RITA CASTILHO

MARINE BIOGEOGRAPHY AND EVOLUTION

ECOLOGICAL BIOGEOGRAPHY

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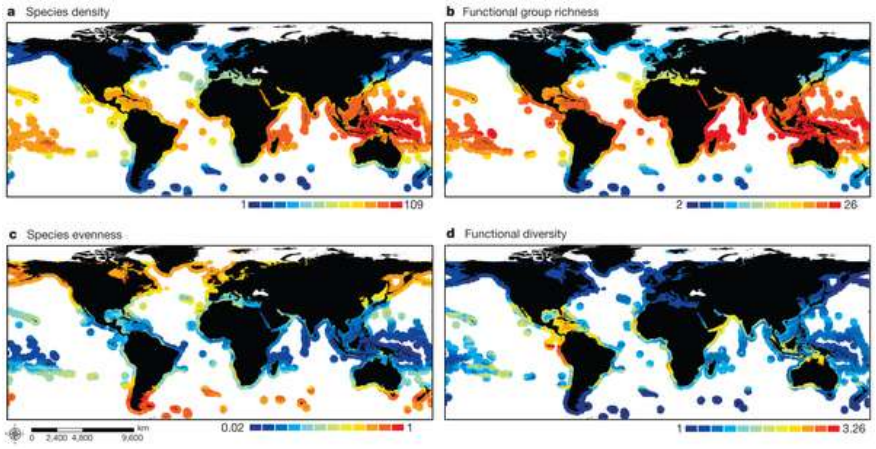
MARINE BIOGEOGRAPHY AND EVOLUTION

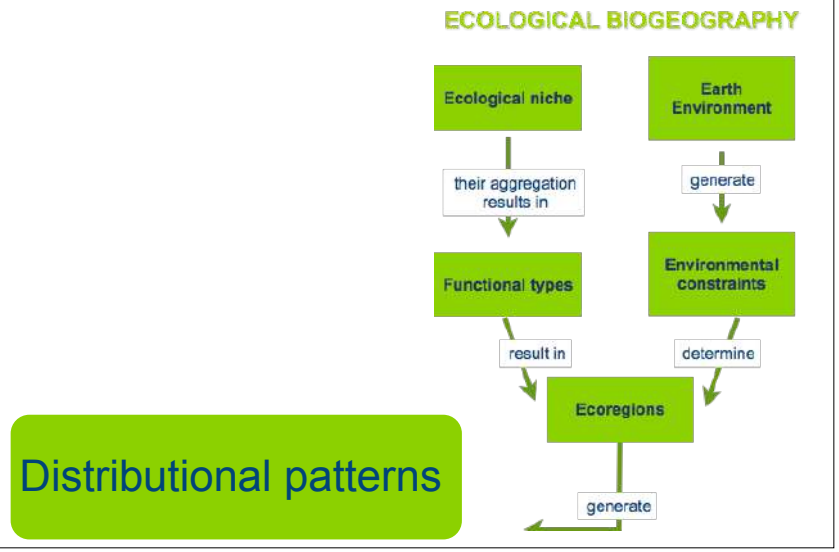
ECOLOGICAL BIOGEOGRAPHY

outline

- DEFINITION
- PATTERNS
- SCALE
- WHAT IS BIODIVERSITY
- DIVERSITY MEASUREMENTS
- NUMBER OF SPECIES
- CORAL TRIANGLE

Accounts for the **present** distributions in terms of interactions between organisms and their physical and biotic environments





Why is a species confined to its present range in space?

What enables it to live where it does?

What prevents it from expanding into another areas?

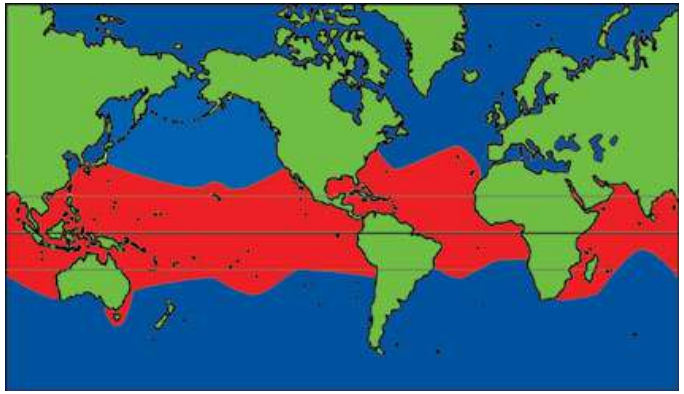
What roles do water, climate, latitude, topography and interactions with other organisms play in limiting its distribution?

How do we account for the replacement of species as one moves from one environment to another?

Why are there more species in the tropics than in cooler environments?

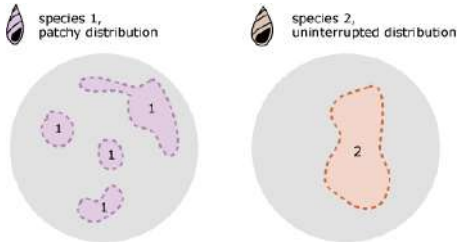
What controls the diversity of organisms that is found in any particular region?

Short-term periods of time, with local, within-habitat, intracontinental questions, with species and subspecies living organisms.



