Ecoregions and global biodiversity hotspots

How and why are regions prioritised for conservation?

The wilderness concept

- One approach to conservation could be to prioritise "pristine" wilderness

- Natural areas relatively unaffected by human activities

- e.g. Mittermeier et al. (2003)

- 24 wilderness areas, all >1 million hectares, are >70% intact with human densities of less than or equal to five people per km 2 .

- Wilderness covers 44% of all land but is inhabited by only 3% of people.
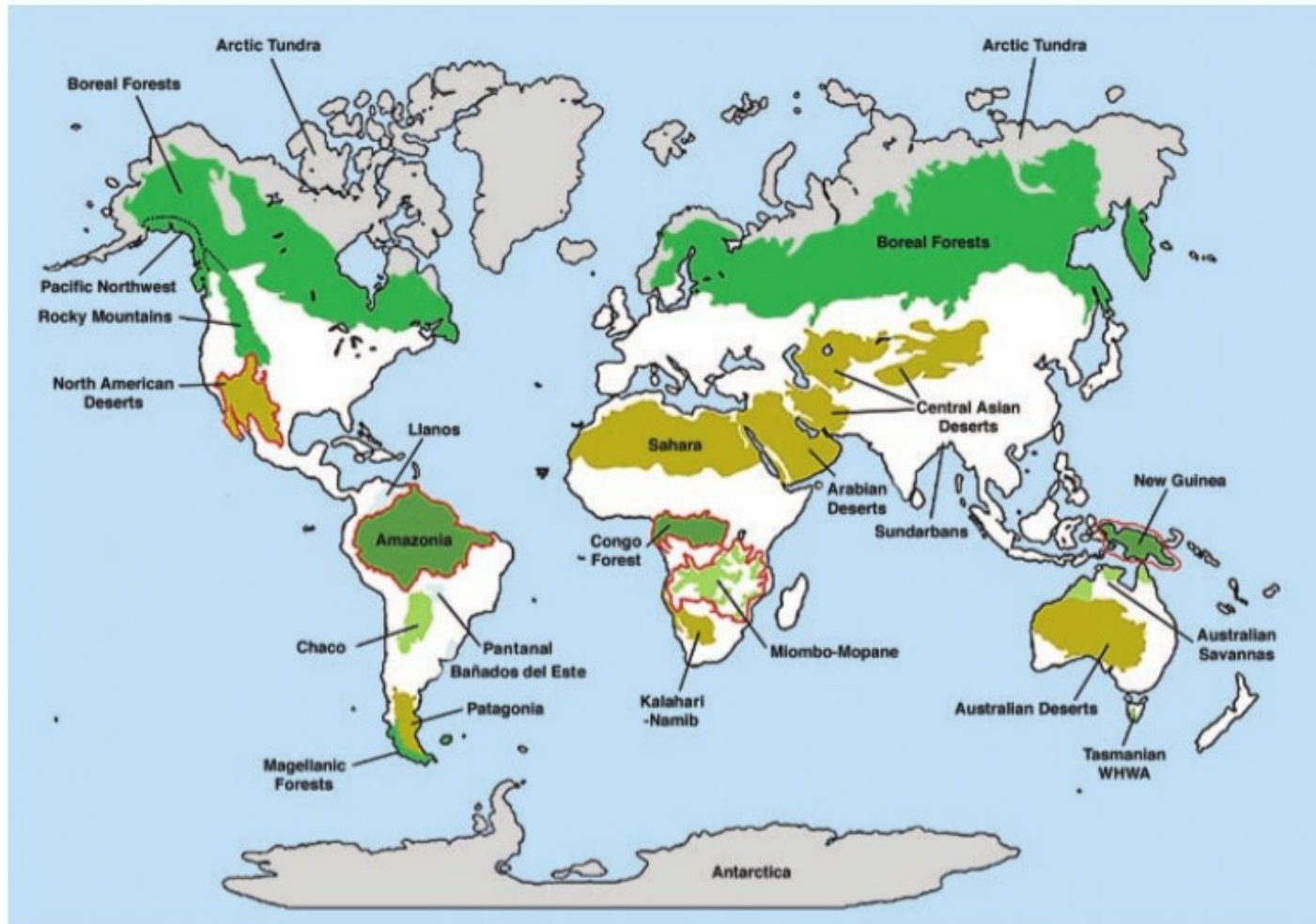
Remaining wilderness

Fig. 1. Overall map showing wilderness areas, human population density less than or equal to five people per km², with biomes shaded, and the five high-biodiversity wilderness areas outlined in red.

