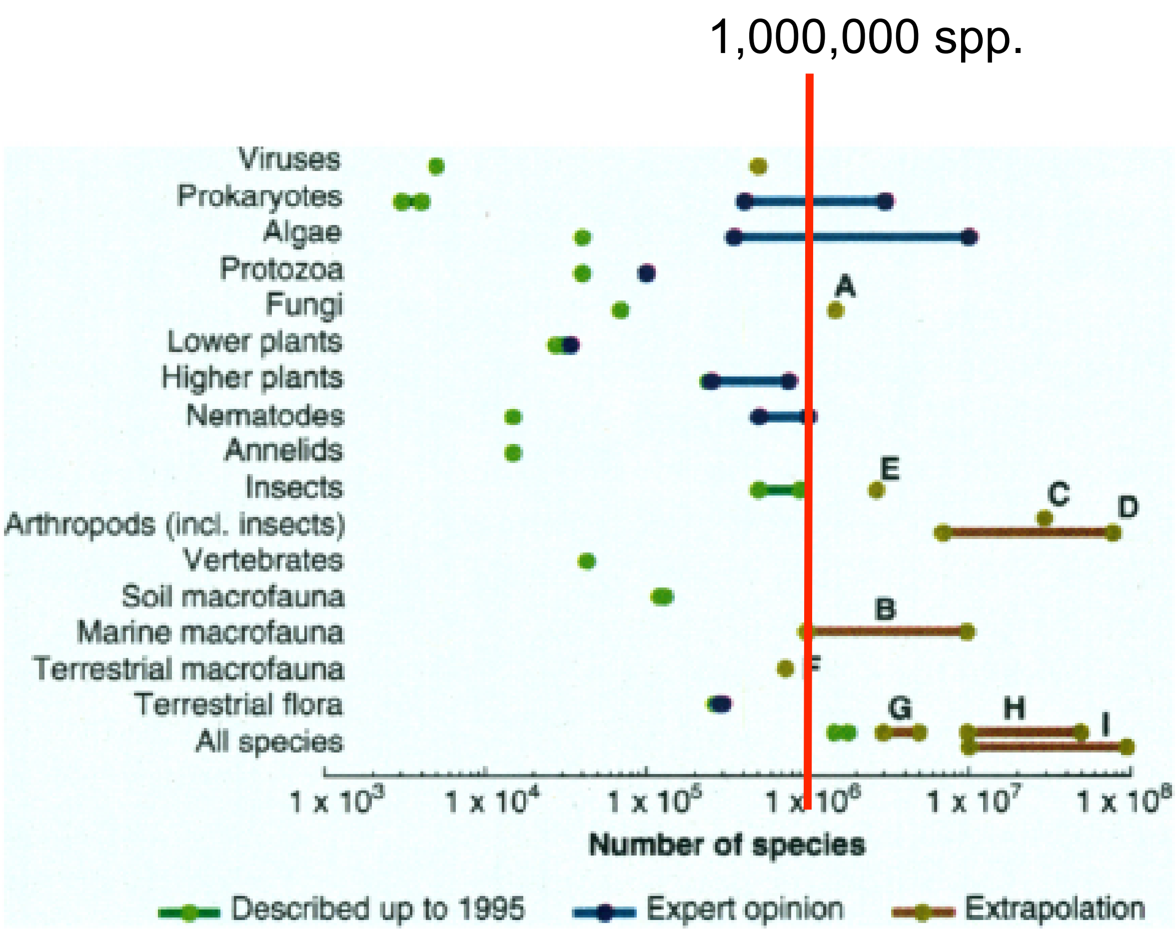
What is biodiversity?

Number of Species



Wide range between described and actual

Pimm et al., 1995

Distribution of species among groups

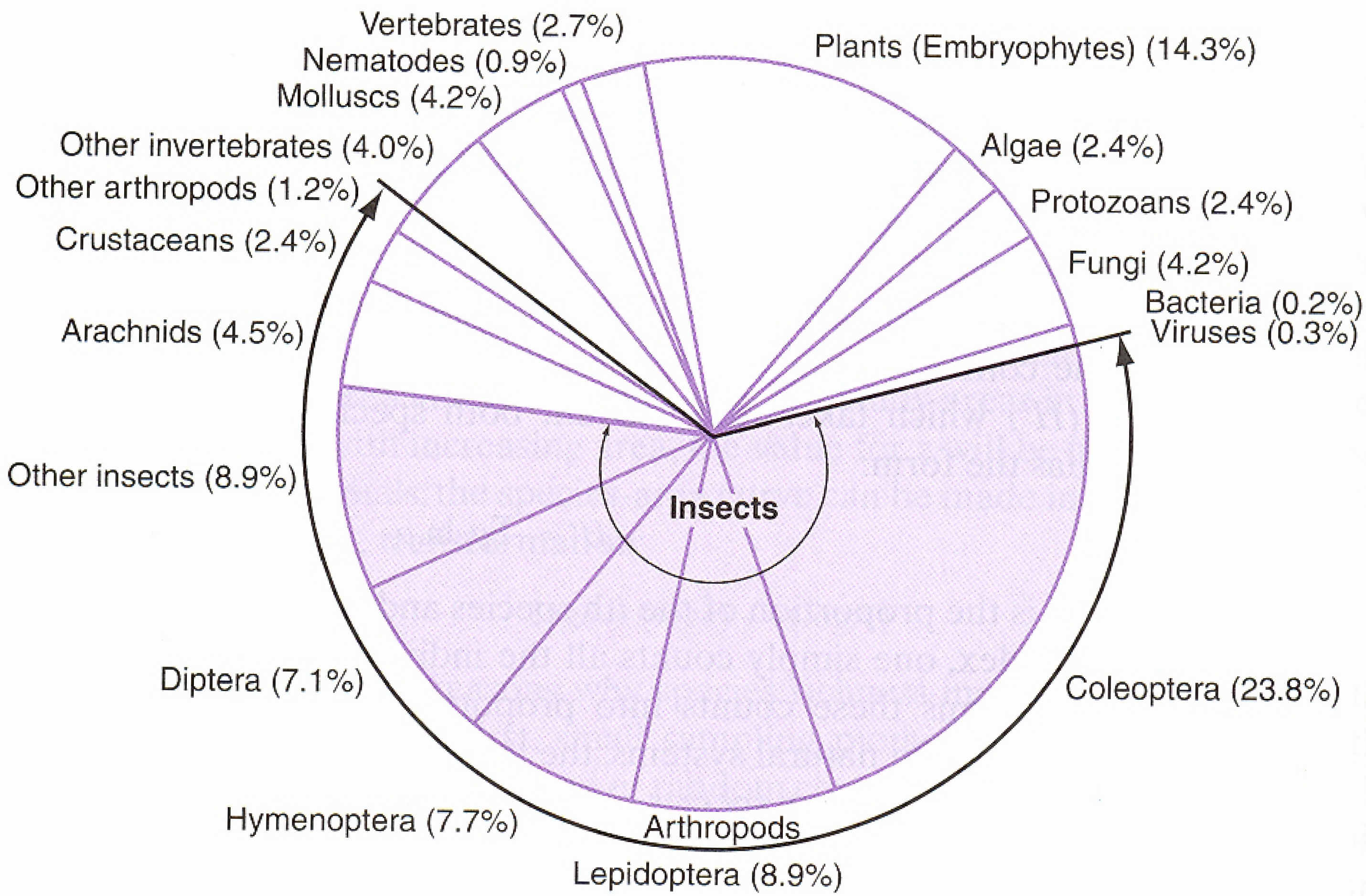


FIGURE 14.2 The distribution of known species (in 1990) among different plant and animal groups (after World Conservation Monitoring Center, 1992).

