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Impacts of Human Disturbances on Alaskan Brown Bears (*Ursus arctos*): A Literature Review

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Impacts of Human Disturbances on Alaskan Brown Bears (*Ursus arctos*): A Literature Review

by

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An undergraduate honors thesis submitted in partial fulfillment of the requirements for

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Thesis Advisor

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Personal Connection

I was fourteen years old when my family established our roots in Kodiak, Alaska in 2014. Moving from Stockton, California was an extreme culture shock to say the least. Trading a busy city with concrete walkways and streets for an island with lush green forests and dirt roads was something I could have never imagined. In the beginning, moving to a new town left me feeling like an outsider except in the moments that I would spend outdoors. I found solace and comfort in the morning fresh air, greenery, and bird sounds.

I still remember when my dad would take my siblings and I out for walks at the local beaches, hikes on the nearest mountains, and early morning trips to hunt for deer. Although we only intended to get some fresh air and have fun, sometimes our adventures would lead us straight into brown bear territory. There is nothing like seeing the big, magnificent creatures in person. Time seems to slow down as your heart rate increases, but above all else you cannot help but be overwhelmed with fascinating awe of their grandeur. My curiosity for them continued to grow after learning that Kodiak bears have lived exclusively on the island and isolated from other bears in Alaska for nearly 12,000 years. Due to their long history of existence, it's estimated that there are about 3,500 bears; a total density of 0.7 bears per square mile. (Van Daele, L. (n.d.). Their strong presence on a small island with roughly 5,000 people left me wondering: Can human disturbances alter Alaskan brown bears' spatial, feeding, and social behaviors?

Abstract

This thematic literature review presents a comprehensive analysis of the existing research on the various human disturbances that impact Alaskan brown bears (*Ursus arctos*). It meticulously explores key findings, trends, and gaps in the literature, focusing on the overarching themes of *Land-Use Overlap, Hunting and Poaching, Noise Pollution, and Industrial Development*. By synthesizing and critically evaluating a wide range of studies, this review aims to deepen our understanding of the common sources of disturbances and their implications on the spatial, feeding, and social behaviors of brown bears. A brown bear's response to human activities varies in intensity and is dependent on the type of disturbance(s) but generally brown bears will either flee from their location, change the time of their feeding patterns, relocate to an undisturbed area and/or continue with their daily activity patterns despite human presence. Future research on the relationship between humans and brown bears should look into the long-term impacts of habitat fragmentation and they may consider incorporating newer technologies into their methodology.

Keywords: *Ursus arctos*, Alaska, brown bear, recreation, aircraft, land-use overlap, habitat fragmentation, and human disturbance

1. Introduction

Brown bears (*Ursus arctos*) are an important keystone species within forests due to their role in nutrient cycling, seed dispersal, and predator-prey dynamics (Helfield & Naiman, 2006). Their ability to cycle nutrients and disperse seeds is directly related to their nutritional diets that are supported by their habitat. Brown bears forage forests for berries, and rivers and streams for salmon. When they excrete their droppings, the seeds from berries are spread throughout the land and nitrogen is specifically passed down from salmon and back into the forest as fertilizer.

Brown bears play a crucial role in promoting plant growth and sustaining healthy forests by consuming berries, salmon, and occasionally hunting other animals. This helps maintain balance in the ecosystem by preventing overgrazing by other mammals (Schueman, 2022). However, human disturbances pose a threat to brown bears, causing changes in their spatial, feeding, and social behaviors.

A unique characteristic of brown bears is the fact that they are the most widely distributed mammals and largest living carnivores in the world (García-Rodríguez et al., 2021). Their distribution expands from North America to eastern and western Europe, northern Asia, the Himalayan Mountains, and the island of Hokkaido in Japan (Brown Bear, 2017). Depending on their location, their habitats can be found in coastal forests, boreal forests, subalpine mountain areas, or desert and semi desert areas. Each habitat type then determines the types of food available and the frequency of exposure to humans and industrialization. In order to reduce the variance of brown bear behaviors due to the previously mentioned factors, this review focuses specifically on brown bears residing in Alaska.

