Proteus Partners Annual Meeting 2014

Hosted by BP at Jesus College, Cambridge 13th-14th May

Governance of the oceans and areas beyond national jurisdiction

Kristian Teleki
Director of Global Engagement, Global Ocean Commission

UNEP WCMC

proteus

Proteus Partners Annual Meeting 2014

Hosted by BP at Jesus College, Cambridge 13th-14th May

Marine data: past, present and future

Damon Stanwell-Smith
Head of Marine, UNEP-WCMC

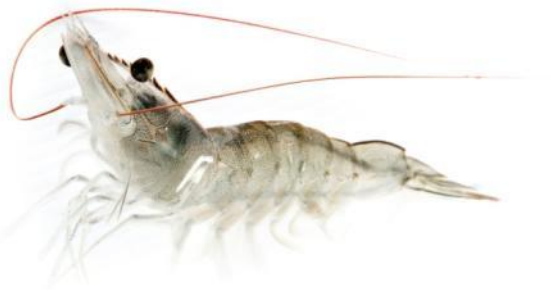
UNEP WCMC

proteus

Marine Data

Past
Present
Future

Dr Damon Stanwell-Smith
Head, Marine Programme, UNEP-WCMC



UNEP WCMC

Sperm whale *Seasonality*

Past
Present
Future

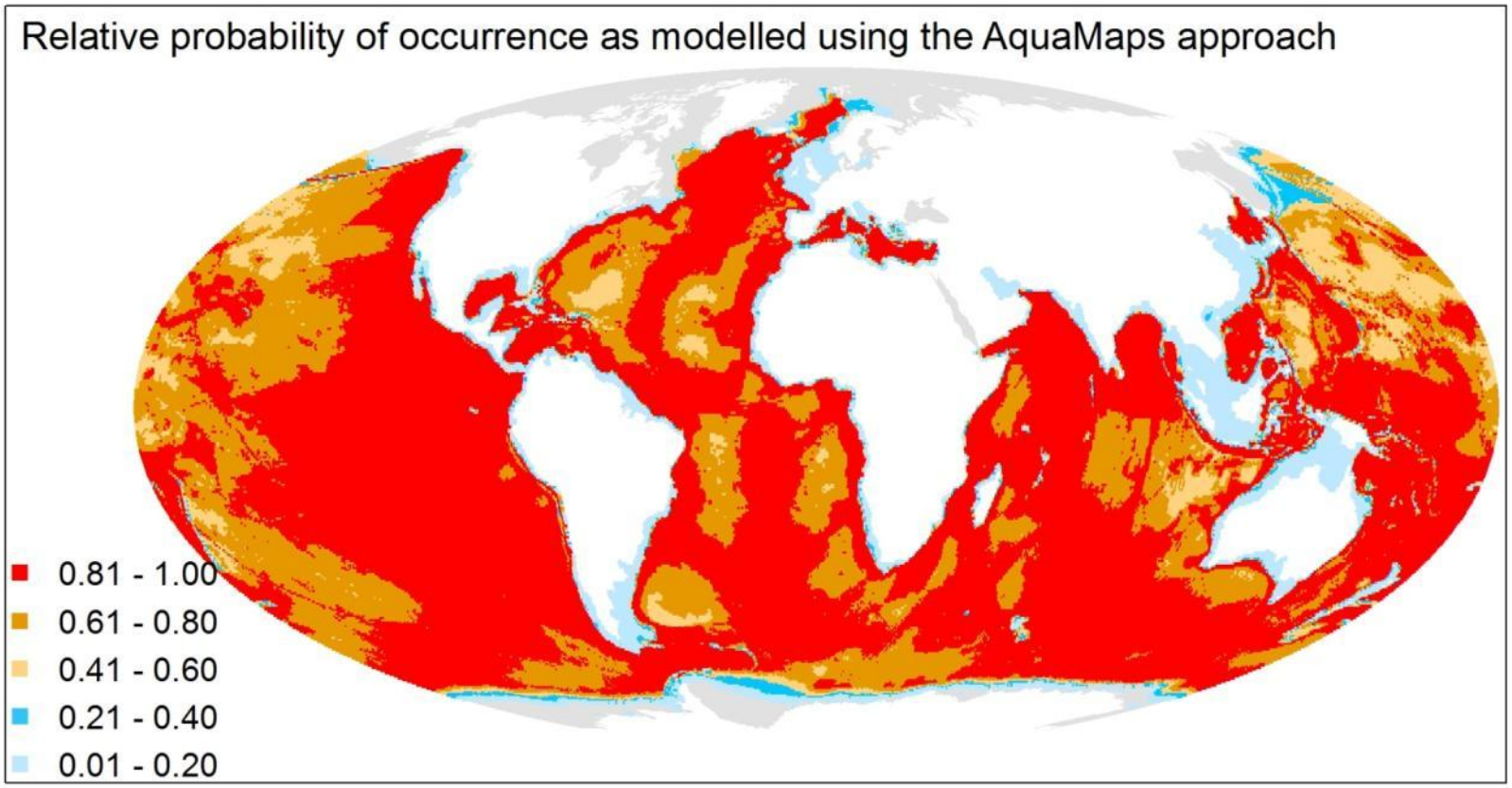
***Moby Dick*, Herman Melville (1851), chapter 44 "The Chart"**