Number of new species described recently

TABLE 14.1 Number of New Species Described per Year between 1978 and 1987 for Selected Groups of Organisms

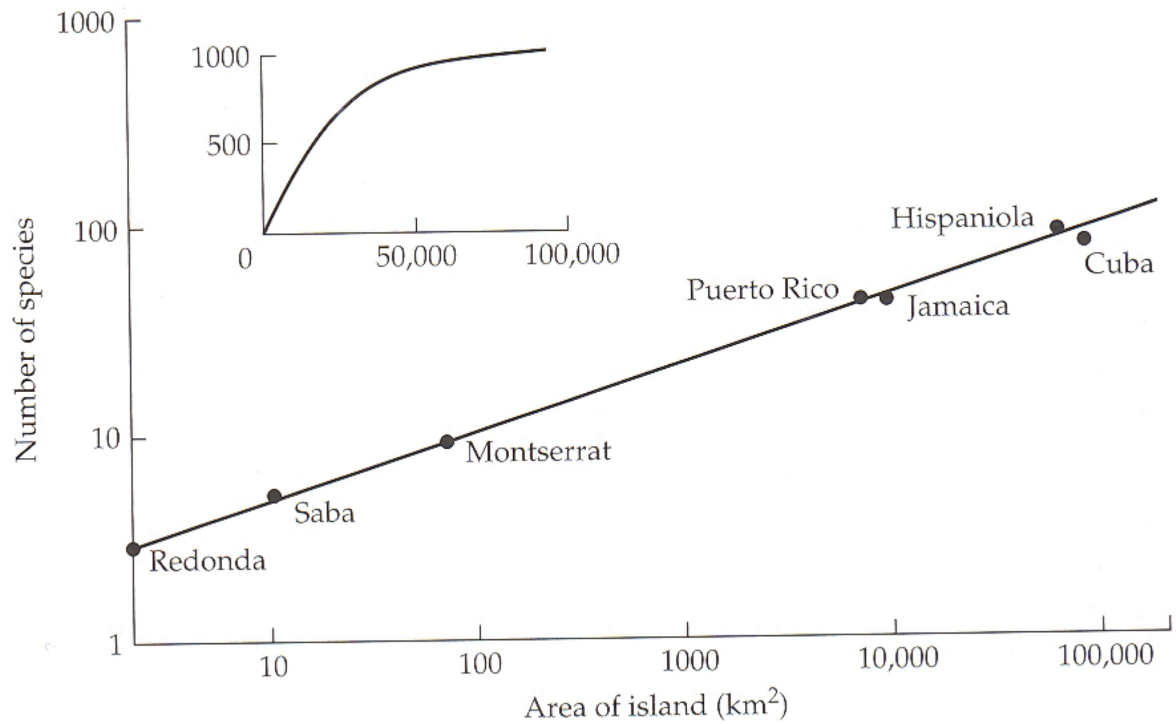
Organisms	Species Described Per Year (1978–1987)
Mammals	
Birds	
Amphibians and reptiles	
Fish	
Mollusks	
Insects	
Arachnids	

Source: World Conservation Monitoring Center (1992).

How many?

Species-area curve

FIGURE 13.1 The empirical relationship between number of species (*S*) and island area (*A*) for reptiles and amphibians of the West Indies, plotted from the original data of Darlington (1957). Note that both axes are logarithmic, and the points are well fitted by a straight line and the equation $S = cA^z$, where *c* and *z* are fitted values. Inset depicts this relationship in arithmetic space. (After MacArthur and Wilson 1967.)



Lomolino et al., 2006

Species-area curve

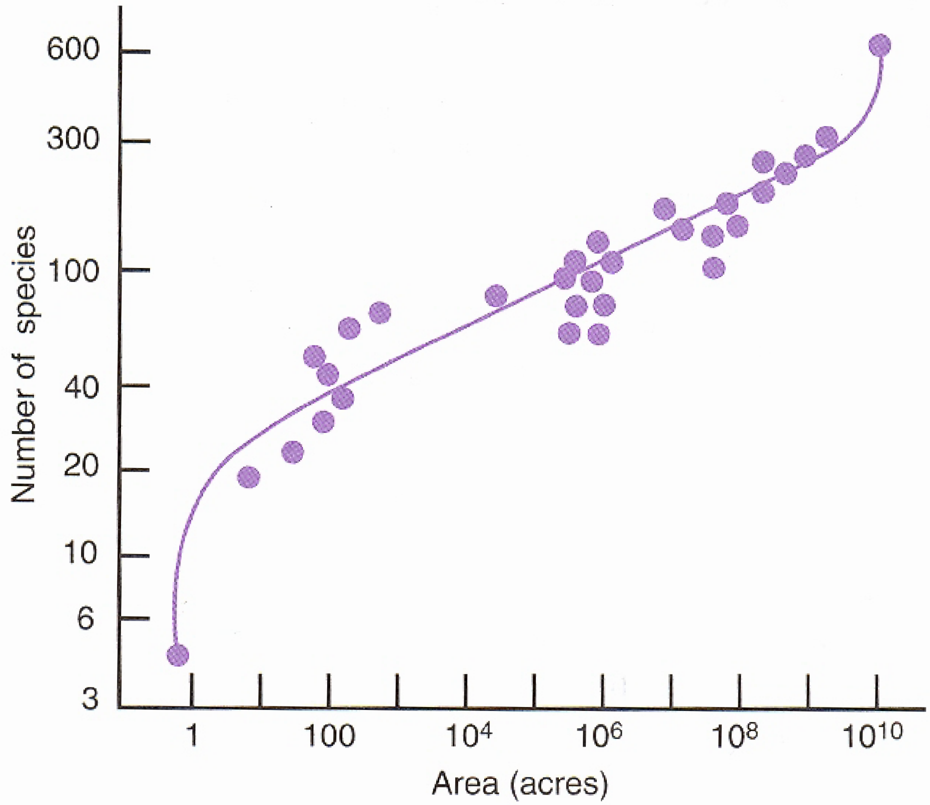


FIGURE 14.1 The relationship between sampling area and bird species richness in North America. The data are plotted on a log-log graph to render the species-area curve into a relatively straight line. As the size of the sampling area increases, the number of bird species found also increases (after Preston, 1960).

Species-area curves for different animal groups

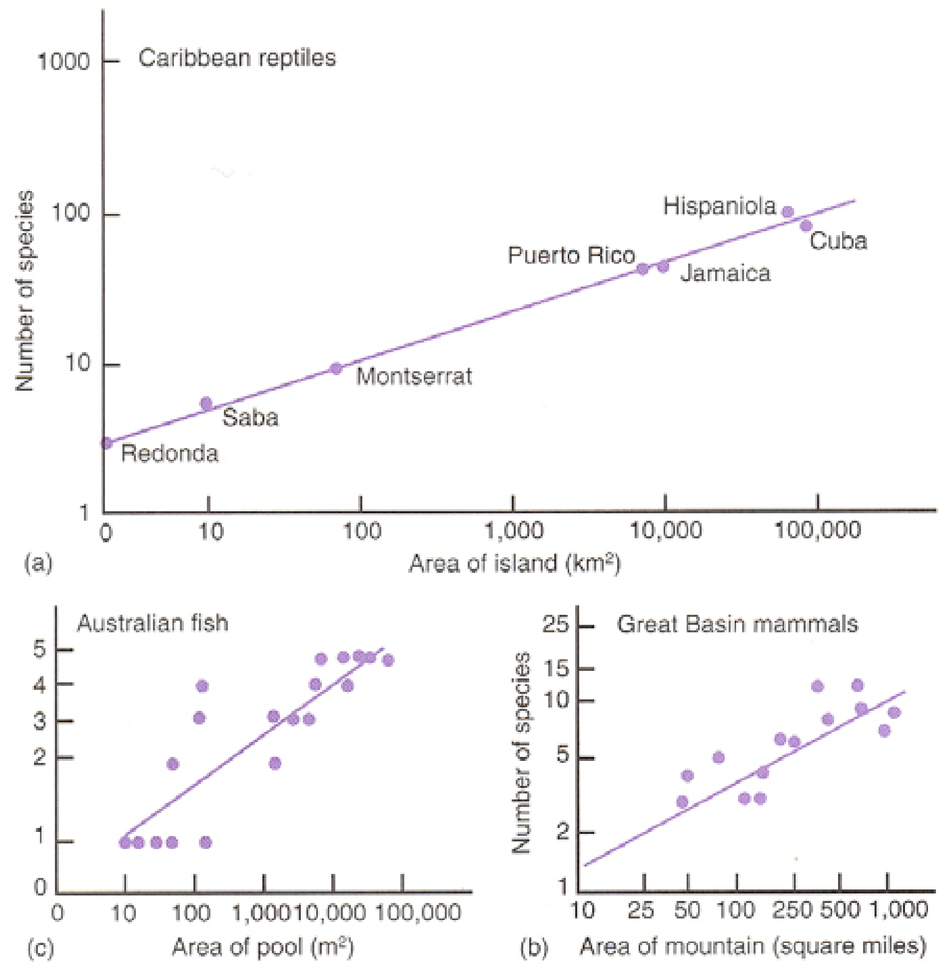
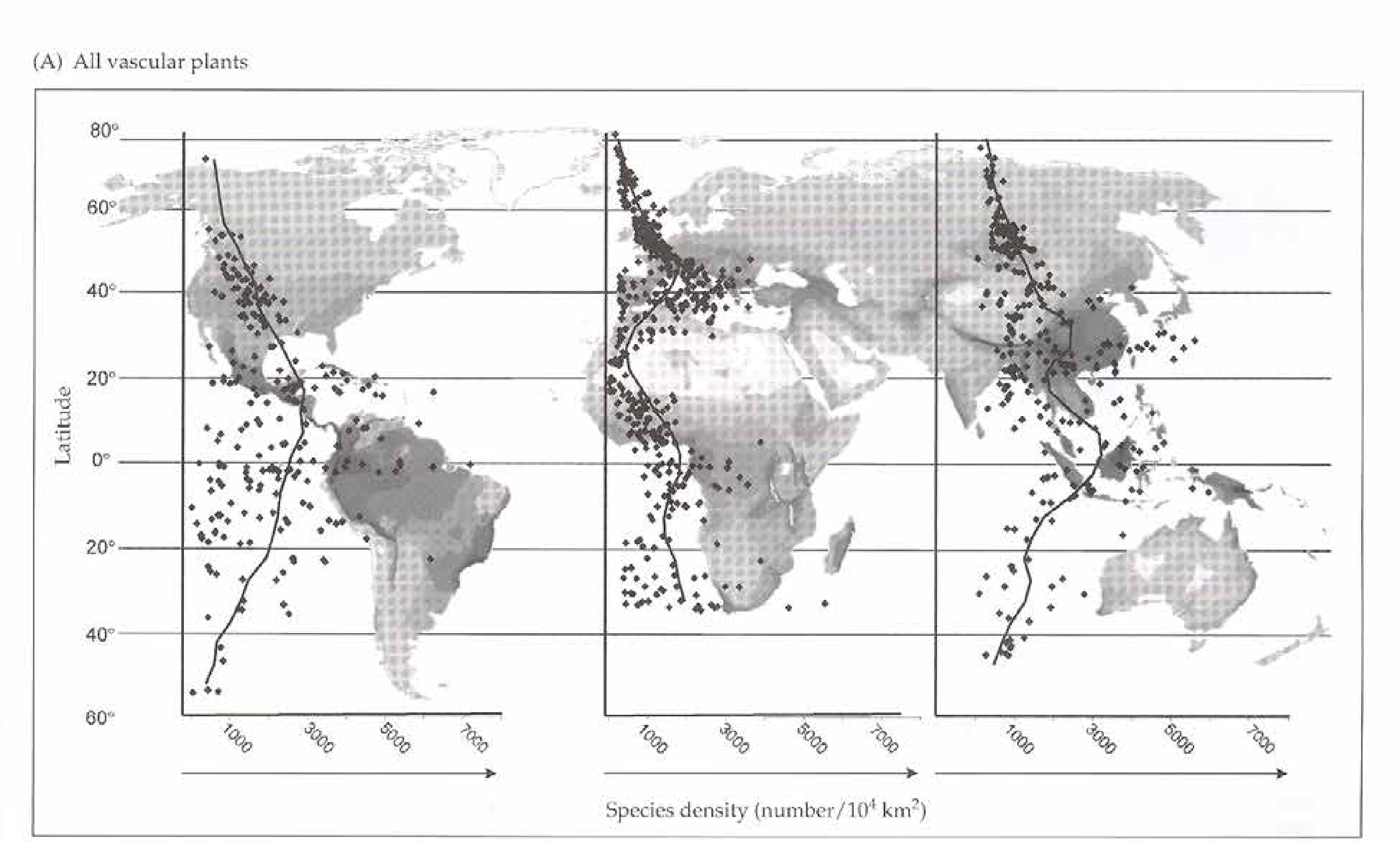


