Comparative analysis of the Inland Sea of Japan and the Northern Adriatic Sea: Can changes in anthropogenic pressure disclose jellyfish outbreaks?

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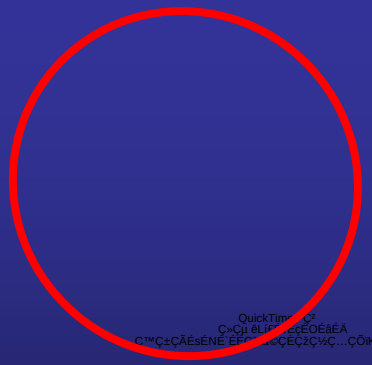


Northern Adriatic Sea

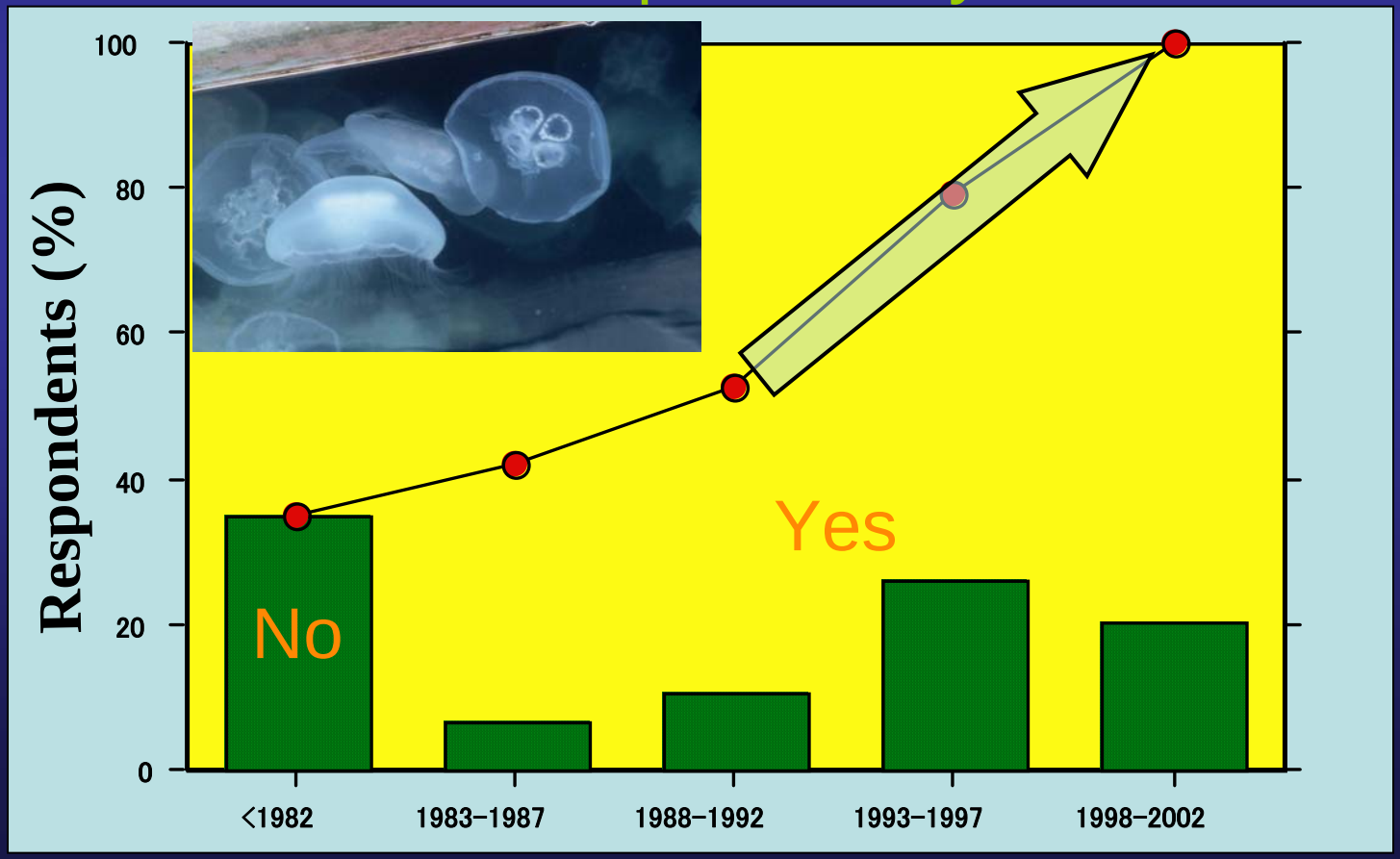
Comparison: the Inland Sea of Japan (ISJ) vs the Northern Adriatic Sea (NAS)

	ISJ	NAS
Area (km^2)	23,202	19,000
Average depth (m)	38.0	34.0
Volume (km^3)	881.5	635
Annual river flow volume (km^3/yr)	50,000	90,000
Rain catchment area (km^2)	47,895	118,000
Water residence time (months)	15	2~3
Annual temperature range (^oC)	10~28	10~26
Median chlorophyll *a* biomass (mg/m^2)	2	2
Annual primary production (g C/m^2/yr)	285	90
Population (million)	30	25

Increase of *Aurelia aurita* medusae in the Inland Sea of Japan

Polls of 1,152 fishermen with ≥20 years of experience:
"Did *Aurelia aurita* medusae increase?"

