Zoogeography

Lesson 8

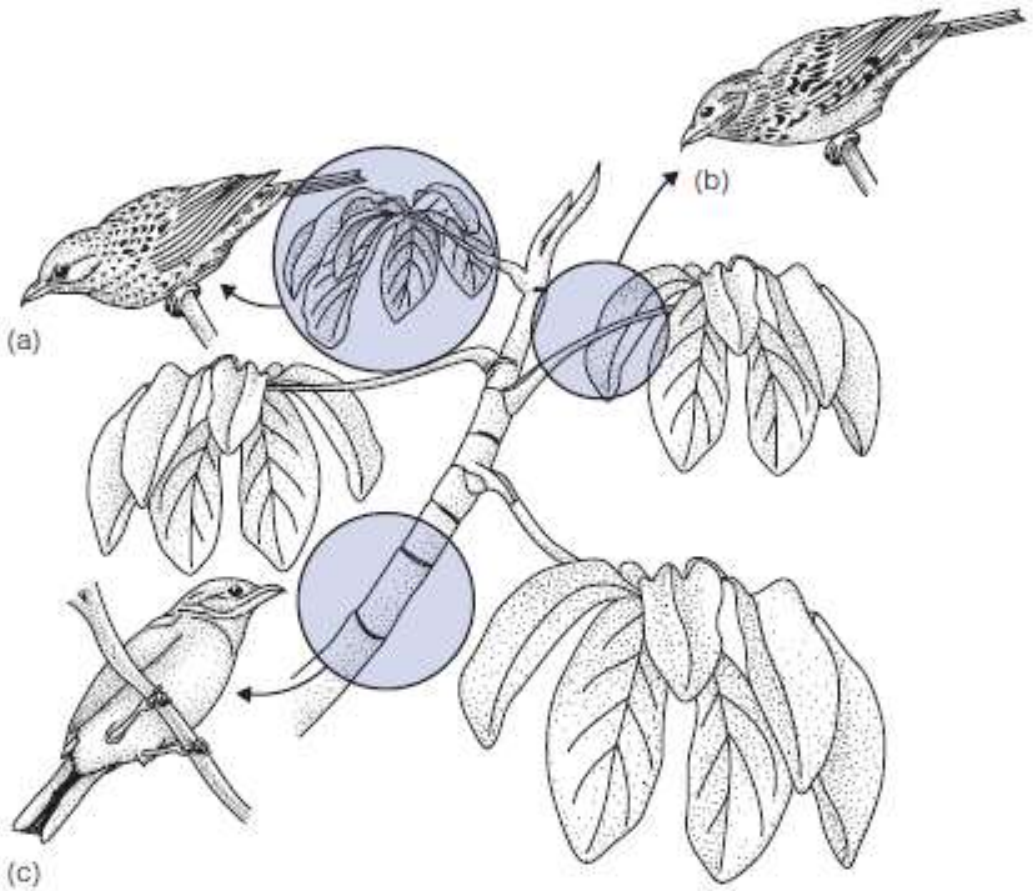

Figure 2.37 Three species of tanager that coexist in the same forest on the island of Trinidad in the West Indies. All feed on insects, but they exploit different microhabitats within the canopy and thus avoid direct competition. (a) The speckled tanager takes insects from the underside of leaves; (b) the turquoise tanager obtains its insects from fine twigs and leaf petioles; and (c) the bay-headed tanager preys upon insects on the main branches.

(a) the speckled tanager (*Tangara guttata*)

(b) the bay-headed tanager (*Tangara gyrola*)

(c) the turquoise tanager (*Tangara mexicana*)

