Basics of Biodiversity

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Important Terms

- **Alpha, beta and gamma diversity**. The species diversity (or richness) of a local community or habitat (α-), the difference in diversity associated with differences in habitat or spatial scale (β-), and the total diversity of a region or other spatial unit (γ)
- **Biodiversity**. The variety of life, at all levels of organization, classified both by evolutionary (phylogenetic) and ecological (functional) criteria
- **Diversity index**. A mathematical expression that combines species richness and evenness as a measure of diversity.
- **Evenness**. A measure of the homogeneity of abundances in a sample or a community
- **Functional diversity**. The variety and number of species that fulfill different functional roles in a community or ecosystem

- **Relative abundance**. The quantitative pattern of rarity and commonness among species in a sample or a community
- **Richness estimator**. A statistical estimate of the true species richness of a community or larger sampling universe, including unobserved species, based on sample data
- **Species accumulation curve**. The observed number of species in a survey or collection as a function of the accumulated number of individuals or samples
- **Species–area relation**. The generally decelerating but ever-increasing number of species as sampling area increases
- **Species richness**. The number of species in a community, in a landscape or marine scape, or in a region
- **Keystone Species:** Within biological communities, certain species may be important in determining the ability of large numbers of other species to persist in the community. These crucial species have been termed **keystone species** (Paine, 1966; Terborgh, 1986). Protecting keystone species is a priority for conservation efforts, because if a keystone species is lost from a conservation area, numerous other species might be lost as well.

UMBRELLA SPECIES

Umbrella species are **species** selected for making conservation-related decisions, typically because protecting these **species** indirectly protects the many other **species** that make up the ecological community of its habitat.

Examples

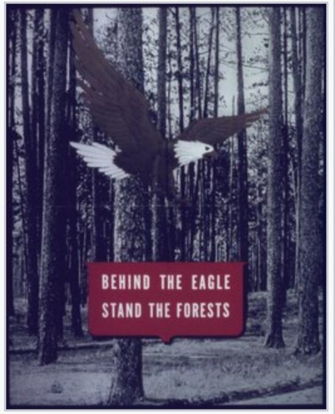
- Northern spotted owls and old-growth forest: Molluscs and salamanders are within the protective boundaries of the northern spotted owl.
- Bay checkerspot butterfly and grasslands.
- Amur tigers in the Russian Far East are considered umbrella/keystone species due to their impact on the deer and boar in their ecosystem.

FLAGSHIP SPECIES

In conservation biology, a flagship species is a species chosen to raise support for biodiversity conservation in a given place or social context. Definitions have varied, but they have tended to focus on the strategic goals and the socio-economic nature of the concept, to support the marketing of a conservation effort. The species need to be popular, to work as symbols or icons, and to stimulate people to provide money or support.

Species selected since the idea was developed in 1980s include widely recognised and charismatic species like the black rhinoceros, the Bengal tiger, and the Asian elephant. More locally significant species like the Chesapeake blue crab and the Pemba flying fox have suited a cultural and social context.