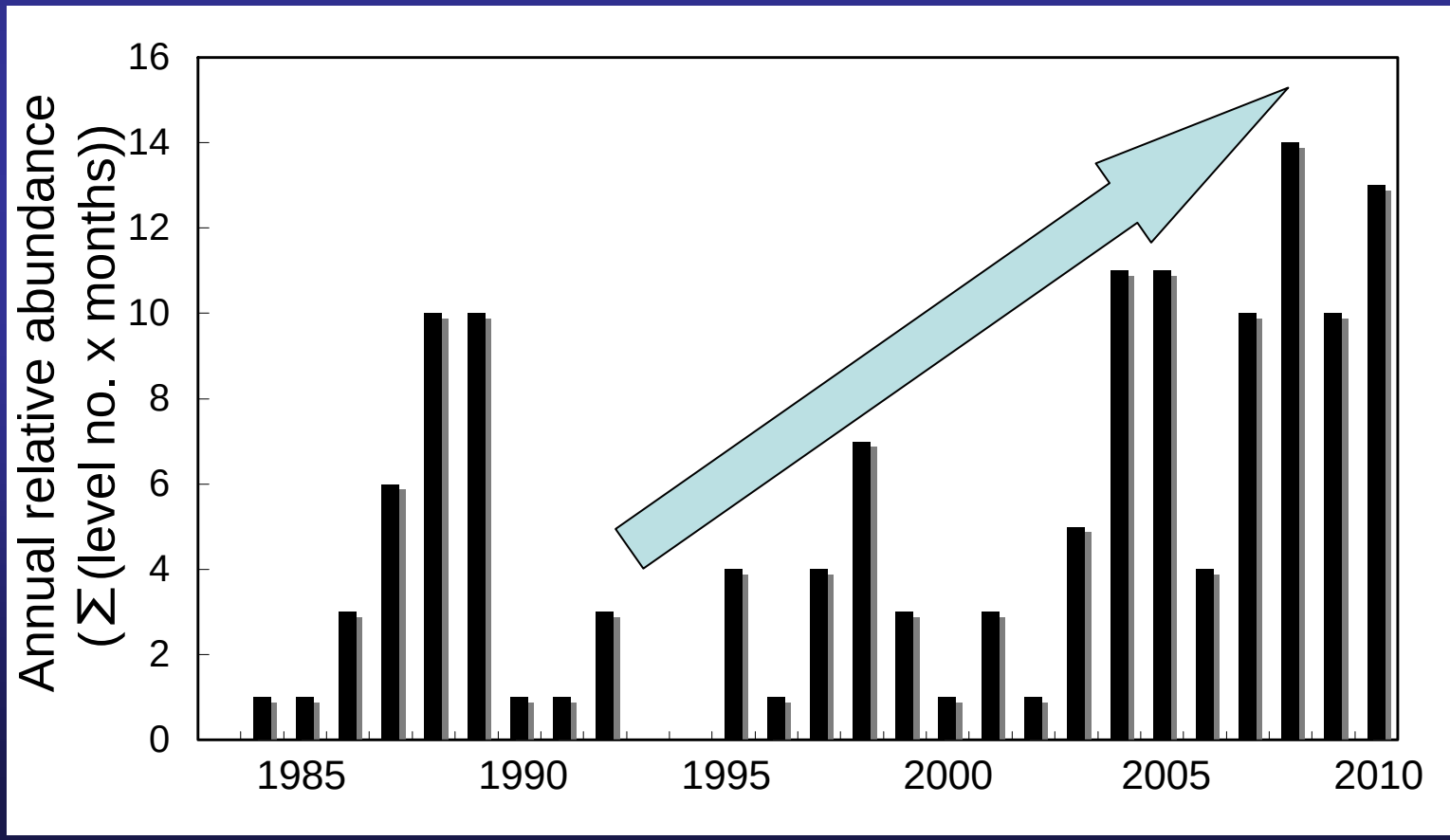
Respondents:
35%: "No", 65%: "Yes, particularly after the 1990s"



Increase of *Aurelia aurita* medusae in the Northern Adriatic Sea (Gulf of Trieste)

Based on monthly monitoring of relative abundance

Level 0: absent, Level 1: present but few,
Level 2: several, Level 3: many (bloom)