FIGURE 14.9 The relationship between island area and species richness for reptiles and amphibians in the Caribbean. The relationship between fish species richness and spring-pond size in the Australian desert, and between boreal mammal species richness and montane habitat area on isolated mounatins in the Great Basin of North America (after MacArthur and Wilson, 1967; Kodric-Brown and Brown, 1993; and Brown, 1971).

Geographic patterns of biodiversity



Lomolino et al., 2006

Latitudinal gradients of biodiversity

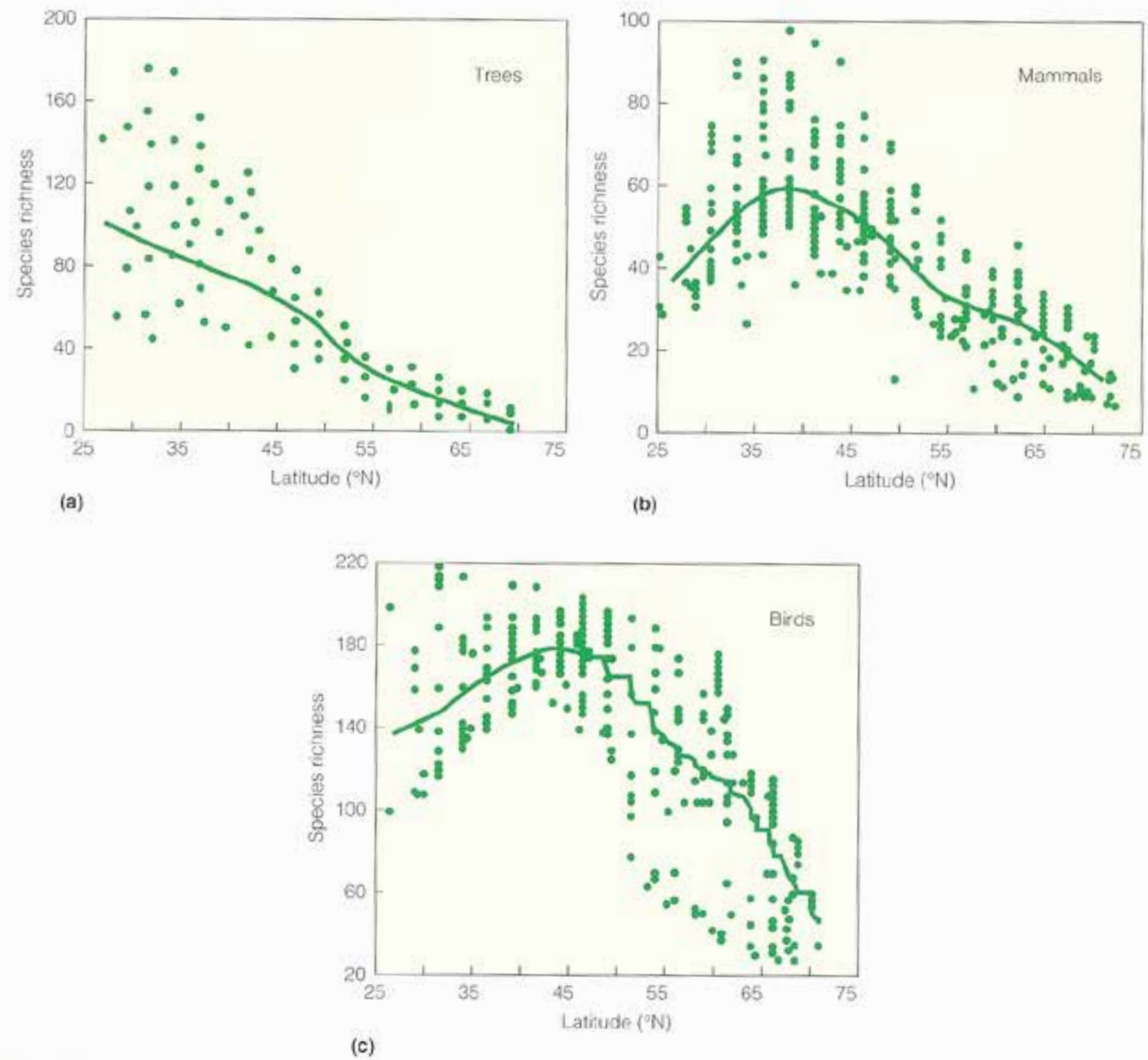
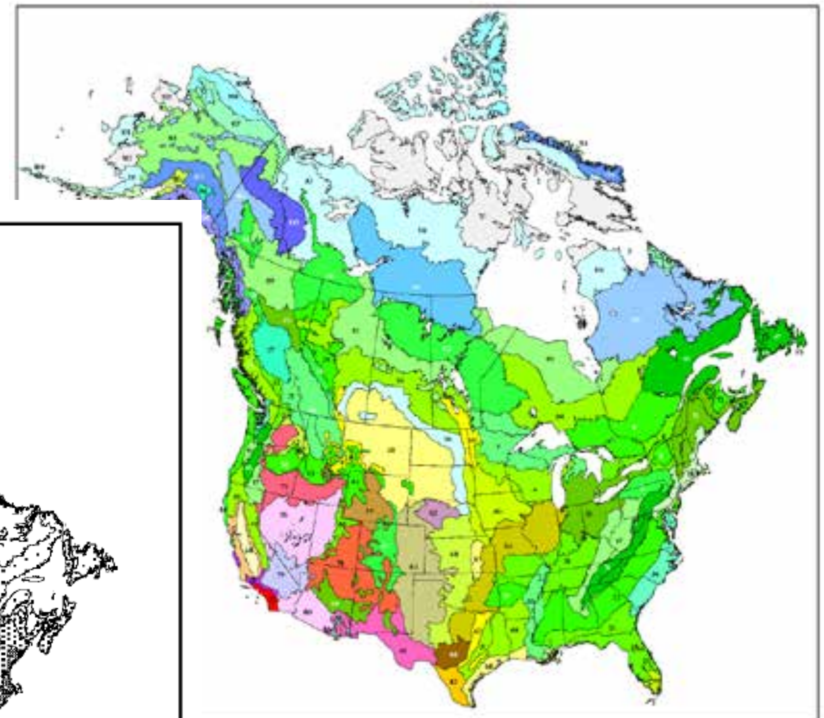


Figure 26.7 | North American latitudinal gradients in species richness for **(a)** trees, **(b)** mammals, and **(c)** birds based on cells of 2.5° × 2.5° latitude/longitude. Species richness per cell is based on range maps for individual species. (Adapted from Currie 1991.)

