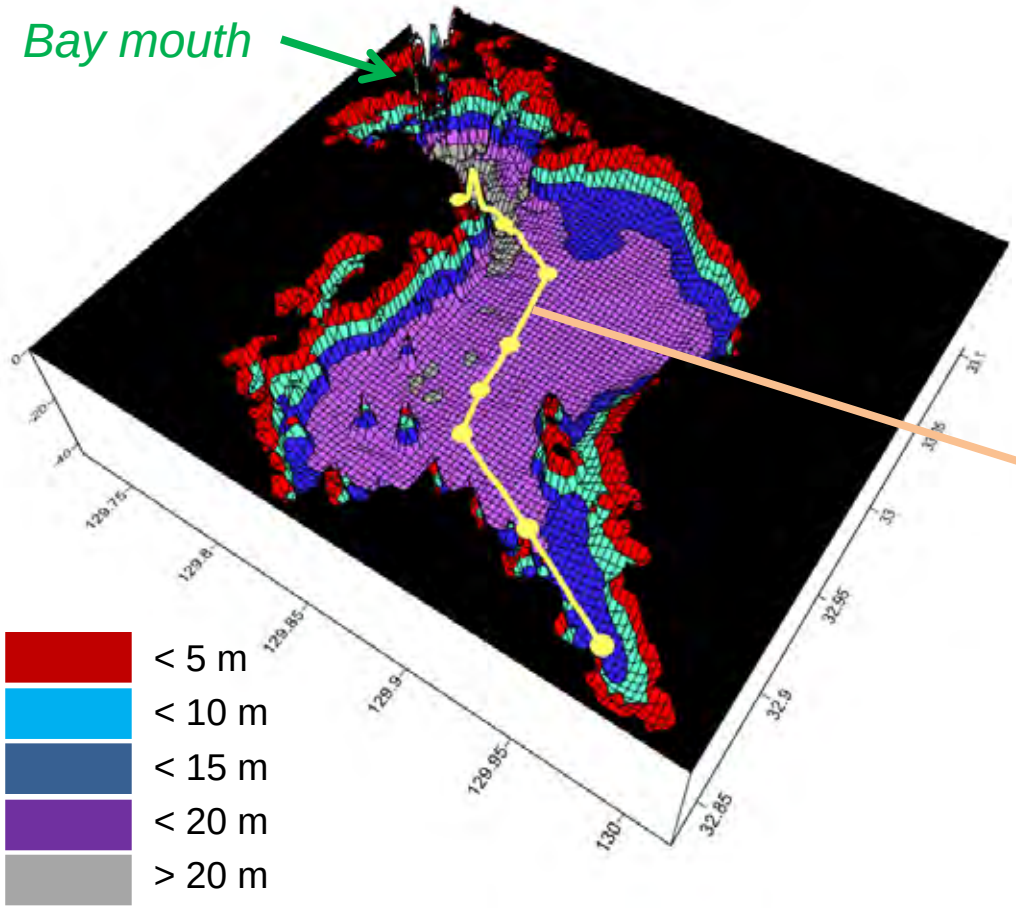
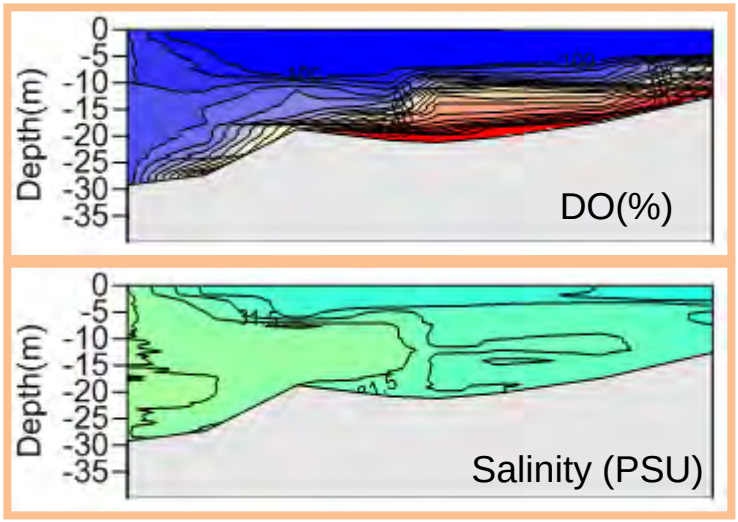




- *Average depth : 15 m with a flat basin*
- *The area < 5 m : 8.6%*

- *Occurrence of hypoxia in summer ← the regional-scale cyclonic circulation (Takahashi et al, 2009)*

