Trendylyzer: a Long-Term Trend Analysis on Biogeographic Data from OBIS

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Lucca (Italia), September 23-25, 2013

One Ocean – One Planet

* The Ocean represents 71% of the Earth's surface and
* 99% of the living space on the planet by volume
* Marine Plankton provides 50% of the O_2 we breathe
* The ocean regulates climate by storing heat and absorbing 30% of the CO_2 we produce
* Over 3 billion people depend on marine and coastal biodiversity resources for their livelihoods.

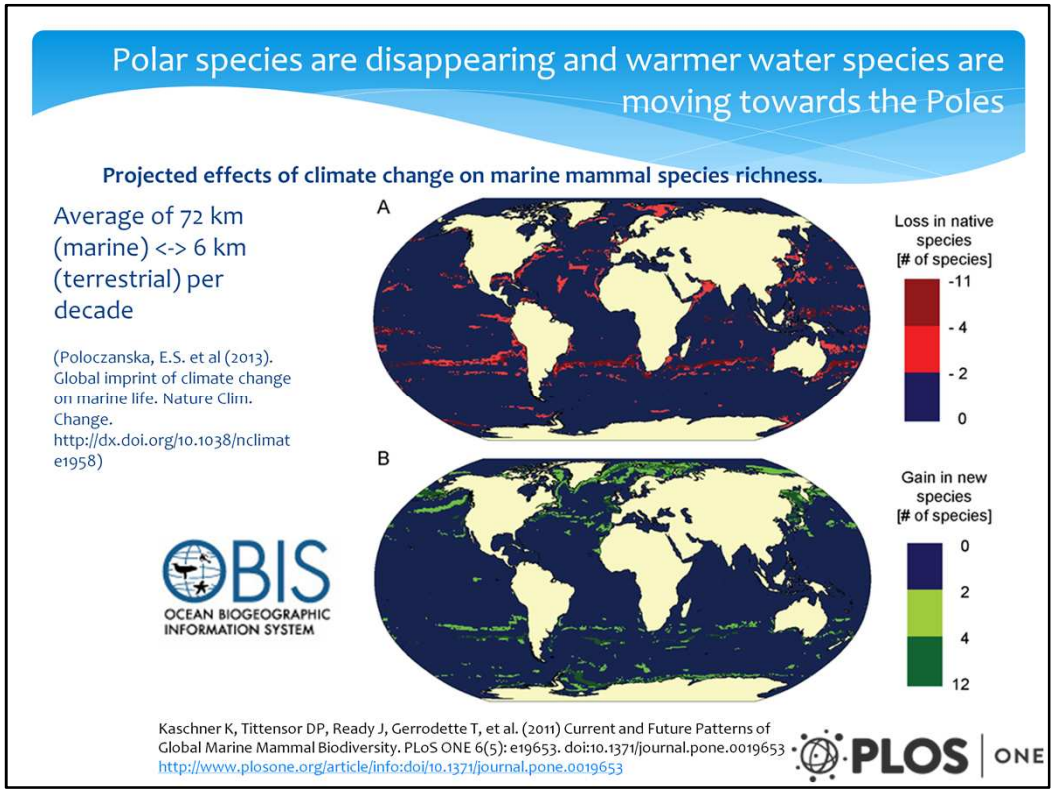
we only have one planet - We only have one ocean

Ocean is under threat

* Climate change (rising temperature, acidification, melting sea ice..)
* Overfishing (30% of fish stocks overexploited)
* Pollution (micro plastics, 500 dead zones)
* Invasive species (Pests, Fouling, toxic algae)
* Habitat destruction (mangrove deforestation, bottom-trawling)
* **60% of the world's major marine ecosystems have been degraded or are being used unsustainably.**

Ocean is under threat

Effect on biodiversity?



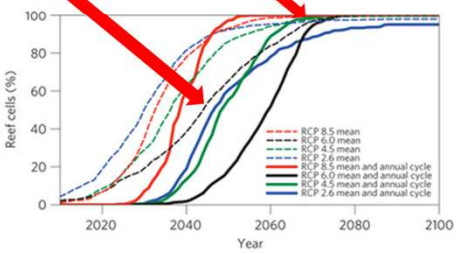
We observed that Marine Species are moving much faster to the Poles than terrestrial species. With a loss in native species and a gain in new species.

Corals are bleaching

50%

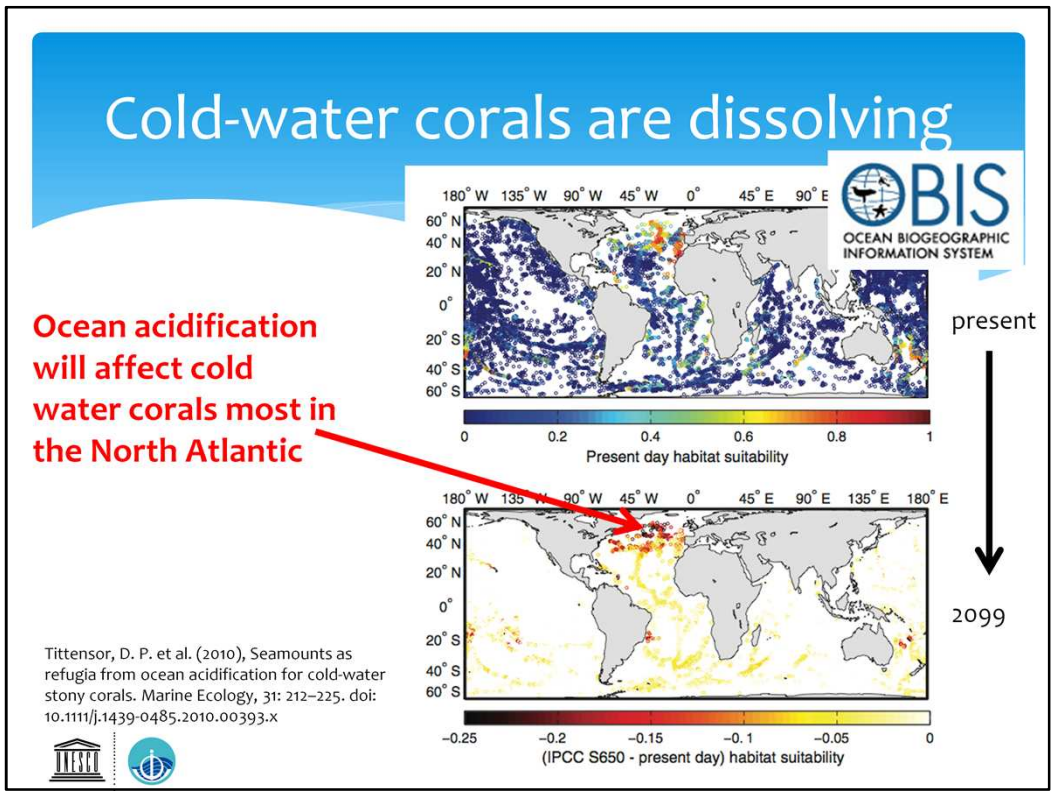
100%

Figure 1: Percentage of reef cells projected to experience bleaching per year.