Smith and Smith, 2006

Geographic patterns of biodiversity

WWF ecoregions



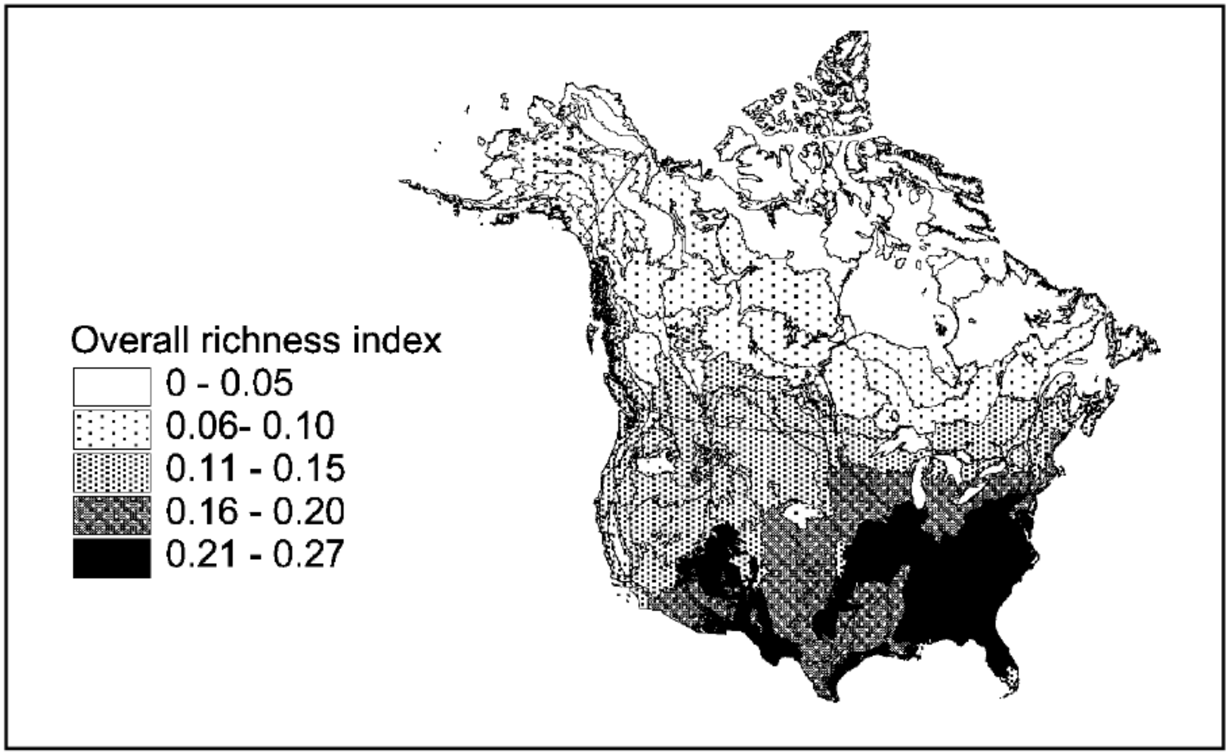


Figure 2. Map of overall richness index. This map incorporates richness values for all nine taxa: mammals, birds, reptiles, amphibians, butterflies, tiger beetles, land snails, trees, and nontree vascular plants.

Ricketts et al., 1999

Species richness (S) at high latitudes is 1-10% of S at lower latitudes

TABLE 14.2 Examples of Latitudinal Gradients of Species Richness for Selected Terrestrial and Marine Organisms

Organism	Region	Low Lat. Species	Richness	High Lat. Species	Richness
Mammals	N. America	8° N	240	66° N	21
Mammals	S. America	13° N	327	54° S	26
Land birds	N. America	8° N	600	66° N	50
Reptiles	N. America	30° N	60	45° N	10
Amphibians	N. America	30° N	40	45° N	10
Ants	S. America	20° S	220	55° S	2
Orchids	S. America	0°	2500	55° S	15
Marine fish	N. America	32° N	229	42° N	119
Marine mollusks	N. America	25° N	500	50° N	65

Source: Brown and Lomolino, 1998.

low latitudes

high latitudes

S at higher elevations is less than that of S at lower elevations

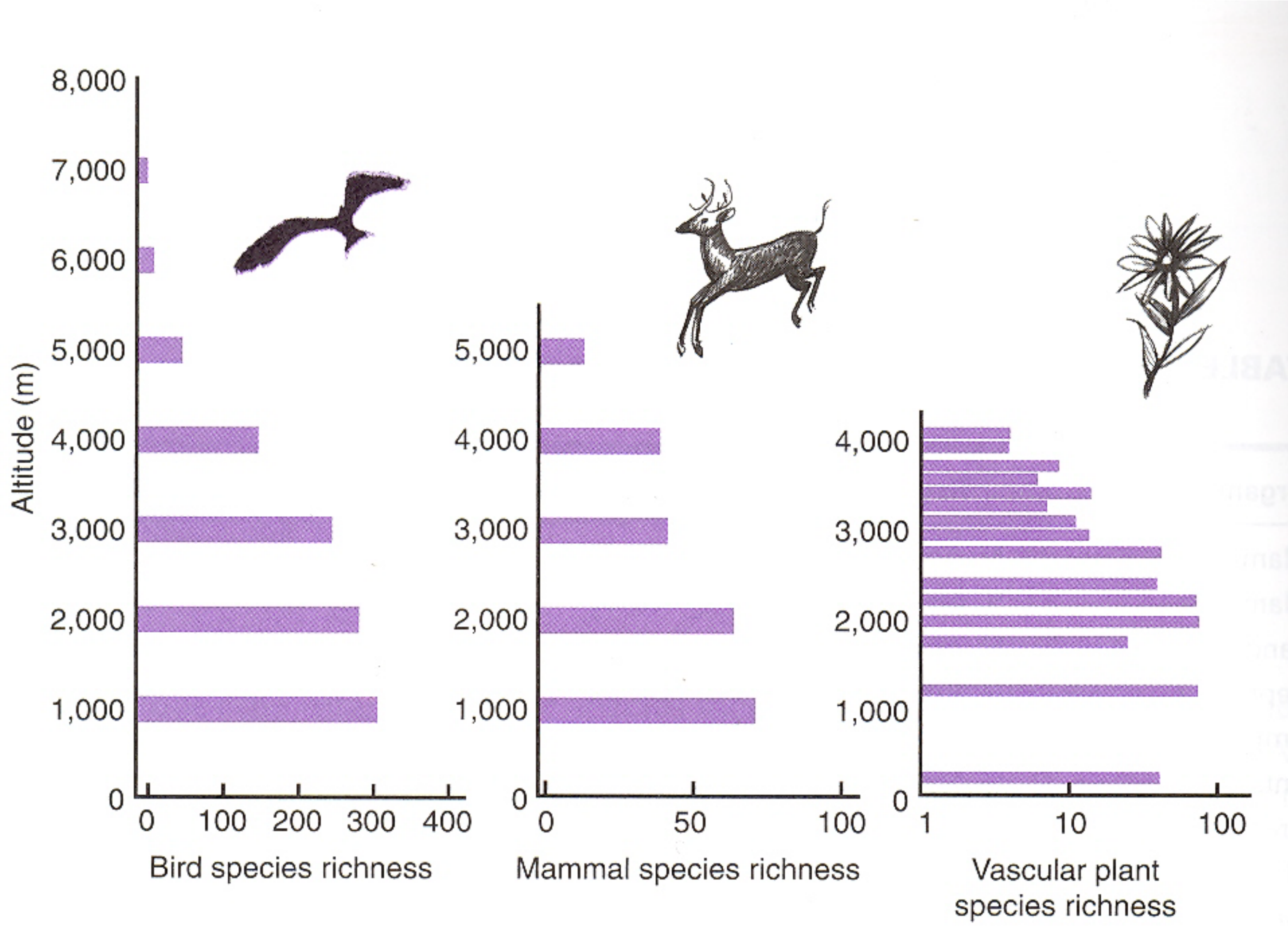


FIGURE 14.4 Declining species richness of birds and mammals at higher elevations in the Himalayan Mountains (after Begnn et al. 1996; Hunter and Yonzon, 1992; Whittaker, 1997).

