

A photograph of a sunset over the ocean. The sun is low on the horizon, partially obscured by clouds, creating a warm, golden glow. The sky is a mix of blue and orange, with scattered white and grey clouds. The ocean surface is dark blue with gentle waves.

Some Implications of Subarctic Pacific Deoxygenation

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Away from the ocean surface, oxygen, nutrients and carbon dioxide are linked via respiration:



i.e. O/N ~ 8 and O₂/CO₂ ~ 1.2

Oxygen losses increase nutrients and ocean acidity.

"The impact of respiration on carbonate chemistry and pH is most acute in hypoxic and anoxic basins, where metabolic CO₂ accumulates to high concentrations.

(In the lower St Lawrence Estuary) the pH of the bottom waters has decreased by 0.2 to 0.3 over the last 75 years, which is four to six times greater than can be attributed to the uptake of anthropogenic CO₂."

Mucci, Starr, Gilbert and Sundby (2011)

Oxic Habitat

Atmosphere:

Humans live in mining communities high in the Himalayas and Andes (5100 m).

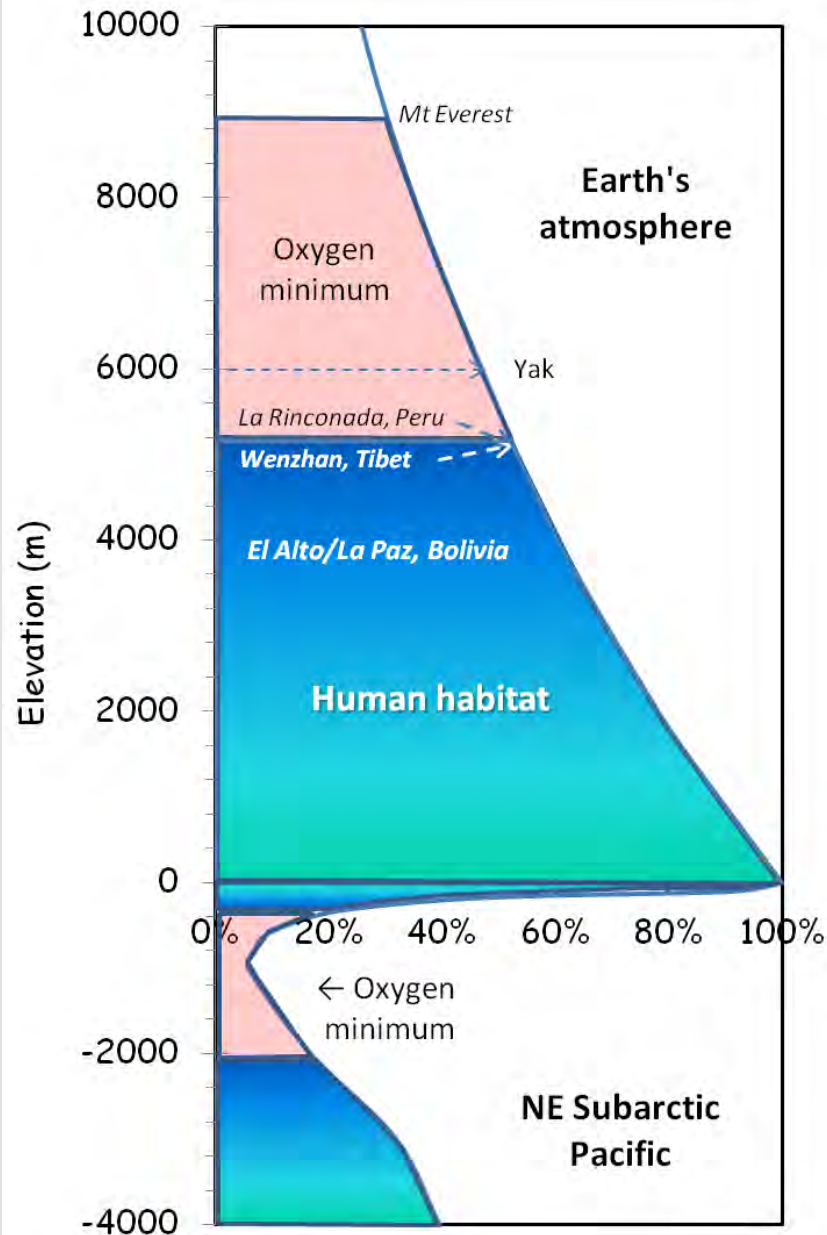
2 million people live at ~4000 m in Bolivia.

