

Supplementary Materials for

Capacity to support predators scales with habitat size

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Supplementary Materials

Section S1. Drivers of secondary production

Across the habitat size gradient we sampled, there was no systematic variation in major drivers of secondary production in streams (39), stream temperature or individual primary consumer biomass (fig. S1).

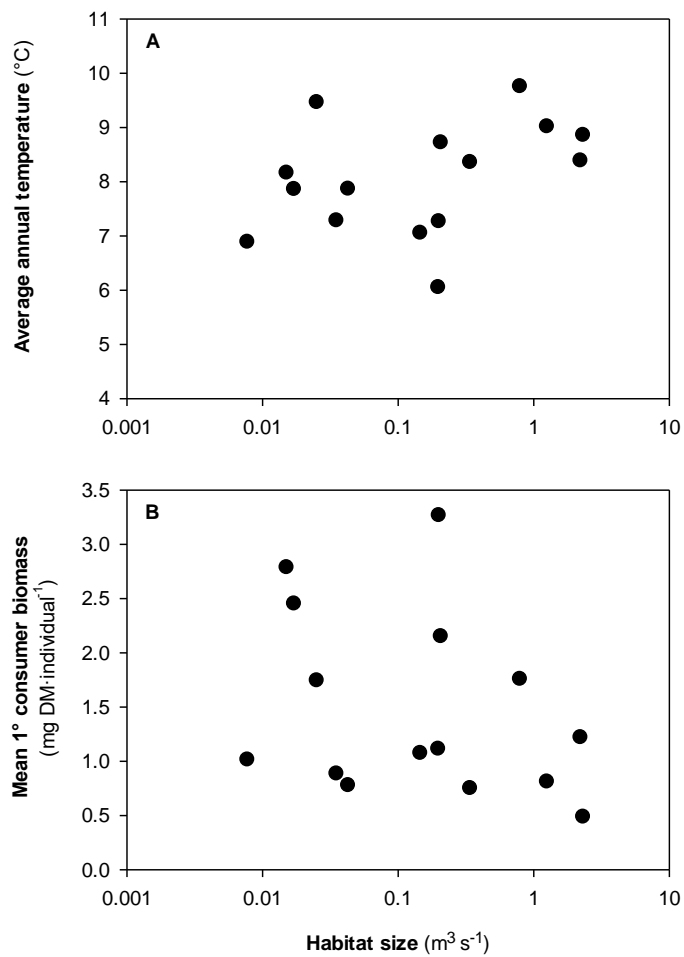


Fig. S1. Variation in major drivers of secondary production. Variation in (A) mean annual temperature and the (B) mean individual biomass of primary consumer invertebrates in relation to discharge from 15 rivers in the Waimakariri and Rakaia River catchments, New Zealand.

Moreover, nutrient concentrations are consistently very low across the range of streams we sampled (36), and a surrogate measure of collective nutrient concentrations, specific conductivity, also shows no consistent relationship across the subset of 15 streams where we have measured it, and it is certainly not higher for larger streams (fig. S2).

