d4science

EGEE'09
21 September 2009
Barcelona (Spain)

# AquaMaps: Mapping Biodiversity Hotspots and Assessing Impacts of Climate Change


- K.Kaschner (FAO & Albert-Ludwigs-University of Freiburg), M. Taconet (FAO), A. Ellenbroek (FAO), N. Bailly (WFC), L. Pagano (CNR)



e-infrastructure

CAPACITIES

# Outline

- Our problem
- One solution
  - & its limitations
- Towards better solution.....

# Our Problem

We want to save the world....

# Our Goals

- Long-term protection of marine biodiversity
- Implementation of Ecosystems Approach to Fisheries

# Who's involved?

FAO
RFBs

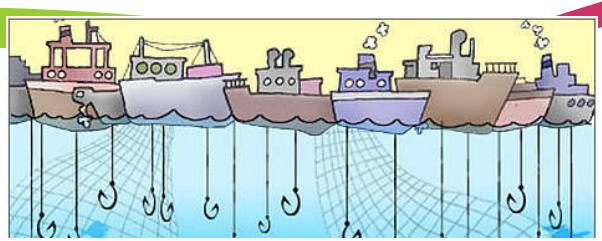
WFC
GBIF
CoML / OBIS
IUCN
IOC
ESA

Fisheries

Production systems / Fleets

Ecosystems approach to Fisheries

Resources of commercial interest



biodiversity

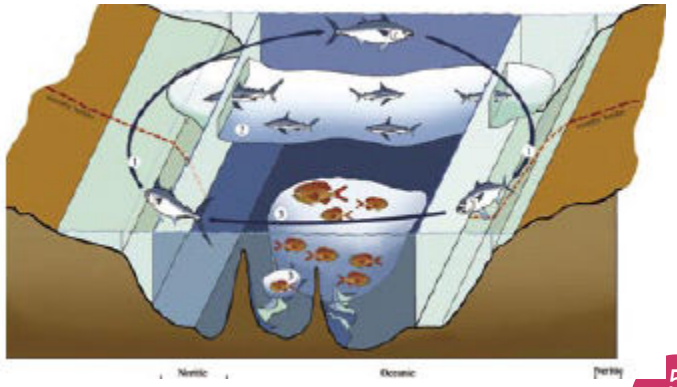
Marine Conservation

Broader ecosystem

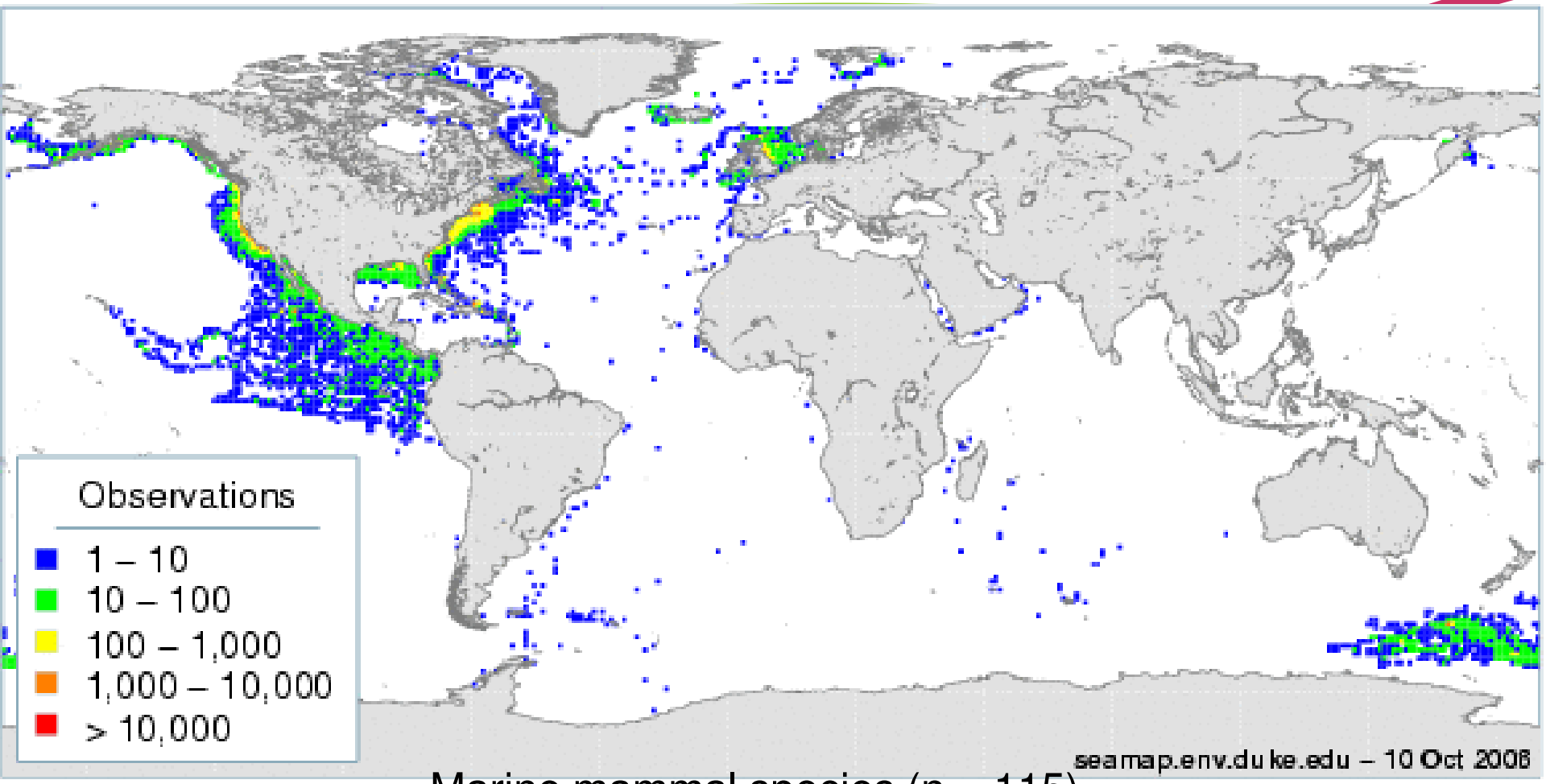
Environment

Environmental Monitoring

Physical environment

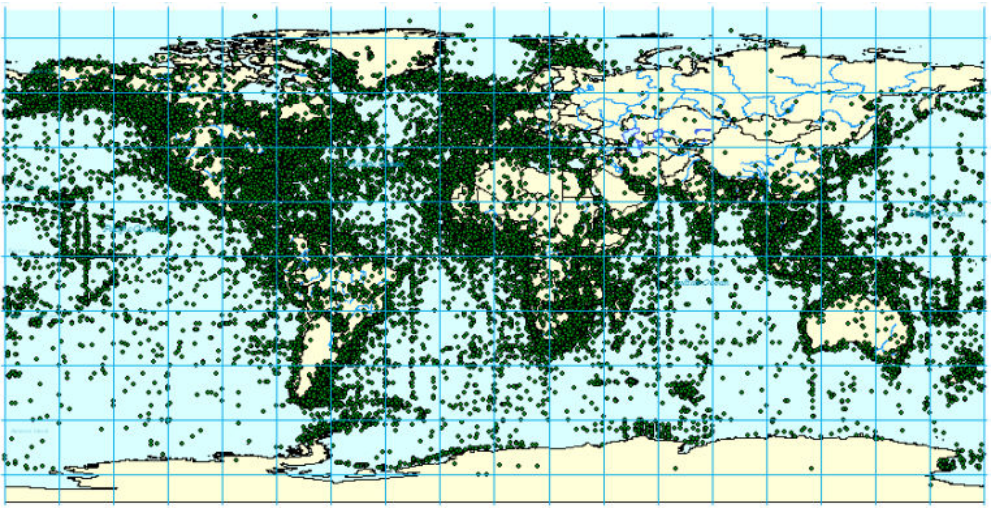


# Our Problem, More Specifically: Limited Information about Species Occurrence




Marine mammal species (n = 115)
Currently available point occurence data

# Our Problem, More Specifically: Limited Information about Species Occurrence



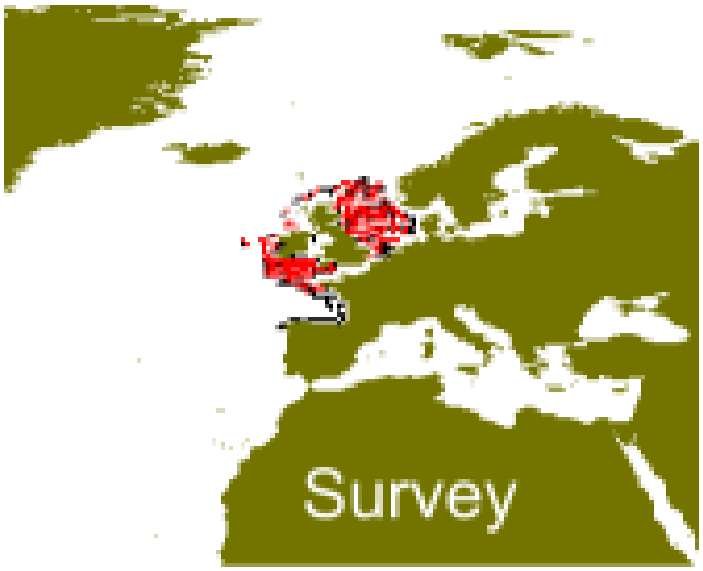
800,000 occurrence records (www.gbif.org)

