



Royal Netherlands Institute for Sea Research



Observation of Marine Biodiversity: Perspectives and Challenges

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and Ecosystem Functioning MarBEF+



What is biodiversity?

- Three components: genes, species, habitats (definition of the Convention on Biological Diversity)
- Marine biodiversity research investigates marine species, their genes and gene products, and the coastal and open sea habitats in which they live.
- Focus predominantly on species (species richness, species diversity), increasingly also on genes and gene products and habitats (ecosystems).
- Relevant to Taxonomy, Ecology, Biogeochemistry, Fisheries, Ecosystem Management, Conservation etc.



Why marine biodiversity observation?

- Marine Biodiversity is an essential descriptor of the state of marine ecosystems and changes thereof
- Marine Biodiversity is changing and in many cases decreasing rapidly due to climate change, fisheries, acidification, eutrophication, invading species ...
- Changes in biodiversity and ecosystem state are mostly unpredictable and require surveillance at the right spatial and temporal scales in order to be detected, monitored and, if necessary, managed.



What challenges?

- Identify adequate descriptors and indicators of marine biodiversity (change) in Europe
- Survey (monitor) changes in biodiversity at the relevant spatial and temporal scales and with adequate technologies
 - Spatial = ecosystems, basins, LME's
 - Temporal = decades
- Base surveys on agreed EU (and globally) standardized, quality assured methods and protocols.
- Provide freely (and easily) accessible data bases (and e-science platforms and laboratories)
- Create an adequate legal framework



Challenge 1: Adequate descriptors and Indicators



Over 31000 marine species now known from European waters

- The European Register of Marine Species (including only plants and animals) as maintained by MarBEF grew with 1,371 species since 2006. The list now (2009) totals 31,455 marine species of plants and animals in Europe, which makes this the best known continent thanks to efforts of hundreds of taxonomists and ecologists.
- More than 136 plant and animal species found since 2006 are new to science, but in the microbial domain the number of new 'species' has grown exponentially.

Global Biodiversity: Indicators of Recent Declines

Stuart H. M. Butchart,^{1,2*} Matt Walpole,¹ Ben Collen,³ Arco van Strien,⁴
Jörn P. W. Scharlemann,¹ Rosamunde E. A. Almond,¹ Jonathan E. M. Baillie,³
Bastian Bomhard,¹ Claire Brown,¹ John Bruno,⁵ Kent E. Carpenter,⁶ Geneviève M. Carr,^{7†}
Janice Chanson,⁸ Anna M. Chenery,¹ Jorge Csirke,⁹ Nick C. Davidson,¹⁰ Frank Dentener,¹¹
Matt Foster,¹² Alessandro Galli,¹³ James N. Galloway,¹⁴ Piero Genovesi,¹⁵
Richard D. Gregory,¹⁶ Marc Hockings,¹⁷ Valerie Kapos,^{1,18} Jean-Francois Lamarque,¹⁹
Fiona Leverington,¹⁷ Jonathan Loh,²⁰ Melodie A. McGeoch,²¹ Louise McRae,³
Anahit Minasyan,²² Monica Hernández Morcillo,¹ Thomasina E. E. Oldfield,²³ Daniel Pauly,²⁴
Suhel Quader,²⁵ Carmen Revenga,²⁶ John R. Sauer,²⁷ Benjamin Skolnik,²⁸ Dian Spear,²⁹
Damon Stanwell-Smith,¹ Simon N. Stuart,^{1,12,30,31} Andy Symes,² Megan Tierney,¹
Tristan D. Tyrrell,¹ Jean-Christophe Vié,³² Reg Watson²⁴

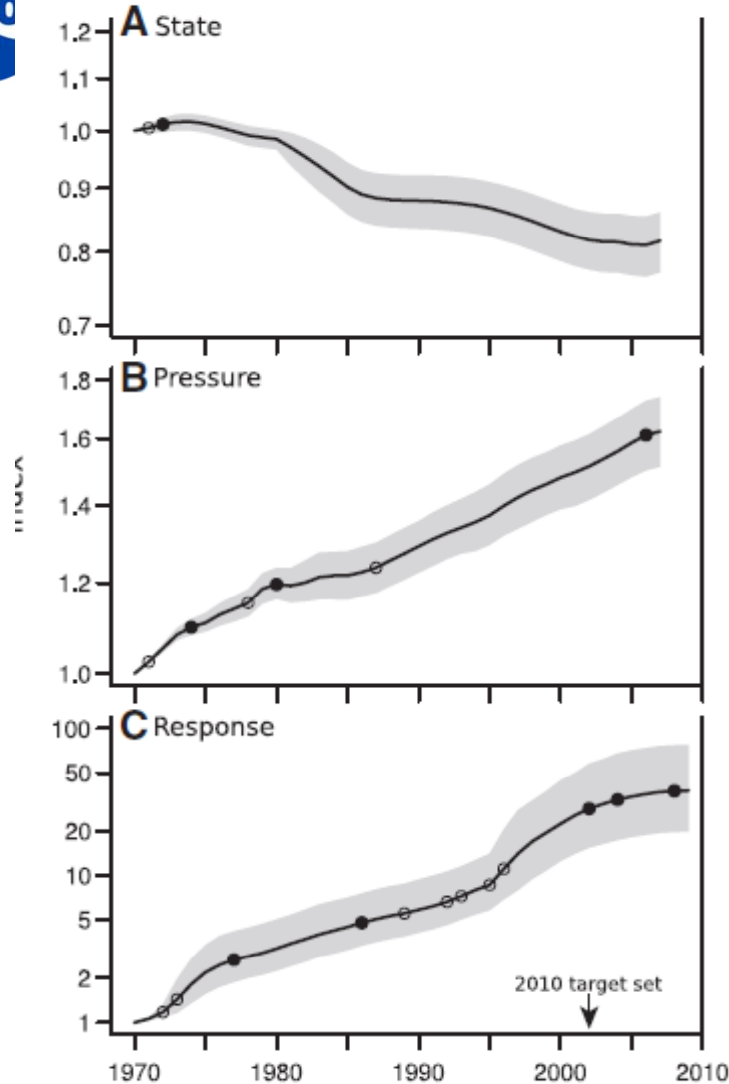
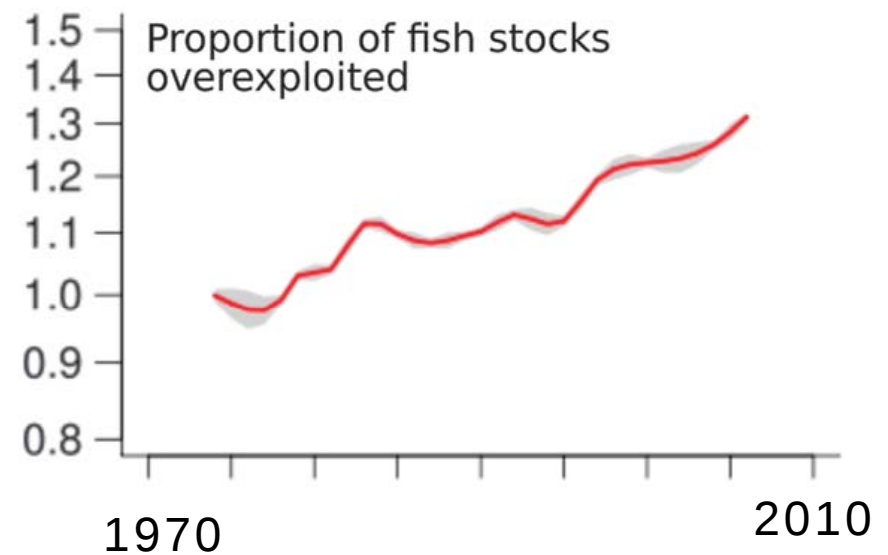
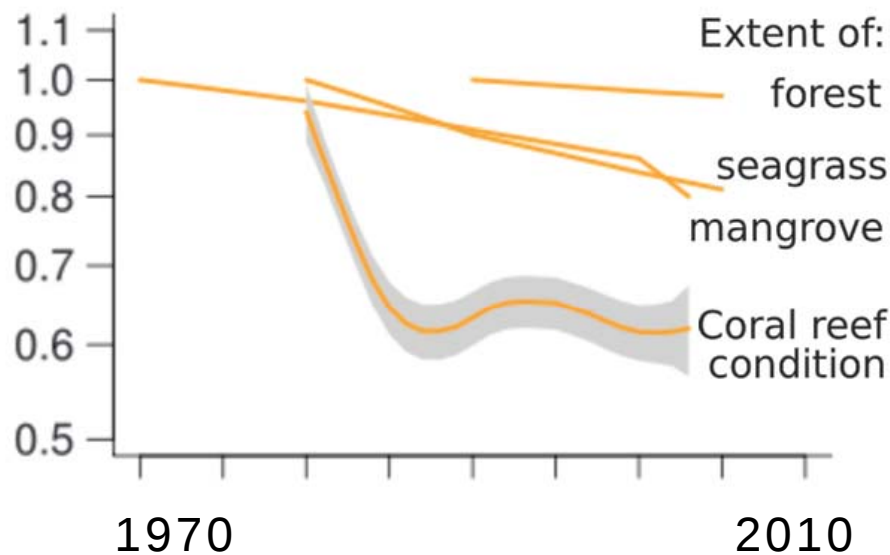
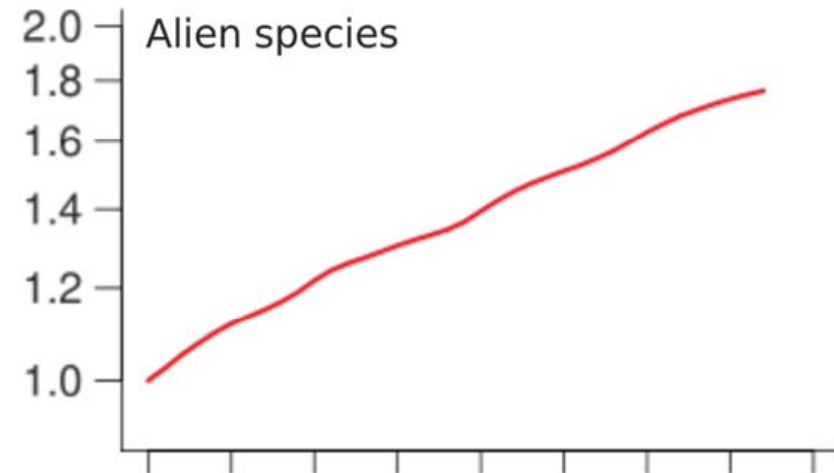
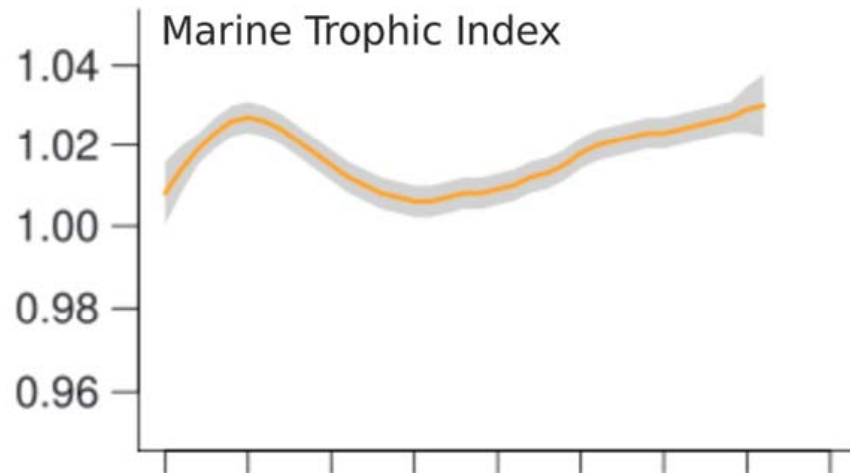


