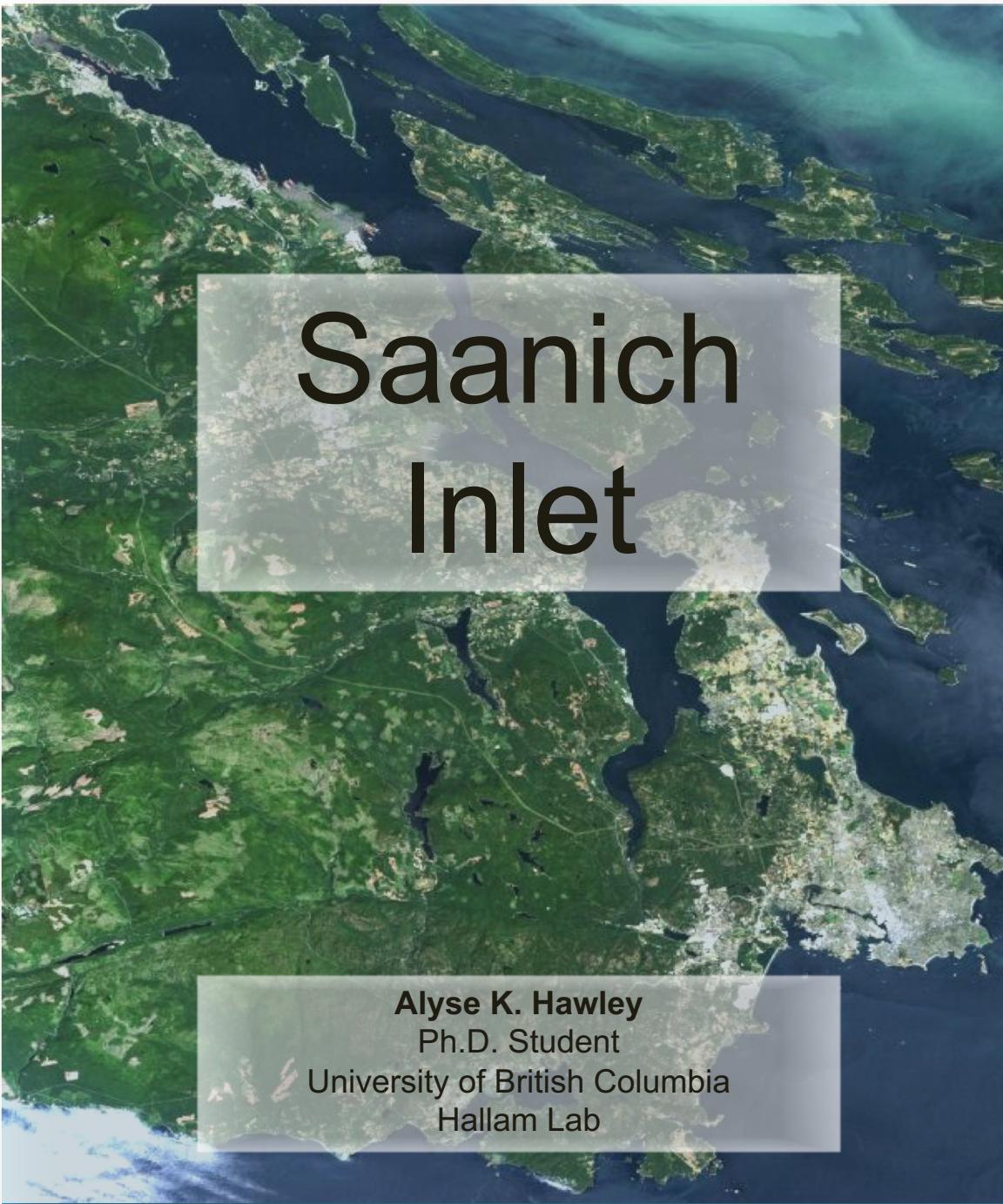




*Brand new workshops featuring Saanich Inlet data
and working with the tidyverse*

*By ECOSCOPE with support from the Microbiome
Research Network*

<http://ecoscope.ubc.ca>



Saanich Inlet

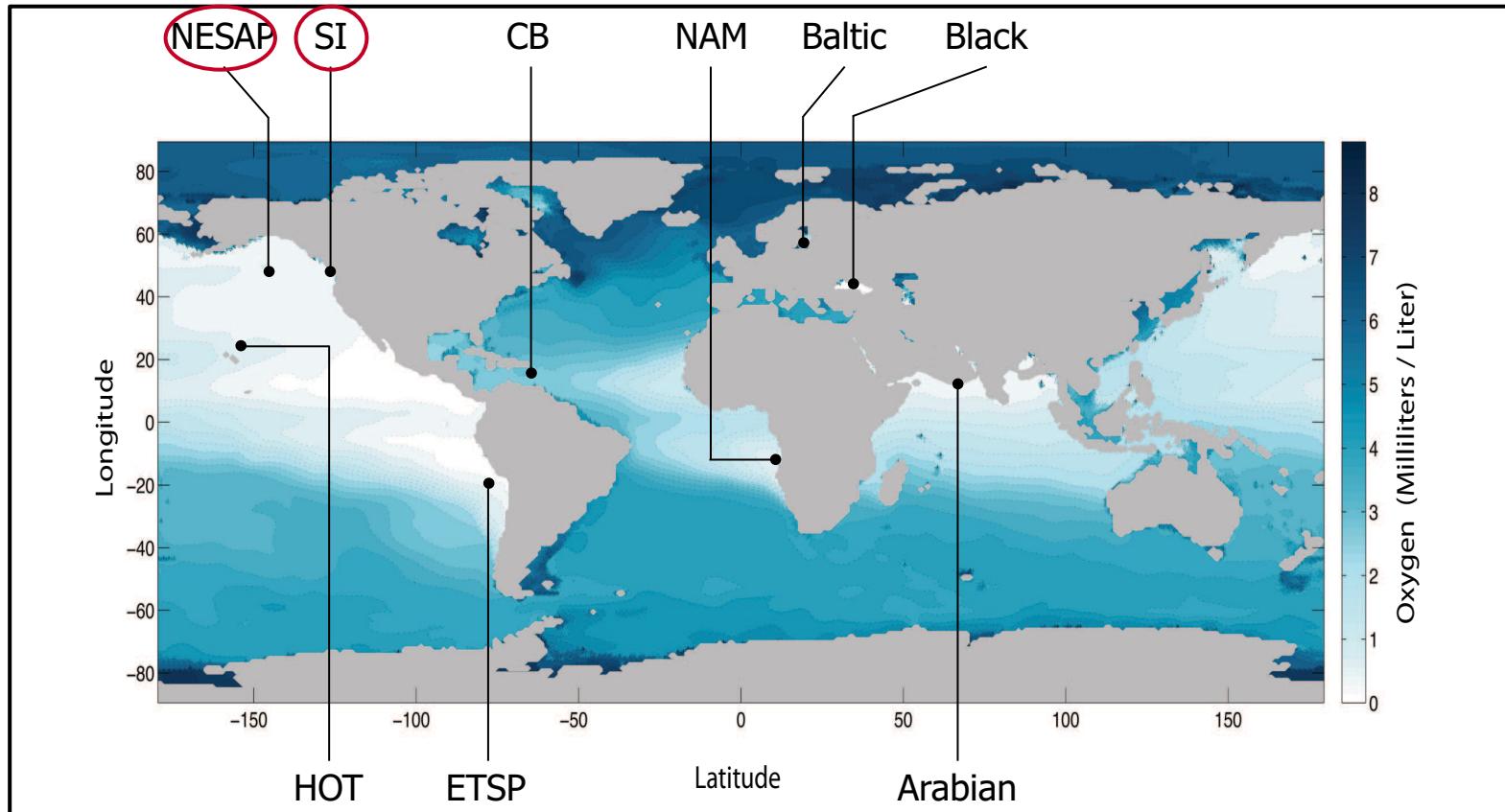
Alyse K. Hawley
Ph.D. Student
University of British Columbia
Hallam Lab



Ocean De-oxygenation

Oxygen Minimum Zones

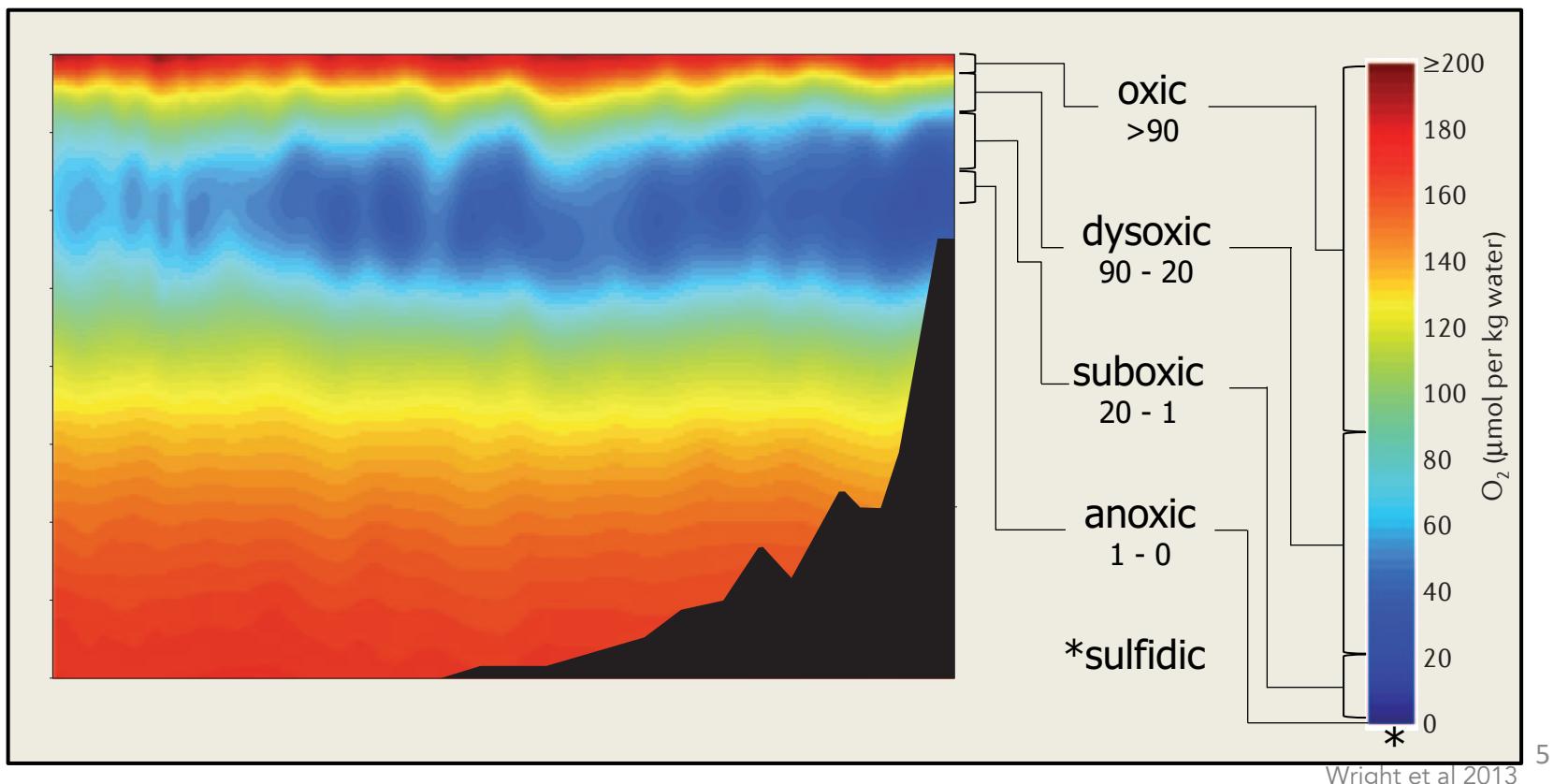
- Areas with O_2 concentration $< 20\mu M$
- 7% of global ocean volume
- Occur naturally on western continental margins and enclosed basins



