The impact of climate change on small pelagic fisheries

NEREUS
PREDICTING THE FUTURE OCEAN
ネレウス
未来の海を考える

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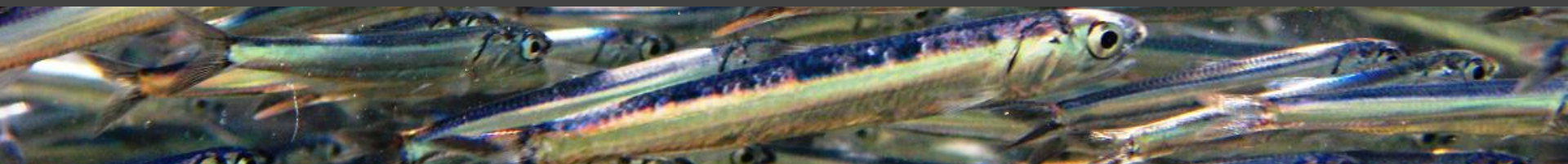
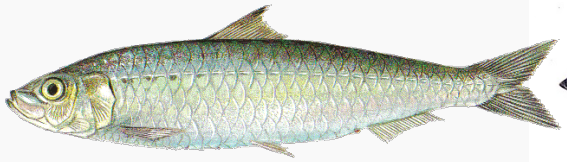


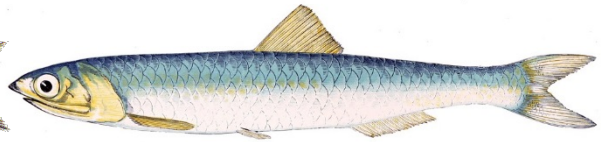
Characteristics of "small pelagic fisheries"

Small, schooling fishes that inhabit the open ocean are immensely productive, supporting nutritionally important and lucrative fisheries.

Populations in specific regions of the ocean can number in the ***TENS of BILLIONS*** of individual fish.



sardine

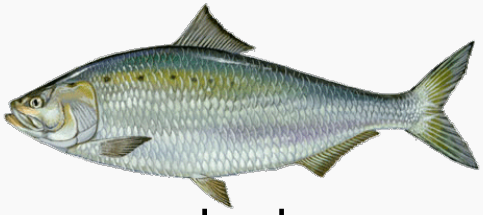


anchovy

herring

menhaden

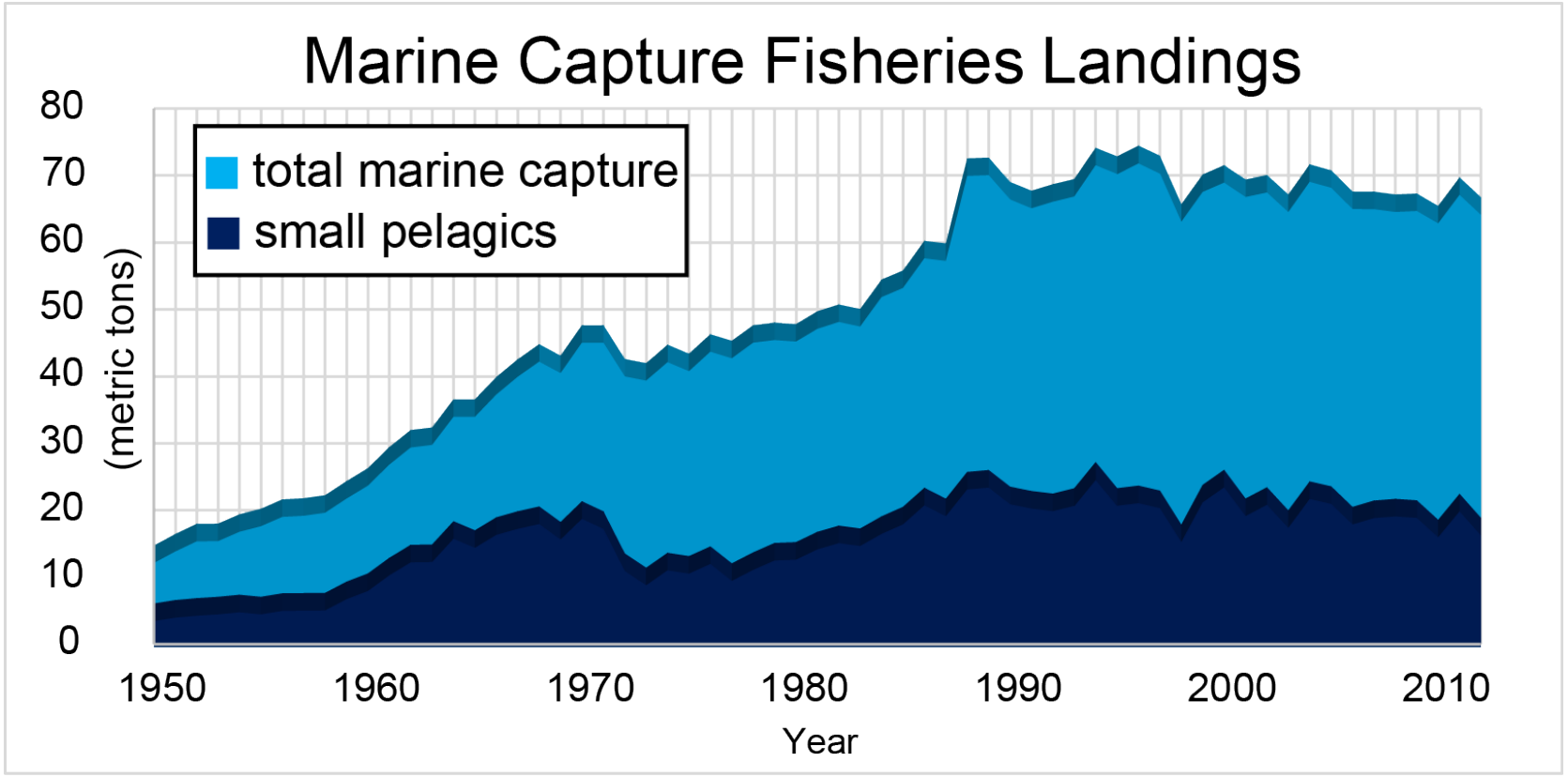
sprat



shad

Though small, their populations are massive

Small pelagic fisheries compose more than **one quarter of the global marine capture fisheries**.

