HABITAT FRAGMENTATION AND THE ECOLOGICAL NETWORK

BRIDGE

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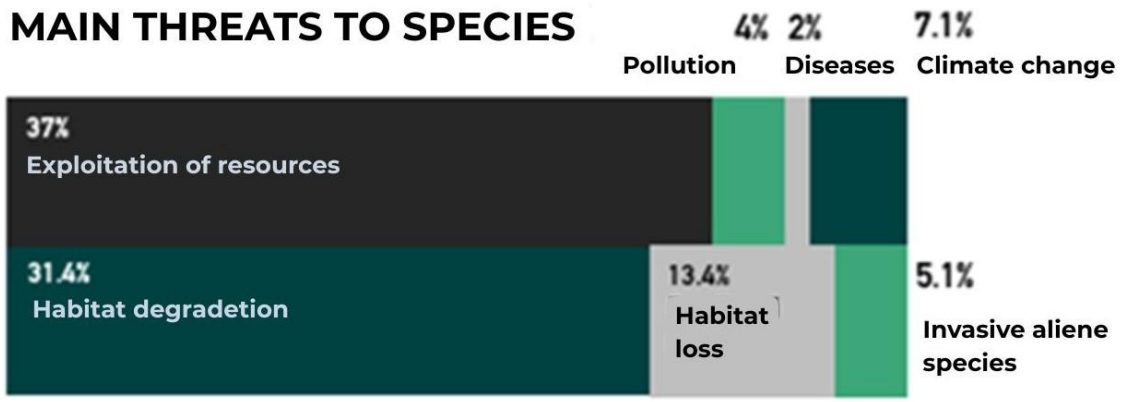
Habitat loss and degradation: a global problem



Habitat degradation and destruction account for almost half of the threats to species living on our planet.

Habitat destruction is carried out through human actions such as deforestation, drying up of wetlands, urbanisation and intensive agriculture. These processes are often permanent and irreversible. If habitats can be reconstructed, it takes enormous resources and a long time before a habitat similar to the previous one is obtained, both structurally and functionally.
Habitats are also degraded by humans, e.g. through pollution, the invasion of alien species and the destruction of ecosystem processes. A degraded habitat can be rehabilitated by reconstructing the processes and functions it performs within the ecosystem in which it is embedded.

Habitat loss and fragmentation

Habitat loss *due to urbanisation and land-use change (e.g. from natural to agricultural land) causes increasing fragmentation of natural habitats, resulting in a loss of continuity in the landscape.*

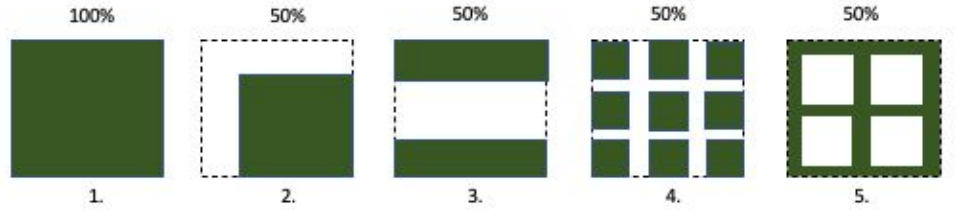
The effects are diverse and profound, affecting both the species present and the functionality of ecosystems.

Effects of habitat fragmentation

When analysing the phenomenon of habitat fragmentation in an area, at least three factors must be considered to assess its effects:

1. number of patches (=fragments) remaining;
2. average patch size;
3. average isolation.

Fragmentation causes effects at the level of populations, communities and ecosystems, to varying degrees depending on the three factors identified above. If, for example, we reduce a habitat by 50%, we may have different types of scenarios, as shown in the figure. The more the number of fragments increases, the more the area of each decreases and the more the margin with non-habitat areas increases, with patches more or less isolated (scenarios 3 and 4) or connected to each other (scenario 5). Medium- or large-sized fragments (scenario 2), on the other hand, can still support a good number of native species: the isolation of fragments is reduced and allows for recolonisation and dispersal of individuals from present populations. Medium to large fragments also retain small marginal areas, leaving much of the core area of the fragment untouched.