Oxygen Minimum Zones

- Form in subsurface waters
- Result of respiration of organic matter from surface waters
- Decreased ventilation

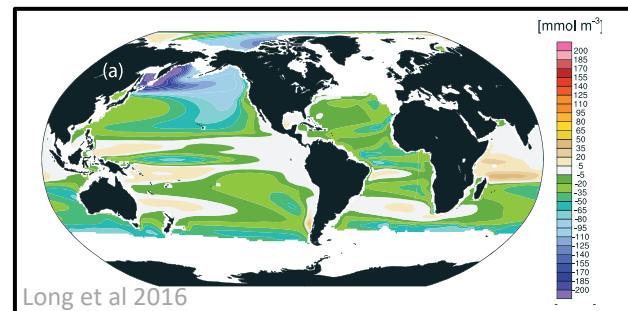
Host diverse microbial communities that mediate important biogeochemical processes



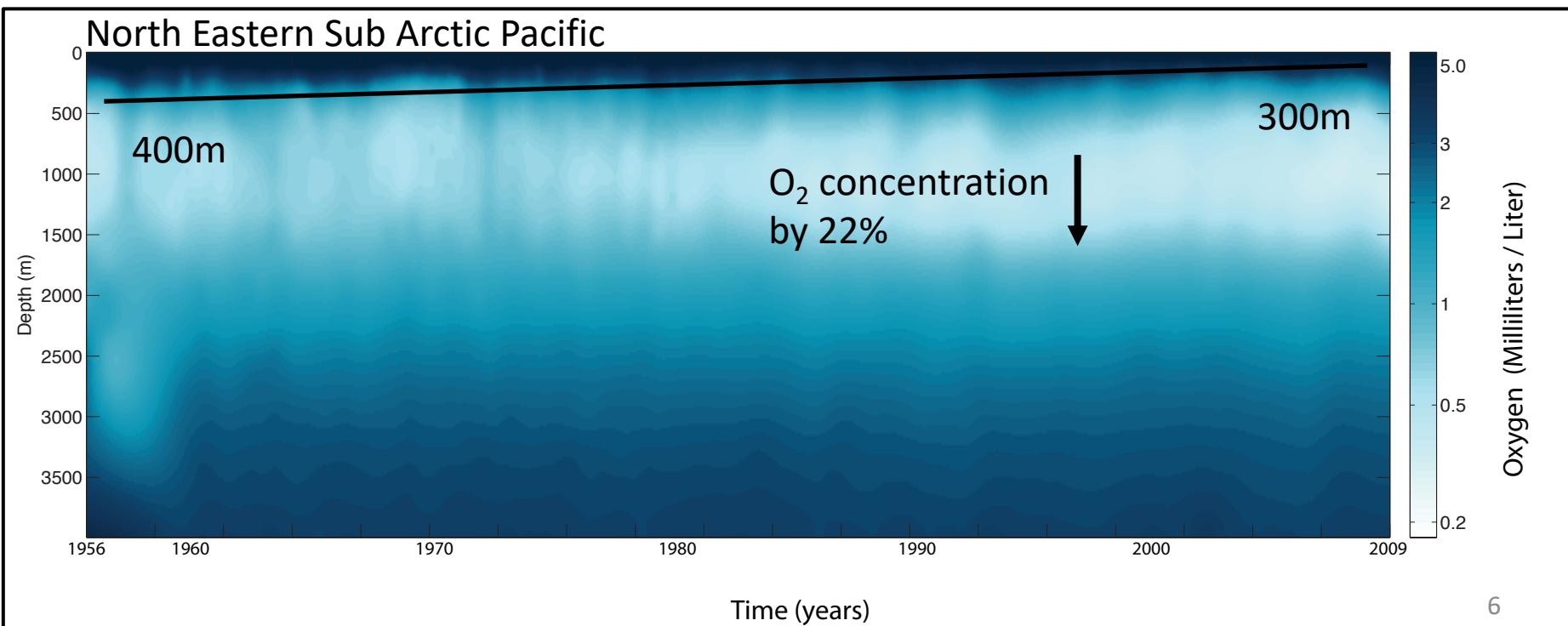
Expansion and Intensification

- Warming ocean surface temperatures increases stratification and reduces mixing
- Organic matter input (eutrophication) increases surface primary productivity

22% reduction in O₂ over past 50 years in the NESAP



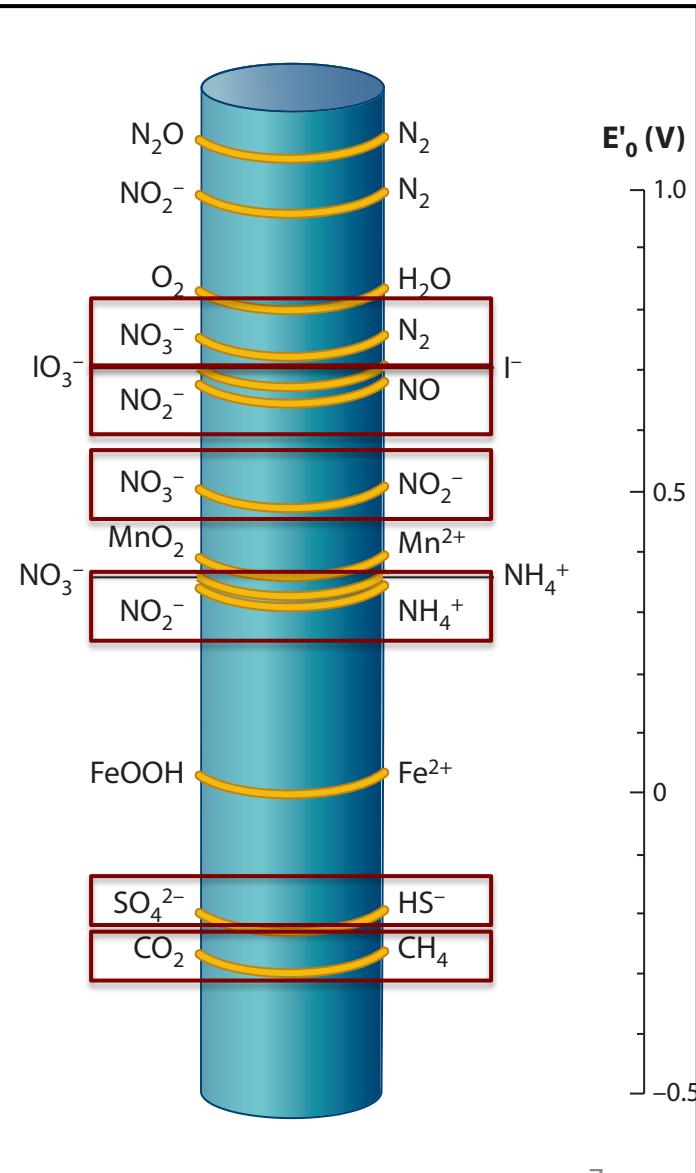
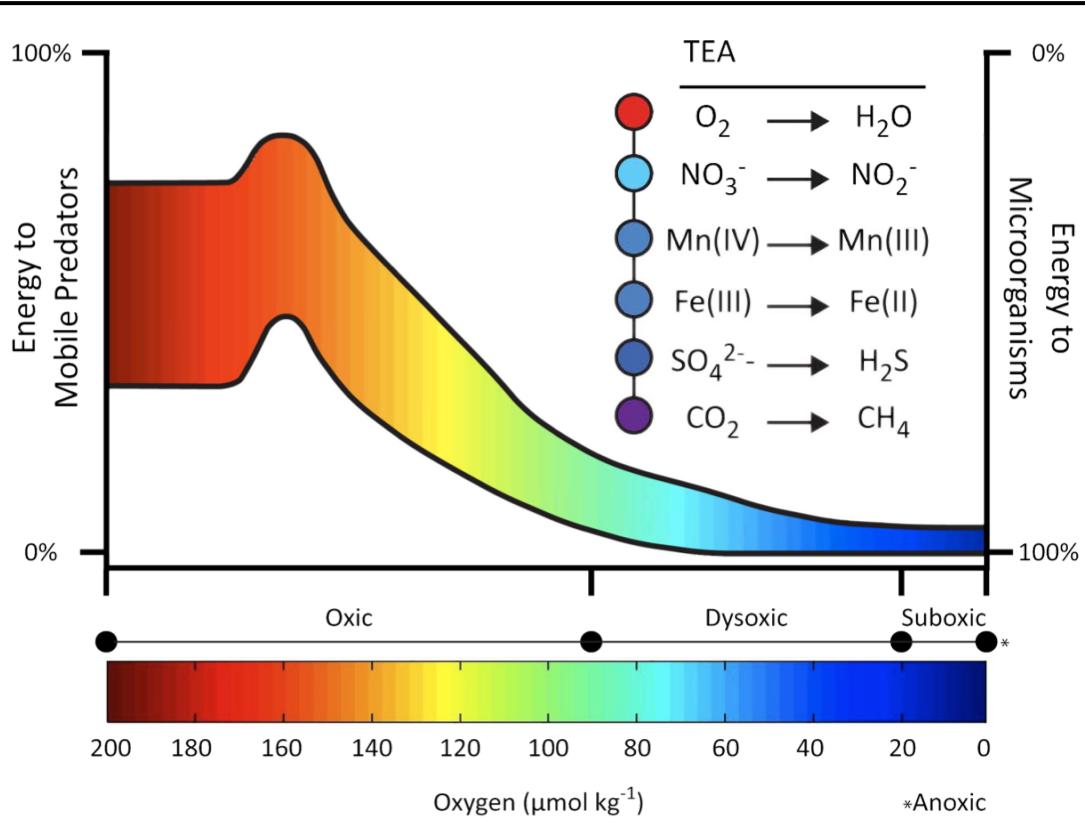
Widespread de-oxygenation by 2030-2040