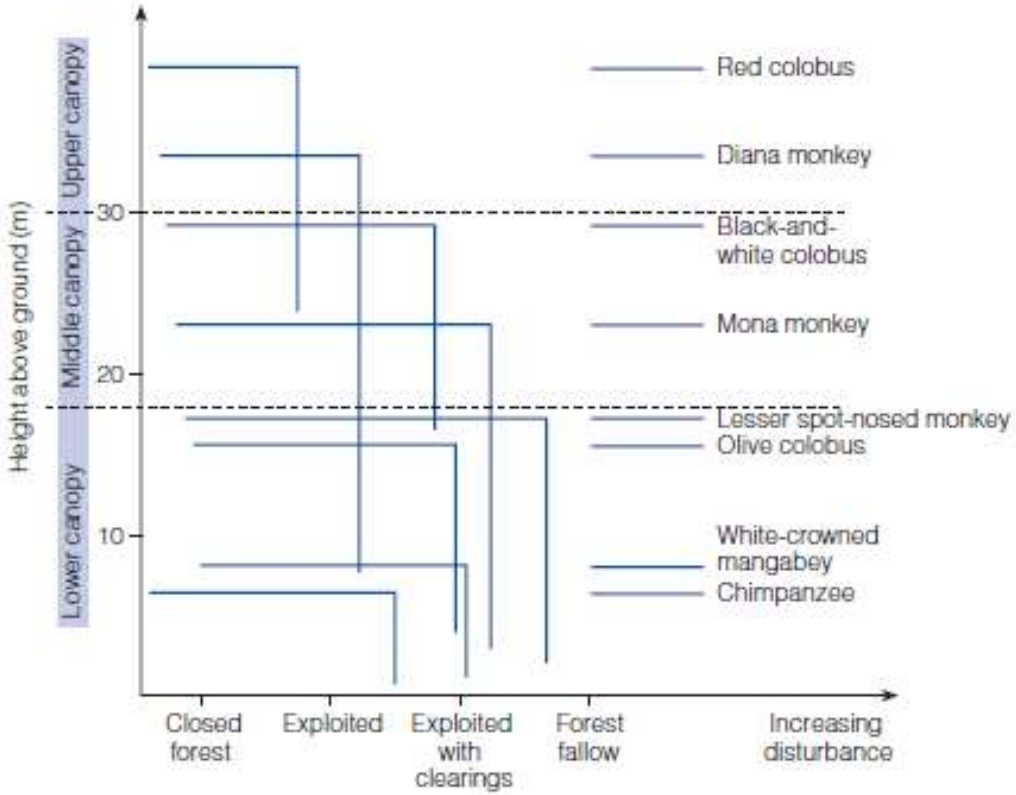

Figure 2.38 Diagram to illustrate the limits to different niche requirements of a range of primate species in the tropical forest of West Africa in relation to canopy height and degree of human disturbance. Each species indicated occupies the space below and to the left of the lines. Although the demands of the various species overlap, each has a particular height in the canopy or a type of site where it is most efficient as a competitor, and therefore more successful. From Martin [49].

Predators and Prey

Experimentally: predators sometimes eat all the representatives of a species in their environment, particularly when the species is already rare.

In reality: it is not in the interests of predatory species to eliminate a prey species, because if they do this they destroy a potential source of food.

No species is preyed upon too heavily, and the predators can always turn to alternative food species if the numbers of their usual prey should be reduced by climatic or other influences (**prey switching**)

Prey switching of this type has been described on the island of Newfoundland, where the grey wolf (*Canis lupus*) and the lynx (*Lynx lynx*) were major predators in the 19th century, but where the wolf is now extinct as a result of human persecution.

The lynx was a rare animal until a new potential prey animal was introduced to the island in 1864, namely, the snowshoe hare (*Lepus americanus*).

The hares multiplied rapidly, and so did the lynxes in response to the newly available food source.

- The snowshoe hare population crashed to low levels in 1915 and the lynx, faced with starvation, switched its attentions to caribou calves, which had once been a major food source for the wolf.
- The snowshoe hare has now developed a 10-year cycle of high and low population levels, and the lynx has continued to switch between hare and caribou depending upon whether the former is in a peak or a trough