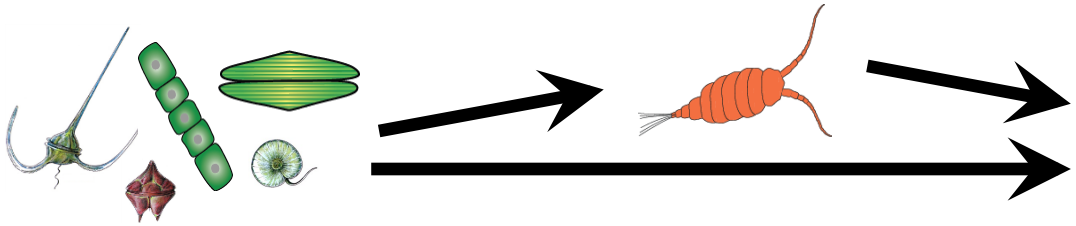


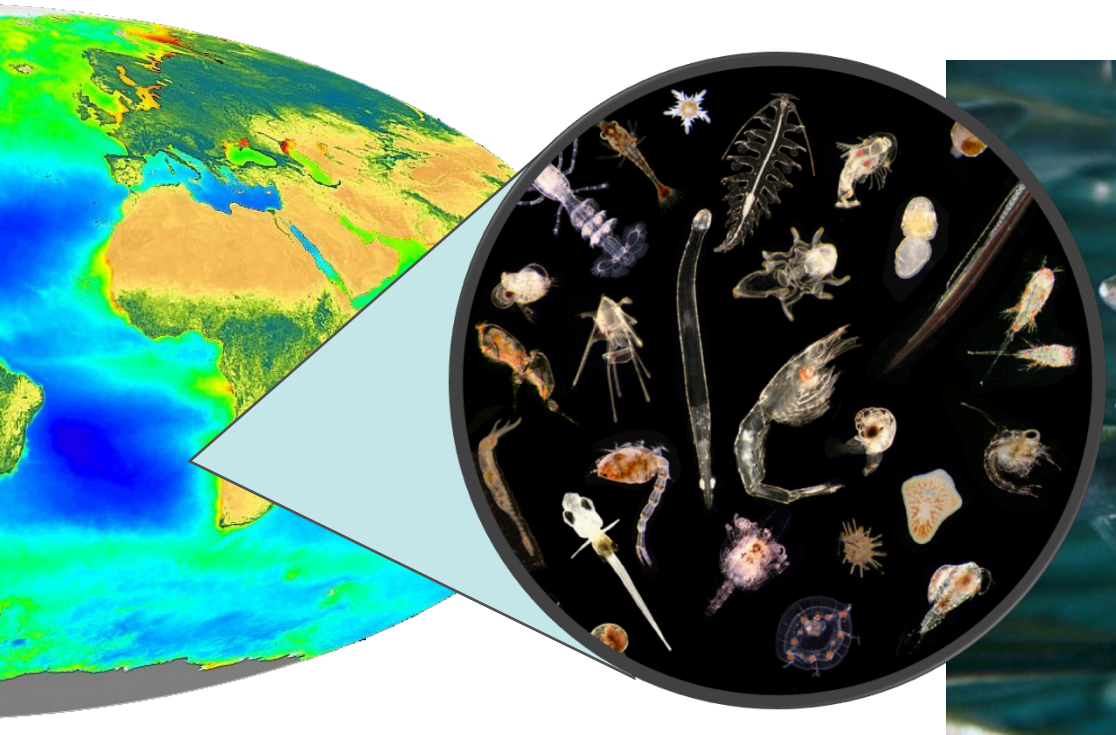
UN FAO (2012)

Small pelagic fishes feed on plankton

These small pelagic fishes are *planktivorous*.

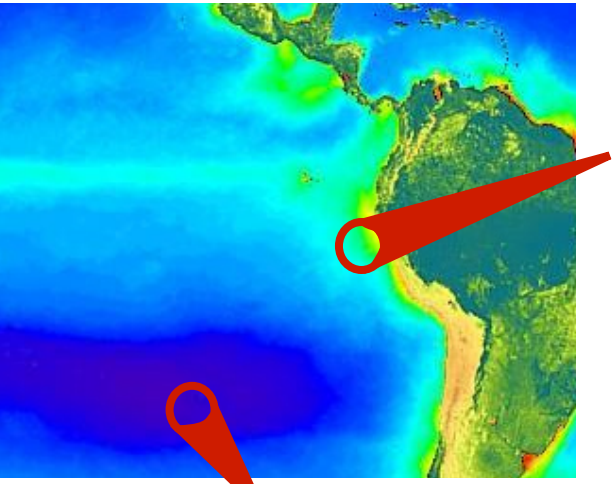
They filter their food directly from the water column.