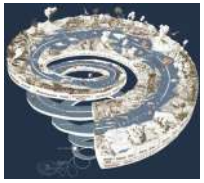
PATTERNS

No two species are identical in their patterns of distribution



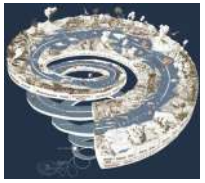
Causes of patterns also vary with the spatial scale

Factors in patterns of distribution

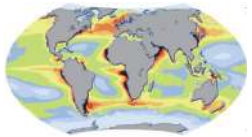


Geological history

Factors in patterns of distribution

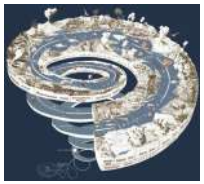


Geological history

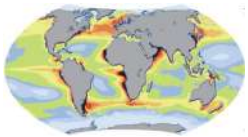


Availability of food

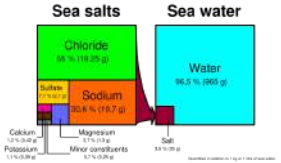
Factors in patterns of distribution



Geological history

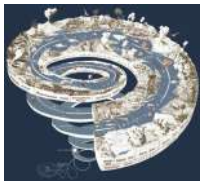


Availability of food

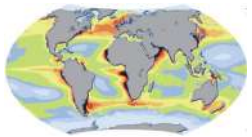


Chemistry of Environment

Factors in patterns of distribution



Geological history



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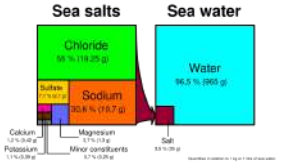
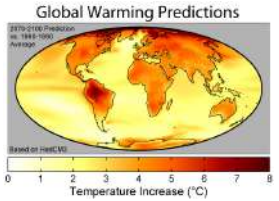
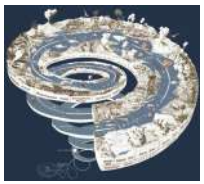


Chemistry of Environment

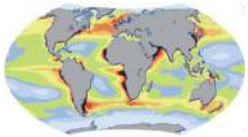


Climate

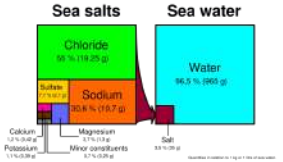
Factors in patterns of distribution



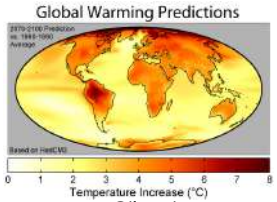
Geological history



Availability of food



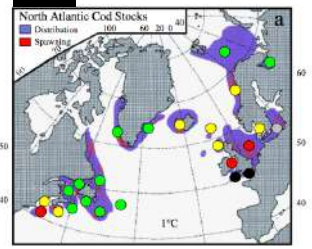
Chemistry of Environment



Climate

Competition

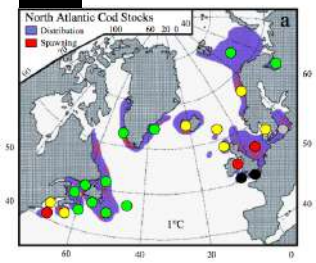
1°C



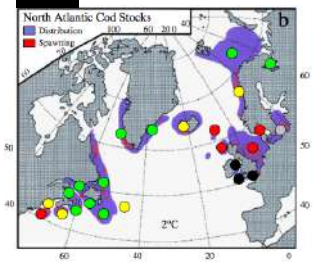
Increase
No change
Decrease
Collapse
?

Expected changes in the abundance of the cod stocks with a temperature increase above current levels.

1°C



2°C



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No change
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Expected changes in the abundance of the cod stocks with a temperature increase above current levels.

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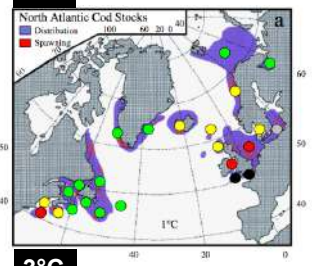
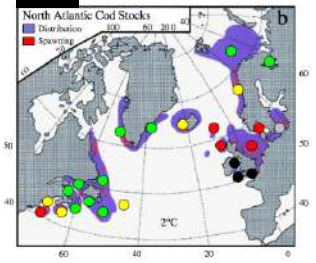
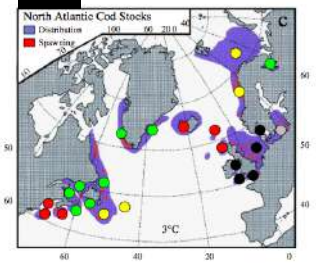


2°C

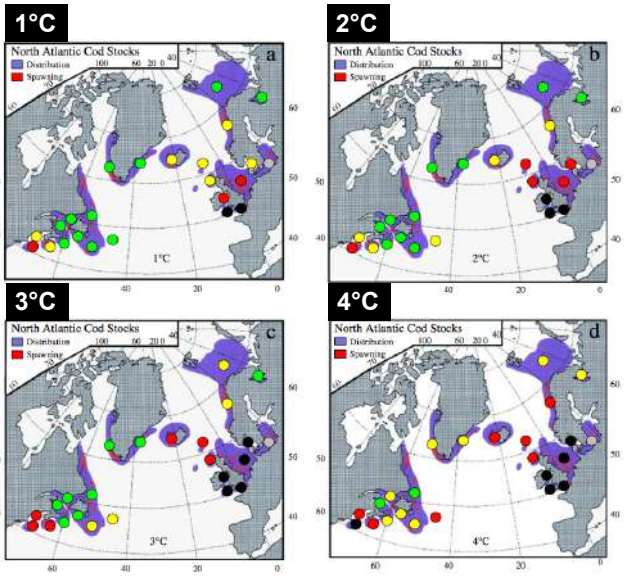


3°C



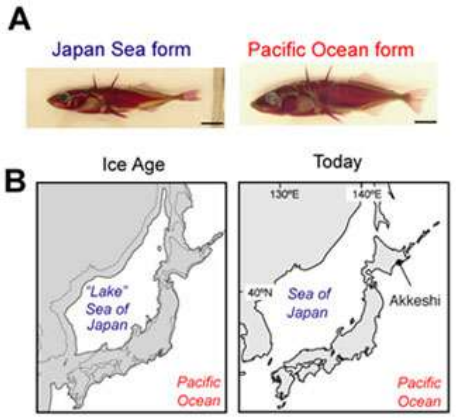
Increase
No change
Decrease
Collapse
?

Expected changes in the abundance of the cod stocks with a temperature increase above current levels.



