DO SPAWNING SALMON INDIRECTLY INFLUENCE UNGULATE SPACE USE IN THE COPPER RIVER DELTA, ALASKA BY ATTRACTING BEARS?

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Introduction

- Pacific salmon (*Oncorhynchus spp.)* and brown bears (*Ursus arctos*) are keystone species in coastal Alaskan ecosystems.[1]
- Coastal Alaskan bears, an important predator of both salmon and ungulates, kill live salmon and transport them to the bank to be consumed, aiding in the cycling of nutrients within the ecosystem.[2]
- Ungulates also benefit from salmon's presence in the food web due to nutrient inputs that salmon provide in terrestrial riparian areas.[3]
- In some ecosystems, ungulates have been observed changing their space use to avoid locations where they are more likely to encounter predators, leading to a "landscape of fear" hypothesis. [4]
- If the landscape of fear influences interactions between bears and ungulates in salmon-rich ecosystems it would indirectly link salmon and ungulates; the timing of salmon runs would indirectly influence ungulate use of productive riparian habitat through bear avoidance.

Purpose of the Study

Goal

- The goal of this study was to examine if, by attracting bears, the timing of salmon spawning had an indirect effect on ungulate use of riparian areas.

Objectives

- Quantify ungulate and bear presence at salmon spawning sites in the Copper River Delta region.
- Analyze relationships between bear and ungulate detection data in relation to salmon spawning timing to assess the strength of evidence for indirect effects between salmon and ungulates.

Abstract

One of the key challenges in ecology is understanding the drivers of animal movements and distributions. Here, I used remote camera photography to examine whether the timing of spawning salmon altered ungulate space use due to the presence of bears. Using observational data collection methods, I quantified ungulate and bear presence at individual salmon spawning sites. I then analyzed relationships between bear and ungulate detection data to test for indirect effects between salmon and ungulates by applying linear regression models. A zero-inflated negative binomial model suggested that increases in bear detections are associated with decreases in ungulate detections. Results did reveal little overlap in the timing of ungulate and bear use of stream habitat during salmon spawning times, however, rigorous testing of my hypothesis may be limited by low rates of ungulate detection. Research dedicated to understanding the indirect effects of the timing of salmon spawning in the Copper River Delta can help evaluate the evidence for trophic interactions at various ecosystem levels. It may also offer insights into the potential magnitude the impact salmon has on the prey of large predators, other herbivore densities, plant communities, riparian area morphology, and essential ecosystem functions.

Methods

- Remote cameras were placed at field sites from 2013 through 2019.
- The field sites were chosen to capture the breadth of thermal and hydrological variation in the study area with consideration for the logistical challenges of working in remote areas.
- Relationships between salmon presence and bear and moose detection data were analyzed using generalized linear modeling techniques.
- Further analysis was done by site to examine overlap in ungulate and bear detection data.
- Distributions of bear and ungulate detections as well as salmon spawning durations at these locations were graphed and inspected, and the observed patterns were qualitatively analyzed.

Study Area

- Copper River Delta, Alaska
- Critical spawning habitat for coho salmon (*Oncorhynchus kisutch*) and sockeye salmon (*Oncorhynchus nerka*)
- Protected as critical habitat for many species of wildlife

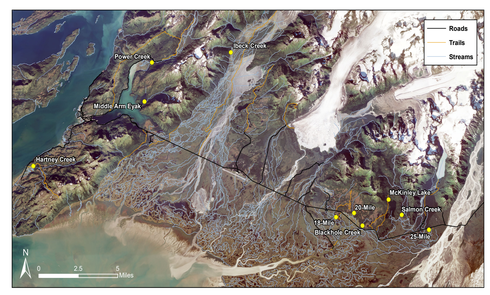

Figure 1. Remote Camera Sites for Study, Cordova Ranger District, 2018.

Results

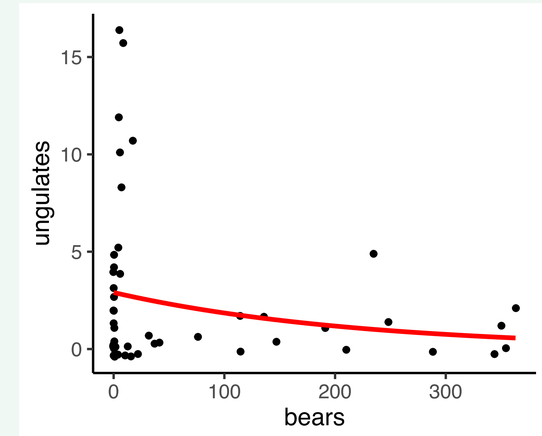

Figure 2. Number of ungulate detections as a function of bear detections at monitoring sites, (*N*=38). The red line shows the estimated relationship between ungulate counts and bear counts from a zero-inflated negative binomial model (estimated slope on the link scale = -0.004497, *z*= -2.212, *P*=0.027). Points are jittered to avoid over-plotting.

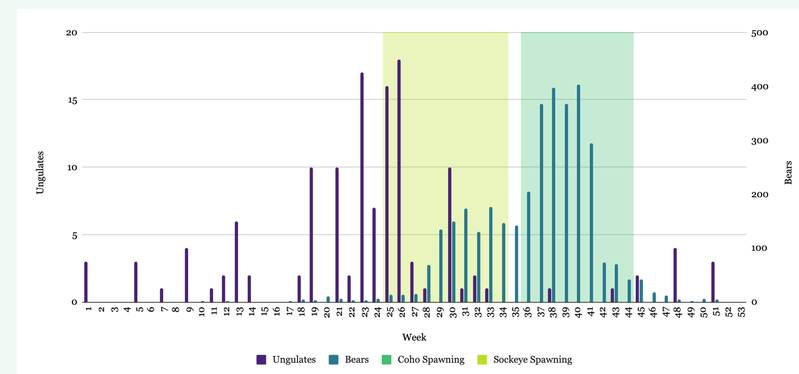

Figure 5. Ungulate and bear detections by week across all monitoring years and across all monitoring sites. The average sockeye salmon spawning timing is noted in light green shading and the average coho salmon spawning timing is noted in dark green shading.

Conclusions

- The results of this study suggest that increases in bear detections are associated with decreases in ungulate detections, indicating that in times when bears are frequenting riparian areas, ungulates tend to be elsewhere.
- Further studies are needed to identify ways in which moose and Sitka black-tailed deer alter their space use in response to the risk of predation by bears when bears are occupying known salmon spawning locations.

References

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