

Inferring prey perception of relative danger in large-scale marine systems

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ABSTRACT

Problem: Infer relative danger from spatially segregated predators in large-scale marine systems, using individual differences in prey foraging behaviour.

Mathematical models: Optimization of trade-offs between predation risk and energy gain.

Key assumption: Foraging individuals choosing to incur higher risk of predation should experience higher energetic gain than individuals choosing safer foraging options.

Organisms: Alaskan harbour seals foraging under predation risk from killer whales and Pacific sleeper sharks in shallow and deep strata, respectively. Sleeper sharks are elusive predators and their interactions with prey are difficult to measure directly.

Method: Our method infers the relative danger from different predator types that is theoretically most plausible according to intermediate consumer behaviour. We predicted net energy gain and predation risk per foraging dive, parameterizing an analytical model with data on seal behaviour and the spatial distributions of predators and resources. We used assumptions about relative danger from different predator types as treatments in a computer experiment. We sought the treatment combination best supporting the assumption that individuals that risk more should gain more by plotting the individual seals' predicted cumulative energy gain against cumulative predation risk. Improved statistical fit for a positive and monotonic relationship implied greater support.

Conclusions: Our key assumption was best supported when assuming that relative danger from sleeper sharks is much greater than that from killer whales, suggesting that sub-lethal effects of sharks on Alaskan harbour seals might be much stronger than previously thought.

Keywords: diving behaviour, harbour seal, hazardous duty pay, individual variation in risk-taking, killer whale, Pacific herring, Pacific sleeper shark, predation risk, resource distribution, risk–energy trade-offs, sub-lethal effects of predators, walleye pollock.

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