Eurasian lynx as flagship for a protected area in Poland

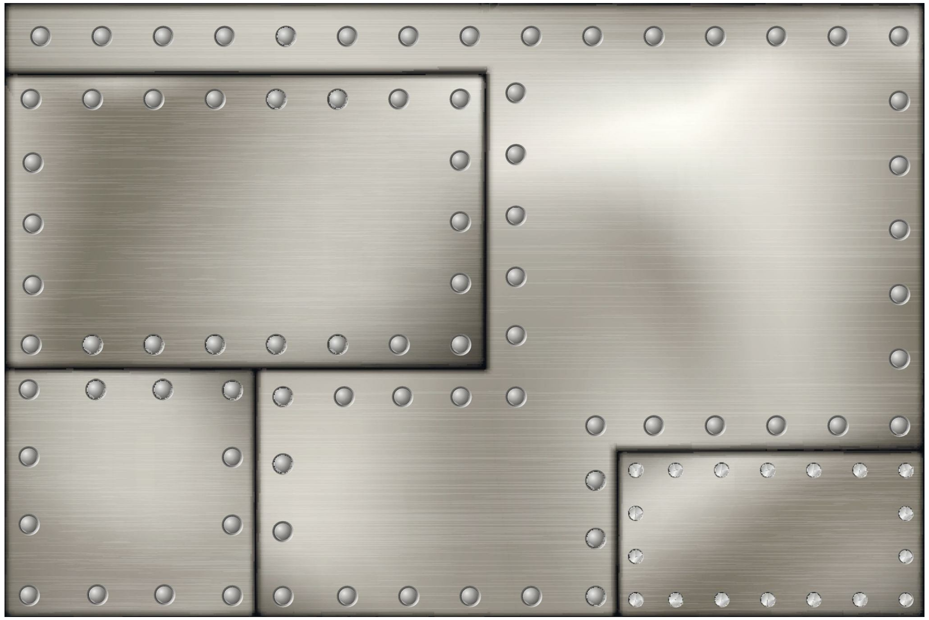


Bald eagle as flagship for forests in the United States

5000 Tanzanian shillings bank note with Black rhinoceros as flagship for the country's wildlife

Rivet popper hypothesis

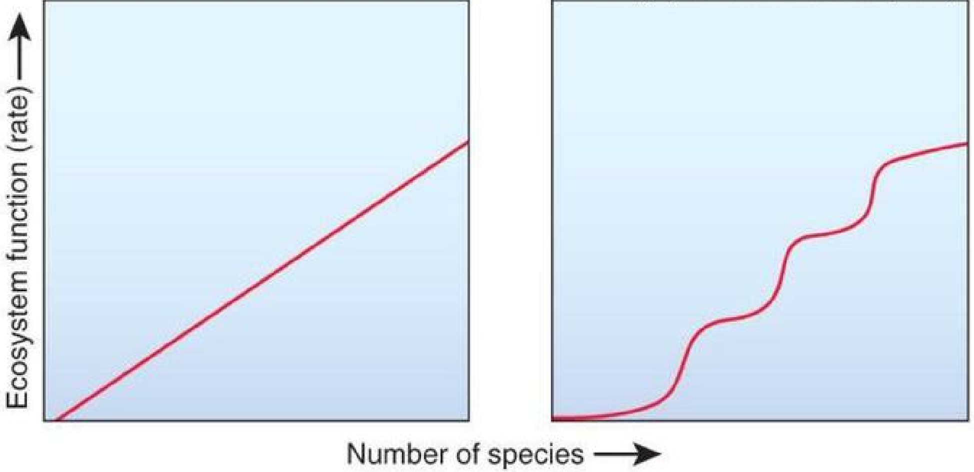
Rivet: a short metal pin or bolt for holding together two plates of metal, its headless end being beaten out or pressed down when in place



Rivet popper hypothesis

- Ecologist Paul Ehrlich gave rivet popper hypothesis to help understand the contribution species richness, He compared each species with rivet in the body of an airplane. (i) This hypothesis explains that ecosystem to be an airplane and the species to be the rivets joining all parts together. (ii) If every passenger travelling in the airplane start taking rivets home (causing a species to become extinct), initially it may not affect flight safety (proper functioning of ecosystem), but over a period of time the plane becomes weak and dangerous (species become endangered and then extinct).

- How much diversity for proper function?
  - Elton’s hypothesis linking diversity and stability suggests a linear correlation between diversity and ecosystem function
  - Rivet hypothesis – species are like rivets with each playing a small critical role