OMZ energetics

As O_2 is depleted microbes use alternative terminal electron acceptors (TEAs) for respiration

- production of N_2O CH_4 H_2S
- CO_2 fixation

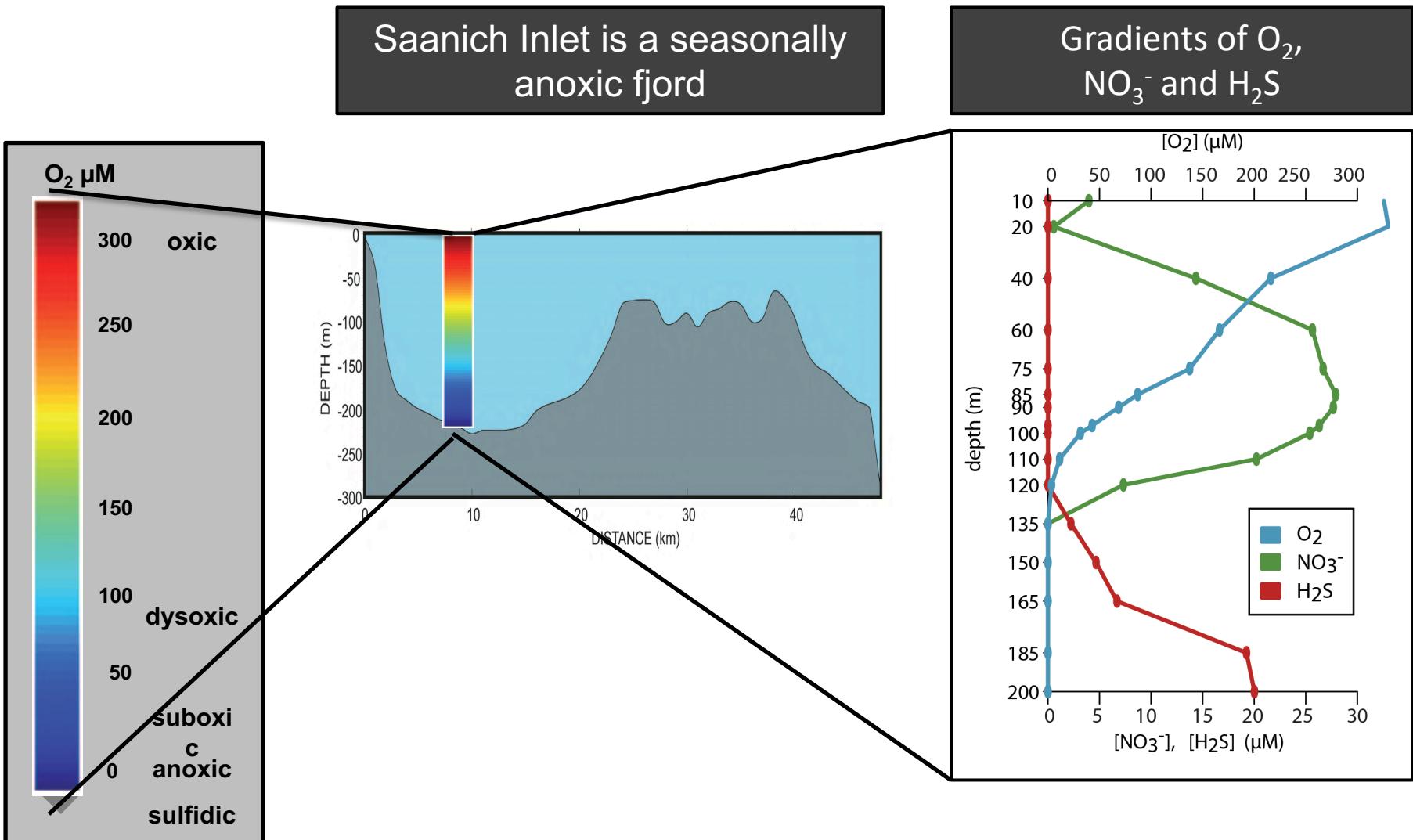




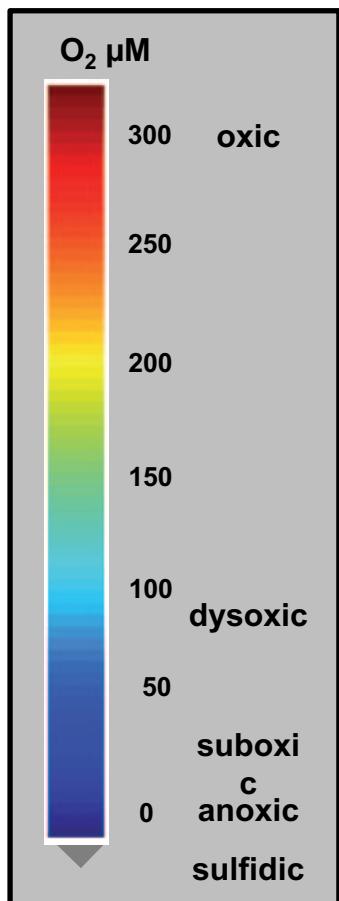
Saanich Inlet

Victoria

Saanich Inlet Model OMZ



Biogeochemical Processes



O_2 depletion changes nutrient and energy flow through the ecosystem

Denitrification
Anammox

N_2O , CO_2
 CH_4

Nitrogen Loss

Dark Carbon
Fixation

Climate Active
Gases

Sulfur Cycling

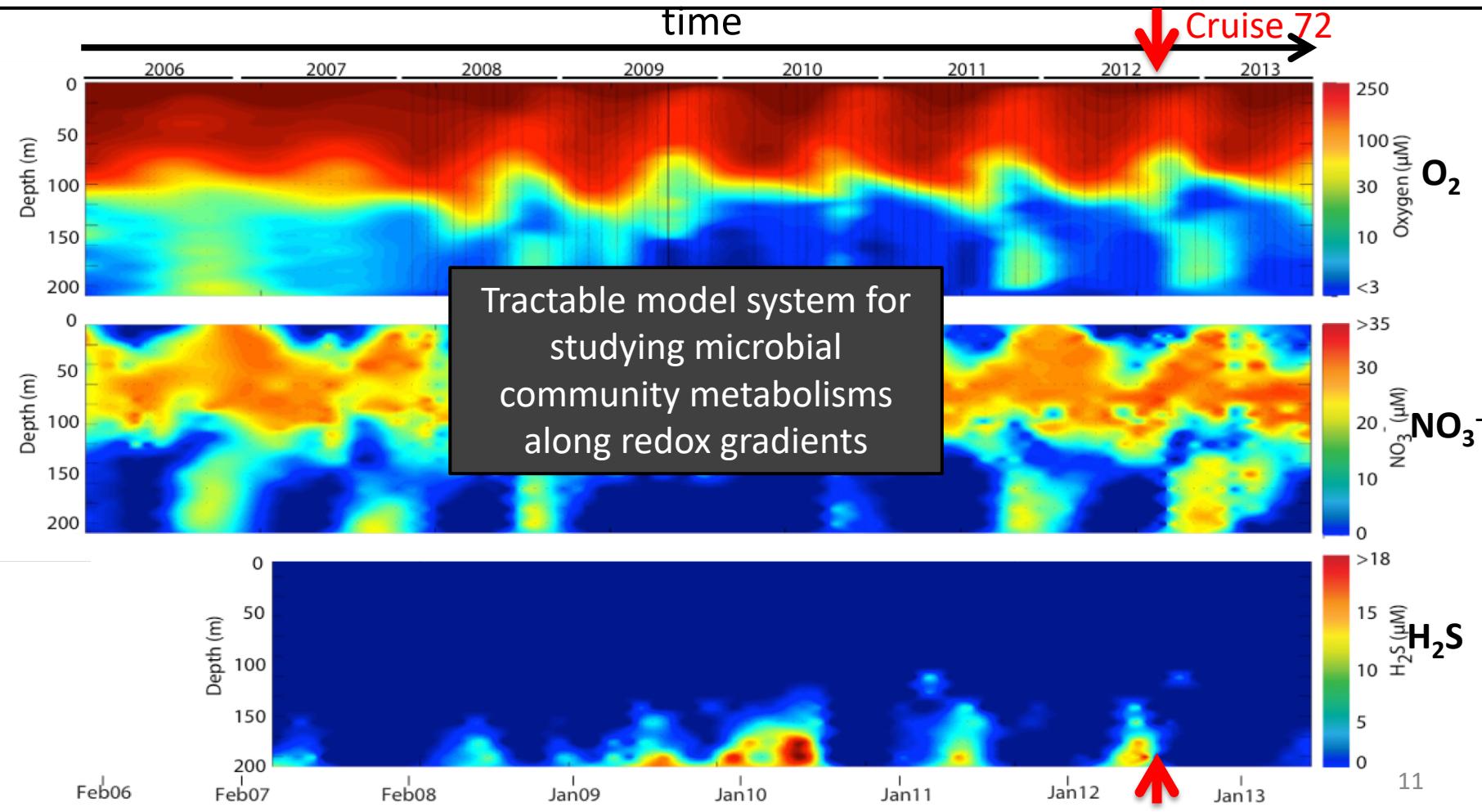
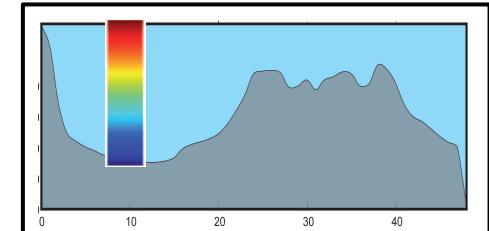
Chemoautotrophic
metabolism

