Environmental DNA in the Ocean

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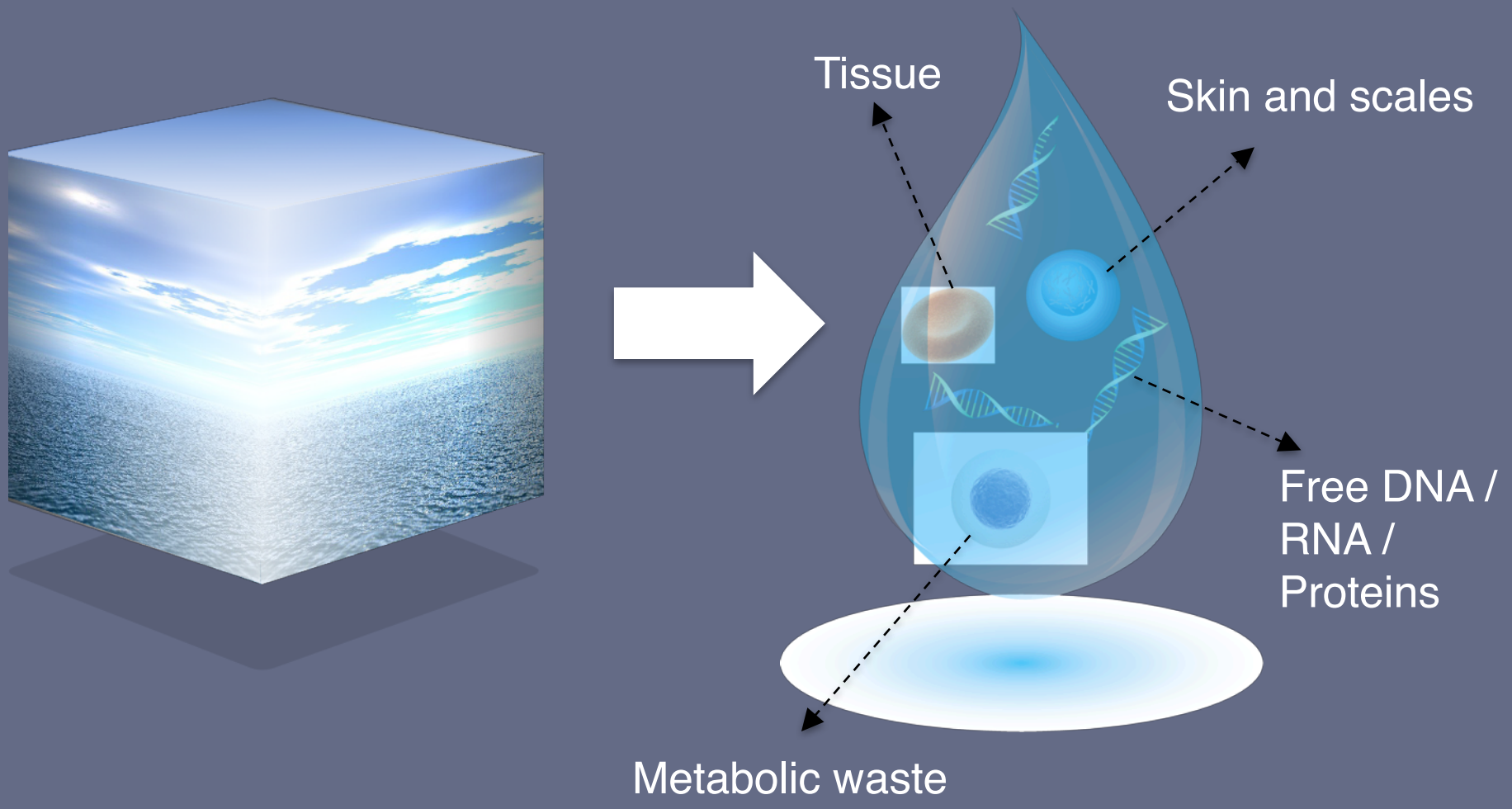
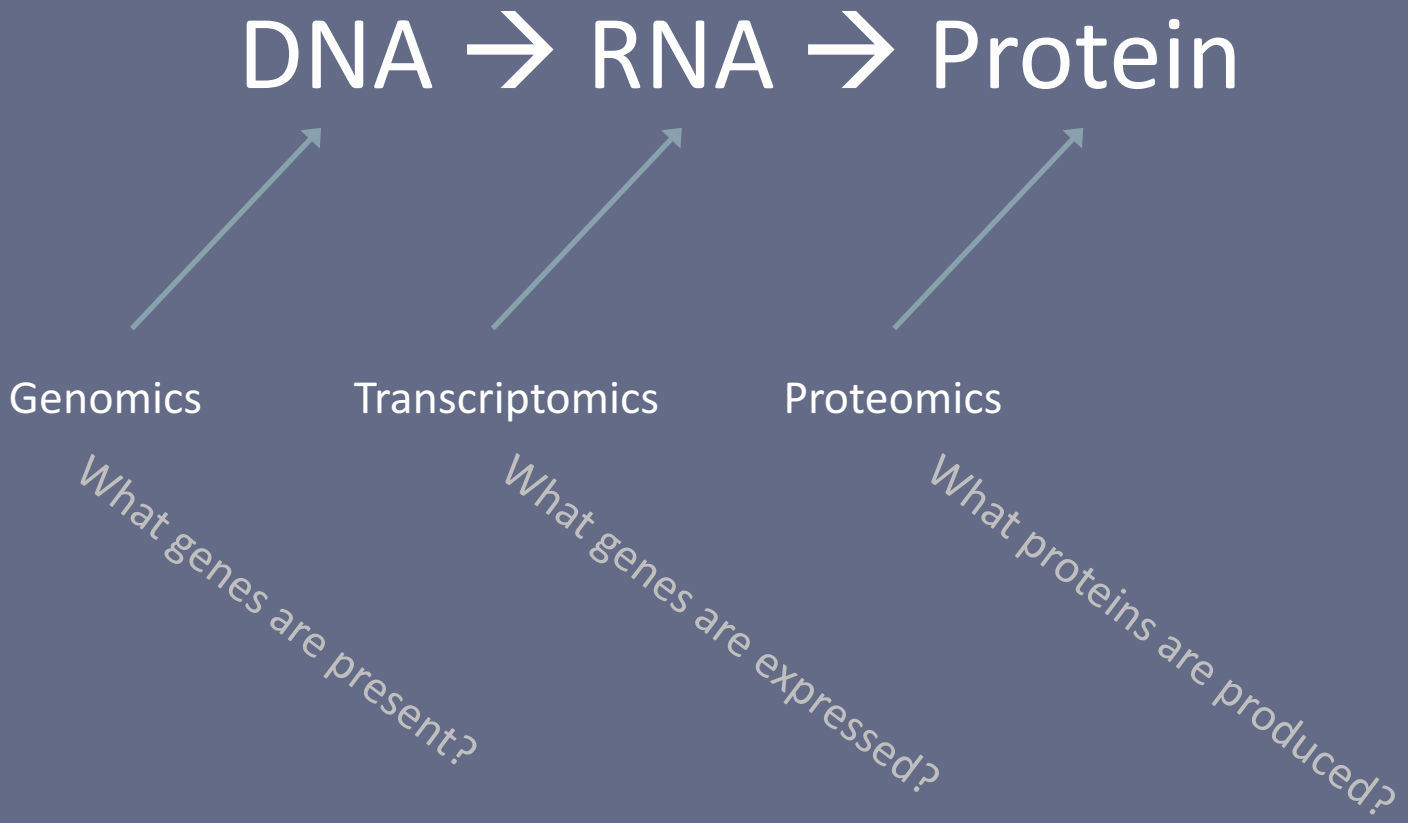
Conventional Biological Sampling