https://www.youtube.com/watch?feature=player_embedded&v=Tn7fQ5mYHPA

UNEP WCMC

Sperm whale *Mar - May*

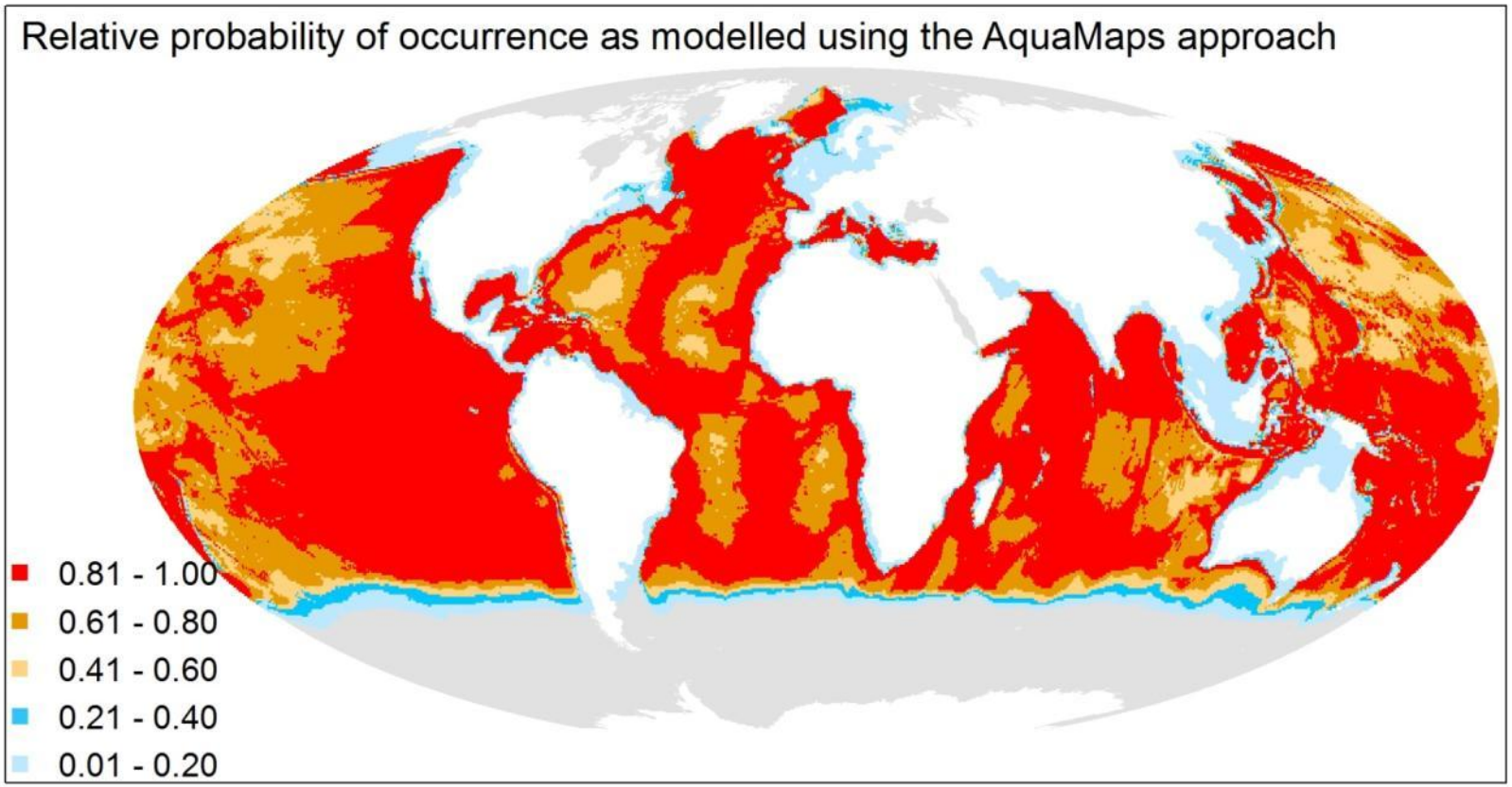
Past
Present
Future



UNEP WCMC

Sperm whale *Jun - Aug*

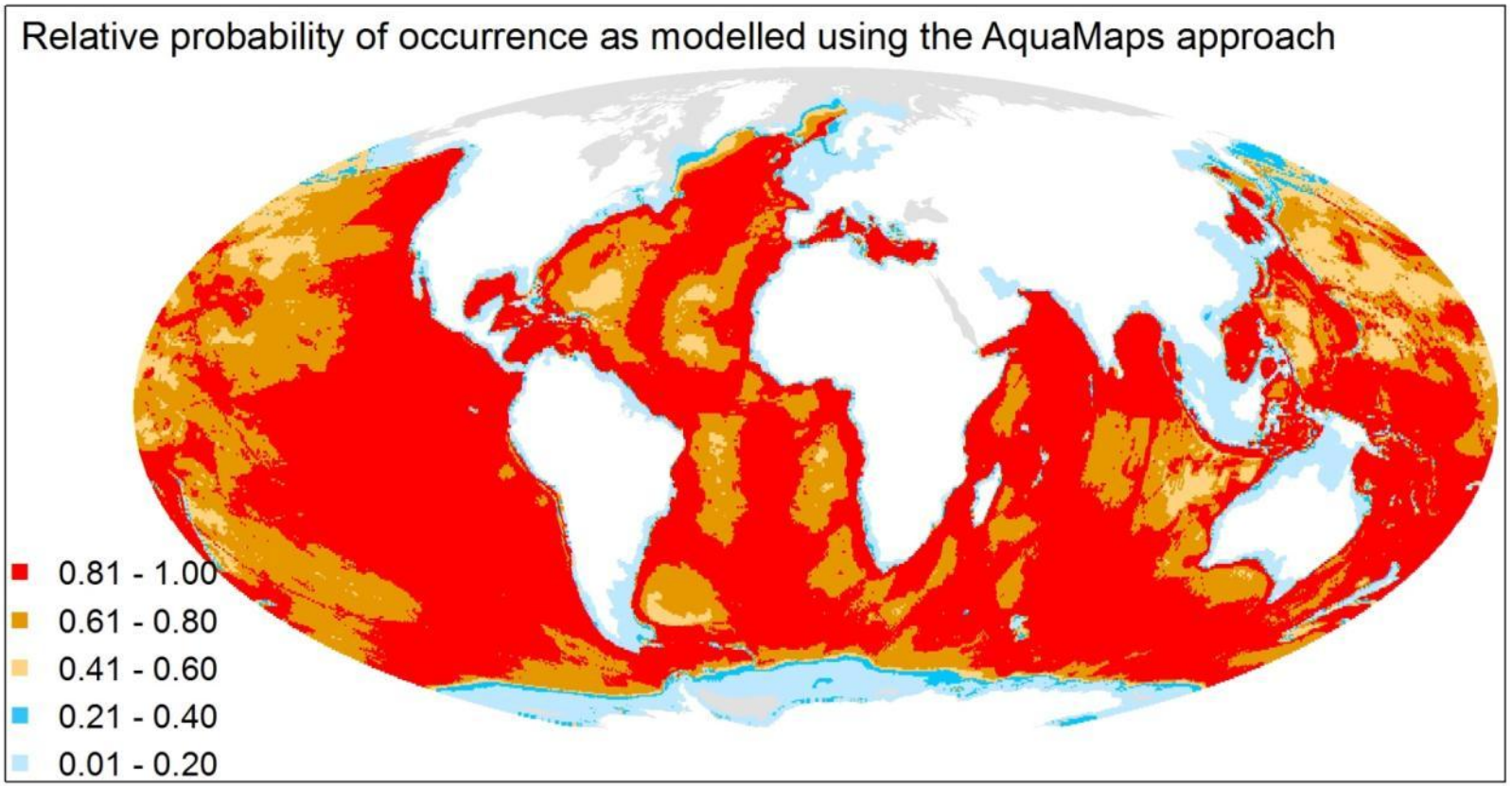
Past
Present
Future



UNEP WCMC

Sperm whale *Sep – Nov*

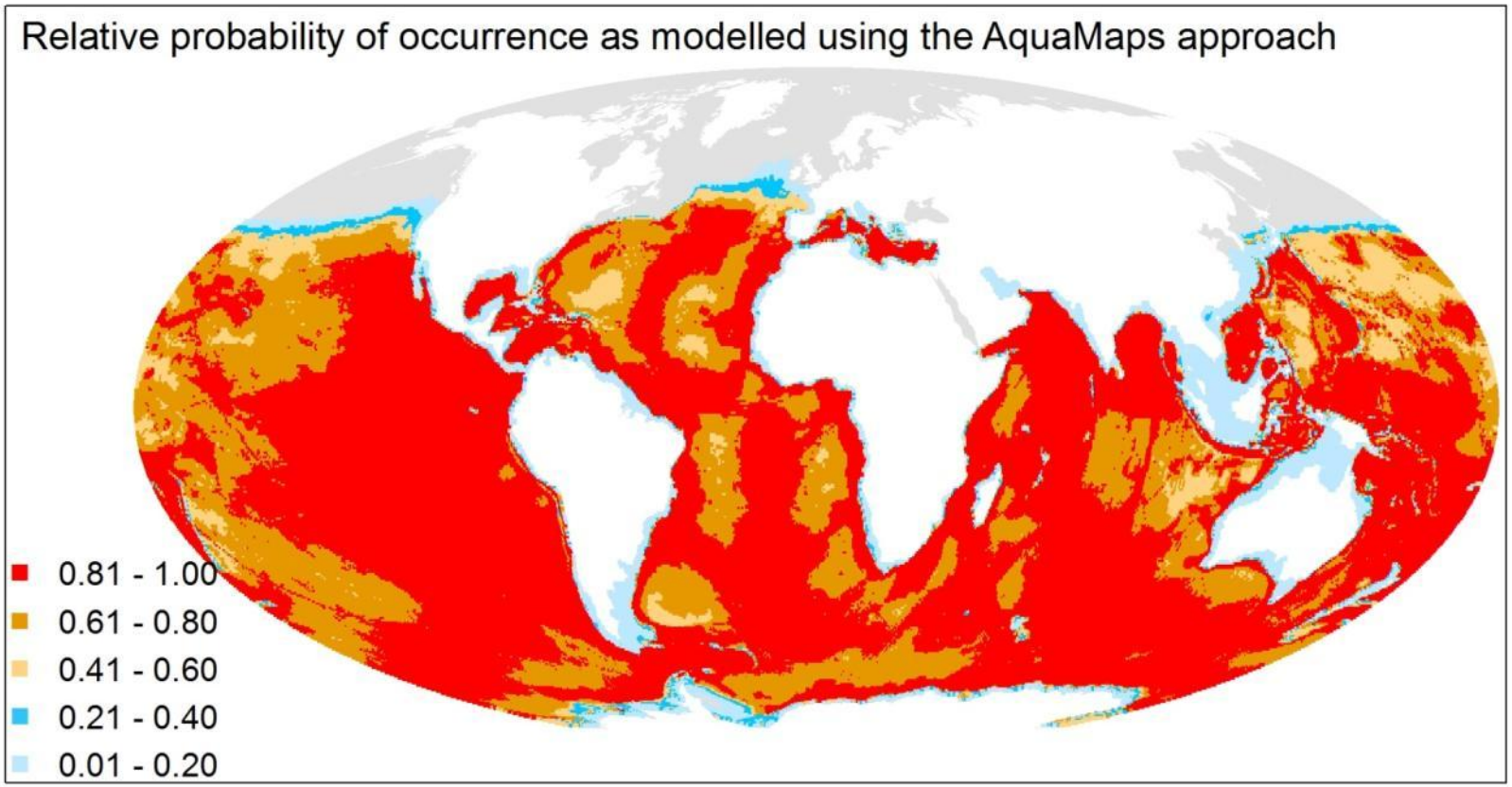
Past
Present
Future



UNEP WCMC

Sperm whale *Dec - Feb*

Past
Present
Future



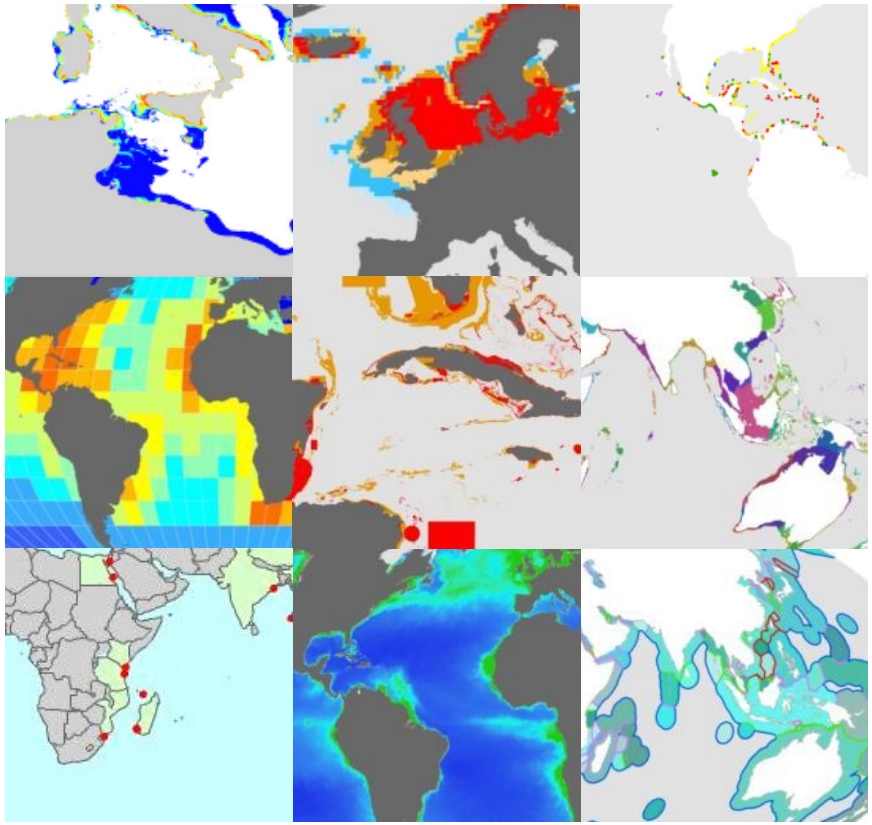
UNEP WCMC

Past
Present
Future

Marine Data Manual
Overview of 78 datasets

Nine Categories

- Biogenic habitat
- Species distribution
- Species habitat
- Biodiversity metric
- Area of biodiversity importance
- Biogeographic classification
- Ecological status and impact
- Environment descriptor
- Administration



UNEP WCMC

Past
Present
Future

Ocean Data Viewer

http://data.unep-wcmc.org/

Nine Categories

- Biogenic habitat
- Species distribution
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UNEP WCMC

Past
Present
Future

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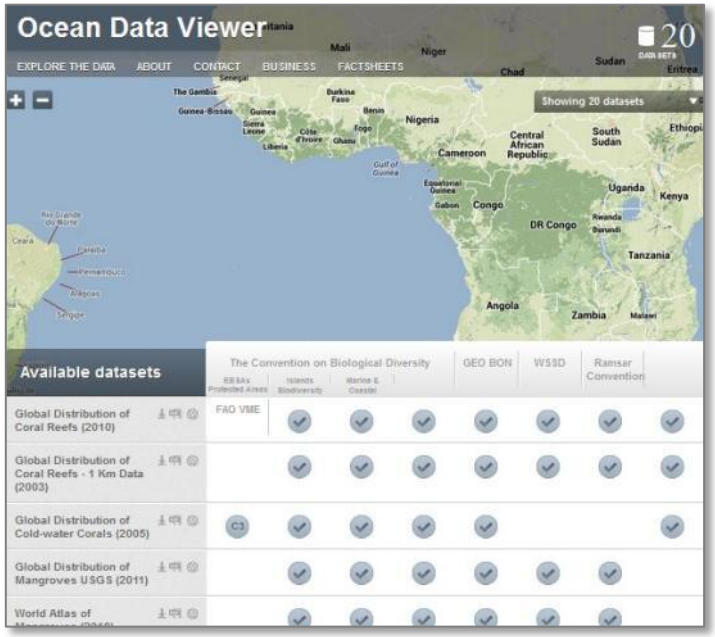

Ocean Data Viewer

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Past
Present
Future

Nine Categories

- Biogenic habitat
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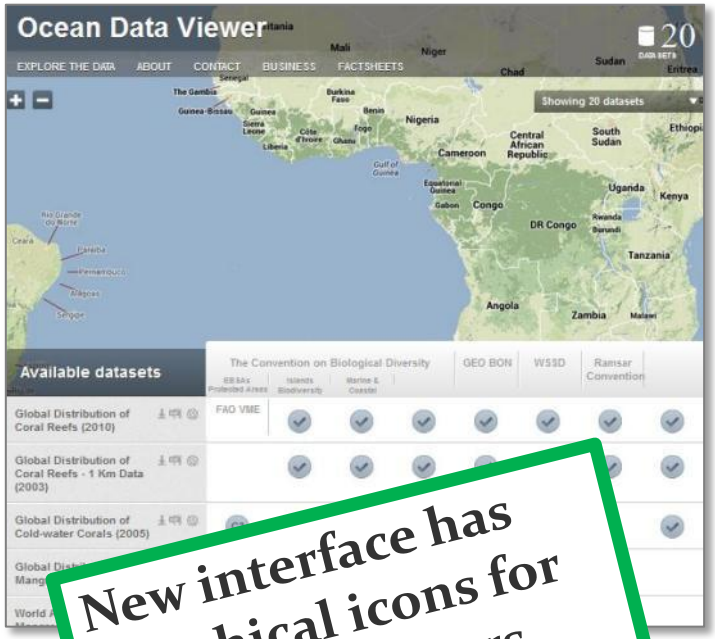
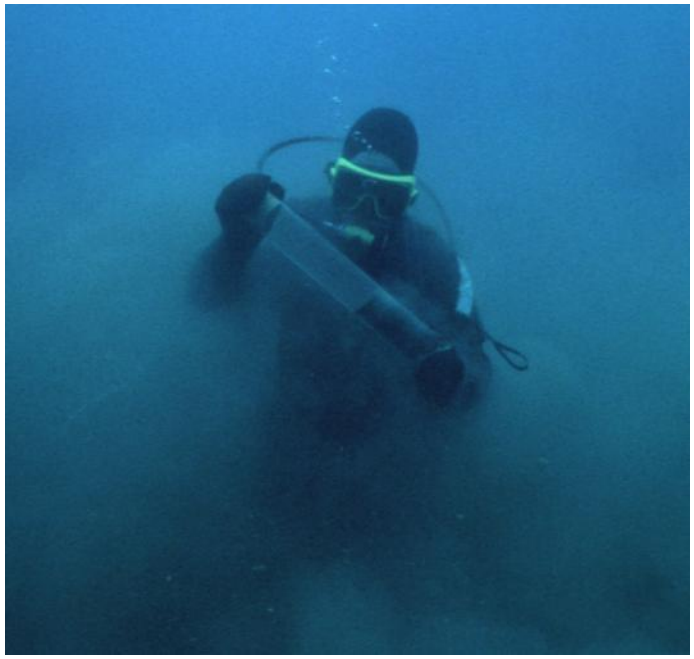


UNEP WCMC

2D sea bed – benthic biodiversity

Past
Present
Future

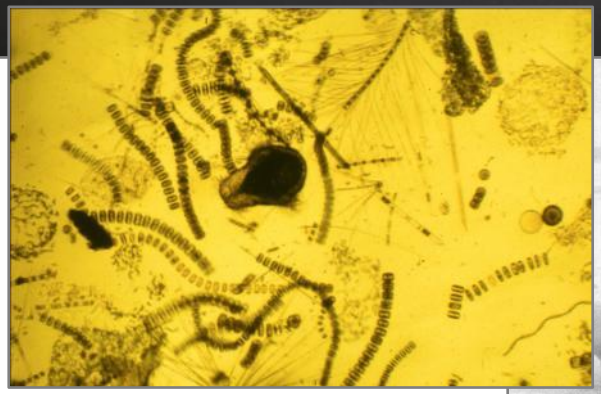


UNEP WCMC

2D sea bed – benthic biodiversity

3D volume – pelagic biodiversity

Past
Present
Future



UNEP WCMC

Past
Present
Future

UNEP-WCMC marine work 2014-2016

- **Improving priority global marine biodiversity-relevant data**
- **Spatial planning in ABNJ**
- **Marine ecosystem service assessment, mapping, valuation**
- **Decision support tool development**