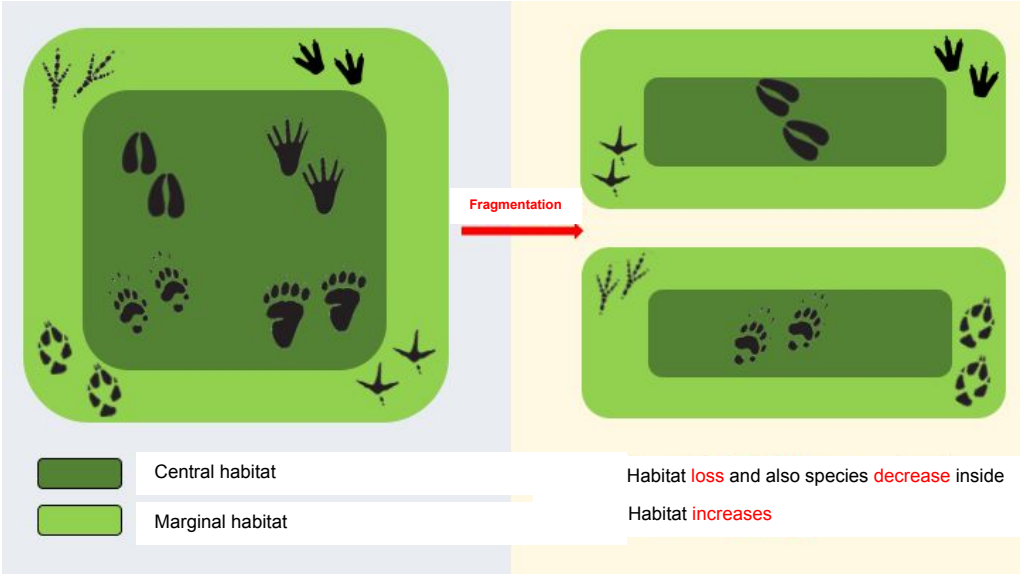


Effects of habitat fragmentation

The **marginal** and central **areas** of an ecosystem have different characteristics, which are exploited by different species.

The marginal areas are more subject to external disturbance, the entry of predators from other habitats and pathogens, and are more affected by microclimatic variations.
They are, therefore areas occupied by more plastic species that can adapt well to different conditions and are less sensitive to disturbance.
The most ecologically demanding species, those that need undisturbed environments and are also more stable in terms of microclimate, occupy the central areas.

Fragmentation can significantly reduce the core areas of a habitat, leading to the disappearance of the species that live there, with an important loss of specific richness: we speak in this case of the **MARGINE EFFECT.**



Effects of habitat fragmentation

Fragmentation has direct effects on the biotic community and thus on ecosystem functionality, resulting in the degradation of ecosystem services

*The **loss of habitat-specific richness** is only one of the consequences of fragmentation, but it causes other effects that can be disruptive.*

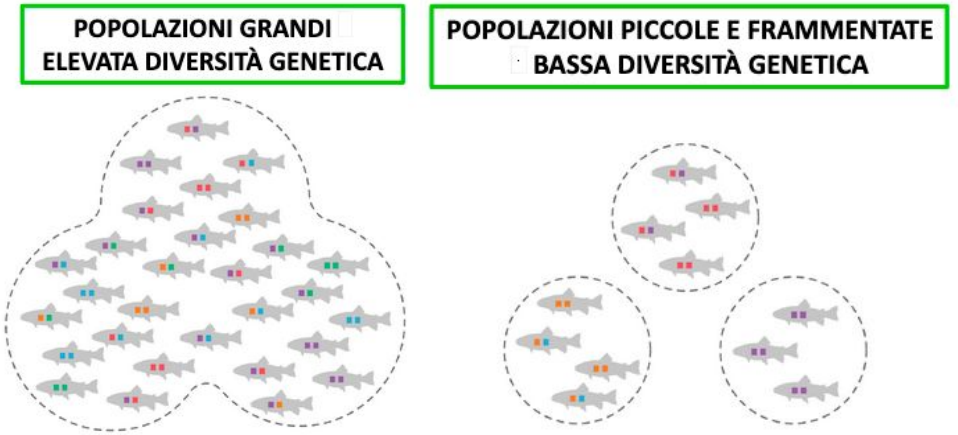
The loss of species leads in fact to an alteration of the biotic community, with potential consequences on the functionality of the entire ecosystem. Each species is embedded in a dense network of relationships, not only trophic, with all the other species in an ecosystem, and the disappearance of one or more of them may result in the complete loss of a specific function (e.g. decomposer) within this complex network. The more fragmentation affects a habitat, the more disruptive are its effects on the functionality of the entire ecosystem in which it is inserted, thus also degrading the services that that given ecosystem is able to provide.