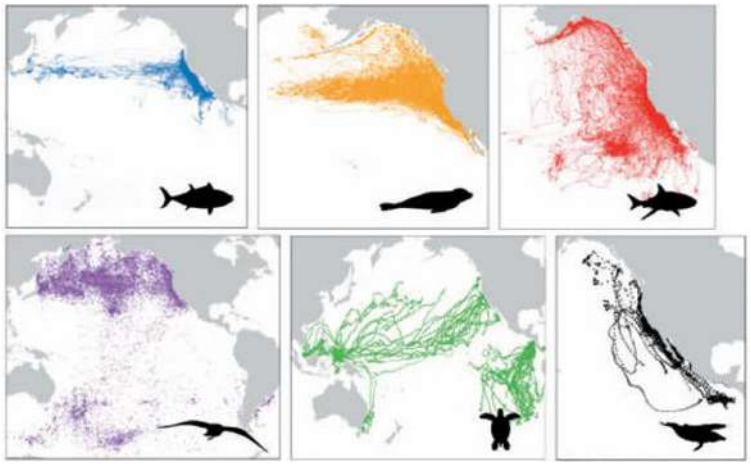
Expected changes in the abundance of the cod stocks with a temperature increase above current levels.

Spatial and temporal isolation leads to speciation

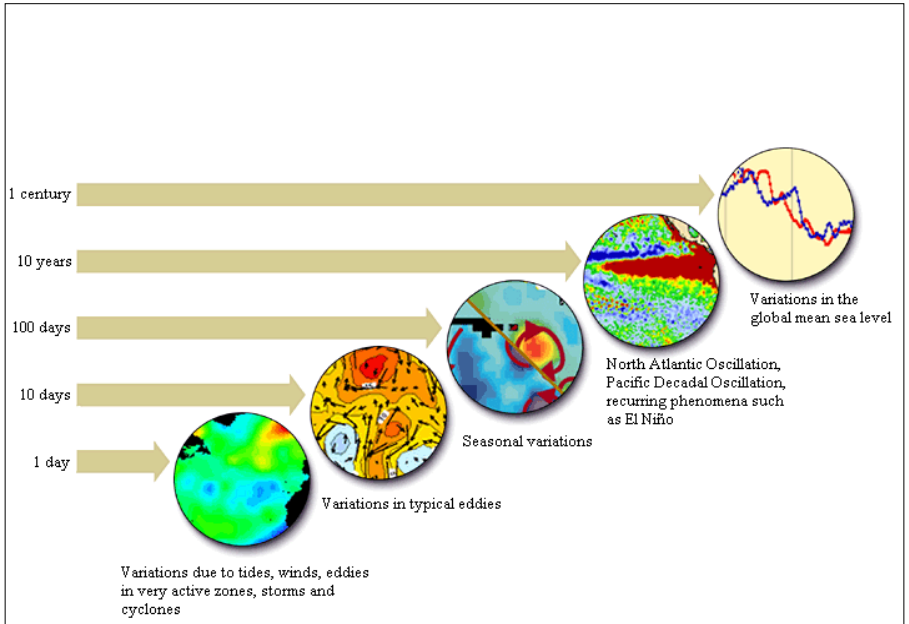


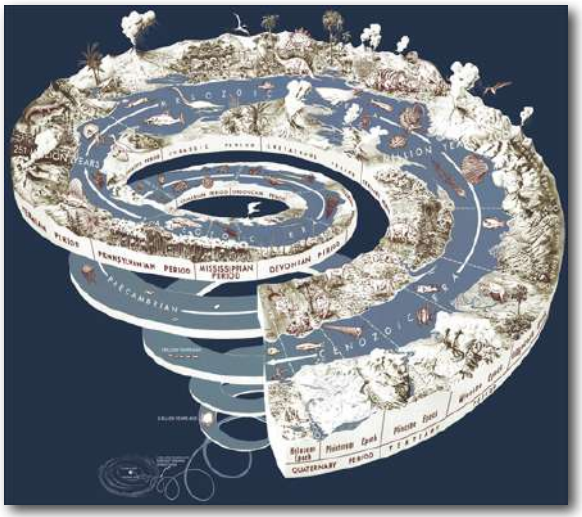
Ravinet et al. PloS One in press

Migratory movements



SCALE

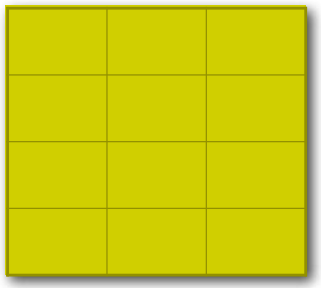


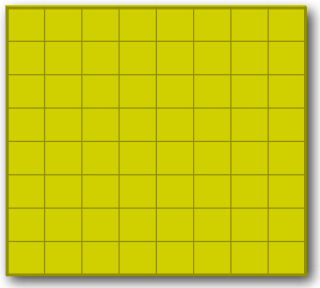


- **Spatial and temporal dimension of sampling and observation**
  - **Extent: size of the study area or the duration of time under consideration**
  - **Grain: level of spatial resolution**