UNEP WCMC

Past
Present
Future

UNEP-WCMC marine work 2014-2016

- **Improving priority global marine biodiversity-relevant data**
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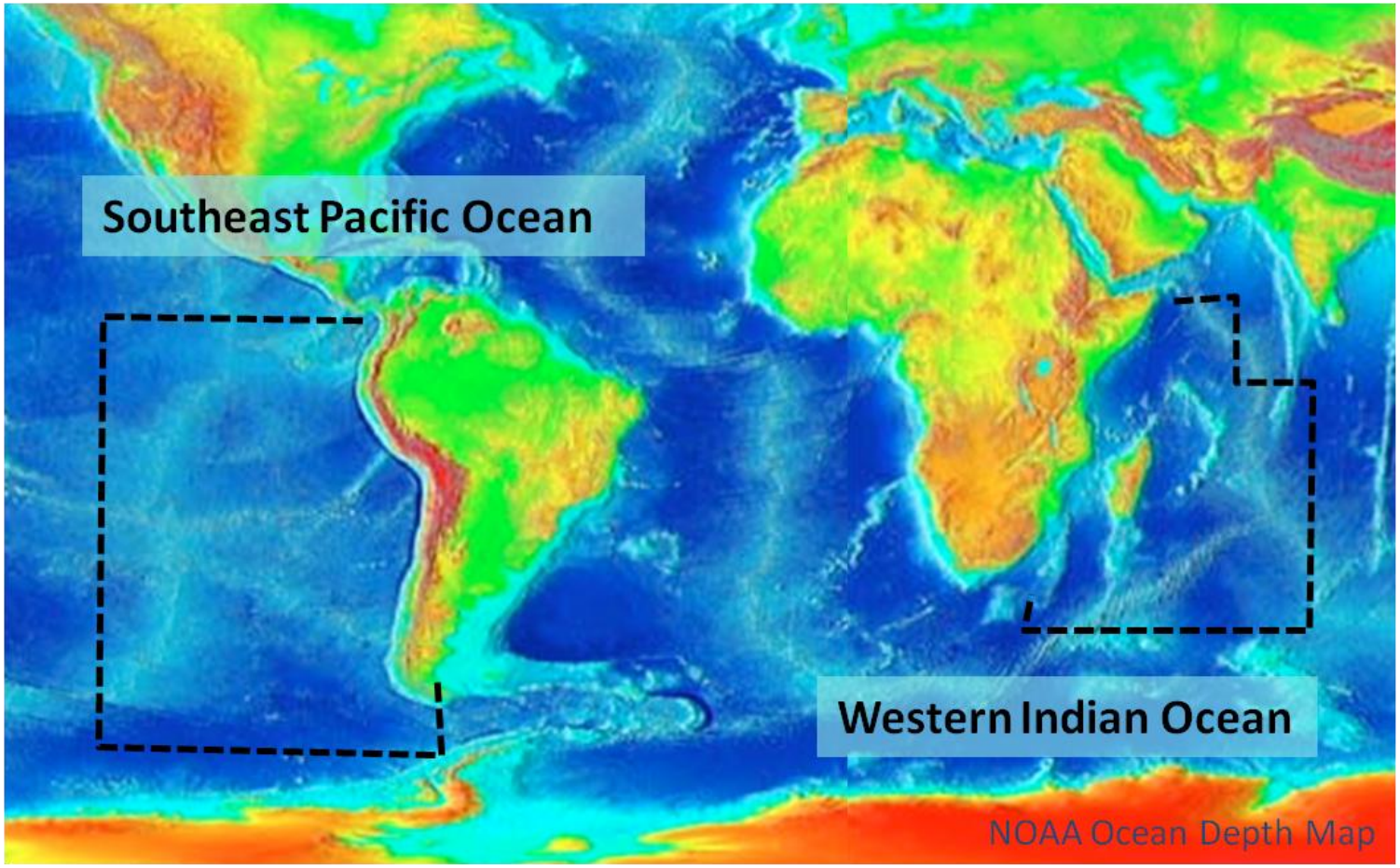
UNEP WCMC

UNEP-WCMC ABNJ area based planning project

Past
Present
Future

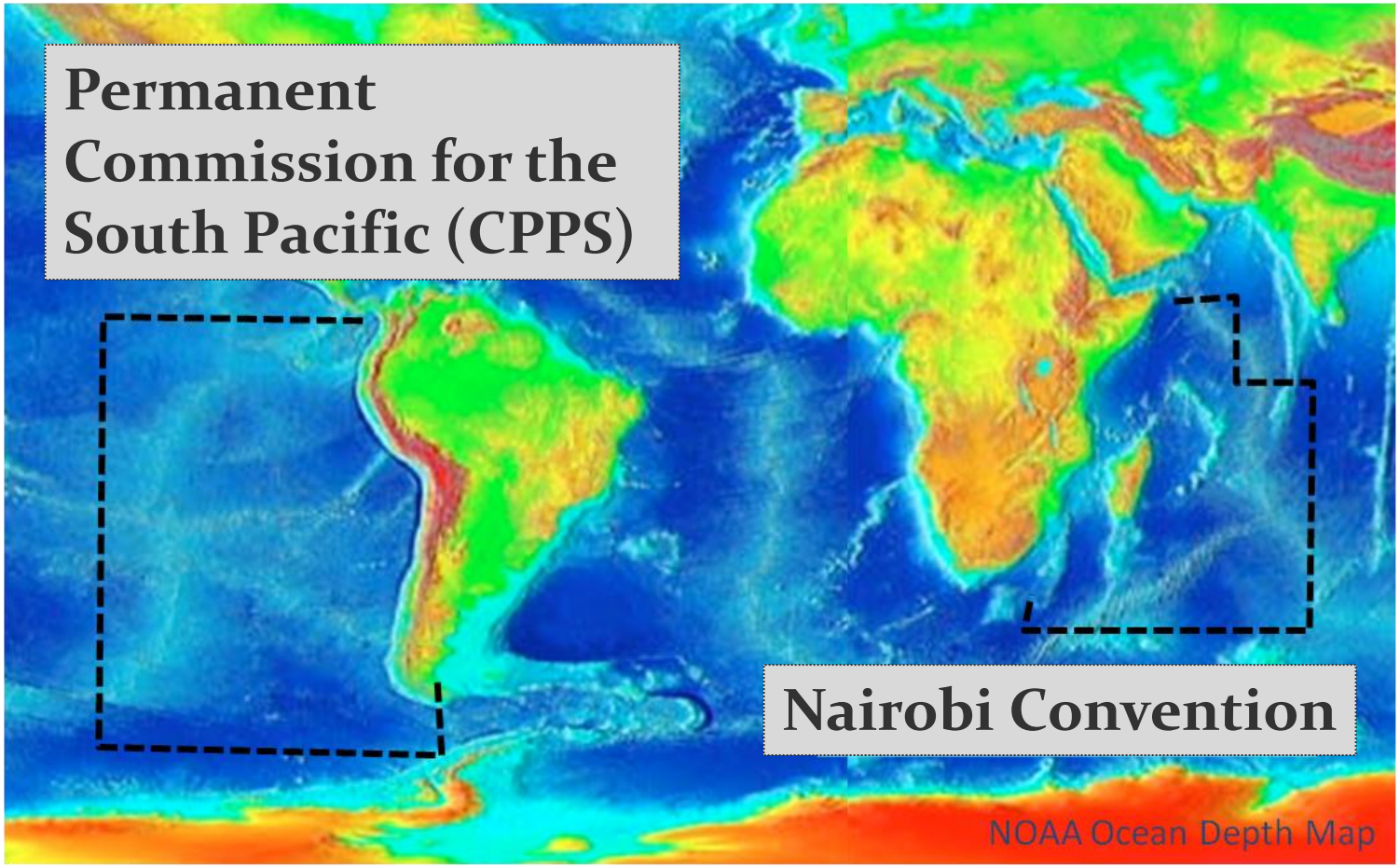


UNEP WCMC

UNEP-WCMC ABNJ area based planning project

Past
Present
Future

GEF (World Bank) funded, 5 years 2014-2018



UNEP WCMC

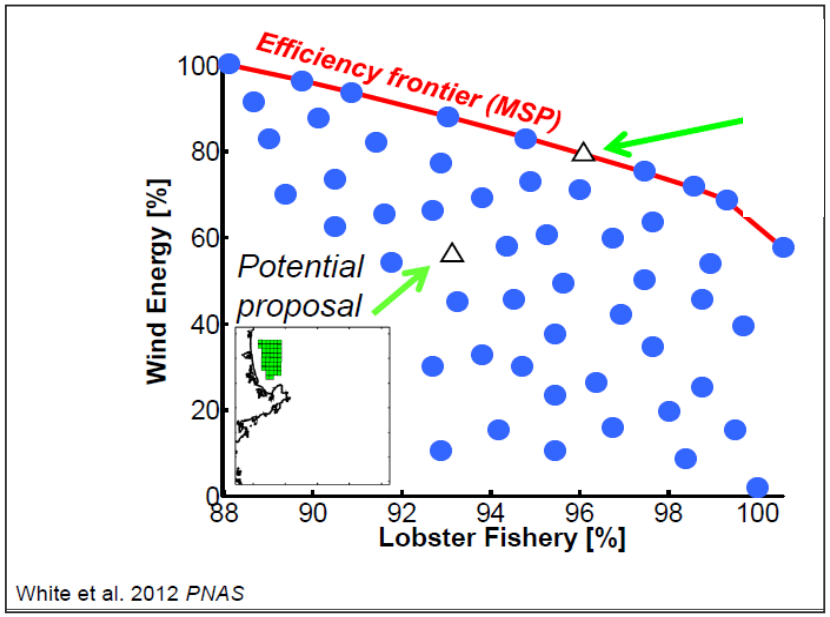
UNEP-WCMC ABNJ area based planning project

1. ***Explore how area-based planning tools can be adapted to ABNJ***

Past
Present
Future

MPA network planning

Analysing trade-offs



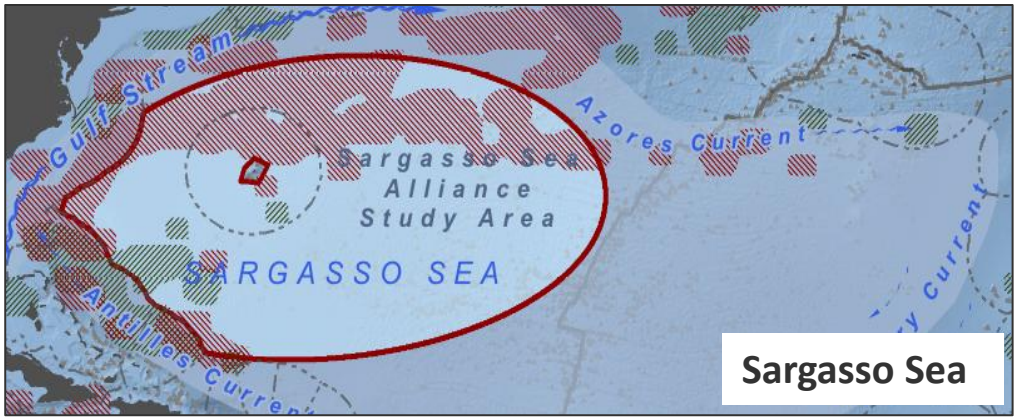
Valuing ecosystem services

UNEP WCMC

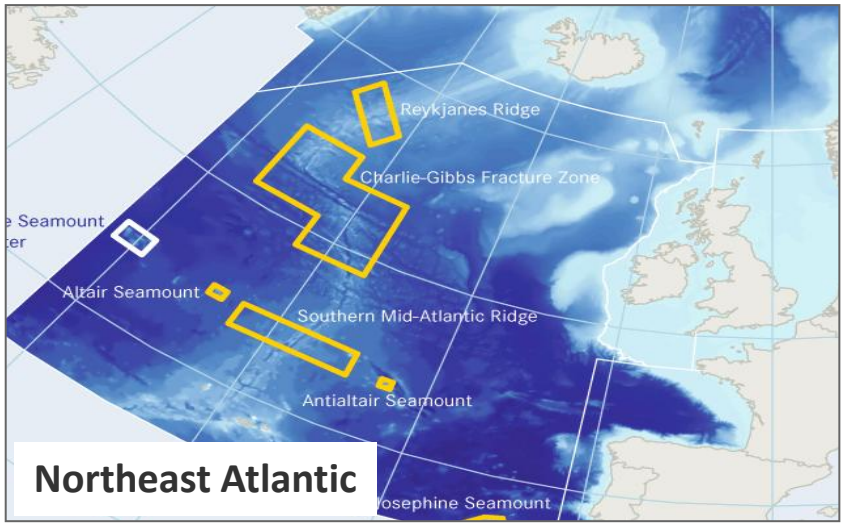
UNEP-WCMC ABNJ area based planning project

Past
Present
Future

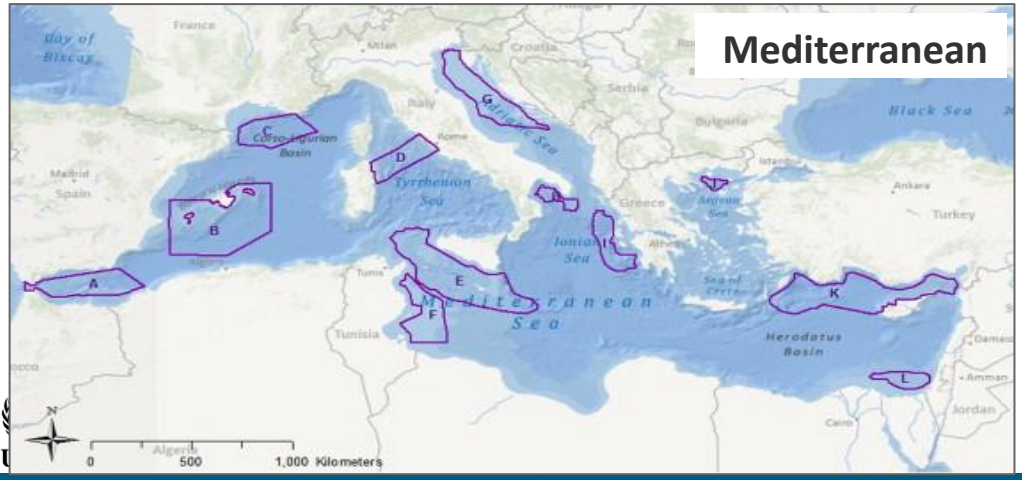
2. ***Share the challenges and successes of existing ABP experiences in ABNJ***