Wilderness concept

- Wilderness areas may not be the most biodiverse (many tropical forest ecoregions are **not** wilderness)

- Large areas of wilderness may be homogeneous in character

- Definition of wilderness problematic and anthropocentric (debate)

- Wilderness may be easy to conserve by definition (low human impact to combat)

World population link

- http://luminocity3d.org/WorldPopDen/#10/-0.04
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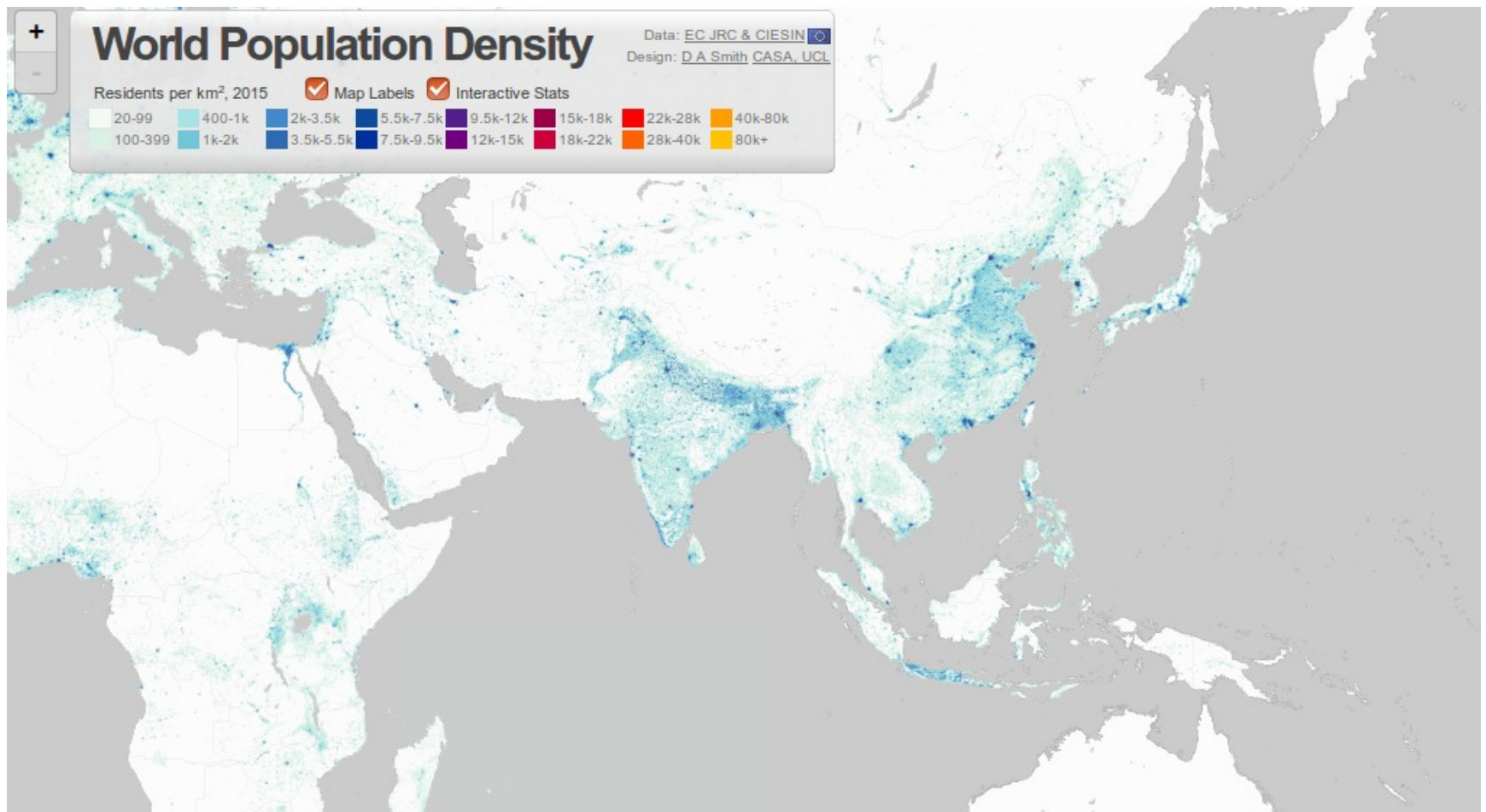
Prioritisation based on biodiversity

- First initiative with major international impact proposed by Norman Myers (2000)

- Major article published in Nature

- Used by big international NGOs such as Conservation International, The Nature Conservancy and WWF

- Consulted 100+ expert scientists

Motivation

- Number of species threatened with extinction outstrips available resources to conserve all of them

- How can we support the most species at the least cost?