Size of the study area

Level of spatial resolution



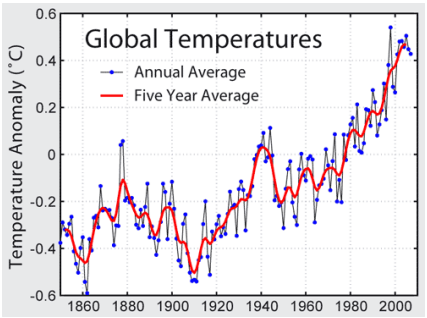


Duration

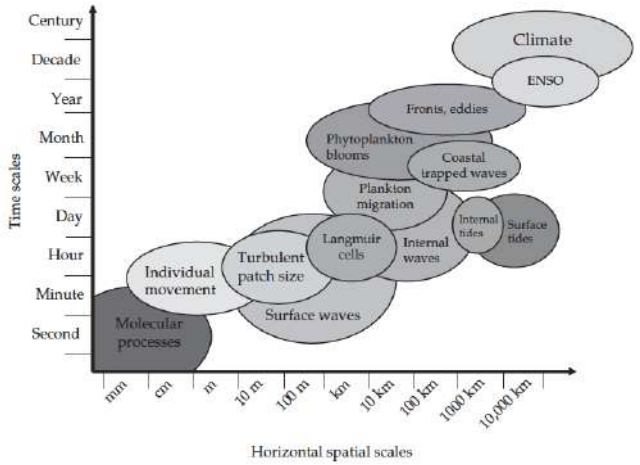
1 week

1 month

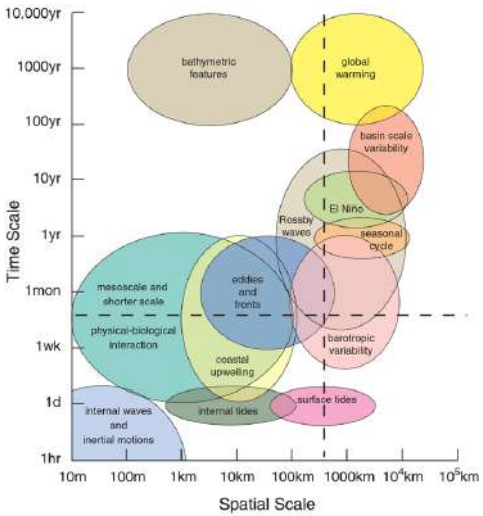
1 year



Dickey, T. D., 2001, The role of new technology in advancing ocean biogeochemical research, Oceanography, 14, 417-425



Schematic drawing showing the dominant space- and time-scales in the marine environment for physical processes and biological population



Schematic drawing showing the dominant space- and time-scales in the marine environment for physical processes and biological population

WHAT IS BIODIVERSITY

http://www.thedailystar.net/op-ed/why-mainstreaming-biodiversity-the-call-the-day-1227517

WHAT COMES TO OUR MIND?

"A definition of biodiversity that is altogether simple, comprehensive, and fully operation (i.e., responsive to real-life management and regulatory questions) is unlikely to be found"

Noss (1990)

"The total variability of life on earth"

(Heywood et al. 1995)

"The variety and variability among living organisms and the ecological complexes in which they occur"

OTA (1987)

"The variability of life from all sources, including within species, between species, and of ecosystems"

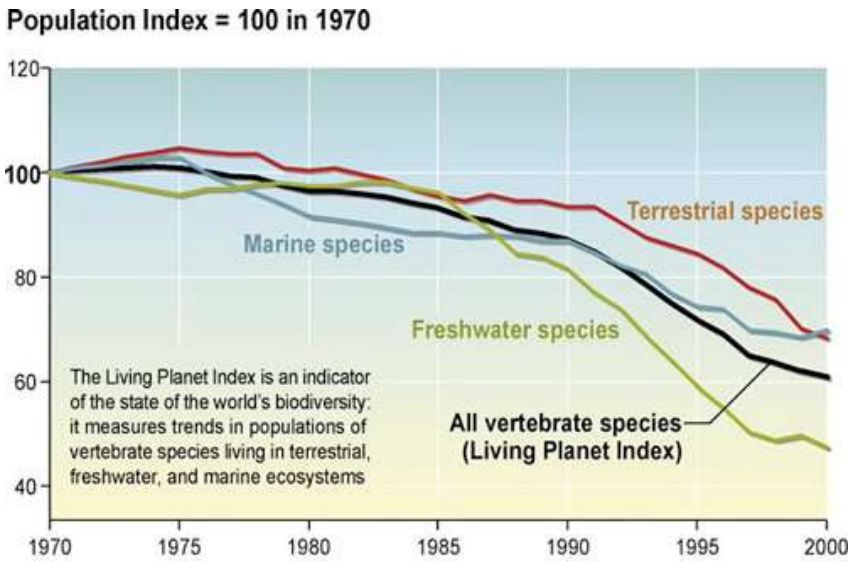
Whitaker and Fernandez-Palacios (2007).

"... the variety of life and its processes; ... the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur."

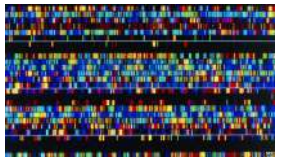
Keystone Center (1991)

"Biodiversity, simply stated, is the total expression of life on Earth"

Conservation International

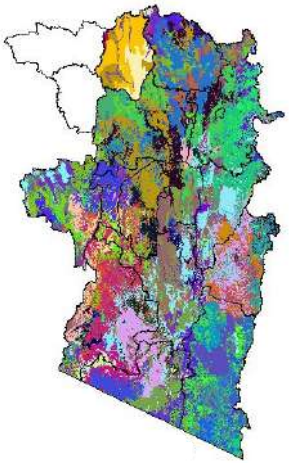


Biodiversity means the full range of life on earth



Genetic Diversity

Species Diversity



Ecosystem Diversity

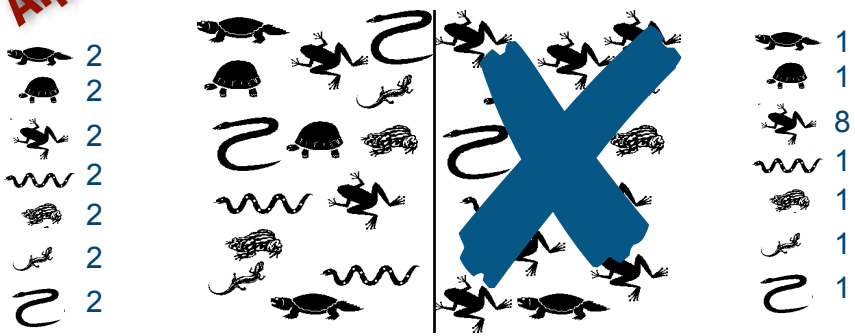
Genetic component	Spatial component	Temporal component
within individuals	communities	daily
within populations	ecosystems	seasonal
between populations	landscape ecoregions	annual
between species	biogeographic regions	geological or evolutionary