The yak survives to an altitude of 6000 m, with oxygen still >50% of surface levels.

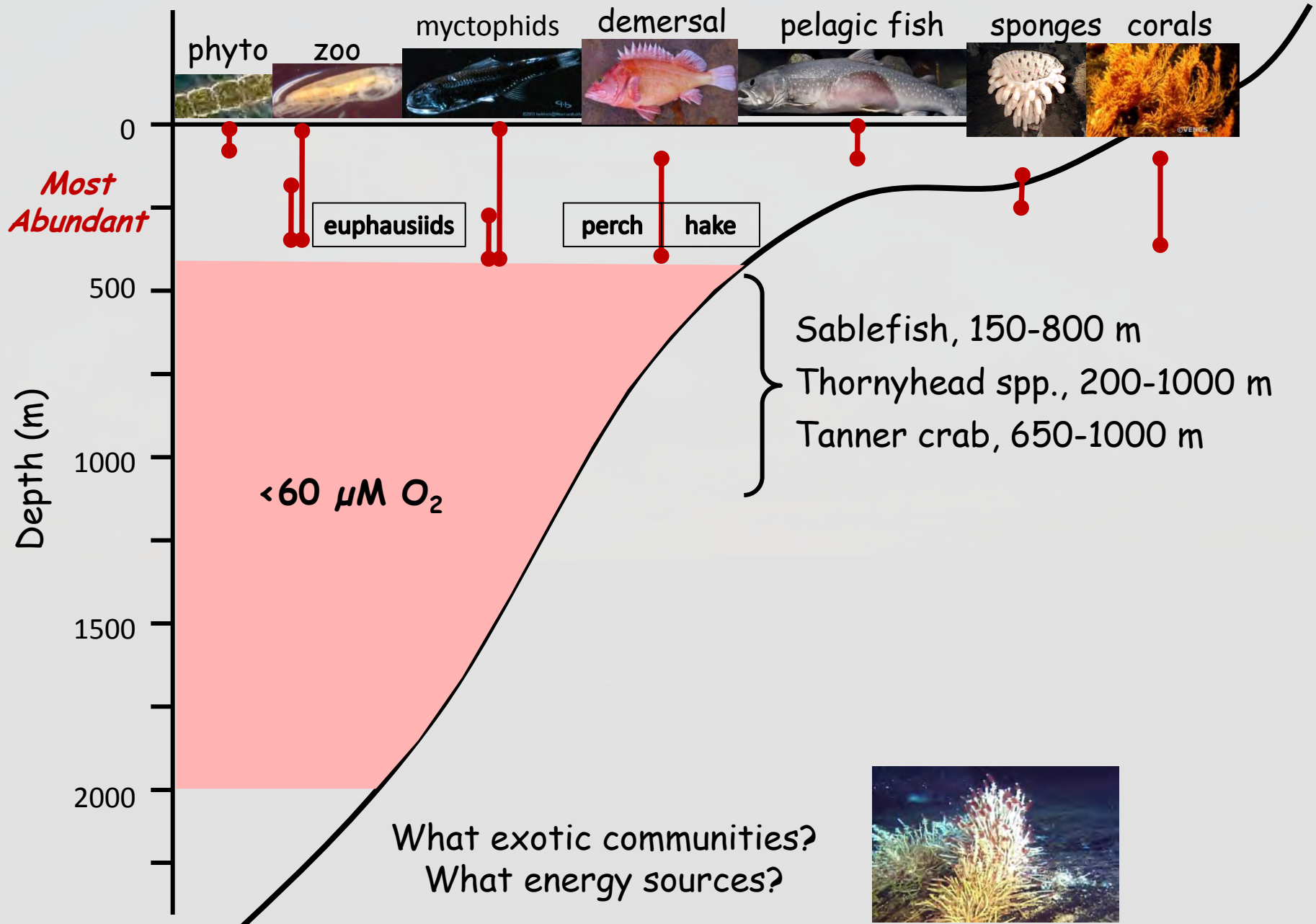
N Pacific Ocean:

Oxygen restricts the habitat of most animals to the upper few hundred meters.

e.g. >80% of the BC groundfish biomass is found in waters with >20% oxygen saturation.