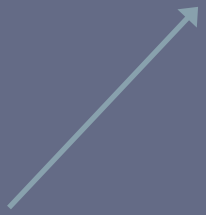
The Ocean is a Soup of Information



Relevant ‘omics



DNA



Genomics

What genes are present?

Diagnostic

- Which species are present/absent?
- Which species characterize “good” vs. “bad” habitats?
- Where/when does a species congregate?

Functional

- Are genetic pathways in place to fix carbon?
- Are complementary / competitive functions present?

DNA as a Sampling Tool

From microbes…

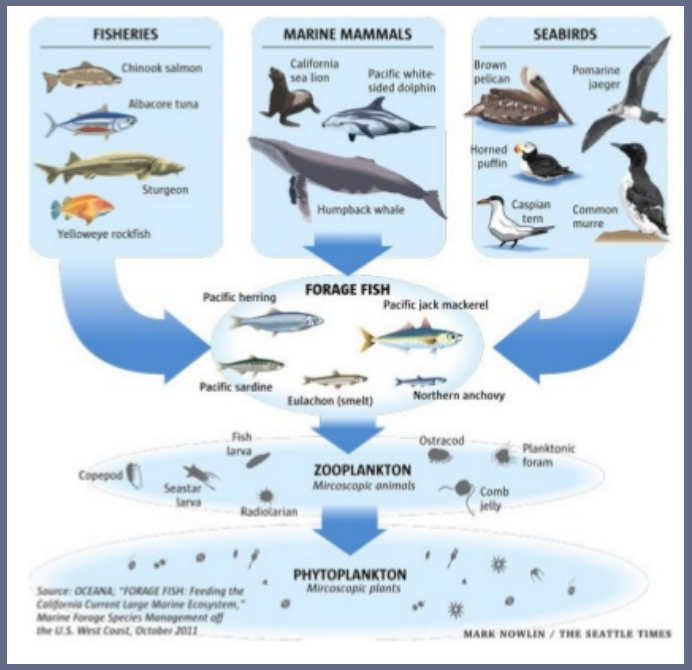
Science
AAAS

Environmental Genome Shotgun Sequencing of the Sargasso Sea
J. Craig Venter *et al.*
Science **304**, 66 (2004);
DOI: 10.1126/science.1093857