SO_4^{2+} reduction
 H_2S oxidation

Saanich Inlet Model OMZ

Annual cycles of
stratification and renewal

Gradients of O₂,
NO₃⁻ and H₂S



Saanich Inlet: Sampling



CTD: pressure, temperature, salinity, O₂, fluorescence

Chemistry: NO₃⁻, NO₂⁻, NH₄⁺, PO₄³⁻, Si₄⁴⁻, H₂S

Dissolved Gases: N₂O and CH₄

Community structure: 1L water for 16S tags

Single Cell Genomics: 1ml water

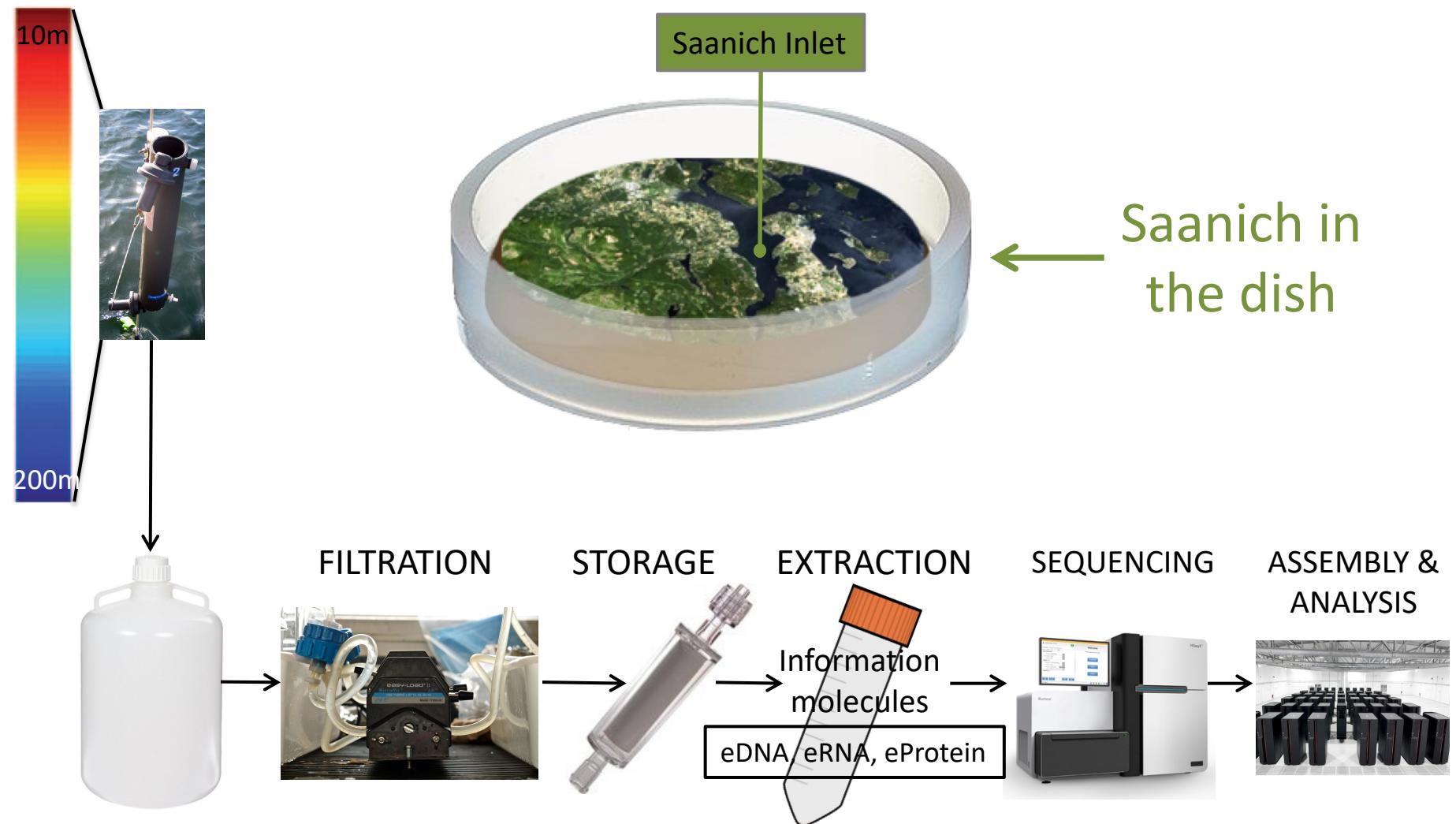
Metagenomics: 20L water

Metatranscriptomics: 2L water – filtered on-board

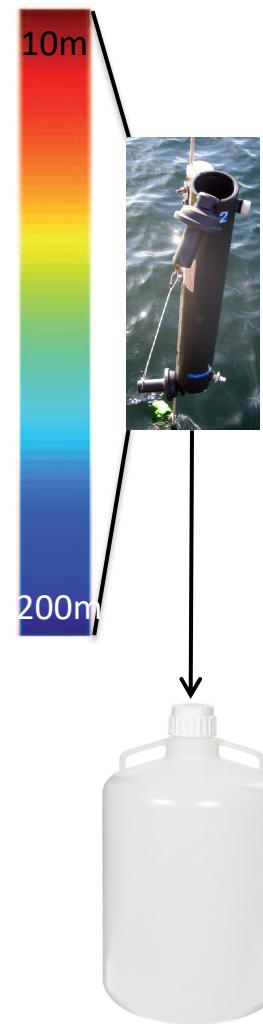
Metaproteomics: 2L water – filtered on-board



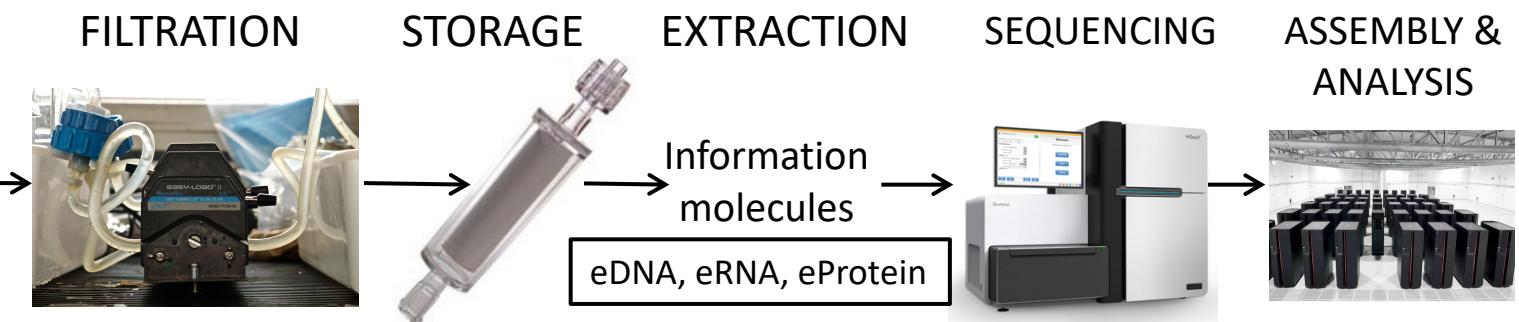
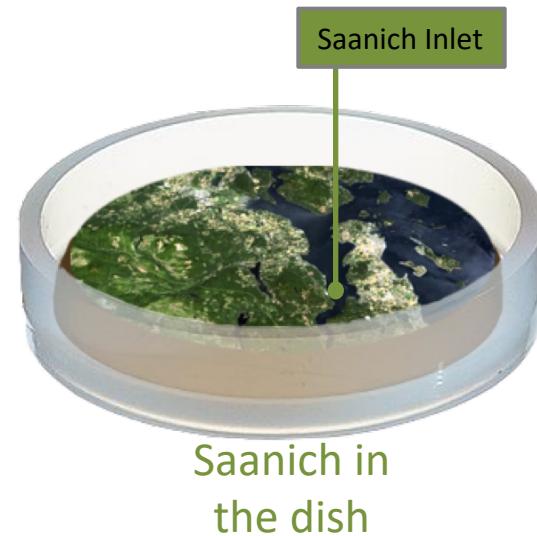
Saanich Inlet: ‘The Experiment’



Saanich Inlet: ‘The Experiment’

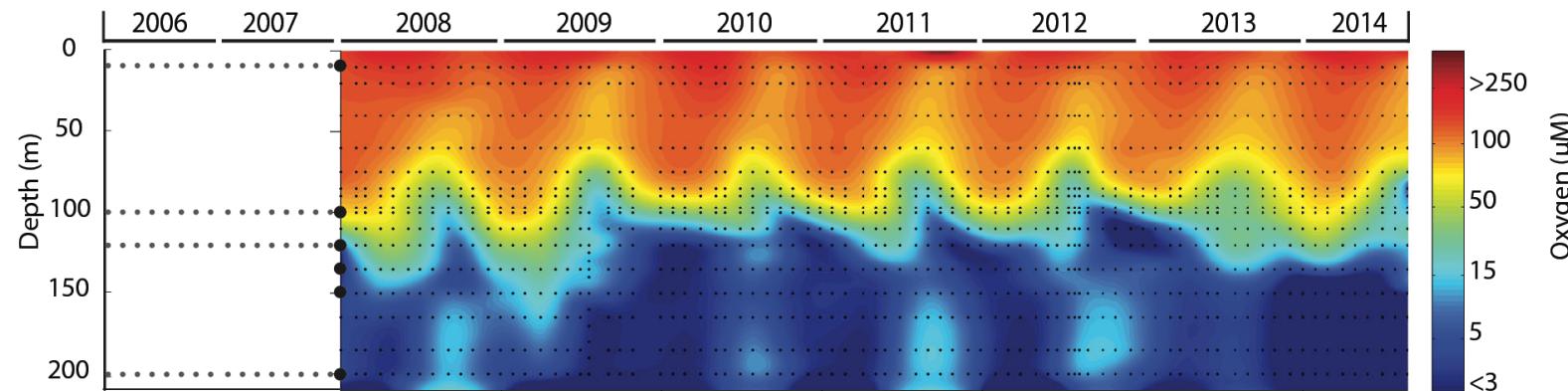


Every month for 10 years
=
11 Olympic size swimming pools
and
4300 sterivex filters