Fragmentation of tropics drove allopatric speciation

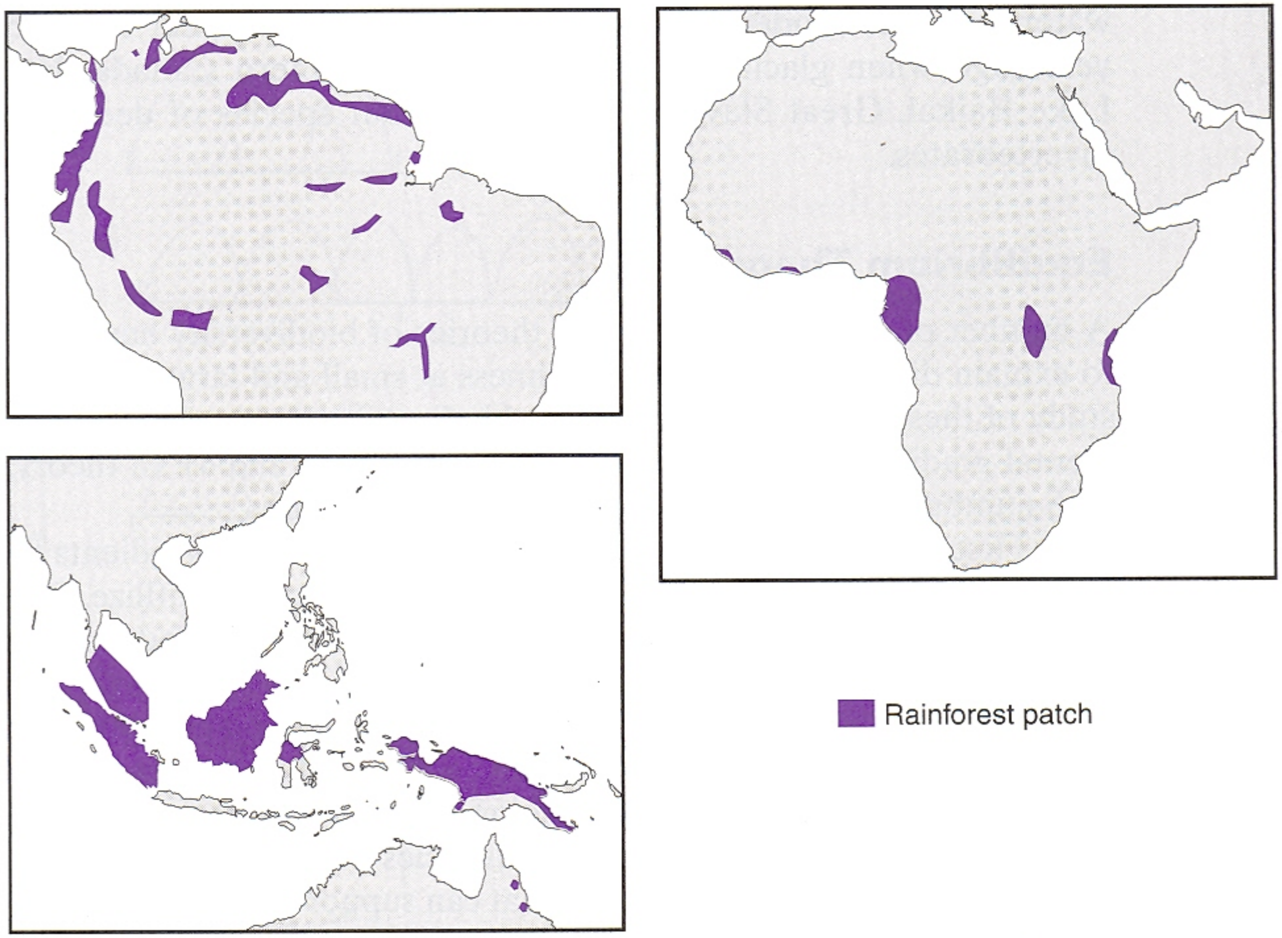


FIGURE 14.5 Suggested extent of tropical rainforest in South America, Africa, and Southeast Asia during the last glacial maximum approximately 20,000 years ago (after Tallis, 1991). However, not all biogeographers believe that the fragmentation of rainforest was so severe.

Local biodiversity differences can be explained by historical theory

Lake Baikal: 1 M years old:
580 benthic invertebrates, many endemic

www.lib.utexas.edu/maps/middle_east_and_asia/asia_ref04.jpg

Great Slave Lake: 10,000 years old:
4 benthic invertebrates

www.worldlakes.org/uploads/GreatSlave
%20Lake_locatmap.gif

Relevant theories about resource gradients and niches

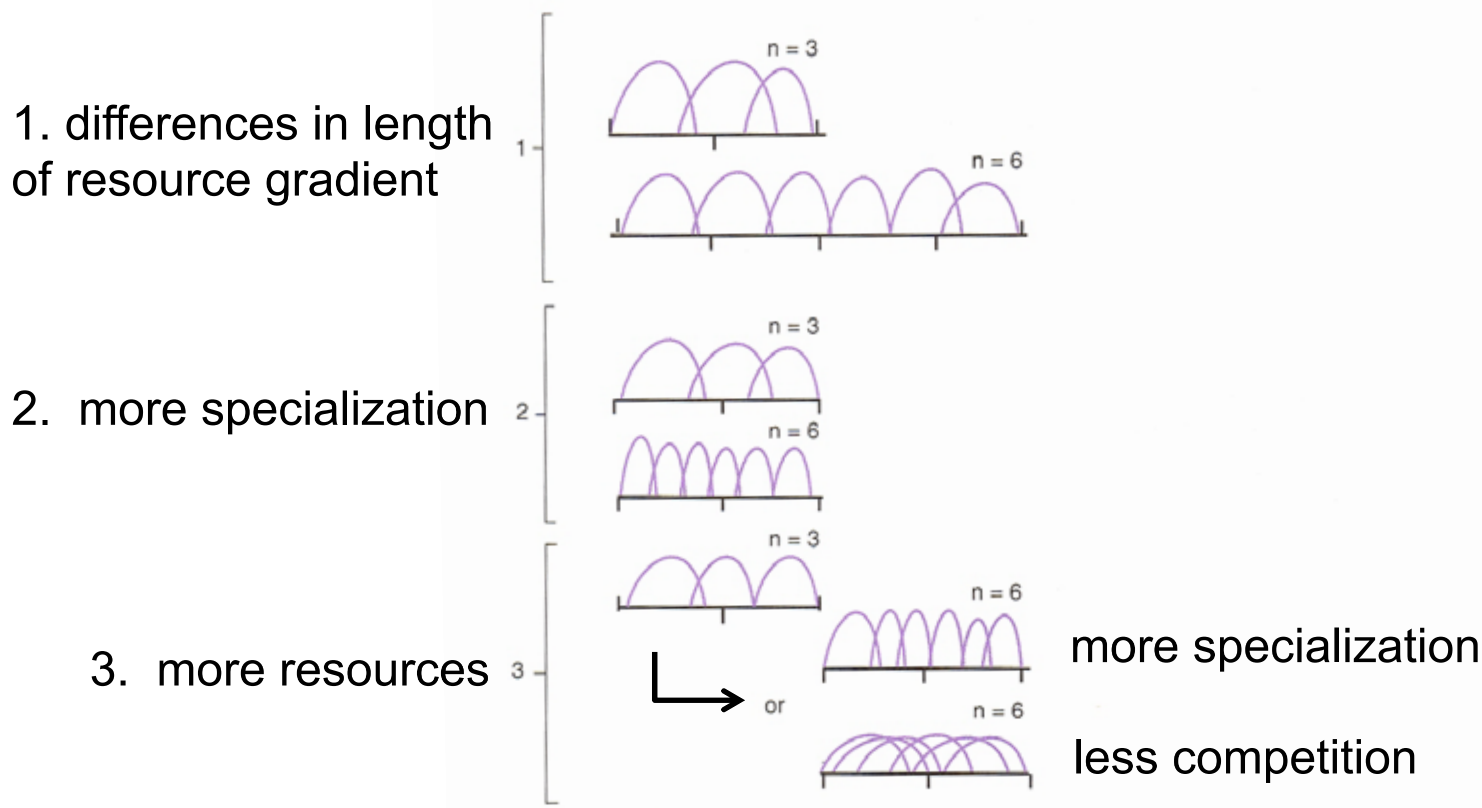
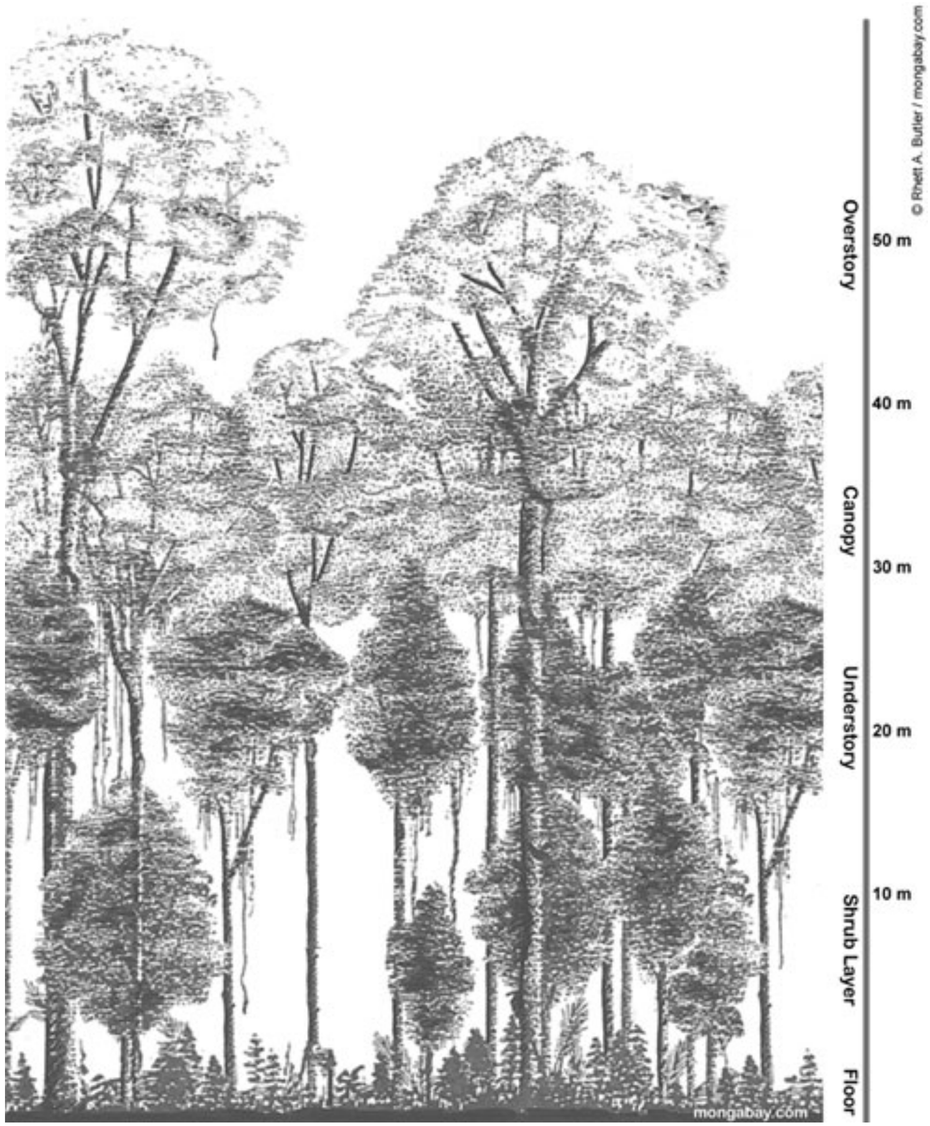