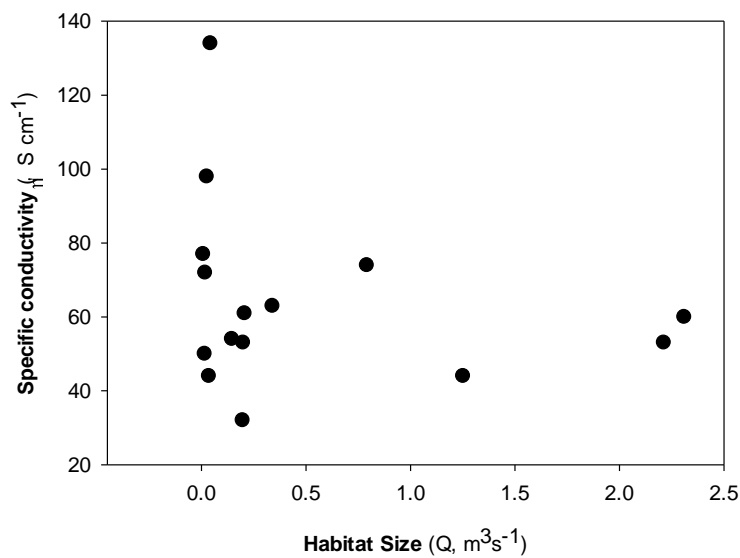


Fig. S2. Variation in stream water–specific conductivity in relation to discharge from 15 rivers in the Waimakariri and Rakaia river catchments, New Zealand.

Section S2. Intermediate predators

Alternative metrics of the body size of predators in the rivers studied, including maximum predator size and mean predator size, had fits with habitat size similar to that of our P_{50} measure of predator body size in rivers (maximum fish size [g DM] = $91.2H^{0.89}$, $R^2 = 0.54$, $F_{1,22} = 25.53$, $P < 0.001$; mean fish size [g DM] = $6.3H^{0.62}$, $R^2 = 0.49$, $F_{1,22} = 21.41$, $P < 0.001$).

Although not part of our predictions, the increases in median predator body size of predators with habitat size were, not unexpectedly, associated with reductions in the abundance of a subcategory of smaller, intermediate, predators along the habitat size gradient. Predatory invertebrate biomass per-unit-area declined with habitat size ($R^2 = 0.21$, $F_{1,27} = 7.337$, $P = 0.012$; fig. S3 A), and was also negatively related to predator P_{50} size ($R^2 = 0.25$, $F_{1,25} = 8.51$, $P < 0.01$; fig. S3 B).

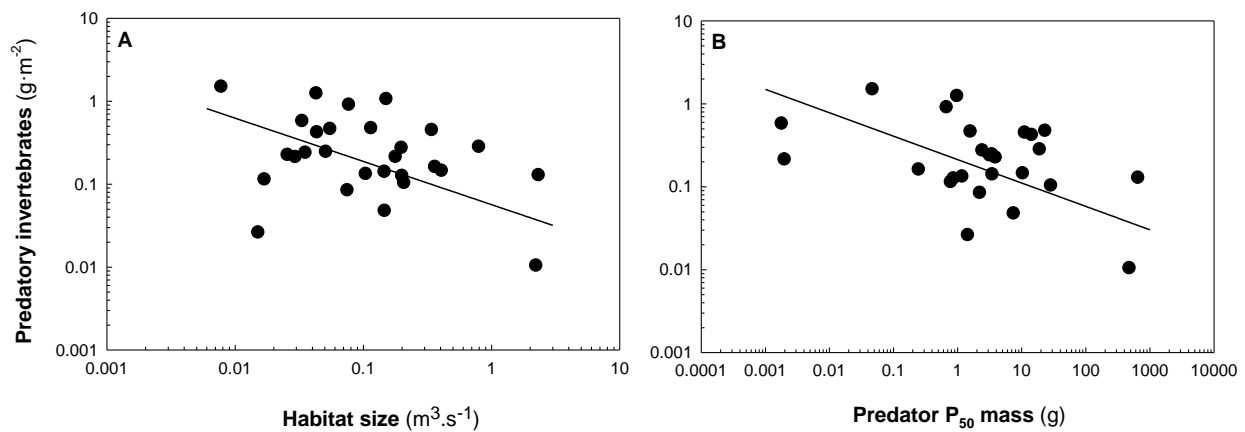


Fig. S3. Patterns in abundance of predatory invertebrates. Biomass per-unit-area (measured by dry mass) of predatory invertebrates across the gradients of habitat size (A) and predator size (B) measured in 29 grassland river food webs.