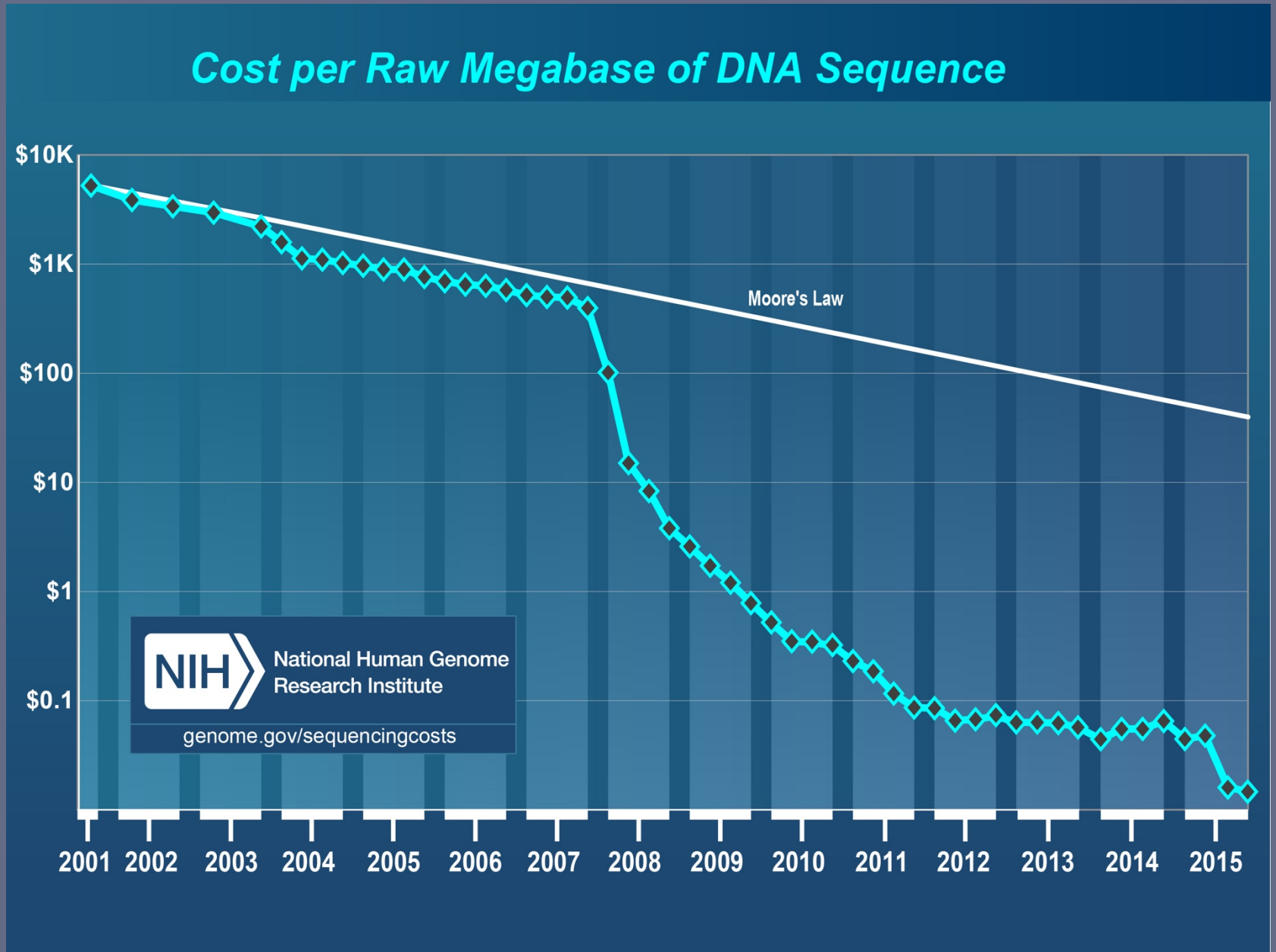
To killer whales

Two eDNA techniques

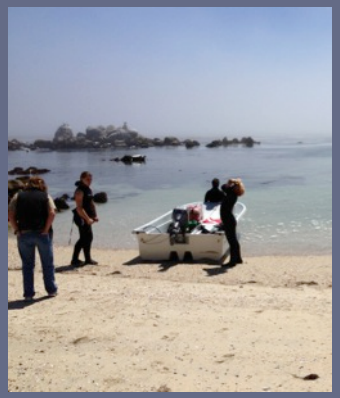
- Quantitative PCR (qPCR)
  - One species at a time
  - Quantitative
- Sequencing
  - Hundreds/thousands of species at a time
  - Less quantitative



Sequencing costs



eDNA workflow



Water sampling

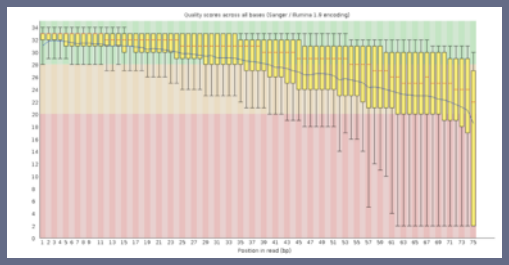
Water filtration

DNA extraction

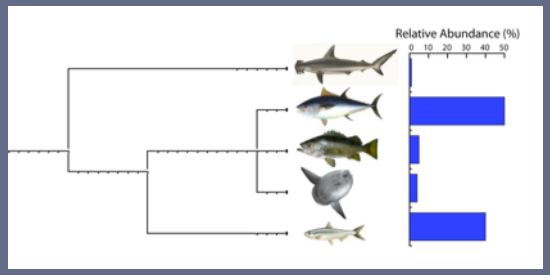
qPCR

PCR

Sequencing



Bioinformatics



Taxonomic annotation

Targeting organisms in mixed samples

Community DNA

A tweezer / photocopier

PCR amplification using
taxon-specific primers

Vertebrate DNA

What Benefit?