300,000 described marine species

> 1,000 000 potential species

➔.....not a lot of data / species

# So, what to do?



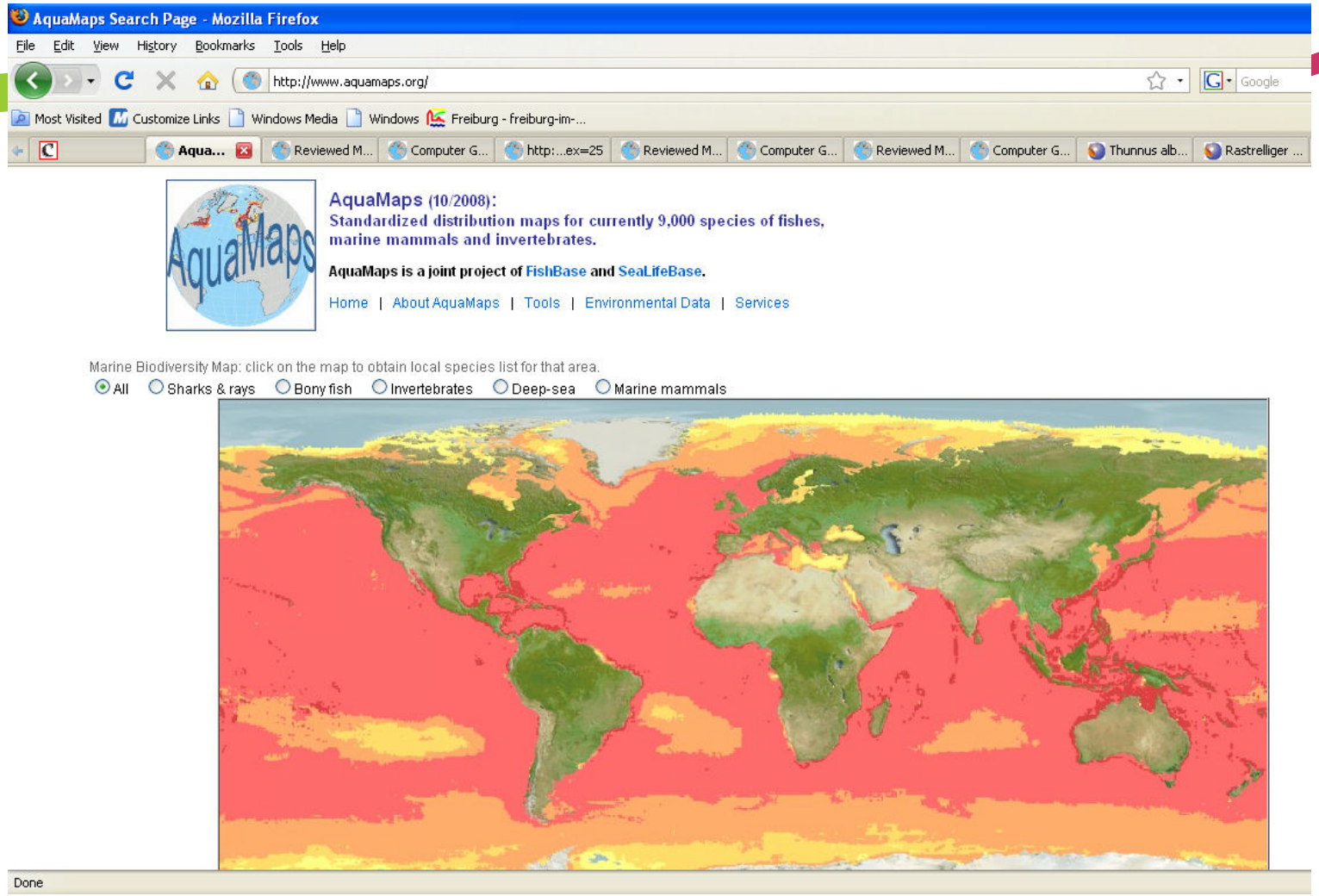


Solea Solea – Common Sole

# The Solution: Species Distribution Modelling


- Input
  - Occurrence data & information
  - Environmental layers
- Algorithms
  - RES / AquaMaps (ecological niche model)
  - BioClim
  - Maxent….
- Predictions
  - Existing distribution (mostly annual average)
  - Temporal projections (future/historic)

# Our Solution: AquaMaps



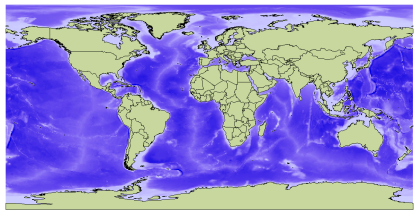

www.aquamaps.org

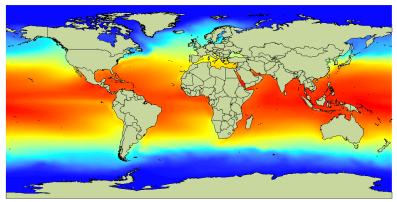
# Our Solution: AquaMaps

... produce computer-generated, reproducable species range maps for (evenually) all species using available data and a transparent, easily understandable and modifiable approach, so maps can be reviewed and improved by species experts.

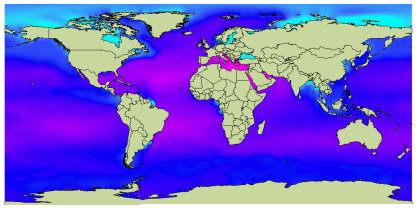
- ➔ very large / global scale
- ➔ low temporal resolution (annual average)
- ➔ can deal with data poor species
- ➔ can deal with imperfect input data

# AquaMaps – how does it work?

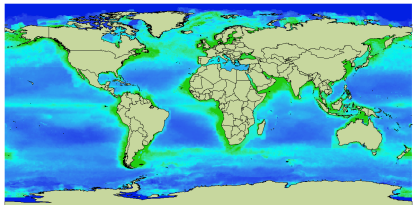




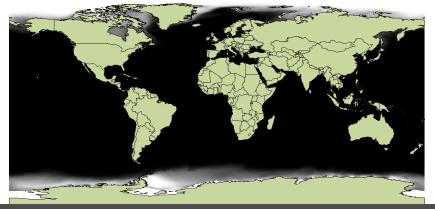
- Bathymetry
- Temperature
  - Sea surface temperature (SST) for pelagic species (0-200 m)
  - Bottom temperature for non-pelagic species (>200 m)
- Salinity
  - Sea surface salinity for pelagic species
  - Bottom salinity for non-pelagic species



- Primary production
- Sea Ice Concentration
- Distance to land (for special cases)

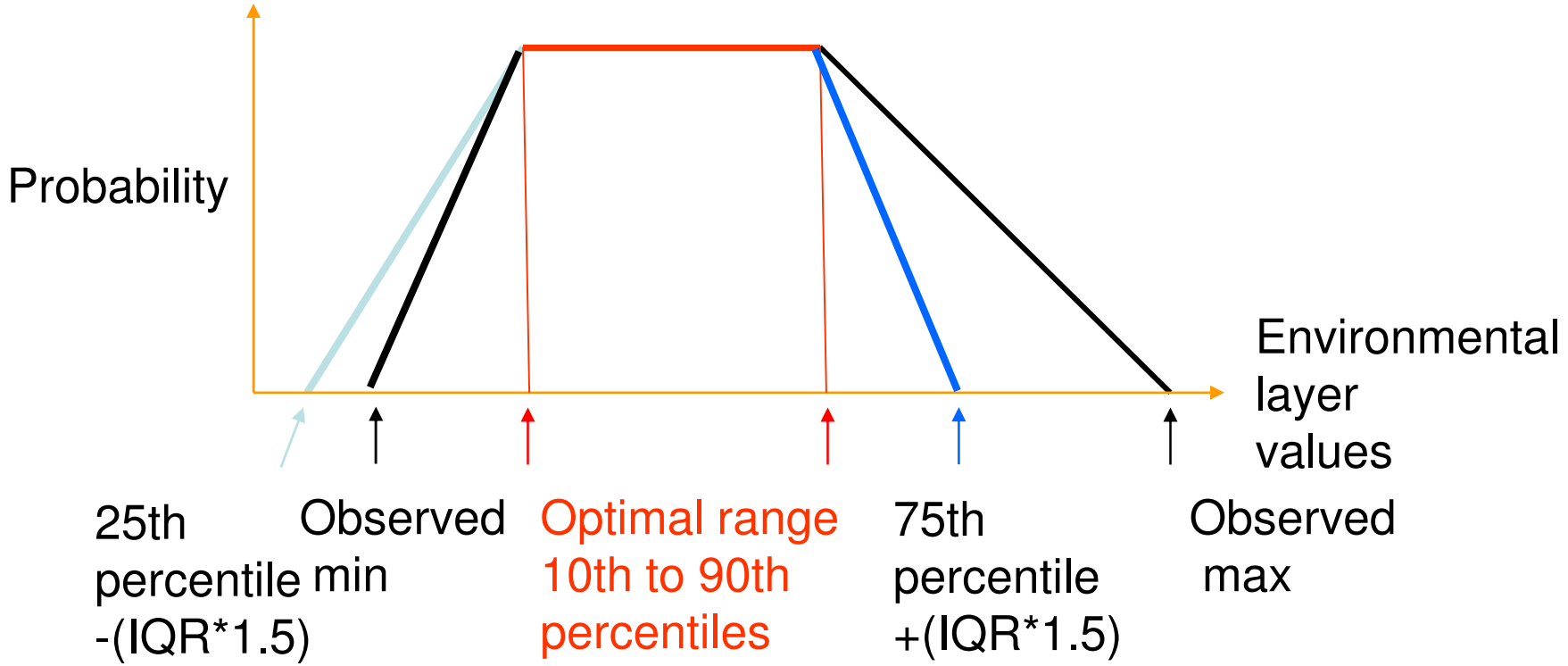


➔Global raster: 0.5 degree lat x lon = 180,000 cells



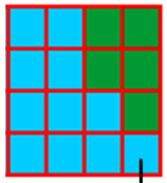
# AquaMaps – how does it work?