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Parasites and Hosts

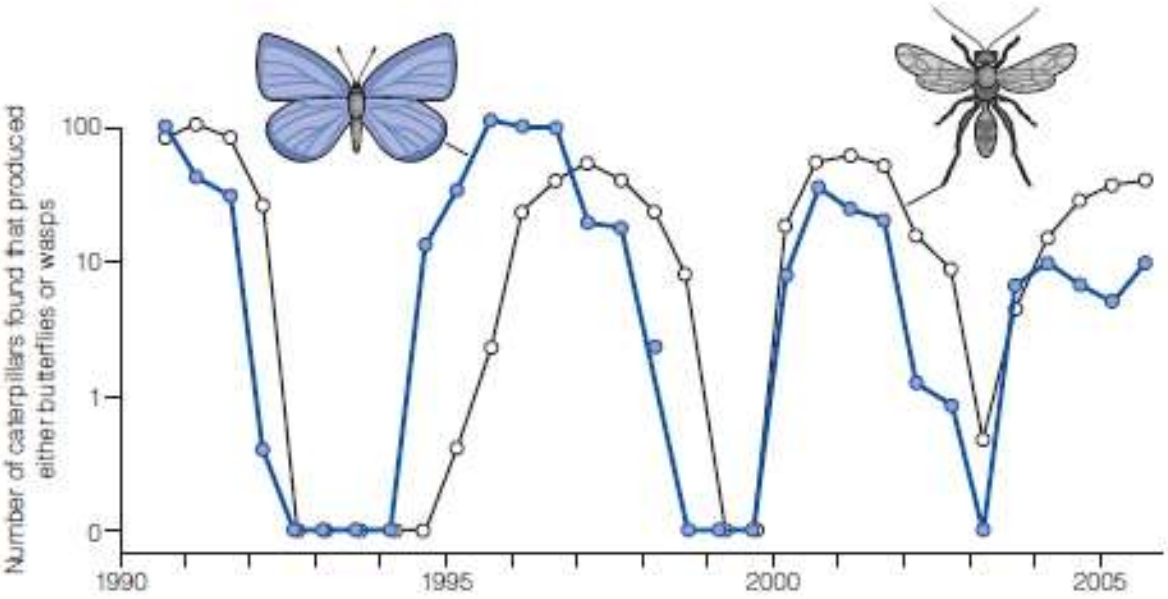


Figure 2.35 Cyclic population fluctuations in the holly blue butterfly and the parasitoid wasp *Listrodomus nycthemerus*. The butterfly population tends to peak every 2–3 years while the wasp population is low. From Thomas and Lewington [43]. (Reproduced with permission of Bloomsbury Publishing plc.)

Although parasitism causes a collapse in the butterfly population, this is only temporary and recovery takes place after the collapse of the parasite population, creating a cycle.

Predatory starfish

Many studies of natural communities have confirmed the hypothesis that predators may increase the number of different species that can live in a habitat. The American ecologist Robert T. Paine made an especially fine study on the animal community of a rocky shore on the Pacific coast of North America [55]. The community included 15 species, comprising acorn barnacles, limpets, chitons, mussels, dog whelks and one major predator, the starfish *Pisaster ochraceus*, a generalist which fed on all the other species. Paine carried out an experiment on a small area of the shore in which he removed all the starfish and prevented any others from entering. Within a few months, 60–80% of the available space in the experimental area was occupied by newly settled barnacles, which began to grow over other species and eliminate them. After a year or so, however, the barnacles themselves began to be crowded out by large numbers of small but rapidly growing mussels, and when the study ended these completely dominated the community, which now consisted of only eight species. The removal of predators thus resulted in the halving of the number of species, and there was additional evidence that the number of plant species of the community (mainly rock-encrusting algae) was also reduced, because of competition from the barnacles and mussels for the available space.

Migration

Latitudinal movements of animals in order to take advantage of long summer days and high productivity in the high latitudes, and then to retreat to lower latitudes to avoid the stresses of the winter season.