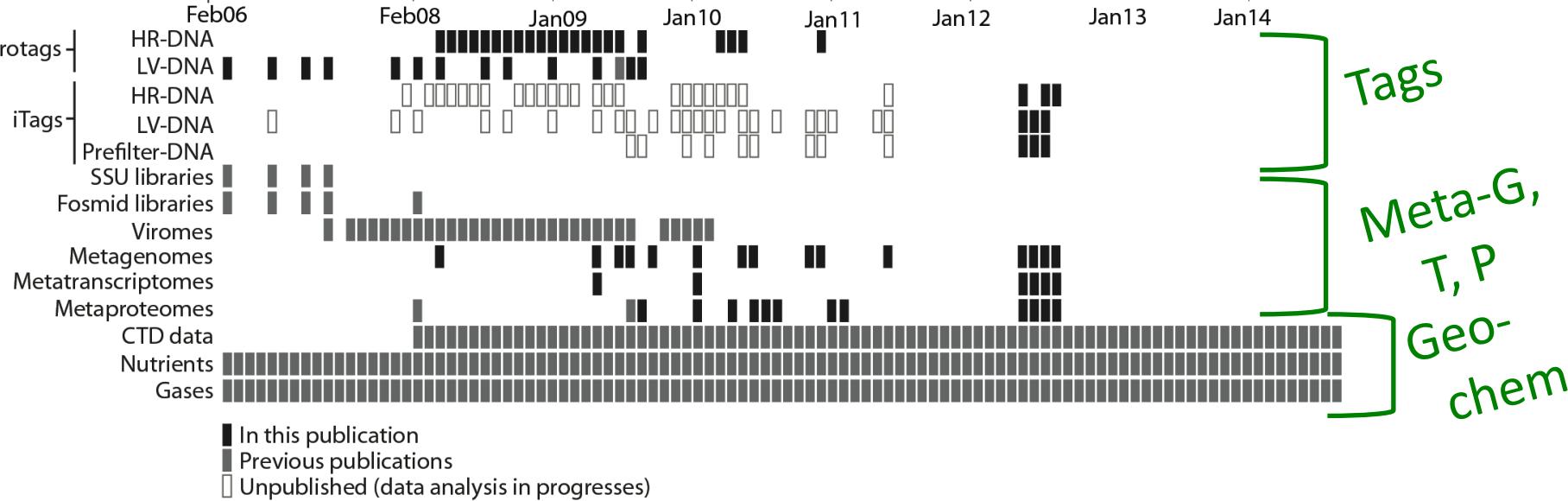


Saanich Inlet multi-omic time series

A



B



Ecological Questions

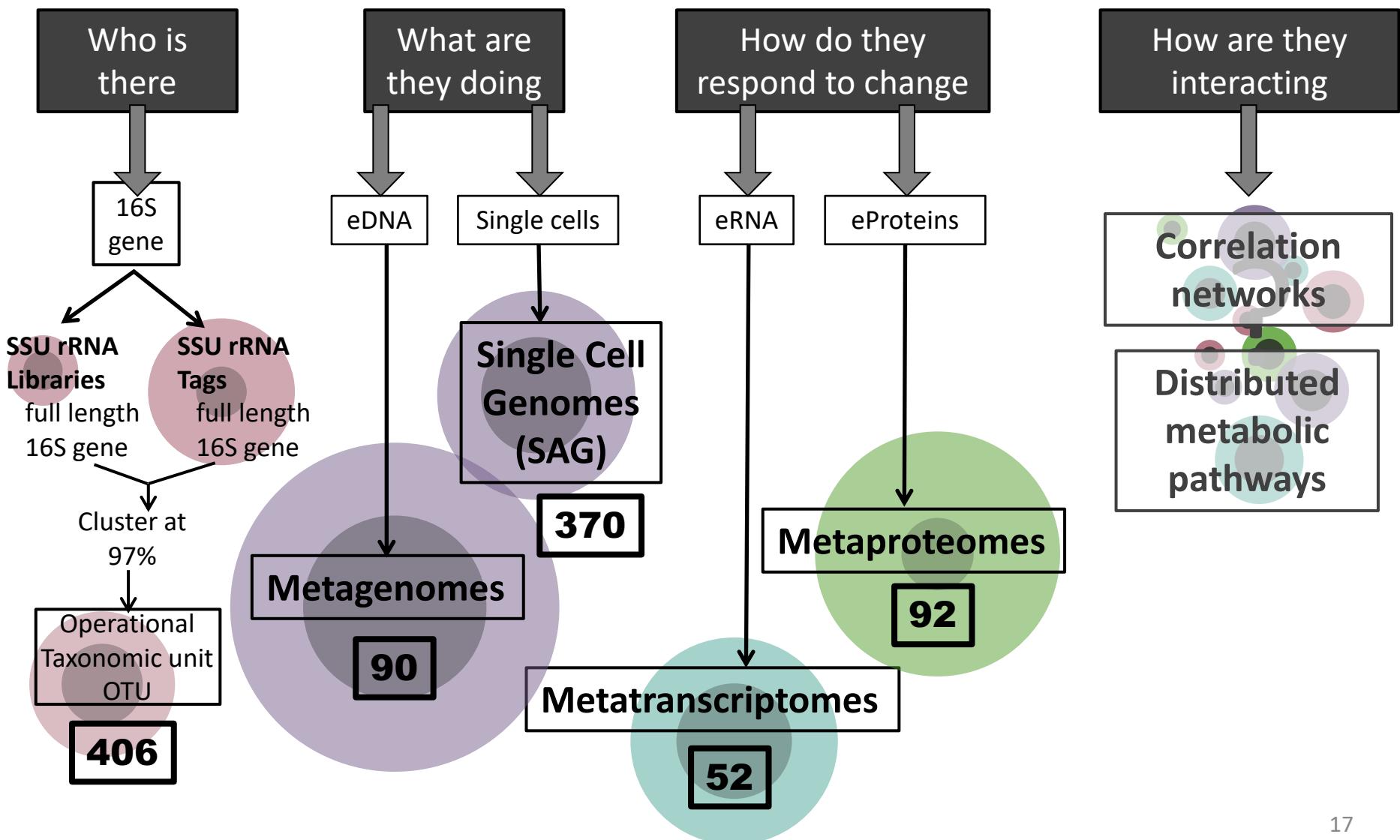
Who is there

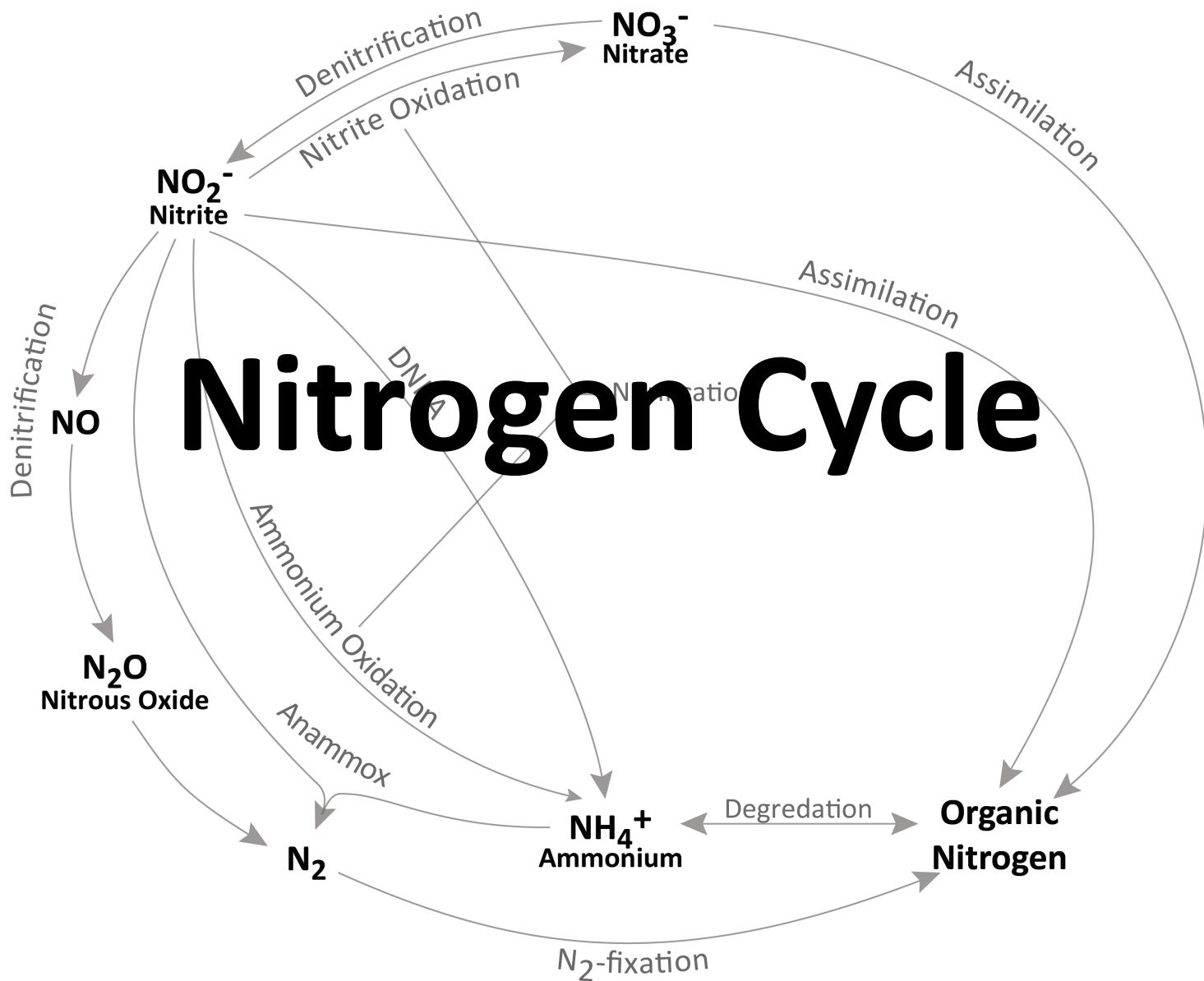
What are they doing

How do they respond to change

How are they interacting

Molecular Datasets and Tools