The decline in smaller intermediate predators as habitat size increased is likely indicative of the strengthening of top-down control as predator body sizes increased. This is not unexpected given the role body size plays in controlling the strength of trophic interactions (6). Importantly, however, top-down control did not cascade down to primary consumer level such that the abundance of primary consumers was reduced as habitat size increased. Therefore, increasing top-down control with increased habitat size cannot explain the altered predator-prey biomass

ratios we observed. Top-down forcing is an important mechanism for the control of trophic structure and its influence on primary consumers and producers is highly contingent, so it could still act in concert with the mechanisms we describe.

Table S1. Location (New Zealand map grid) and habitat size (measured in terms of discharge and stream order) of sites sampled from the Waimakariri and Rakaia river catchments of the South Island, New Zealand to provide information on predator and prey abundance, together with the source of the data.

| Site name | NZMG Easting | Northing | Discharge ($\text{m}^3 \cdot \text{s}^{-1}$) | Stream Order | Source† |
|-----------------------|--------------|----------|--|--------------|---------|
| Acheron River | 2402460 | 5763670 | 0.145 | 3 | 1 |
| Antipodes Creek Lower | 2402885 | 5763135 | 0.017 | 3 | 1 |
| Broken River | 2406520 | 5778765 | 1.251 | 4 | 1 |
| Cave Stream | 2407050 | 5782325 | 0.051 | 2 | 2 |
| Coach Stream | 2409200 | 5765985 | 0.025 | 2 | 1 |
| Coopers Creek | 2438820 | 5767755 | 0.104 | 4 | 3 |
| Craigieburn River | 2409640 | 5785225 | 0.359 | 3 | 3 |
| Dry Gorge River | 2406615 | 5770860 | 0.043 | 2 | 3 |
| Dry Spring | 2405475 | 5771425 | 0.015 | 2 | 1 |
| Emanon Stream | 2406330 | 5767885 | 0.033 | 2 | 3 |
| Fan Stream | 2414190 | 5796295 | 0.043 | 1 | 4 |
| Ghost Stream | 2407610 | 5773575 | 0.177 | 3 | 3 |
| Grasmere River | 2408765 | 5796365 | 0.791 | 4 | 1 |
| Helm Stream | 2402620 | 5762215 | 0.077 | 3 | 4 |
| Binser Stream | 2413010 | 5799530 | 0.114 | 3 | 4 |
| Middle Bush Stream | 2409255 | 5796250 | 0.029 | 1 | 4 |
| Pylon Gully Stream | 2406300 | 5796175 | 0.145 | 2 | 4 |
| Little Kowai River | 2423265 | 5765255 | 0.055 | 2 | 3 |
| Lower Farm Stream | 2412935 | 5799995 | 0.199 | 3 | 1 |
| Manson's Creek | 2409635 | 5785435 | 0.197 | 2 | 5 |

| | | | | | |
|-----------------------|---------|---------|--------|---|---|
| Mt White Hut Creek | 2422960 | 5795895 | 0.150 | 2 | 4 |
| One Tree Swamp Stream | 2406440 | 5800130 | 2.31 | 2 | 1 |
| Pass Stream | 2406445 | 5767460 | 0.035 | 2 | 1 |
| Porter River | 2406955 | 5773080 | 2.21 | 4 | 1 |
| Pudding Hill Stream | 2392245 | 5732895 | 0.074 | 1 | 3 |
| Rayban Stream | 2405290 | 5770825 | 0.405 | 1 | 4 |
| Slip Spring | 2405145 | 5771525 | 0.339 | 3 | 1 |
| Tussock Creek | 2404075 | 5764710 | 0.0077 | 1 | 1 |
| Waimakariri Spring | 2413500 | 5798075 | 0.206 | 1 | 1 |

† 1, McHugh *et al* (21); 2, Unpublished data, P.G. Jellyman – sampled January 2009; 3, P.A. McHugh, R.A.

Thompson & A. R. McIntosh unpublished data – sampled January 2010; 4, Nyström *et al.* (36); 5, A.R. McIntosh, unpublished data, sampled December 2005.