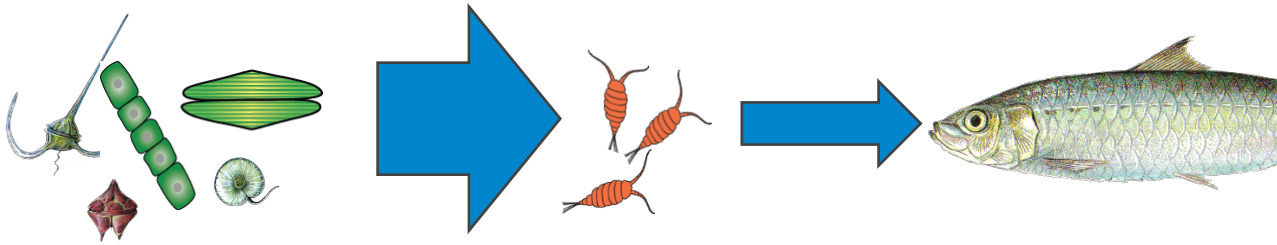




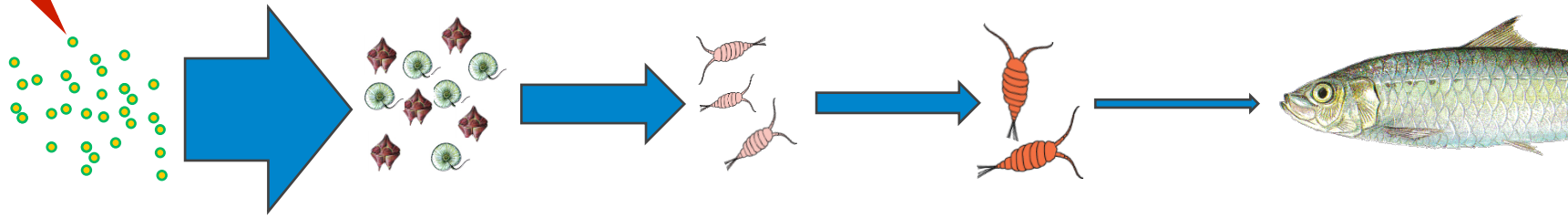
Food chains vary in their length and efficiency

The structure of the marine ecosystem varies greatly regionally and temporally. These short, efficient food chains are not ubiquitous.



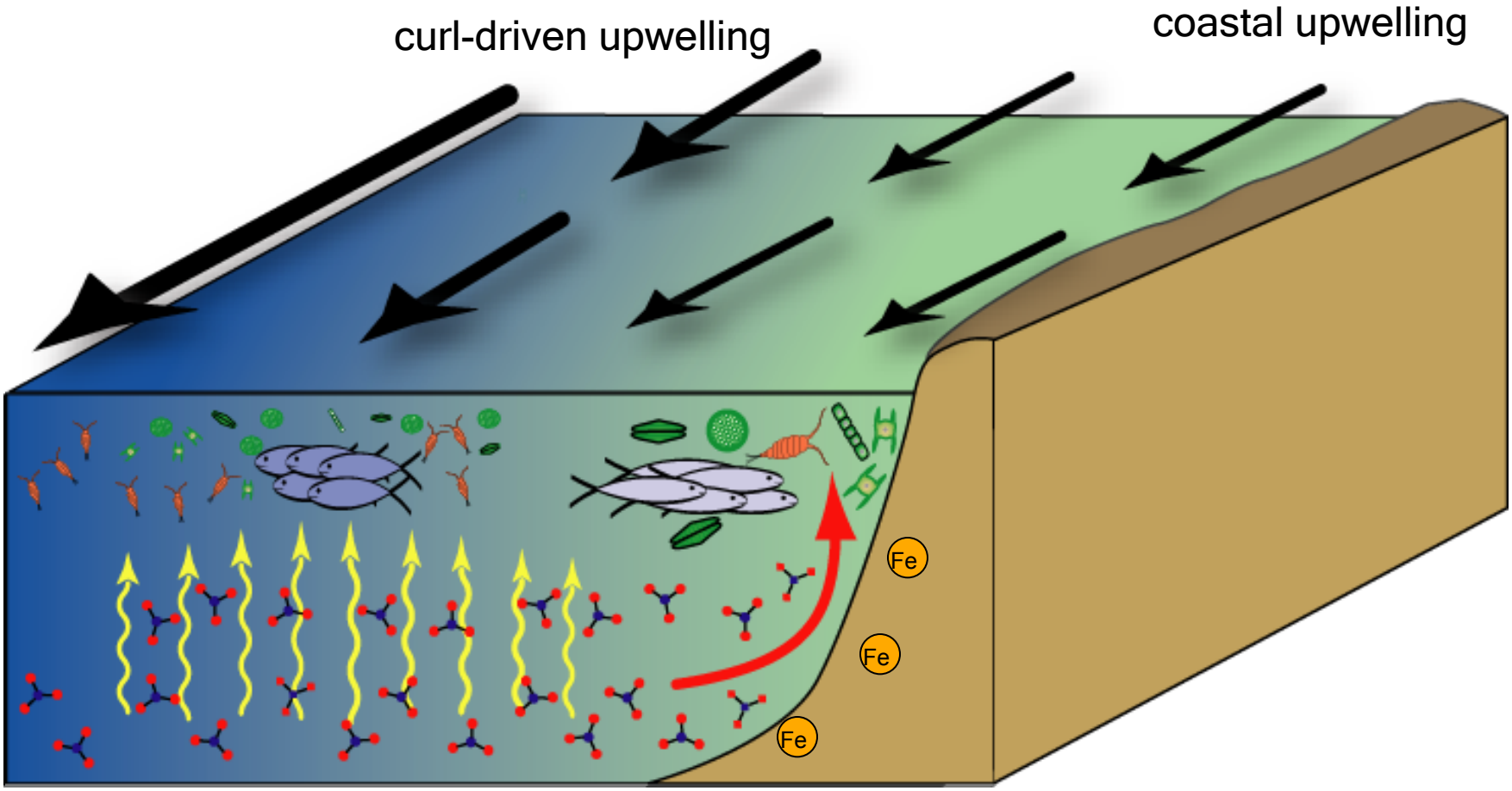


Regions with high productivity of large phytoplankton support efficient transfer of organic matter and energy to fish.