## Environmental envelopes

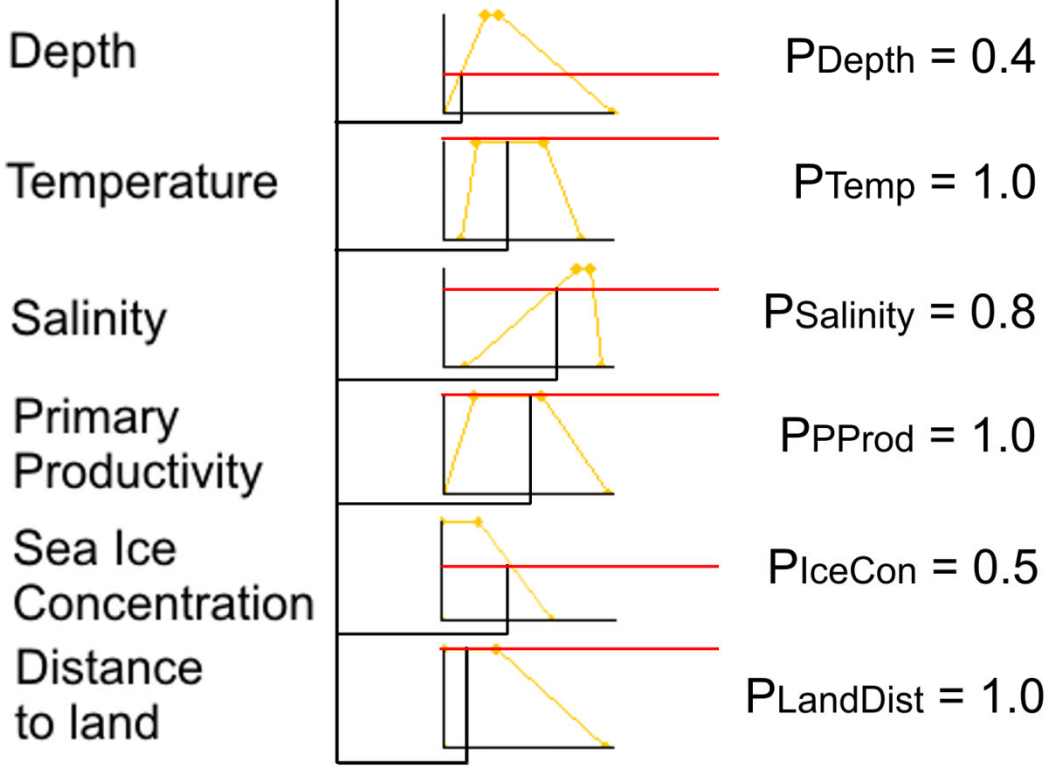



IQR = interquartile range

# AquaMaps – how does it work?



$$P_{Cell} = \sqrt[6]{(0.4 \times 1.0 \times 0.8 \times 1.0 \times 0.5 \times 1.0)} = 0.737$$



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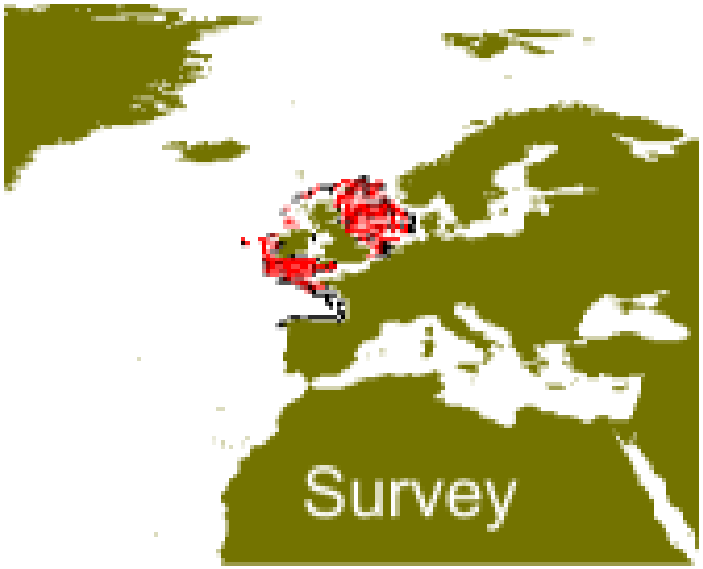



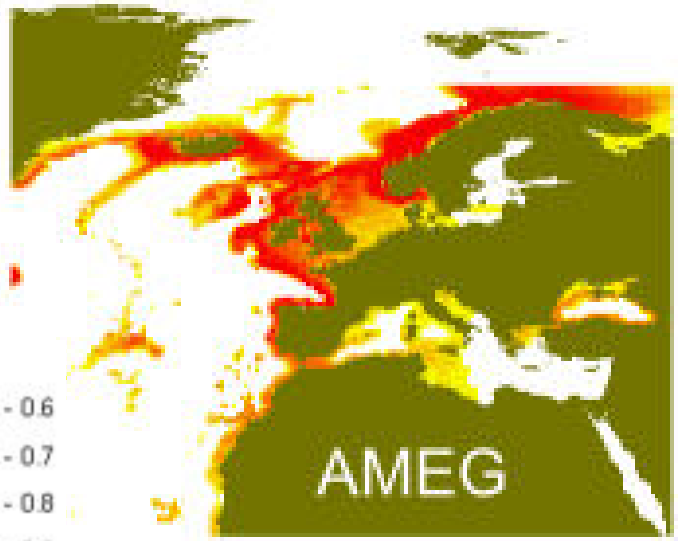


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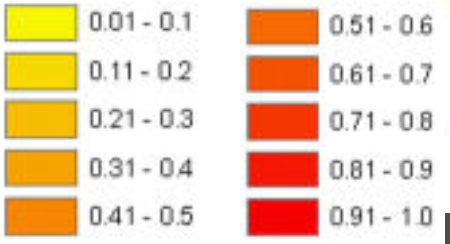