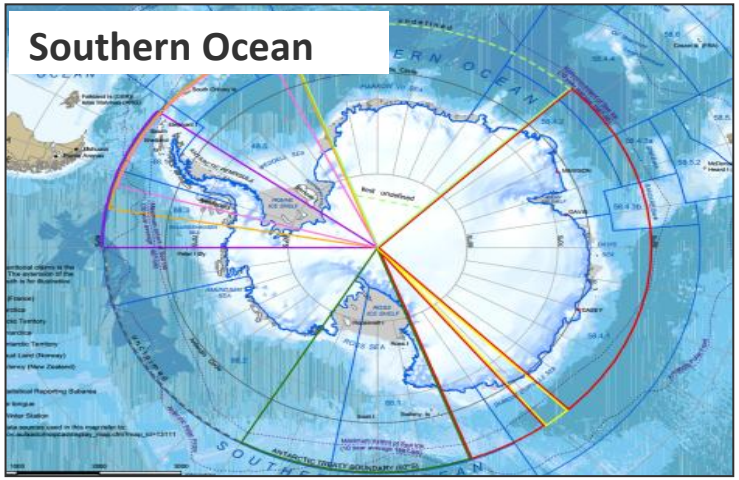
Sargasso Sea



Northeast Atlantic



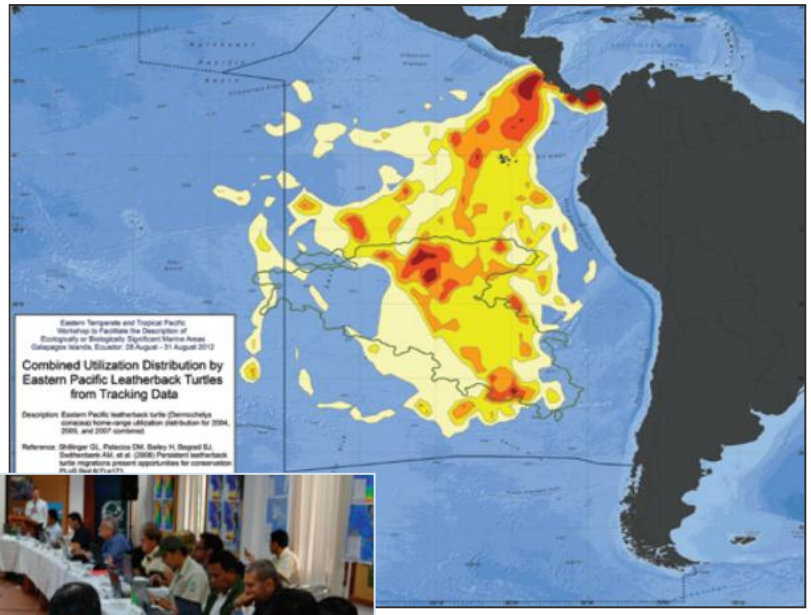
Mediterranean



UNEP-WCMC ABNJ area based planning project

Past
Present
Future

3. ***Test area-based planning tools in multi-sectoral planning processes***



Past
Present
Future

Working with you…

Proteus Partners Annual Meeting 2014

Hosted by BP at Jesus College, Cambridge 13th-14th May

The value of conservation modelling

Lucas Joppa
Head of Conservation Science Research Unit, Microsoft Research

UNEP WCMC

proteus

Microsoft Research

The Value of Conservation Modelling

Lucas Joppa
Computational Ecology and Environmental Science Group

Environmental Data to Decisions

Microsoft Translator | Choose language

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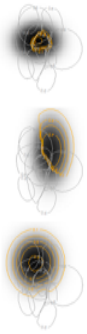
Computational Ecology and Environmental Science

Predictive Models || Why Microsoft? || Real Ecologists || The Science || The Software



Predictive Models of Ecological Systems

The Computational Ecology and Environmental Science Group (CEES) develop, for ecological systems, the kind of useful predictive models we take for granted in other areas, such as physical engineering. To develop such models, we find that we need to invent a variety of new concepts, algorithms, and methods – which we then package into re-useable software tools. In this way, we can help Microsoft to substantially improve environmental management. [read more here]

Why Microsoft?

Individuals, governments and businesses are showing an unprecedented level of concern for environmental issues, and for good reason – humanity is facing some serious global environmental challenges, including climate change, food security, and the possibility of pandemics. Solving these challenges requires new kinds of science enabled by new kinds of scientific software. And the world's largest

--- More about CEES ---
Projects
Software tools
Publications

--- See also ---
Computational Science Lab
Biological Computation Group
Research Connections E3
Microsoft Research Cambridge

CEES People (MS internal)


Drew Purves


Matthew Smith


Lucas Joppa


Vassily Lyutsarev


Piero Visconti

Science

Policy

Tools & Technology

Microsoft Research, UNEP-WCMC, and IUCN

IUCN Red List Partnership

IUCN

SSC
Species Survival Commission

BirdLife INTERNATIONAL
Partnership for nature and people

BGCI
Plants for the Planet

CONSERVATION INTERNATIONAL

NatureServe

Kew
ROYAL BOTANIC GARDENS

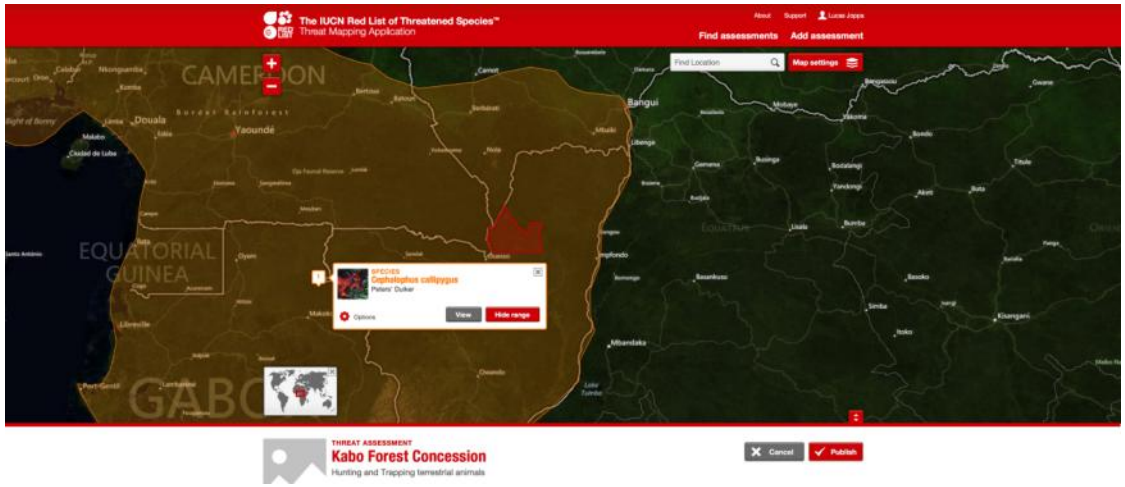
TEXAS A&M UNIVERSITY
Texas A&M University

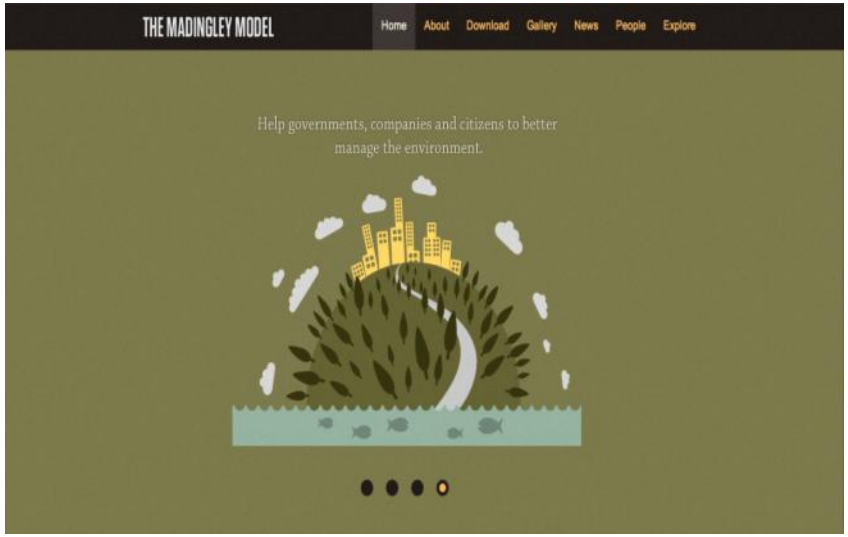
ZSL
LIVING CONSERVATION

SAPIENZA
UNIVERSITÀ DI ROMA

WILDSCREEN
PROMOTING CONSERVATION THROUGH WILDLIFE IMAGERY

Microsoft





WDPA

Microsoft Research

The Value of Conservation Modelling

"All models are wrong but some are useful."
George E.P. Box

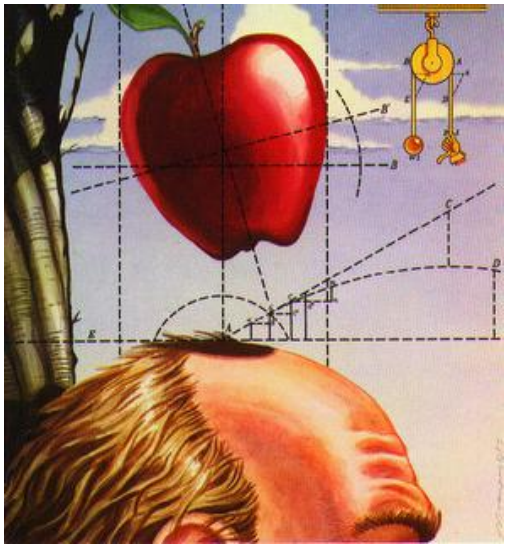
Just How Valuable Can a Model Be?

We do this every day…

Driving cars, flying in planes…

Which usually works out ok

Chris Bishop didn't die because…



Data

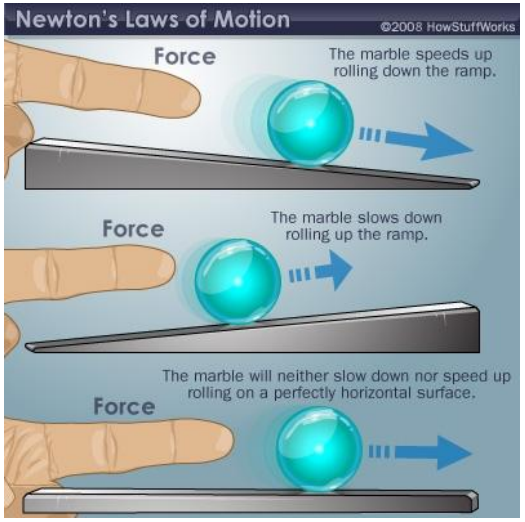
+

Theory

+

Experiments

=



Near predictive certainty

Models Allow ACTIONABLE Predictions…

But we also do this every day

Deforestation, ocean acidification, CO2 emissions, species extinctions

And that probably isn't a good idea…

+ Climate change | + Habitat destruction | +Climate change + Habitat destruction | Control | Replicates

We need models to….

help us UNDERSTAND the fundamentals of a system and to make ACTIONABLE predictions

What is a model?

$$J_{pe}^{*} = J_{p}^{*}\left(-\frac{\omega_0}{2}\right) = qC_pD_p\left\{\frac{q}{kT}p_E V_e \coth C_p\omega_0 - \frac{p_C q}{kT}V_c \operatorname{csch} C_p\omega_0 + \frac{\omega_1}{L_p}\left(\operatorname{csch} C_p\omega_0\right)\left[\left(p_E - p_n\right)\operatorname{csch}\frac{\omega_0}{L_p} - \left(p_C - p_n\right)\coth\frac{\omega_0}{L_p}\right]\right\}$$

$$J_{pc}^{*} = J_{p}^{*}\left(+\frac{\omega_0}{2}\right) = qC_pD_p\left\{\frac{q}{kT}p_E V_e \operatorname{csch} C_p\omega_0 - \frac{p_C q}{kT}V_c \coth C_p\omega_0 + \frac{\omega_1}{L_p}\left(\coth C_p\omega_0\right)\left[\left(p_E - p_n\right)\operatorname{csch}\frac{\omega_0}{L_p} - \left(p_C - p_n\right)\coth\frac{\omega_0}{L_p}\right]\right\}$$

A substitute for a real system

-conceptual
-statistical
-mathematical, etc. etc.

Conservation Questions (in brief and at random!)…

How many species are there?