Alpha diversity

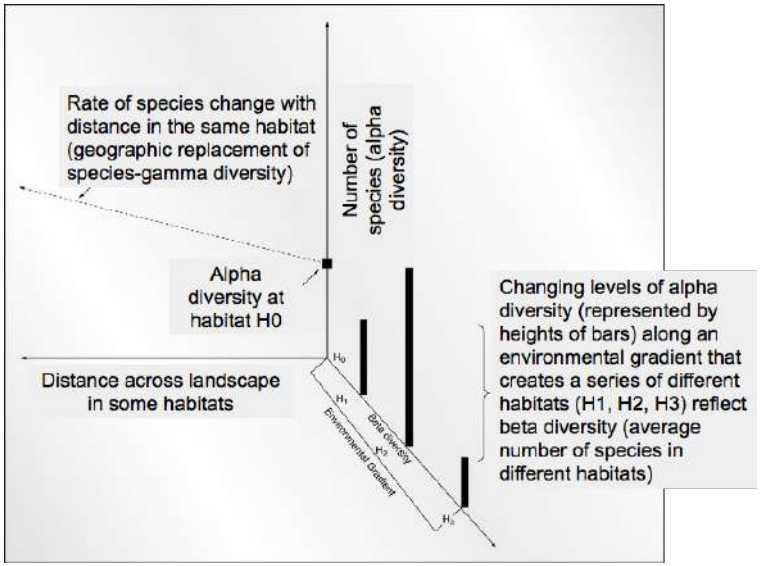
The number of species per unit.

The more species present in a sample, the 'richer' the sample.

Alpha diversity

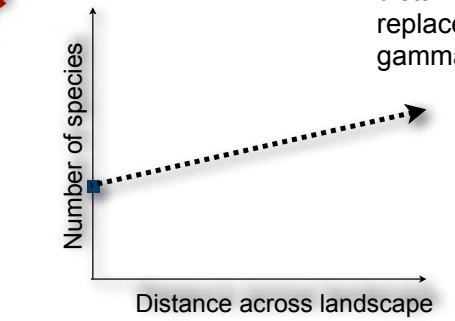


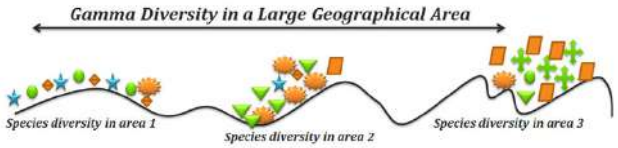
Evenness is a measure of the relative abundance of the different species making up the richness of an area.

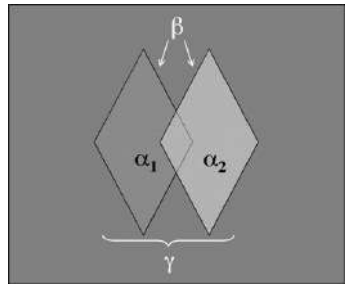


Gamma diversity

Rate of species change with distance (geographical replacement of species = gamma diversity)







Alpha-diversity

Measured locally, at a single site.

Number of species in a local homogenous community.

Beta-diversity

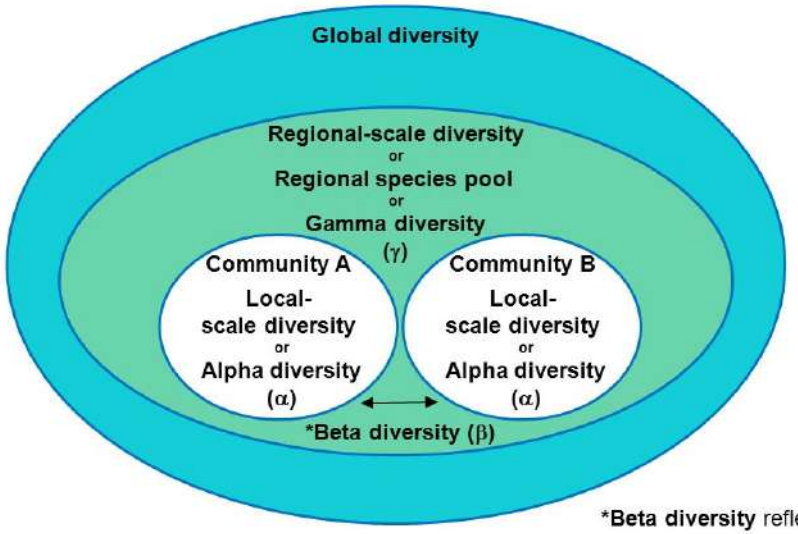
Measures the uniqueness; the difference between two sites.

Species distributions among different habitats.

Gamma-diversity

Measured over a large scale, same concept as alpha-diversity.

Number of species in a region where there are no barriers to dispersal



Original concept from Whittaker (1975)

***Beta diversity** reflects species turnover

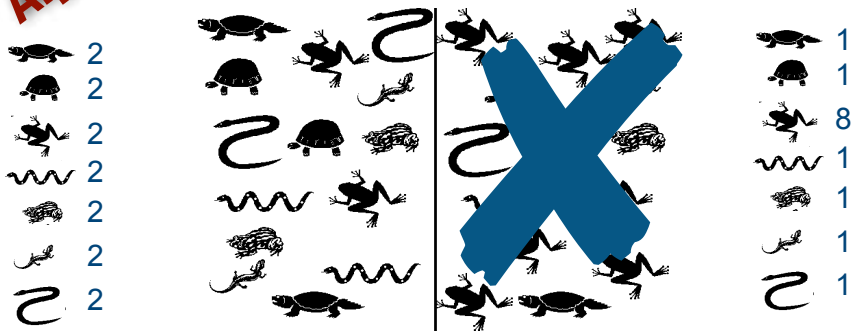
NUMBER OF SPECIES

Alpha diversity

The number of species per unit.

The more species present in a sample, the 'richer' the sample.

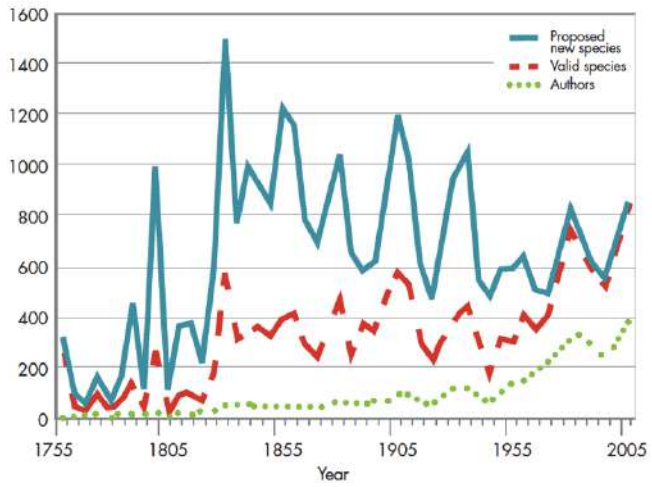
Alpha diversity



Evenness is a measure of the relative abundance of the different species making up the richness of an area.