Fig. 2. Aggregated indices of (A) the state of biodiversity based on nine indicators of species' population trends, habitat extent and condition, and community composition; (B) pressures on biodiversity based on five indicators of ecological footprint, nitrogen deposition, numbers of alien species, overexploitation, and climatic impacts; and (C) responses for biodiversity based on six indicators of protected area extent and biodiversity coverage, policy responses to invasive alien species, sustainable forest management, and biodiversity-related aid. Values in 1970 set to 1. Shading shows 95% confidence intervals derived from 1000 bootstraps. Significant positive/upward (open circles) and negative/downward (filled circles) inflections are indicated.

Marine Indicators ?





Marine Menace

Alien invasive species in the marine environment

Black Sea disaster
the comb jelly

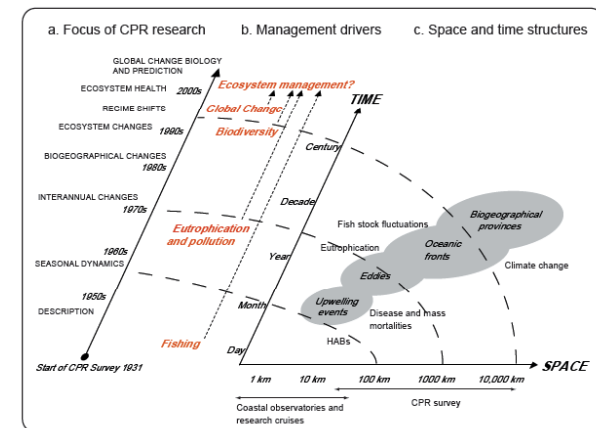
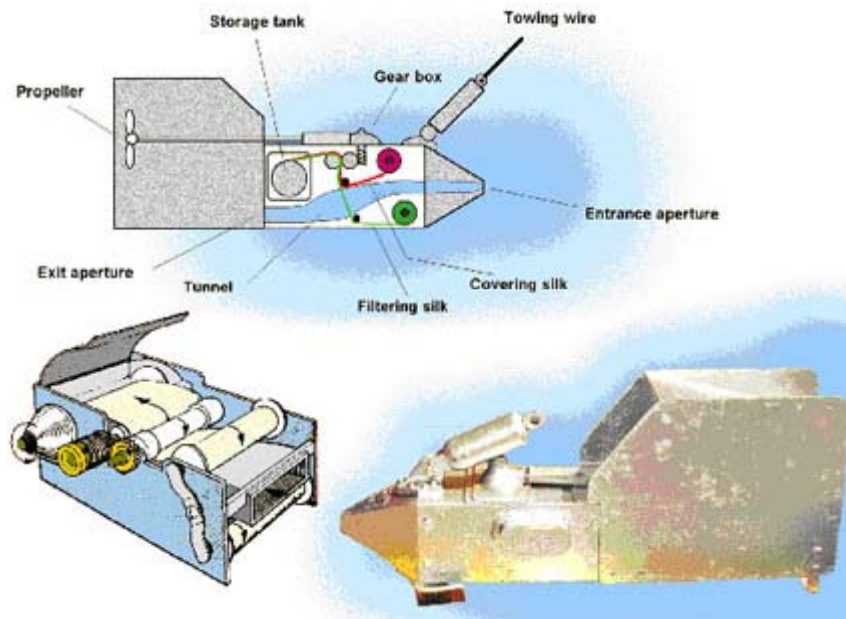
In the early 1980s, the comb jelly was accidentally introduced via ship ballast water to the Black Sea. It was also introduced into the Caspian Sea via the ballast water of oil tankers. In its new predator-free habitat, the jellyfish wreaked havoc on the entire ecosystem of the Black Sea. The situation was made worse by nutrient and other pollution. By 1992, the annual losses caused by drops in commercial catches of marketable fish were estimated at least US\$ 240 million.





