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* *Additional reasons why patch size might impact the difference in autotrophic-heterotrophic ratios*.
  + This has been found in experimental settings. Larger experimental kelp patches had a higher ratio of kelp to epifauna (Shelamoff2020).
  + Differences in trophy have been found across sizes in nature. For example, in estuaries, ecosystem size influences their trophy because how long the nutrients stay inside the estuary does not grow linearly with estuary size (Nidziekoa2018).
* Furthermore, patch size can also change ecosystem function (LeCraw et al., 2017; Yang et al., 2021). For example, larger patches can be more productive because they have species richness which allows them to use resources more efficiently (complementarity effects) (Delong & Gibert, 2019).
* We used the isolated controls to create virtual meta-ecosystems (that is, pairing two patches to calculate the diversity levels, yet without having these patches connected by flows of resources). We constructed these virtual control meta-ecosystems by bootstrapping (without replacement) all possible pairs of isolated patches to compare to SLLS and MMMM.
* The size of ecosystems and the movement of non-living resources among them, such as leaf litter and inorganic nutrients, are essential factors that affect both biodiversity and ecosystem function. However, there has been a lack of attention given to whether and how ecosystem size and flows of non-living resources interact with each other, affecting ecosystems. This lack of attention is likely due to the fact that controlling for ecosystem size and resource flow in natural settings is challenging. Ignoring this interaction could mean ignoring a ubiquitous mechanism that drives biodiversity and ecosystem function, as natural ecosystems come in different sizes and are connected to other ecosystems through the movement of non-living resources (Gounand et al., 2018, *Nat. Commun.*).

Conclusion

While we demonstrated that ecosystem size mediates the effects of resource flow on the biodiversity and function of ecosystems of the same type, resources often also flow among ecosystems of different types, which could even aggravate the effect demonstrated. This connection among ecosystems of different types is often overlooked in studies examining the effects of ecosystem size variations on biodiversity, as they focus on the effects of the fragmentation of a single ecosystem type (mainly forests) on biodiversity.

# Low disturbance significance

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| --- | --- | --- | --- |
| **Response variable** | **Comparison** | **Full model  p (low disturbance)** | **Reduced model p (low disturbance)** |
| Mean **α-**diversity  (meta-ecosystem) | SLLS vs SL | **.002** |  |
| MMMM vs MM |  |  |
| β-diversity  (meta-ecosystem) | SLLS vs SL | **.007** |  |
| MMMM vs MM |  |  |
| γ-diversity  (meta-ecosystem) | SLLS vs SL |  |  |
| MMMM vs MM |  |  |
| Total biomass  (meta-ecosystem) | SLLS vs SL |  |  |
| MMMM vs MM |  | **0.026** |

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| **Response variable** | **Comparison** | **Full model  p (low disturbance)** | **Reduced model p (low disturbance)** |
| Biomass  (ecosystem) | SL vs S |  | **.004** |
| SL vs SS |  | **< .001** |
| Ss vs S |  |  |
| MM vs M |  | **.003** |
| LS vs L | **.064** |  |
| LS vs LL |  |  |
| LL vs L | **.071** |  |
| Shannon Index  (ecosystem) | SL vs S | **.001** |  |
| SL vs SS | **< .001** |  |
| Ss vs S |  |  |
| MM vs M |  |  |
| LS vs L | **.048** |  |
| LS vs LL |  |  |
| LL vs L | **.064** |  |

Our study shows that meta-ecosystems of the same total size yet differing in local ecosystem size can differ in their biodiversity and function. Meta-ecosystem ecology shows that resource flows between ecosystems can impact biodiversity (e.g., Gounand et al., 2017; Gravel, Mouquet, et al., 2010; Marleau & Guichard, 2019; Peller et al., 2022) and ecosystem function (e.g., Gounand et al., 2014; Harvey et al., 2023; Marleau et al., 2010). For example, meta-ecosystem theory predicts resource flows can influence species persistence and competitors' coexistence (Gounand et al., 2017; Gravel, Mouquet, et al., 2010). Detritus flowing from productive ecosystems could, for instance, allow the persistence of species in unproductive ecosystems that would otherwise go extinct (Gravel, Mouquet, et al., 2010). Also, for example, resources exchanged between autotrophic and heterotrophic ecosystems can increase or decrease meta-ecosystem productivity according to whether resource stoichiometry exacerbates or relaxes their limiting nutrients (Pichon et al., 2023). However, meta-ecosystem theory and previous experiments have typically assumed the size of connected ecosystems to be the same (but see Harvey et al., 2018, 2020), thereby ignoring how differences in ecosystem size observed in natural systems (e.g., Fahrig, 2003) may modulate local and meta-ecosystem richness and function through flows of resources. Our results suggest that integrating ecosystem size into meta-ecosystem ecology would help us further understand how resource flows shape biodiversity. In particular, we suggest that resources flowing into large ecosystems should have a limited influence, whereas meta-ecosystem theory generally predicts effects on all ecosystems.

**Appendix S6 results – differences between the low and the high disturbance**

The following are the results of both low and high disturbance regimes combined. Unless stated otherwise, the results apply to both regimes. Weak trends are not included to make the comparisons between levels easier to understand. At the meta-ecosystem level, resource flow effects were mediated by patch size asymmetry, as resource flow increased α-diversity, decreased β-diversity, and decreased meta-ecosystem biomass in SLLS but not in MMMM (but at low disturbance resource flows increased meta-ecosystem function in MMMM but not SLLS). Resource flow had no effects on γ-diversity.

At the local level, small ecosystems that were connected to large ecosystems had higher diversity and biomass than when unconnected (SL vs S), as being connected to a large patch benefitted diversity and biomass (SL vs SS) (although for biomass this was only through the size of the connected patches in high disturbance). Also at the local level, large ecosystems that were connected to small ecosystems were either similar in biodiversity and lower in biomass through the size of the connected patch (high disturbance) or had less biodiversity (but no evidence for the size of the connected patch) and similar biomass (low disturbance) than when unconnected (LS vs L). Finally, in medium ecosystems we observed no effect of the connection on biodiversity but an increase in biomass in the low disturbance (MM vs M).

Finally, at the local level, unconnected larger ecosystems had a higher ratio of autotrophic individuals to heterotrophic individuals in the high but not low disturbance (S vs M vs L).