Winners and Losers in the Future Ocean

Insights from Millions of Samples

Rainer Froese
IFM-GEOMAR, Kiel, Germany
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Overview

• Millions of points, and then what?
• AquaMaps approach to range maps
• Some example maps
• Species richness map and transect
• MPA planning tool
• Invasives tool
• Winners and losers in the future Ocean
• Conclusions
2 Million Points in FishBase
(in 2000)
30 Million Collection Records for 118,000 Species in OBIS
GBIF: 260 Million Records
So We Have Millions of Points

- Now what?
- Where is the beef?
- Does it explain the origin of the Universe?
- Does it cure cancer?
- Why should I care?
- What’s the point?
Show Species Distribution:
60,152 points for *Gadus morhua* in GBIF
Map for *Gadus morhua* in EOL
We Must Do Better

- *Gadus morhua*, Atlantic Cod, is one of the best known species in the World
- We know its range, ecosystems, countries
- We know its preferences for depth, habitat, temperature, salinity, ...
Environmental Layers Used by AquaMaps

Depth | Temperature | Salinity | Primary productivity | Sea ice concentration

Depth (Mean, Minimum, Maximum)
Suitable Habitat for *Gadus morhua*
Range Map
for *Gadus morhua*
2050 Range Map
for Gadus morhua
AquaMaps Attempts to Combine Points with other Knowledge

- Mass-production of computer-generated distribution maps
- Based on known range, environmental preferences and known occurrences
- With expert editing of `computer maps´
- For eventually all species on Earth
Currently >11,000 Maps

- Half of all marine fishes (~7,000)
- All marine mammals
- All marine reptiles (turtles, snakes)
- Many seabirds
- Over 2,000 invertebrates
- Important invasive species
Examples from AquaMaps
Whale shark (cosmopolitan)
Whale shark
(cosmopolitan)
**Rhincodon typus**  Smith, 1828

**Whale shark**

**Classification**
Elasmobranchii | Orectolobiformes | Rhincodontidae

**Synonyms**
*Rhiniodon typus, Micristodus punctatus, Rhinodon pentalineatus*, ... more

**Common names**
Requin baleine, Tiburón ballena, Tofu sa, ... more

Upload your photos and videos
| All pictures | Google image | Stamps |

Add your observation in Fish Watcher
| Native range | All suitable habitat | PointMap | Year 2050 |

Picture by Postberg, J.

AquaMaps  Data sources: GBIF OBIS
Distribution
Circumglobal in tropical and warm temperate seas. Western Atlantic: New York, USA through the Caribbean to central Brazil. Eastern Atlantic: Senegal to Gulf of Guinea; St. Paul's Rocks (Ref. 13121). Indian Ocean: throughout the region, including the Red Sea and the Persian Gulf. Western Pacific: Japan to Australia and Hawaii. Eastern Pacific: California, USA to Chile. Identified as one of the species with an unfavorable conservation status in Appendix II of the Bonn Convention for the Conservation of Migratory Species of Wild Animals in 1999. Classified as a highly migratory species, in Annex I of the 1982 United Nations Convention on the Law of the Sea (UNCLOS) which called for 'coordinated management and assessment to better understand cumulative impacts of fishing effort on the status of the shared populations' of these sharks (Ref. 26139). Included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since May 2003 which regulates international trade of this species. This can partially implement the original objective of the FAO International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks). However, international trade still exists.

Countries | FAO areas | Ecosystems | Occurrences | Introductions
### Countries where *Rhincodon typus* is found

<table>
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<tr>
<th>Country</th>
<th>ABB</th>
<th>Status</th>
<th>Main Ref.</th>
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Examples from AquaMaps
Blackfin spiderfish (continental shelves)
Global Species Richness

www.aquamaps.org
Tools:
Equatorial Species Richness Transect across the Indo-Pacific
Tools:
Where to Place an MPA
Tools

*Mnemiopsis leidyi* (invasive Black Sea)
Tools

*Mnemiopsis leidyi* (invasive Black Sea)
How About Climate Change?
## Expected Changes in Environmental Parameters in 2050