Challenge 2: adequate surveys

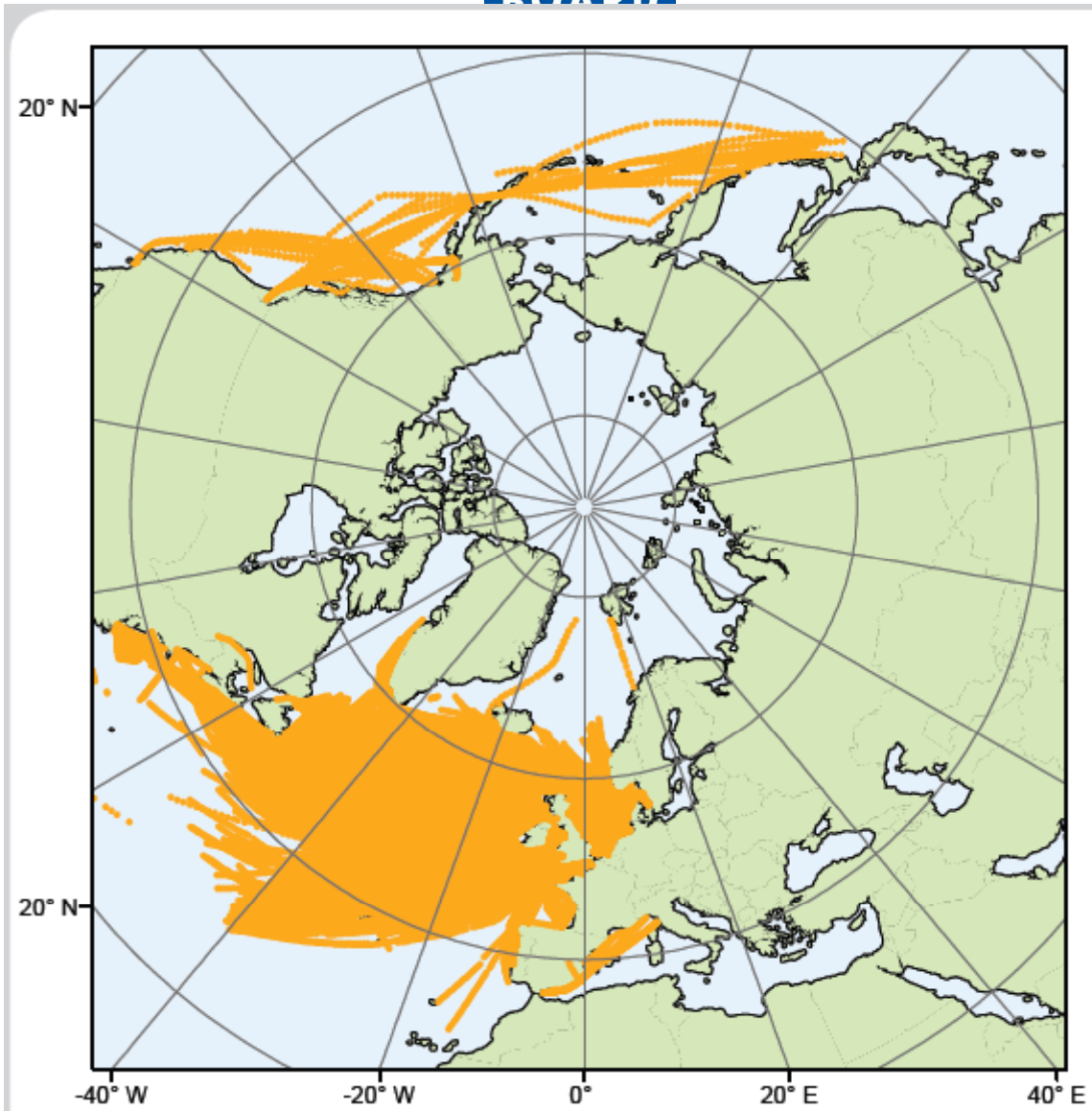
The Continuous Plankton Recorder CPR

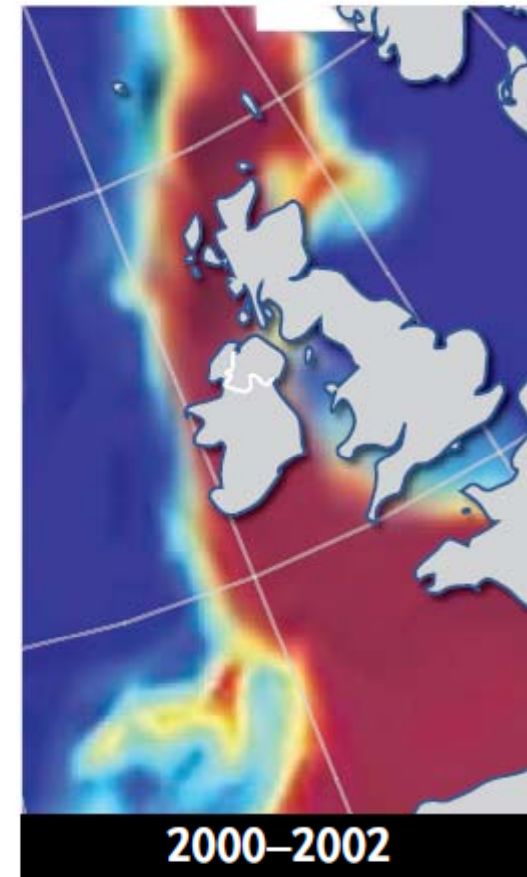
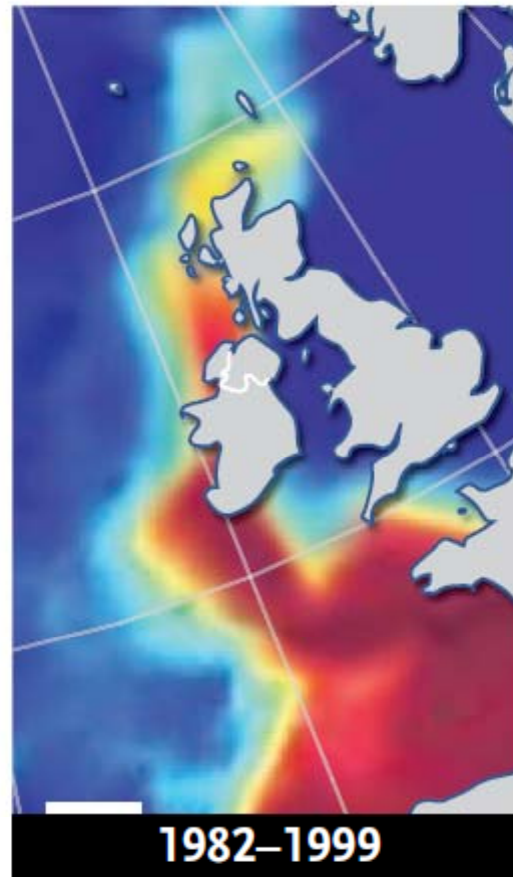
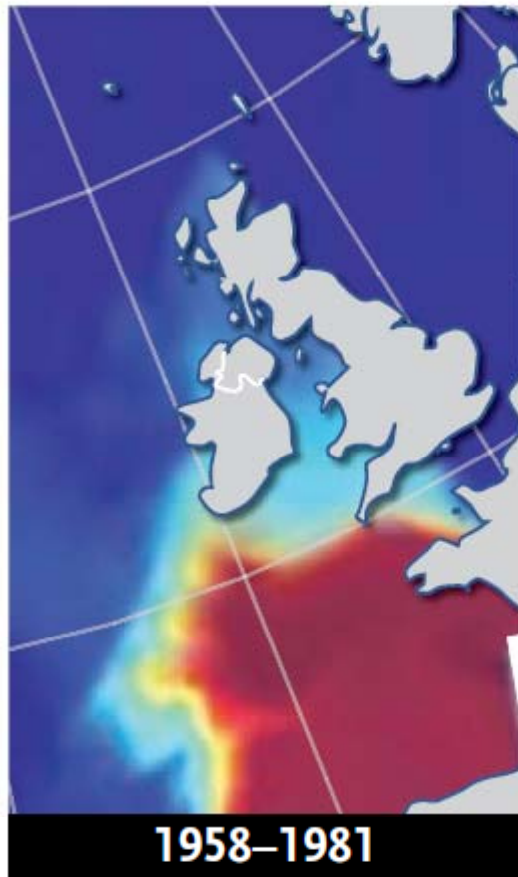


**Passenger/cruise Ro-Ro ferry
PRIDE OF BILBAO**
P&O Ferries, Portsmouth UK,
SA route: Bilbao, Spain to
Portsmouth, UK
From: May 2004

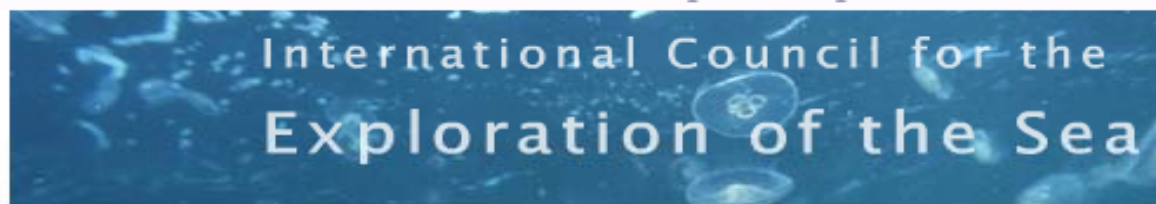


**Passenger /Ro-Ro ferry
BRETAGNE**
Brittany Ferries, Roscoff,
France
PR route: Plymouth to Roscoff,
Western Channel
From December 2004





Mean number of species per CPR sample



Taxonomy

Osteichthyes, Clupeiformes, Clupeidae

Maximum size

40 cm TL, though usually <35 cm.