Main purposes of this study

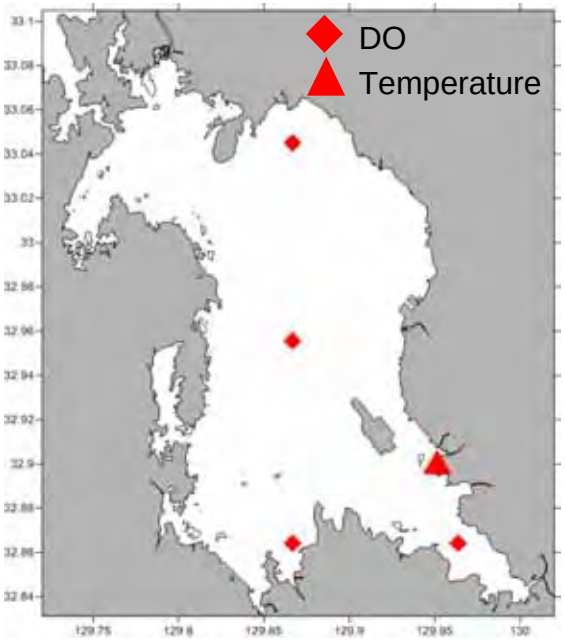
- *to investigate the long-term changes in fish community structure in Omura bay*

- *to attest the possible causes of those changes*

Based on the results of the above-mentioned analysis,

- *to deepen our understanding of anthropogenic effect on a coastal marine ecosystem*

Data set



➢ Environmental data

- ✓ *Temperature (National Pearl Research Laboratory)*
- ✓ *Dissolved oxygen (Nagasaki Prefectural Institute of Fisheries)*
- ✓ *Reclamation (Geospatial Information Authority of Japan)*

➢ Climate index

- ✓ *Pacific Decadal Oscillation (http://jisao.washington.edu/pdo/PDO.latest)*

➢ Catch data

- ✓ *Statiscal Yearbook of Ministry of Agriculture, Forestry and fisheries in Japan*
- ✓ *Fish groups (26 species) are divided into four groups based on their feeding habit*

- ***Pelagic planktivores (5 species)***
- ***Pelagic piscivores (8 species)***
- ***Demersal piscivores (4 species)***
- ***Demersal benthivores (9 species)***

Data analysis

➢ Fishing efforts and Catch Per Unit Effort (CPUE)

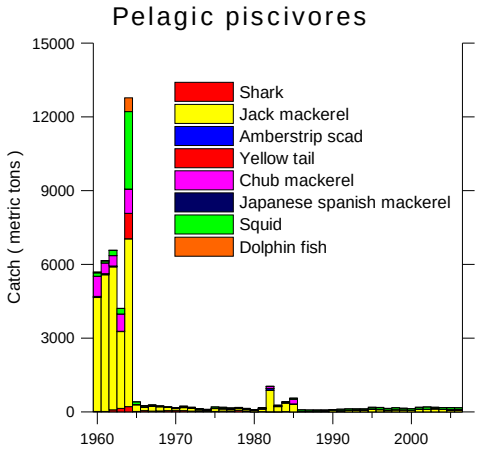
- ✓ *Fishing effort : the cumulated days in the year for purse seine and bottom trawl*
- ✓ *Catch per unit effort*
- ❖ *Pelagic domain : metric tons / days for purse seine*
- ❖ *Demersal domain : metric tons / days for bottom trawl*