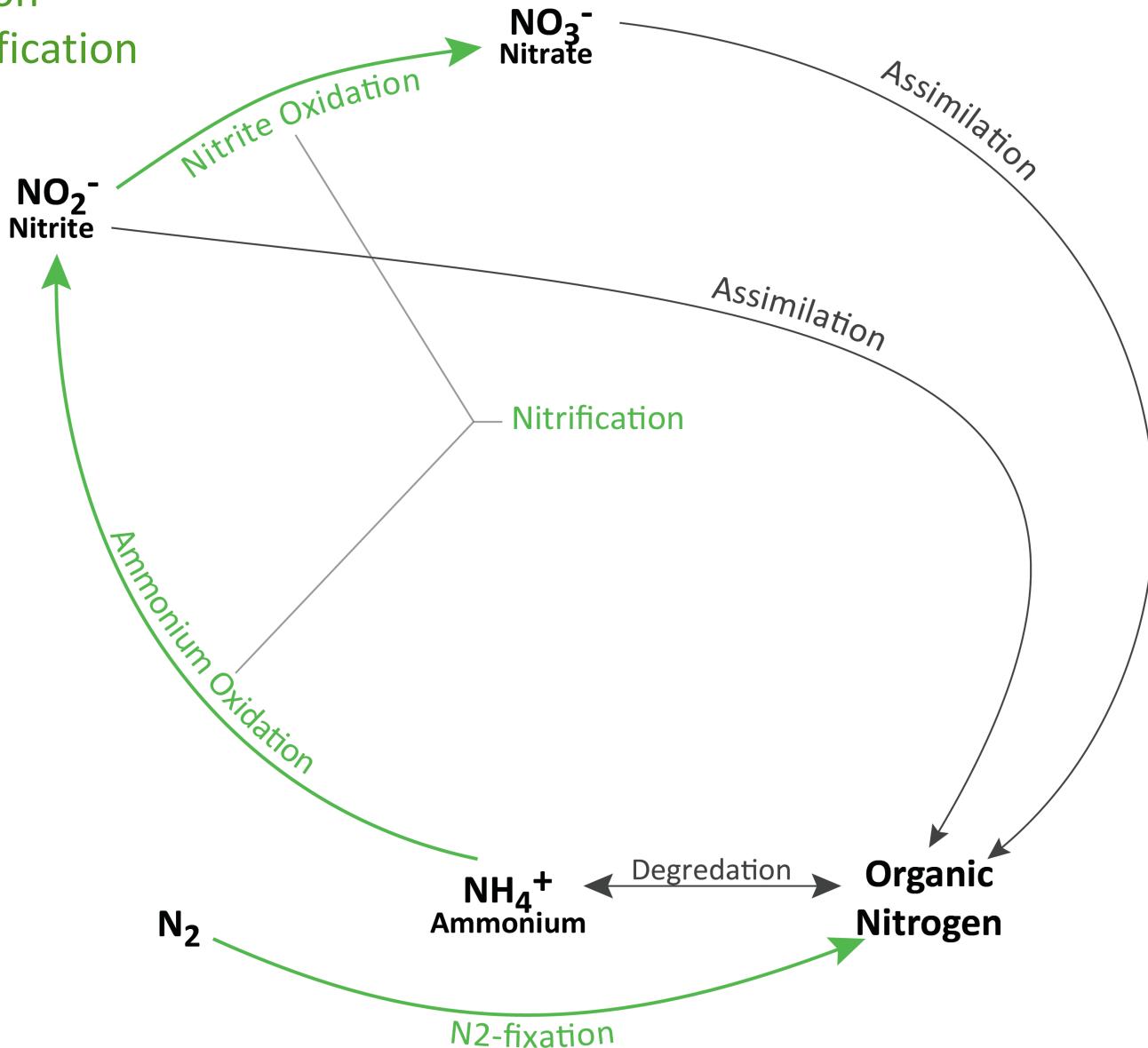




Aerobic Processes

→ N-fixation
& nitrification

Occurs primarily in oxic
and dysoxic water



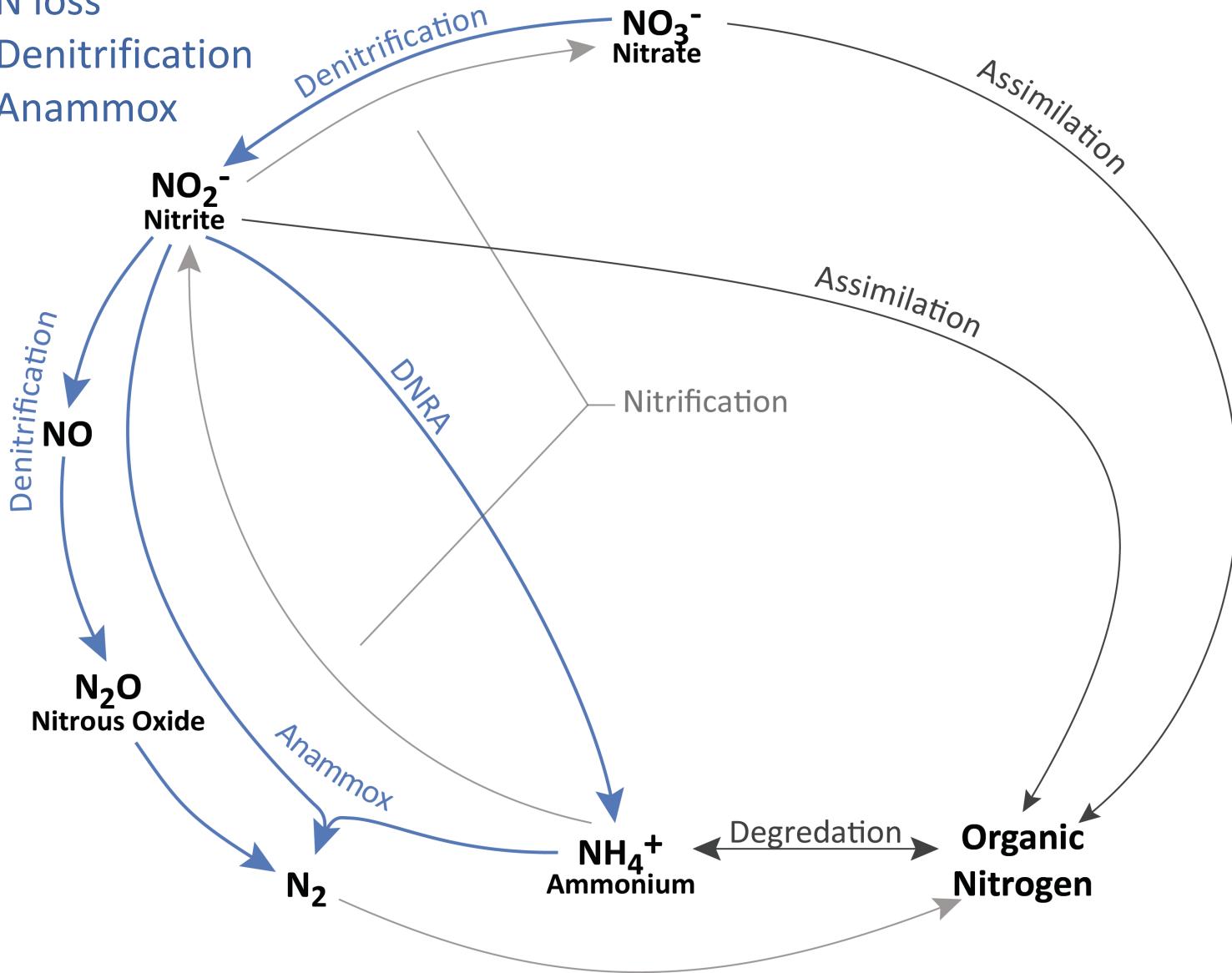
Anaerobic Processes

Occurs primarily in OMZs

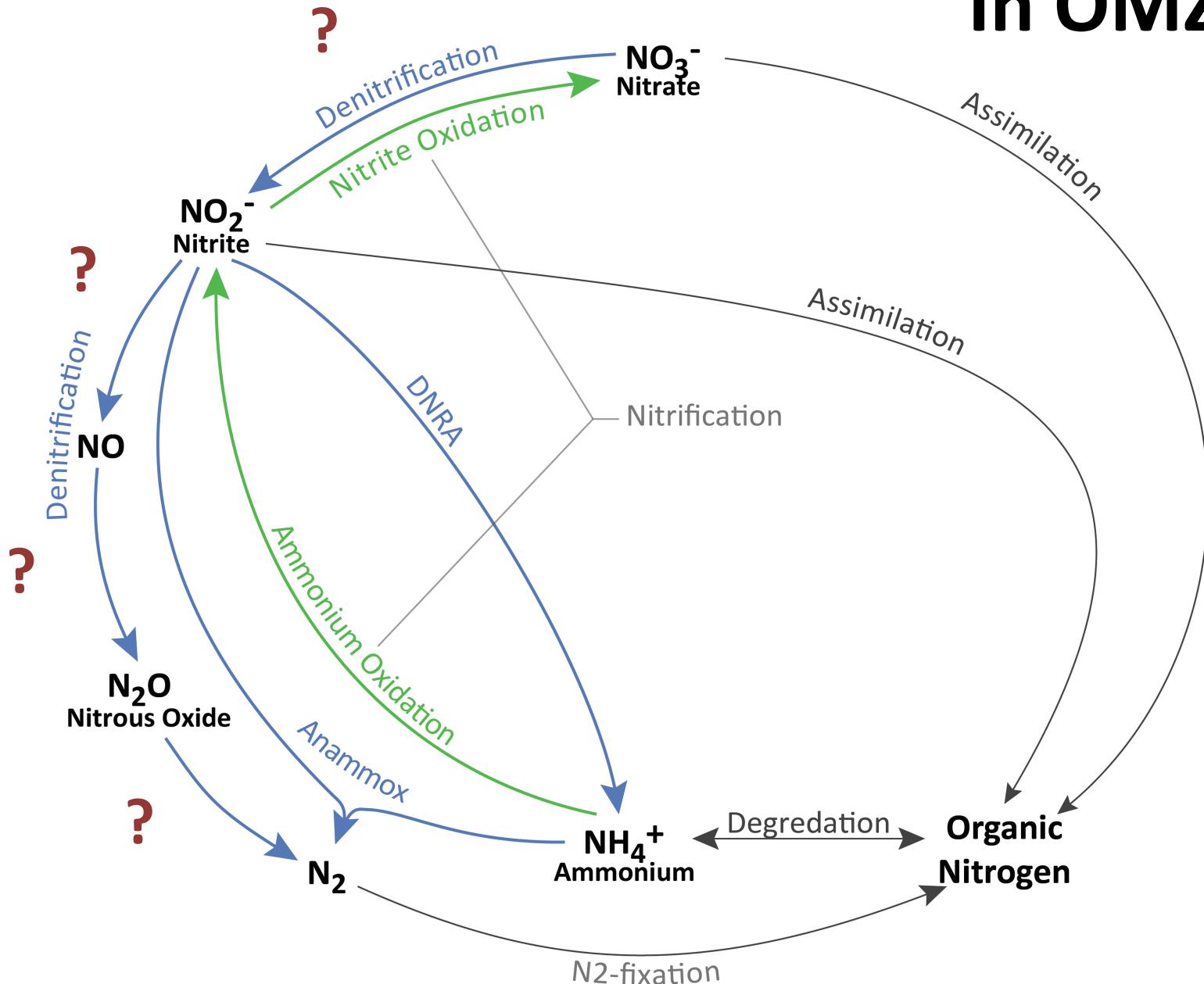
→ N loss

Denitrification