Effect of temperature and food supply on polyp reproduction rate

Duration: 35 days

Temperature
18°C
22°C
26°C
28°C

Eutrophication

Warming

Number of buds polyp^{-1}

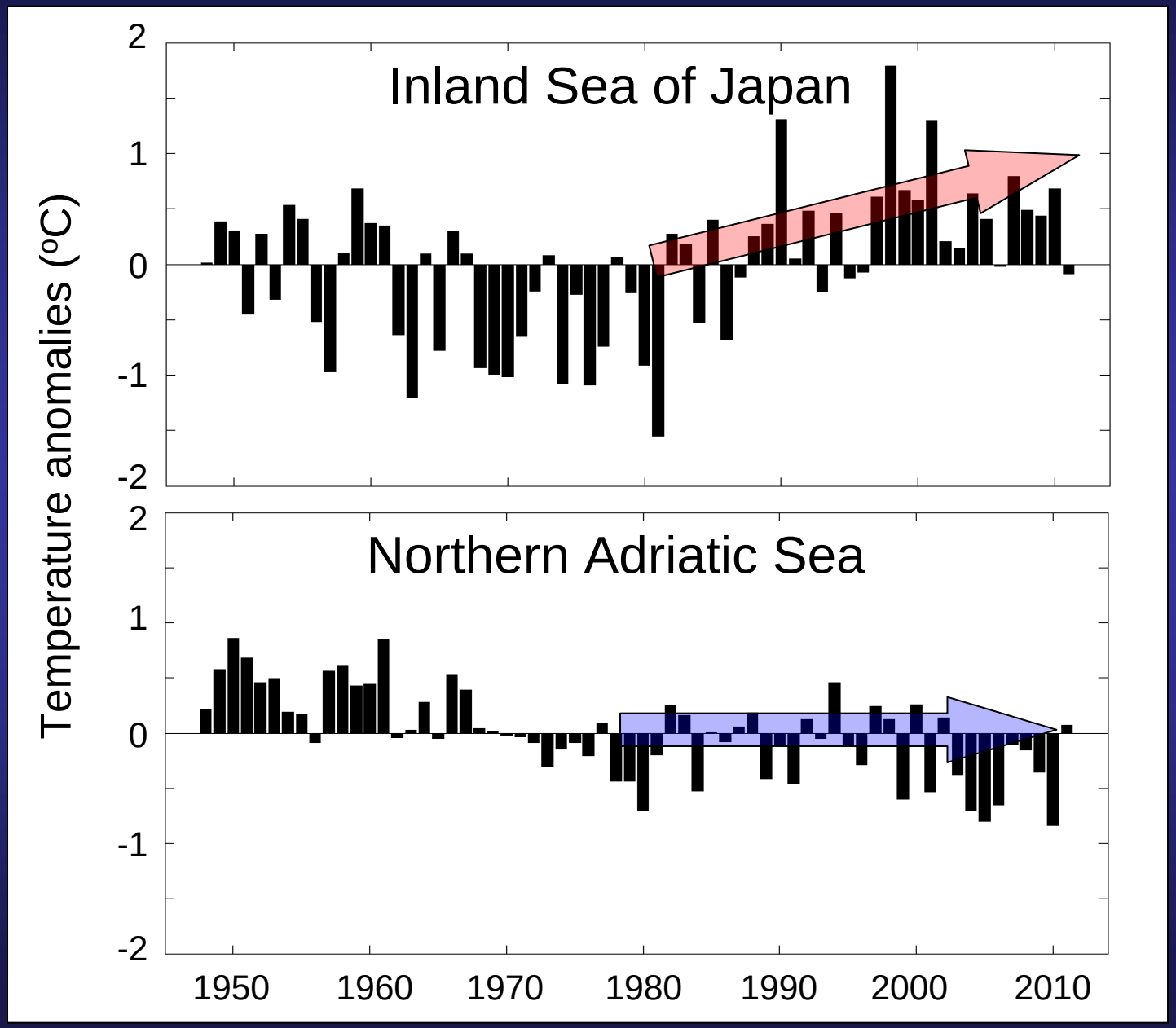
0
10
20
30
40
50

1.7
3.3
6.6
10.0
13.3

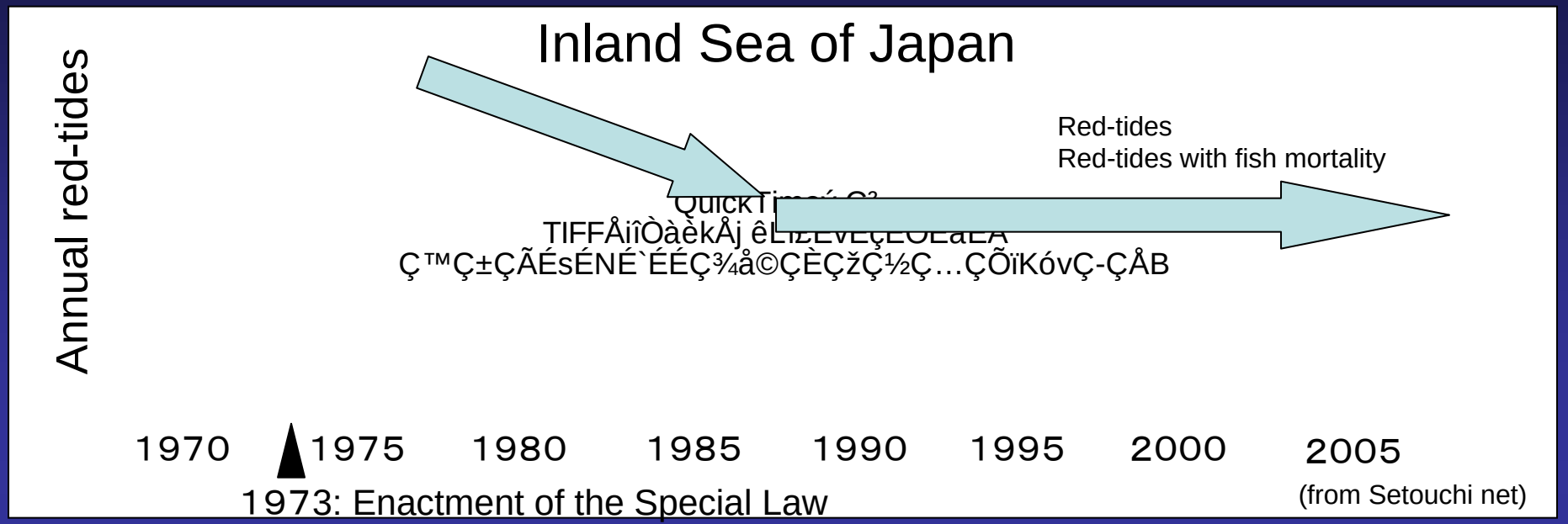
Food supply (μg C polyp^{-1} d^{-1})

(from Han and Uye, 2010)