In contrast, in regions with a phytoplankton community composed of tiny individuals, the transfer of energy to fisheries is low.

Upwelling forces nutrients to the surface

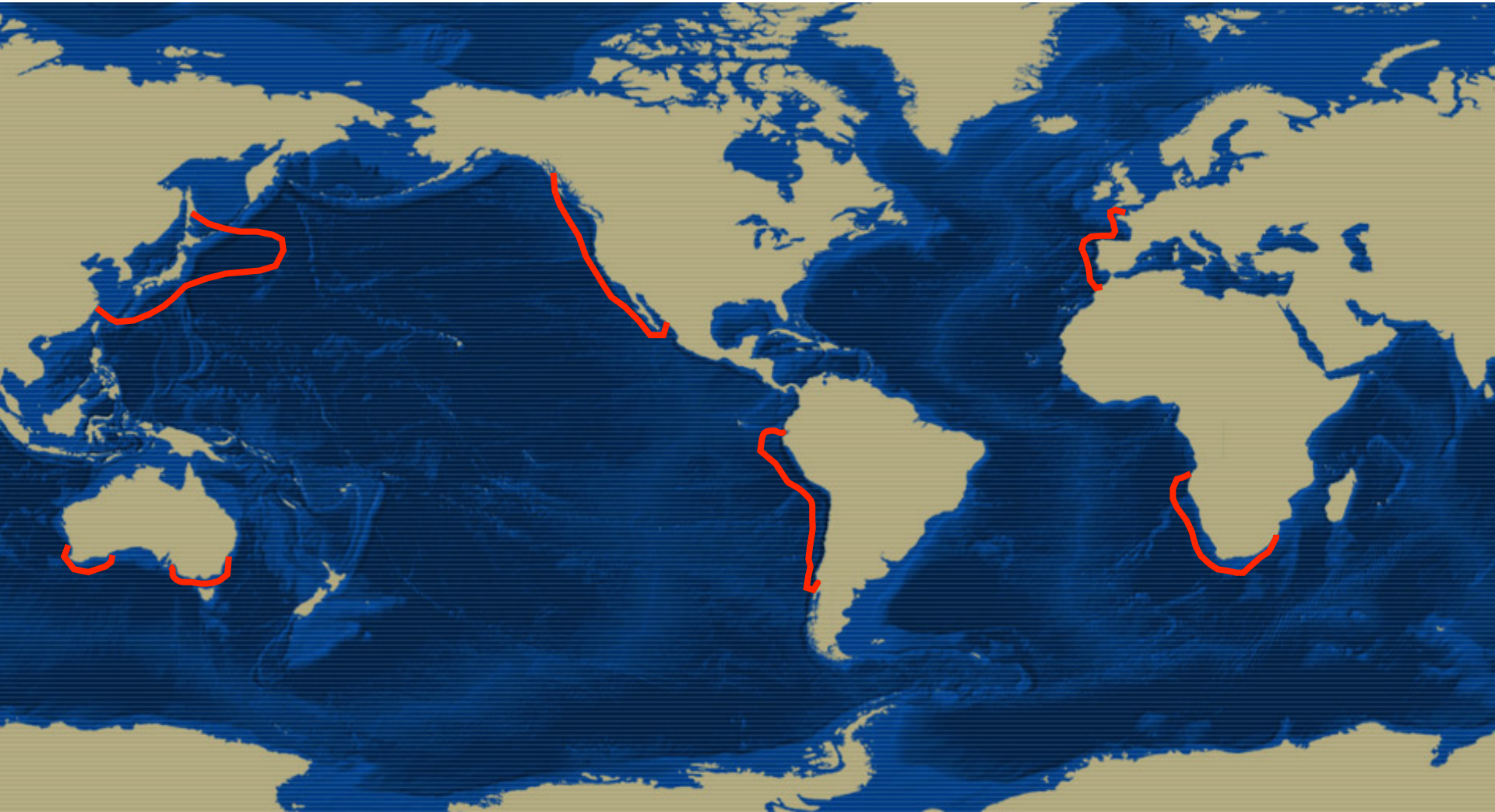


= macronutrients

Rykaczewski and Checkley (2008)

Major small pelagic fisheries exist in upwelling zones

Key regions of production include major west coasts and the Kuroshio.

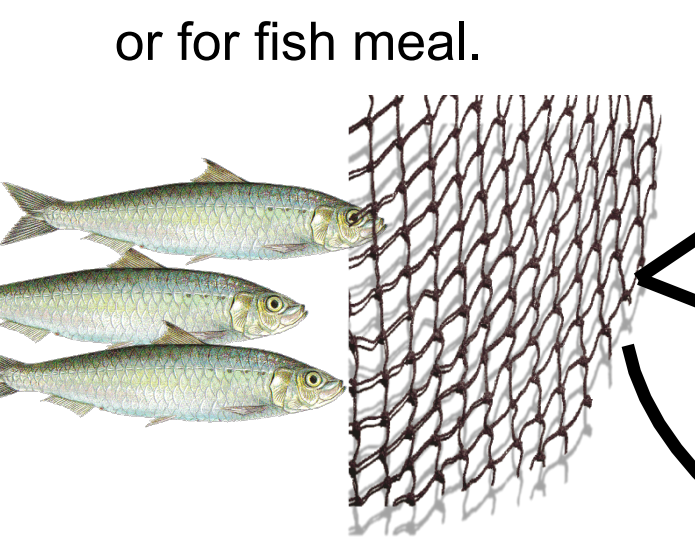


Influence of these fish extend beyond the local regions they inhabit

Block et al. (2011)

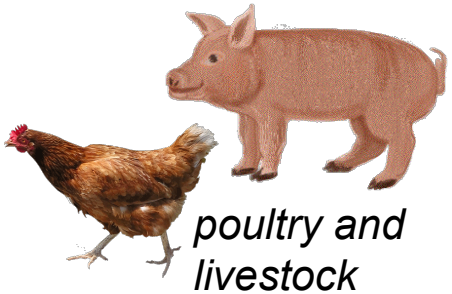
Pathways of utilization for small pelagics

Products are utilized directly for human consumption, aquaculture feed, or for fish meal.