NE Pacific Habitat



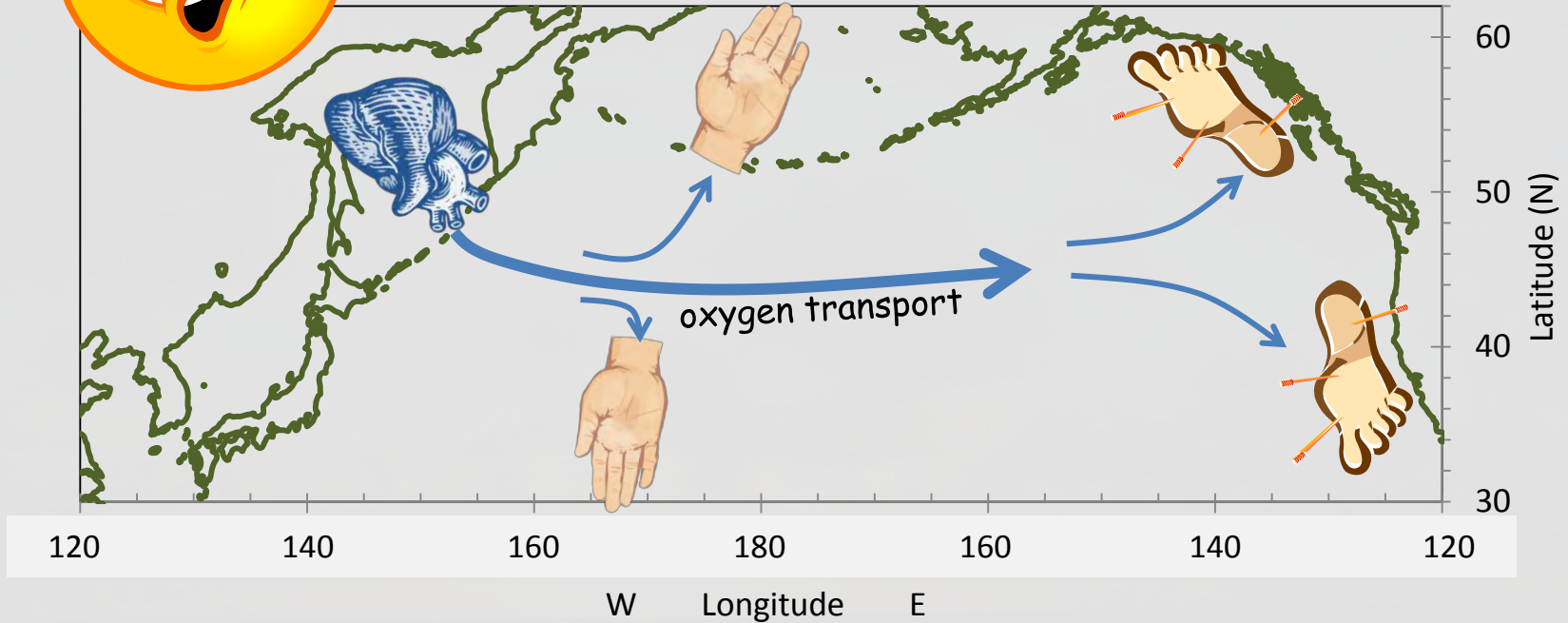
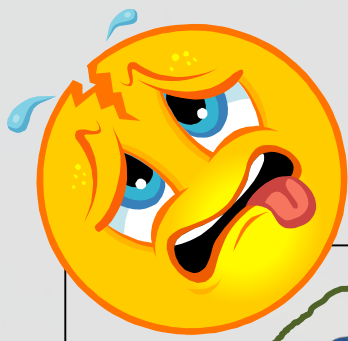


If the oxygen gradient were as strong on land as it is in the NE Pacific Ocean:

◀◀◀◀ Humans could not live above the 43rd floor of the Empire State Building (New York City)

N Pacific Oxygen Transport

Is the patient well?



