In the past decades, there has been a big push to study ecosystem function, in particular, to understand how species richness is related to ecosystem function (Naeem et al., 1994; Tilman & Downing, 1994). We want to the functioning of ecosystems so that we can then preserve it in face of global change so that nature can keep providing those services that our societies are based on. Experiments that were carried out at a local level. However, this is only a single patch approach to ecosystem function. If we want to understand how ecosystem function is determined at a landscape scale, we need to scale up our research (Gonzalez et al., 2020). In other words, we need to look at the landscape and see what patches they are made of and how they are connected.

Alongside dispersal (Gonzalez et al., 2009), the flow of resources (dead stuff – detritus and inorganic nutrients) has been shown to play a role in determining ecosystem function. For example, the reciprocal flow of limiting nutrients has been experimentally found to increase ecosystem function when heterogeneity would otherwise partition different nutrients into different ecosystems (Gülzow et al., 2019). Ecosystems that are connected through the flow of resources are referred to as meta-ecosystems (Loreau et al., 2003). The meta-ecosystem network in which ecosystems are embedded has also been shown to influence their functioning, as it is dependent on the topology of the network, the average number of connections per ecosystem and the number of connections of the most connected ecosystem (Marleau et al., 2014).

However, these models have been all considering all patches being the same size. The size of both the receiving and donor patches has the potential to alter meta-ecosystem dynamics. First, the size of the **donor ecosystem**. Larger patches have more species (MacArthur & Wilson, 1963) and are therefore predicted to have higher function (Benedetti-Cecchi, 2005), they will produce more detritus (not tested yet). Larger patches also produce more detritus just because of geometrical reasons. For example, lotic and lentic systems both provide emerging insects to terrestrial ecosystems. The larger the river/lake, the more emerging insects will reach the terrestrial ecosystem, reason why (Gratton & vander Zanden, 2009). Also, larger donor patches sometimes contain higher trophic levels (Post et al., 2000) and therefore will produce detritus with higher amounts of nitrogen and phosphorus compared to carbon (reference). Also, as larger ecosystems are more resistant (Greig et al., 2022), they will produce less detritus. The size of the **receiving ecosystem** is also important. As smaller ecosystems should be more permeable to detritus (higher perimeter:area ratio). For example, resources flowing from the sea to an island increase secondary production the most in small islands (Polis & Hurd, 1996) and salmon subsidies have the strongest effects in small river watersheds (why?) (Hocking & Reimchen, 2009).  
As larger ecosystems are more resistant (Greig et al., 2022), they will need less detritus to counteract the effects of perturbations that is creating resource flow. Speak now about the feedback loop.

Here, we test how patch size alters meta-ecosystem function using a protist microcosm experiment (Altermatt et al., 2015). We here refer to biomass production as ecosystem function, which we use interchangeably. Two meta-ecosystems of the same total volume but of patches of different size were constructed. The first meta-ecosystem was composed of a small and a large patch (small-large meta-ecosystem). The other meta-ecosystem was composed of two medium patches (medium-medium meta-ecosystem). All patches started with the same protist community (nine water ciliates, one alga, and one rotifer). Resources flowed bidirectionally between the two patches, with the same magnitude. Resource flows were created by boiling a fixed volume of the community and poring it into the receiving patch. This caused small patches to be more disturbed than medium patches and medium patches be more disturbed than large patches. No dispersal occurred throughout the experiment. We additionally created also the following control treatments: isolated small, medium, and large patches, as well as meta-ecosystems with two small patches (small-small meta-ecosystems), meta-ecosystems with two medium patches (medium-medium meta-ecosystems), and meta-ecosystems with two large patches (large-large meta-ecosystems).

The inflow of resources coming from a productive patch have already been shown to be beneficial for the functioning of ecosystems under perturbations (Colombo, 2021). Therefore, small patches that receive a lot of resources will recover better from the perturbations that cause resource flow, meanwhile the larger patches will recover worse. The effects of resource flow on meta-ecosystem function will depend on how much large patches increase the function of the small patches and how much the small patches decrease the function of the large patches.

Diagram

Description automatically generated

*Figure 1. We compared two patch meta-ecosystems that were made of patches of either the same size or of different size.*

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