Description

A highly abundant pelagic species. They are filter feeders that feed on a variety of planktonic organisms. There are various spring and autumn spawning sub-populations, each with specific spawning sites. Eggs are laid in dense layers on gravel. Larvae are pelagic. Metamorphosis after 2-7 months depending on spawning time.

Description of stocks

Herring is widely distributed in the Northwest and Northeast Atlantic. Within the Northeast Atlantic, they are distributed from the northern Bay of Biscay to Greenland, and east into the Barents Sea.

Legal MLS

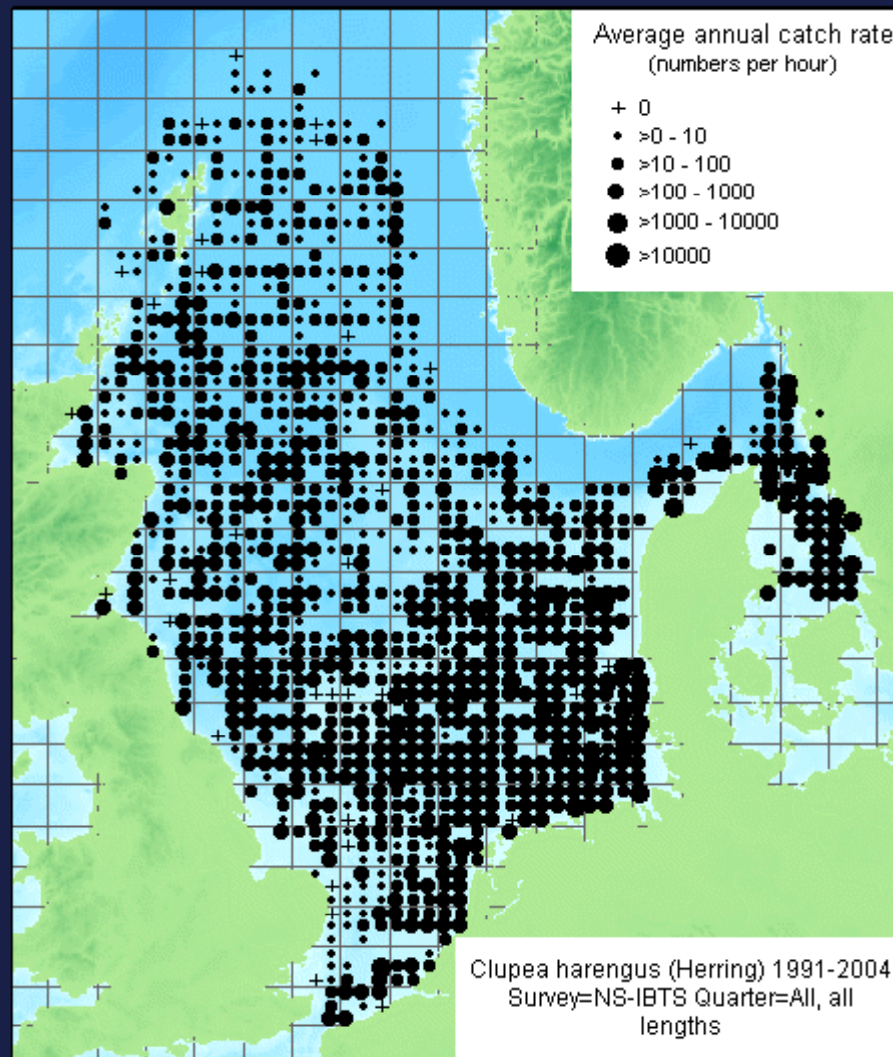
20 cm in the North Sea and 18 cm in the Skagerrak

Interest to fisheries

Herring is one of the most important commercial species taken in the North Sea, where it is targeted in purse seine and trawl fisheries. It is also a by-catch in industrial fisheries and small-mesh fisheries. Some inshore fisheries continue to fish for herring using drift nets.

Status of stocks- [see graph](#)

Landings increased after the Second World War to a peak of 2 million tonnes, though subsequent over-fishing and recruitment failure caused a collapse of the stock in the early 1970s. The fishery was closed from 1977-1981 to allow the stocks to recover. Management for herring has since improved and they are now harvested sustainably.



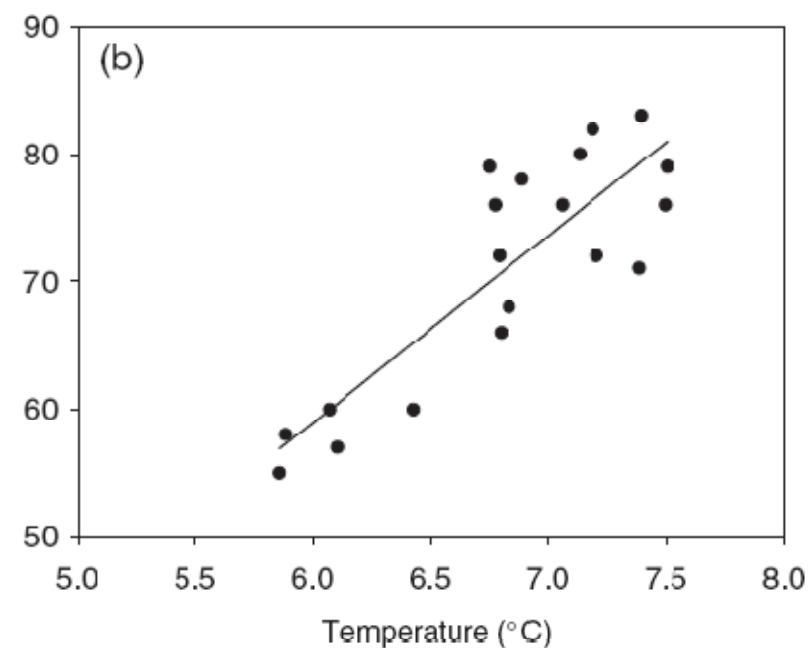
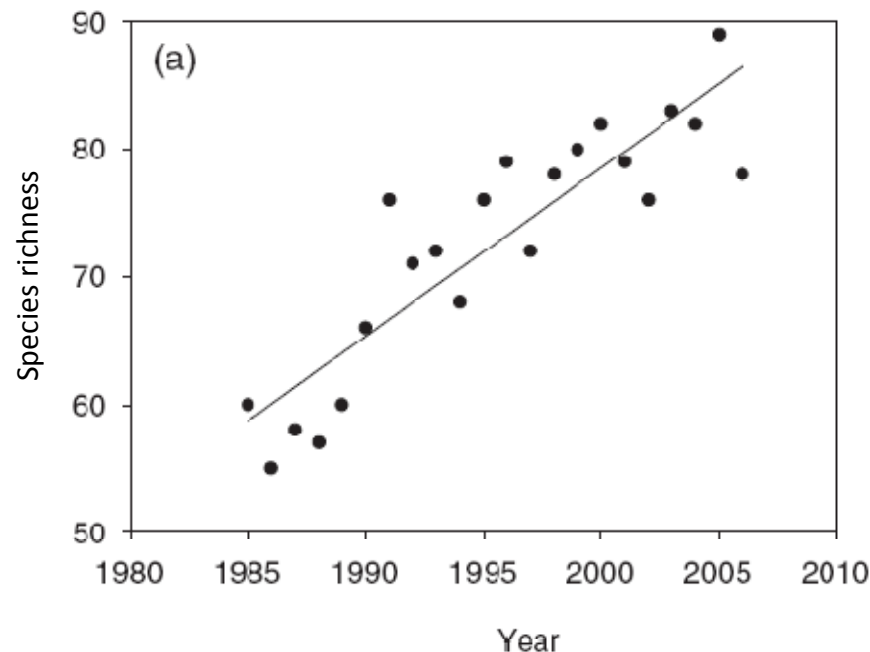
Climate induced increases in species richness of marine fishes

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Fish Species Richness in the North Sea has strongly increased over time

- o Small southern species increase
- o Large northern species decrease their range





MR. T. O. M. SOPWITH AND HIS PARTY'S RECORD CATCH OF TUNNY CAUGHT OFF SCARBOROUGH



Climate Change and Overexploitation lead to decreasing numbers of top predators.
 Example: Bluefin Tuna caught in the North Sea UK 1933 (upper two) Denmark (lower) 1946. The species has now disappeared completely. (MacKenzie and Myers, 2007)

