Cannibalism in Red King Crabs: Effects of Habitat, Predator Interference, and Predator Size on the Functional Response

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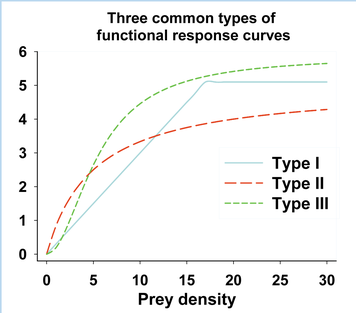
Introduction

Juvenile crabs are highly vulnerable to predation and generally seek out habitats that minimize their predation risk. In this study we examine how habitat interacts with predator interference, predators reducing foraging efficiency though interactions with each other, and predator size to determine predation risk for juvenile red king crabs (*Paralithodes camtschaticus*), at a range of prey densities.

The predator functional response

The predator functional response describes how predation rate varies with prey density. There are three common types: Type I or linear, Type II or inversely density dependent, and Type III or density dependent. The distinction between the functional responses is critical in determining prey population stability. Type II functional responses are destabilizing because predation risk for prey increases at low prey densities. Type III responses are stabilizing because predation risk decreases at low prey densities, creating a low density refuge. In a type I response predation risk does not vary with prey density. The functional response can change with many factors; the addition of complex habitat or alternative prey, for example, can change a type II response into a type III



Red king crabs

- Important fishery species in Bering Sea
- Juveniles are generally found in complex habitats
- Little is known about their predator-prey relationships
- Are known to be cannibalistic

Study objectives

- Determine the functional response of cannibalistic predators and how it varies with:
  1. Habitat
  2. Predator density (i.e. predator interference)
  3. Predator size

Acknowledgments

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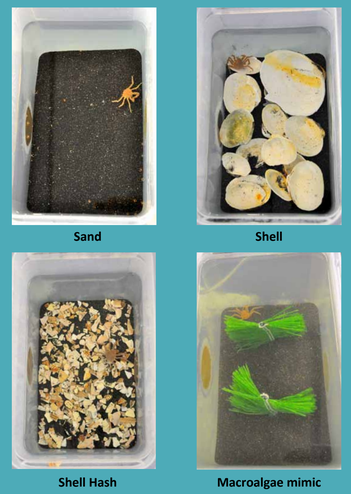
Methods

Animals

- Prey: Year-0 juveniles, 2-5mm carapace width
- Predators
  - Year-1 juveniles, 15-25 mm carapace length
  - Year-2 juveniles, 30-40 mm carapace length

Habitats



Experimental protocol

- Predators starved 24-48 hrs
- Prey acclimated in microcosms overnight
- Predators introduced in morning
- Trial duration of 2 hrs
- Predators removed and surviving prey counted
- All experiments fully crossed with 5 replicates per treatment
- Controls (no predators) run in all experiments (recovery of control animals was >98% in all cases).

Experiment 1: Habitat

- Habitats: Sand, Shell, and Shell hash
- Predators: Year-1 only
- Prey densities: 2, 5, 10, 18, 25 per microcosm

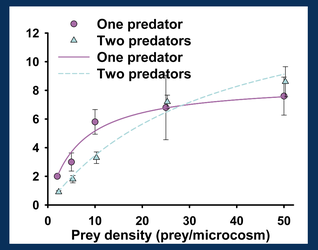
Experiment 2: Predator interference

- Habitats: Sand only
- Predators: Year-1 only
- Prey densities: 2, 5, 10, 25, 50 per microcosm

Experiment 3: Habitat and predator size

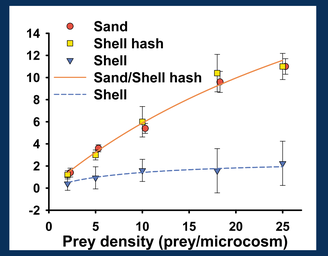
- Habitats: Sand and Macroalgae mimic
- Predators: Year-1 and Year-2
- Prey densities: 2, 5, 12, 25, 35, 50 per microcosm

Results



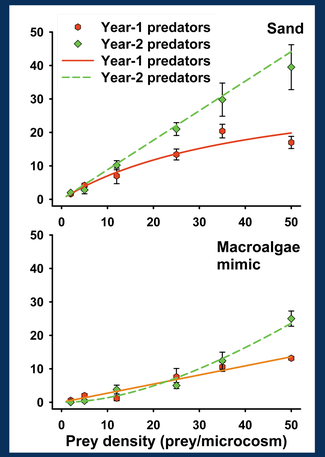
Habitat

- Functional response Type II in all habitats
- Sand and Shell hash did not differ
- Lowest predation in Shell habitat



Predator interference

- Functional response Type II at both predator densities
- Significant difference between predator densities
- Possible interference at low prey densities



Habitat and predator size

- Functional response Type II at both predator densities
- Significant difference between predator densities
- Possible interference at low prey densities

Conclusions

- Structured habitats provide a refuge from predation for year-0 red king crabs
- Complex 3-dimentional habitat may be necessary to provide a low density refuge from predation
- Predator efficiency is a function of habitat complexity and predator size
- Older red king crab display minimal interference
- Complex habitats represent essential habitat for red king crab juveniles