Winter warming in Siberia results in

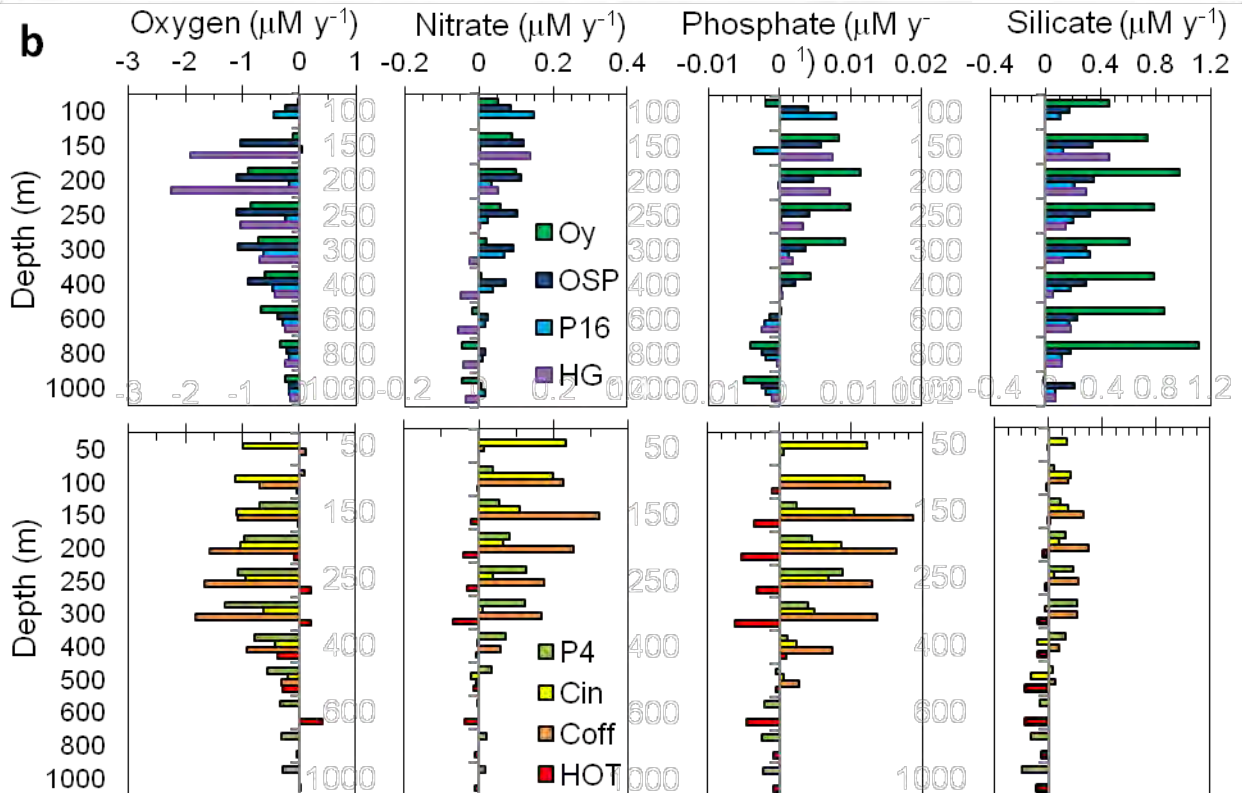
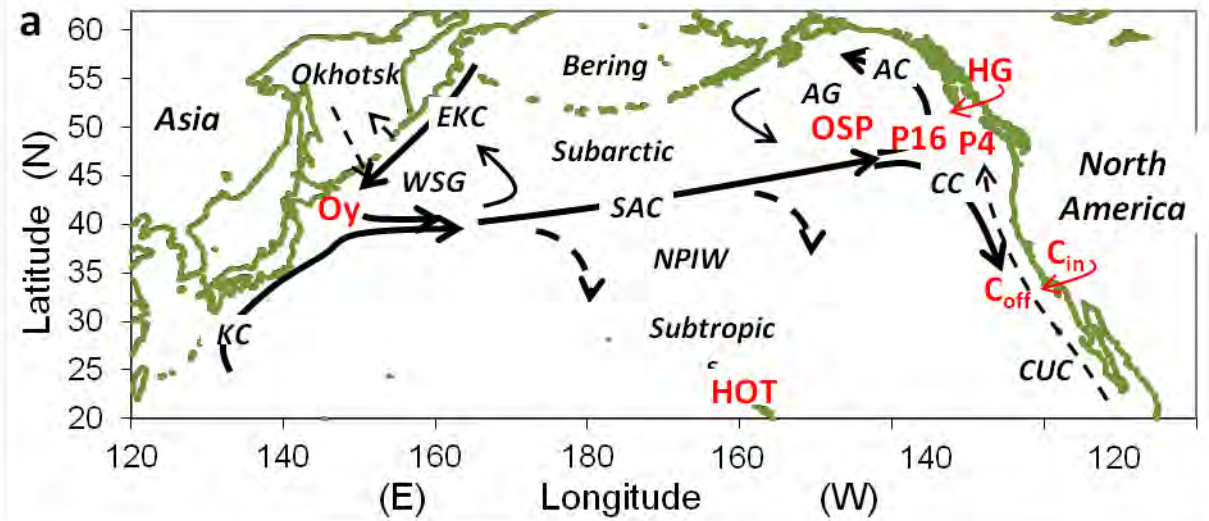
- less ice formation in Okhotsk Sea
- less dense water production
- less oxygen transport to the intermediate ocean

Future warming will exacerbate this trend (highly likely).