A search based on the centralized question, “What human disturbances alter the Alaskan brown bears' spatial, feeding, and social behaviors?” was used to conduct this literature review. Scholarly sources of information identified from this search are presented below in a thematic order. The initial theme, known as Land-Use Overlap, focuses on the impacts of tourism, general public use, and trail use on brown bears. It examines how these activities disturb brown bears

and it explores the effects on various aspects of their behavior. This includes investigating changes in brown bears feeding behaviors, examining the denning period (the resting time during winter months), studying the temporal cycle (activity patterns on a daily or seasonal scale), and analyzing the spatial patterns (distances traveled for daily or seasonal activity). The subsequent section delves into the impacts of *Hunting and Poaching* on population dynamics. It presents findings from studies that monitored (1) the interactivity between deer hunters and bears, (2) brown bear population composition following liberalized deer hunting laws of the mid-late 1880's and (3) cub survival rates following liberalized hunting laws. The third section covers *Noise Pollution* emitted from aircrafts and the behavioral impacts on bears. Finally, *Industrial Developments* includes material related to construction activities and the effects on home ranges, which are the areas regularly traveled by brown bears. These themes were selected to assess human disturbances from short-term or seasonal impacts (tourism, hunting, and recreational activities) to long term impacts (habitat fragmentation).

The search engines used to gather sources were Google Scholar and the PSU Library with the search terms: Alaska, brown bear, recreation, aircraft, fragmentation, and human disturbance. Only primary sources including peer-reviewed journal articles and literature reviews were included. The review concludes with recommendations for future work by researchers studying the relationships between human disturbances and Alaskan brown bears.

2. Human Threats on Alaskan Brown Bears

2.1 Land-Use Overlap

Recreational activities like tourism, general public use, trail use, and bear viewing can lead to land-use overlap between humans and bears. As a result, human activity can facilitate the temporal and spatial patterns of brown bear foraging. For example, brown bears will either increase their daytime foraging activity, transition to a nocturnal feeding pattern, or alter

community-level interactions when human activity is present (Rode, 2007, Kilfoil et al., 2023, Coltrane & Sinnot, 2015).

Coltrane and Sinnot (2015) found that brown bears in Anchorage, Alaska alter their foraging behavior to avoid peak human activity by choosing to forage in the early morning, late evening and during periods of darkness as humans are more active during daylight. A different study implemented experimental tourism, meaning they intentionally brought in a group of people into populated brown bear areas (Douglas River and Glacier and Seepage Creeks) to study the impacts of human activity on their feeding behavioral practices. Similar to the previous study, results showed that nighttime resource use increased at all study sites, further implying that wildlife viewing and other recreational activities can alter animal behavior (Rode, 2007).

However, this is not always the case as some studies have found brown bear presence increased along with human presence. For example, females with cubs and subadults (bears up to 5 years of age) were seen to be active during separate times along tributaries in Lake Aleknagik, Alaska regardless of human presence (Kilfoil et al., 2023). This relationship can be seen below in Figure 1; Graph A where the human presence is marked by the black line and females with cubs in blue and subadults in green. Through this relationship, the authors showed that human presence can offer temporal refuge, allowing this class of bears to forage for salmon while the dominant adult bears are less active.