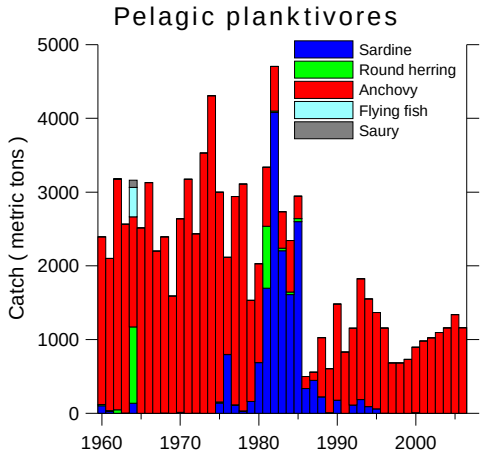
➢ Mean Trophic Level

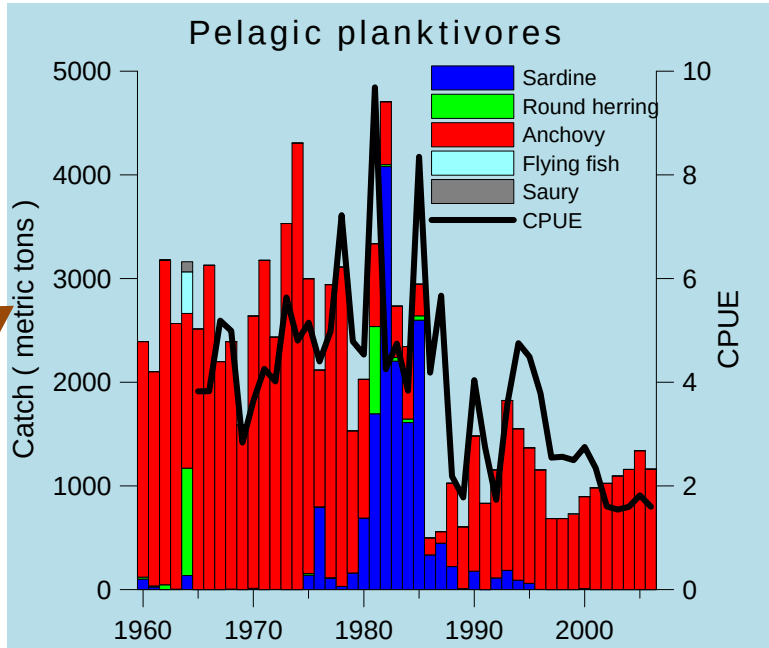
$$MTL = \sum_{i=1}^{n} Y_{iy} TL_i \Big/ \sum_{i=1}^{n} Y_{iy}$$

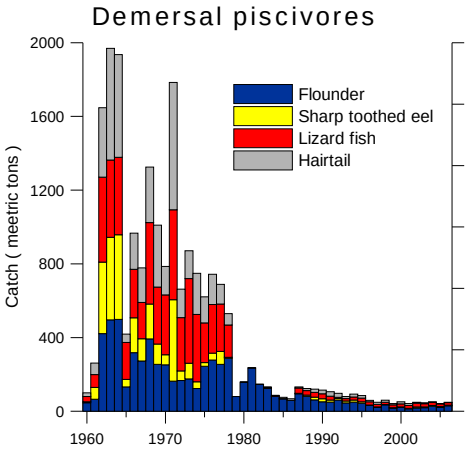
- ✓ *Where Y_{iy} is the catch of species i in the year and TL_i is its trophic level from fish base (http://www.fishbase.org/search.php)*

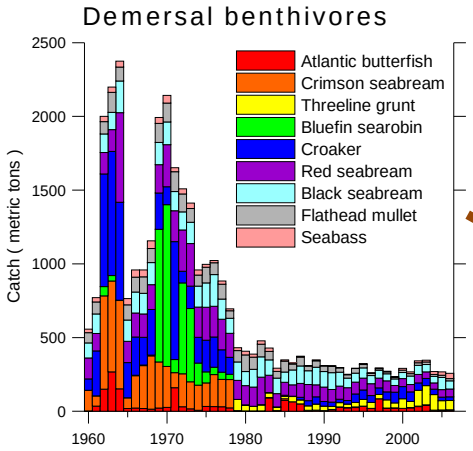
Chronological variation in fish community structure in Omura bay