- "Silver bullet" strategy

- Focus on "Hotspots" where there are more species at risk

Concept

- Define hotspots' boundaries by "biological commonalities"

- Focus on species, rather than populations or other taxa

- Two main criteria:

  - Species endemism

  - Degree of threat.

Qualification as hotspot

- Contains 0.5% (1,500 of the world's then estimated 300,000 plant species) as endemics

- Plants emphasised as it was assumed that their distributions were well known (questionable assumption)

- Four vertebrate groups also included comprising 27,298 species

  - 4,809 mammals

  - 9,881 birds

 - 7,828 reptiles

  - 4,780 amphibians

An excluded group

- Invertebrates not included as limited data
  - At least 95% of all species,
  - Mainly insects, especially beetles
- Erwin (1982) estimated 30 million as the total number of species based on very limited data and some questionable assumptions
  - Found 1,200 species of beetles living in *Luehea seemannii* trees.
  - 163 of the species assumed to be monophagous
  - Then assumed that there were 50,000 species of trees in the tropics
  - Beetles make up around 40% of all insects
  - So … Erwin extrapolated to produce the estimate
- Myers also assumed that insect diversity tracked plant diversity
- Gaston, (1991) estimated 5 million insect species globally

Linnean shortfall

- Insects are an example of the "Linnean" shortfall

- We do not know how many species there are as we have not yet classified them

- The Linnean shortfall also applies to plants, and especially to microbes and fungi

- Hotspot approach with regards to plants assumes that the true number of species is proportional to the recorded number.