NUMBER OF SPECIES

Number of new marine fish species and subspecies by year



Why is biodiversity important to biogeography?

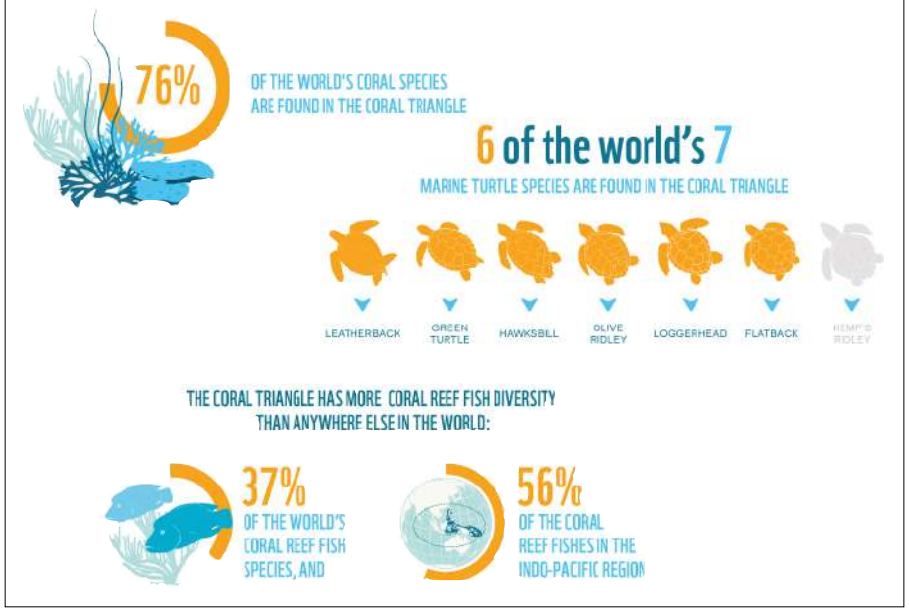
CORAL TRIANGLE


Safeguarding a diverse coral habitat
Regional governments are announcing a new plan to protect the Coral Triangle from land-erosion runoff, coral harvesting and fishing by dynamiting reefs. Coral already is dying there due to warming water.
CHINA
LAOS
THAI.
CAM.
VIET.
PHILIPPINES
MALAYSIA
INDONESIA
Coral Triangle
Pacific Ocean
Kimbe Bay
SOLOMON ISLANDS
PAPUA NEW GUINEA
Indian Ocean
EAST TIMOR
AUSTRALIA
Coral Sea
0 400 mi
0 400 km
SOURCES: Coral Triangle Center; World Wildlife Fund; ESRI
AP


THE CORAL TRIANGLE IS A
6 MILLION KM² AREA
COVERING PARTS OR THE ENTIRETY OF 6 COUNTRIES
PHILIPPINES
MALAYSIA
INDONESIA
PAPUA NEW GUINEA
SOLOMON ISLANDS
TIMOR LESTE


76%
OF THE WORLD'S CORAL SPECIES
ARE FOUND IN THE CORAL TRIANGLE


76%
OF THE WORLD'S CORAL SPECIES
ARE FOUND IN THE CORAL TRIANGLE
6 of the world's 7
MARINE TURTLE SPECIES ARE FOUND IN THE CORAL TRIANGLE
LEATHERBACK
GREEN TURTLE
HAWKSBILL
OLIVE RIDLEY
LOGGERHEAD
FLATBACK
KEMP'S RIDLEY