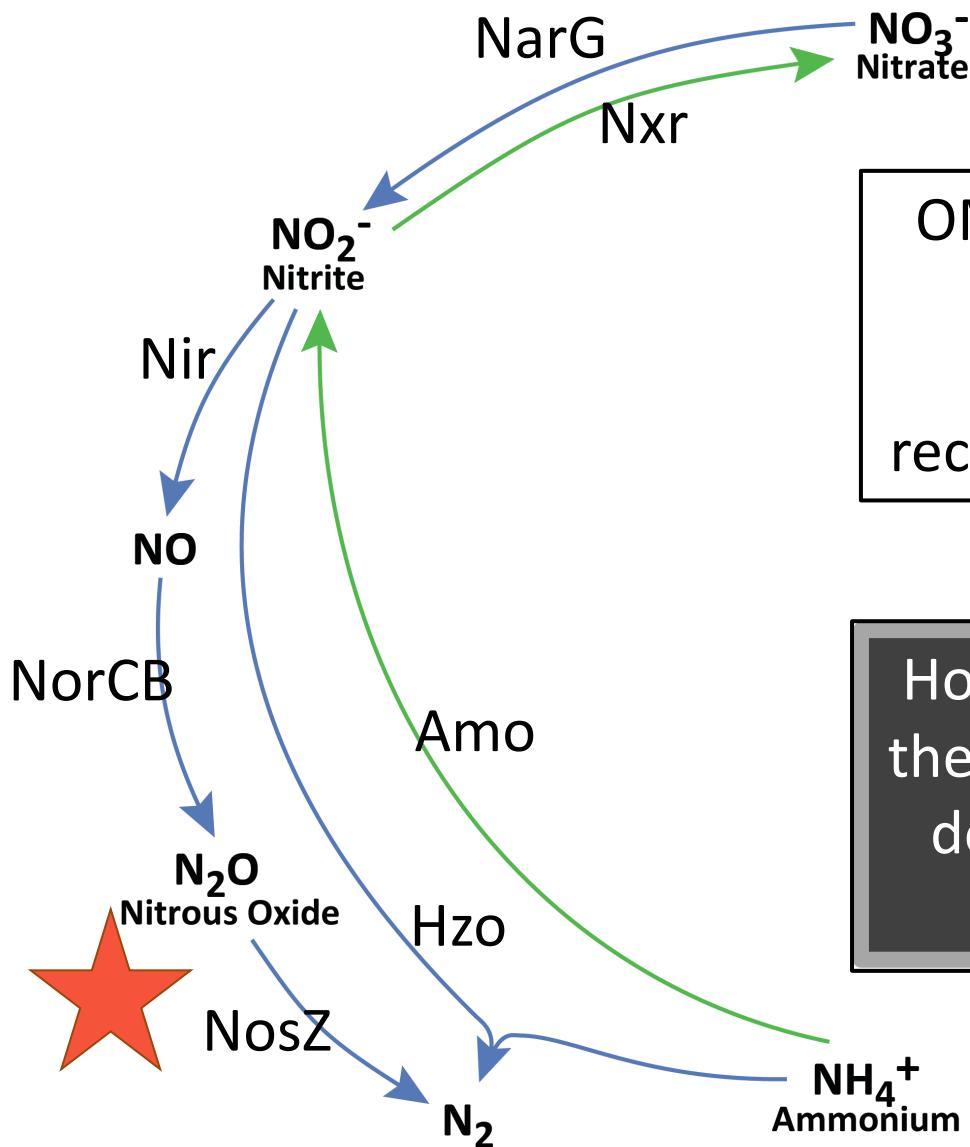
Anammox



In OMZs



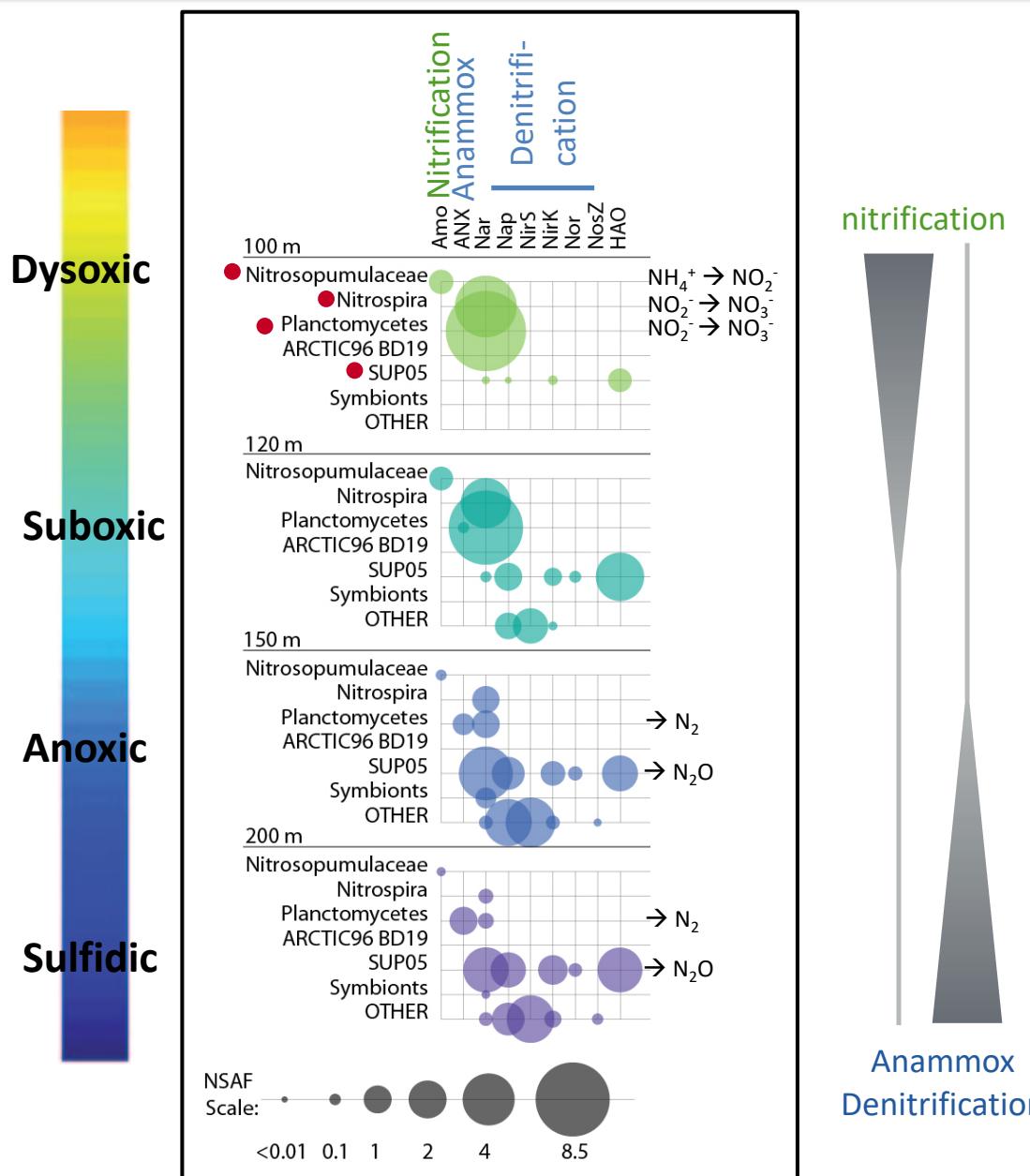
In OMZs



OMZ microbial metabolism
regulates the balance
between N loss and N
recycling in the Global Ocean

How does the redox state of
the water column predict the
dominant biogeochemical
process?