Myer's hotspots
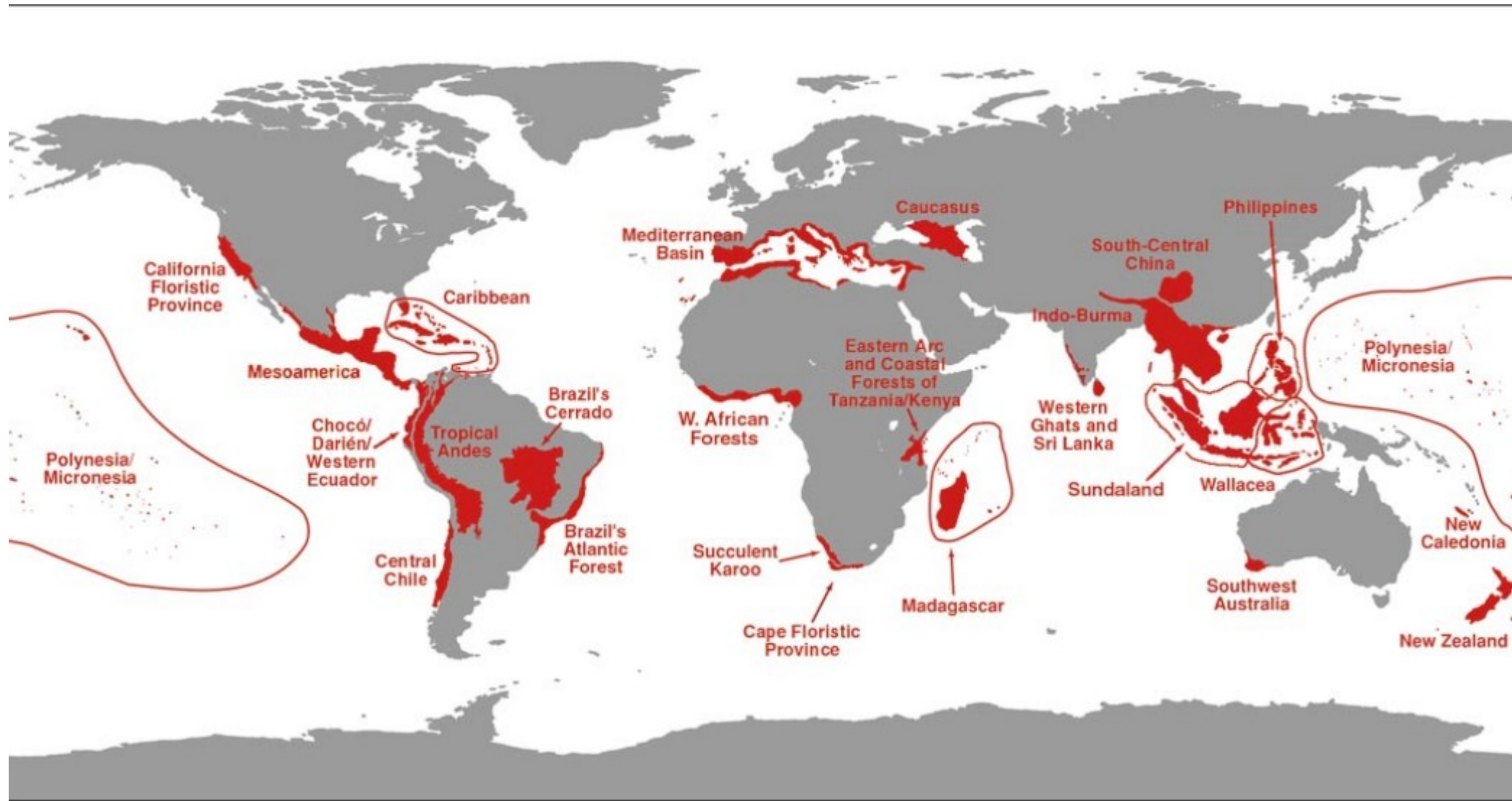
Myer's hotspots

| Hotspot	Original extent of primary vegetation (km^2)	Remaining primary vegetation (km^2) (% of original extent)	Area protected (km^2) (% of hotspot)	Plant species	Endemic plants (% of global plants, 300,000)	Vertebrate species	Endemic vertebrate (% of global vertebrates, 27,298
Tropical Andes	1,258,000	314,500 (25.0)	79,687 (25.3)	45,000	20,000 (6.7%)	3,389	1,567 (5.7%)
Mesoamerica	1,155,000	231,000 (20.0)	138,437 (59.9)	24,000	5,000 (1.7%)	2,859	1,159 (4.2%)
Caribbean	263,500	29,840 (11.3)	29,840 (100.0)	12,000	7,000 (2.3%)	1,518	779 (2.9%)
Brazil's Atlantic Forest	1,227,600	91,930 (7.5)	33,084 (35.9)	20,000	8,000 (2.7%)	1,361	567 (2.1%)
Choc/Darien/Western Ecuador	260,600	63,000 (24.2)	16,471 (26.1)	9,000	2,250 (0.8%)	1,625	418 (1.5%)
Brazil's Cerrado	1,783,200	356,630 (20.0)	22,000 (6.2)	10,000	4,400 (1.5%)	1,268	117 (0.4%)
Central Chile	300,000	90,000 (30.0)	9,167 (10.2)	3,429	1,605 (0.5%)	335	61 (0.2%)
California Floristic Province	324,000	80,000 (24.7)	31,443 (39.3)	4,426	2,125 (0.7%)	584	71 (0.3%)
Madagascar*	594,150	59,038 (9.9)	11,548 (19.6)	12,000	9,704 (3.2%)	987	771 (2.8%)
Eastern Arc and Coastal Forests of Tanzania/Kenya	30,000	2,000 (6.7)	2,000 (100.0)	4,000	1,500 (0.5%)	1,019	121 (0.4%)