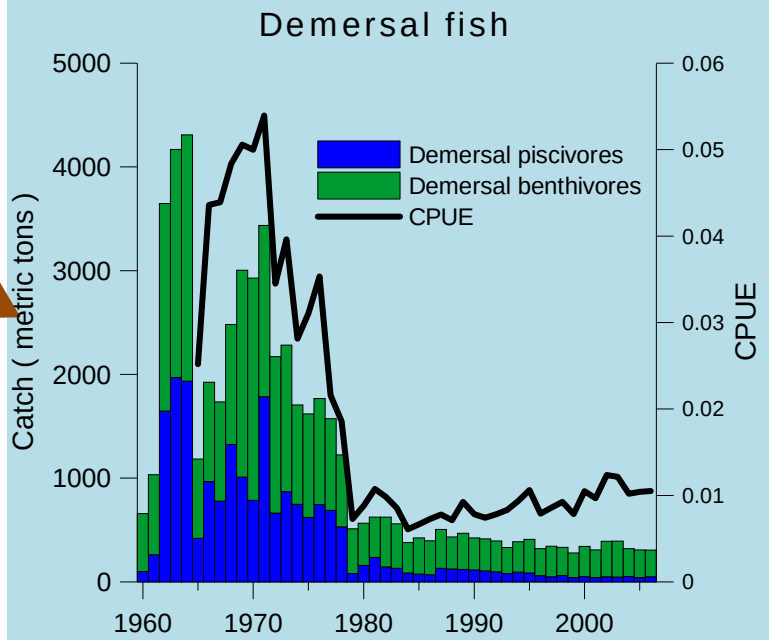






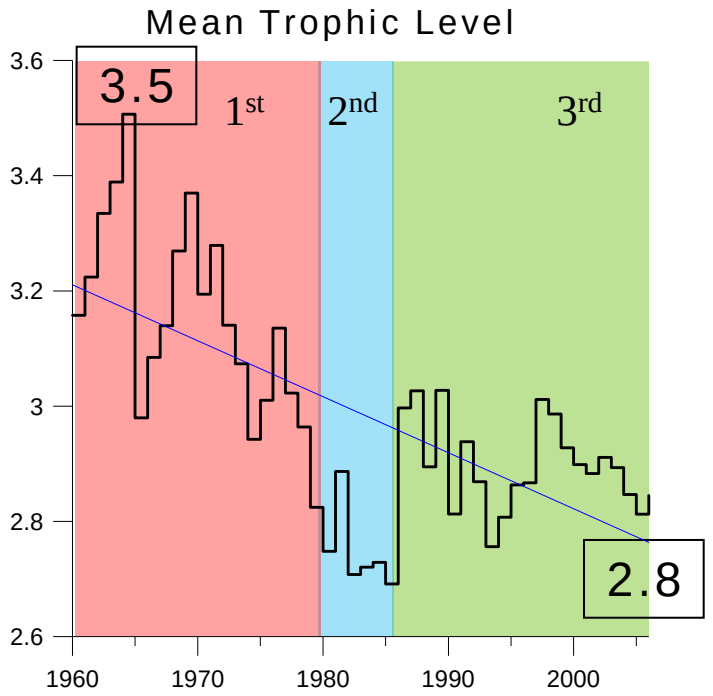




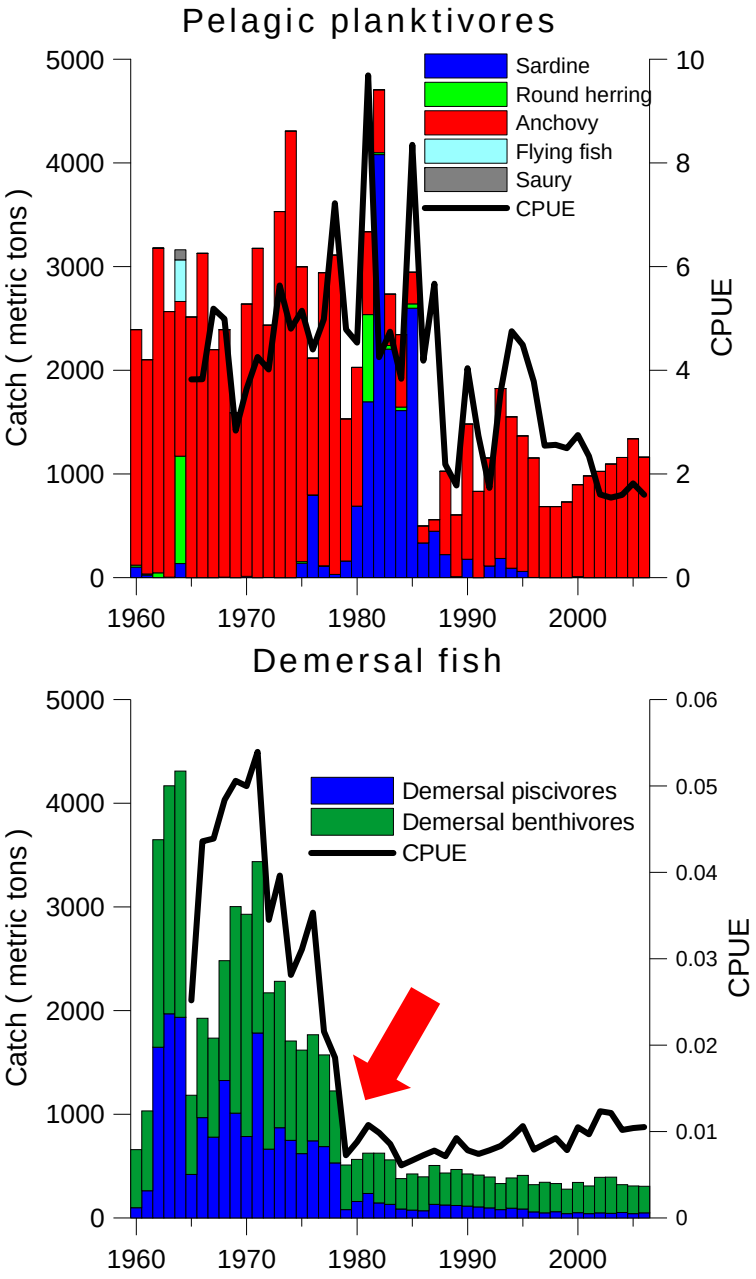


◆ Change in Mean Trophic Level (MTL)