FIGURE 14.6 Hypothetical resource gradients and niche spaces for species in low- and high-diversity geographic areas. The first example represents a situation in which the high-diversity region has greater environmental variability and thus greater gradient length and available niche space. The second example represents a situation in which gradient lengths are equal, but the the region with high biodiversity accommodates more species because the organisms living there possess more specialized niches and require less length along the resource gradient. The third example represents a situation in which resource abundance is higher in the area with high biodiversity and thus can accommodate more species either because (a) the abundance of the resource allows the area to support very specialized species that exist using a small portion of the resource gradient and niche space, or (b) they must compete less for the abundant resources and have greater gradient and niche overlap.

Habitat variability influences biodiversity



Vertical structure of a rainforest

www.mongabay.com

Increases in bird species diversity in response to habitat variability

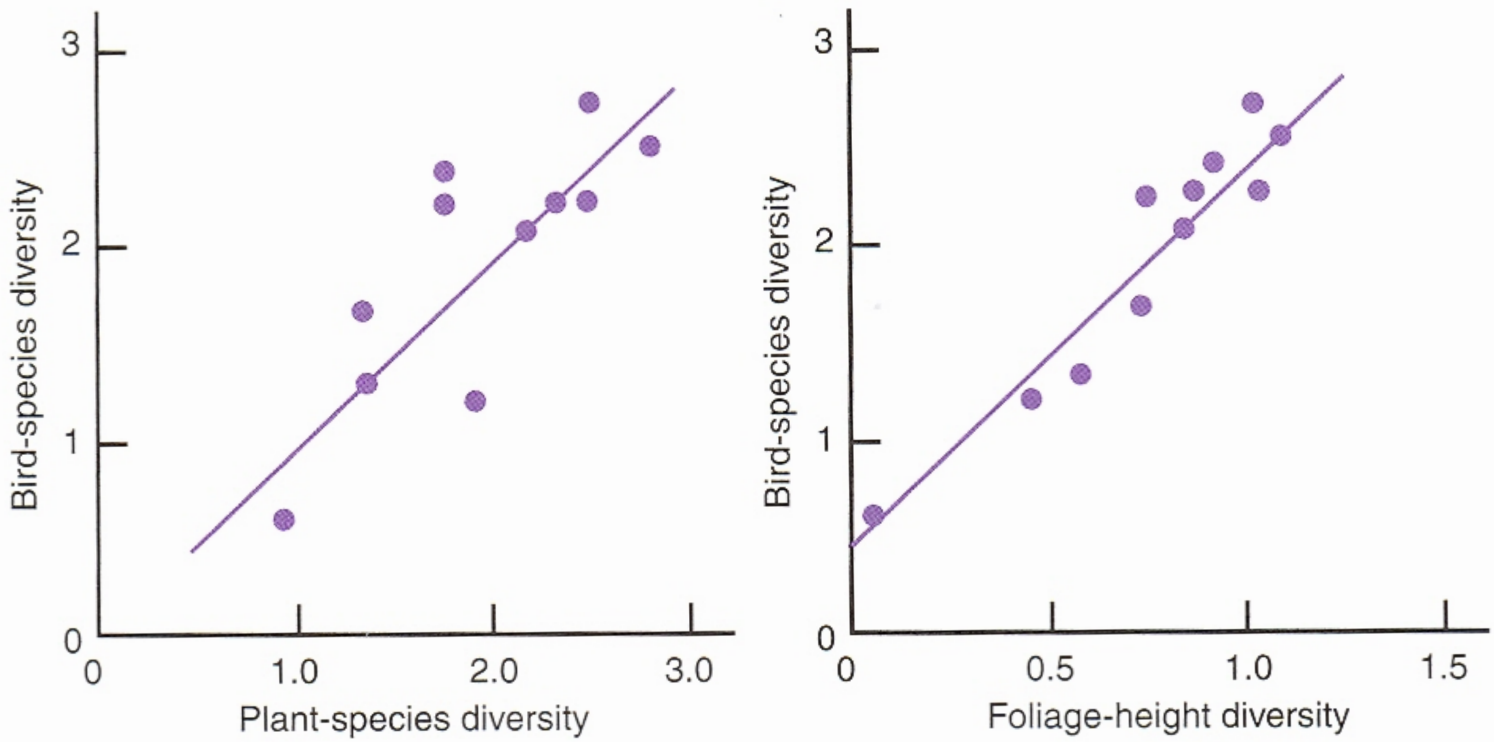
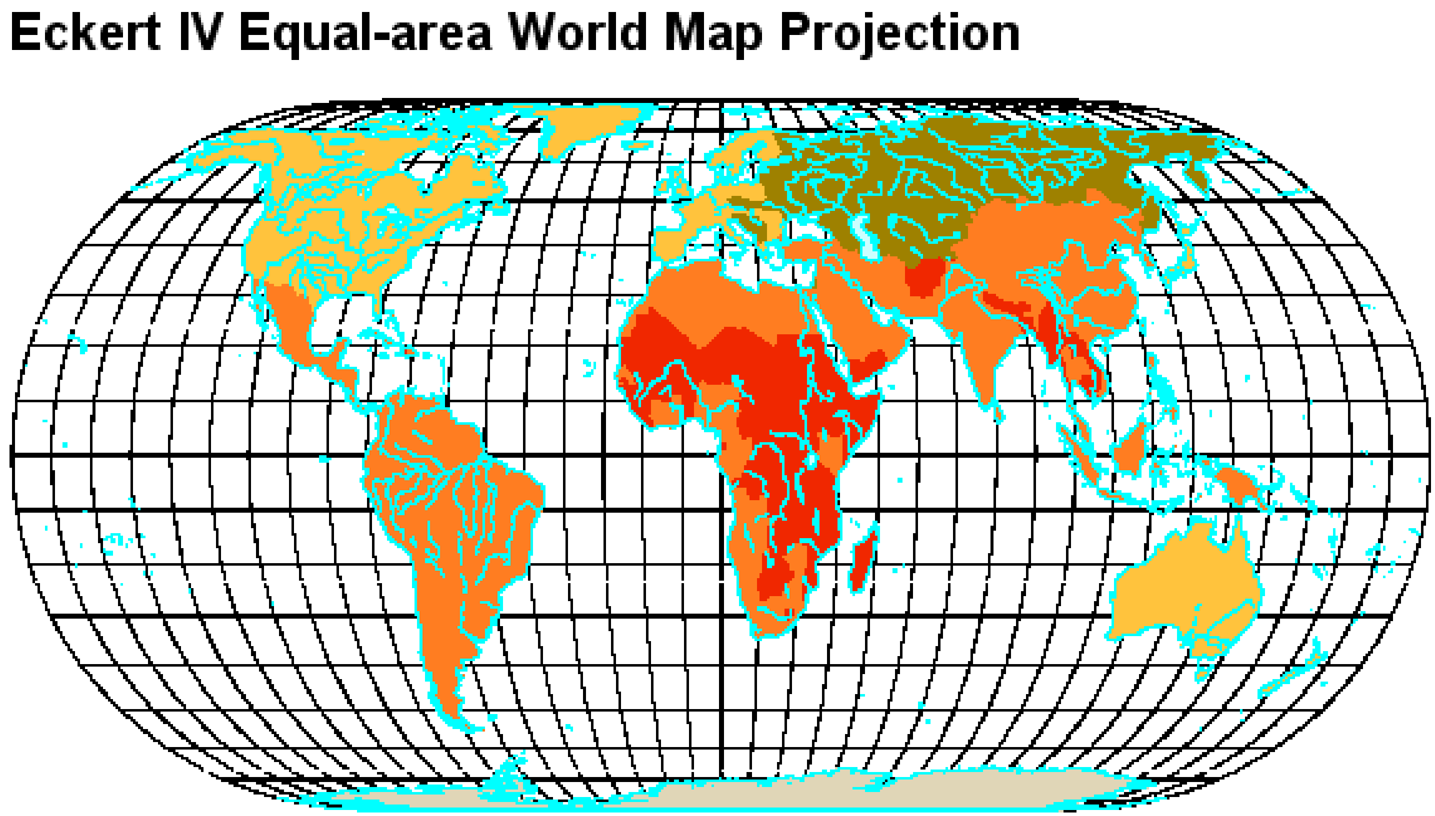