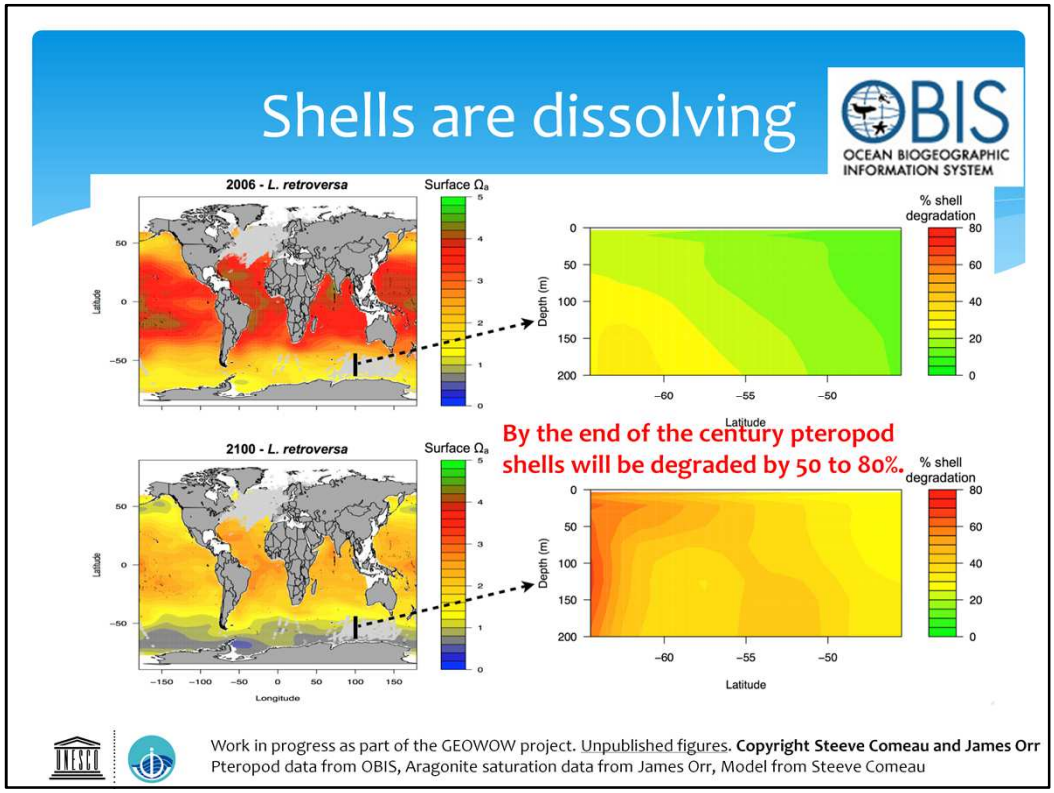


Projected years reef cells experience bleaching conditions annually for three RCP scenarios, using model ensembles that are un-adjusted (mean alone) and adjusted (for the annual cycle and mean).

van Hooidonk et al. 2013. Temporary refugia for coral reefs in a warming world. Nature Clim. Change http://dx.doi.org/10.1038/nclimate1829



Ocean acidification will affect cold water corals most in the North Atlantic



By the end of the century pteropod shells will be degraded by 50 to 80%.


Plastic Ingestion
Plastic Ingestion
PLASTIC
PLANKTON
fragments
80% of the pollution at sea comes from land

90% of large predator fish stocks are gone

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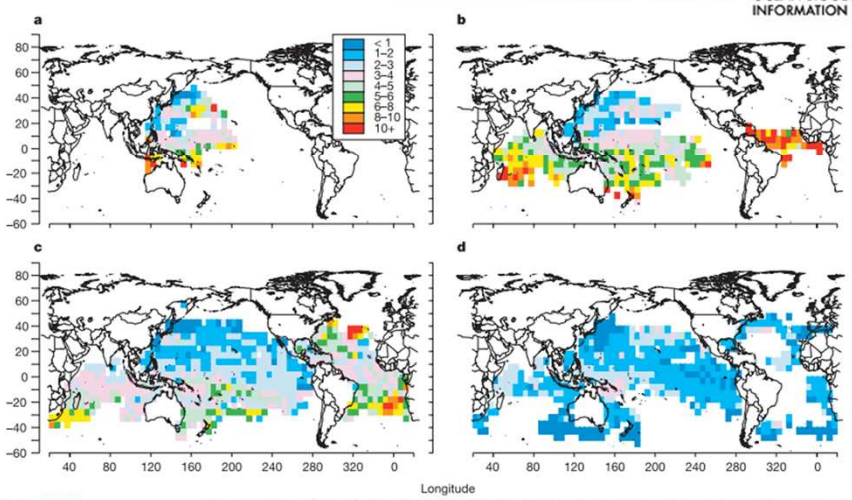
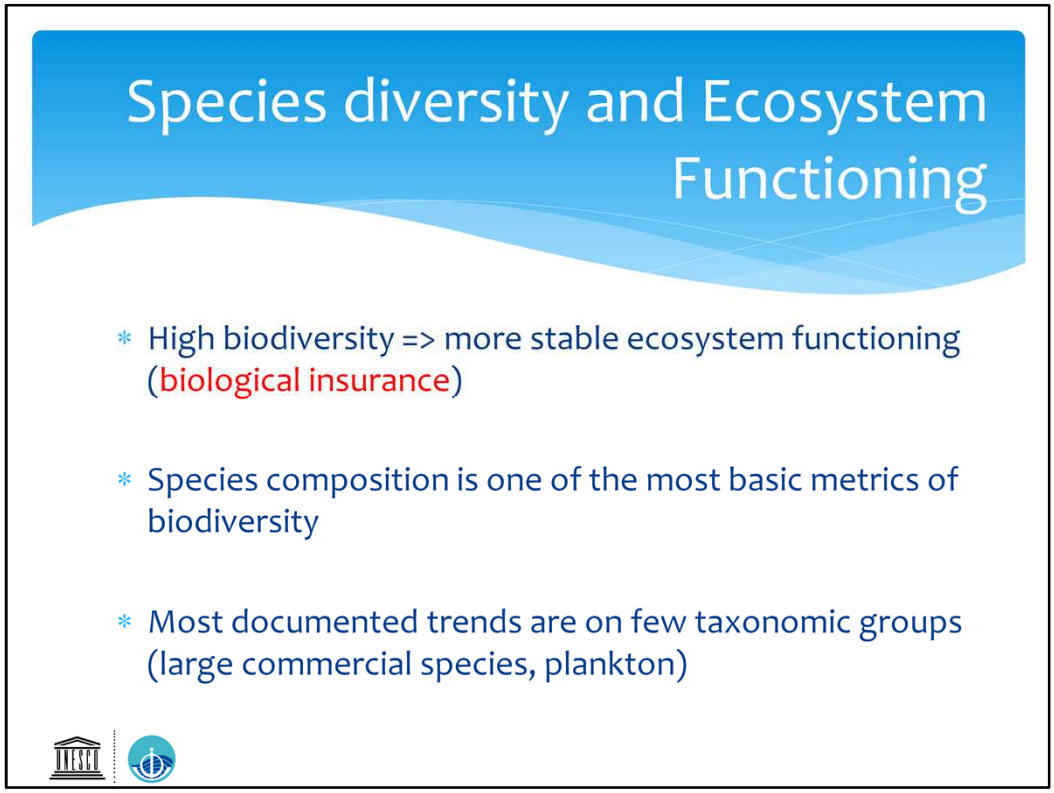


Myer & Worm (2003). Rapid worldwide depletion of predatory fish communities. Nature. 423