- ***The highest level of MTL in the first phase***
- ***The lowest level in the second phase***
- ***Continuous low level in the third phase***



Chronological variation in fish community structure in Omura bay



The time change was divided into three phases ;

✓ ***The first phase (1960-1979) :***

→ *dominated by anchovy in the pelagic domain and characterized a variety of demersal fish species*

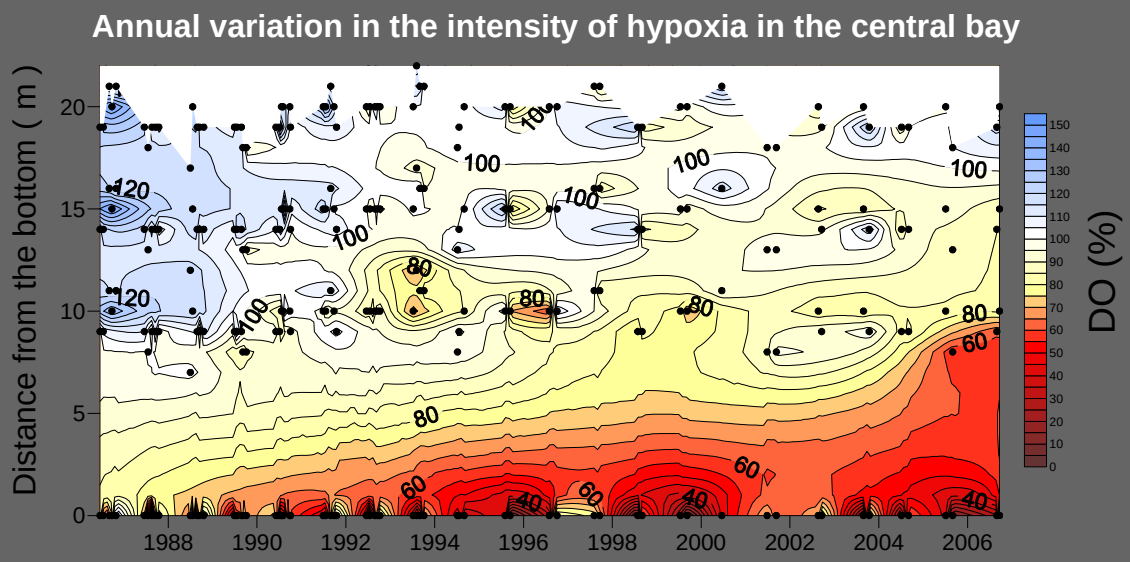
✓ ***The second phase (1980-1985) :***

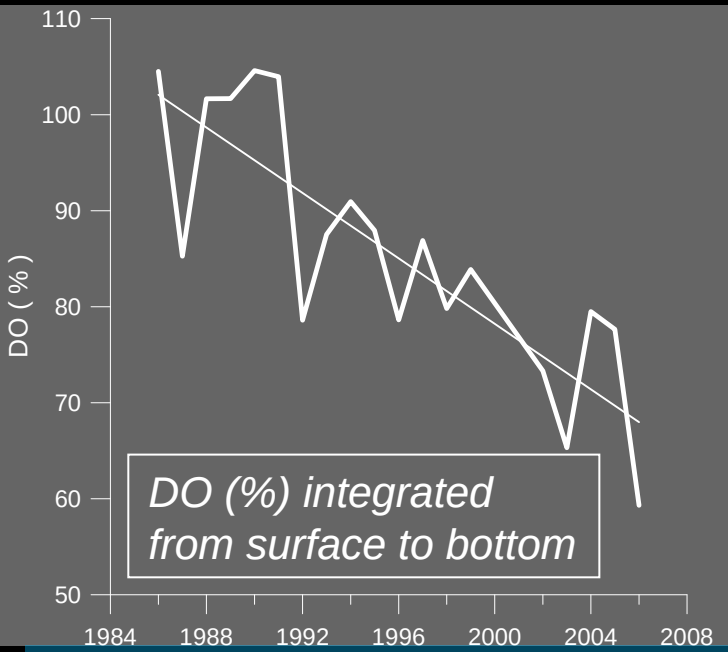
→ *the remarkable decline in demersal fish landings with sardine dominance in the pelagic domain*