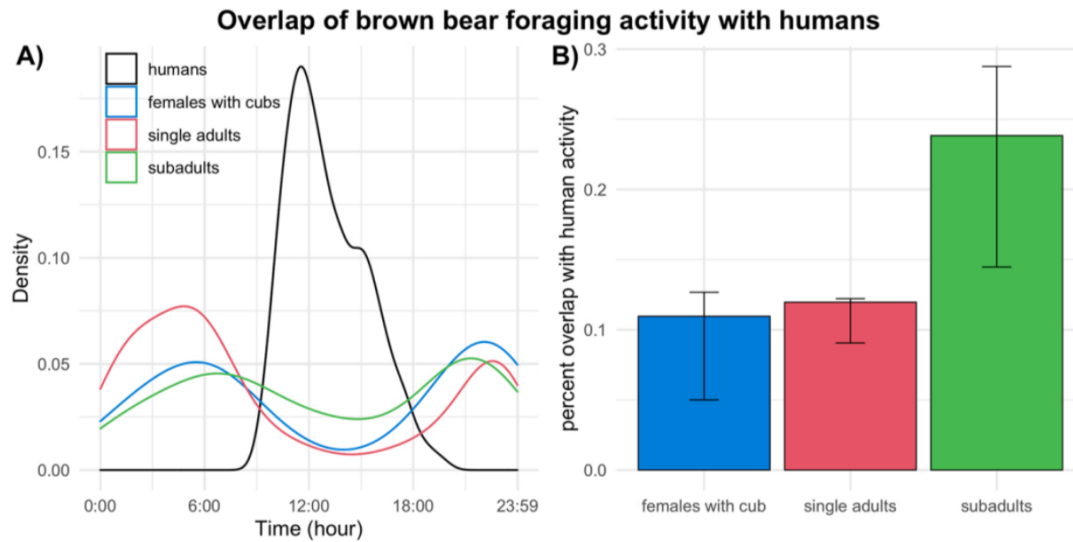


Figure 1. Graph A shows the overlap of brown bear foraging activity with humans – human activity is the black solid line, females with cubs in blue, single adults in red, and subadults in green. Graph B shows the mean overlap with human activity for females with cubs, single adults, and subadults. Error bars show a 95 % confidence interval (Kilfoil et al., 2023).

General public use and guided tours:

A form of altered behavior different to those of daytime human activity and experimental tourism has resulted from the presence of general public use and structured bear viewing. On the O'Malley River, northeast from Akhiok, Alaska, both activities generally elicited a running response from bears. According to Wilker and Barnes (1998), bears displayed a higher tendency to retreat in 37% of the observed cases during periods of general public activity compared to only six percent during years of organized bear viewing. Researchers suggested general public use on a river is less structured and more sporadic, which may induce a stronger reaction from bears compared to consistent predictable patterns of people as those with guided tours. In other words, bears are less skittish when exposed to repeated human exposure.

Contrastly, in the context of public use on trails, humans and bears have developed predictable seasonal patterns of overlap. Coltrane and Sinnott (2015) found that overlap occurred

more often between cubs, subadults, adult bears, and humans from July through early September when trail use is at its peak during a 24-hour period. However, their study only looked at activity patterns so a comparison between the intensity of bear responses to predictable human presence on trails versus rivers cannot be made.

Human presence during denning:

When humans are present near a bear's den site, which is the area where they rest, it can disturb the bear's denning period. The denning period refers to the time bears spend resting at their den site. Linnell (2000) states, "Because of strict energy constraints and the importance of the den structure, disturbance in this phase of the annual cycle may have greater negative effects on survival and reproduction than disturbance at other times of the year". The risks associated with early den abandonment pertain mostly to cubs. It can end with mortality if they choose to follow their mother to investigate the source of disturbance rather than reserving their energy for hibernation. Research has suggested that human activity closer than 1 kilometer and especially within 200 meters within a den resulted in den abandonment making it the most vulnerable proximity of human exposure (Harding and Nagy 1980, Reynolds et al. 1986, & Huber and Roth 1996).

2.2 Hunting and Poaching

Land-use overlap also occurs between hunters and bears in addition to the land-use overlap sources previously mentioned. When hunters possess harvested meat, they increase the likelihood of raising life-threatening conflict with bears (Barnes, 1994). This observation was supported by a survey that was sent out to deer hunters where they reported that two bears were recorded to have raided deer-hunting camps for meat and nine were reported to have been within less than 200 meters from hunting camps (Barnes, 1994). Consequently, between eight and ten respondents out of 135 surveyed reported having a life-threatening experience with a bear (Barnes, 1994). Bears may grow accustomed to the presence of deer hunters if hunters are returning to the same area, leaving bears to expect deer meat from them. Bears may also develop

a greater comfort zone in getting within close proximity of hunters. A consequence to this has been recorded as bear mortality. Barnes (1994) found that two female bears were killed by hunters in defense of life or property. The death of bears, especially females, is critical to a brown bear population as the number of reproductive females limits population growth. The same study noted that territory overlap between bears and deer hunters occurred more often along the coast compared to inland areas, making it critical information for hunters to know in order to reduce bear mortality.