Challenge 3: Use of New observation methods

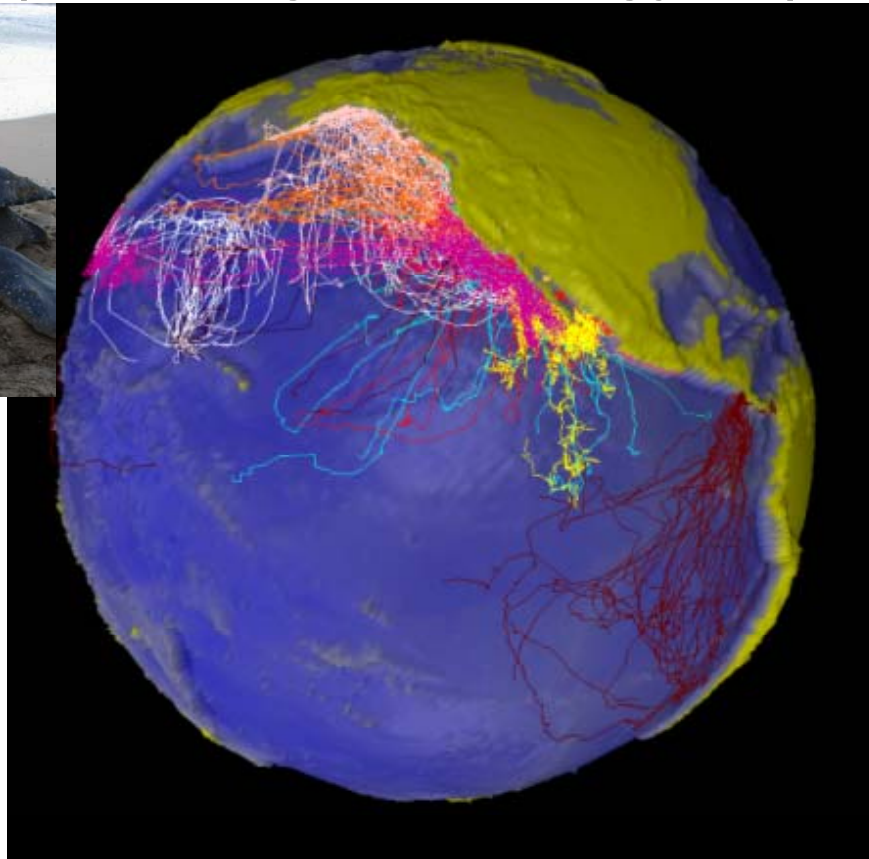
- A few examples from the Census of Marine Life





CoML & Ocean Observing

Monitoring far animal migrations by tagging & telemetry – providing technology & protocols