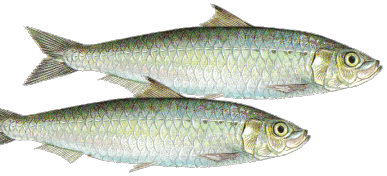
canned, frozen and fresh fish

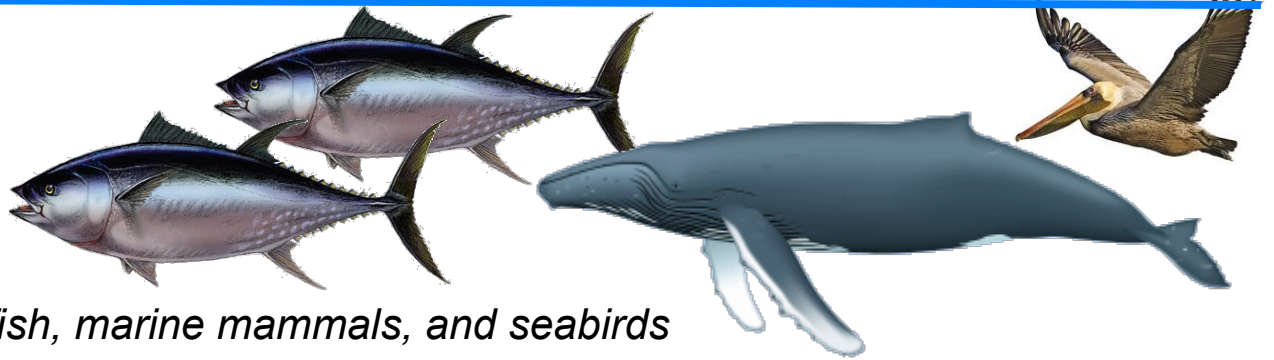
fish meal



poultry and livestock

aquaculture



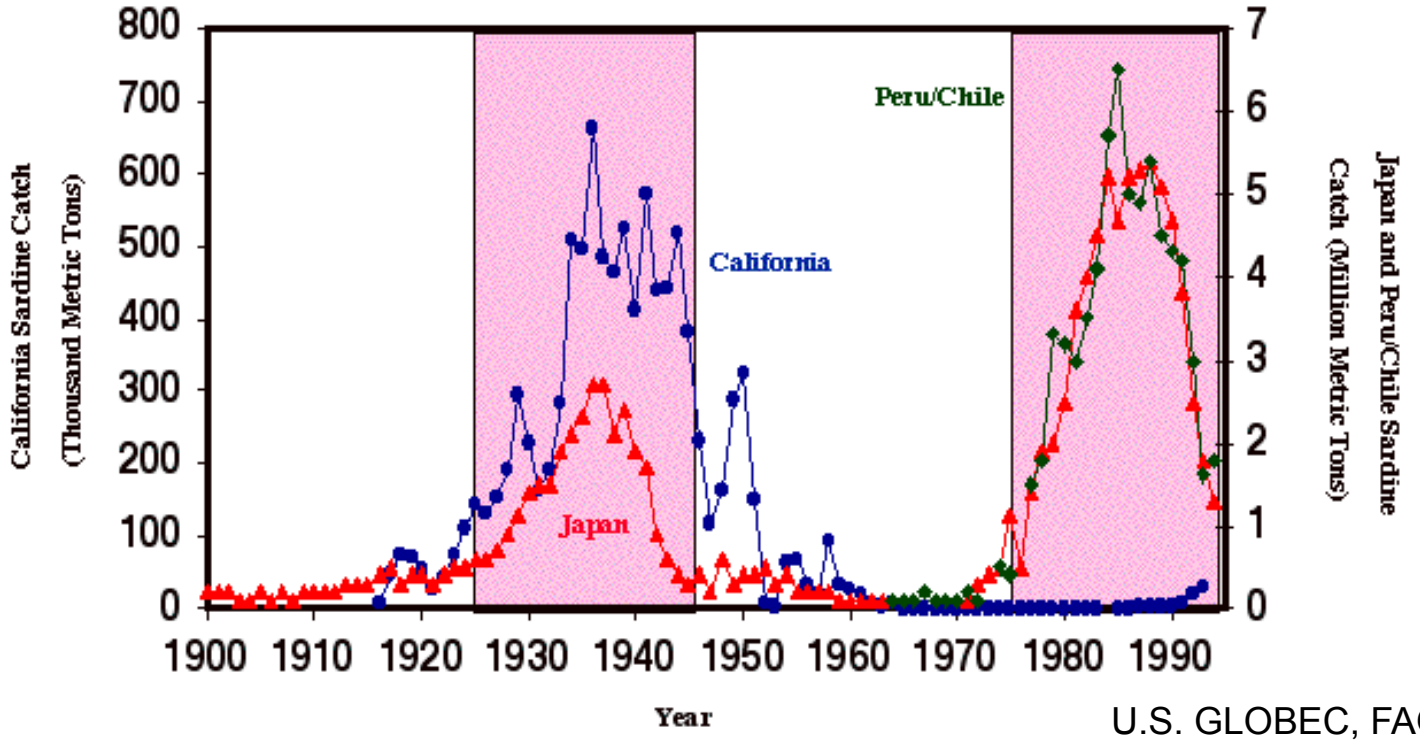


tuna, billfish, marine mammals, and seabirds

Variability of small pelagic fisheries

Populations of small pelagic notoriously variable at interannual to inter-decadal periods, exhibiting boom-and-bust cycles.