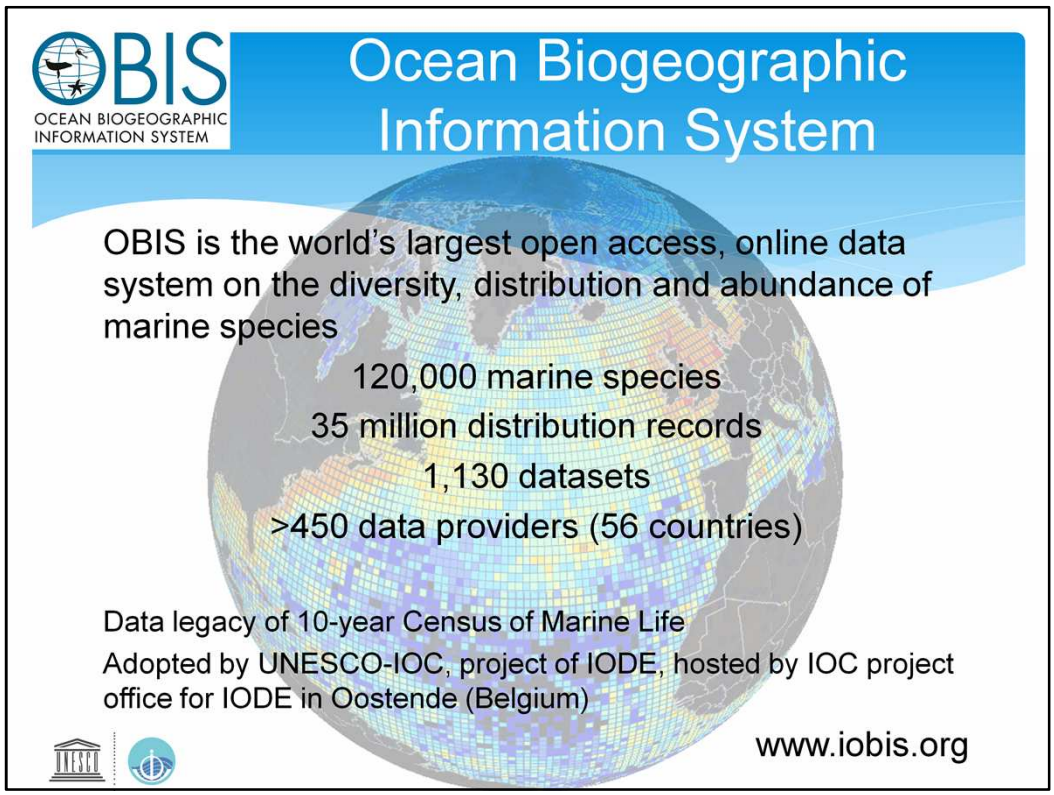
Are we losing species?

Based on the IUCN Red List:

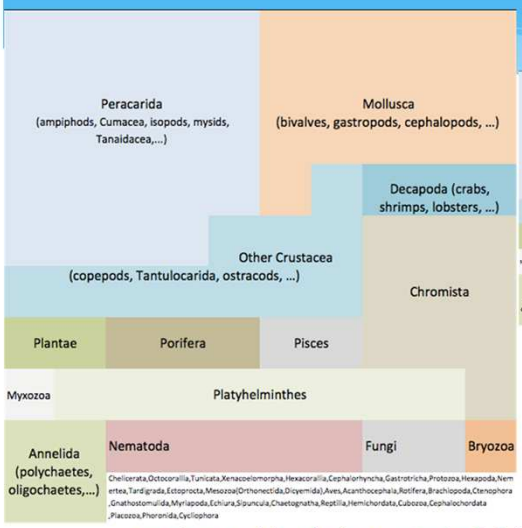
* Only 2% of known global extinctions are marine
* Only 3% of known endangered (and critical endangered) species are marine
* Few global marine extinctions are documented, but many local extirpations, and decreasing populations



Species are important for ecosystem functioning.


OBIS
OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM
Ocean Biogeographic Information System
OBIS is the world's largest open access, online data system on the diversity, distribution and abundance of marine species
120,000 marine species
35 million distribution records
1,130 datasets
>450 data providers (56 countries)
Data legacy of 10-year Census of Marine Life
Adopted by UNESCO-IOC, project of IODE, hosted by IOC project office for IODE in Oostende (Belgium)
www.iobis.org

Marine Species Diversity
The knowns and unknowns?



700K – 1 million marine species

230K described

120K in OBIS

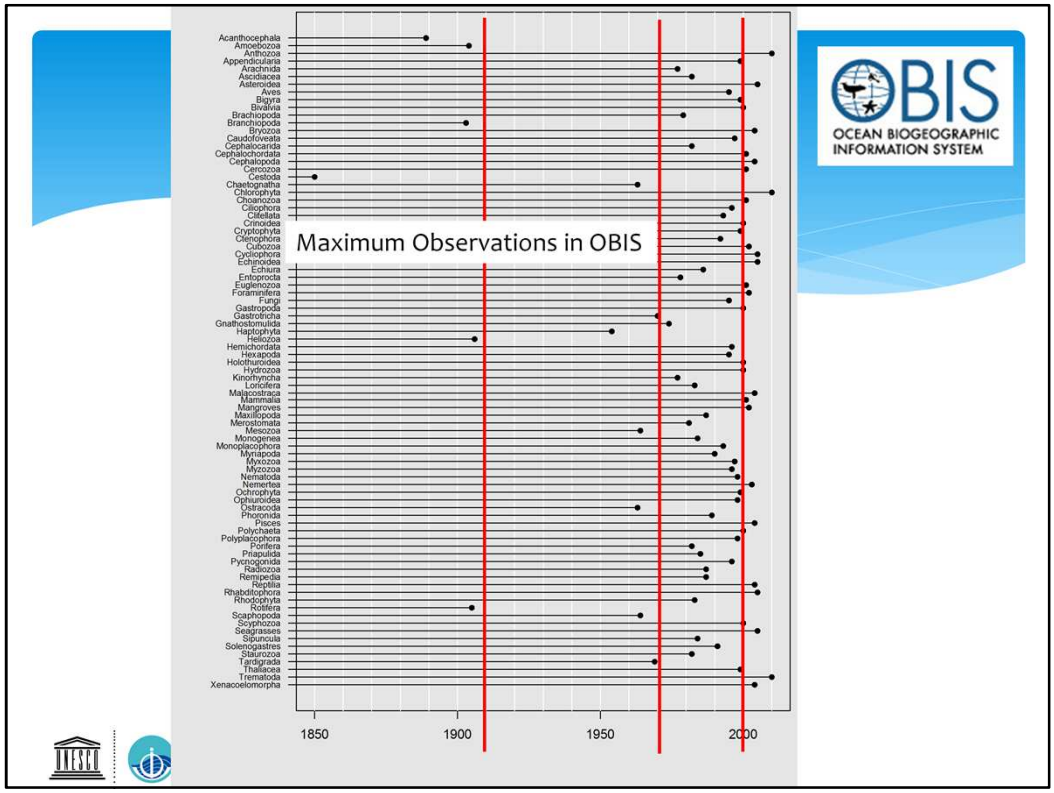
12K OBIS/year

5,4K IUCN assessment

Appeltans et al (2012). The Magnitude of Global Species Diversity, Current Biology 22

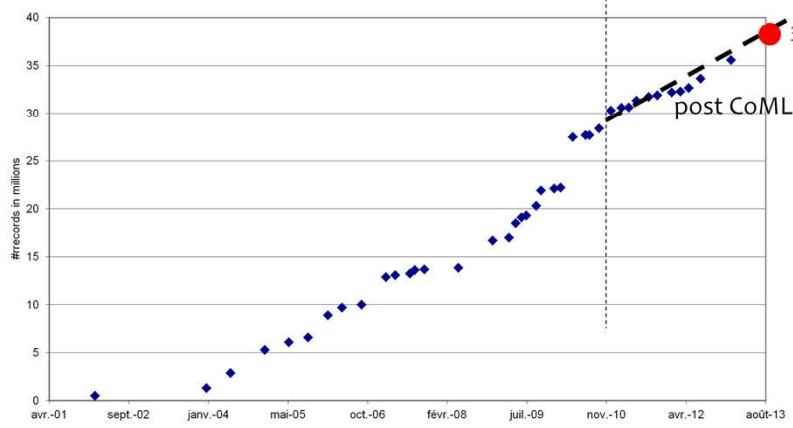
Knowledge gaps

* Only 1/3 to 1/4 of marine species are known
* 2/3 of known marine species have < 3 observations
* Only 5% of known species diversity is observed per year
* Most data from large vertebrates (fish, birds, mammals)
* Most data from Northern Hemisphere (least biodiversity rich)
* Most data from coastal areas (mid waters almost unexplored)
* Very little historical data - only 100 marine species have a yearly record between 1955 and 2005



What is also interesting is that many taxonomic groups reached their maximum Nr of observations many years ago.