Water temperature change



Eutrophication or oligotrophication

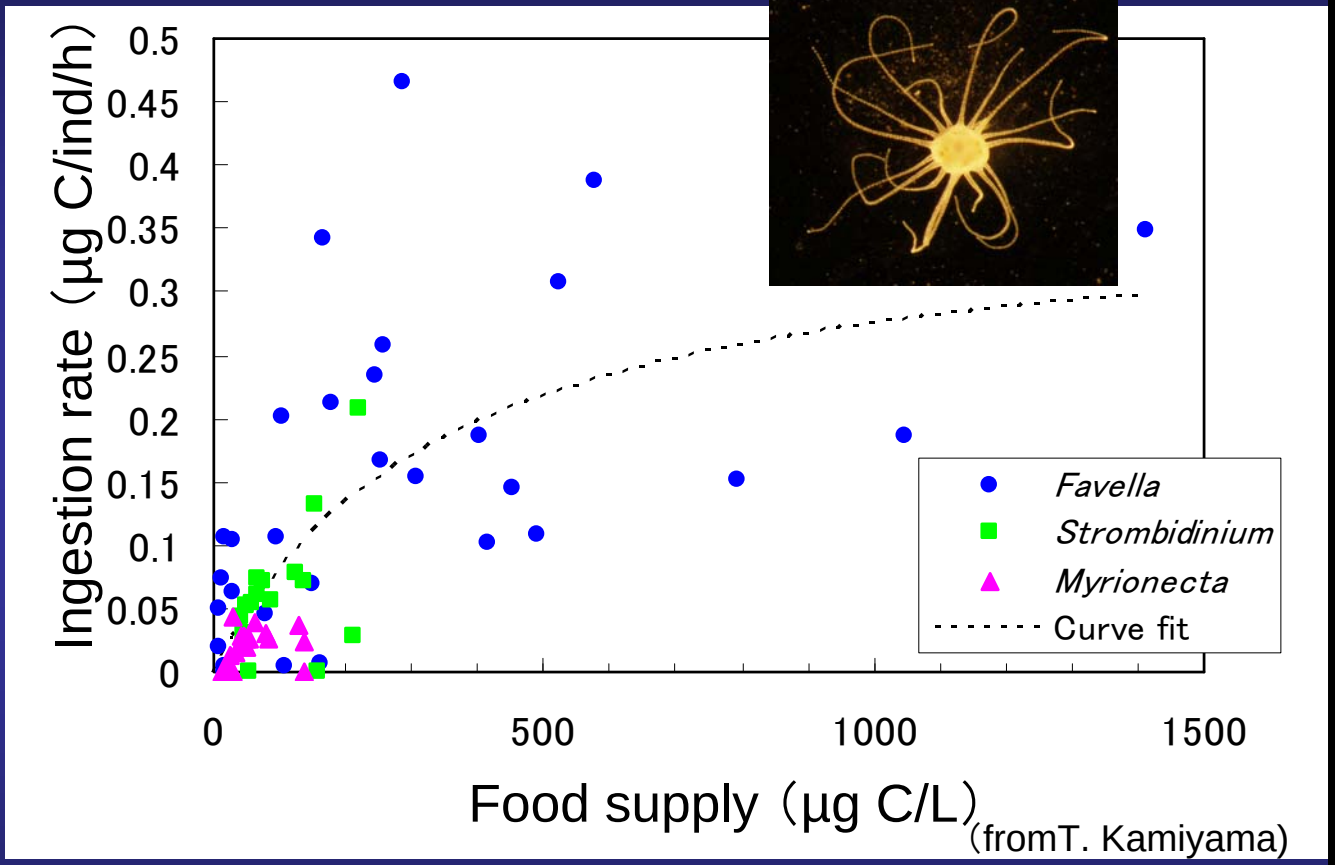


Northern Adriatic Sea

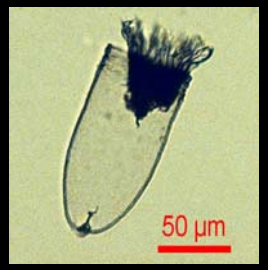
In the 1970s and 80s, eutrophication was considerable (e.g. frequent red tides, high chlorophyll concentrations and proliferation of benthic algae such as *Ulva).*

In late 1980s and 90s, measures (e.g. sewage treatment, ban of P in detergents, modified practice of agriculture) were taken to result in oligotrophication

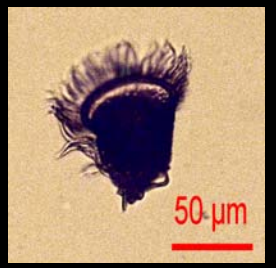
Polyp's main food: Microzooplankton



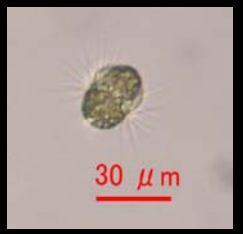
(fromT. Kamiyama)



Favella spp.
ESD=55 µm, 46 µm



Strombidium sp.
ESD=38 µm

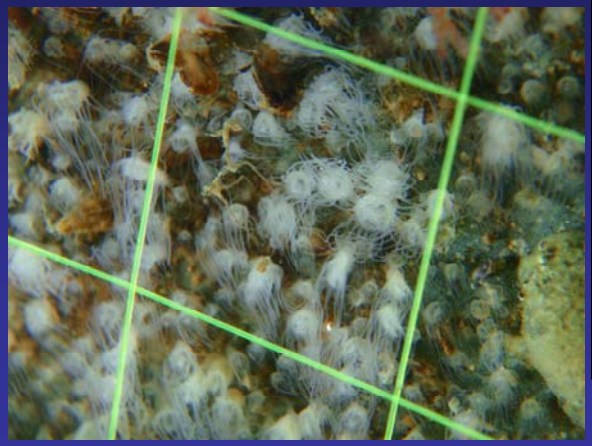


Myrionecta rubra
ESD=21 µm

Microzooplankton may increase in local areas:
- Local eutrophication
- Change in nutrient (N, P, Si) composition
- Dominance of microbial food chain