Ready et al, accepted

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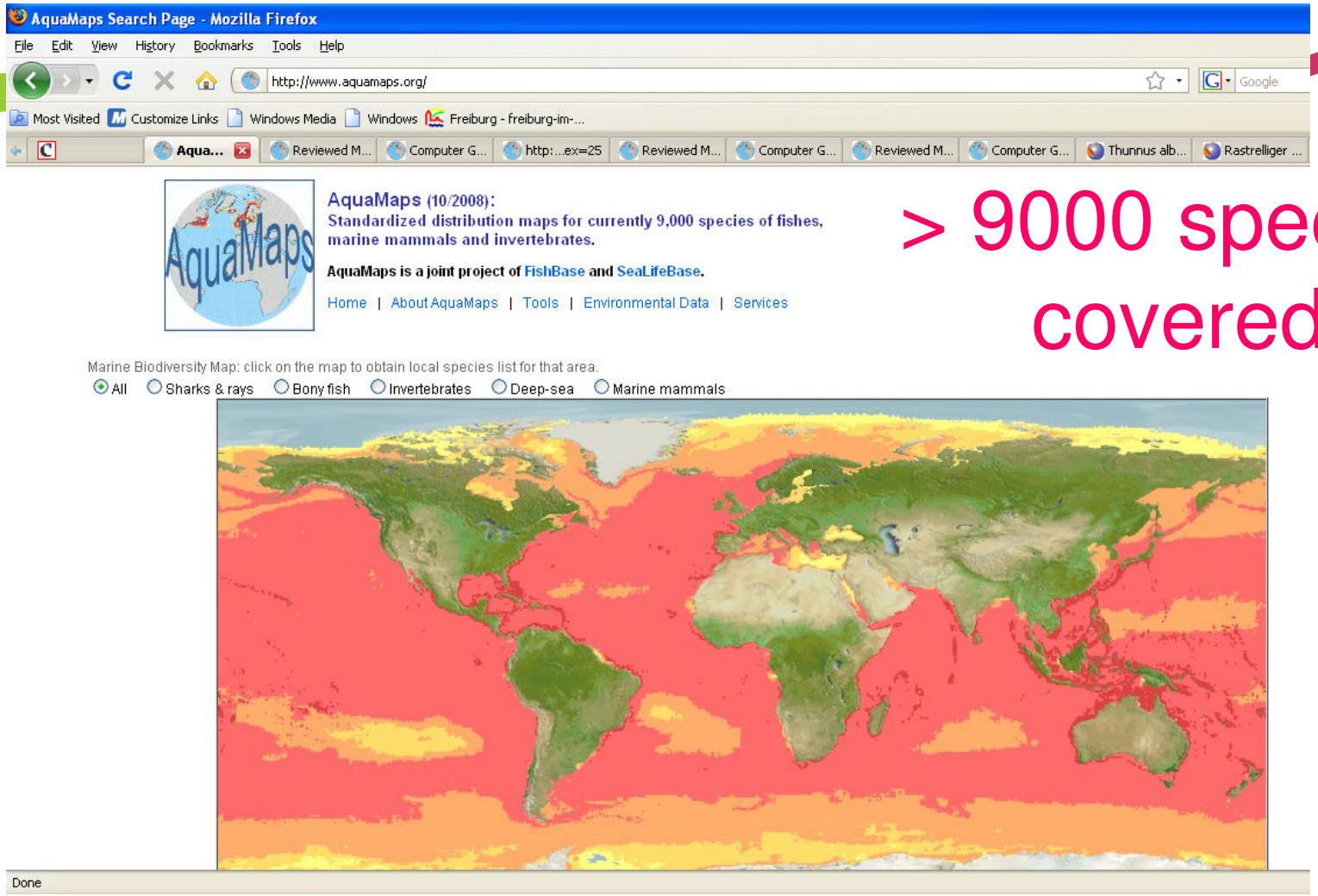
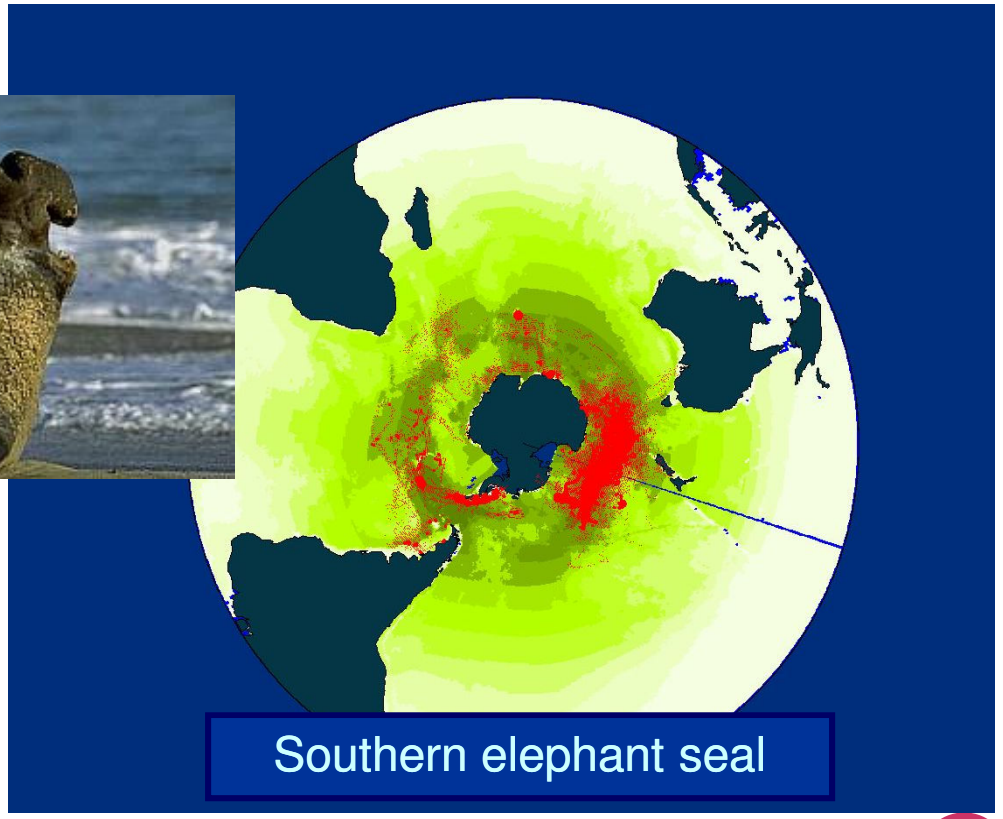



> 9000 species covered

www.aquamaps.org

# AquaMaps – how good is it?

- Validating individual species range maps
  - Kaschner et al, 2006



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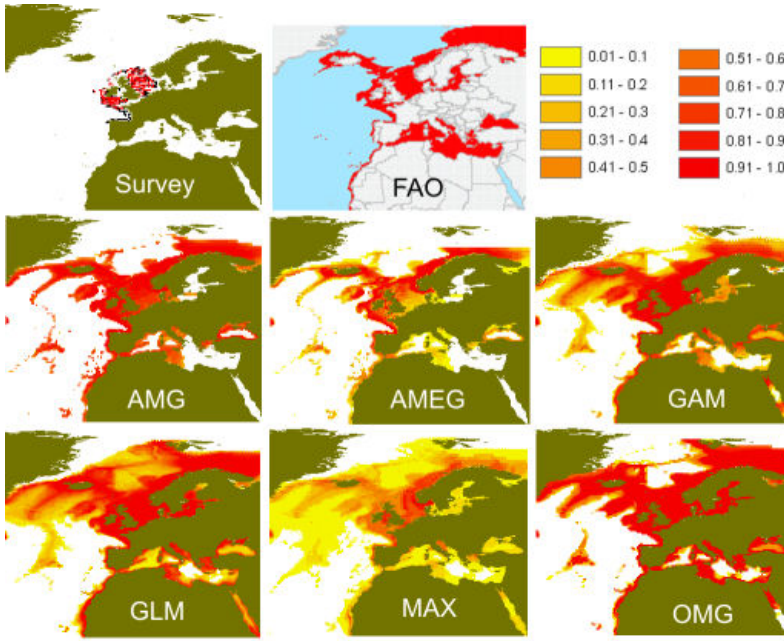
- Testing model performance in comparison to other approaches
  - J.Ready, K.Kaschner et al, accepted



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- Validating individual species range maps
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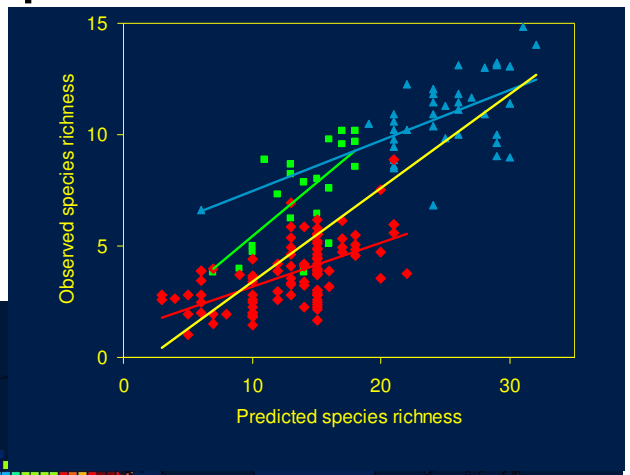
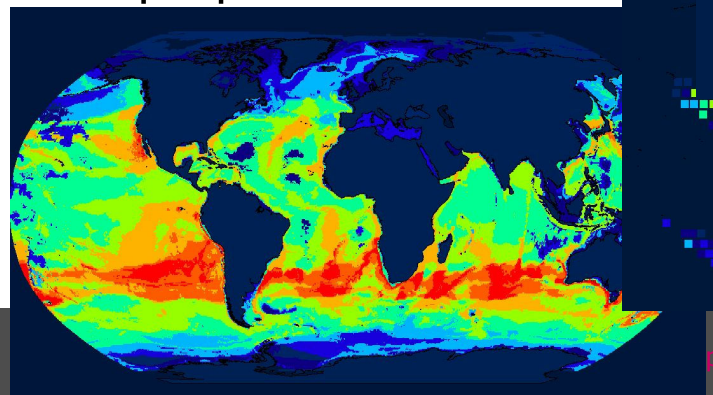
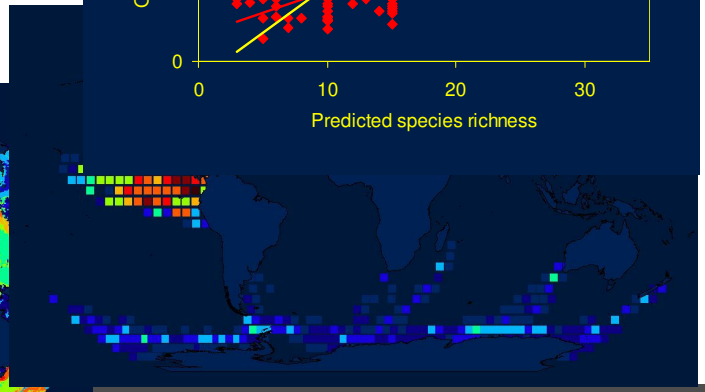
- Testing model performance in comparison to other approaches
  - J.Ready, K.Kaschner et al, accepted
- Validating species richness maps
  - K.Kaschner et al, in prep