This has severe impacts on the industries and economies the depend directly on these resources.

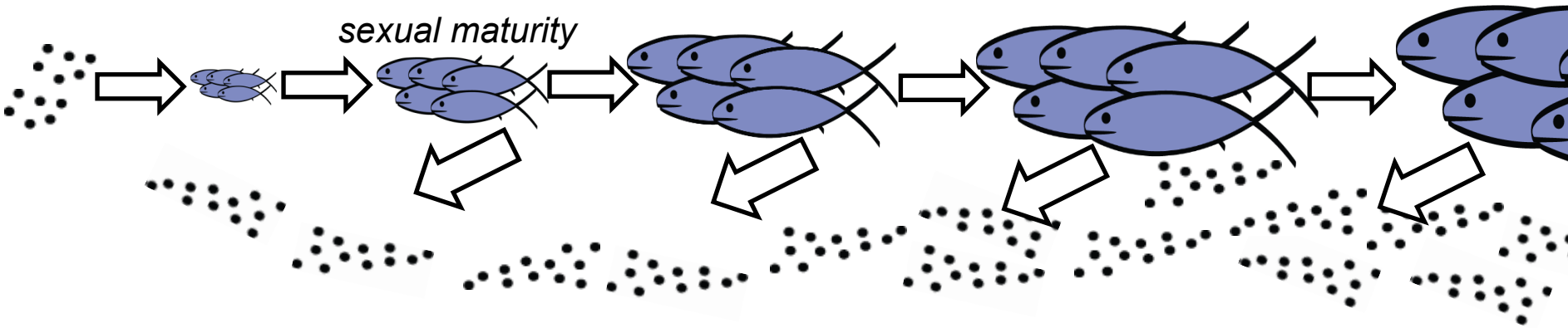


U.S. GLOBEC, FAO (1995)

Extremely sensitivity to past climate variability

Three main factors have driven the extreme sensitivity to climate variability:

1) *Intense fishing mortality* that truncates population age structure and prevents stocks from recovery.



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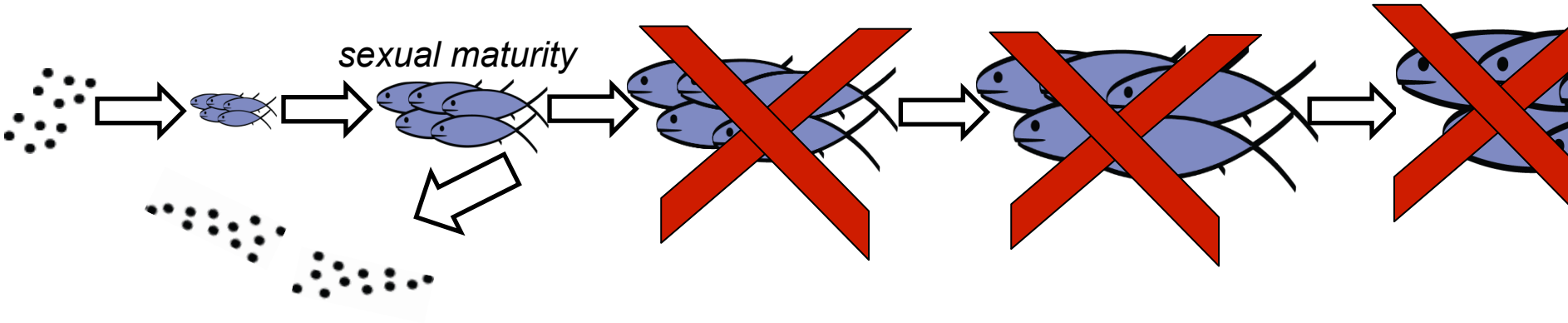

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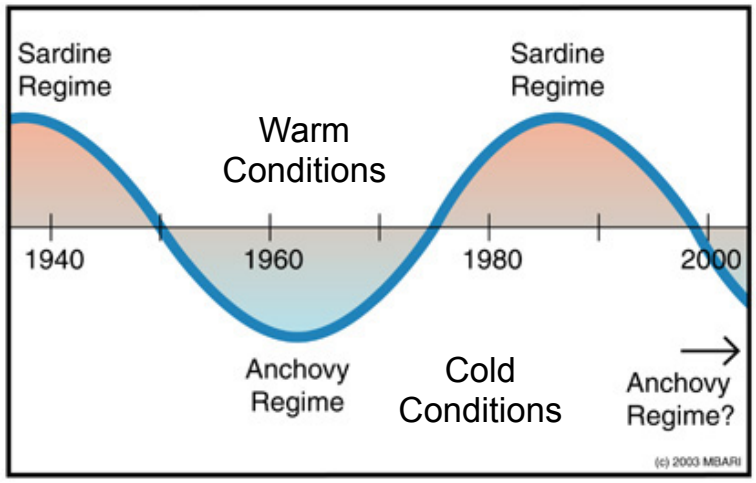
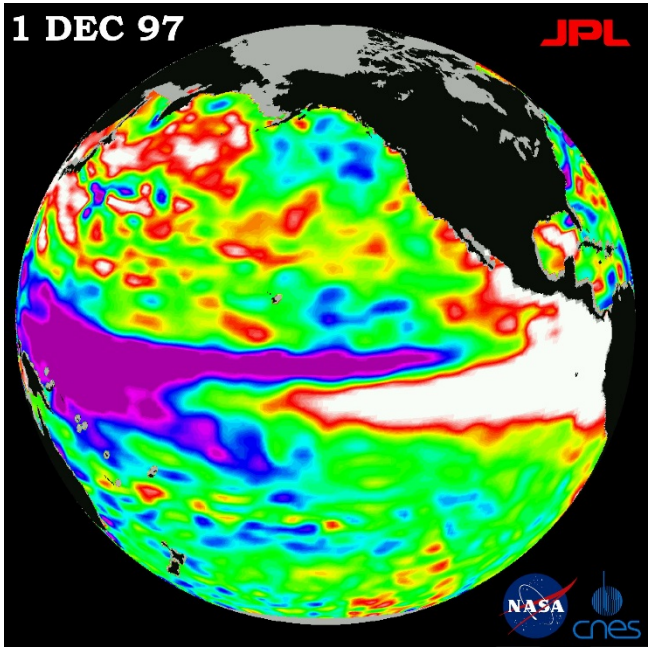
1) *Intense fishing mortality* that truncates population age structure and prevents stocks from recovery.
2) High natural population growth rates.
3) Modes of physical/biological climate variability with strong regional expression (*e.g.*, El Niño).