Western African Forests	1,265,000	126,500 (10.0)	20,324 (16.1)	9,000	2,250 (0.8%)	1,320	270 (1.0%)
Cape Floristic Province	74,000	18,000 (24.3)	14,060 (78.1)	8,200	5,682 (1.9%)	562	53 (0.2%)
Succulent Karoo	112,000	30,000 (26.8)	2,352 (7.8)	4,849	1,940 (0.6%)	472	45 (0.2%)
Mediterranean Basin	2,362,000	110,000 (4.7)	42,123 (38.3)	25,000	13,000 (4.3%)	770	235 (0.9%)
Caucasus	500,000	50,000 (10.0)	14,050 (28.1)	6,300	1,600 (0.5%)	632	59 (0.2%)
Sundaland	1,600,000	125,000 (7.8)	90,000 (72.0)	25,000	15,000 (5.0%)	1,800	701 (2.6%)
Wallacea	347,000	52,020 (15.0)	20,415 (39.2)	10,000	1,500 (0.5%)	1,142	529 (1.9%)
Philippines	300,800	9,023 (3.0)	3,910 (43.3)	7,620	5,832 (1.9%)	1,093	518 (1.9%)
Indo-Burma	2,060,000	100,000 (4.9)	100,000 (100.0)	13,500	7,000 (2.3%)	2,185	528 (1.9%)
South-Central China	800,000	64,000 (8.0)	16,562 (25.9)	12,000	3,500 (1.2%)	1,141	178 (0.7%)
Western Ghats/Sri Lanka	182,500	12,450 (6.8)	12,450 (100.0)	4,780	2,180 (0.7%)	1,073	355 (1.3%)
SW Australia	309,850	33,336 (10.8)	33,336 (100.0)	5,469	4,331 (1.4%)	456	100 (0.4%)
New Caledonia	18,600	5,200 (28.0)	526.7 (10.1)	3,332	2,551 (0.9%)	190	84 (0.3%)
New Zealand	270,500	59,400 (22.0)	52,068 (87.7)	2,300	1,865 (0.6%)	217	136 (0.5%)
Polynesia/Micronesia	46,000	10,024 (21.8)	4,913 (49.0)	6,557	3,334 (1.1%)	342	223 (0.8%)
Totals	17,444,300	2,122,891 (12.2)	800,767 (37.7)	†	133,149 (44%)	†	9,645 (35%)