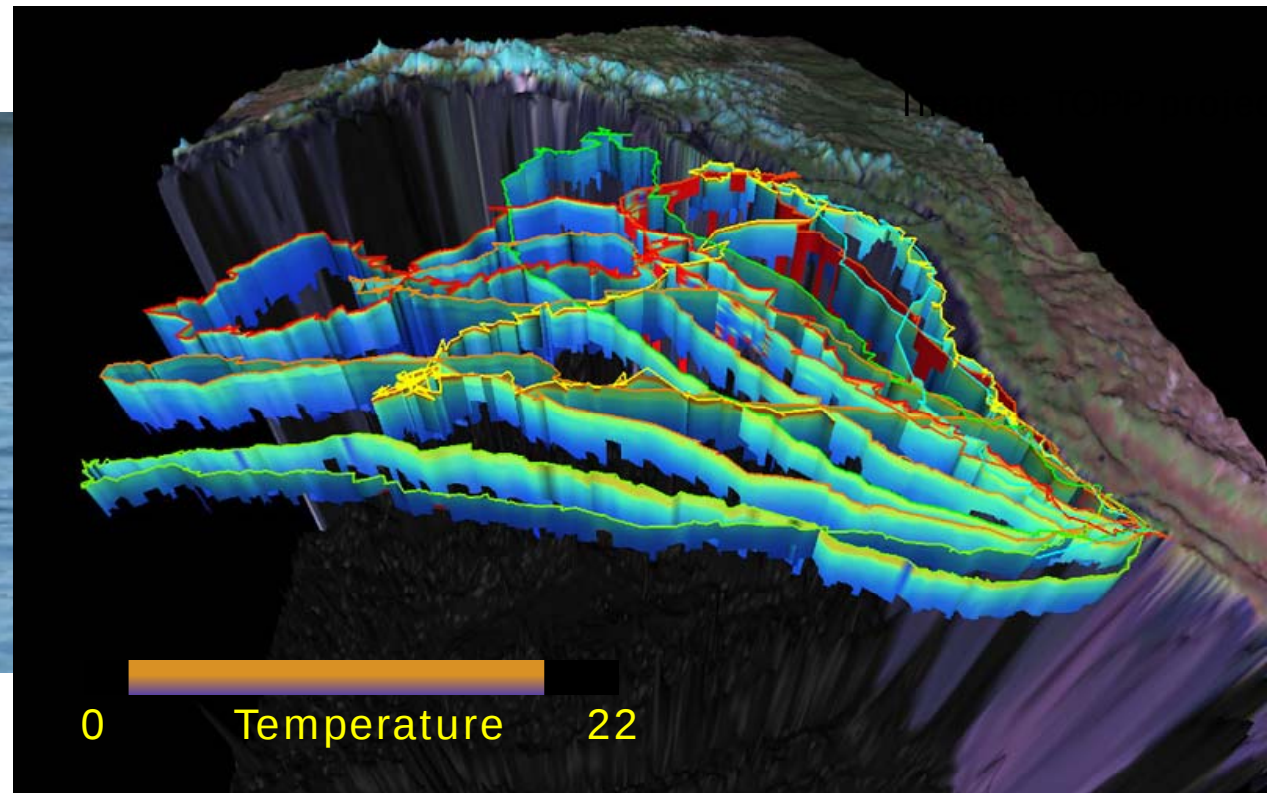
Images: TOPP & POST projects

CoML & Ocean Observing

Animal oceanographers – collecting vast amounts of oceanographic data

Some animals
dive 1000m

Photo: Dan Costa, University
of California Santa Cruz



7 seals tracked during 2-3 month summer feeding migrations

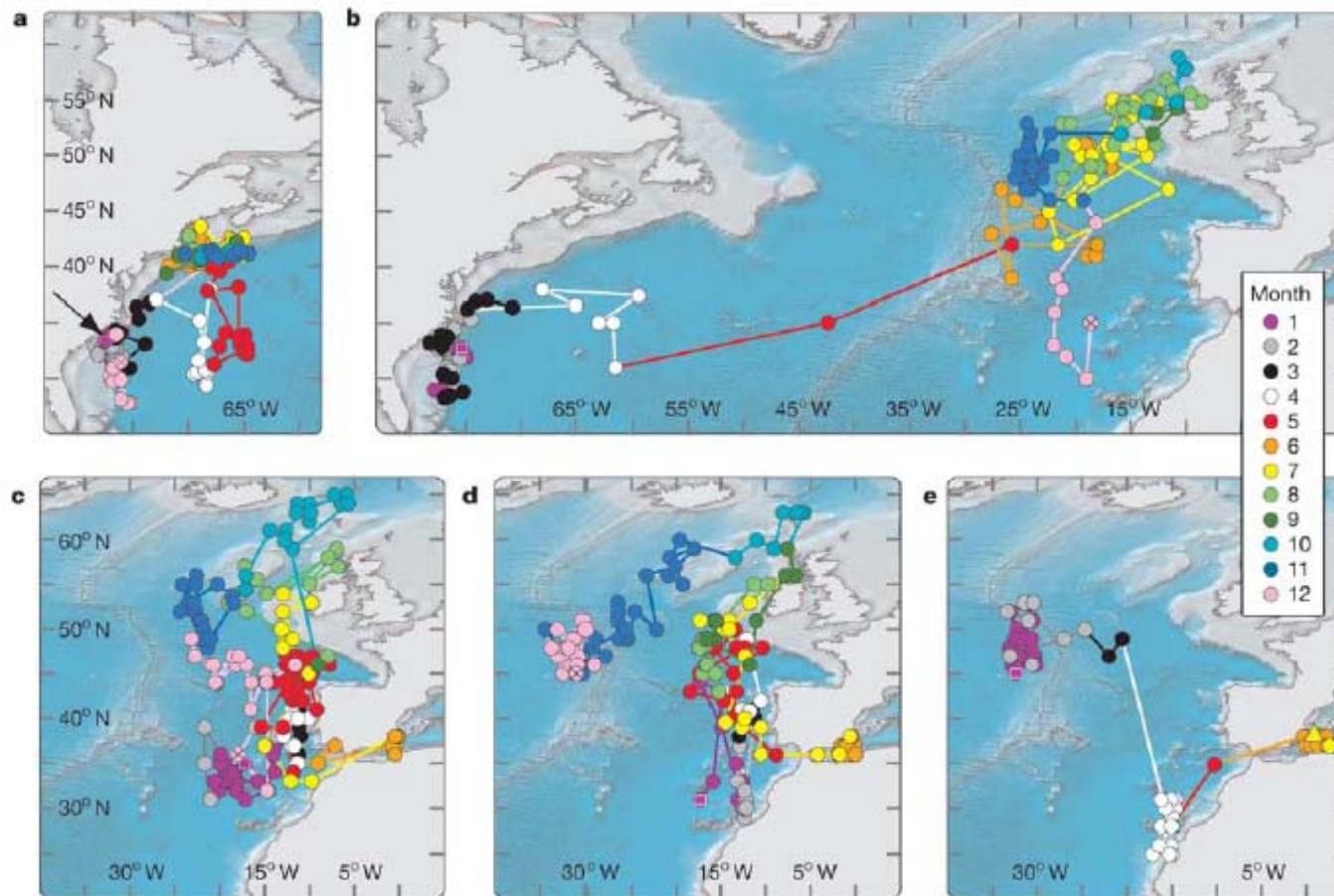


Figure 3 Movements over 4.5 years of one individual Atlantic bluefin tuna (603) that was tagged in the western Atlantic in 1999 and demonstrated site fidelity to a known spawning area in the Mediterranean Sea (2001–2003). Each panel shows a year of the fish's track; colour denotes month of each position. Start and end points for each year are denoted by a square and cross-hatched circle, respectively. **a**, The bluefin tuna was released off North Carolina on 17 January 1999 (arrow, 191 cm CFL) and showed a year of western

residency. **b**, In 2000, the bluefin tuna showed transatlantic movement to the eastern Atlantic. **c–e**, Three consecutive years of movements from the eastern Atlantic into the Mediterranean Sea, to the vicinity of the Balearic Islands, during the breeding season: **c**, 2001; **d**, 2002; **e**, 2003. The fish was recaptured on 2 July 2003 (yellow triangle).



OTN held a workshop December 3-5, 2009, in Faro, Portugal, to discuss plans to deploy a line of acoustic receivers, to be known as the Gibraltar Curtain, spanning the Strait of Gibraltar, between Spain and Morocco, some time next year.