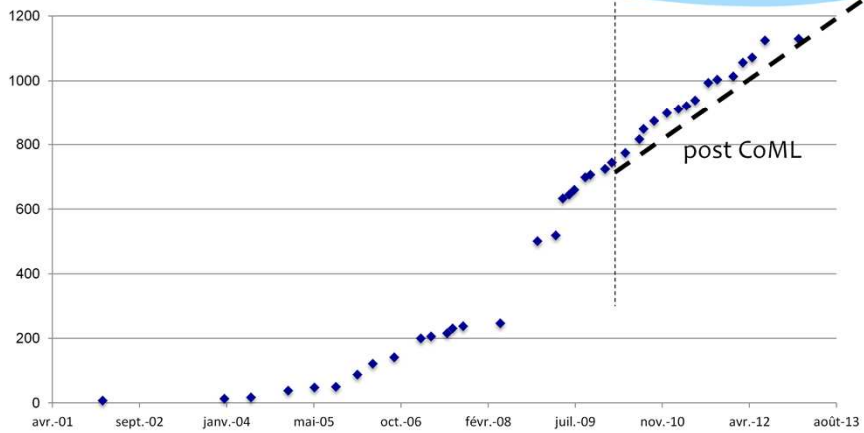
Progress!
Adding more records to OBIS



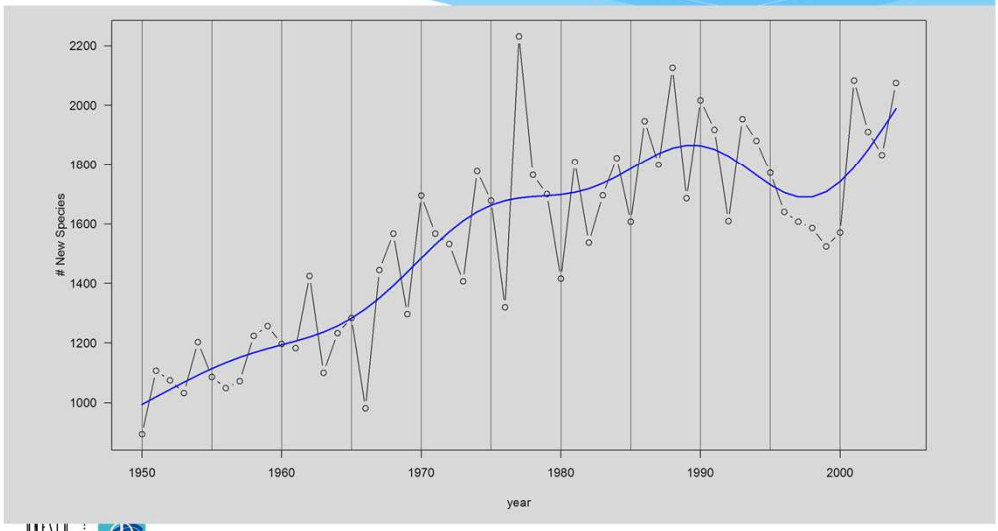
Progress!
Adding more datasets

OBIS OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

244 new datasets soon



Progress!
Adding new species



Progress!
We are filling in the gaps

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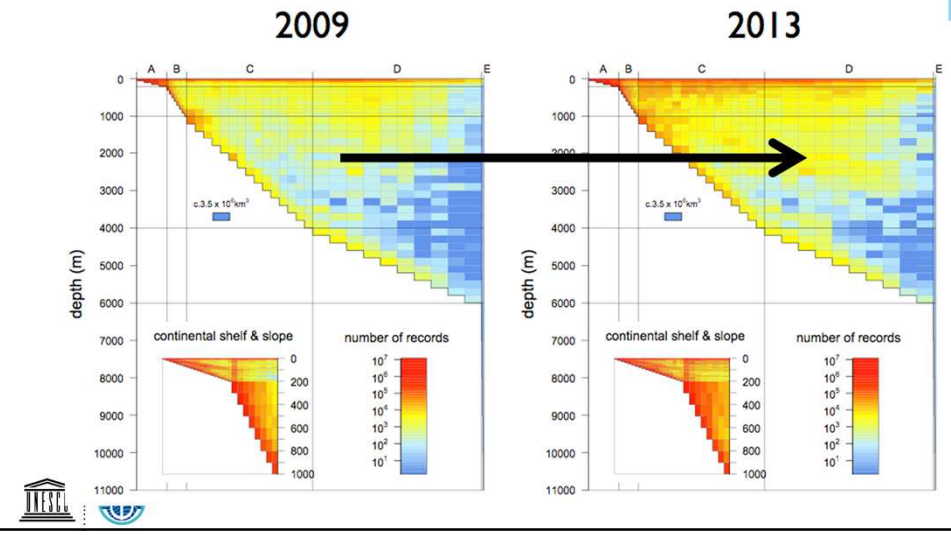
OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM



Data e-infrastructure Initiative for Fisheries Management and Conservation of Marine Living Resources (i-Marine)

- Trendylyzer is a tool developed within iMarine
- iMarine is an initiative aimed at establishing and operating an e-infrastructure supporting the principles of the Ecosystem Approach to Fisheries Management and Conservation of Marine Living Resources.

Research Infrastructures CP & CSA funded by the European Commission under the FP7 Capacities Programme - eInfrastructure Unit DG CONNECT (1 Nov 2011 - 30 April 2014)

iMarine Trendylyzer

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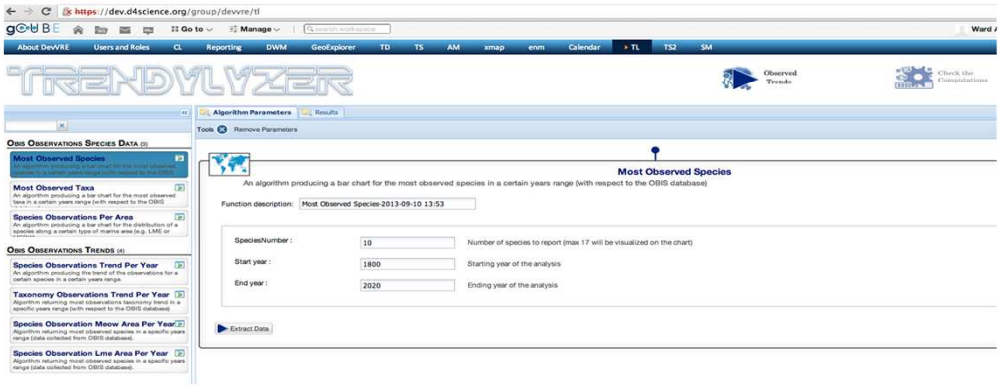