Utility of the approach

- Widely used by conservation bodies in thousands of technical reports

- Cited in introductions when justifying the conservation of almost any Meso American and Andean ecoregion

- Avoids focussing only on emblematic single species, which may be lacking in some regions

- Later studies (eg. Kier et al) broadly support Myer's selection

- However …. the approach has also been widely criticised as simplistic, lacking in granularity and based on incomplete data

Endemism richness
(Kier et al 2009)

Endemism richness

Birds

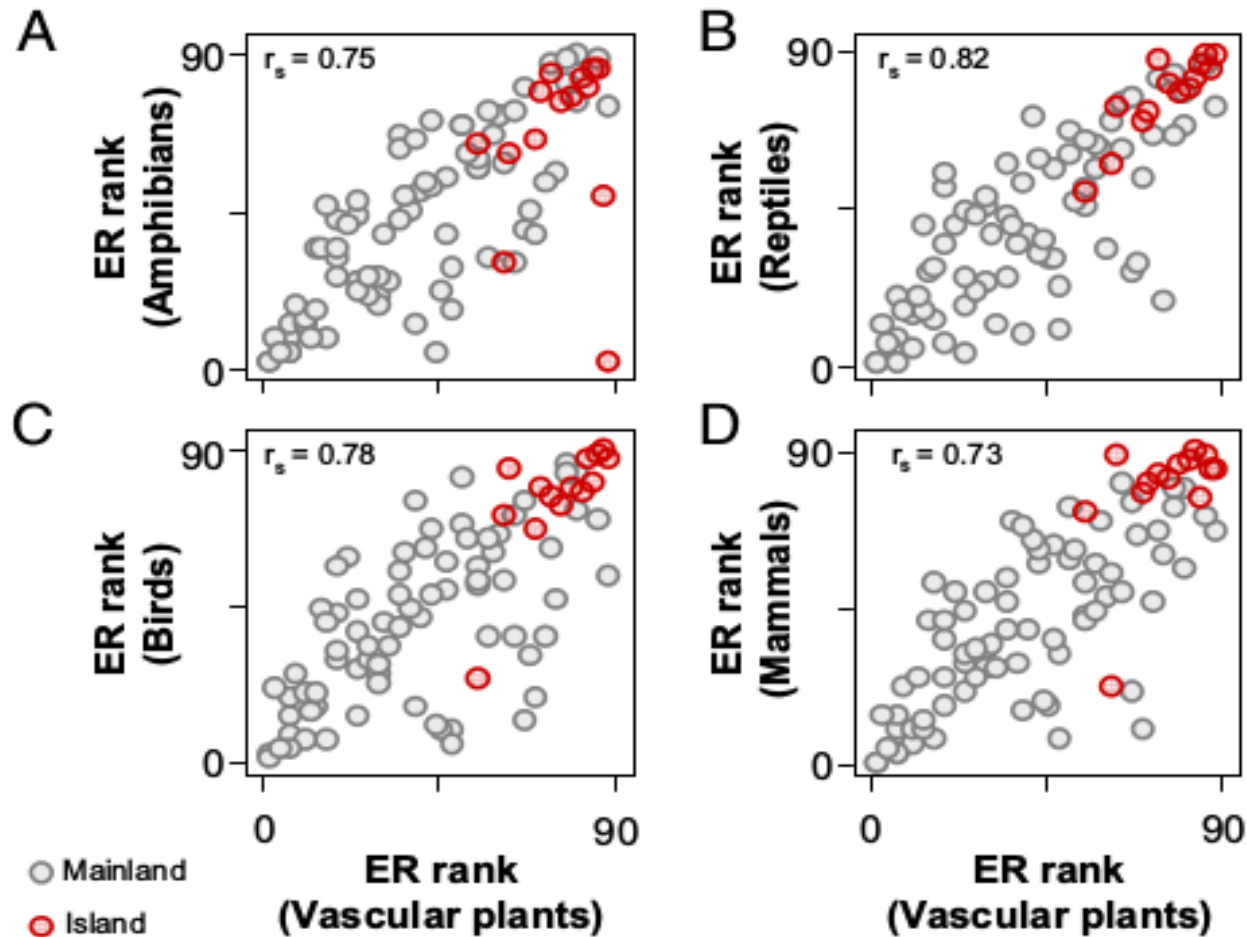|						
<0.21	>0.21	>0.50	>0.81	>1.09	>1.91	>4.11
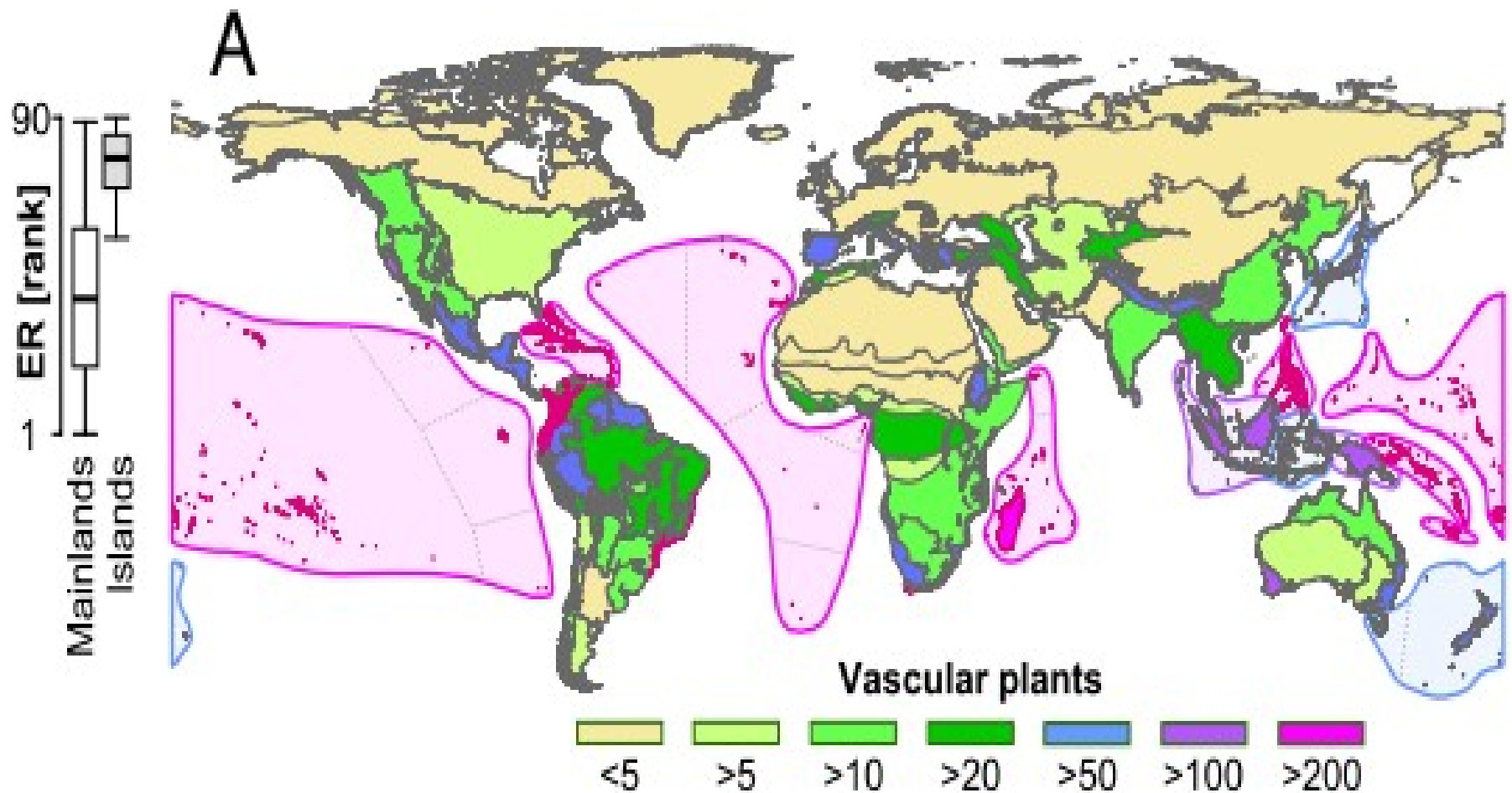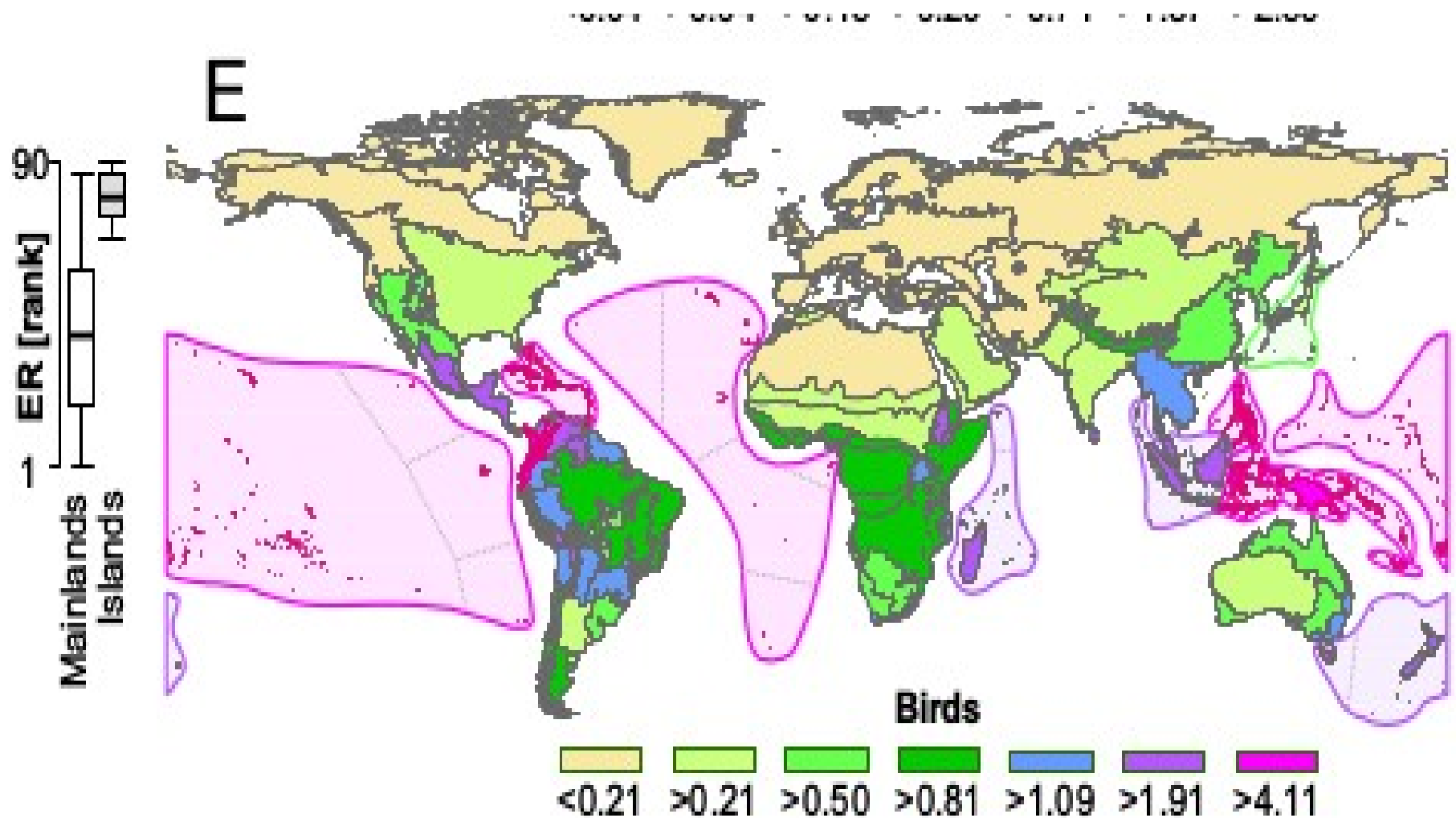
Endemism richness