# AquaMaps – what can we do with it?

**Checklists by Large Marine Ecosystems**

LME Benguela Current n = 66 Search

**Checklists by Country / Islands**

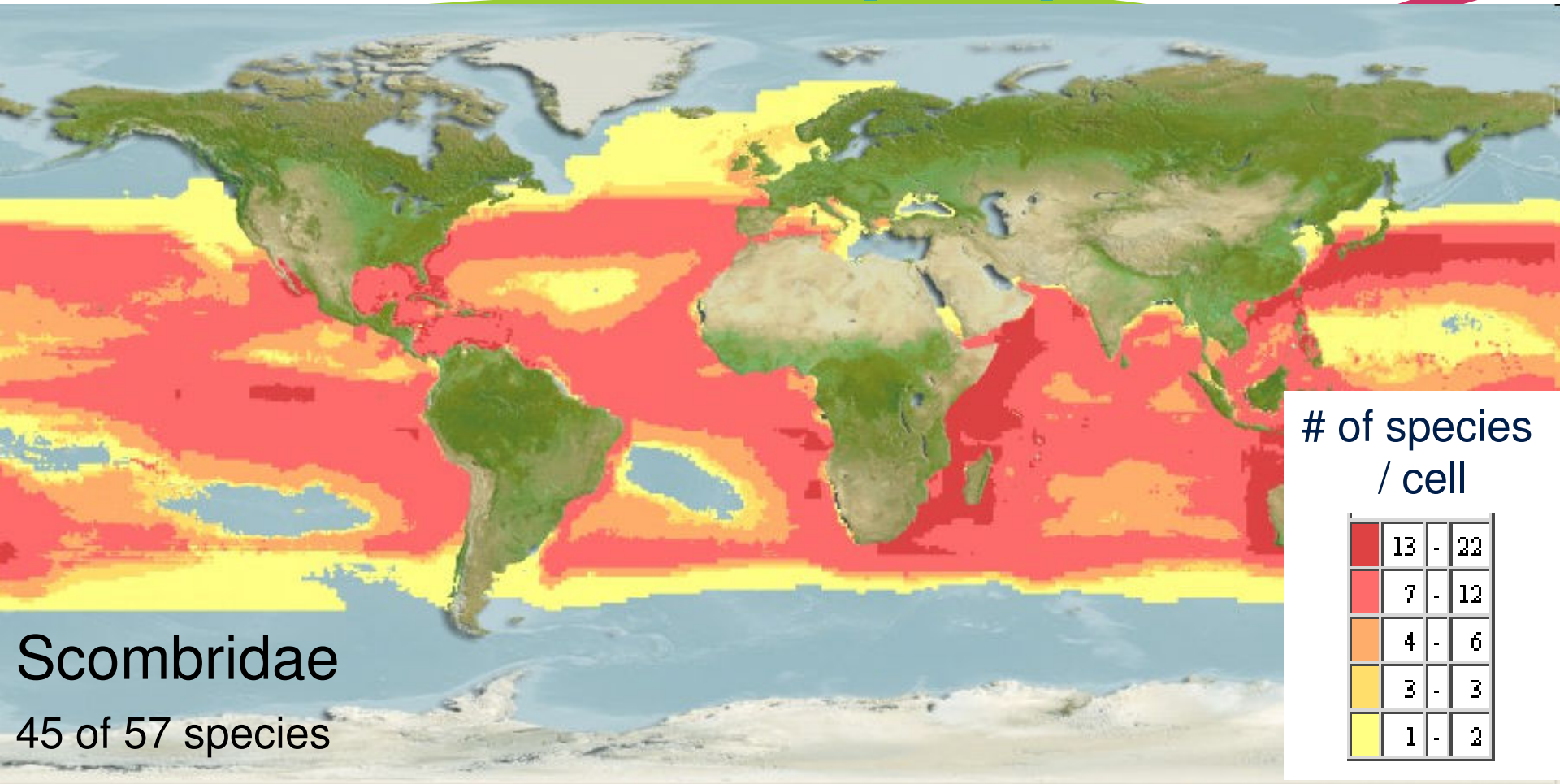
Country n = 240 Search

**Tools**

- Advanced Search
- Biodiversity maps
- Latitudinal transects
- Longitudinal transects
- Climate change maps
- Seasonal maps*
- Before/After maps*
- Expert reviewed maps
- MPA planning tool
- Web service
- Freshwater AquaMaps
- Freshwater checklists
- Invasive species checklists

Note: Tools with ( * ) display point maps.

# AquaMaps – what can we do with it?
# Biodiversity Maps



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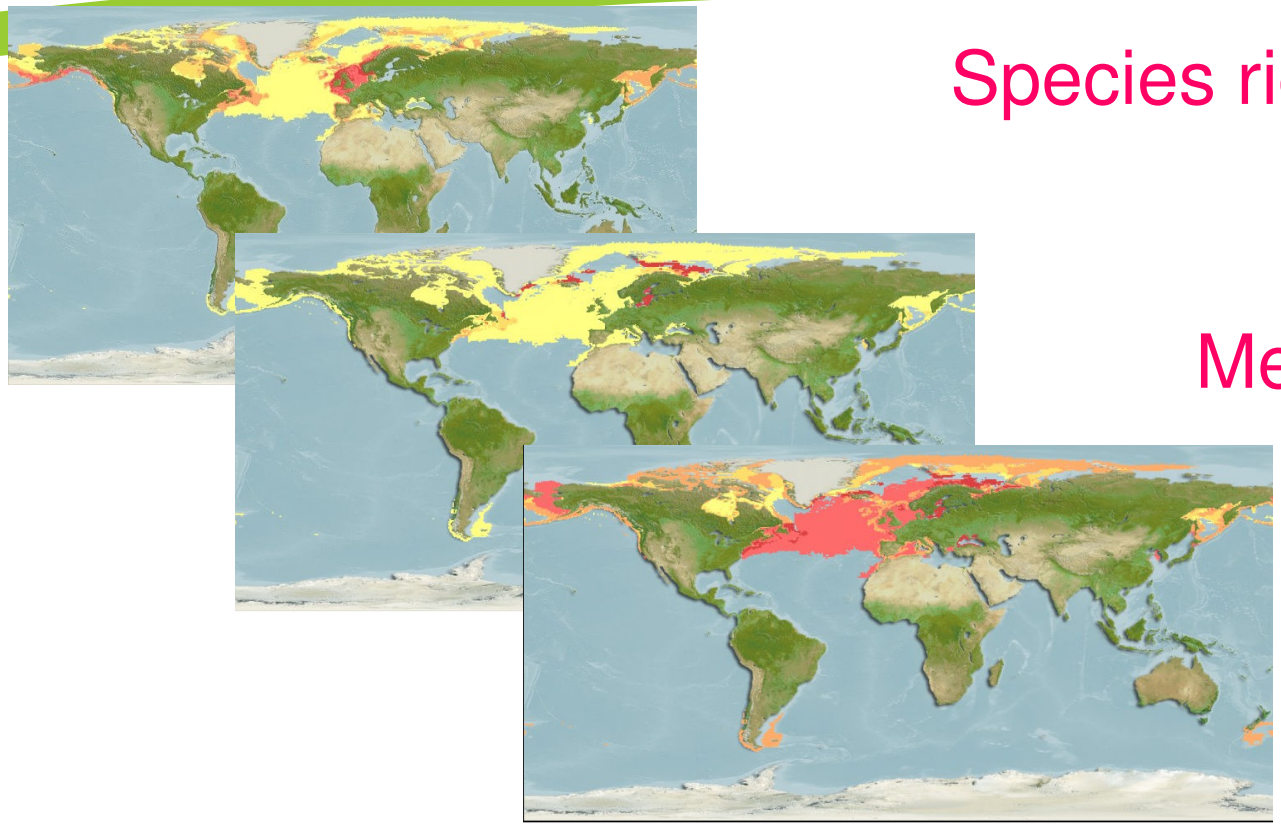

Species richness

Mean length

Mean trophic level

Gadidae: 23 of 25 species

# AquaMaps – what can we do with it?
# Biodiversity Maps

The world, all species:
up to 400 billions computations

# of species / cell

| | | | |
|---|---|---|---|
| | 766 | - | 4021 |
| | 146 | - | 765 |
| | 29 | - | 145 |
| | 6 | - | 28 |
| | 1 | - | 5 |