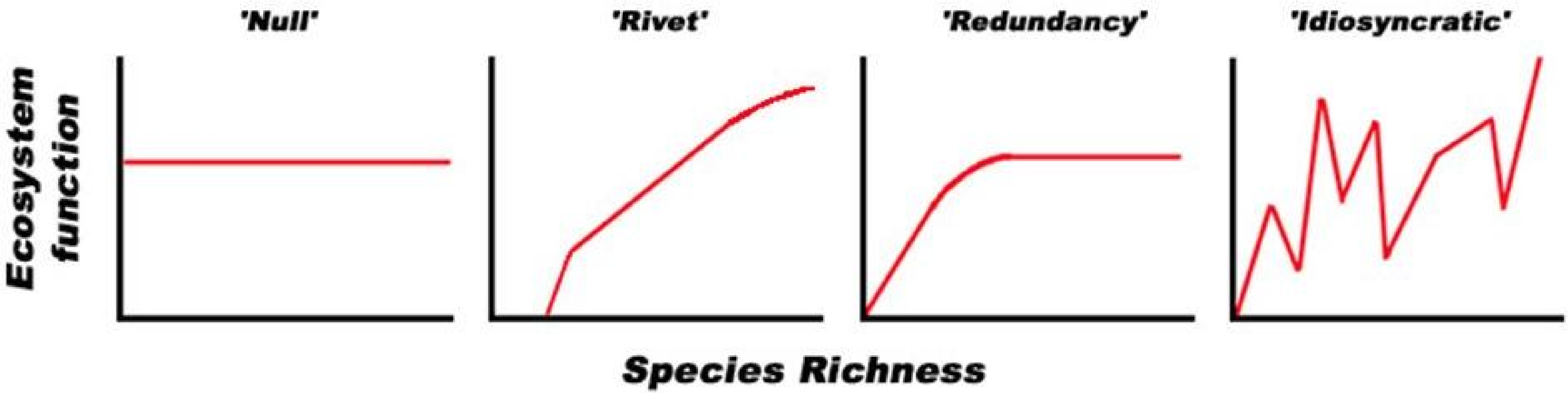


(a) Diversity-stability hypothesis (b) Rivet hypothesis

Rivet — All species make a significant contribution to function and a decrease in diversity leads to a progressive decline in function

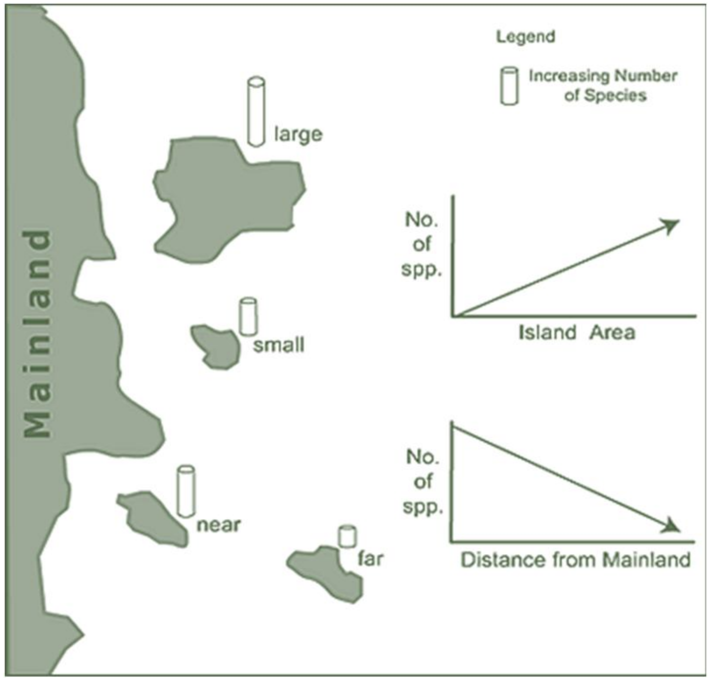
Idiosyncratic — Changes in diversity will result in changes in function, but the direction and magnitude of any response are inherently unpredictable

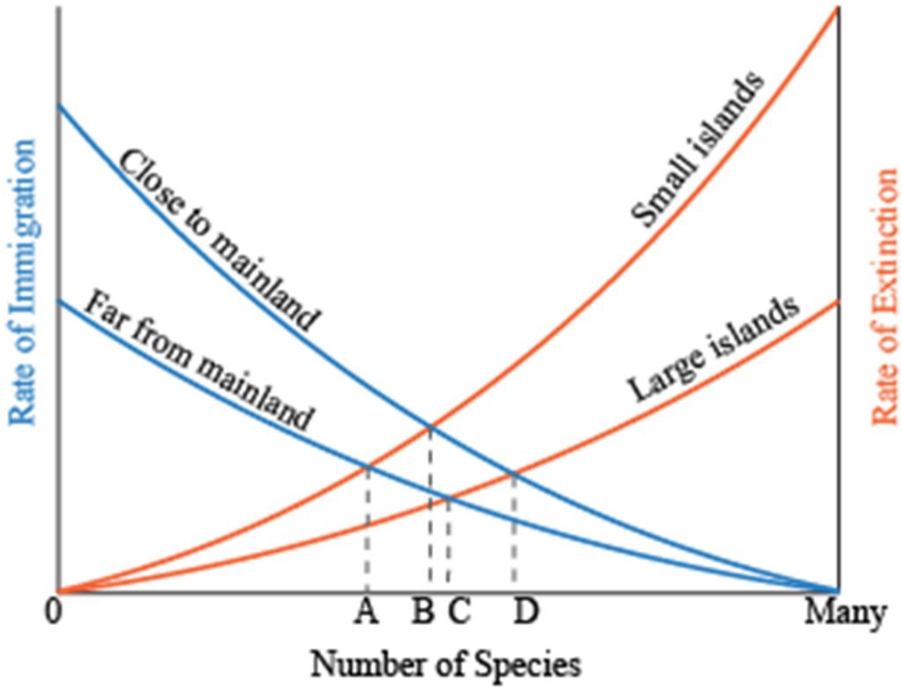
Redundancy — As long as all functional groups are represented, system functioning is independent of diversity