Polyp's habitat: Undersurface of artificial structures

Polyps



Installed on 9 April, 2010

Ephyrae

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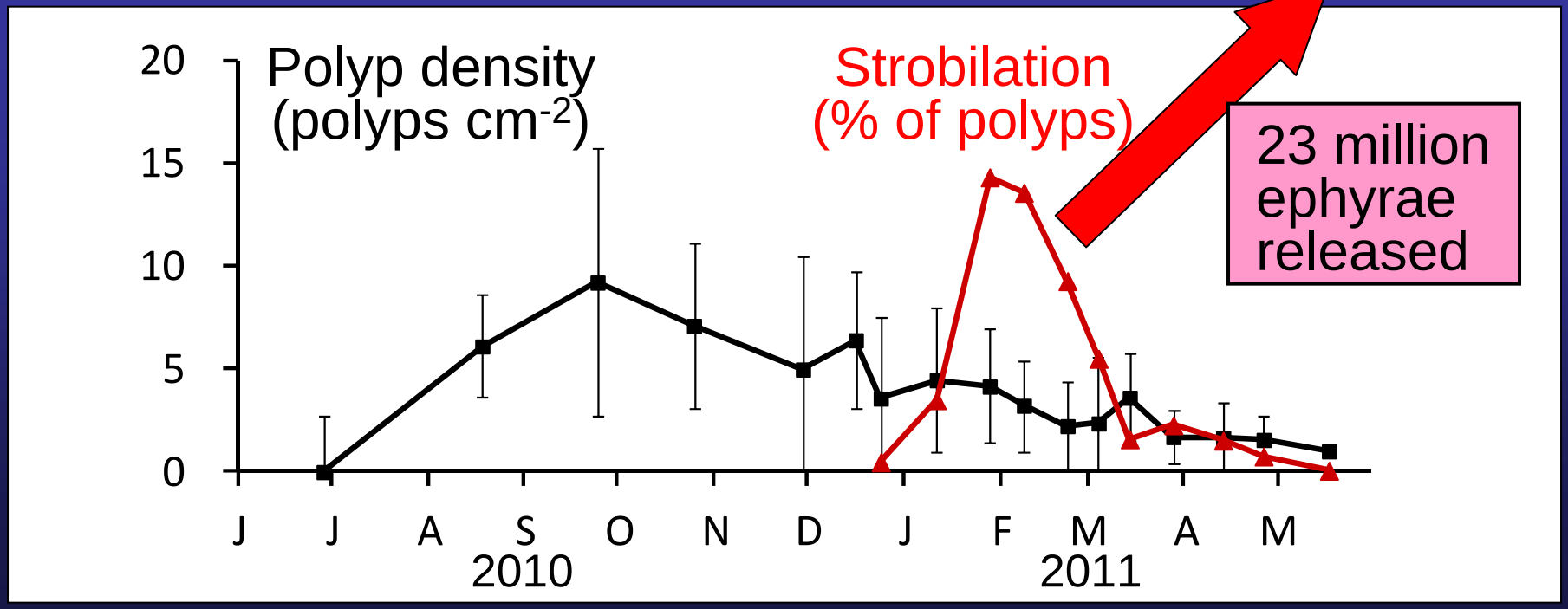

Marine constructions: Artificial coastline

In 1996

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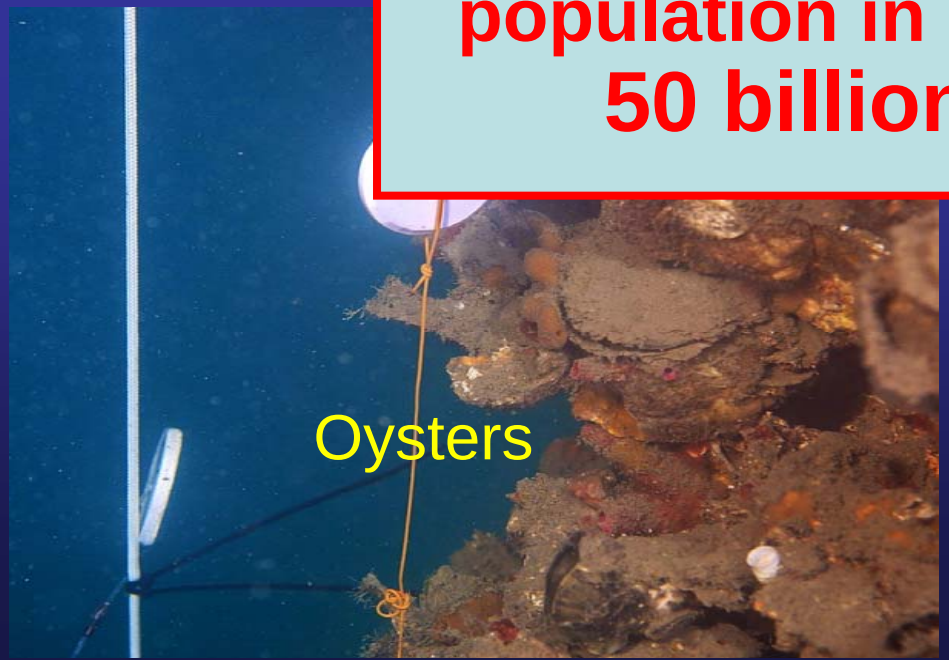
Estuary
Natural
Artificial
Half-Natural

In 1978, total length of artificial coastline: 2,925 km (43.6%)
In 1996, total length of artificial coastline: 3,533 km (48.9%)