qPCR

- Vastly improved detection of rare targets
- Rapid quantification

Amplicon sequencing

- Thousands of species at once
- Alleviates depth/breadth tradeoff

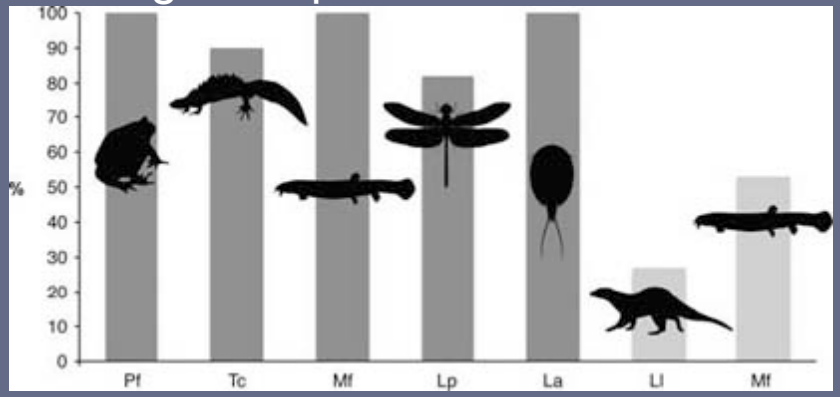
Some examples

qPCR

Invasive species

Jerde et al. 2013, Can J Fish Aquatic Sci 70:522-526

Endangered species

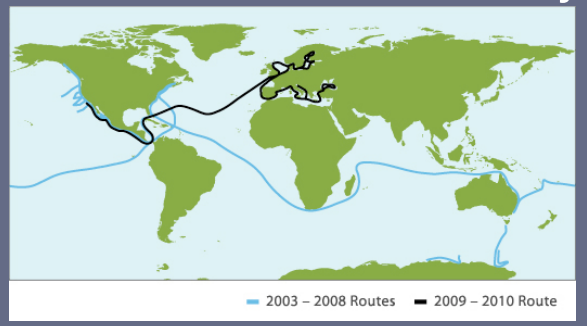


Thomsen et al. 2012, Mol Ecol 21:2565-2573

Sequencing

Plankton and Microbial diversity

Rusch et al. 2007 PLoS Biol 5:e77



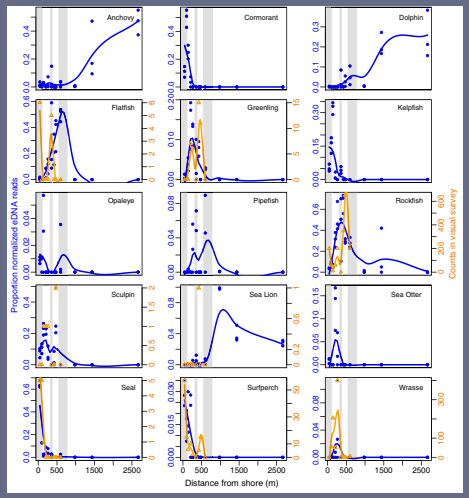
OCEAN PLANKTON

Eukaryotic plankton diversity in the sunlit ocean

Colomban de Vargas,[1,2]*† Stéphane Audic,[1,2]† Nicolas Henry,[1,2]† Johan Decelle,[1,2]†

Community Surveys

Port et al. 2016



Frontiers and Challenges

- Quantification

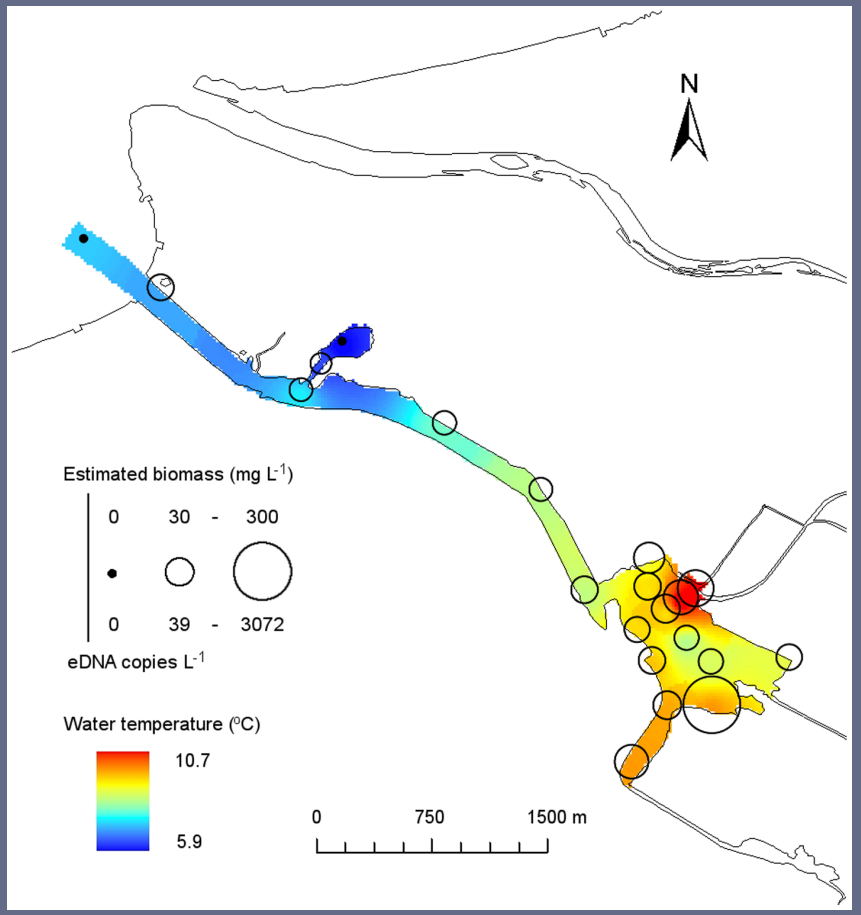
  1 fish ≠ 1 eDNA read

- Amplification-free techniques

  (e.g., Xin Zhou, China Agricultural University)

- Generalizing results

  spatial/temporal resolution



Takahara et al. 2012

And Introducing…

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