Species Area Relationship

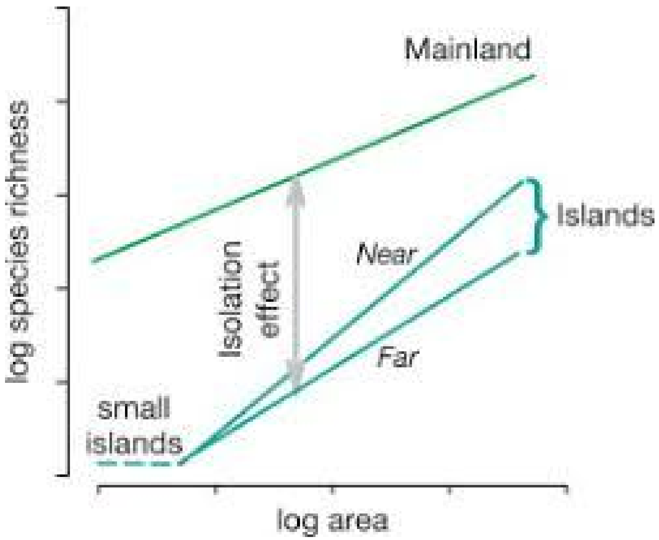
- MacArthur and Wilson proposed the "equilibrium model of island biogeography" in the 1960ís.
- The basic idea of the model is that the number of species on an island is determined by the immigration of new species and the extinction of species already present; when these two rates balance one another, the species number is at equilibrium. An important assumption of the model is that the population sizes for each species are proportional to island size.