N, S, C Biogeochemical Proteins in Saanich

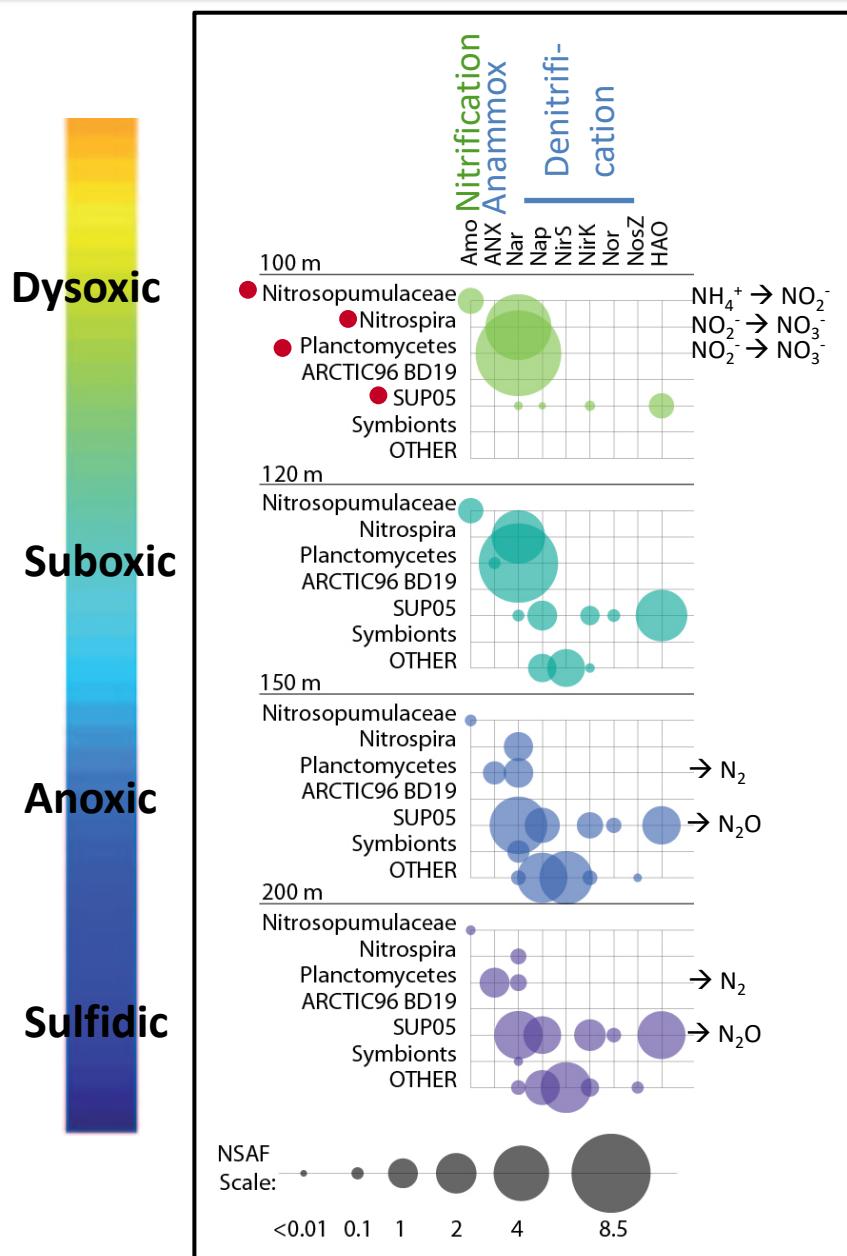


Proteins collected from different points in the water column along the redox gradient

Protein sequences mapped to metagenomic data

Taxonomy and function identified via database search

N, S, C Biogeochemical Proteins in Saanich

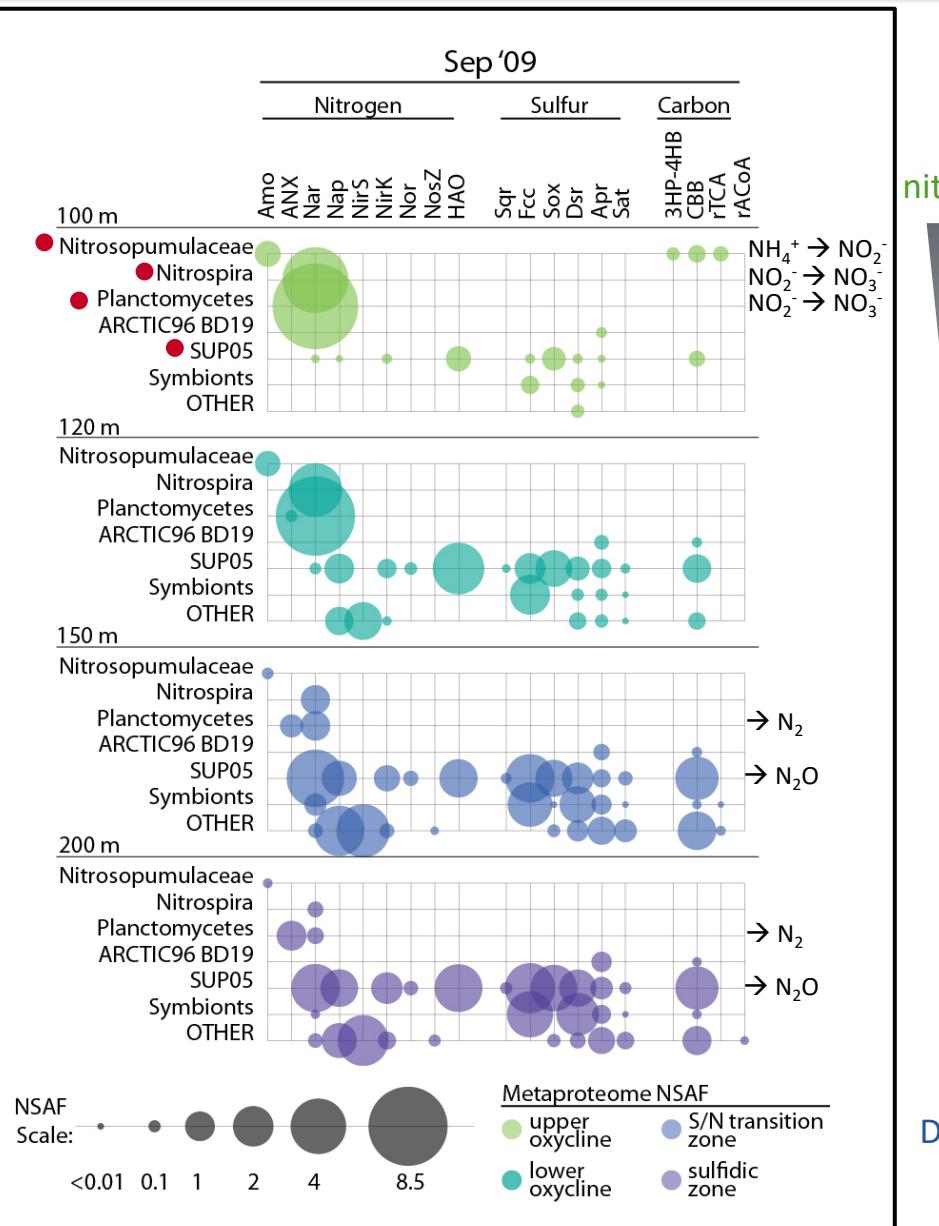


nitrification

Anammox
Denitrification

Shifts in proteins involved
in N cycling and N loss
along redox gradient

N, S, C Biogeochemical Proteins in Saanich



nitrification

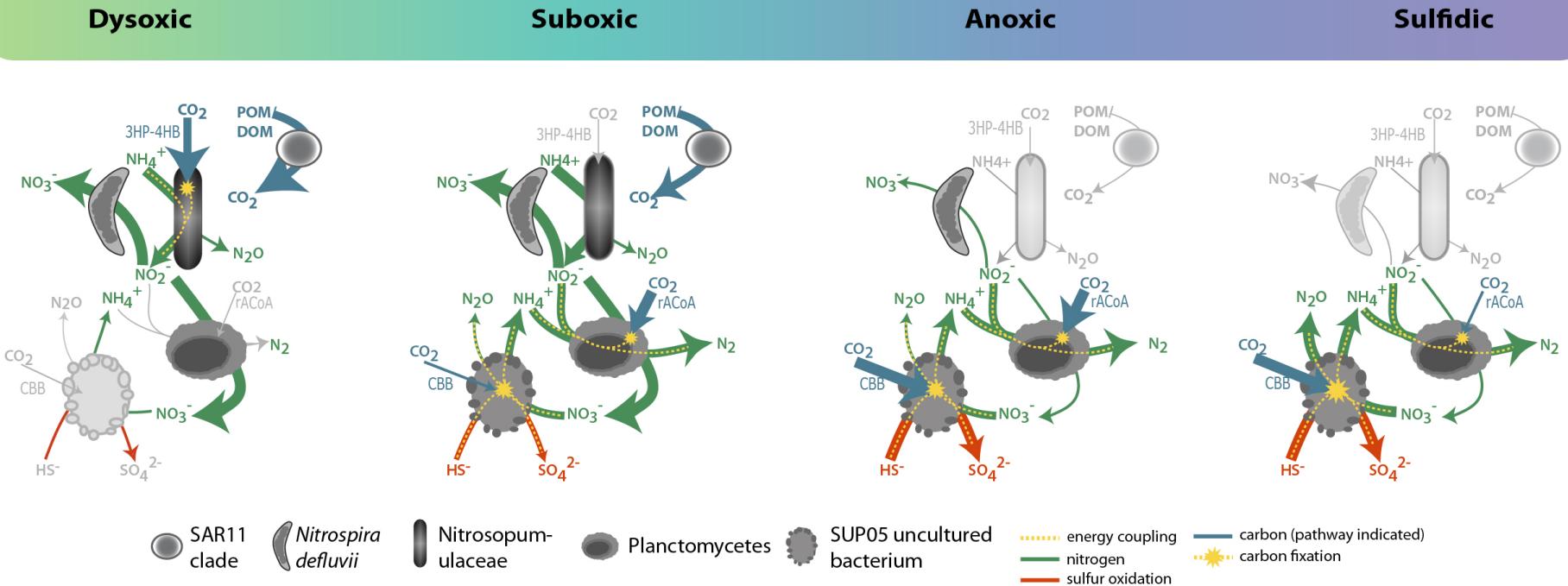
Shifts in proteins involved
in N cycling and N loss
along redox gradient

Anammox
Denitrification

Increase in sulfide oxidation
proteins with decreased oxygen

Distributed metabolism

Shifts in dominant microbial processes and interactions along redox gradient



Hawley et al 2014

Distributed conceptual metabolic model based on protein expression from dominant microbial groups along the redox gradient

Saanich Inlet: Sampling



Saanich Inlet Microbial Community

Relative abundance of microbial groups in Saanich Inlet by 16S tags