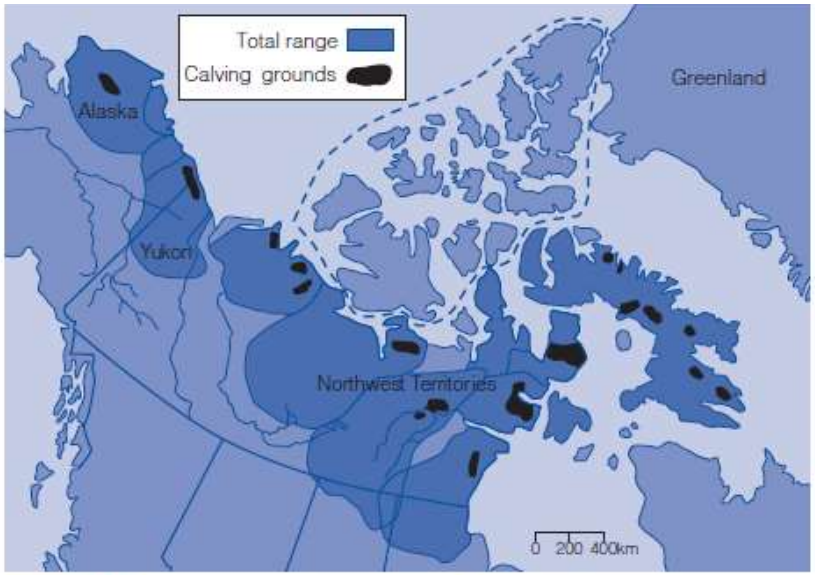


Figure 2.39 Ranges of caribou herds in North America, also showing their calving grounds to which they migrate each spring. Caribou are also located on the islands enclosed within the dashed line. From Sage [59].

Migration

Figure 2.40 Breeding grounds, migration routes and wintering grounds of the white-fronted goose (*Anser albifrons*). From Mead [60].

- circumpolar distribution pattern, in summer breeding season.

- winter in southern parts of North America and Central America, in Europe and the Persian Gulf, and in Japan and eastern China, depending upon their breeding season.

Migration

- nests in the Arctic

- then it travels toward the Antarctic during the northern hemisphere winter.

-This bird enjoys more daylight in the course of its life than any other organism.