FIGURE 14.7 The relationship between bird species diversity in the deciduous forest of the eastern United States and vegetation structure (after MacArthur and MacArthur, 1961)

Large area in tropics allows for greater S



atlas.nrcan.gc.ca/site/english/learningresources/carto_corner/eckert.gif/image_view

Intermediate Disturbance Hypothesis

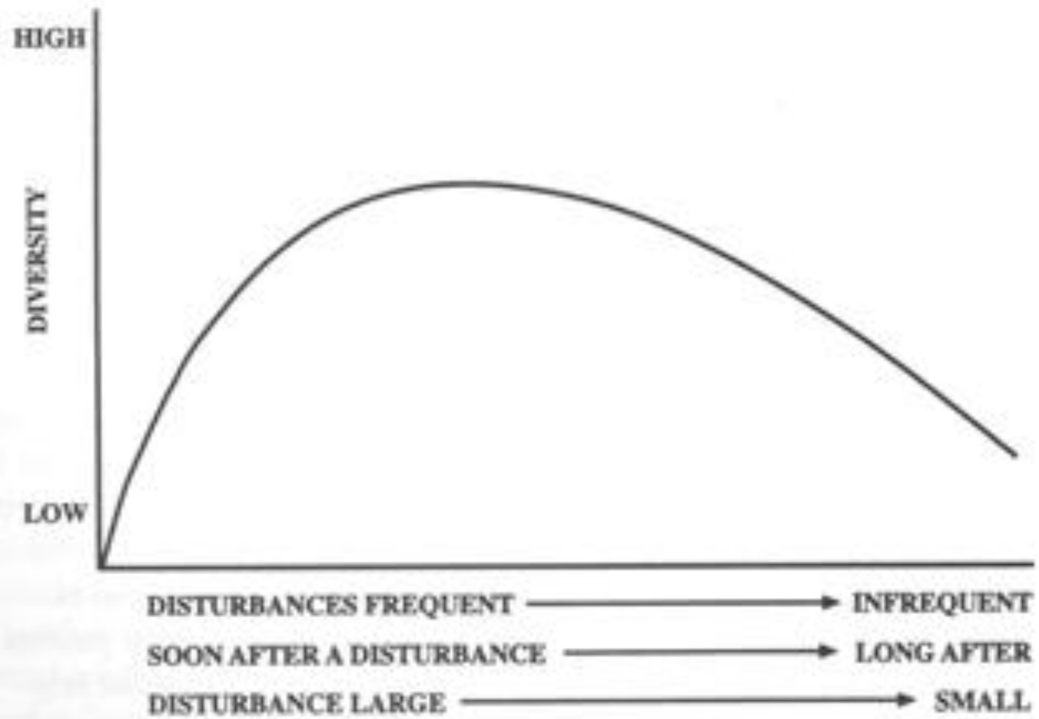


FIGURE 3-3.
The intermediate disturbance hypothesis. The greatest biological diversity is expected to occur at intermediate levels of disturbance. (Modified from Connell 1978.)

efc.muskie.usm.maine.edu/Landscape_Ecology_for_Planners_files/slide0061_image078.jpg

Following disturbances, where is biodiversity highest?

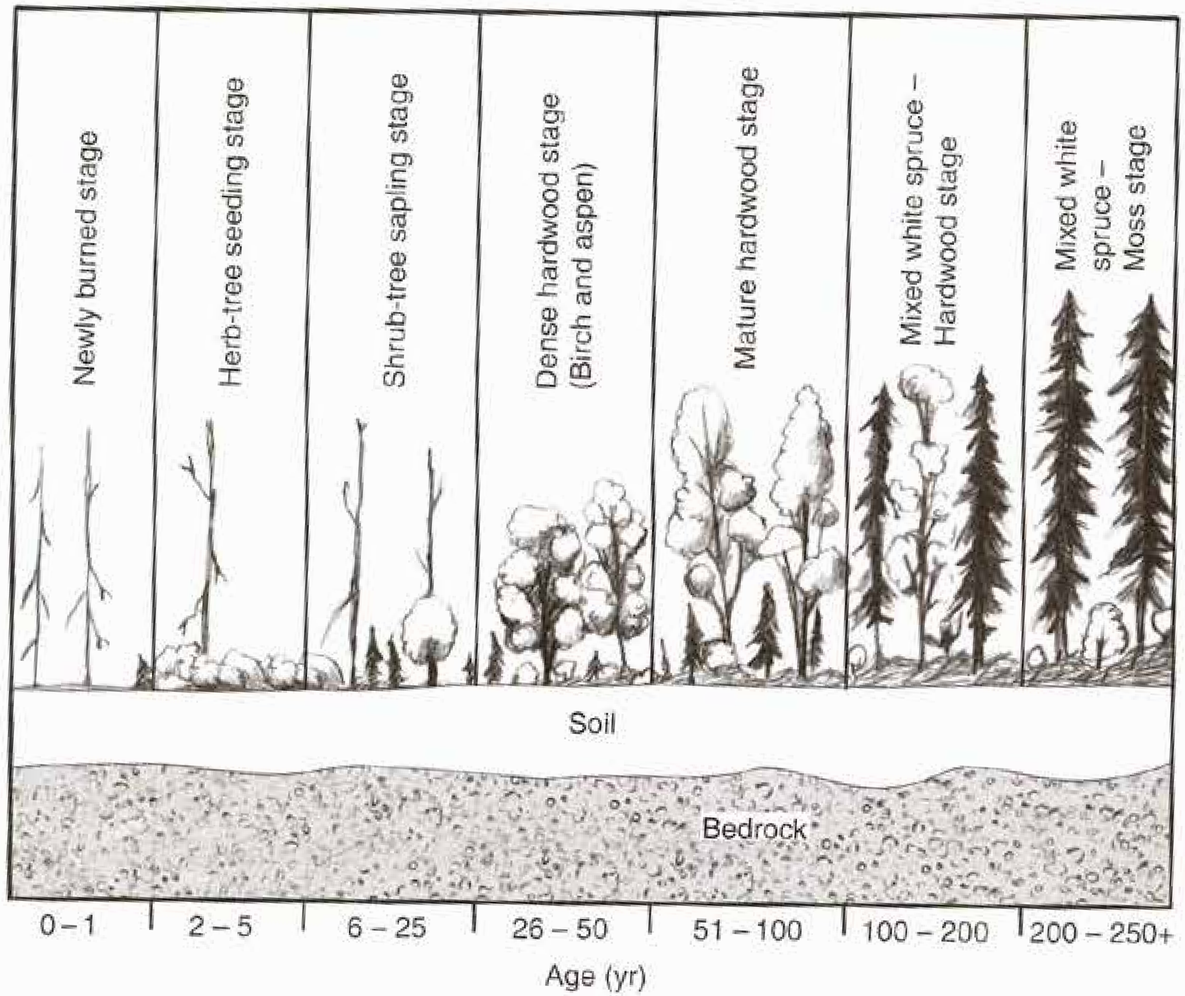


FIGURE 5.7 Idealized post-fire succession in a boreal white spruce *(Picea glauca)* forest (after Van Cleve and Viereck, 1981).