Ray-finned fishes
6544 of 29184 species

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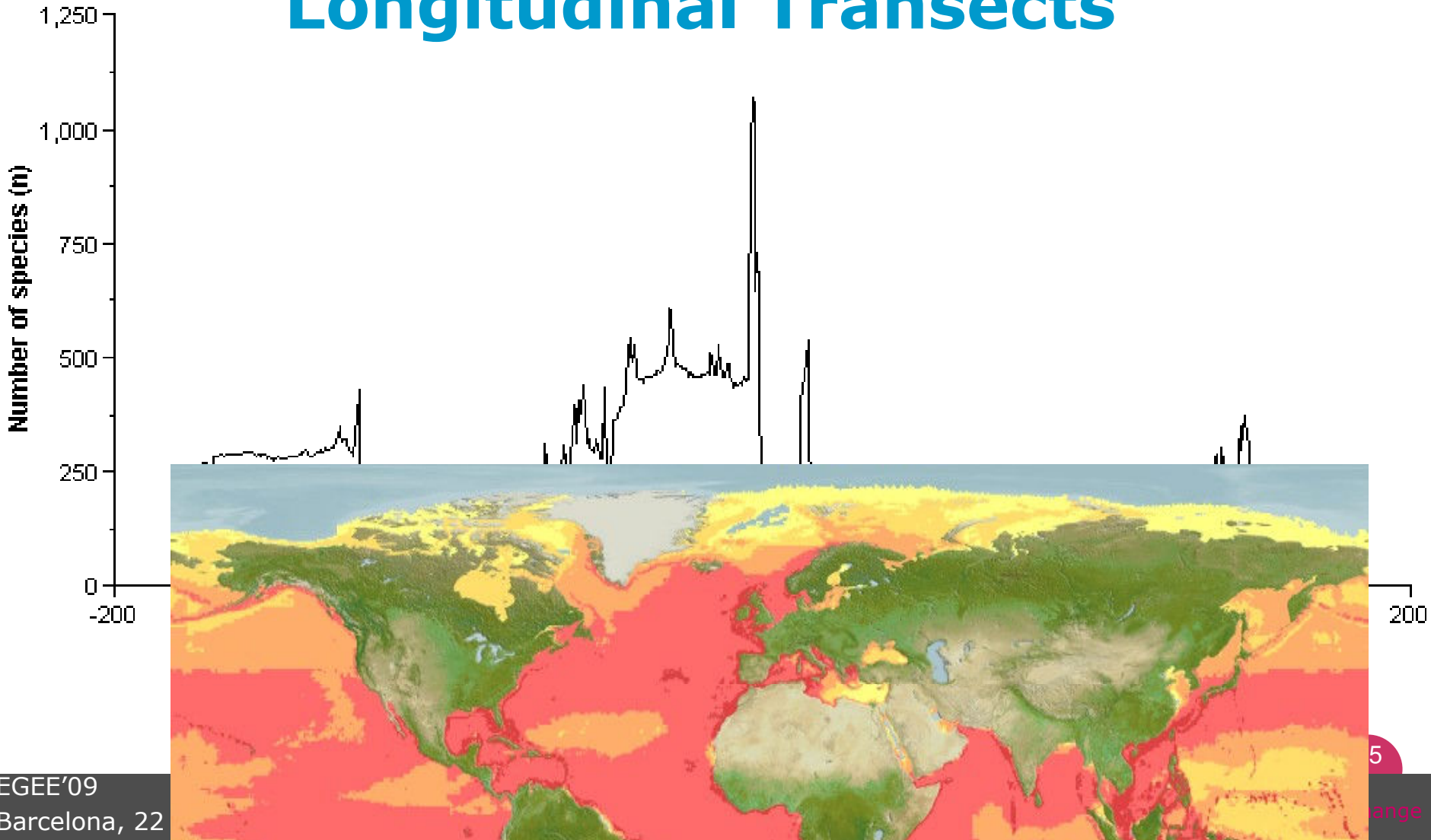
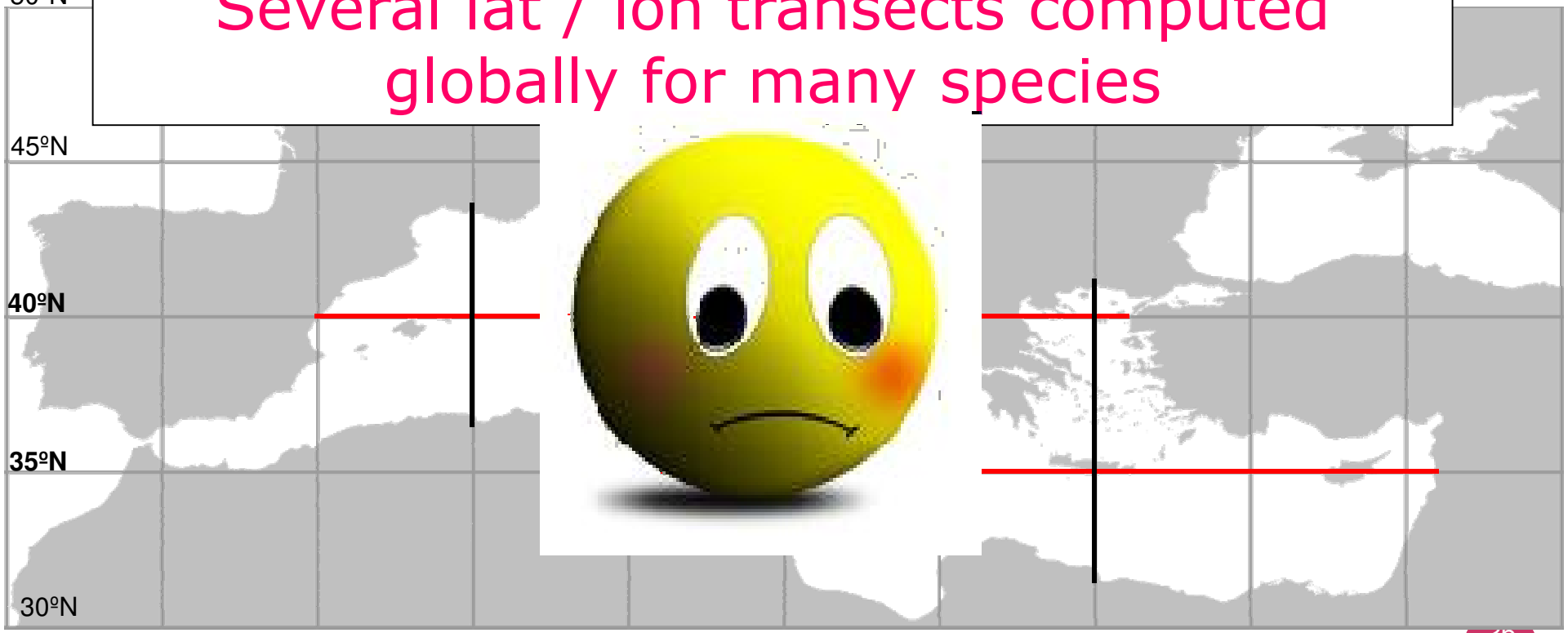


# AquaMaps – what can we do with it?

**Longitudinal gradients**

**Latitudinal gradients**

Several lat / lon transects computed globally for many species



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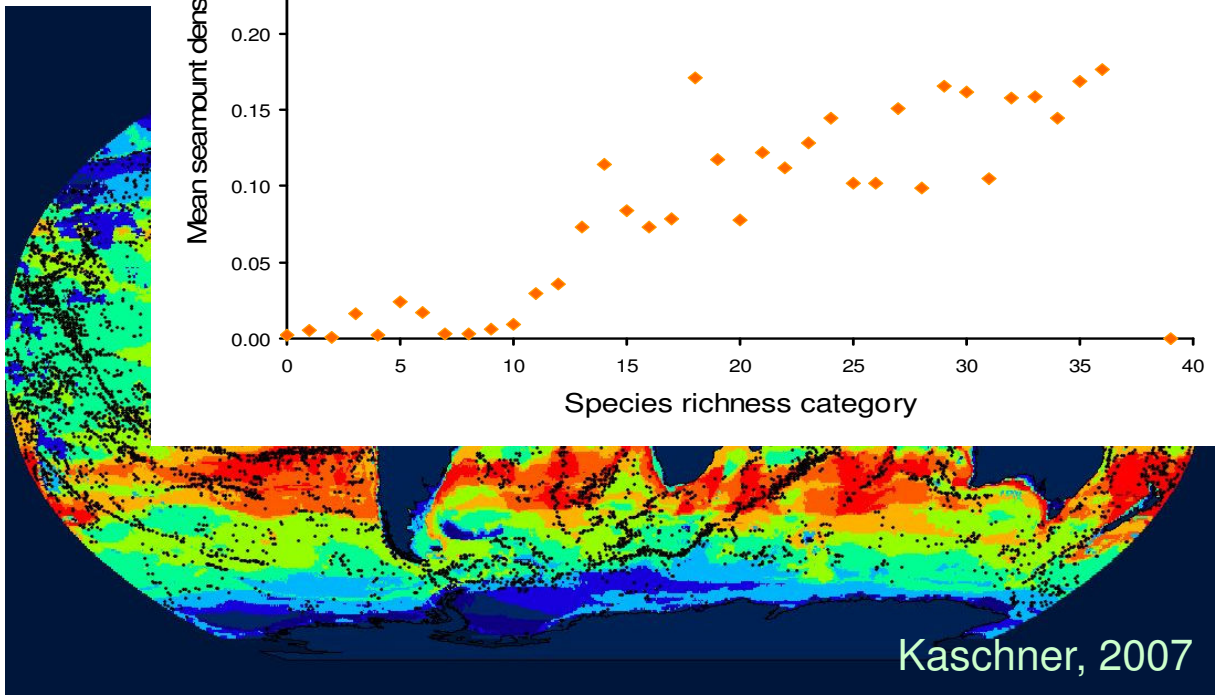
# AquaMaps – what can we do with it?
# MPA Planning