Challenge 4: microbial and genetic biodiversity

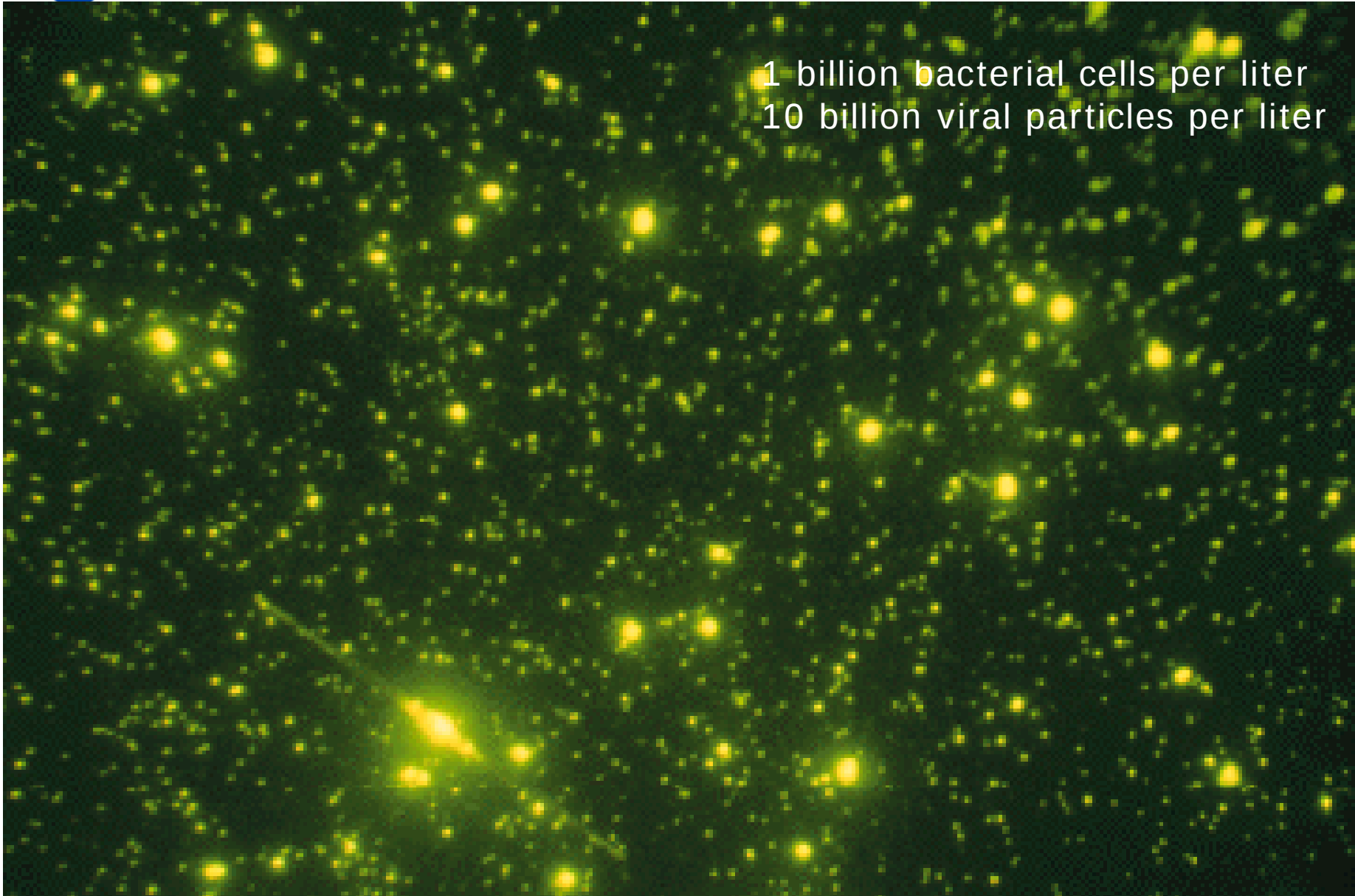


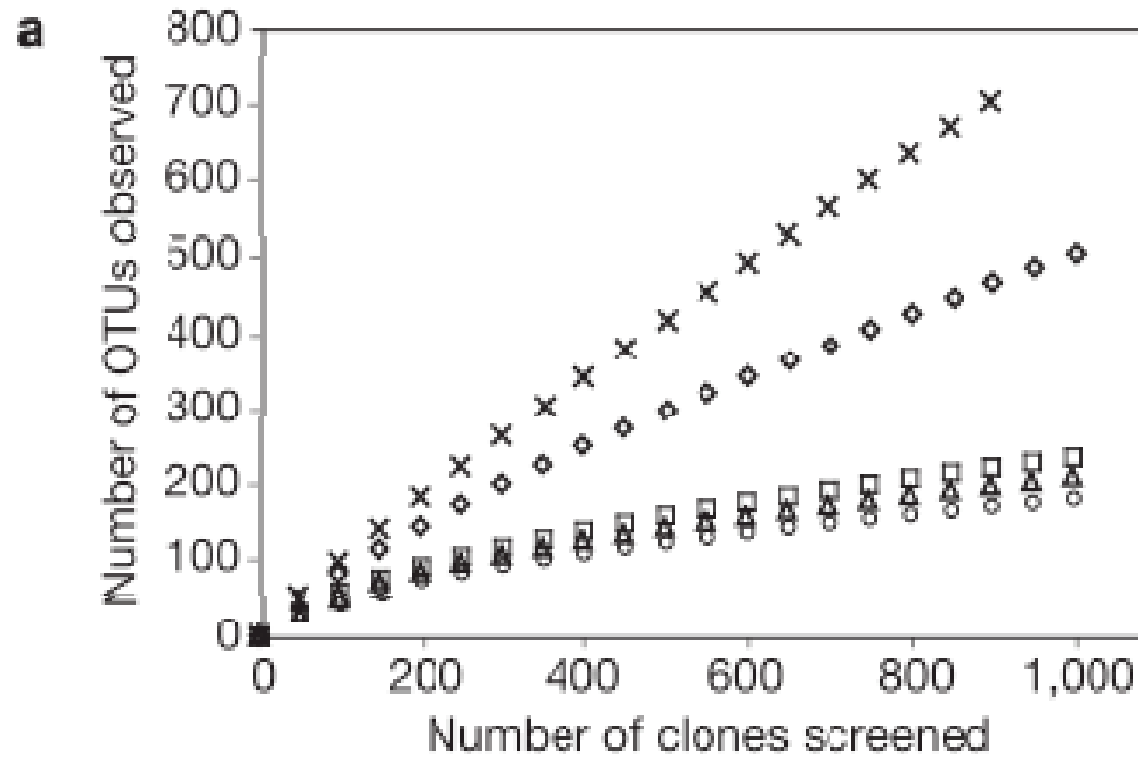
commentary

More than meets the eye

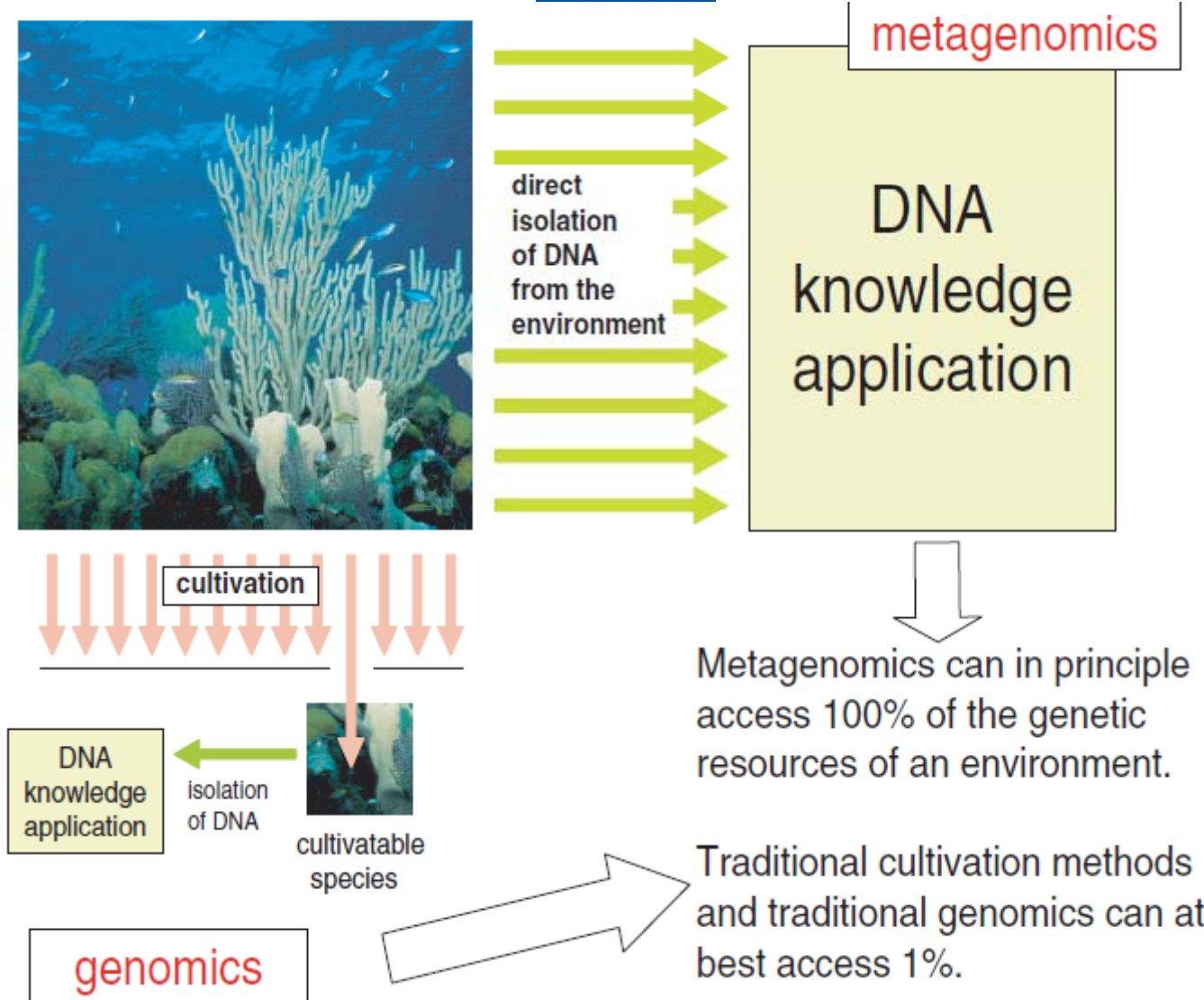
Earth's real biodiversity is invisible, whether we like it or not.