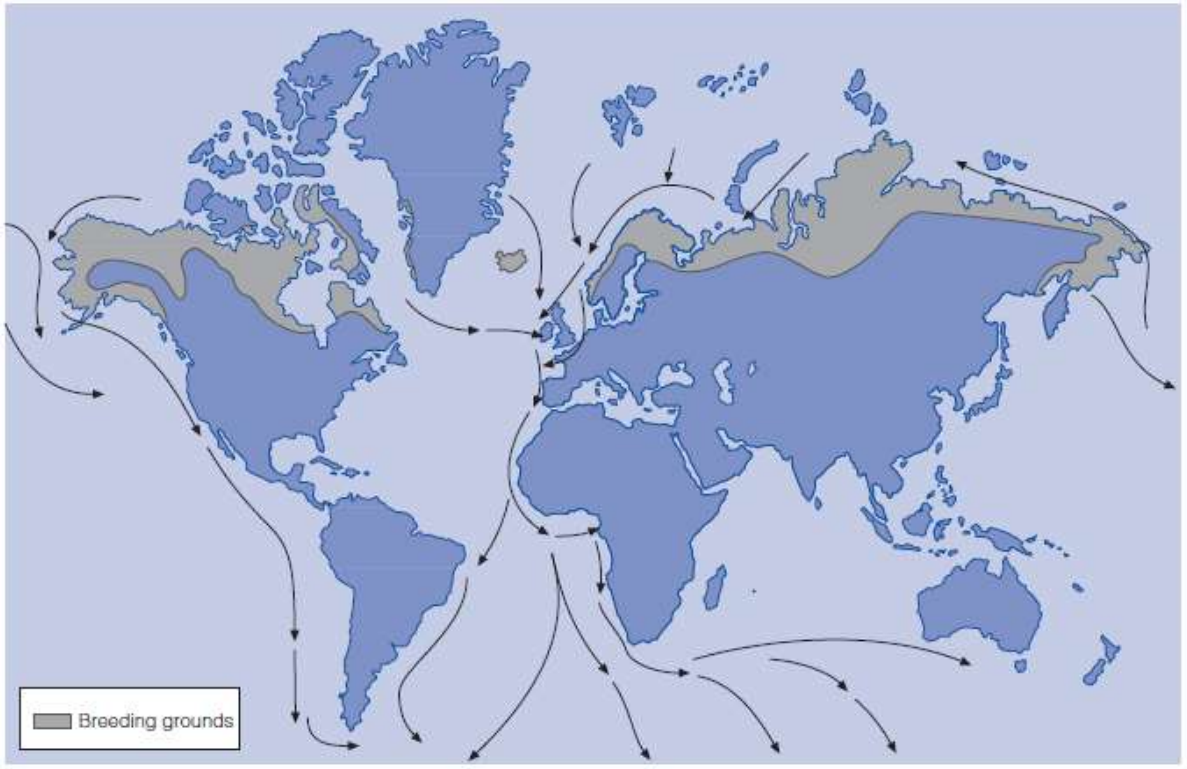


Figure 2.41 Breeding grounds, migration routes and wintering area of the Arctic tern (*Sterna paradisaea*). From Mead [60].

Migration

- Migrates between Canada and the Pacific Northwest to Central and South America each fall, returning in the spring.

- 42 days to fly from Panama to Canada (the actual travel involved consists of 18 nights of flying).

- The rest of the time is taken up with resting at stopover locations along the route.

Over the 4800 km journey, 4450 kJ of energy is expended (1 kJ/ each Km).

- only 29% of the energy lost is expended on the actual flight; the remainder is lost during the stopover rests (recuperating and seeking food at these locations)

Invasion

The success of a species can, in part, be measured by its geographical distribution, and the ability to move into new areas.

introduced into Central Park, New York, in 1891. Since then, it has spread widely and is now present throughout the United States

it has partially displaced the bluebird (*Sialia sialis*) and the yellow-shafted subspecies of the northern flicker (*Colaptes auratus*).

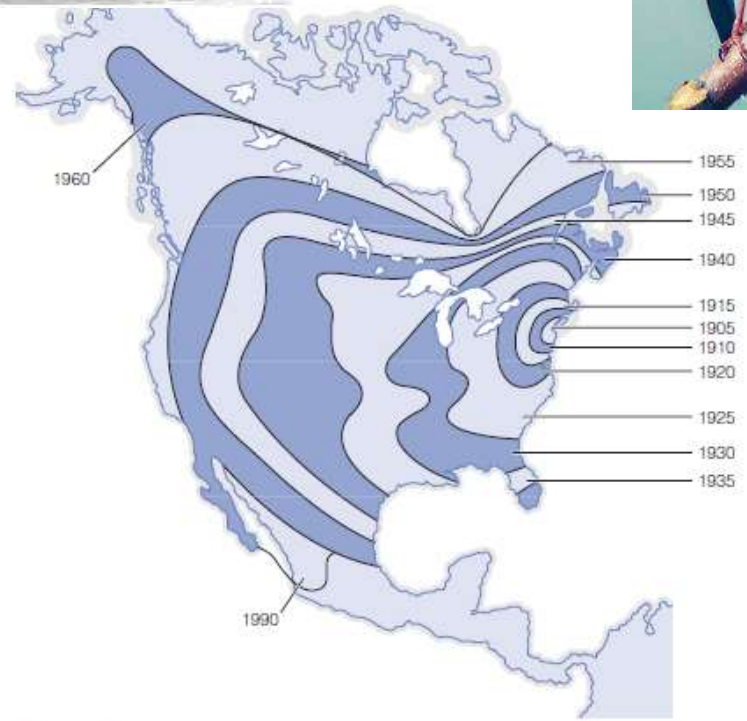


Figure 2.43 Map of North America showing the range extension of the European starling (*Sturnus vulgaris*) following its introduction to the continent late in the nineteenth century. Adapted from Baughman [12].

Invasion

Figure 2.44 Map of North America showing the range extension of the Eurasian collared dove (*Streptopelia decaocto*) since its introduction to the Bahamas in the 1970s. Its spread in North America follows a similarly rapid extension of range in Europe over the last century.