✓ ***The third phase (1986-2006) :***

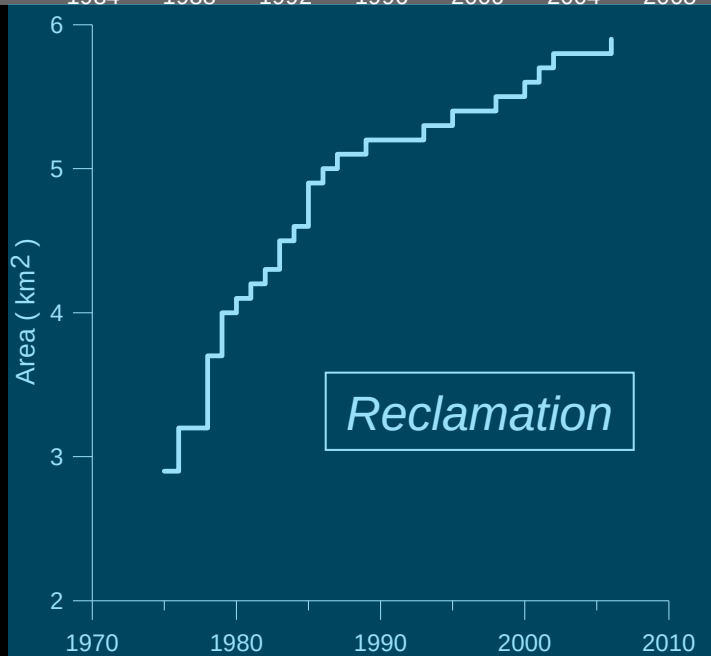
→ *anchovy return with further reducing demersal fish landings*