Fragmentation and the increase in marginal areas also increase the likelihood of the entry of alien species, whether plant or animal, again affecting the complex network of relationships present in an ecosystem, triggering mechanisms of competition with native species and thus further increasing the risk of their disappearance from habitat fragments.

Effects of habitat fragmentation

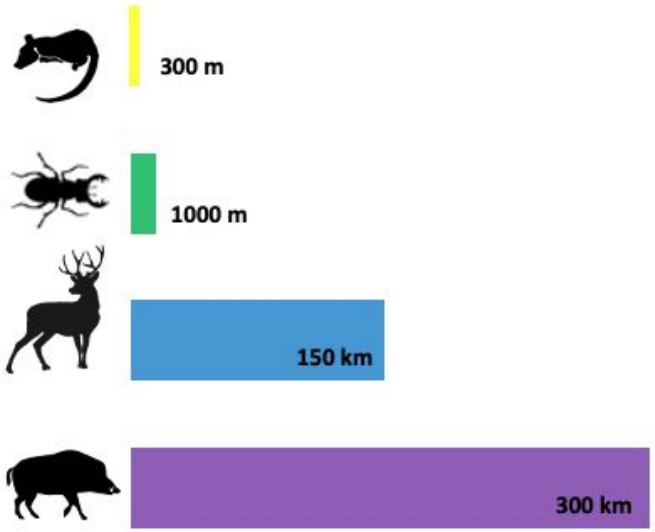
The isolation of habitat patches *can lead to the isolation of entire populations, especially in the case of species with low vagility and in the absence of connecting corridors between habitat patches.*

Isolation of populations leads to loss of genetic variability. A completely isolated population does not benefit from the entry of external individuals and thus the entry of new genes, and may undergo inbreeding processes, which occur through the mating of individuals with a close degree of relatedness. As we saw in the lecture "The structure and organisation of biodiversity", low genetic diversity implies a lower adaptive capacity, lower resilience and, consequently, a lower probability of long-term survival of that population. Populations that are isolated by fragmentation may therefore go into local extinction.



Different species different effects

DISPERSAL CAPACITY OF MIDGE, STAG BEETLE, DEER AND WILD BOAR



*The **effects of fragmentation** are different depending on the species considered, particularly with regard to four aspects that characterise the species itself: vagility, ecological plasticity, ethological plasticity and life cycle.*

Species that have a high degree of vagility, and are therefore capable of large movements, can move from one fragment to another to satisfy their ecological needs (e.g. search for food, shelter in the various seasons, search for a partner, etc.). However, the ability to move depends on the presence of passable corridors between one fragment and another and on the permeability of the barriers present. A particularly problematic barrier is that of linear infrastructures, such as roads and railways: when these infrastructures are traversed by fauna, there is often a safety problem, both for the animal and for man, with at least 1.5 million animals killed on average each year on the roads in Italy alone.

For plants, which cannot move independently, the ability to disperse their seeds, for example through wind or animal transport, and consequently the ability or otherwise to colonise nearby fragments must be considered.