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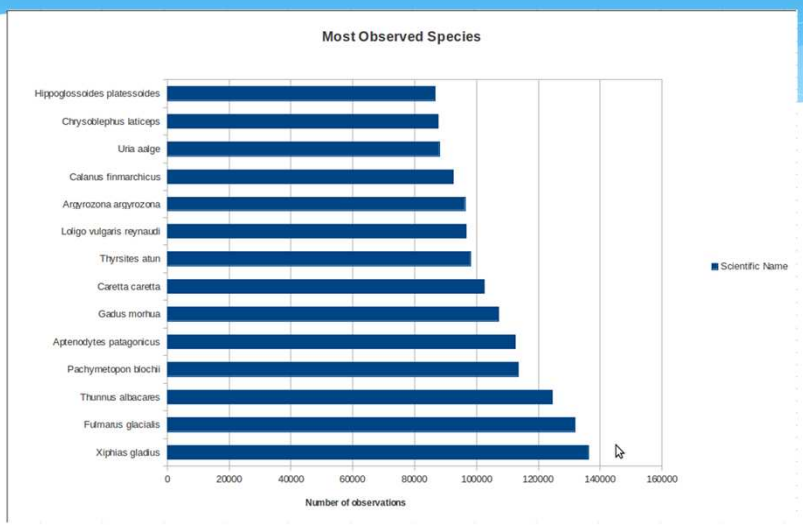
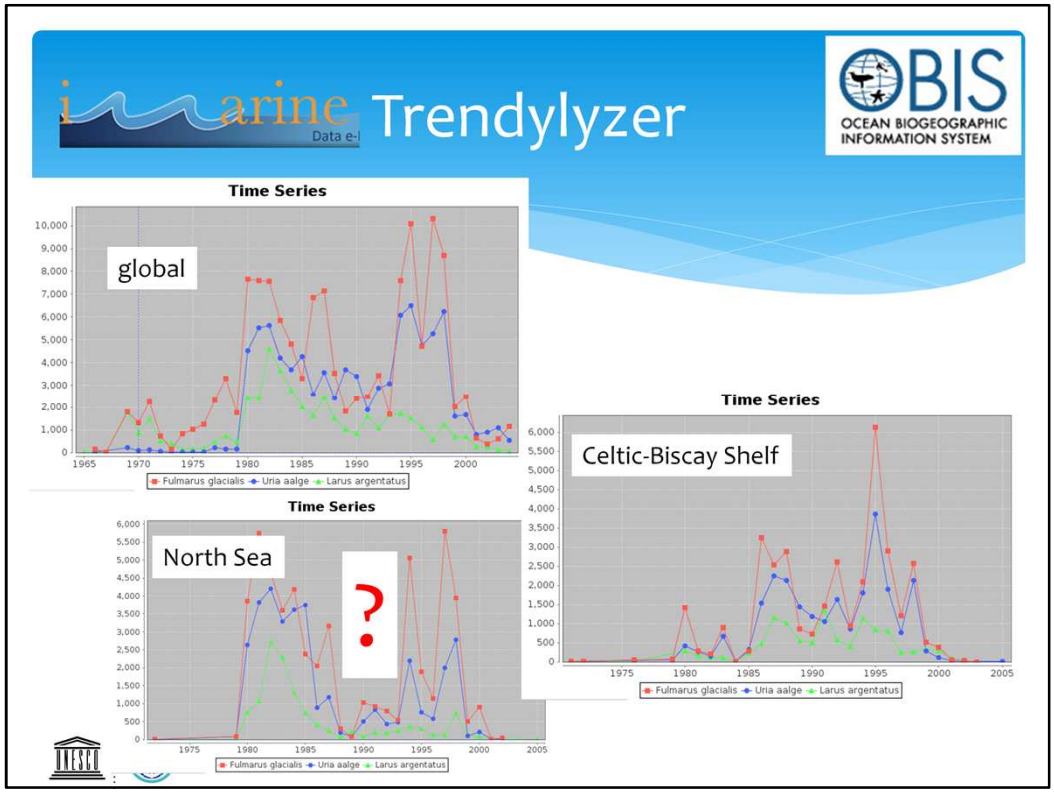
Trendylyzer




marine Data e-I
Trendylyzer
OBIS
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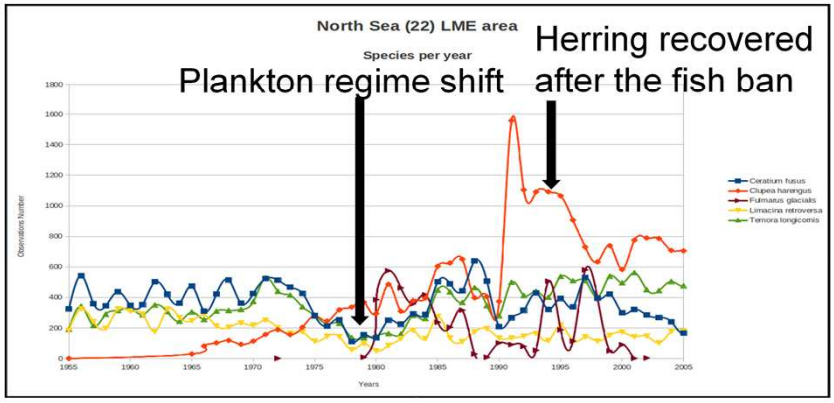
Time Series
global
Fulmarus glacialis
Uria aalge
Larus argentatus
Time Series
North Sea
?
Fulmarus glacialis
Uria aalge
Larus argentatus
Time Series
Celtic-Biscay Shelf
Fulmarus glacialis
Uria aalge
Larus argentatus

Discovering trends in pelagic North Sea species



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Discovering trends in biodiversity

Major problems:

* Data gaps: temporal, geographic and taxonomic scope
* Sampling bias
* Few long-term time series data

Discovering trends in biodiversity

Major problems:

* Most species are rare, or difficult to observe
* Still many new species discoveries

⇒**creates noise in trends**

⇒Which species are most common, and do have enough data?

+ common species may also have a bigger impact on ecosystem functioning compared to uncommon species

Biodiversity indicator based on Common Species?

Questions:

* Are e.g. the 20 most common species for each taxonomic group always common?
* What is the natural variation in common species?
* Do we observe higher variation in species poor regions?
* Are there common species endangered (on the IUCN Red List of threatened species)?

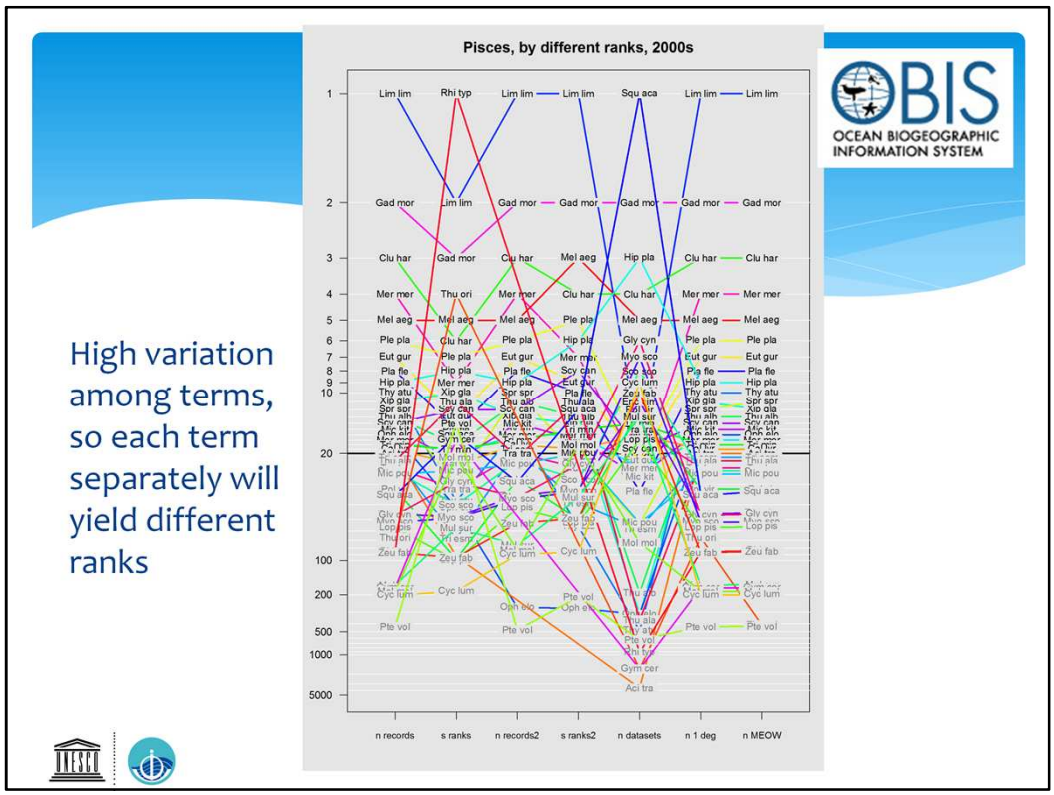
Defining Common Species

For each species:

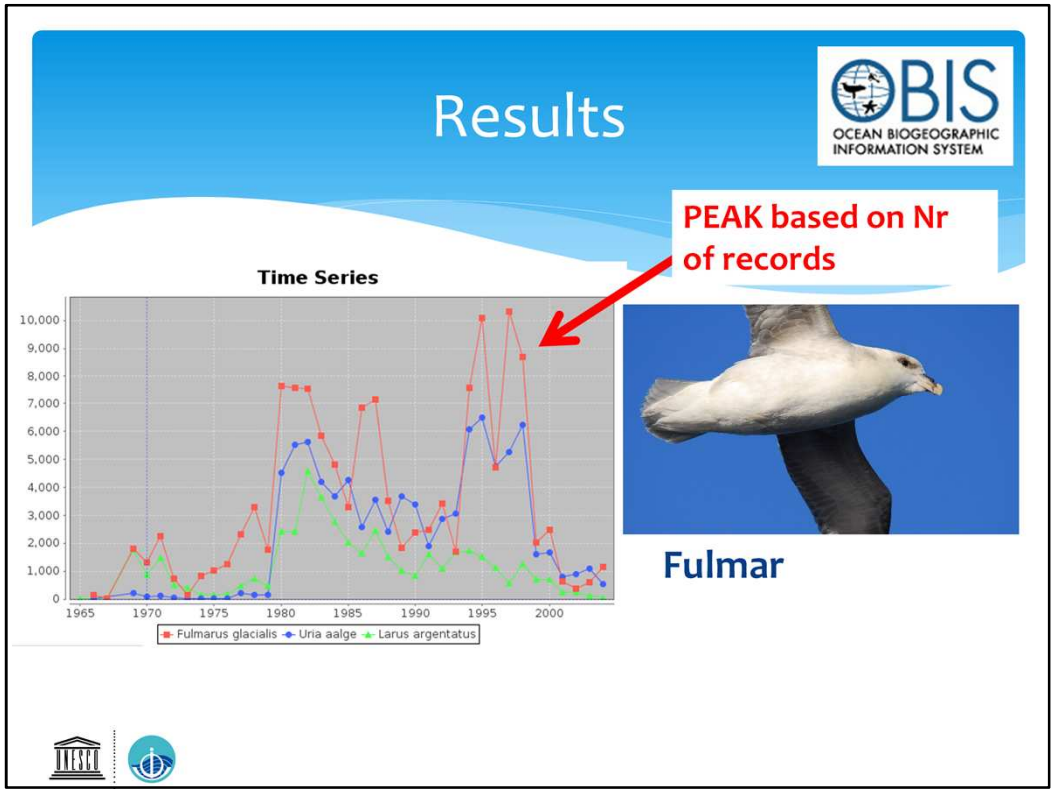
1. Nr of observations
2. Nr of individuals per observation
3. Nr of observations per dataset
4. Nr of datasets
5. Nr of geographical cells
6. Temporal frequency of the observations

Normalizing => relative commonness.

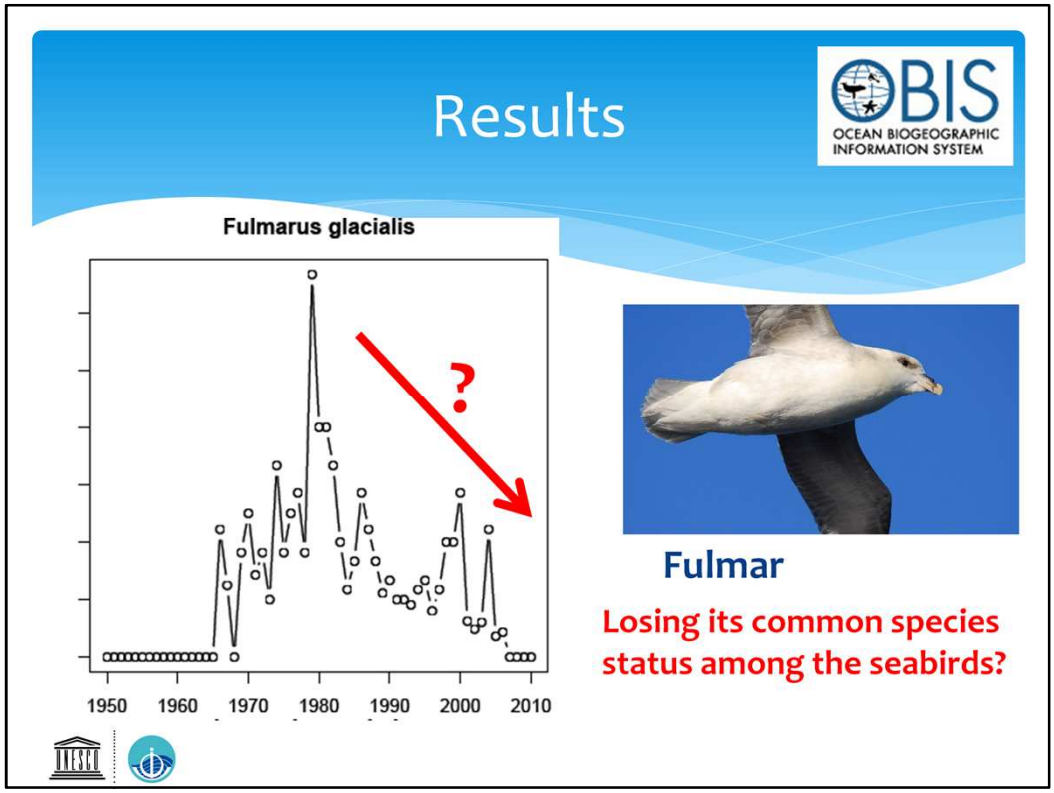
Create score or rank by taxonomic group



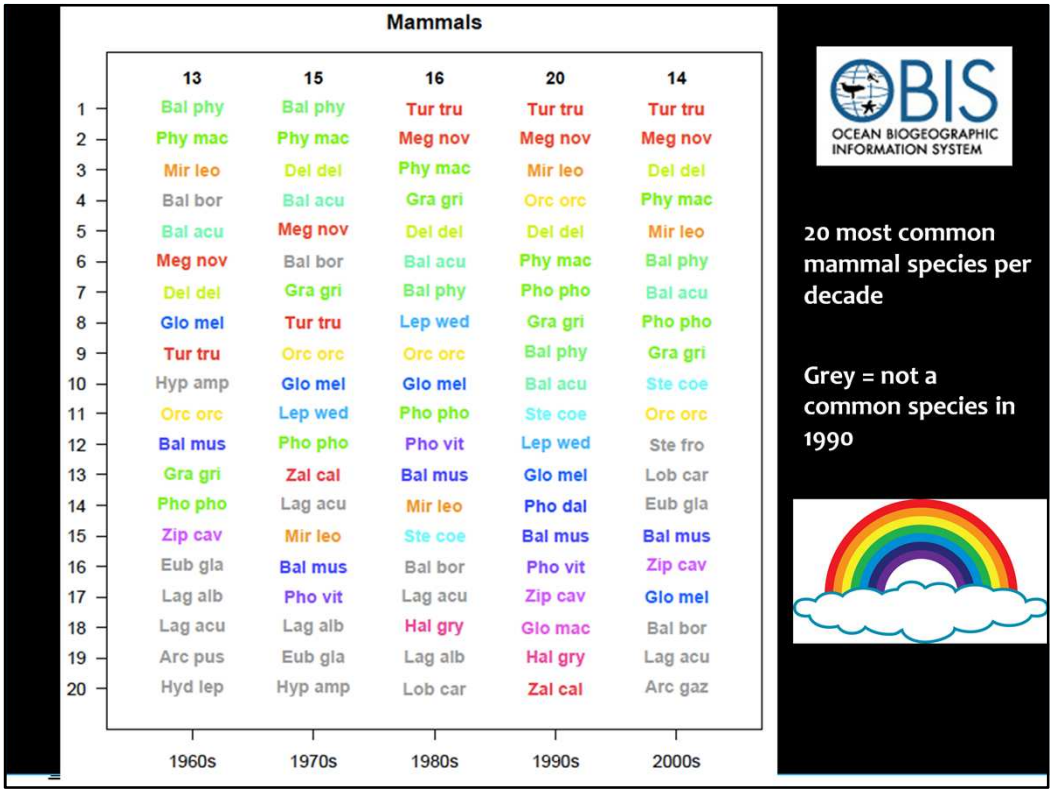
When looking at each term separately, there is a high variation in ranks, with the same fish species listed in the top 10 down below to rank 5000.