How fast are they going extinct?

What are the implications of species invasions?

Where do animals live?

How and why do animals move?

How many individuals of a species is 'enough'?

How will species respond to changing environments?

Do protected areas work?

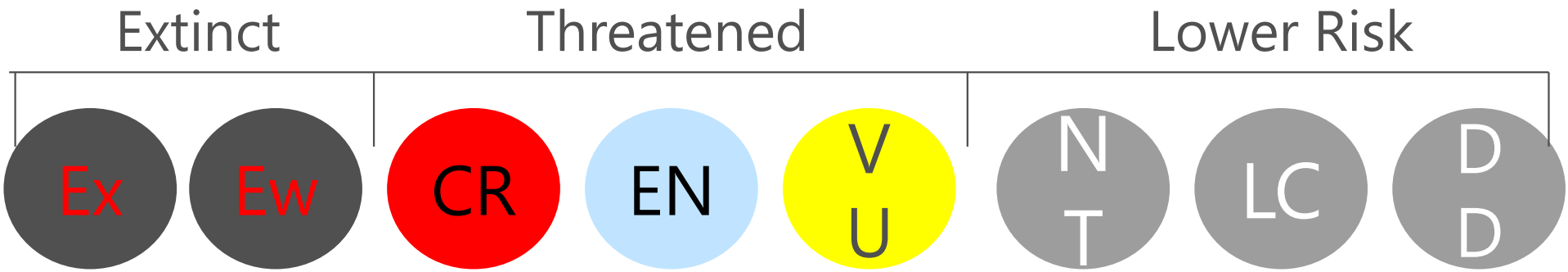
Where should we put protected areas?

What are the knock-on effects of deforestation?

How do individuals interact between and within species?

Let's get specific: IUCN Red List

- Global standard, comprehensive, objective approach for evaluating the conservation status of plant and animal species.
- To become Critically Endangered, Endangered, or Vulnerable?
  - Criterion A: High decline rate
  - Criterion B: Small range area and decline
  - Criterion C: Small population size and decline
  - Criterion D: Very small population size
  - Criterion E: Unfavourable quantitative analysis



And even more specific: Criterion B

Geographical range is very restricted and when other factors suggest that it is at risk.

Range Measure 1: Extent Of Occurrence (EOO)

-Extent of occurrence is defined as the area contained within the shortest continuous boundary that can be drawn to encompass all the known, inferred, or projected sites of occurrence of a species. Risk of extinction is associated with range area itself.

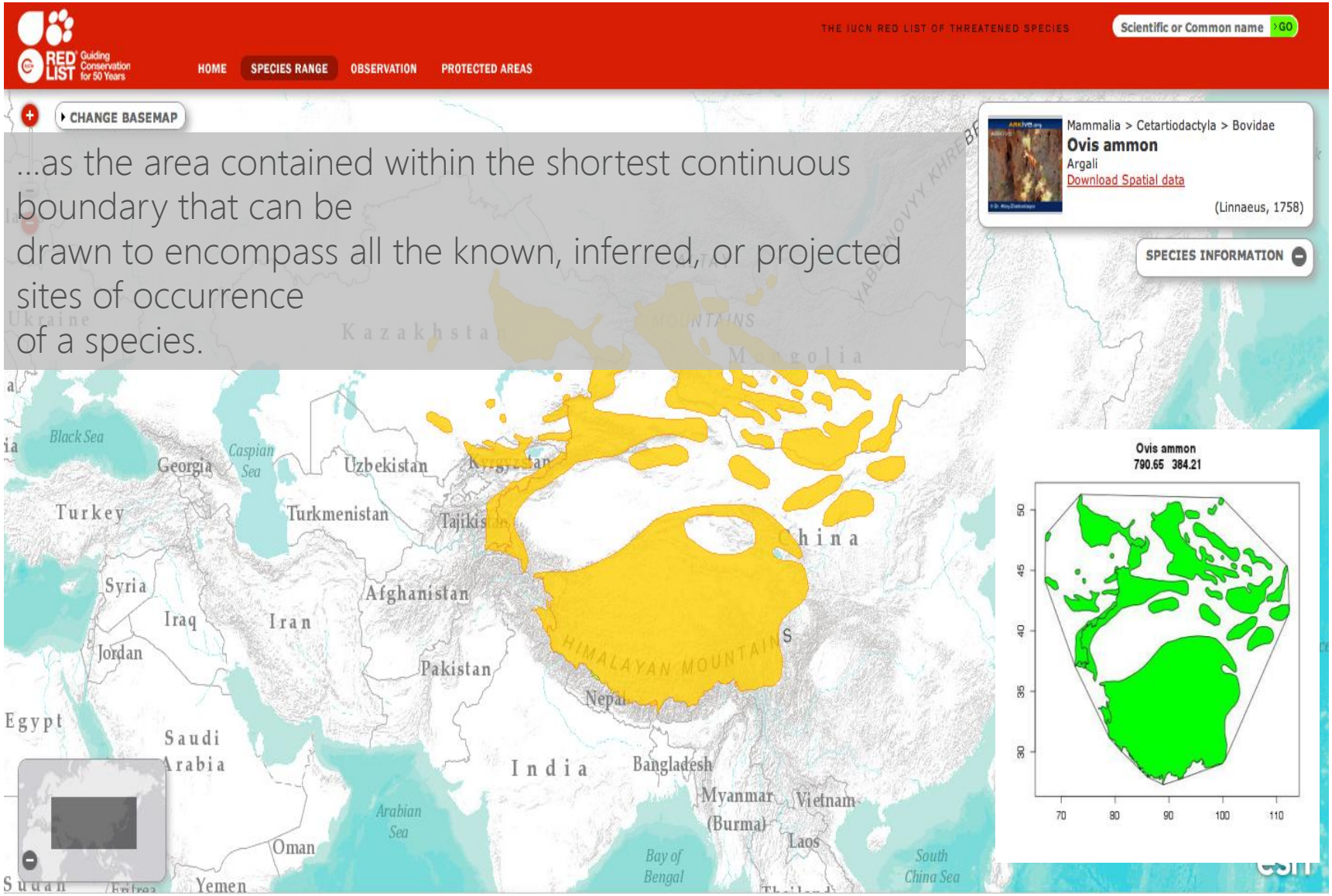
-Critically Endangered = 100km2
-Endangered = 5,000km2
-Vulnerable = 20,000km2.

A species must also exhibit at least 2 other symptoms of risk.

-Some evidence the population is or is projected to be in continuing decline

-Severely fragmented
-Limited to a few locations
-Subject to extreme fluctuations

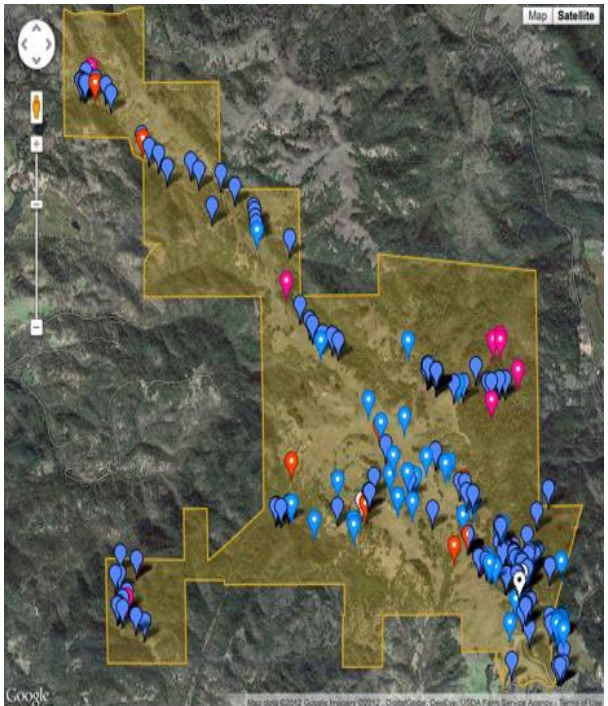
Making the map…



The problem is…

How do we know where species occur?
Previously: Data (Observations); Expert Opinion
Recently: Models

So, can models help us understand where species oc
and assist in Red Listing for Criterion B?

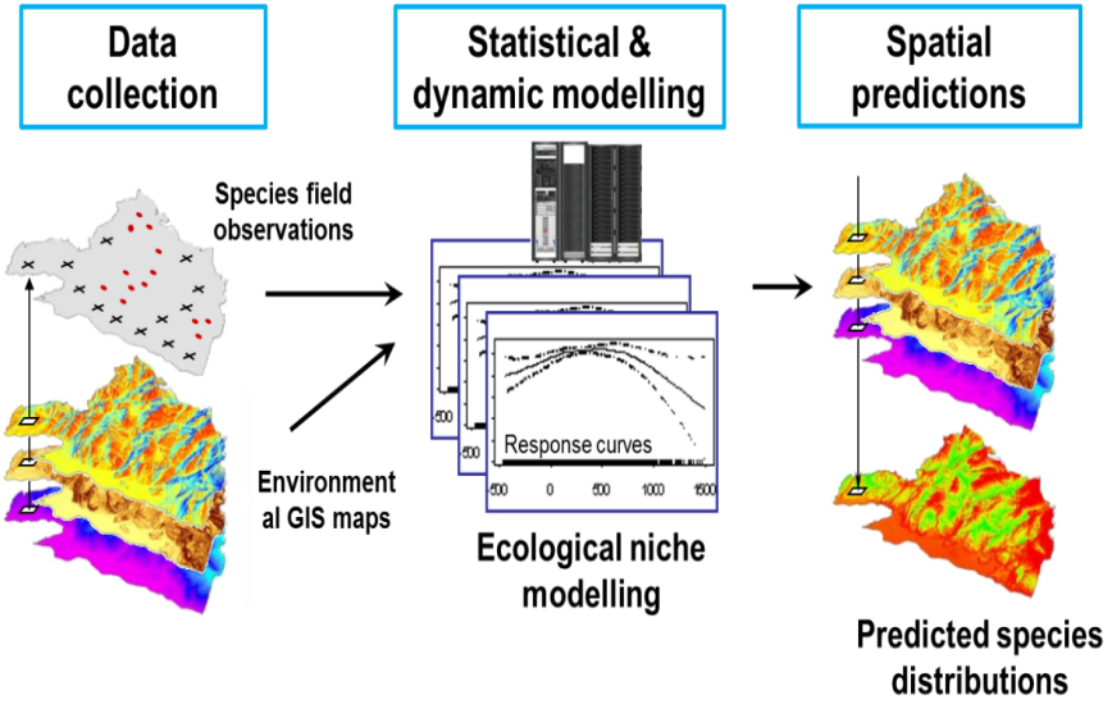


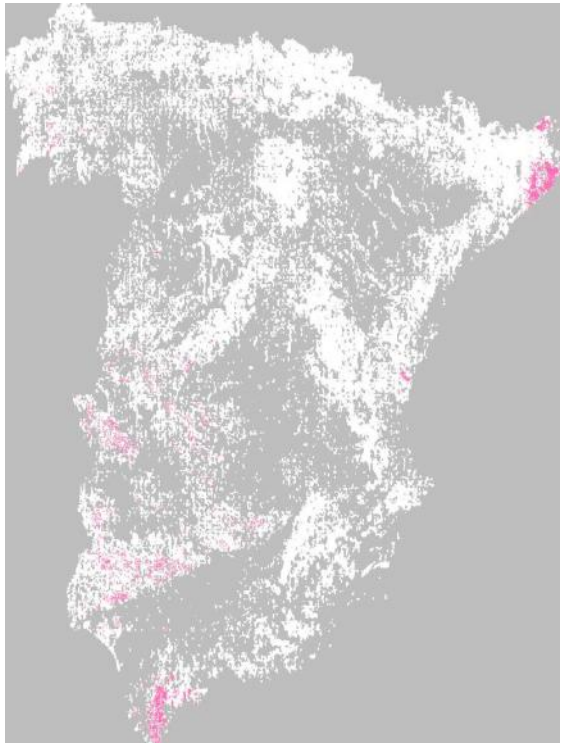
BioBlitz

iNaturalist

A solution?

Species Distribution Modeling: “Models that predict species' potential distributions by combining known occurrence records with environmental variables have much potential for application in studies of ecology, evolution and conservation.”