Polyp colonies in Port of Koper, Slovenia

k pillars

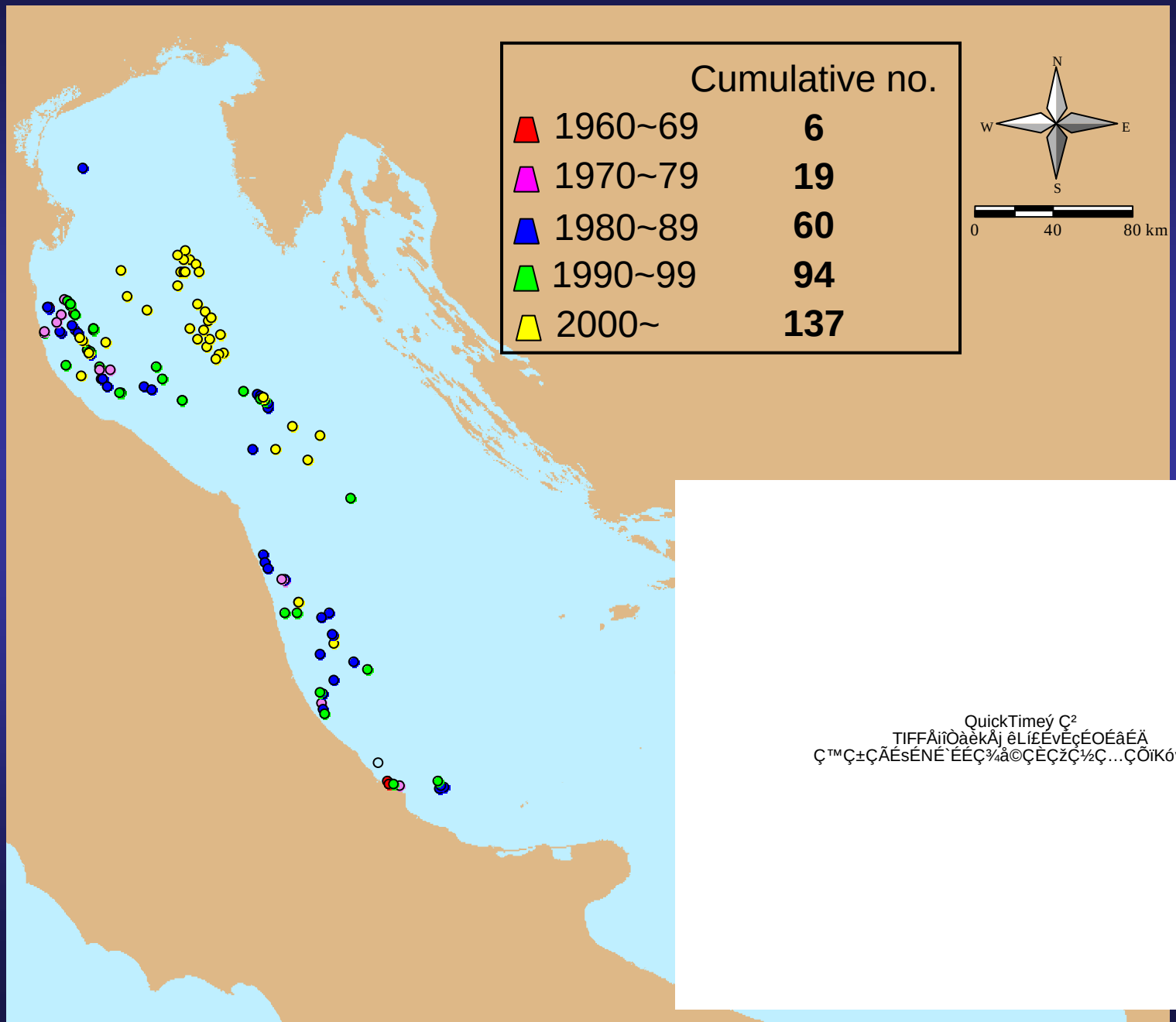
Potential number of ephyrae released from the polyp population in Port of Koper: 50 billion ephyrae



