

Predator nonconsumptive effects on prey demography: Field experimental evidence from the Atlantic coast of Canada

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Predator nonconsumptive effects (NCEs) on prey are ubiquitous in nature. In aquatic systems, such NCEs are often triggered by predator-released waterborne cues that are detected by prey. To minimize predation risk, prey exhibit immediate behavioural responses (e.g., cessation of feeding or moving away). However, the consequences of such responses for prey demography remain poorly understood. This knowledge gap is important to address because, ultimately, demography influences the impact of a species on its community. Therefore, we investigated predator NCEs on two key demographic variables for prey, recruitment and reproduction, through manipulative field experiments in rocky intertidal habitats from Nova Scotia, Canada. As model predator-prey systems, we used dogwhelks (*Nucella lapillus*) and their main prey, barnacles (*Semibalanus balanoides*) and blue mussels (*Mytilus* spp.).

We found that dogwhelk NCEs limited barnacle recruitment by limiting barnacle settlement, as barnacle larvae settled elsewhere when detecting dogwhelk cues, likely to reduce future predation risk as settled organisms grow to adults. The observed nonconsumptive limitation intensified with dogwhelk density but disappeared under high barnacle recruit density (favoured by phytoplanktonic food supply) or in the presence of adult barnacles, seemingly because chemical cues by barnacle recruits and adults are known to attract conspecific larvae seeking settlement. High water motion in wave-exposed environments also eliminated dogwhelk NCEs on barnacle recruitment, apparently through dogwhelk cue dilution. Furthermore, the months-long exposure of barnacle recruits to dogwhelk cues limited reproductive output once the recruits developed into adults. This was probably a result of a reduction of recruit feeding under dogwhelk cue exposure, as found previously in the lab. Our field experiments also showed that dogwhelk cues can also limit recruitment in blue mussels. However, this limitation was less intense than for barnacles, which may be explained by the fact that mussels remain mobile to some extent throughout their benthic life and can, thus, avoid predation more often than barnacles, which are fully sessile after settlement. Overall, our research shows that predator NCEs can affect prey demography by limiting prey recruitment and reproduction and that biotic and abiotic factors can modulate such NCEs.

Keywords: predator nonconsumptive effects; prey demography; recruitment; reproduction; manipulative field experiment; rocky intertidal; dogwhelks; barnacles; mussels