Environmental change in the demersal domain of the bay

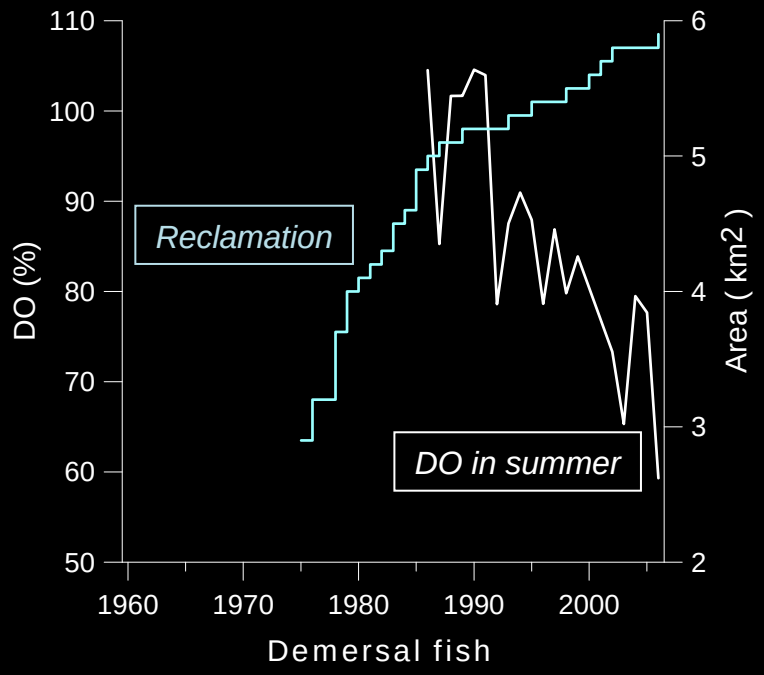


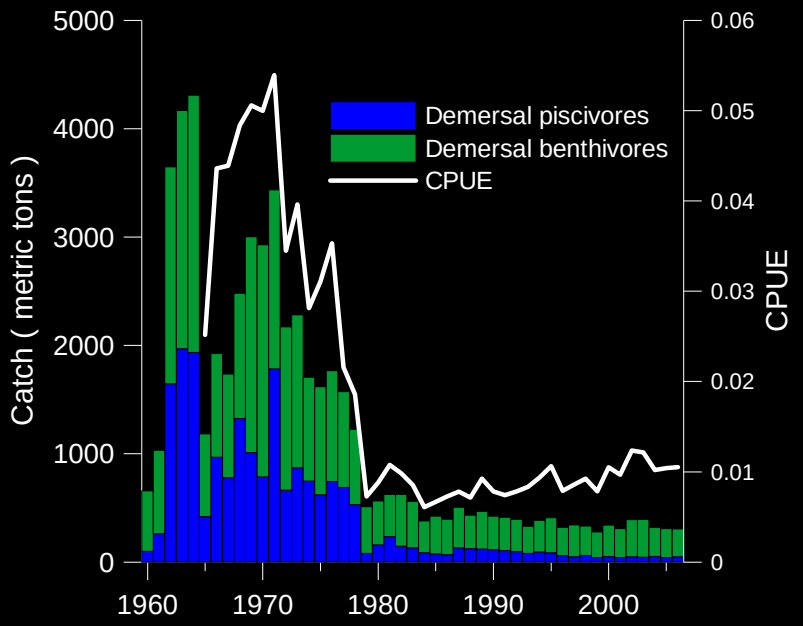


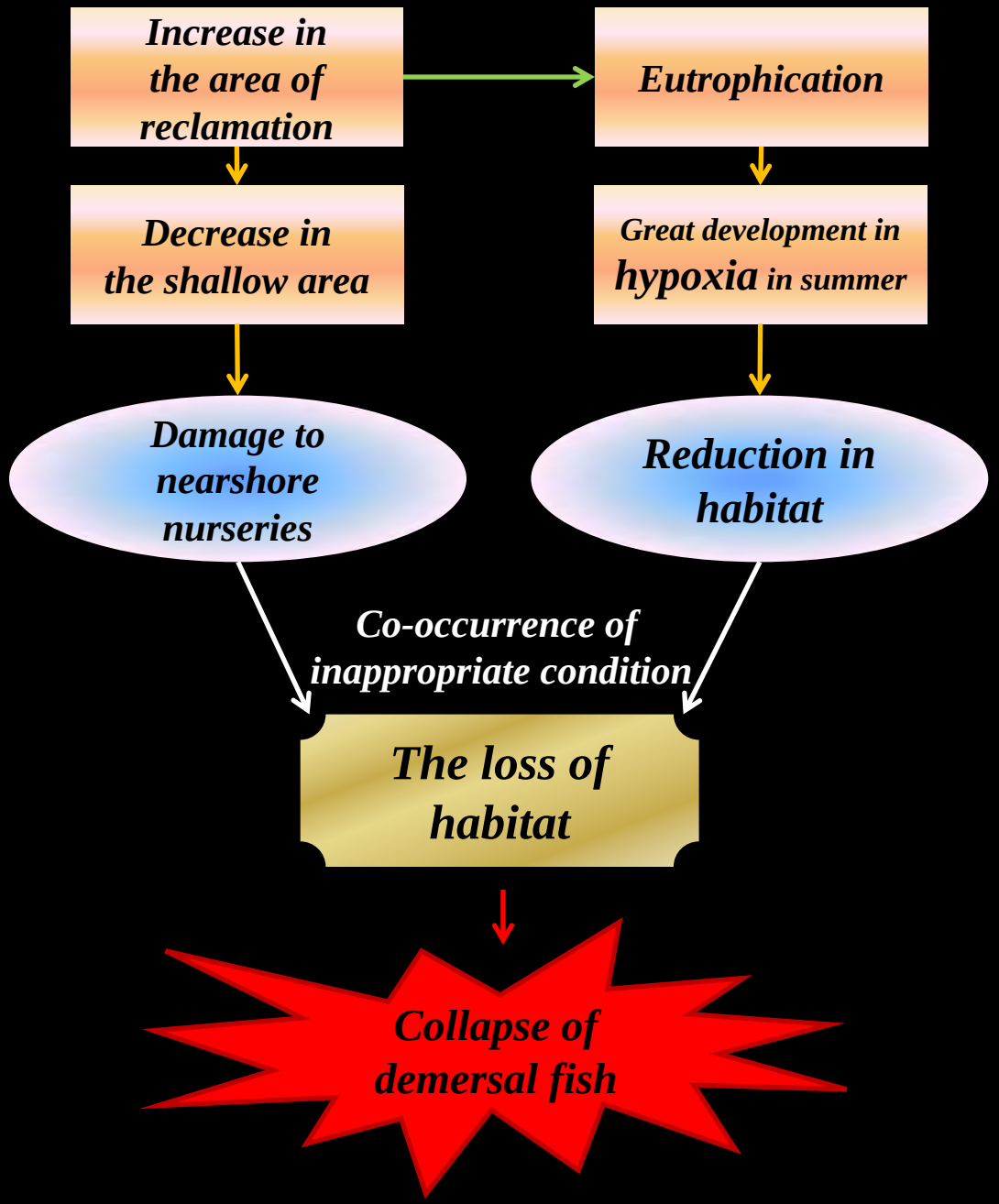
- ***Increase in the intensity of hypoxia in the central bay in summer***
- ***A downward trend in DO integrated from surface to bottom in the bay***
- ***Increase in accumulated areas of reclamation since the late 1970s***