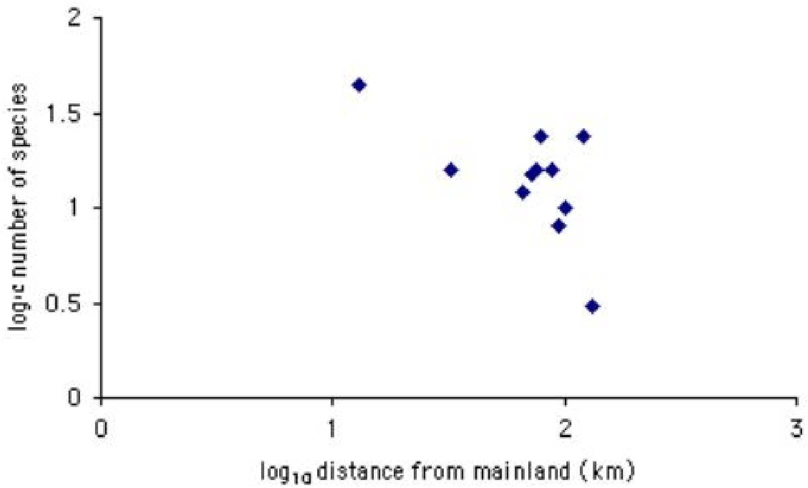




Situation 1: distance difference

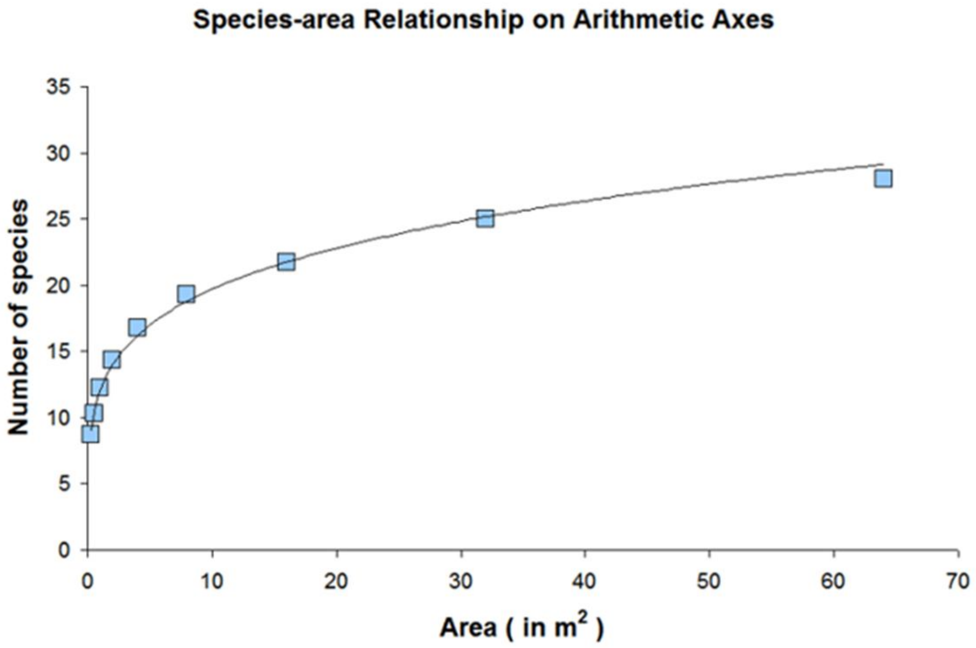
On the other hand, if we have two islands equal in size and habitat diversity but at different distances from the source, then extinction rates would be expected to be the same, but immigration rates would be higher for the nearer island, and at equilibrium the near island would have more species.

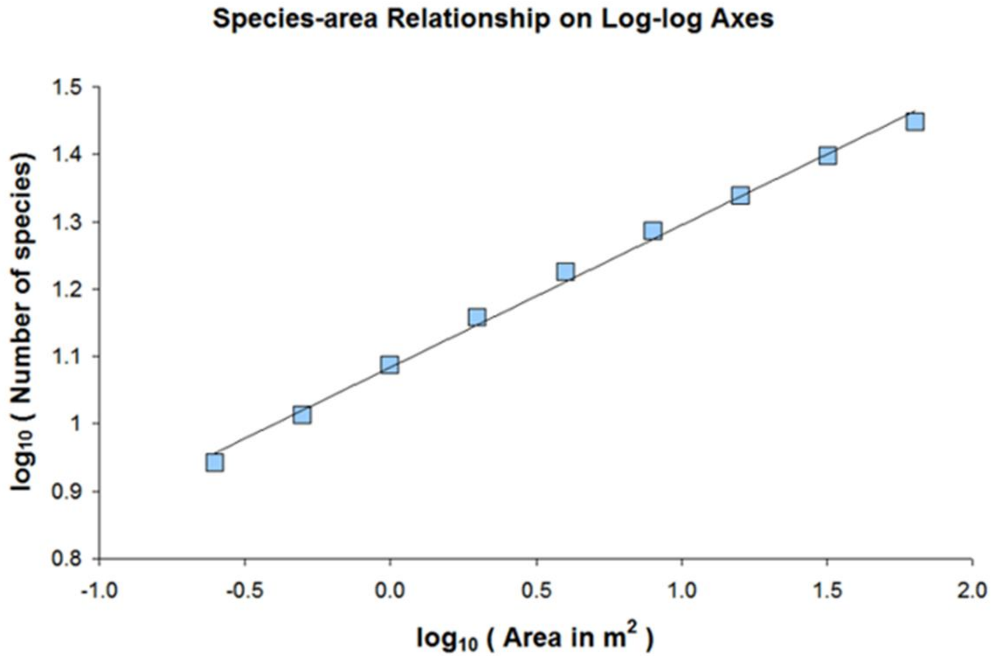




Situation 2: size difference

All other things being equal (habitat diversity and distance to the mainland or source of colonizing species), if we have two islands with the same immigration rates, we would expect extinction rates on large islands to be lower because of their larger population sizes. Therefore larger islands, at equilibrium, would have a greater number of species.





Species-Area Curves

$$S = cA^2$$

S = species richness

A = size of the sampling plot (eg. m^2)

c and ***z*** are fitting parameters

- **_c_ is higher in _biodiverse_ areas**
- **_z_ is higher where species richness rises quickly with area**

$$\log S = (\log c) + z(\log A)$$

- **Importance of Species Area relationship:** Spatial diversity patterns have important implications for conservation of biodiversity, and understanding these patterns contributes to our knowledge of community structure.
- Further, both island size and distance from the mainland are associated with the number of species present. In general, it has been found that the relationship between island area and number of species present is fairly constant for islands in a given geographic region. In this way it is possible to make potentially useful predictions about the number of species on islands (or habitat islands) when little information other than size is available. For conservation planning, knowledge of this relationship is of utmost importance.