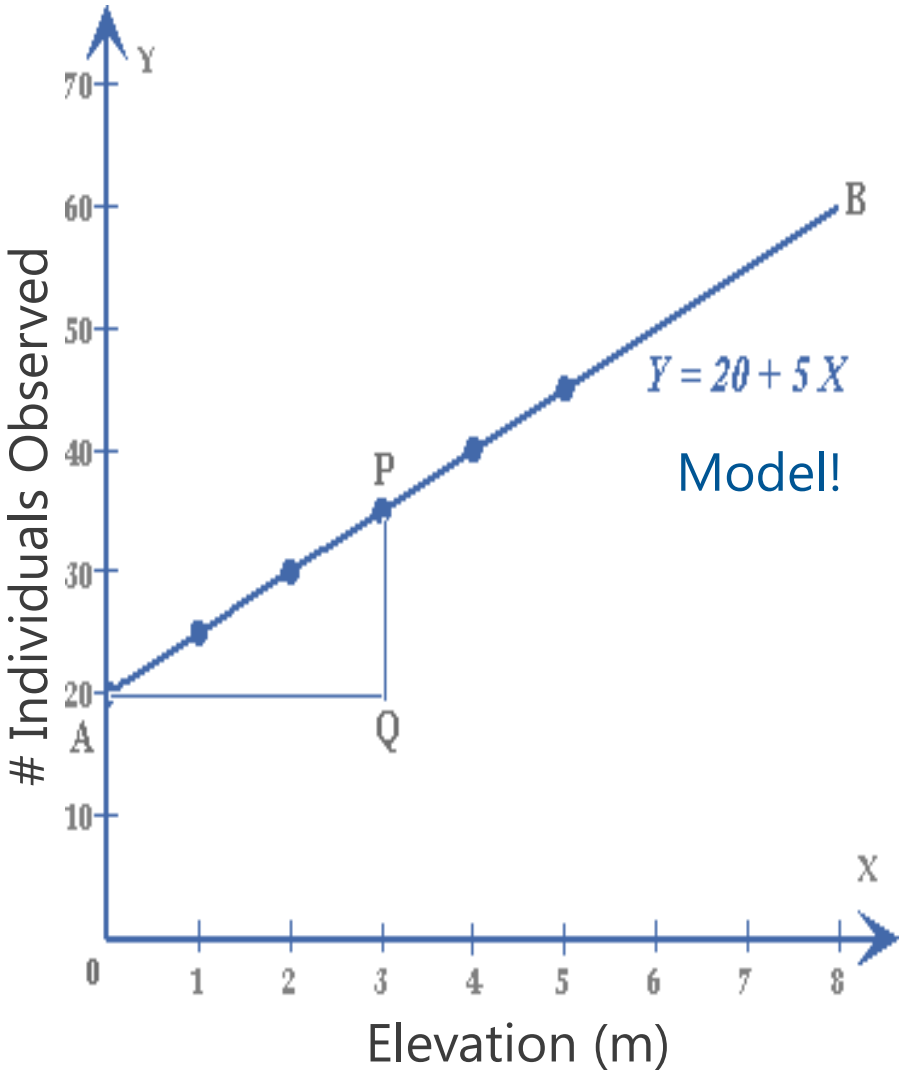




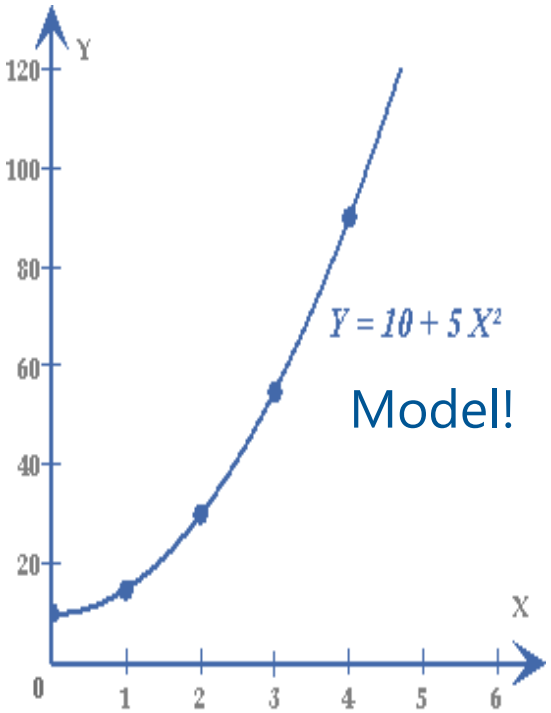
Let's build a model!

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon$$

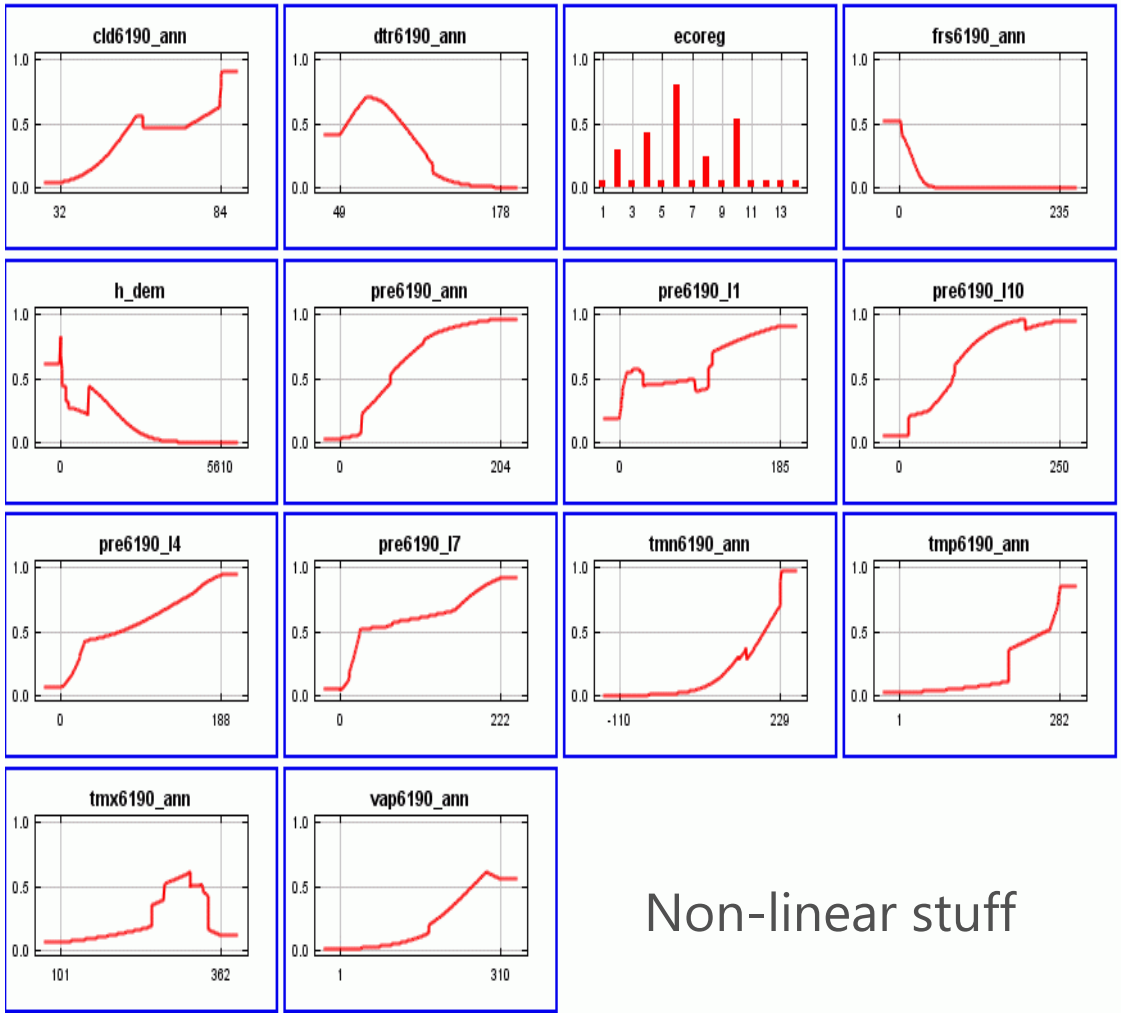
Where X1 = Elevation (m)
Where X2 = Annual Precipitation
Where X3 = Distance to roads (m)



OR



Let's not pay attention to this…



Non-linear stuff

Likelihood stuff

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon$$

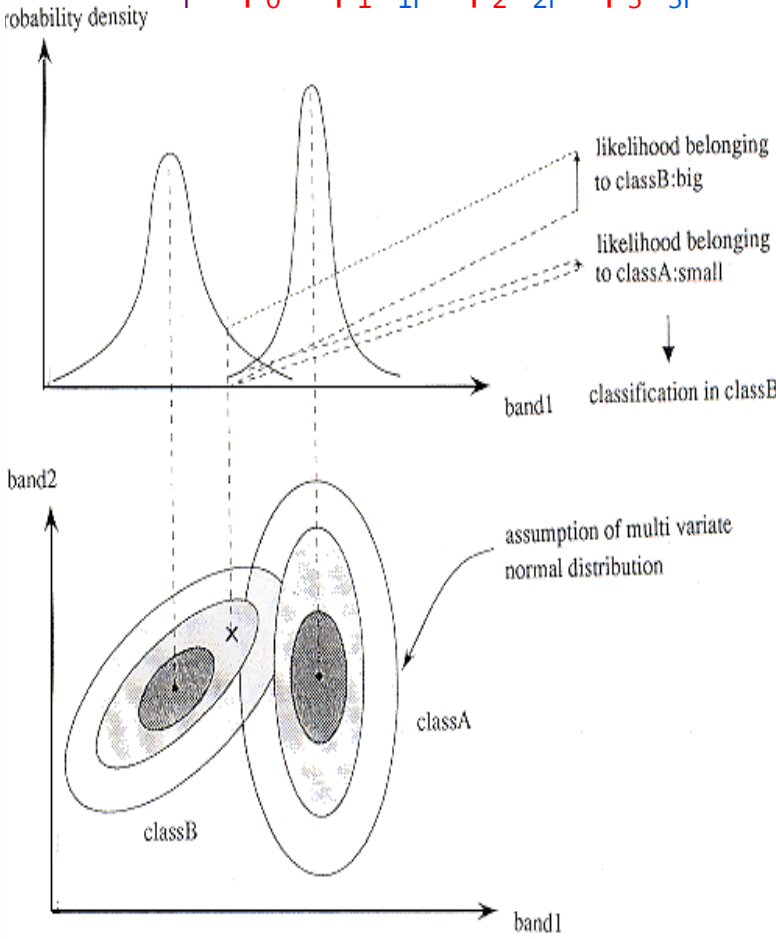


Figure 11.7.1 Concept of Maximum Likelihood Method

We confront model with data

Species	Location	Covariates	Obs	Prob
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	1	0.98
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	1	0.76
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	0	0.05
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	1	0.94
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	0	0.56
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	0	0.45
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	1	0.32
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	1	0.84
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	1	0.91
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	0	0.32
Panthera leo	Lat,Long	X_{1i}; X_{2i};…	1	0.86

And find the 'best' model to explain the data

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon$$

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_4 X_{4i} + \varepsilon$$

$$Y_i = \beta_0 + \beta_1 X^2_{1i} + \beta_2 X^3_{2i} + \beta_3 X^3_{3i} + \varepsilon$$

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_3 X_{3i} + \varepsilon$$

What is best?

-Parsimony

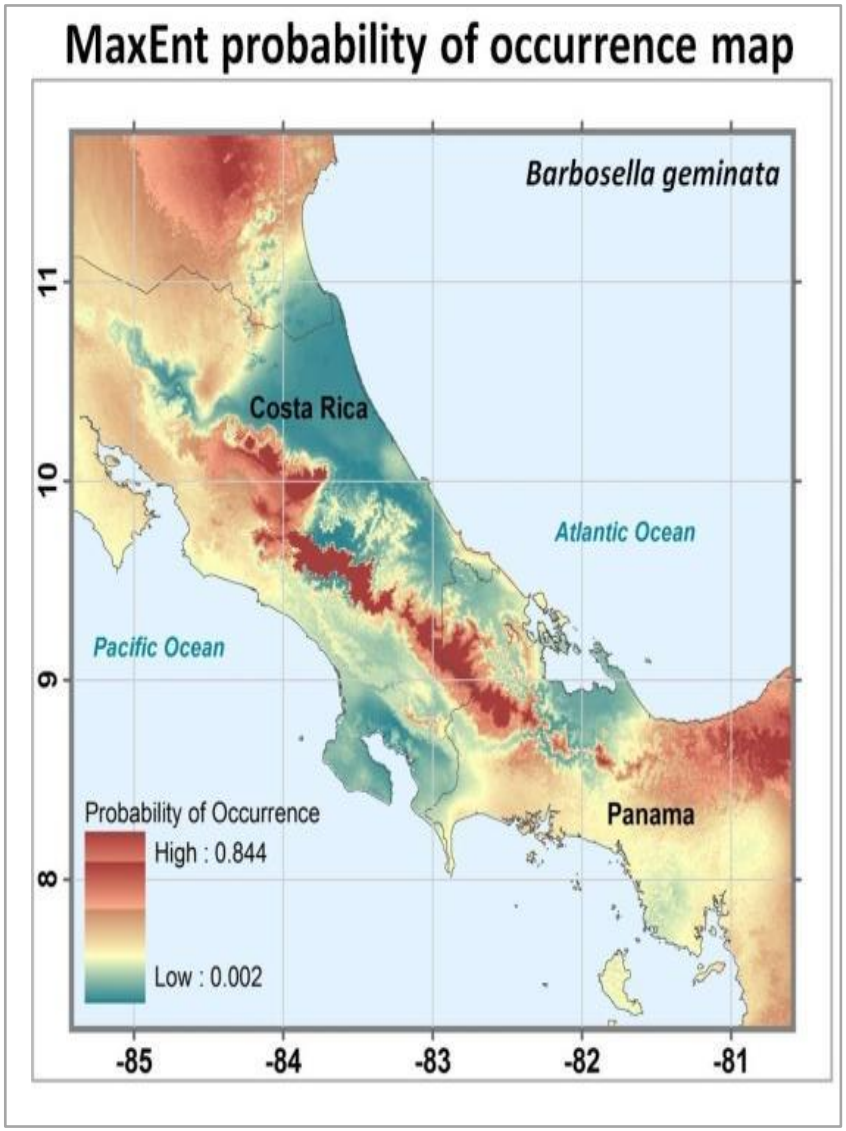
"With four parameters I can fit an elephant, and with five I can make him wiggle his trunk" – John von Neumann