Invasion

An example is the American grey squirrel (*Sciurus carolinensis*), which was introduced into the British Isles in the nineteenth century.

Between 1920 and 1925 the native red squirrel (*Sciurus vulgaris*) suffered a dramatic decline in numbers in Britain, largely due to disease.

! The invader must be able to survive the **pressures of predation** and **parasitism** in its new environment and to face biotic resistance of **local populations.**

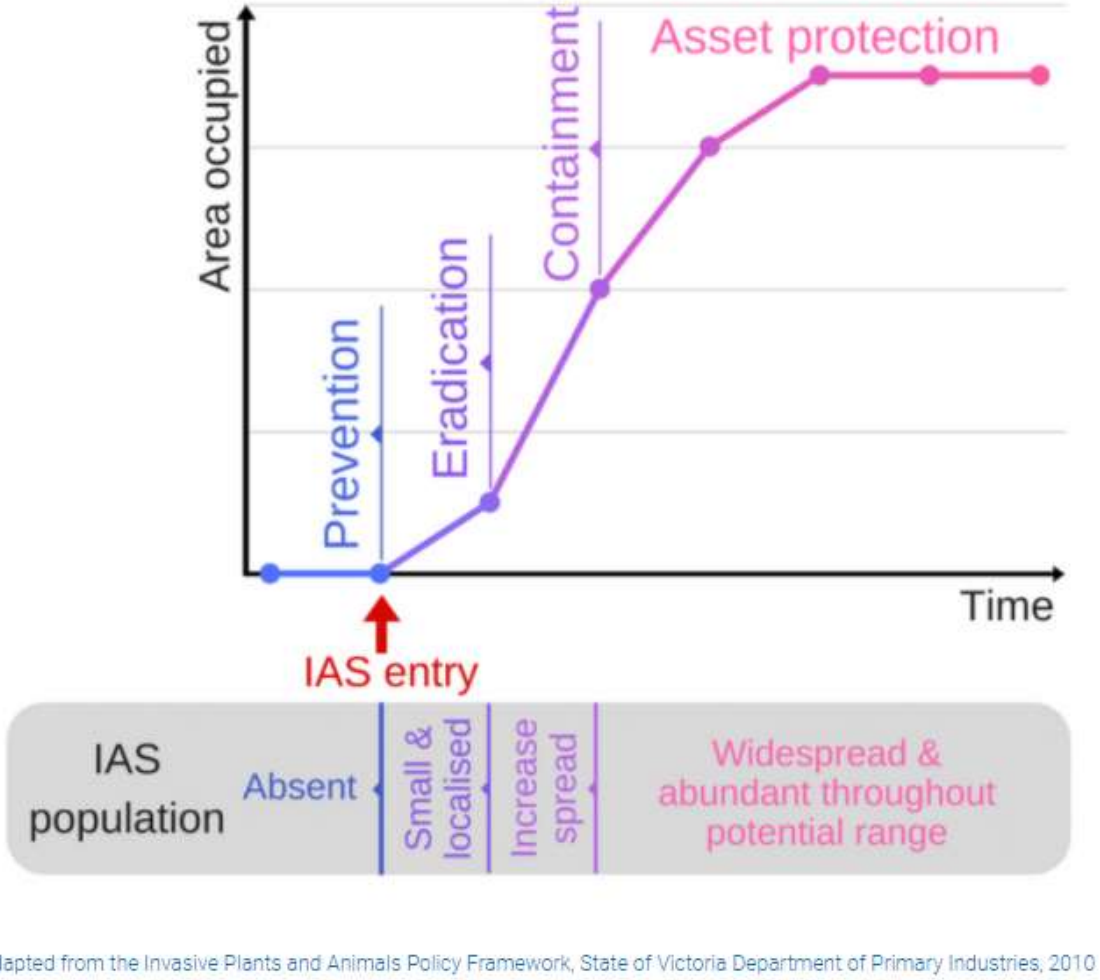
Do not underevaluate the effects of an invader in a new ecosystem!!!