1 billion bacterial cells per liter
10 billion viral particles per liter

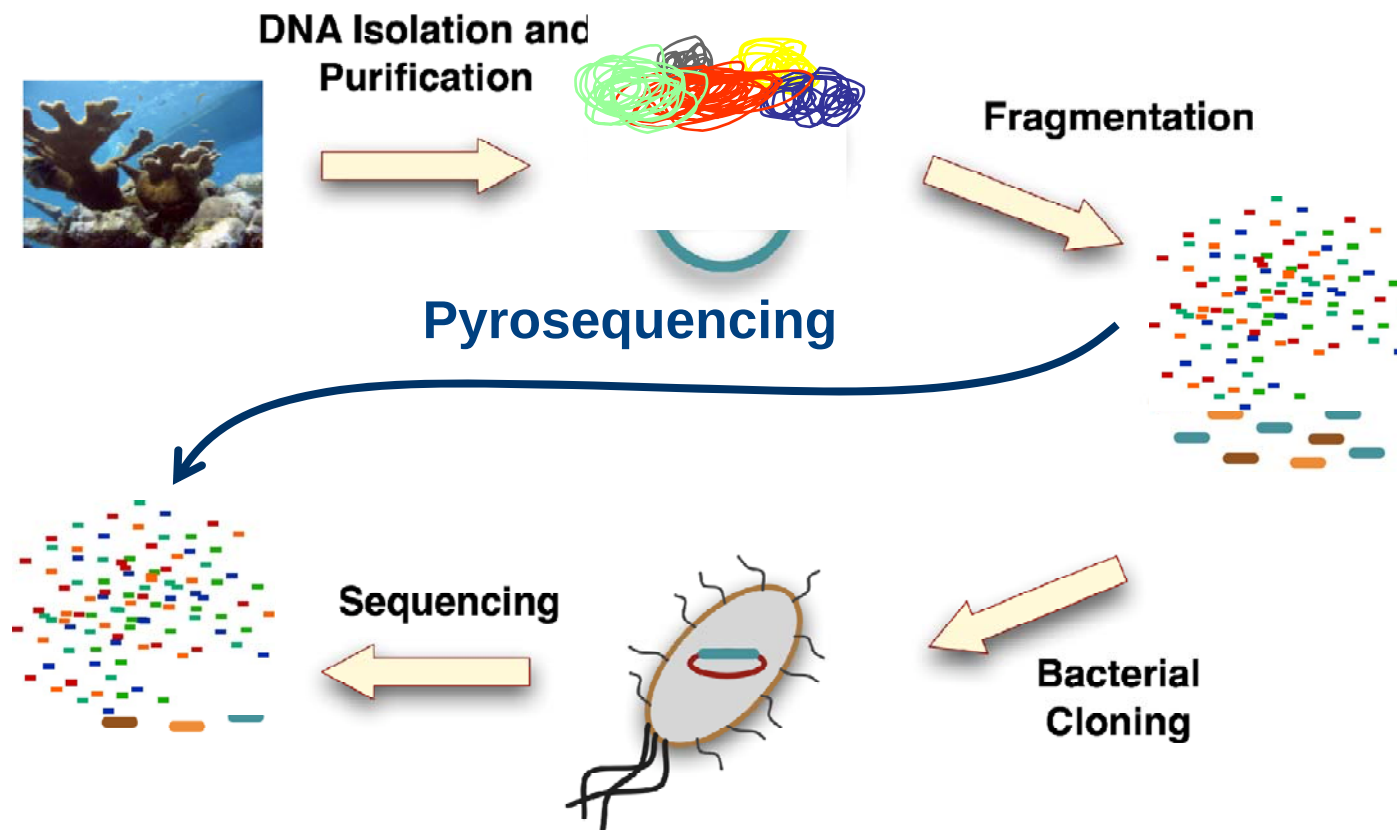




Acinas et al. 2004, Nature
 Pedrós-Alió 2006, TiM



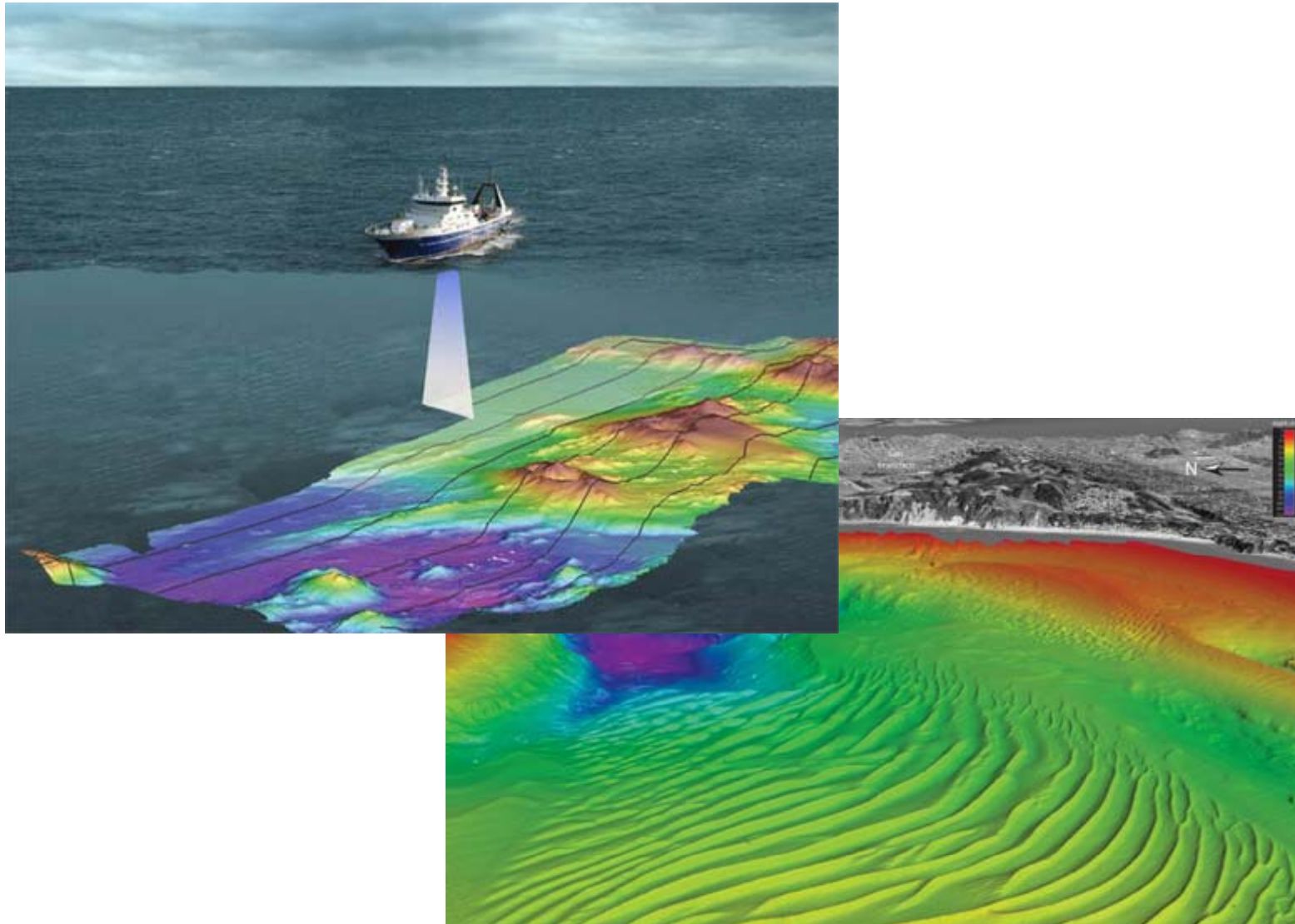
Metagenomics



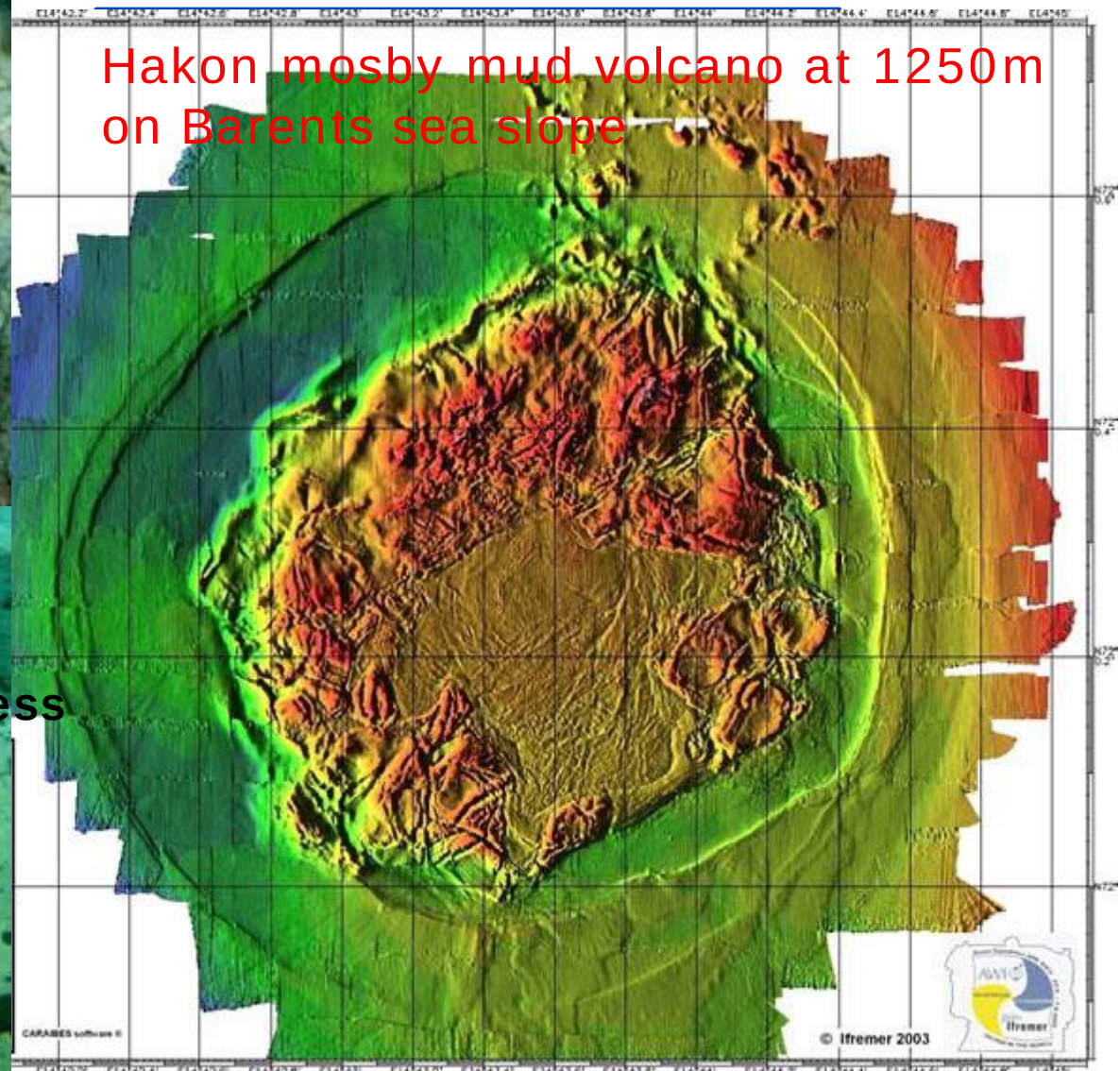


Habitats

- Habitats are formed by interactions between biology, geology, physics and chemistry
- Often a correlation between habitat and biodiversity exists (close or not so close)
- Habitat structure may therefore serve as a predictor of biodiversity
- New observation tools allow for a detailed and rapid mapping of habitats



Hakon mosby mud volcano at 1250m
on Barents sea slope



restricted size, high patchiness

Microbathymetric mapping (Foucher e



Conclusions

- Biodiversity is a layered concept, biodiversity observation consequently can be addressed at different levels
- Gene Level: metagenomics (and other molecular methods) are promising but not yet routine tools for surveillance. They should and will be further developed as the interest in marine microbiology, biotechnology and natural products grows.
- Species Level: existing information is huge but scattered. Access and use should be improved. New survey methods addressing large spatial and long temporal scales must be developed and implemented.
- Habitat Level: Mapping of marine habitats is essential for management and exploitation of marine resources. The link between habitat and species biodiversity must be further studied.



Thank you for your attention