Chavez *et al.* (2003)



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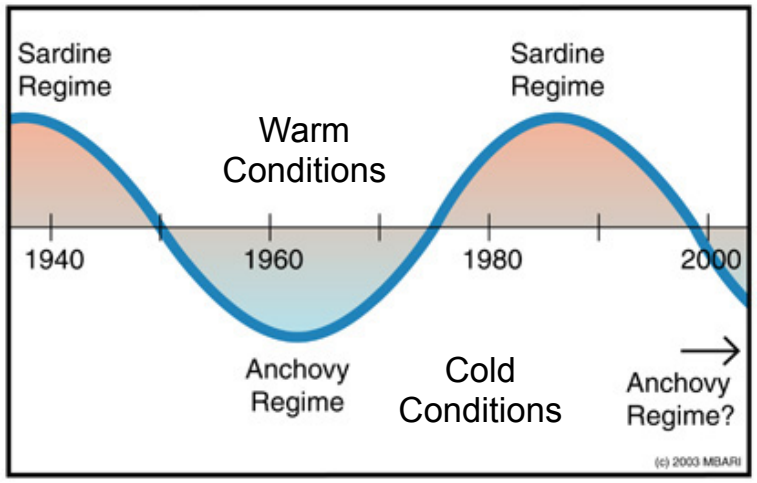
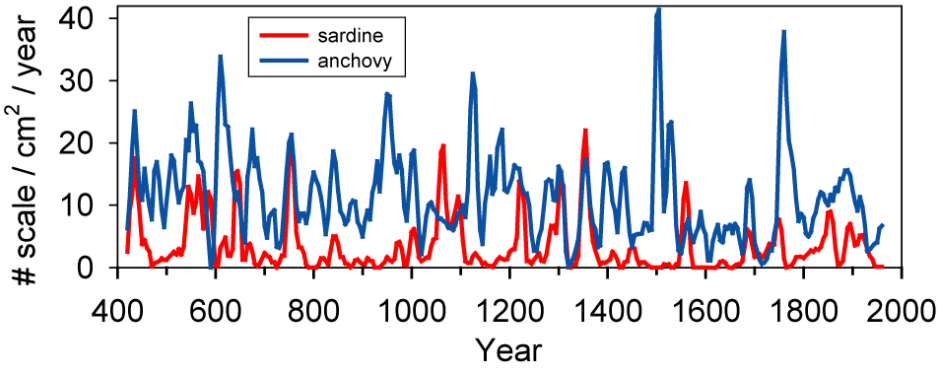


Chavez *et al.* (2003)

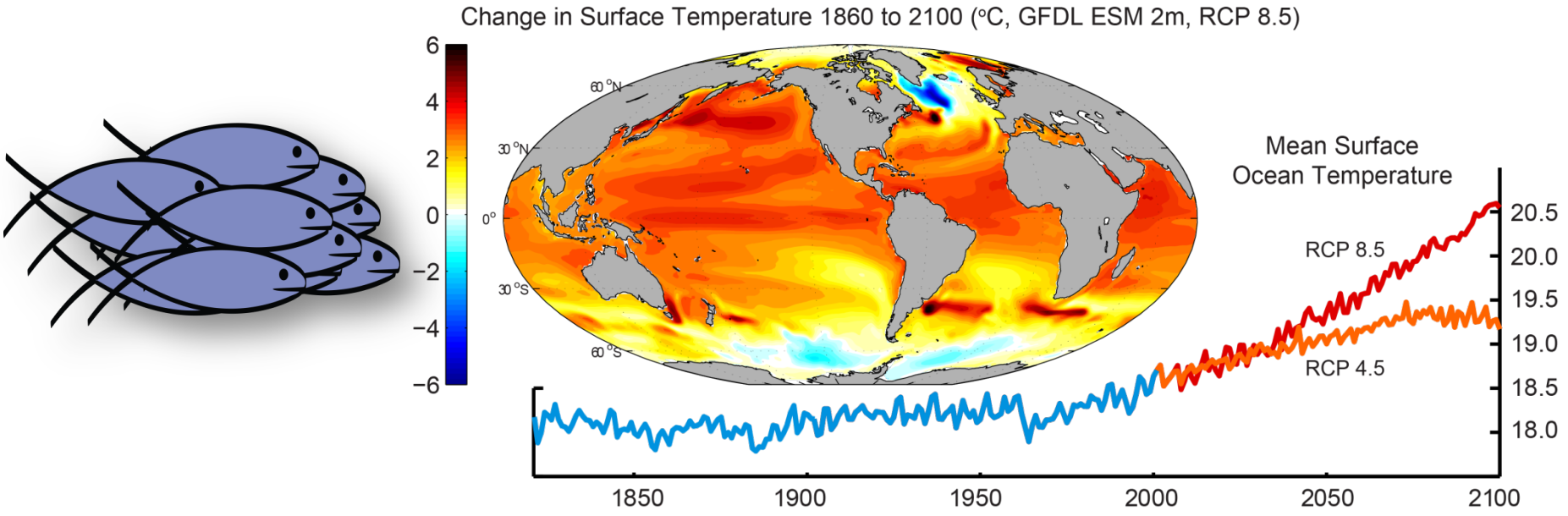
Evidence suggests populations fluctuate in the absence of fishing mortality.