Invasion

- Eradication

- Biological control

- GMOs



Adapted from the Invasive Plants and Animals Policy Framework, State of Victoria Department of Primary Industries, 2010

a quarter of a billion people around the world suffer from malaria each year.

Anopheles gambiae

dsx-female (*AgdsxF*) exon 5 highly conserved

dsx-male (*AgdsxM*

CRISPR–Cas9-targeted disruption of the intron 4–exon 5

Sterile females

Genetics and Genomics

Simple genetic modification aims to stop mosquitoes spreading malaria

Genetically modifying mosquitoes to express antimalarial genes and pass them on to their offspring is being tested as a new strategy to eliminate malaria.

Research Article

Genetics and Genomics

https://www.nature.com/articles/nbt.4245

Converting endogenous genes of the malaria mosquito into simple non-autonomous gene drives for population replacement

Astrid Hoermann, Sofia Tapanelli, Paolo Capriotti, Giuseppe Del Corsano, Ellen KG Masters, Tibebu Habtewold, George K Christophides, Nikolai Windbichler

Department of Life Sciences, Imperial College London, United Kingdom

https://vimeo.com/143428041

Communities and Ecosystems

- Past history (over 10 000 yrs): assemblages of species change in the course of time.

- Spp come into contact at certain times in their history, but have also been periodically separated as the climate changed.

- Often the associations we now observe are of relatively recent origin and should be regarded as transitory

- The concept of the community, according to this school of thought, must be looked upon as useful but somewhat artificial (or limited in time)

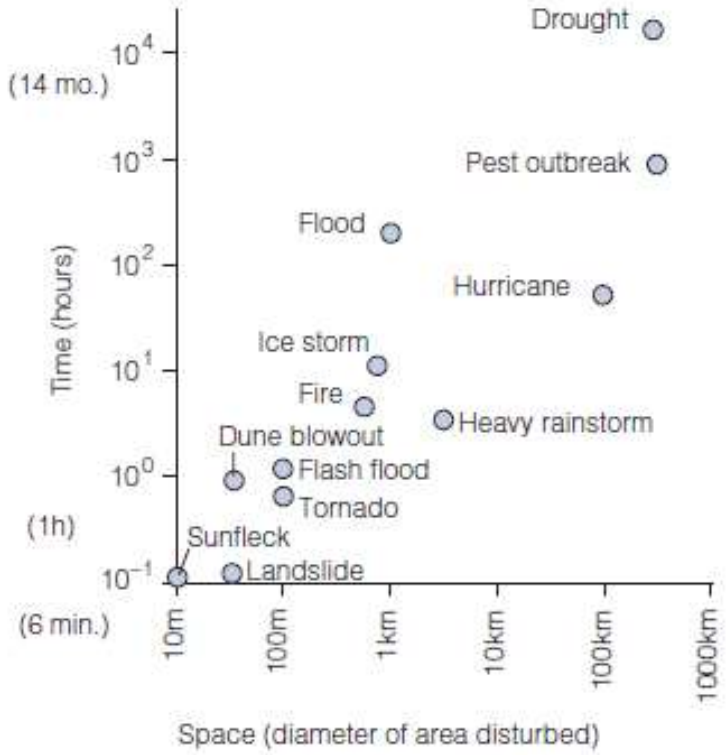


Figure 3.2 Disruption of habitats by disturbance creates a mosaic of patches in different stages of recovery. This leads to an uneven landscape where separate 'communities' of organisms may be perceived. The spatial scale of patches varies with the type of disruption as shown here. Note the log/log scale on the axes. From Forman [5].

Ecosystem

2 concept: **energy flow** ar
into a chemical form by g
feeding upon plants, and
themselves consumed.