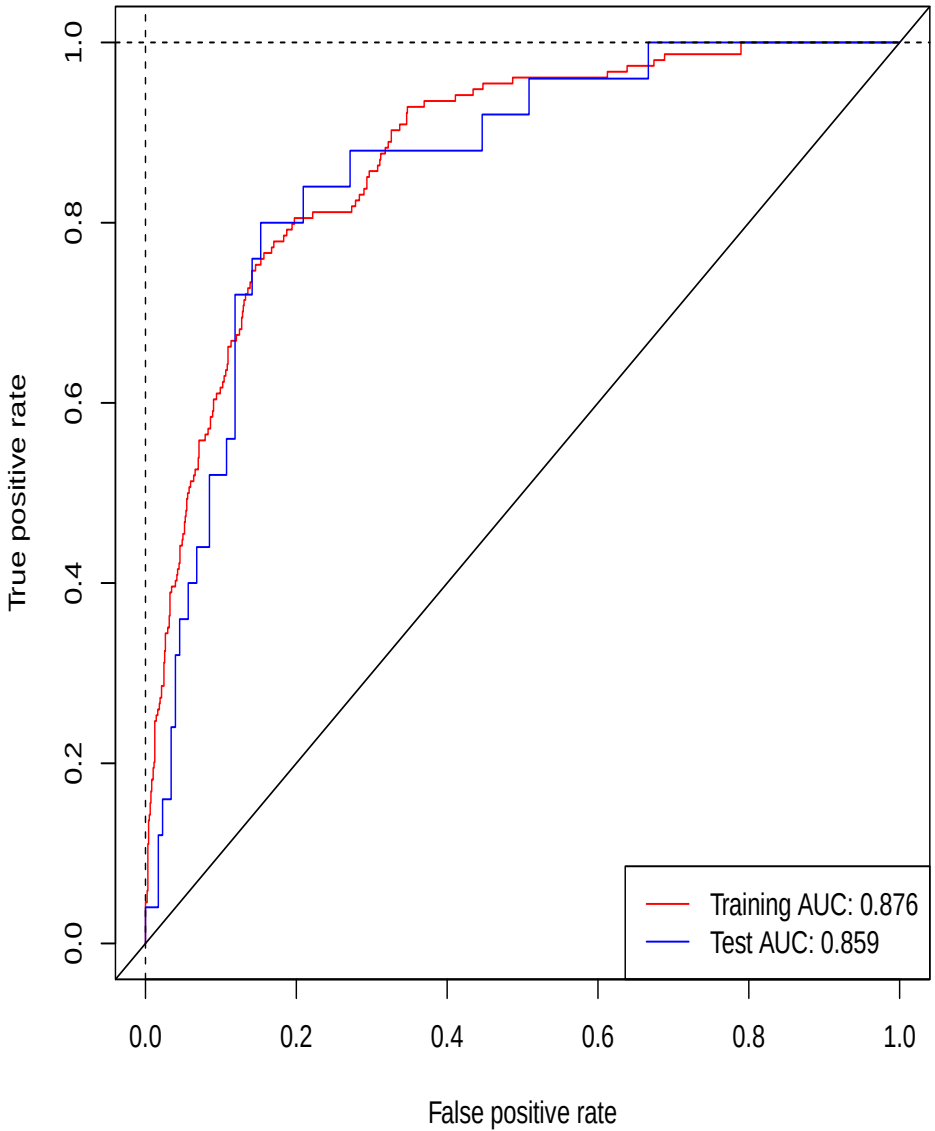
-Accuracy

-Training versus test

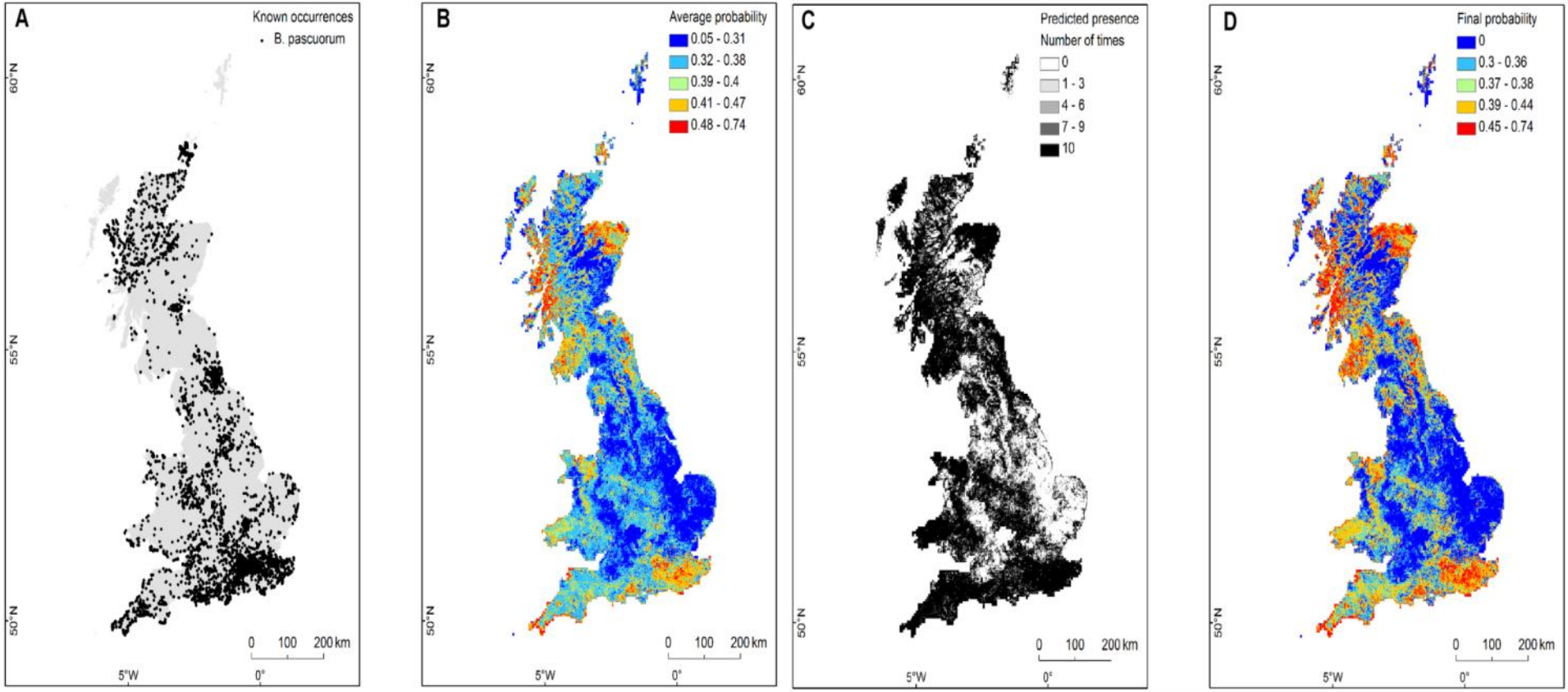
-Whatever you want really…

And assess model performance





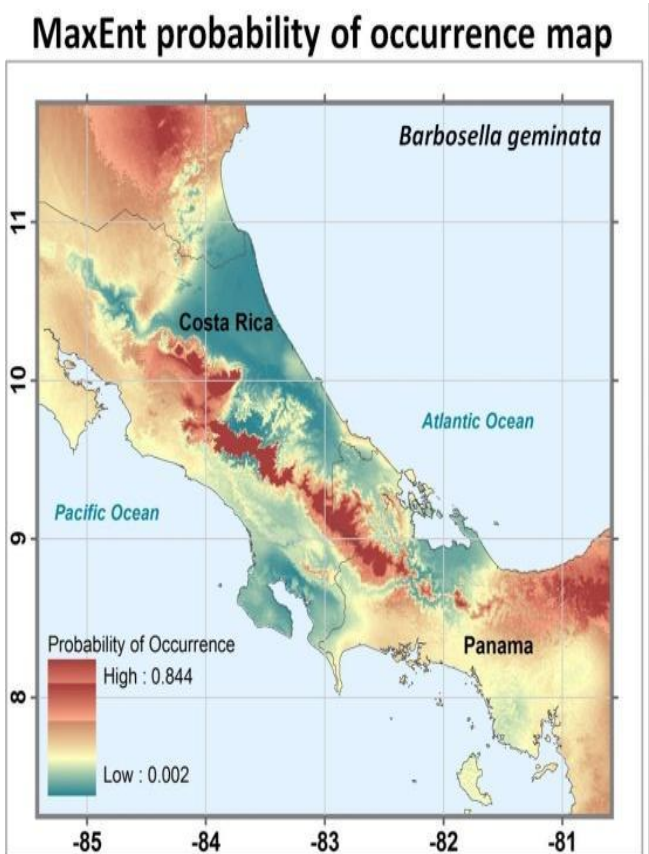
Now what? Choosing a probability threshold



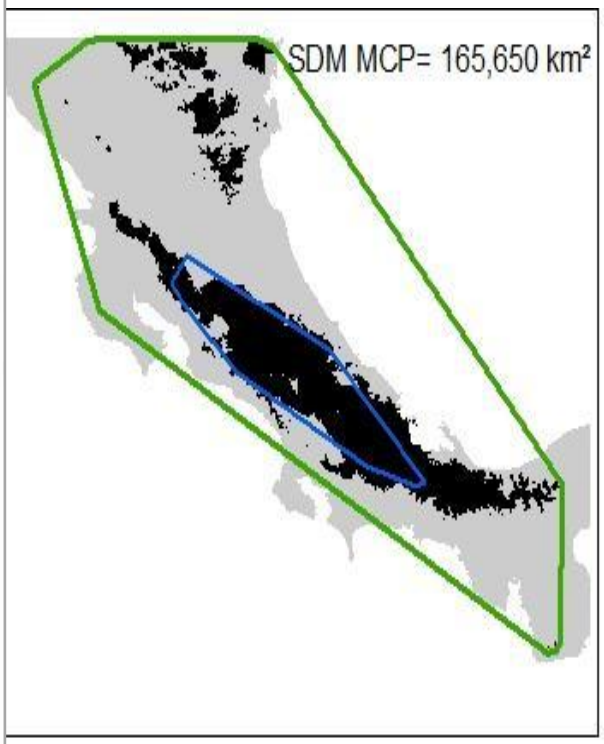
Back to the problem at hand…

Can we use Species Distribution models to confidently predict a species' EOO?

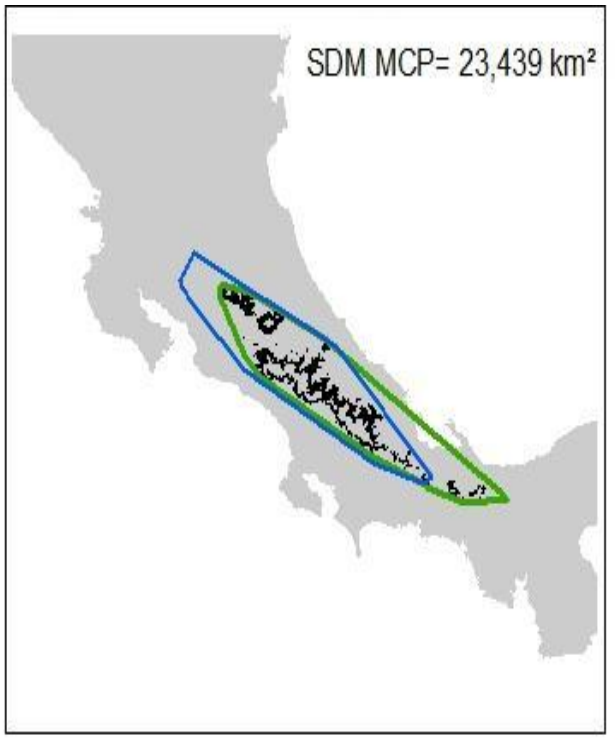
1) Start with known observations of well-sampled species
2) Create model
3) Threshold the model across all probabilities
4) Create the MCP
5) Calculate the EOO
6) Find threshold which best matches Area or Similarity