Oysters

Strobilated polyps

Marine constructions: Offshore oil/gas platforms



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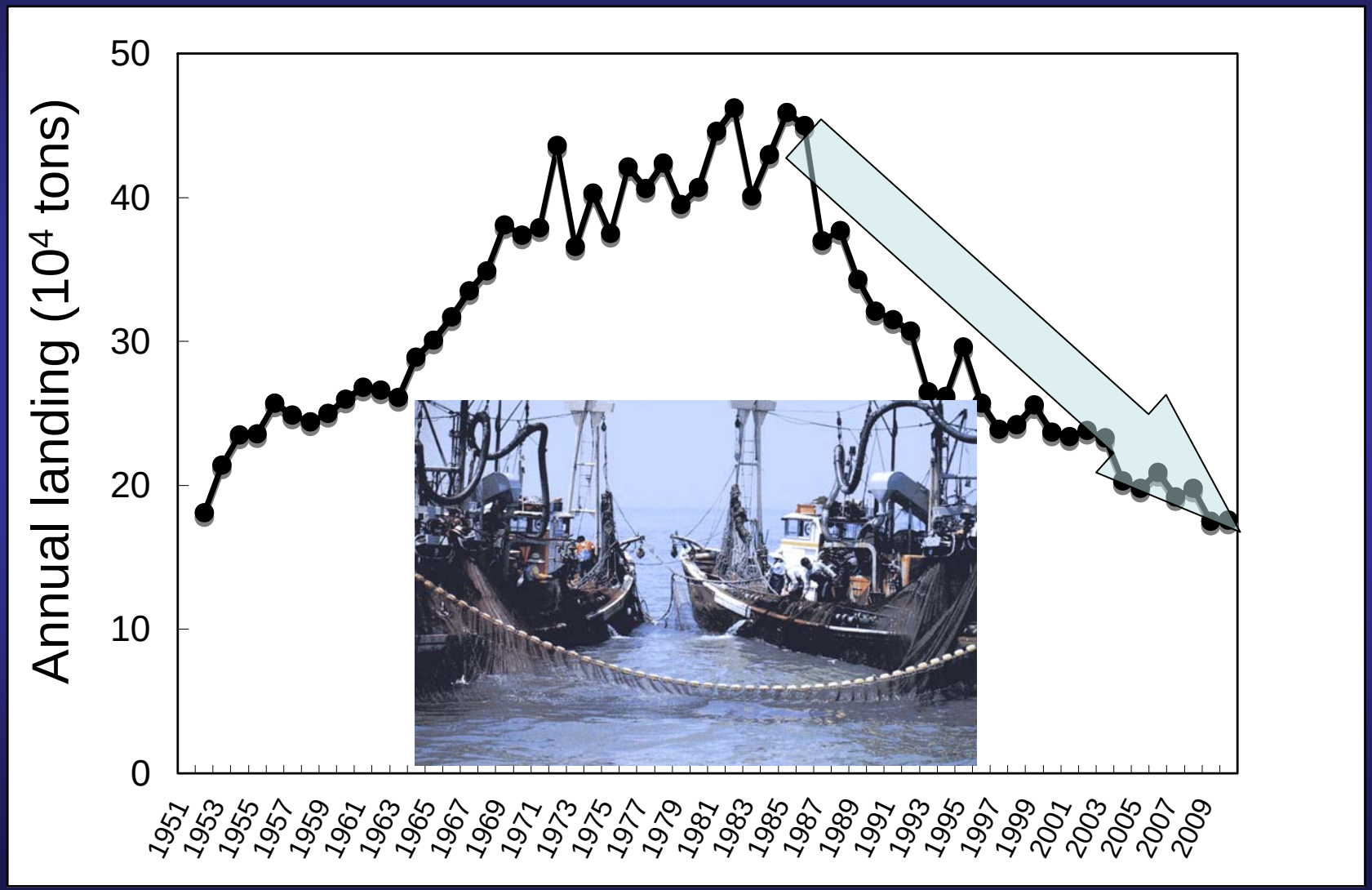
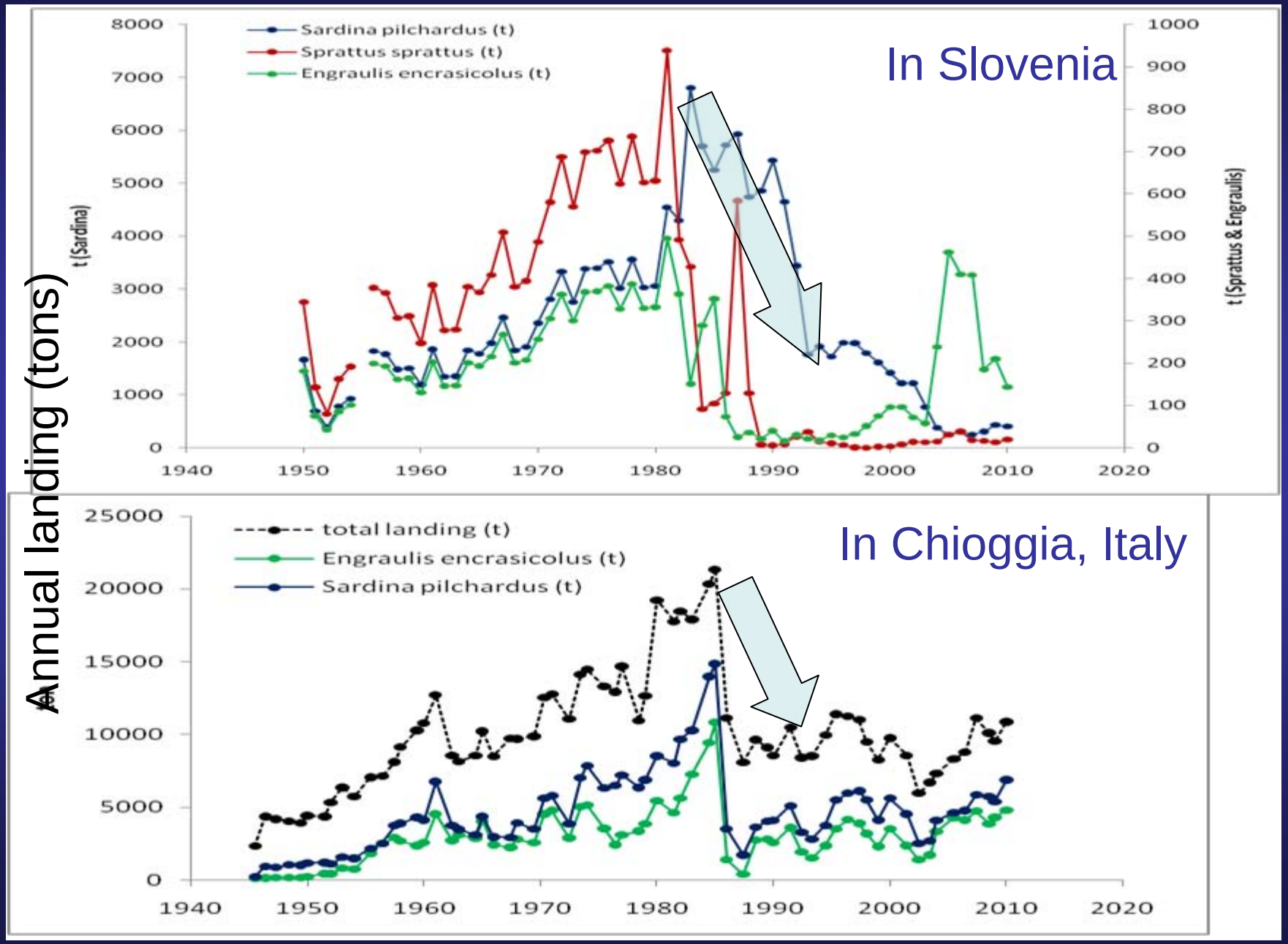
Fish catch in the Inland Sea of Japan