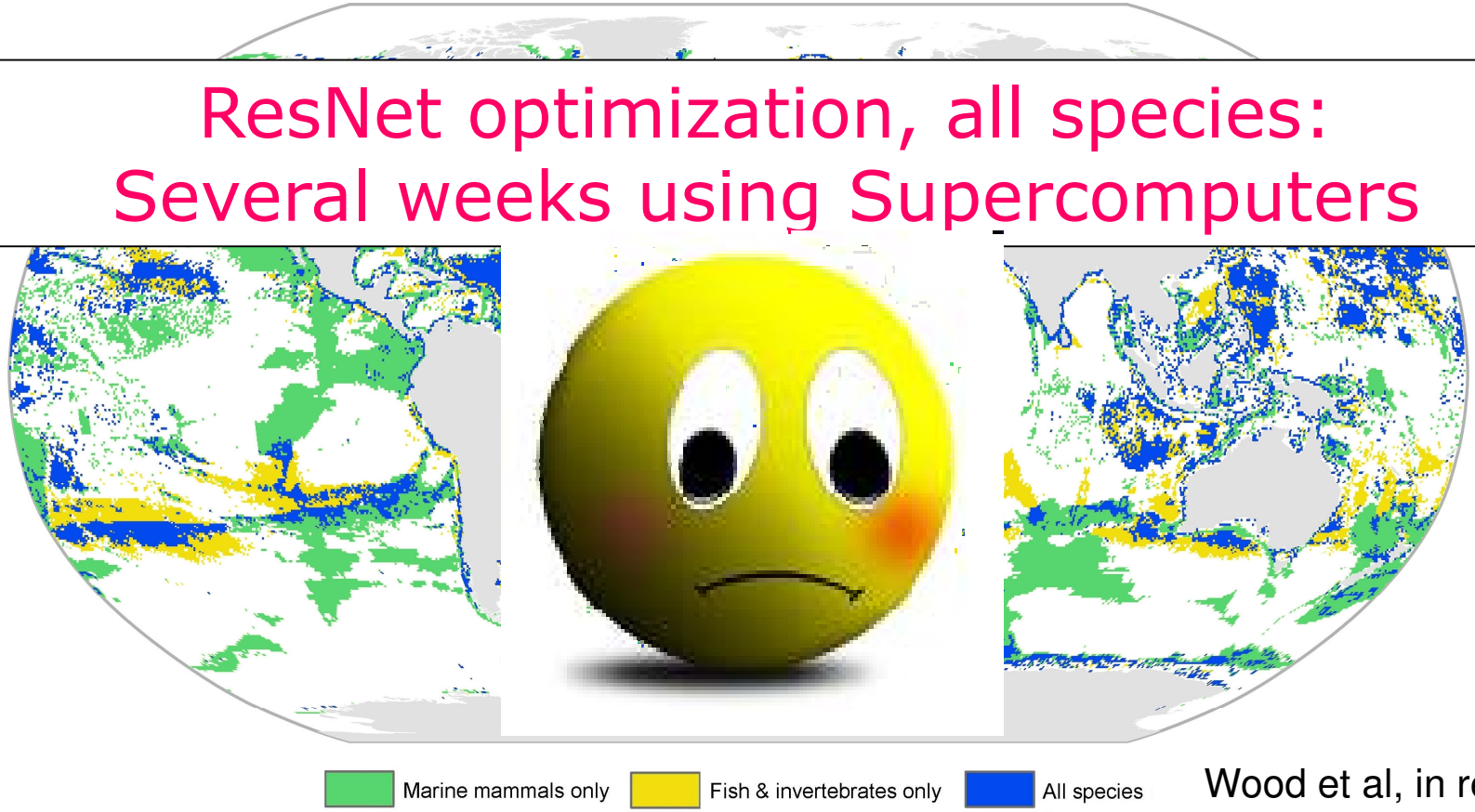
Species selection based on:

- IUCN criteria
- Area dependence
- Resilience
- Fisheries
- Popularity



# AquaMaps – what can we do with it?
# MPA Planning

ResNet optimization, all species:
Several weeks using Supercomputers




Wood et al, in review

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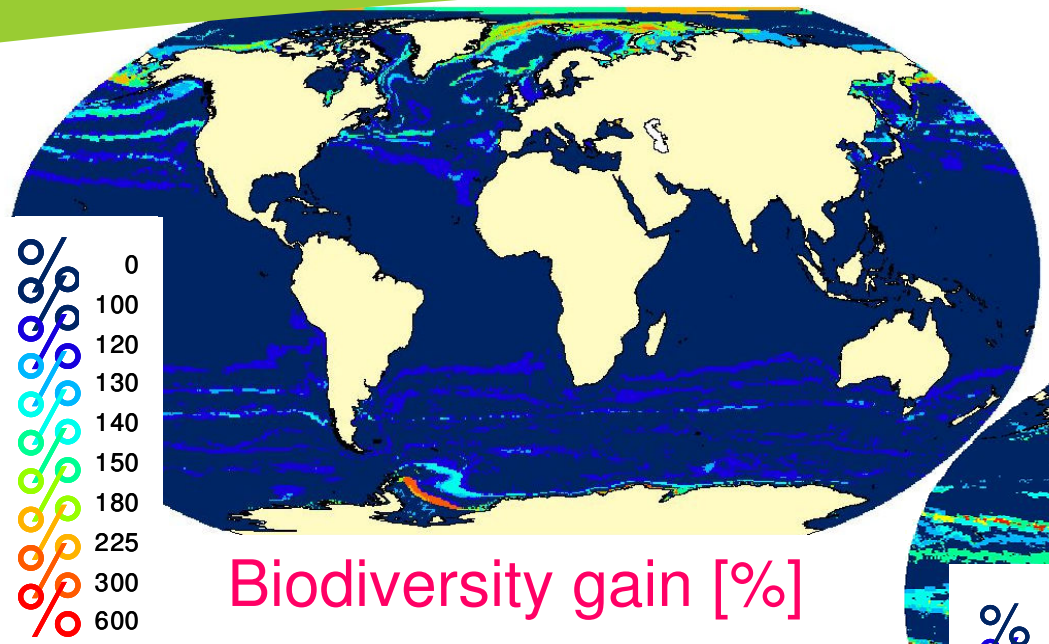
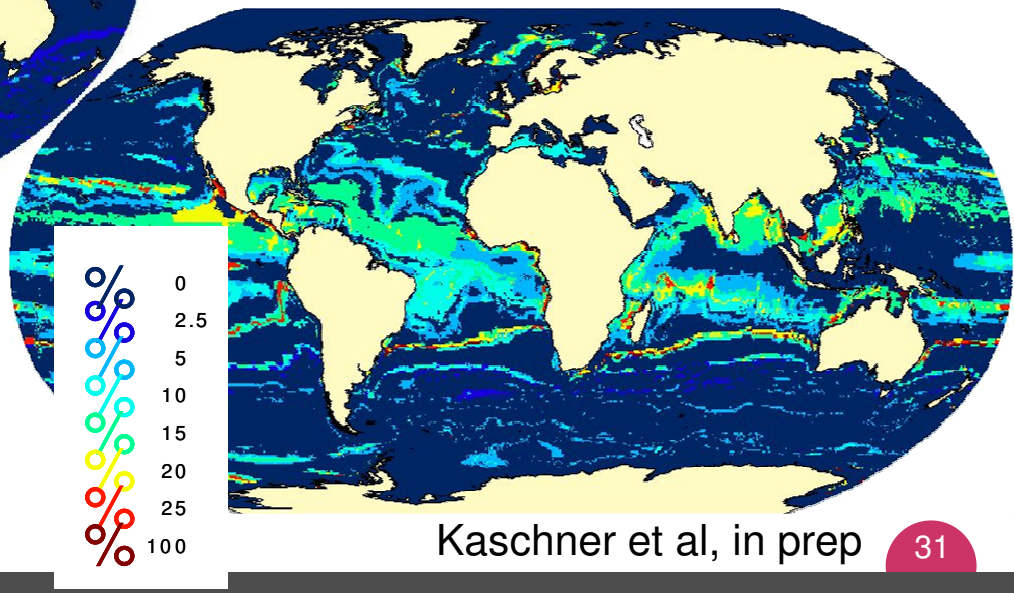



Biodiversity gain [%]

Marine Mammals (n = 115)

Biodiversity loss [%]