25 years of data:

Subarctic Pacific pycnocline is becoming nutrient enriched as it loses O_2 .

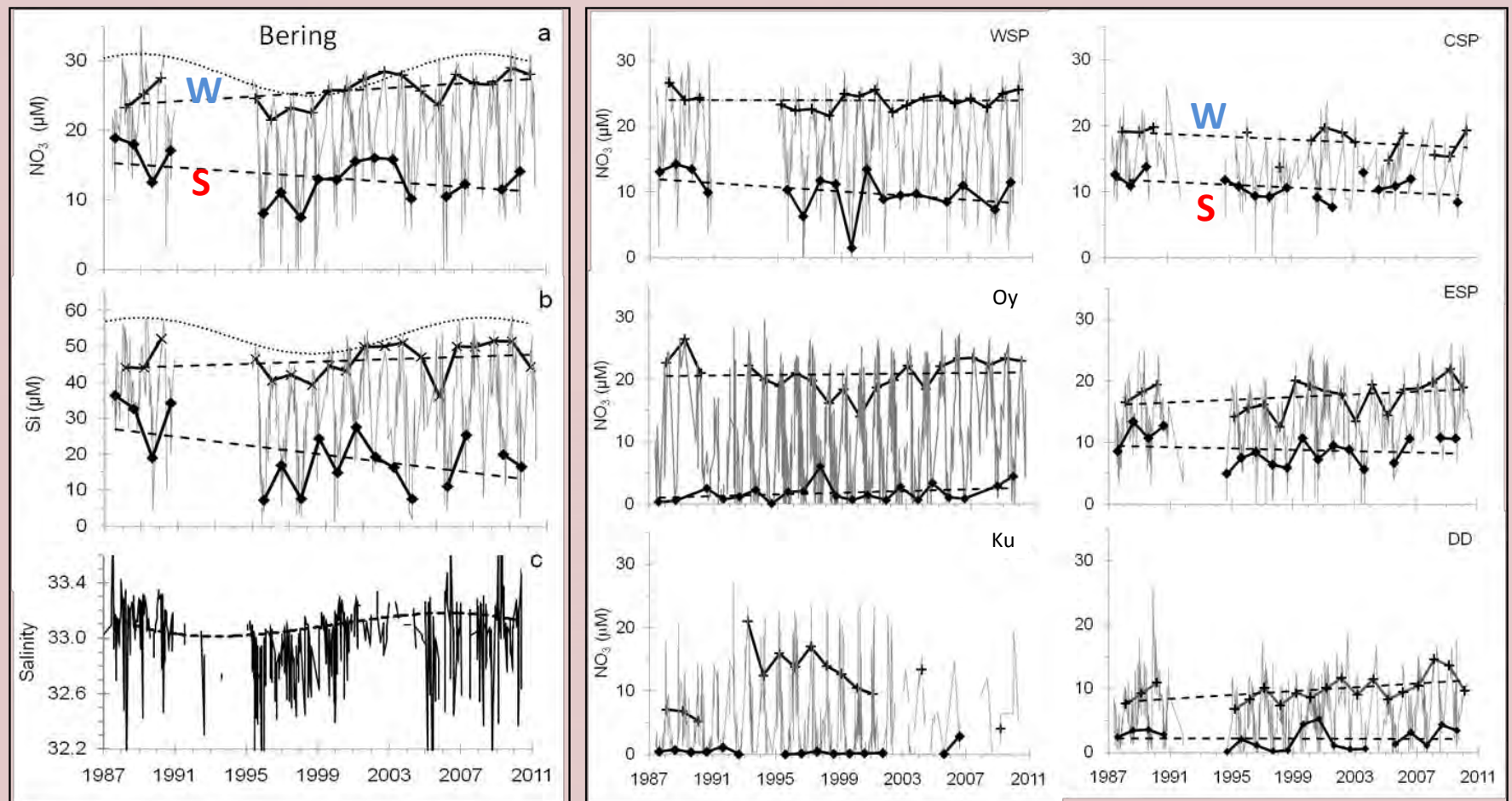
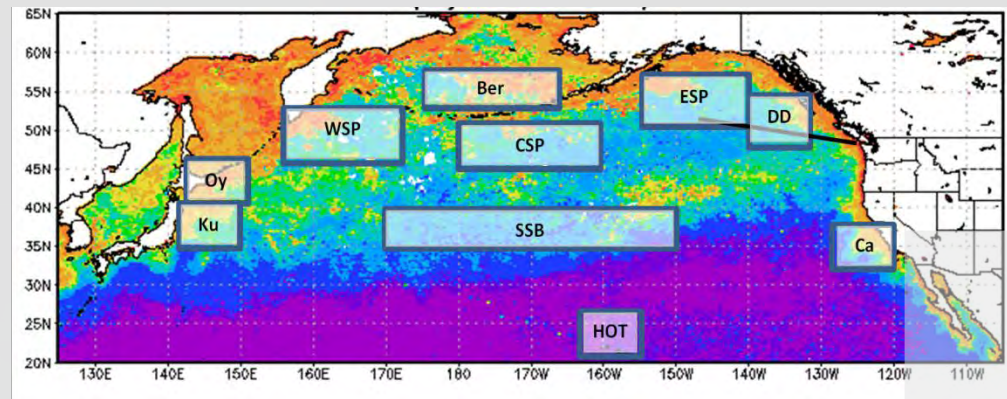
Ratios are close to Redfield except near continental margins where denitrification dominates.