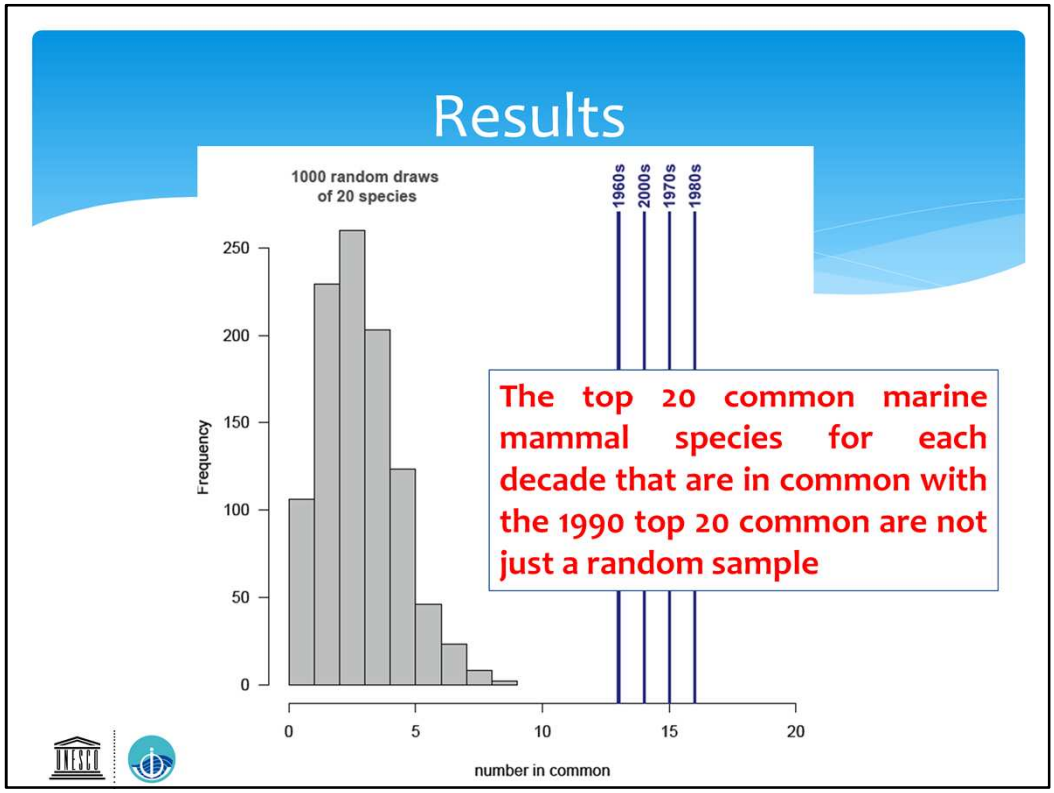
So when you look at Nr of records, the fulmar had high peaks in the 1990s.



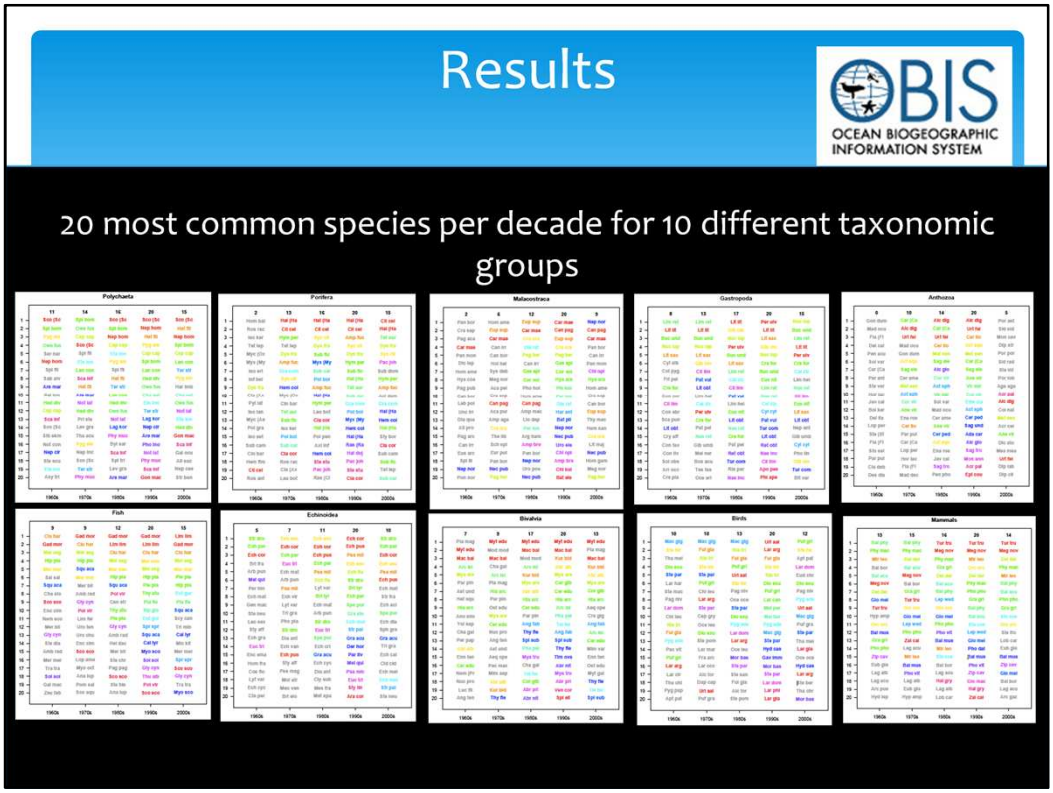
But when you combine all the terms, the Fulmar is losing its common species status among the other seabirds.



We digged further plotting the 20 most common mammal species per decade, and gave rainbow colors to the 1990s list. Grey are those that are not common in 1990. The nice outcome is that there is still a rainbow in the other decades.