Fish catch in the Northern Adriatic Sea



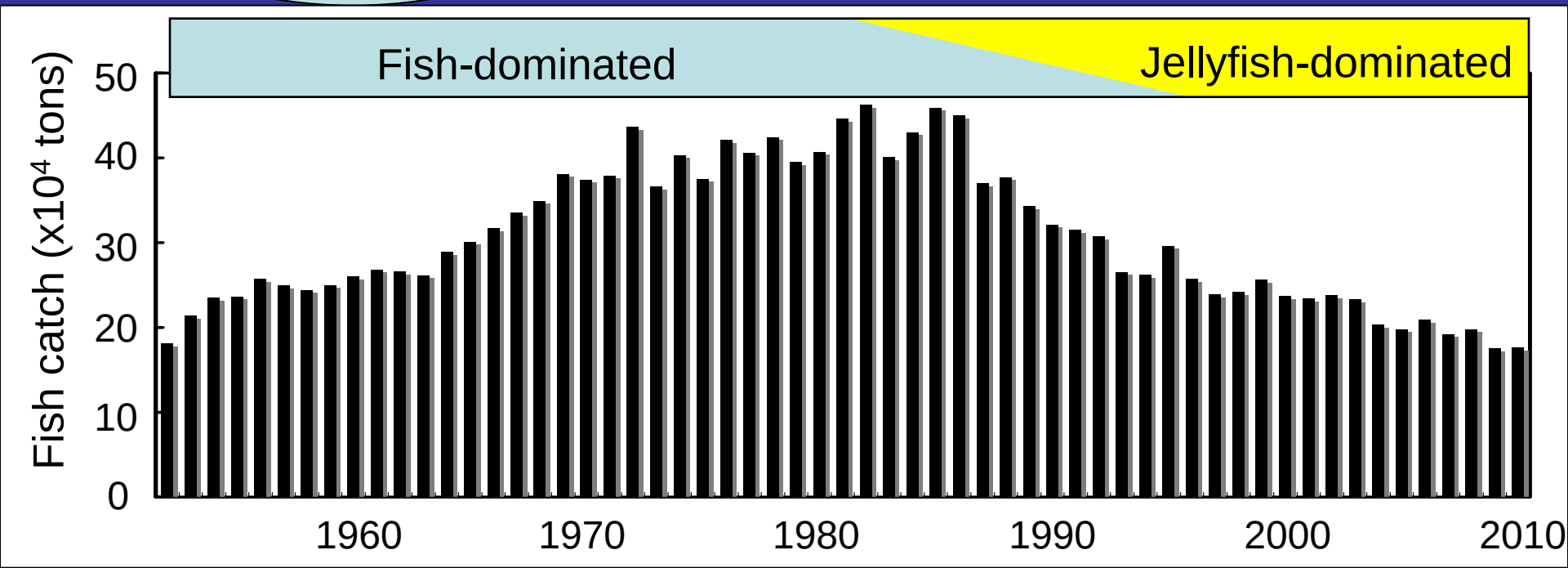
Ecosystem change in the Inland Sea of Japan

Fish-dominated ecosystem

Warming
Marine construction
Overfishing

Eutrophication?

Jellyfish-dominated ecosystem



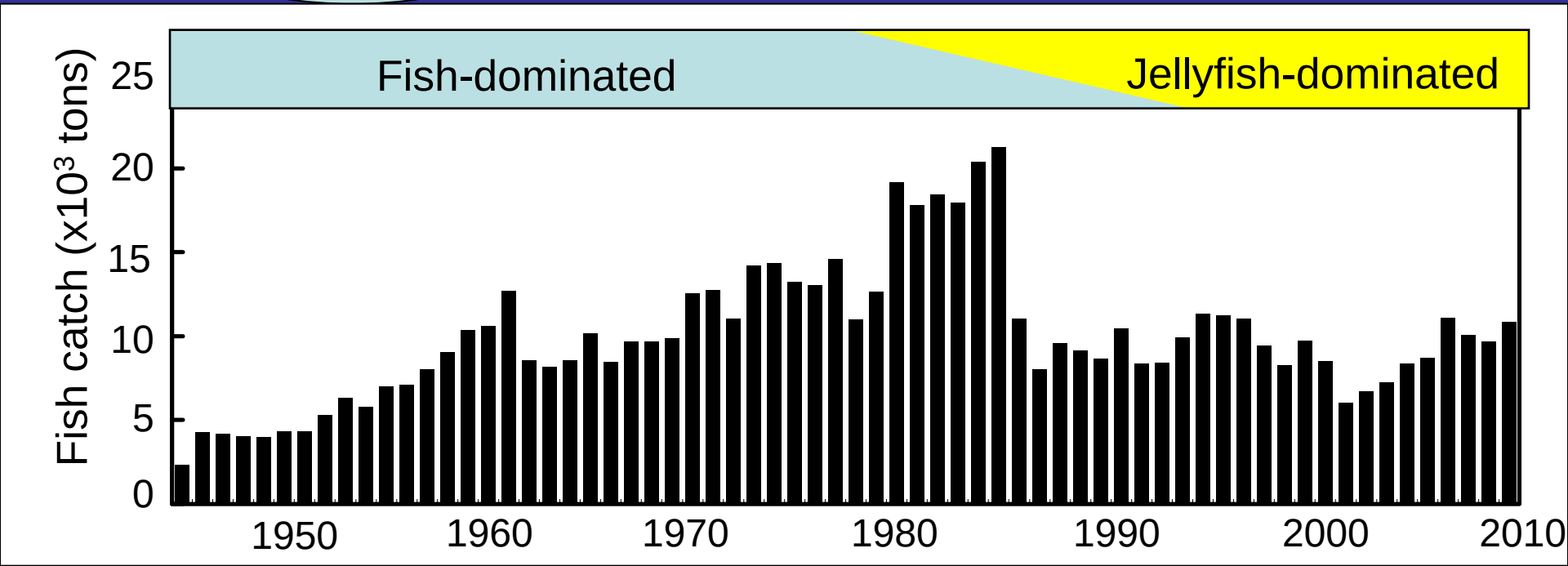
Ecosystem change in the Northern Adriatic Sea

Fish-dominated ecosystem

Marine construction
Overfishing

Warming?
Eutrophication?

Jellyfish-dominated ecosystem



Acknowledgements

This study was conducted under Japan-Slovenia bilateral project on jellyfish bloom.

Funding also from:
1) Slovenian Research Agency (P1-0237)
2) EU FP7 project PERSEUS (No. 287600)
3) Japan Society for Promotion of Science
4) Agriculture, Forestry and Fisheries Research Council, Japan (project name: STOPJELLY)