<table>
<thead>
<tr>
<th>Climate zone</th>
<th>Surface Temp. (°C)</th>
<th>Bottom Temp. (°C)</th>
<th>Salinity</th>
<th>Bottom Salinity</th>
<th>Ice concentration (%)</th>
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<td>+1.6</td>
<td>-1.2</td>
<td>-0.8</td>
<td>-9</td>
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<td>Temperate N</td>
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<td>+0.8</td>
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<tr>
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<tr>
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<td>+0.3</td>
<td>-0.2</td>
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<tr>
<td>Temperate S</td>
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<td>+0.7</td>
<td>-0.1</td>
<td>0.0</td>
<td>-0.3</td>
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<tr>
<td>Antarctic</td>
<td>+0.7</td>
<td>+0.5</td>
<td>-0.2</td>
<td>0.0</td>
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</table>
Preliminary Analysis

- 342 marine fishes with verified maps
- Global suitable habitat in 1999 and 2050
- Only core habitat considered ($P > 0.5$)
More Losers than Winners

Change in area of suitable habitat between 2000 and 2050 for 342 marine fishes. Median loss of area is 6% (95% CL 3.8 – 7.4), significantly different from zero.
No Difference for Sharks

Change in area is not significantly different between 91 sharks & rays and 250 ray-finned fishes. The one species of Holocephali is Chimaera monstrosa.
No Role for Phylogeny

Change in suitable habitat by phylogenetic rank of species, from primitive on the left to highly derived on the right.
No Role for Uniqueness

Change in area with suitable habitat over phylogenetic uniqueness (Faith, Reid and Hunter 2004) of the respective species.
No Role for Size

Change in area with suitable habitat over maximum body length of 342 species of marine fishes.
Change in area is not significantly different between 34 non-migratory (median -3.2%, 95% CL -17 – 1.6) and 96 oceanodromous species (median -3.7, 95% CL -9.4 - -0.8).
Deeper is Better

Change in area by preferred habitat of marine species. For 41 deep sea fishes, the median change of +2% (95% CL -0.9 – +3.7. For 103 demersal fishes, median loss is 3% (95% CL -6.5 - -0.9). For 31 benthopelagic fishes, the median loss of 3.3% (95% CL -12 – 3.8. For 55 pelagic fishes, the median loss is 13% (95% CL -17 - -2.9). For 112 reef-associated fishes, the median loss is 10% (-17 - -6.5).
Polar and Tropical Fishes Lose

Change in area by climate zone. For 43 deep sea species, the median change is not significantly different from zero (median 1.8, 95% CL -2.5 – 3.7). Of five polar species, three lose 9 to 32% of suitable area. For 50 temperate species, median change is +2.3% (95% CL -0.1 – 4.0). For 112 subtropical species, the median loss is 7% (95% CL 3.8 – 13) and for 132 tropical species the median loss is 9% (95% CL 7 – 15).
1st Conclusions about Impact of Climate Change on Marine Fishes

- More losers than winners in the Future Ocean
- Deep sea and demersal fishes are less affected
- Polar and tropical fishes lose, temperate less affected
- Among fishes, phylogeny and size do not seem to play a role
Who Does AquaMaps

• Rainer Froese, IFM-GEOMAR, Coordinator
• Kristin Kaschner, Freiburg Uni., model development
• Sven Kullander, NRM, extension to freshwater
• Jonathan Ready, formerly NRM, implementation
• Tony Rees, CSIRO, mapping tools
• Paul Eastwood, CEFAS, valuation
• Nina Garilao, IFM-GEOMAR, web programming
• Josephine Rius Barile, WFC, database programming
• Kathleen Reyes, WFC, map checking
Some FishBase Team Members
Who Supports AquaMaps

- Governance by FishBase Consortium
- Past support from Pew Charitable Trusts, EU, USGS, OBIS, GBIF, Future Ocean Kiel, D4Science
- Involvement in new projects wanted
Thank You

rfroese@ifm-geomar.de