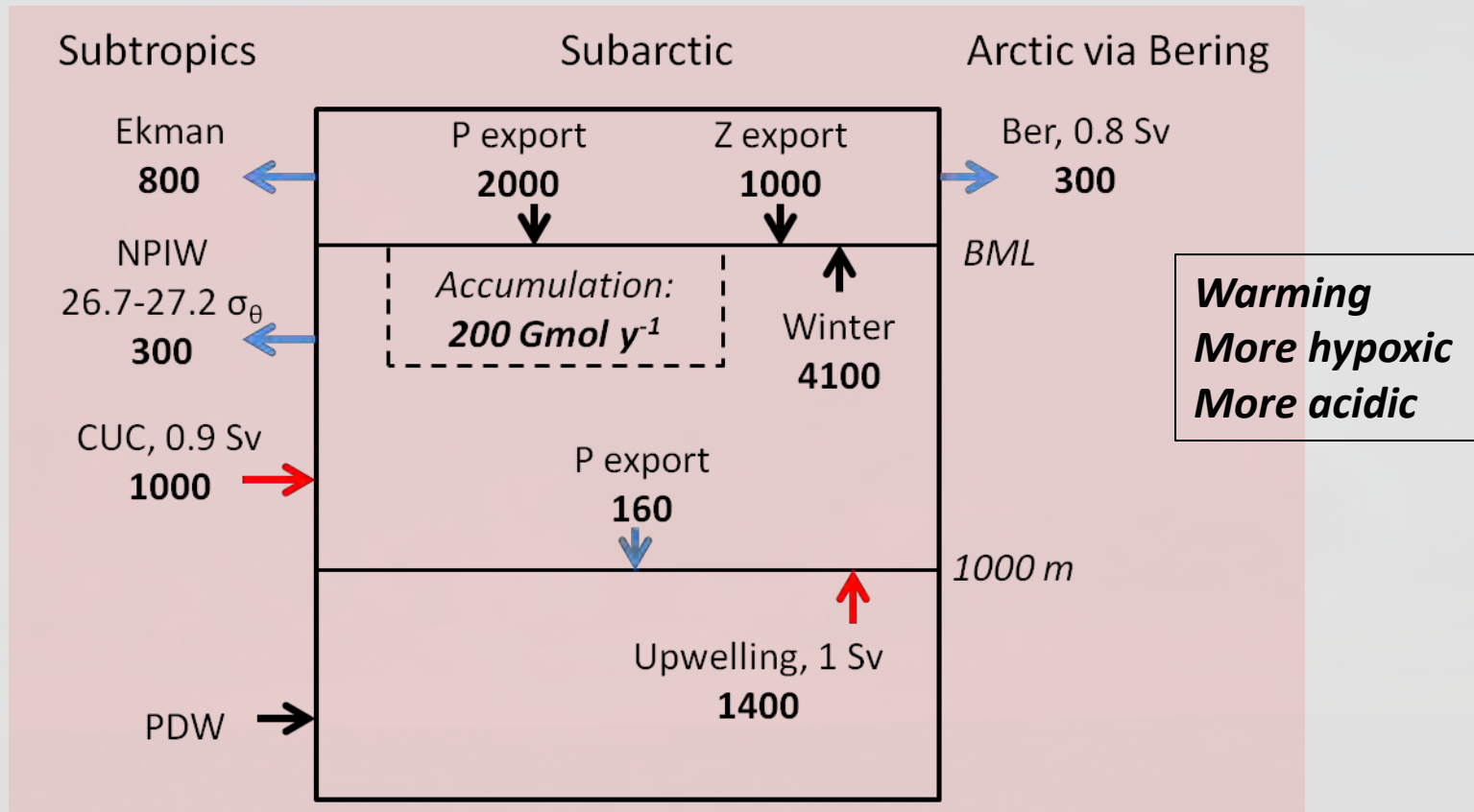
Also, surface layer is freshening
and stratification increasing

but nutrient supply is not declining

because of nutrient enrichment
of the pycnocline.