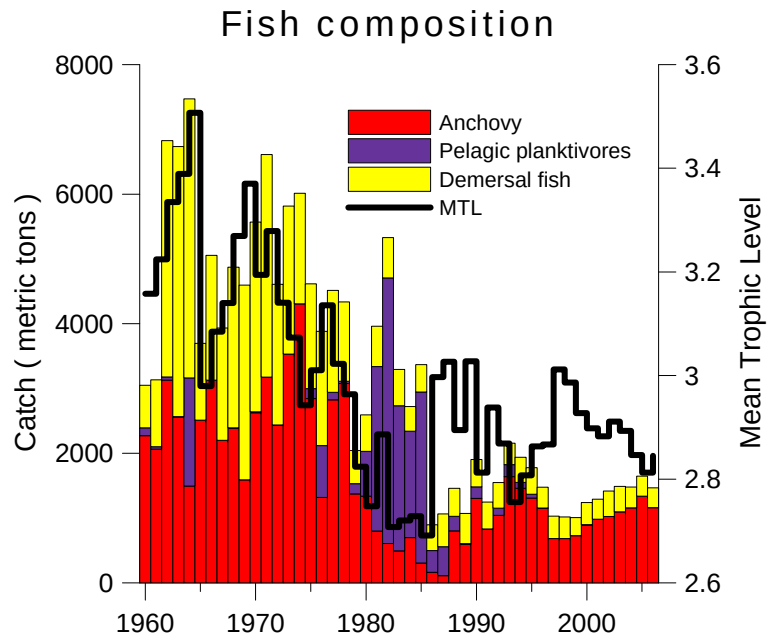
The response of demersal domain to human impacts

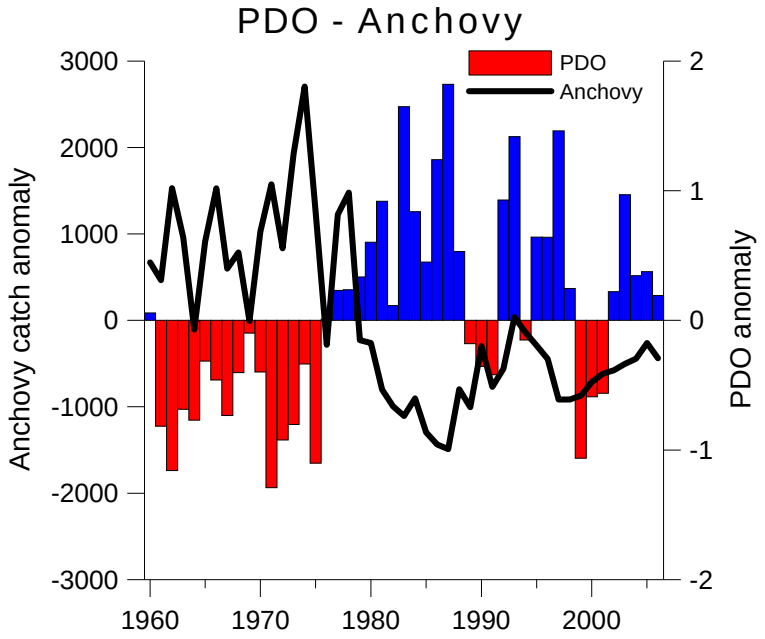






Simplification of fish community structure in the bay





Causes of simplification during the third phase

- ***The collapse of demersal fish***

- ***The lack of species diversity in pelagic domain***

MTL during third phase correlated with anchovy catch (r = -.922, p < 0.01)

- ***The dominance of anchovy with further reducing***

- *Correlationship with Basin-scale temperature fluctuation, Pacific decadal oscillation (r = -. 590, p < 0.01)*
- *Warm phase in the northwestern pacific may enhance the anchovy dominance*

Concluding remarks (1)

- *The long-term change in fish community structure of Omura Bay, an enclosed bay in the western Japan, was divided into three phases.*

❖ ***The first phase (1960-1979):***

✓ *Anchovy dominance in the pelagic domain with abundant and a variety of d emersal fish species*

❖ ***The second phase (1980-1985):***

✓ *Remarkable decline in demersal fish landings*

← *Inappropriate habitat conditions*

✓ *Sardine dominance in the pelagic domain*

← *S/A replacement in the northwestern Pacific*

❖ ***The third phase (1986-2006): Simplified fish community***

✓ *Anchovy return*

← *Basin-scale change in temperature*

✓ *Further reducing demersal fish landings*

← *No signal of recovery*

Concluding remarks (2)

- ***Fish community structure in Omura Bay, especially in the demersal domain, has been seriously damaged by exacerbating habitat conditions caused by regional human impacts. However, fish composition in the pelagic domain seems to be closely related to large-scale variation in environment.***

- ***This suggest that even in an enclosed coastal bay, for clarifying the mechanism of ecosystem structure changes in combination with the anthropogenic impact, it is indispensible to look at a wider scale feature of the ecosystem including the change in the ocean climate of outer seas such as the East China Sea.***