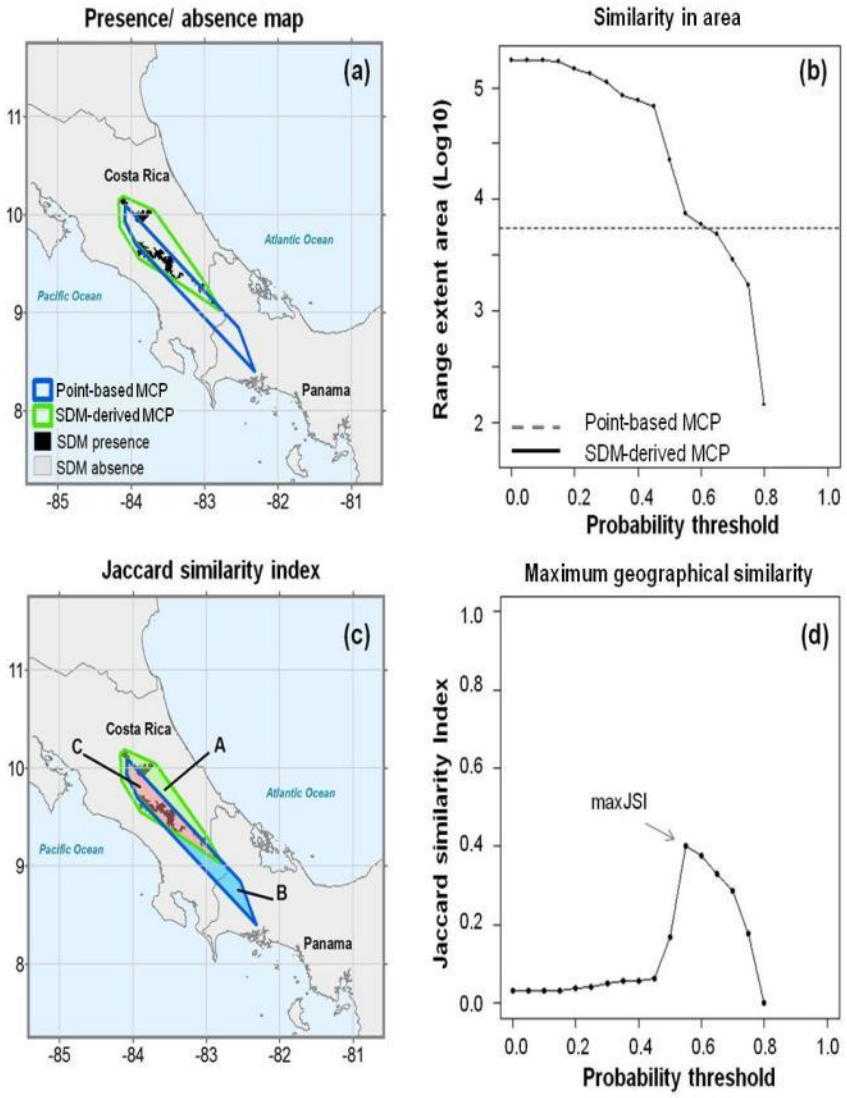
Area Threshold



Similarity Threshold



Choosing a probability threshold



But how do we know if it works?

-Subsample the data…

Does it work?

"The EOOs of the SDM-derived MCPs at the maximum geographical similarity threshold are significantly closer to the EOOs of the full-sample MCPs than the EOOs of the subsample MCPs at all subsample sizes, although the improvement in the estimated EOO is notably larger at sample sizes of 5 and 10"

Does it matter?

"For both of the SRLI species the areas of the SDM-derived MCPs lie within the *Vulnerable* category (5,000 km^2 < EOO < 20,000 km^2), although *C. chiriquiana* was assessed in the *Endangered* category (100 km^2 < EOO < 5,000 km^2). "

And the moral of the story…

Modeling is for Learning!

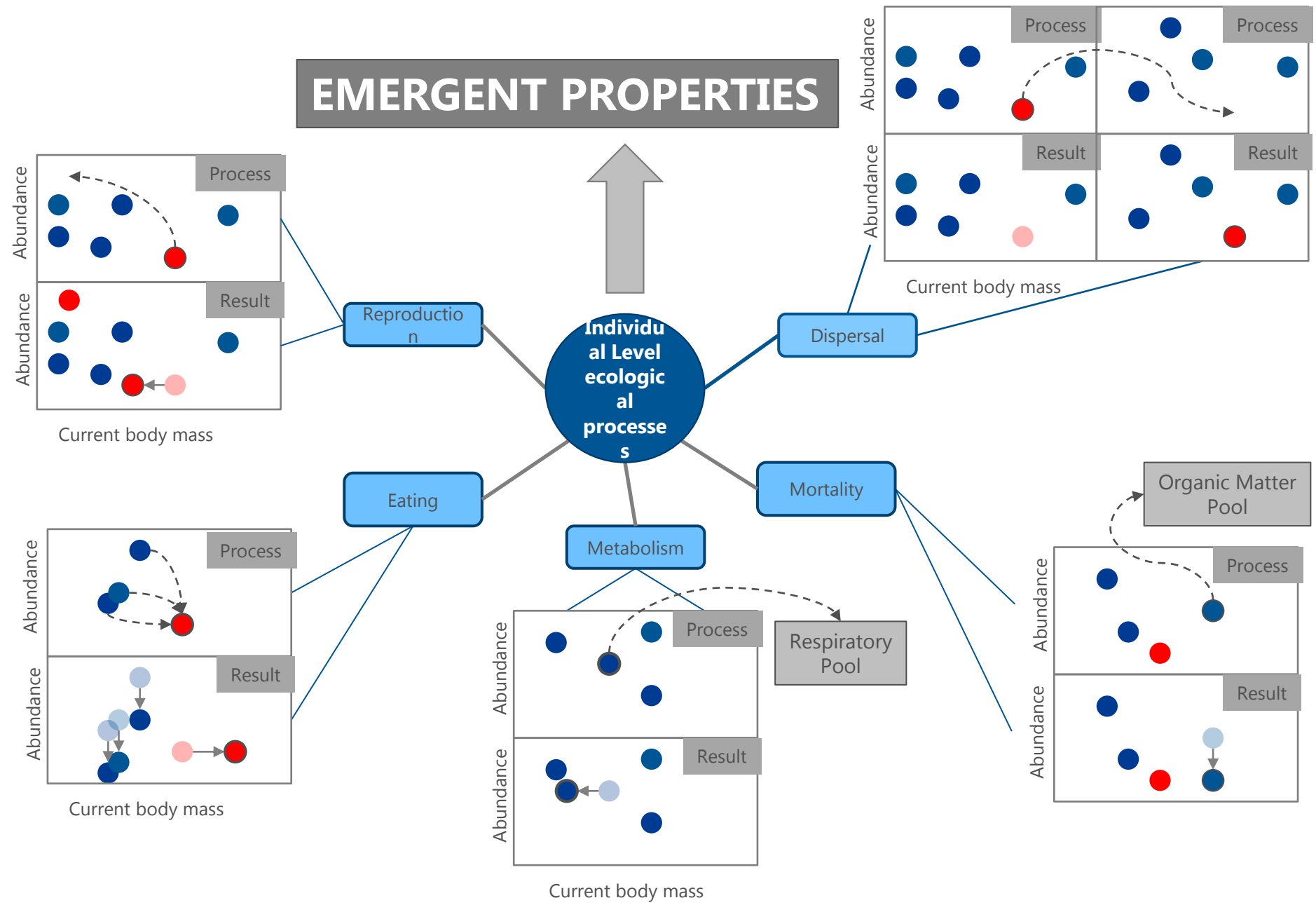
Modeling is iterative!

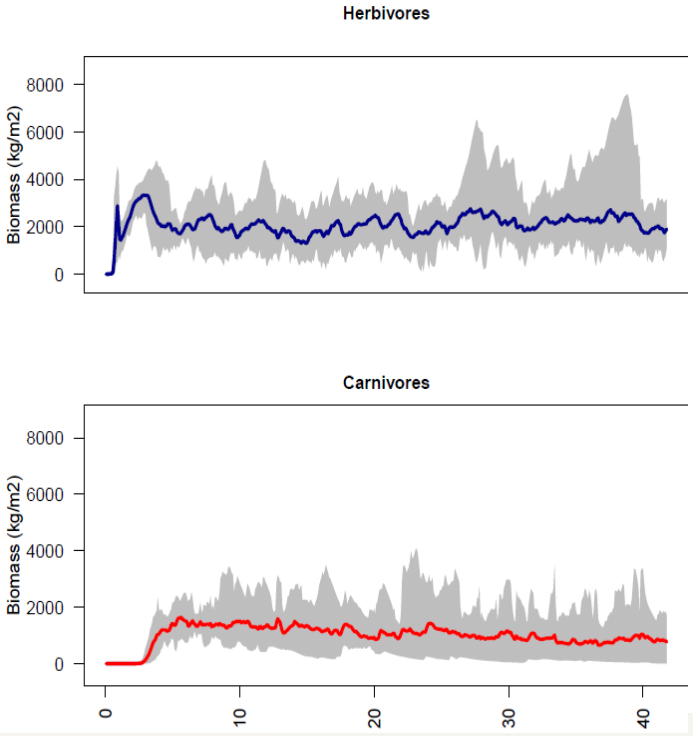
Models *can* assist humans in the process of biodiversity conservation

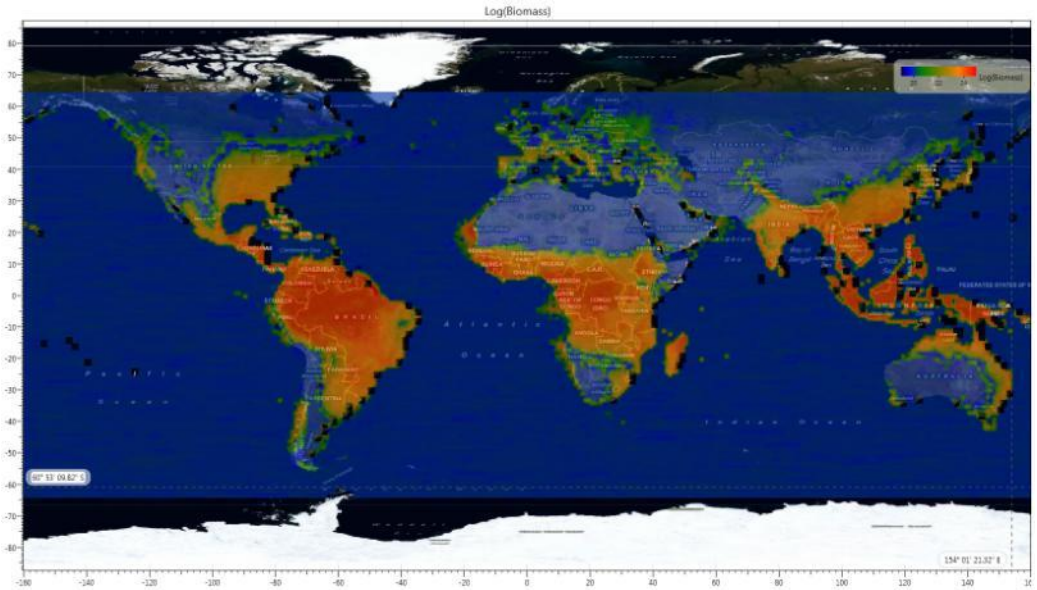
Remember: ‘All models are wrong, but some are useful’

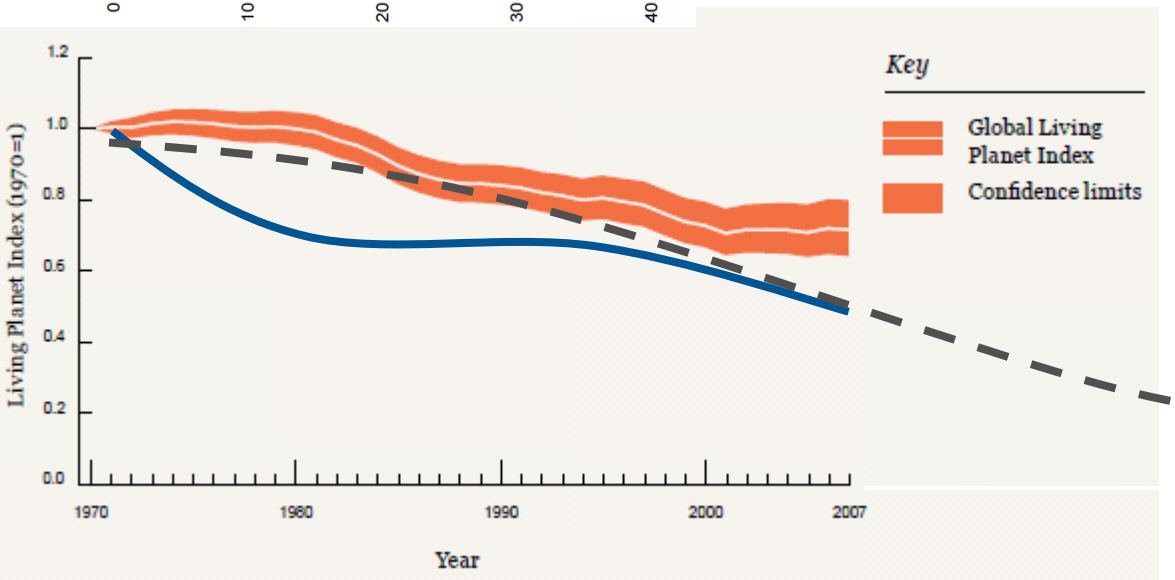
So choose your models carefully!

The Madingley Model









Global Living Planet Functional Index

Madingley Global Living Planet Functional Index

The Madingley model

Proteus Partners Annual Meeting 2014

Hosted by BP at Jesus College, Cambridge 13th-14th May