Kaschner et al, in prep

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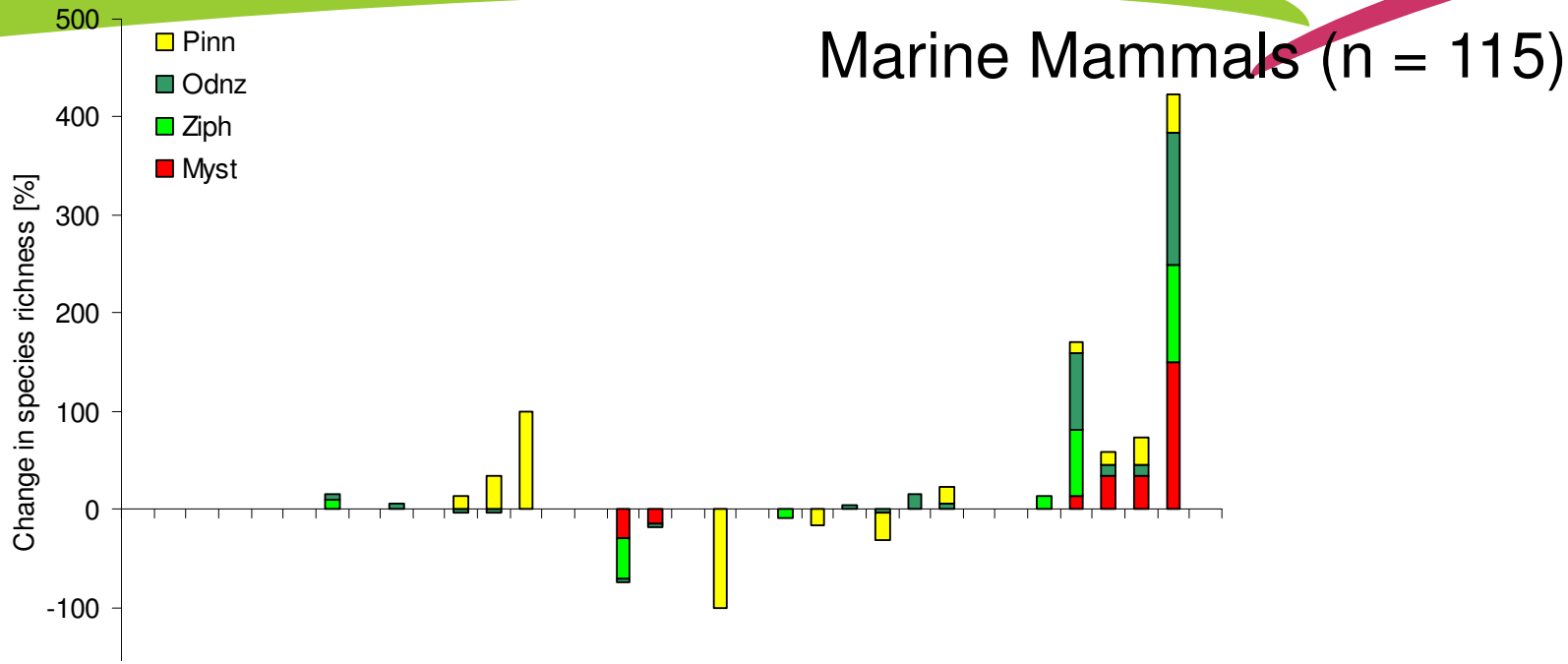
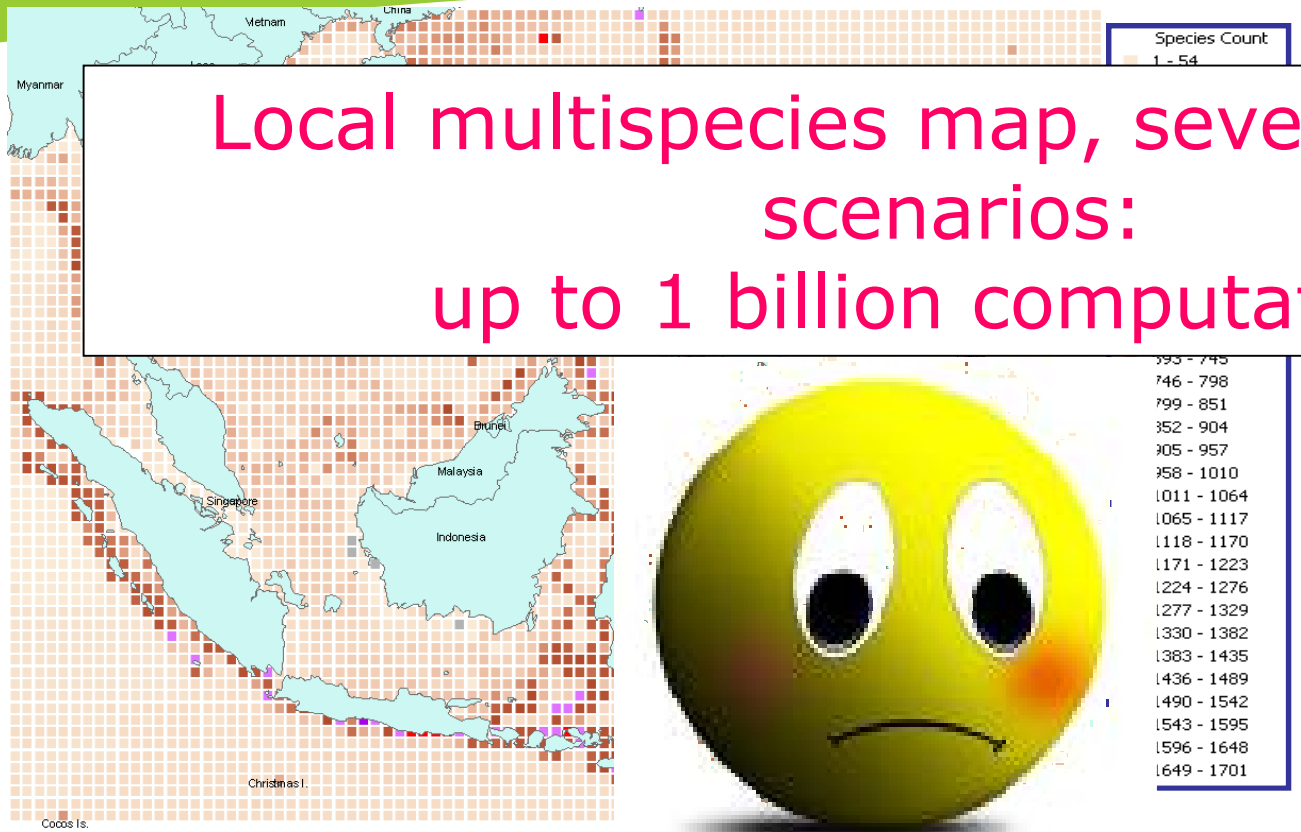



Relative change in species richness by latitude & different taxonomic groups

Kaschner et al, in prep

# AquaMaps – what can we do with it? Modelling Impacts of Climate Change

Local multispecies map, several climate scenarios:
up to 1 billion computations

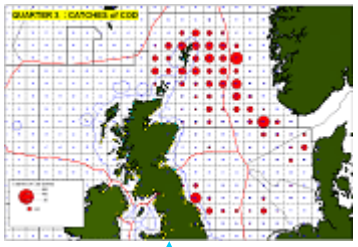





## Fisheries and Climate Change in South China Sea

- 6,188 half degree cells
- 2,540 species
- 5+3 environmental parameters

# Implementing an Ecosystems Approach to Fisheries



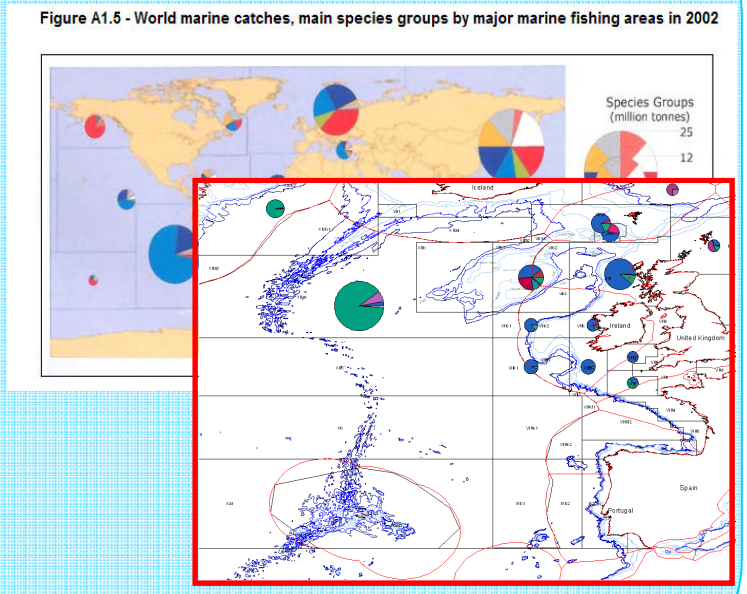
Fishing activity / Catch

**Fisheries**

## Integrated Capture Information System

- product: harmonized and reallocated catch statistics

ICIS



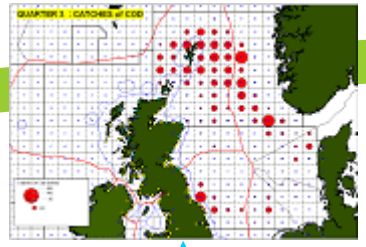

- Requirements
  - harmonization of time series data
  - querying, with aggregation and reallocation rules
  - combining biodiversity information with fisheries Catch time series
  - spatial dimension and mapping (GIS)

# This is where we're going....

## D4Science: Collaborative virtual laboratories (VREs) in support to science

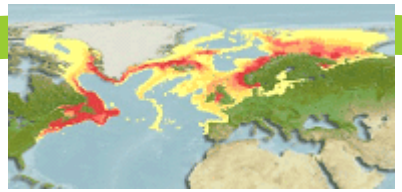
- working environment with access to multidisciplinary data sources and chain workflow processes
- Facilitates control of data sharing and collaborative reporting
- Provides access to GRID Infrastructure, storage and computing powers to all regional fisheries bodies

# This is where we're going....



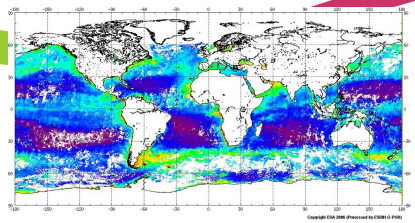
Fishing activity / Catch

**Fisheries**



Vulnerable Marine Ecosystems

**Biodiversity**



Habitats Geo-forms Hydrography

**Oceanography**

D4Science

ICIS/time series

Reference system

Catch statistics

FAO

GIS areas - species

Reference system

Catch statistics

RFBs

Dynamic Aquamaps

Aquamaps

WFC

FishBase

SealifeBase

UBC

Species occurence

OBIS

Environmental monitoring

end-users services

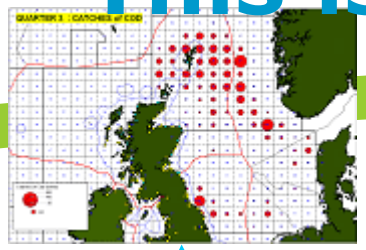
G-POD

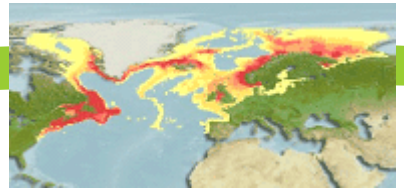
ESA

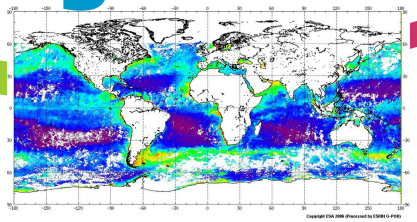
Satellite oceanography

Local

# This is where we're going....







Fishing activity / Catch

Vulnerable Marine Ecosystems

Habitats Geo-forms Hydrography

**Fisheries**

**Biodiversity**

**Oceanography**

D4Science

ICIS/time se

Reference system

Catch statistics

FAO

GIS areas - species

Reference system

Catch statistics

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Dynamic Aquamaps

Aquamaps

WFC

FishBase

SealifeBase

UBC

Species occurence

OBIS

Environmental monitoring

end-users services

G-POD

ESA

Satellite oceanography

Local

# Thank you

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