- Endemism richness of plants and vertebrates **is** strongly related,

- Values on islands exceed those of mainland regions by a factor of 9.5 and 8.1 for plants and vertebrates,

- Human impact index, a measure of current threat, found to be significantly higher on islands.

Endemism richness

Fig. 2. Cross-taxon congruence of endemism richness (ER; range equivalents per 10,000 km^2) of vascular plant and terrestrial vertebrate classes. Ranked values of (A) amphibians, (B) reptiles, (C) birds, and (D) mammals are plotted against vascular plants. Red dots indicate island regions, gray dots mainland regions. Values of Spearman's rank correlation coefficient (r_s) are shown for each relationship (all $P < 0.001$).

The Wallacean shortfall

- The true limits to the distribution of most organisms is not known

- The best records are available for birds

  - Attractive (collected as skins and eggs in past)

  - Vocal (can be heard, when not seen)

  - Diurnal (active when humans are active)

  - Visible, (often in large numbers)

  - Limited in number of species (9 -10 thousand)

  - Tend to interact with humans

  - Relatively easy to identify

The Wallacean shortfall

- Plant distributions far less well known
- Historical reliance on regional floras in the tropics
- Same species may be known by different names
- Collections focus on certain areas
- Most collections close to roads and towns
- Collections reported from botanical gardens and markets
- "Lazarus effect" (Linnean and Wallacean)

The Wallacean shortfall and hotspots

- If we don't have good data on Geographical distributions then there is a problem with using endemism, especially on continents
  - Are the hotspots themselves correctly identified?
  - Are the geographical limits to hotspots correctly drawn?
  - Can areas of special interest within hotspots be identified?

A regional approach

- Myer's hotspots are large scale geographical units

- Lack fine scale spatial resolution

- Do not guide prioritisation of conservation efforts **within** countries such as Mexico, Costa Rica etc

- Ecoregions were therefore proposed by WWF as tools to focus **regional** conservation efforts.

Representation

- Ecoregions recognise the heterogeneity of habitats and ecosystems within realms

- Based on the concept of representativeness

- "Ensure that all ecosystem and habitat types are **represented** by regional conservation strategies"

- i.e. try to ensure that at least **some** area within **each** ecoregion is protected.

Contrast with hotspots

- Ecoregion approach only partially compatible with hotspots approach

- Some areas may need to be prioritised **within** each major habitat type"

- Less diverse habitats or biomes **also** require conservation efforts

- "Half of all species are likely to occur in the world's tropical moist forests, **but** the other 50% of all species are found elsewhere"

Geographical limits vs countries

- An issue shared with hotspots

  - Patterns of biodiversity and ecological processes (e.g., migration) do not conform to political boundaries

  - Species assemblages are adapted to distinct **environmental** conditions (e.g mangroves, lakes, wetlands, dry forests). May be many within each country

  - Reflect different **evolutionary** histories (e.g. islands, mountain tops)

"Global 200"

- Defined by WWF

- An ecoregion is a "relatively large unit of land or water containing a characteristic set of natural communities that share a large majority of their species dynamics, and environmental conditions"

- Global 200 identifies the world's most outstanding examples within major habitat types

Conservation status

- WWF assigned a conservation status to each ecoregion in the Global 200

  - Critically endangered

  - Endangered;

  - Vulnerable; and relatively stable

  - Intact.

- >50% of the ecoregions in the Global 200 are rated as **endangered or critically so**.

Terrestrial ecoregions

- WWF identified 867 terrestrial ecoregions
- Global 200 contains **238** ecoregions
  - 142 terrestrial,
  - 53 freshwater
  - 43 marine
- The TNS ecoregion layer is based on WWF's ecoregions outside the United States

Basis

- Large scale units subdivided
  - Biomes,
  - Biogeographical realms
  - Ecozones
- Form conservation units at regional scale containing defined biological communities.

Criteria

- Ecoregion boundaries are not based on consistent criteria

- Use a range of pre-existing definitions and boundaries based on a range of approaches

- Combine compositional criteria (species lists) with climatic and habitat based criteria

Exercises

- How relevant is the wilderness concept in the context of your chosen region?

- Find out whether your chosen Ecoregion is included in the global 200

- If not, how important is your ecoregion likely to be for Biodiversity conservation?

- Are neighbouring ecoregions in the global 200?

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