76%
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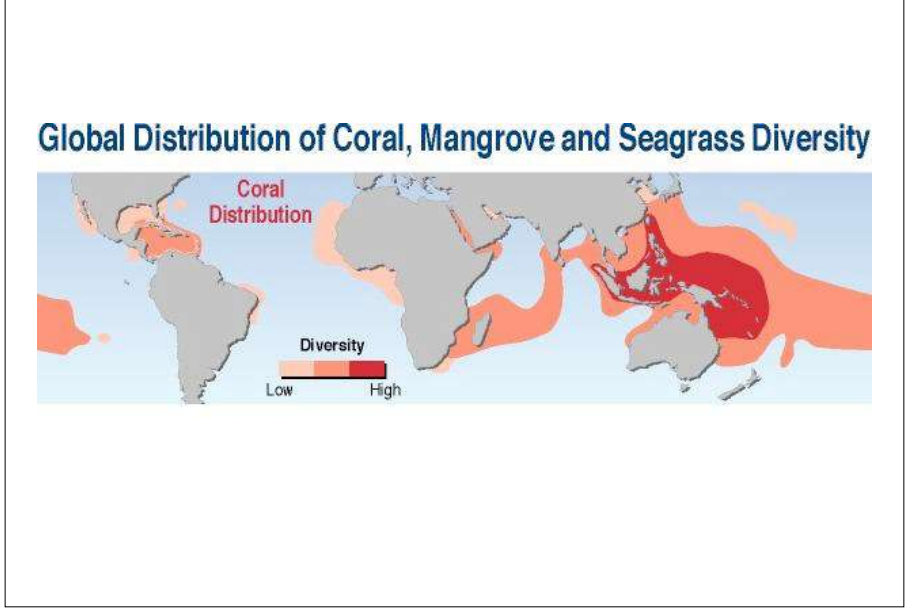
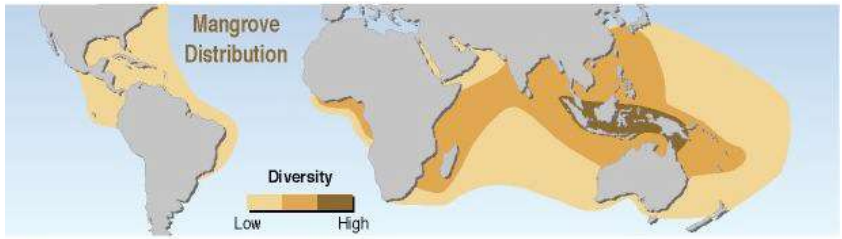
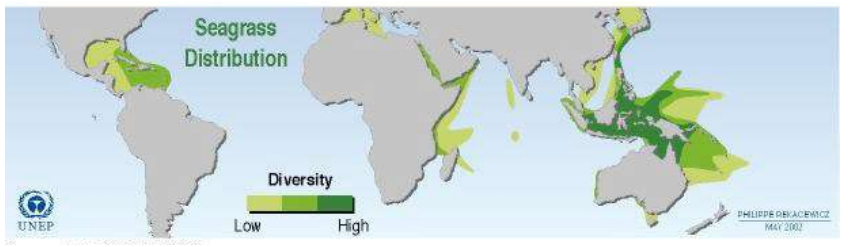
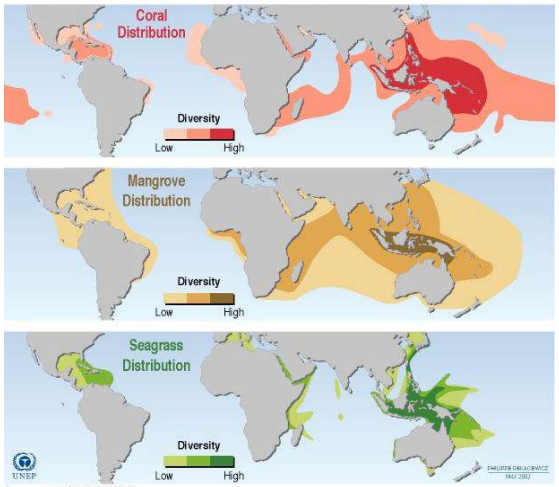
6 of the world's 7
MARINE TURTLE SPECIES ARE FOUND IN THE CORAL TRIANGLE
LEATHERBACK
GREEN TURTLE
HAWKSBILL
OLIVE RIDLEY
LOGGERHEAD
FLATBACK
HEMP'S RIDLEY
THE CORAL TRIANGLE HAS MORE CORAL REEF FISH DIVERSITY
THAN ANYWHERE ELSE IN THE WORLD:
37%
OF THE WORLD'S
CORAL REEF FISH
SPECIES, AND
56%
OF THE CORAL
REEF FISHES IN THE
INDO-PACIFIC REGION


Global Distribution of Coral, Mangrove and Seagrass Diversity
Coral
Distribution
Diversity
Low
High

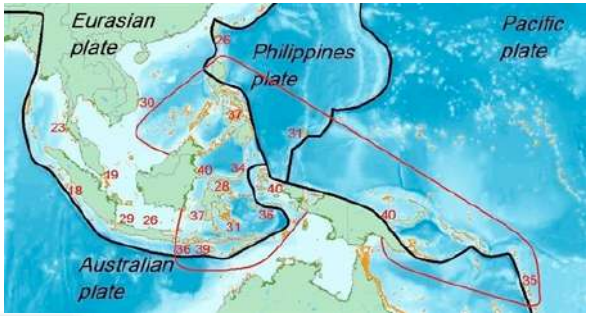

Mangrove
Distribution
Diversity
Low
High


Seagrass
Distribution
Diversity
Low
High
UNEP
PHILIPPE RekACEWICZ
MAY 2002

Global Distribution of Coral, Mangrove and Seagrass Diversity

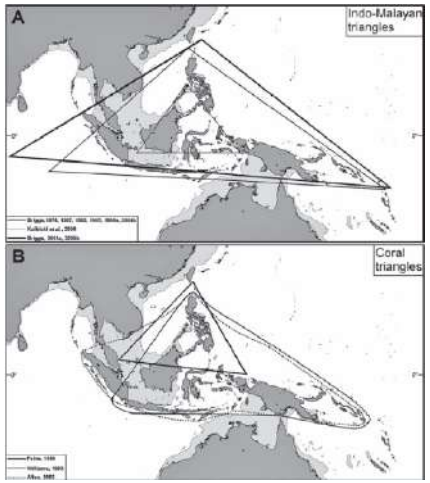


Source : UNEP-WCMC, 2001.



Fungiidae

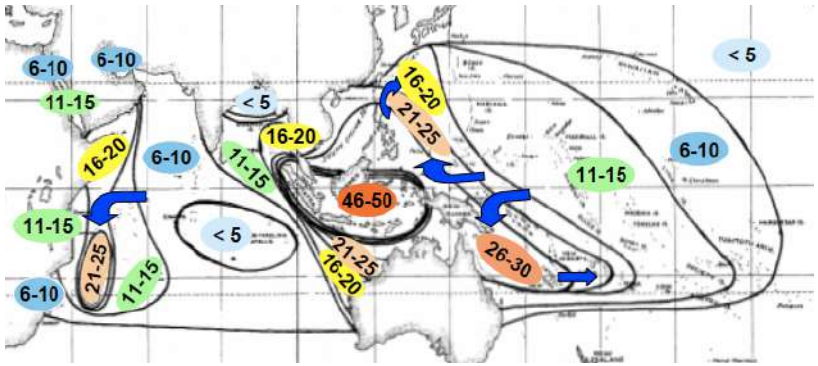
http://science.naturalis.nl/research/departments/marine-zoology/coral-triangle-the-centre-of-maximum-marine-biodiversity-



(**A**) Briggs' (1974) Indo-Malayan centre of marine biodiversity depicted as the "East Indies Triangle" (Briggs, 1987). His later version (Briggs, 2005a) is slightly larger, including all of Sumatra, and therefore more similar to the Coral Triangle indicated by Allen (2002; Fig. 1B). Kulbicki et al. (2004) refer to a centre of fish diversity, which they call "the Philippines–South China Sea–Indonesia triangle";