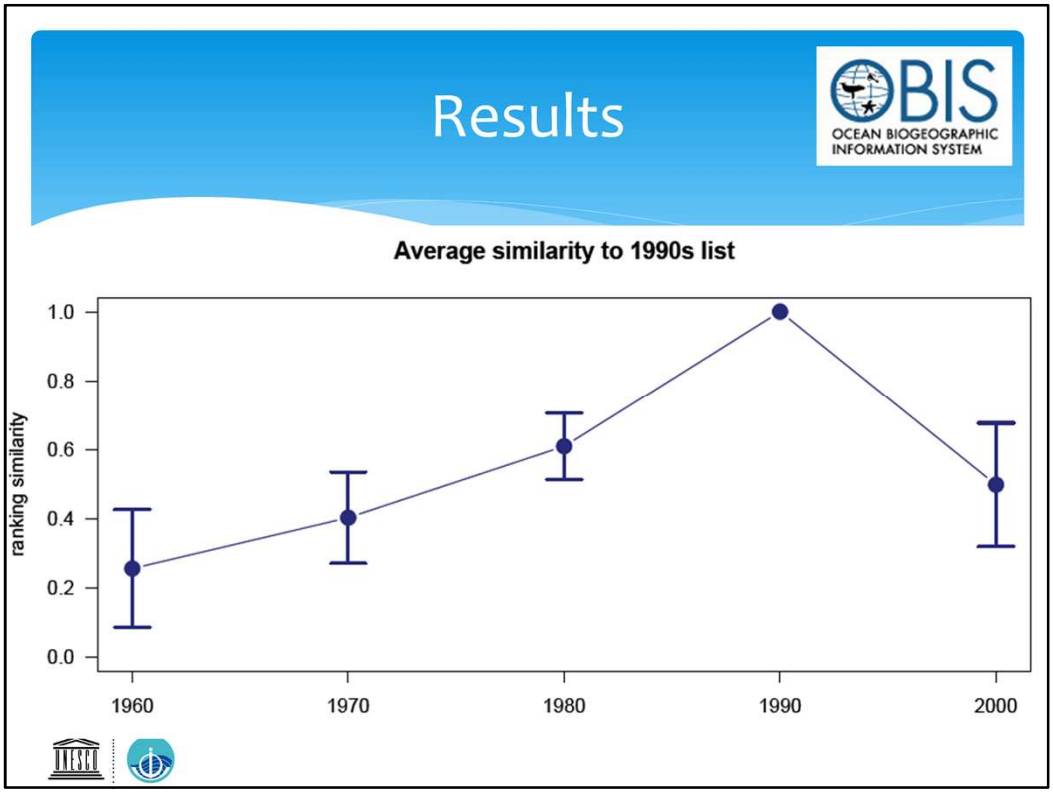


We validated our approach by taking 1000 random samples of 20 mammal species and compared it with 20 common species in that decade. => the set of common species in common between decades are in excess compared to the random set of species.

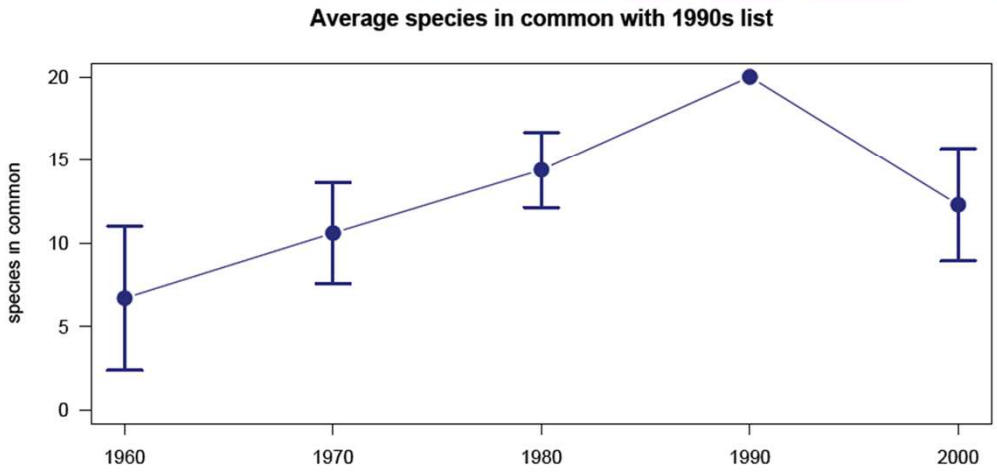


We repeated this for ten different taxonomic groups

Results


Average similarity to 1990s list
ranking similarity
1.0
0.8
0.6
0.4
0.2
0.0
1960
1970
1980
1990
2000

Results


Average species in common with 1990s list
species in common
0
5
10
15
20
1960
1970
1980
1990
2000

Biodiversity trends

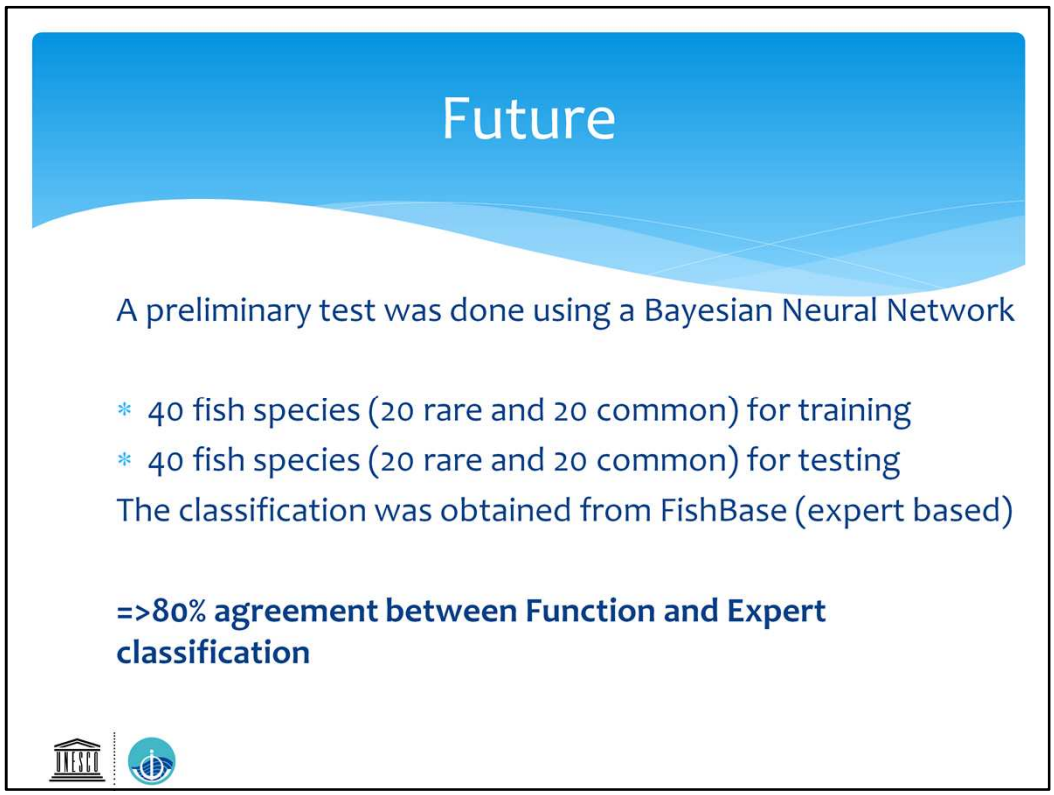
Conclusion

* Work in progress!!
* We detected changes in common species composition:
  * Changing order
  * Species dropping in and out
  * These trends will indicate shifting geographic/taxonomic focus of surveys, together with real changes in the abundance of some common species.
* **=> need to involve experts to validate the trends**

Future

$$CS(s,B,T) = \alpha \log(ind(s)) + \beta \log(intraD(s)) + \gamma \log(interD(s)) + \delta \log(ext(B)) + \tau \log(freq(T))$$

The next step is now to relax the terms of the Commonness Score Function by giving a weight to each term using pattern recognition models such as artificial neural networks.



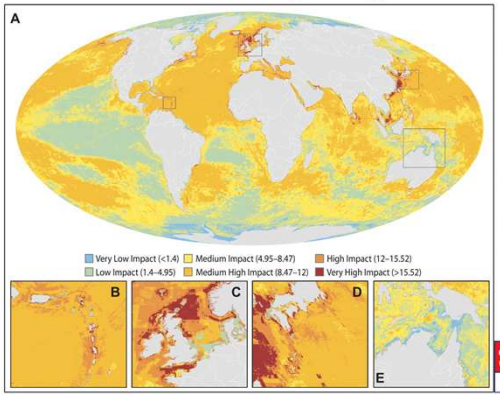
We started this modeling approach by asking FishBase to provide us a list of common and rare fish species, which we then used for training and testing the Neural Network. The good news is that 80% of the classification was in agreement between the Function and the Expert classification.

Future

For Policy Making, **biodiversity trend indicators** only make sense when combined with **environmental** and **socio-economic** data.

B S Halpern et al. Science 2008;319:948-952

Global map (A) of cumulative human impact across 20 ocean ecosystem types.



Science AAAS

Indicators can serve national, regional and global assessments of the Ocean

- 2014: CBD 4th Global Biodiversity Outlook
- 2014: GEF Transboundary Water Assessment
- 2015: 1st UN World Ocean Assessment
- 2018: 1st IPBES assessment

One Planet – One Ocean