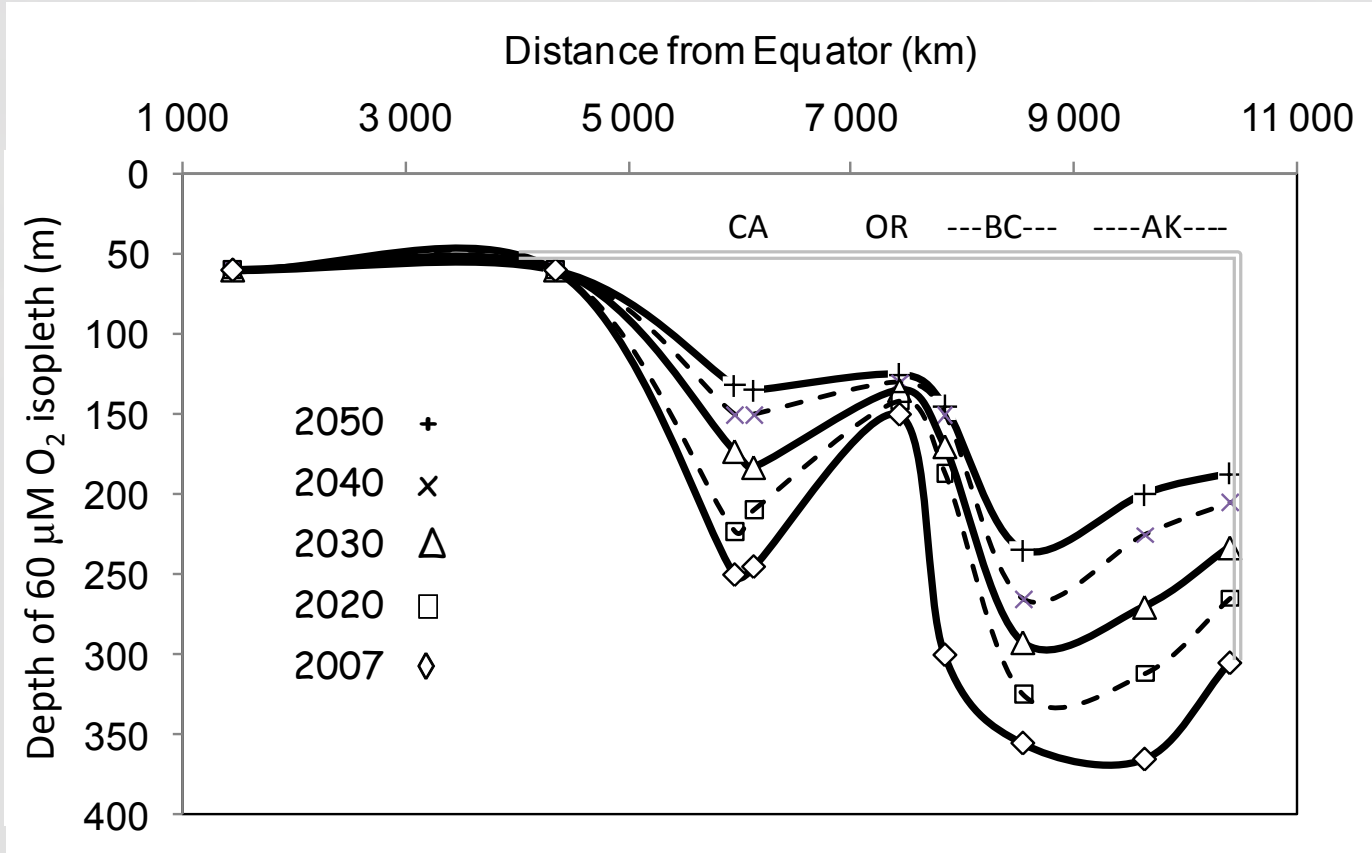
Subarctic Pacific Nitrate Budget:



Export to:

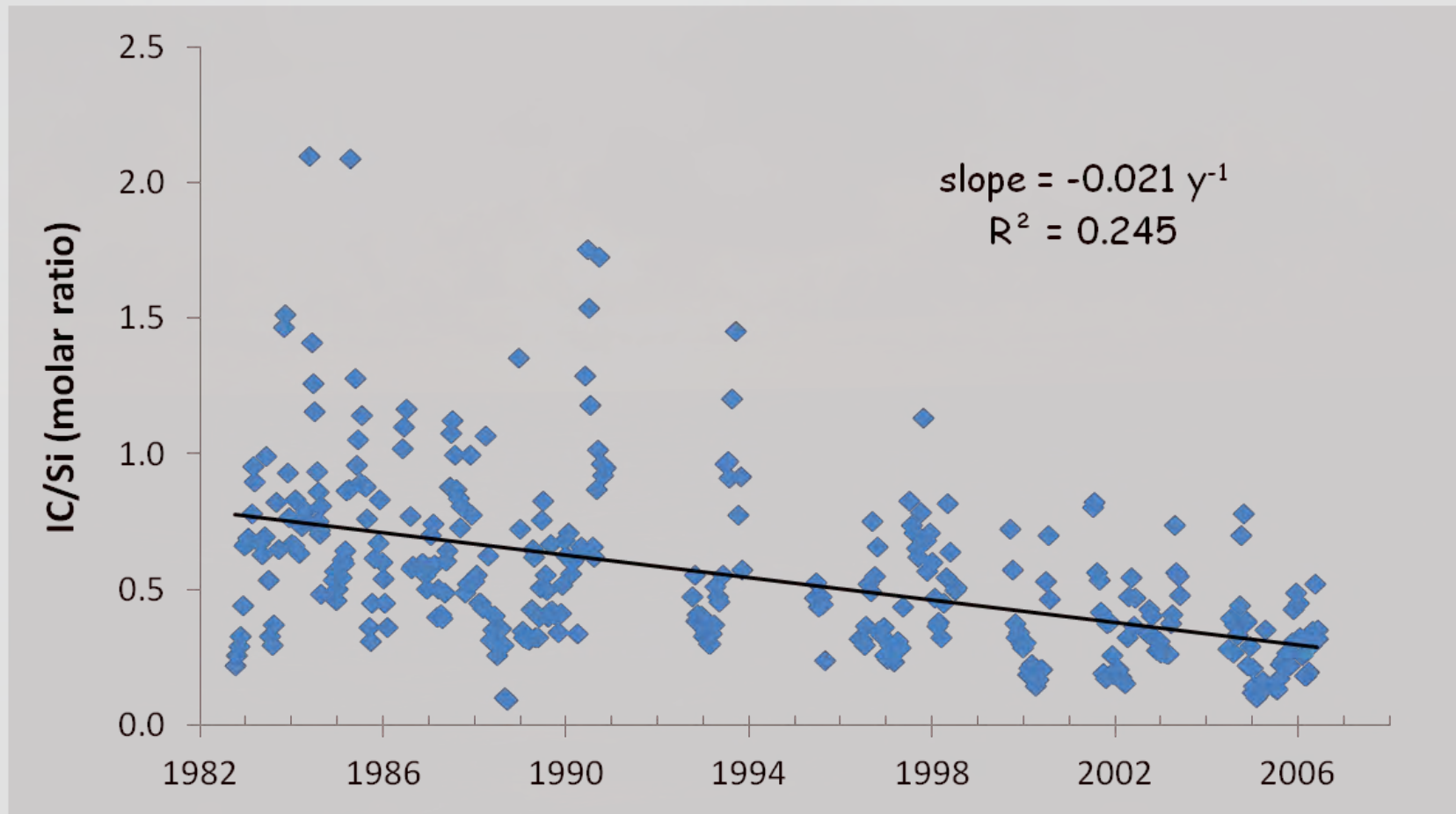
1. Western Arctic (enough to increase PP by 24×10^6 tonnes C)
2. Surface layer of the subtropics (PP increase of 64×10^6 tonnes C)
3. NPIW (observable into the Indian Ocean, upwelled onto continental margins)

A prediction of summer habitat compression (based on oxygen loss rates of the past 25 years)



Acidification of pycnocline waters leads to more carbonate and less silicate dissolution.

A change in particle composition at OSP (3800 m) is largely due to an increase in Si flux.



Suggestions:

1. Assess oxygen loss considering turn-over times of basins
2. Unify studies of acidity and hypoxia
3. Genetic assessment of northern migrations of fishes.
4. More O_2 data - profilers, observatories, bottom trawls...
5. Make data more accessible, essential in understanding large scale processes and impacts on fisheries.