Soutar and Isaacs (1969); Baumgartner et al. (1992)

Response to future climate changes

Given the continued growth in aquaculture and in human population, demand for small pelagic fishes will increase in the future. Recognizing the susceptibility of these fisheries to future climate change is critical.



Response to future climate changes

This is more challenging than developing a more complete understanding of past changes in these ecosystems.

> Climate change is altering the structure and function of marine ecosystems in ways that have not been observed in the past.
>
> Empirical relationships that have been built on past observed relationships *will become less useful* for predicting future responses of small pelagic fisheries to future climate change.

Projecting the impact of climate change on marine ecosystems at a regional scale requires a dynamical and comprehensive understanding of ecosystem processes.

Summary

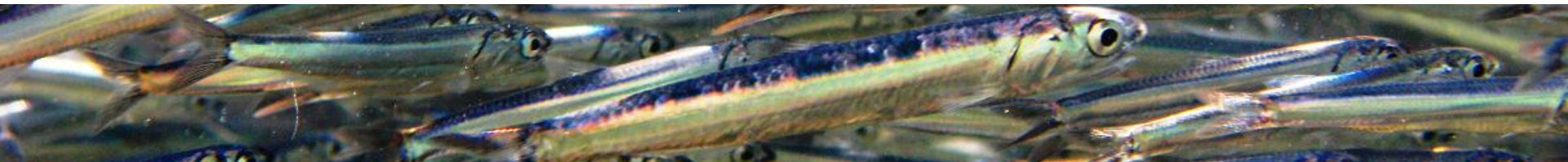
Planktivorous small pelagic fisheries such as sardine, anchovy, and herring, supply about one quarter of the world's marine fish catch and act as prey for tunas, billfishes, marine mammals, and seabirds.

These fish are highly sensitive to natural variability due to high exploitation rates, fast growth rates, and regional physical climate variability.

Future changes in these ecosystems will be influenced by both natural models of variability (e.g., El Niño) and anthropogenic climate change.

The combinations of these climate factors prohibits reliance on past relationships to make projections about the future.

Comprehensive, mechanistic understanding is required if we are to accurately project responses to anthropogenic climate change.



Thanks!

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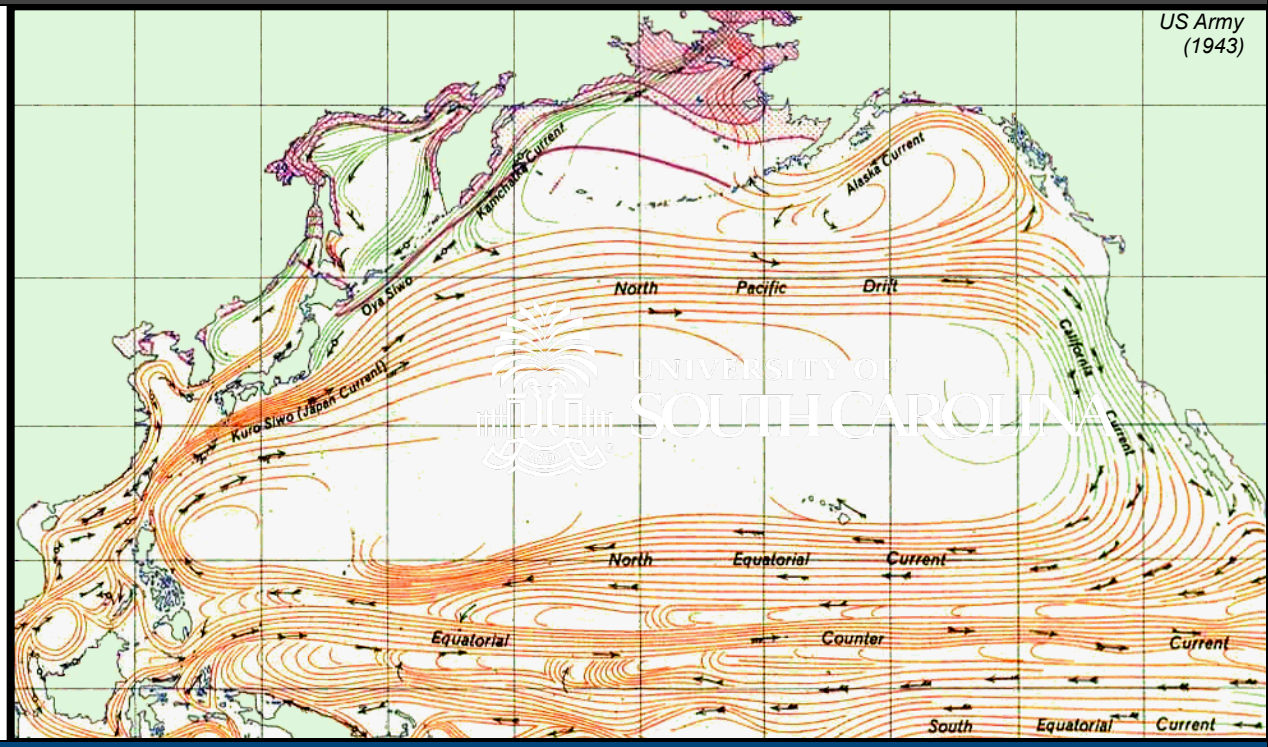

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