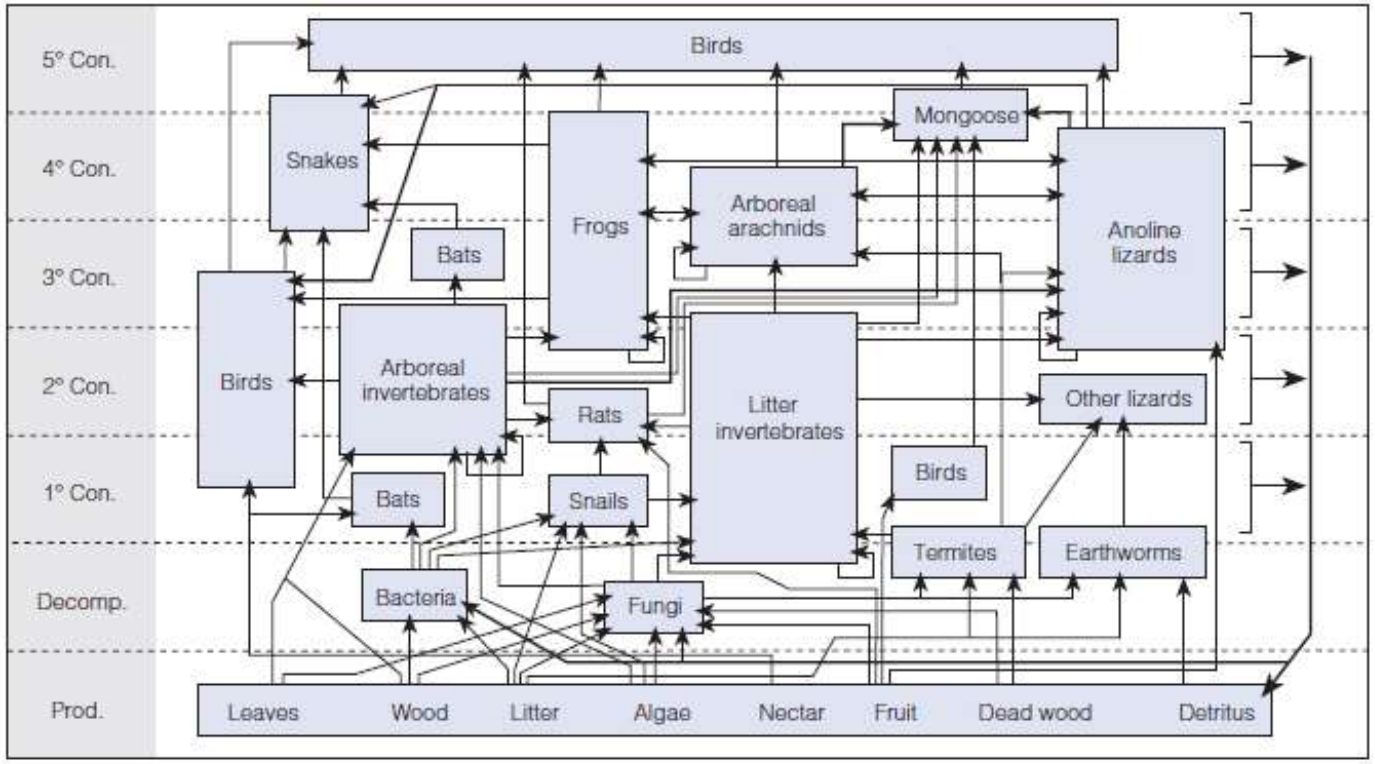


Figure 3.3 Food web of a tropical rainforest derived from the observations of Reagan and Waide at El Verde, Puerto Rico [8]. Organisms are grouped first taxonomically (into boxes) and then arranged in a series of layers (trophic levels) according to their feeding positions in the system. Several taxonomic groups are represented in more than one trophic layer (e.g. birds) because of the varied feeding habits of their component species. Detritus from dead organisms in this diagram is brought back into the base layer with the primary producers (green plants). Together, these form the basic sources of organic energy for the food web.

Field experiment in natural savanna grassland

Comparing sites that have been grazed by the herds of large mammalian herbivores of the tropical grasslands with other sites where these animals had been excluded by the erection of fences, they demonstrated that several nutrients, such as nitrogen and sodium, were cycled more efficiently in the grazed ecosystems. Therefore, grazing animals actually enrich the nutrient availability in the ecosystems they occupy.