(B) The centre of maximum diversity presented as coral triangles (Paine, 1988; Allen, 2002). The centre of reef-associated pennatulacean **octocorals** is also presented as a triangle (Williams, 1993).

http://science.naturalis.nl/research/departments/marine-zoology/coral-triangle-the-centre-of-maximum-marine-biodiversity-



Reaka et al. Patterns of biodiversity and endemism on Indo-West Pacific coral reefs. PNAS (2008), 105:11474

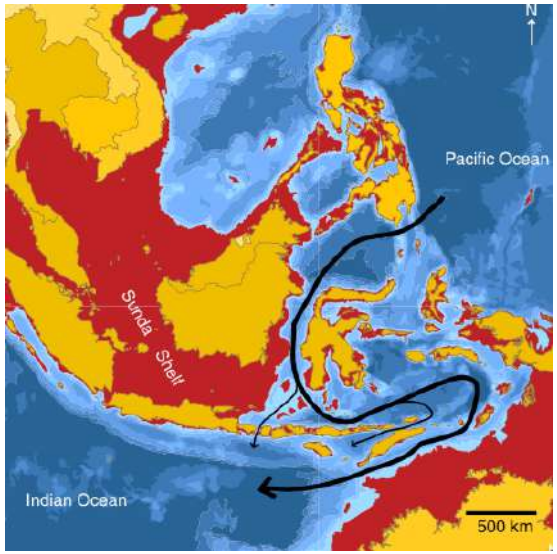
IN RED:

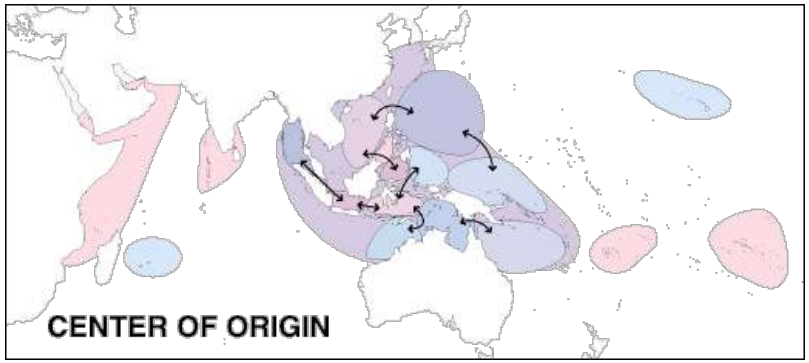
Shallow-water marine habitats (down to the -130 m contour) are highlighted in red, showing the maximum extent of seaway constriction during extreme low-stands in sea level.

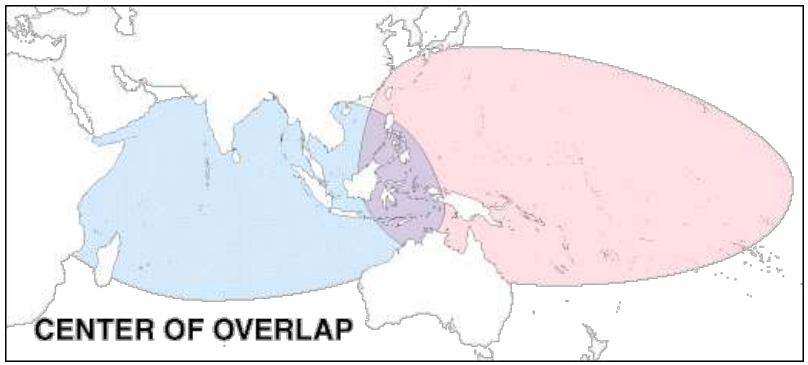
Black lines:

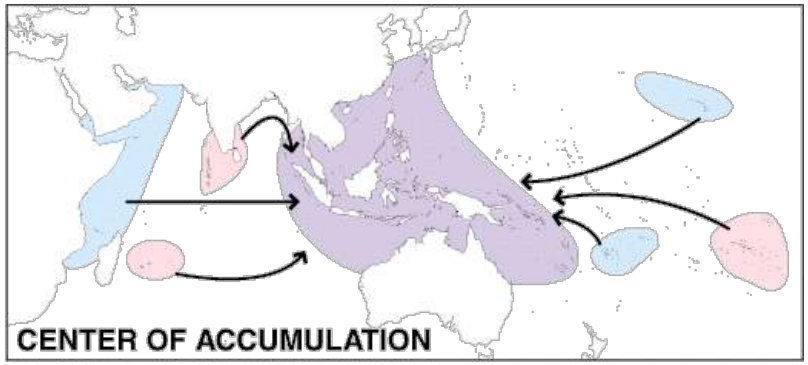
The present day course of the Indonesian Throughflow is represented by black arrows, after Oppo and Rosenthal (2010).

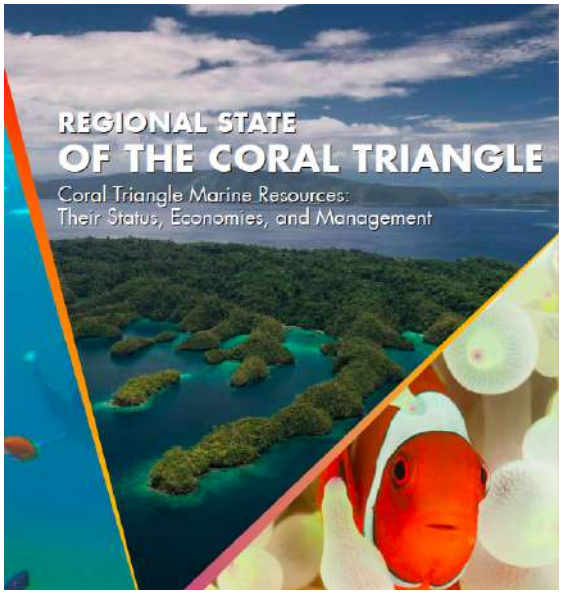
Horne, 2014











outline

DEFINITION

PATTERNS

SCALE

WHAT IS BIODIVERSITY

DIVERSITY MEASUREMENTS

NUMBER OF SPECIES

CORAL TRIANGLE

THE END