

Individual decision-making by prey may affect the strength of food chains

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It is common for the state of an individual prey to influence its response to predators. For example, satiated or vulnerable individuals may be more inclined to cease foraging and flee from predators than hungrier or less vulnerable individuals. It is also well known that predators can benefit primary producers (e.g. plants and algae) by causing prey to graze less. However, these two concepts are rarely considered together; behavioral studies seldom test whether state-dependent prey behavior affects organisms lower on the food chain, and studies of food chains usually assume all individuals behave similarly. However, predators may strongly benefit primary producers when satiated or more vulnerable prey flee, but predators may exert no benefit on primary producers when hungry or less vulnerable prey ignore the predator and continue to graze.

We strengthened the link between individual behavior and community outcomes by testing whether the effect of predators on primary producers hinged on the hunger level or size of the prey. In rocky intertidal tidepools in California, the small predatory seastar *Leptasterias* spp. can cause its abundant herbivorous snail prey *Tegula funebris* to flee tidepools, which benefits tidepool algae. Using short experiments during low tide in the field, we showed that this benefit was strong when snails were well fed or medium-sized because these snails fled tidepools and grazed less. However, the benefit to algae by seastars disappeared when snails were hungry or small because



Leptasterias and Tegula. Photo provided by authors.

the snails continued grazing or ate very little algae, respectively. Though our experiments suggest that large snails were nearly invulnerable to seastar predation, many fled from seastars. However, those large snails remaining actually grazed faster when seastars were present, so in this circumstance seastars had unexpected negative effects on algae.

Because hunger level and size may vary predictably over time and space in nature, the cascading benefits to algae by predators may be patchy. We demonstrate that the common assumption that individuals in a food web are the same may not accurately predict outcomes. Further, state-dependent individual behavior of prey can cause domino effects on lower trophic levels. This approach strengthens our knowledge of the links between individual processes and community outcomes.