Evidence against disturbance as a control on global biodiversity patterns

Intense, frequent fires

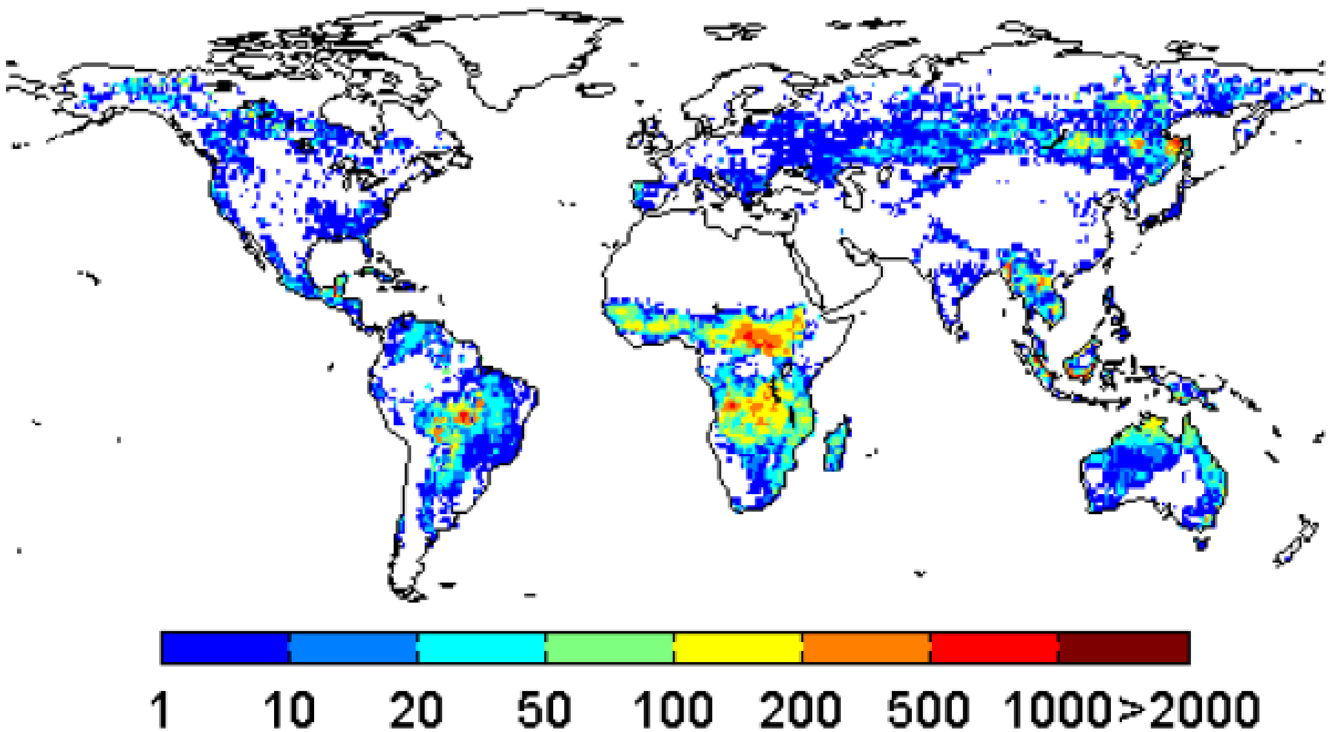


Fig. 6. Mean annual fire emissions (g C m^{-2} $year^{-1}$) averaged ov
1997–2004.

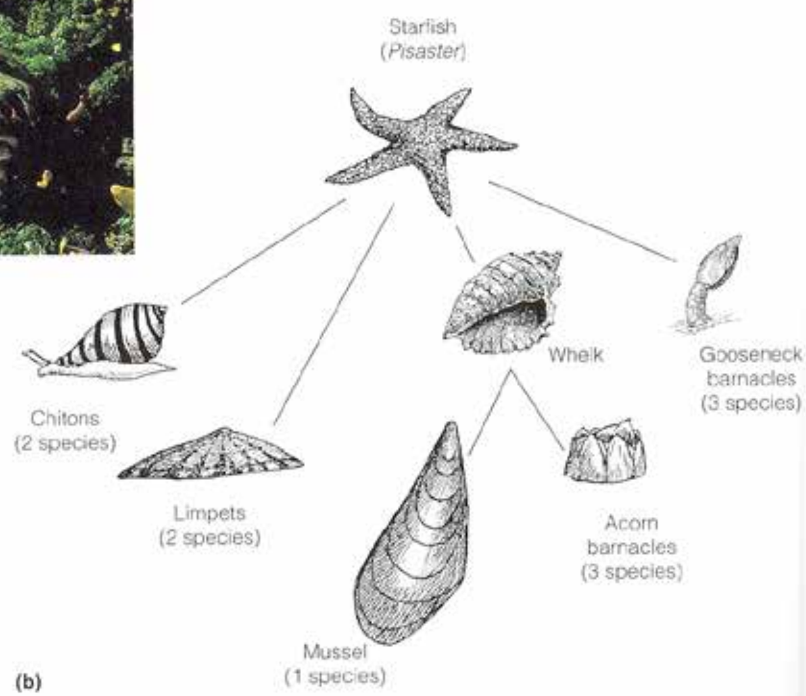
van der Werf et al., 2006

Predator controls on biodiversity

Artificial exclusion experiments

(a)

Figure 17.4 | **(a)** The rocky intertidal zone of the Pacific Northwest coast is inhabited by a variety of species including starfish, barnacles, limpets, chitons, and mussels. **(b)** A food web of this community shows that the starfish *Pisaster* preys on a variety of invertebrate species. The experimental removal of *Pisaster* from the community reduced the diversity of prey species as a result of increased competition. (Adapted from Paine 1969.)



(b)

Prey species before: 15
Prey species after: 8

Smith and Smith, 2006

Increases in diversity with increasing evapotranspiration

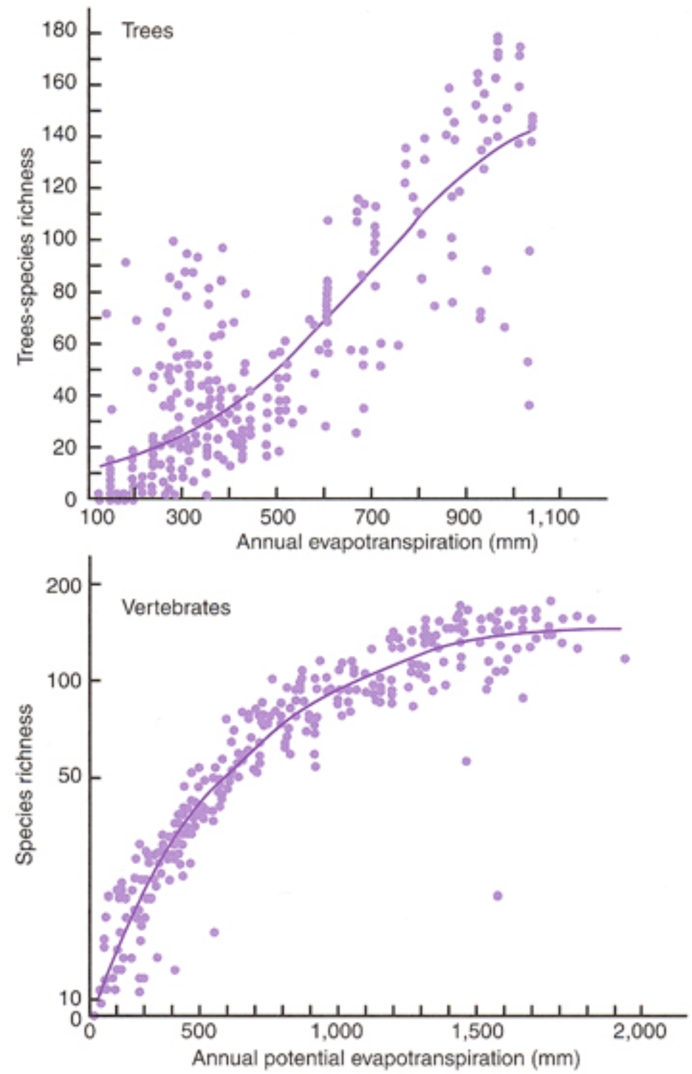


FIGURE 14.8 The relationship between energy and moisture as measured by evapotranspiration and the species diversity of trees and vertebrates in North America (after Currie, 1991).

Types of ecosystem services

Provisioning services

Products obtained from ecosystems

- Food
- Fresh water
- Fuelwood
- Fiber
- Biochemicals
- Genetic resources

Regulating services

Benefits obtained from regulation of ecosystem processes

- Climate regulation
- Pest regulation
- Runoff regulation
- Water purification
- Pollination
- Erosion regulation

Cultural services

Non-material benefits obtained from ecosystems

- Spiritual and religious
- Recreation and ecotourism
- Aesthetic and inspirational
- Educational
- Cultural heritage
- Existence values

Supporting services

Services necessary for the production of all other ecosystem services

- Soil formation
- Nutrient cycling
- Primary production
- Provision of habitat
- Oxygen production

Biodiversity: Life on Earth

Pereira and Cooper, 2006