Different species different effects

If we instead consider the plasticity of a species,

both in terms of ecological and behavioural needs, we can imagine how a particularly demanding species can adapt with difficulty to living in a very fragmented territory, where it is unable to find the resources it needs to survive.

A species that has a particularly restricted diet or needs particular soil conditions to grow, or even requires precise microclimatic conditions at its refuge site, will have great difficulty finding what it needs in a fragmented environment.

The same argument applies to species that have a complex life cycle and require different resources at different times of life or season. Take the example of lepidopterans (butterflies and moths): species of this order lay their eggs on nurse plants that may be species-specific, which means that a species of butterfly lays its eggs exclusively on a certain plant species; once adult, the insect will need different plants to feed. Within a fragmented habitat, it is possible that a lepidopteran may not have the coexistence of a nurse plant and plants suitable for feeding in the adult stage.

As the dispersal capacity of many lepidopterans is limited (a few hundred metres), these animals will not be able to colonise new environments to find the resources they need to survive.

How to take action?

In order to counter the negative effects of fragmentation, it is necessary to think on a landscape level (on a large scale) and to plan for the medium to long term:

1. the protection and increase of habitat quantity
2. the improvement of fragment quality
3. the improvement of connectivity between fragments.

In order to improve habitat quality, it is necessary to identify and control the processes responsible for current degradation phenomena, maintain the minimum conditions for spontaneous habitat renewal and improve the environmental matrix by increasing its complexity.

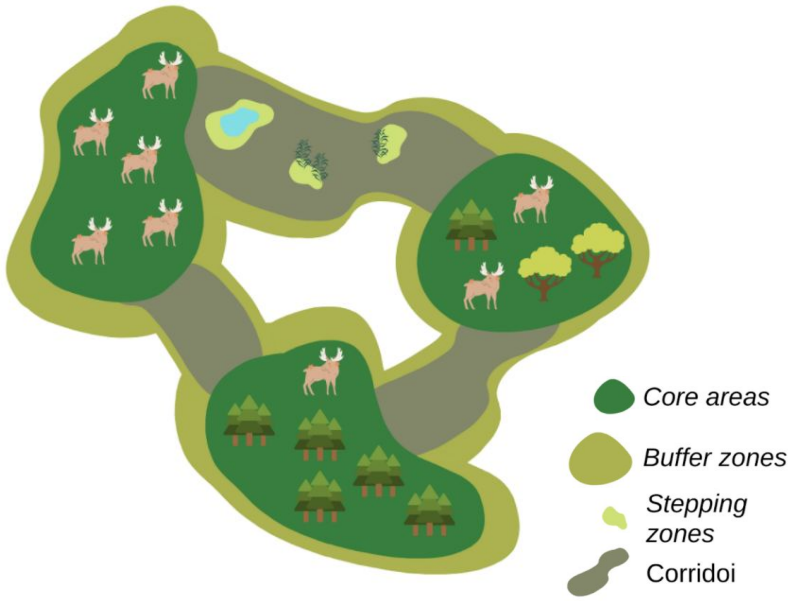
Several strategies, at different scales, can be implemented to improve connectivity:

1. identify and protect existing elements of connectivity between fragments (e.g. linear landscape elements)
2. upgrading existing elements and creating new ones
3. maintaining or creating discontinuous connectivity elements (*stepping stones*)
4. develop and/or maintain large-scale habitat networks.

All these activities serve to build an ecological network.

The ecological network

The ecological network is defined as an interconnected system of habitats, whose biodiversity must be safeguarded



The ecological network consists of several elements:

1. core areas: areas of high naturalness, e.g. protected areas
2. buffer zones: buffer zones located around core areas to ensure a gradual transition of habitats
3. connecting strips (ecological corridors): linear and continuous landscape structures that connect core areas and are the key element of ecological networks as they enable species mobility
4. punctiform or 'scattered' areas (stepping stones): small surface areas that represent important landscape elements to support species in transit through an area or to host particular micro-environments in critical habitat situations (e.g. small ponds in agricultural areas).