During the mid-late 1980s, the state of Alaska approved a liberalized hunting law for brown bears. The primary motive behind increasing brown bear mortality was to increase the numbers of moose and caribou that were available for harvest by Alaskan hunters and to reduce the overwhelming amount of brown bear predation on these species (Miller et al., 2011). Following its implementation, the population estimates of brown bears generally declined and cub survival rates increased. Population densities of bears over 2 years old declined from 1979 through 1987 (Miller, 1990). This was to be expected as a population decline was the aim of the law. In contrast, areas with intensive hunting, such as Susitna and Black Lake, witnessed an increase in cub populations compared to nearby areas with no hunting like Denali National Park and Katmai National Park, as reported by Miller et al. (2003). While these findings suggest that hunting adult brown bears enhances cub survival, it is crucial to consider that the un hunted areas might have had a lower carrying capacity. Carrying capacity refers to the average population size of a species in a specific habitat, and it could potentially lead to lower cub populations in those areas. Thus, strong correlations cannot be made.

2.3 Noise Pollution

Noise pollution is defined as distressing noise that may harm the physical or mental activity of human beings as well as animal life (Jhanwar, 2016). In this context, noise pollution refers to the sounds emitted from aircrafts and its effects on brown bears. Studies showed that noise pollution caused the following behavioral responses: no effect, reduced abundance, mixed

abundance, fleeing, or increased heart rate (Deacy et al., 2019, Wilker & Barnes, 1998, & Reynolds et al., 1986).

Behavioral response to aircrafts:

Deacy et al. (2019) monitored brown bears' responses to noise pollution emitted from aircrafts by using aerial surveys, ground surveys, Global Positioning System (GPS) collars, and time-lapse cameras. The aerial surveys showed that following two sequential aircraft flights 12 hours apart, no significant difference was detected amongst the numbers of bears observed before and after flights. This meant that neither time of day nor time elapsed from previous flight had a statistically significant effect on bear abundance. Similarly, no significant differences were observed in distances traveled following aerial flights. In contrast, a different study showed that brown bears responded to aircrafts by running or walking away on 48% of occasions (Wilker & Barnes, 1998) showing that fleeing can in fact be a response to noise from aircrafts. In addition to fleeing, increased heart rates have also been observed as a behavioral response. One study showed that heart rates specifically increased following den emergence due to aircraft noise (Reynolds et al., 1986). However, during hibernation, aircrafts did not have a significant effect on heart rate when comparing data to heart rates during undisturbed resting periods.

Behavioral response to aircrafts with ground survey evidence:

Ground surveys showed opposing results to the density estimates captured by aerial surveys. On average, a 62% population decline was observed with ground surveys across individual bears within 100 meters of salmon streams when two flights occurred on a 24-hour time scale (Deacy et al., 2019). More specifically, there was a 48% population decrease in male brown bears within 100 meters of streams following survey flights (Deacy et al., 2019). The decrease in male abundance can be inferred as a learned self defense behavior as males are typically hunted and thus, may be more wary of possible threats.

Behavioral response to aircrafts with time-lapse camera evidence:

Using time-lapse camera data, Deacy et al. (2019) found a mixed response for mean bear abundance on a 3-day time scale. On the first day, daily bear detections decreased by 25.2%, then 21.0% on the following day, and by 13.0% on the third day. However, authors noted that bear abundances returned to pre-survey levels after a weekly round of surveys. Although not stated by the researchers, it can be inferred that bears became accustomed to noise pollution from aircrafts over time. Therefore, they observed no threat, and continued to forage along their home corridors, the established area that connects two habitats while providing food and shelter.

2.4 Industrial Developments

From a wildlife manager's perspective, their biggest concerns with industrial developments are the long-term impacts on habitat type, availability, and the connectivity among natural areas. However, most studies surveying brown bear behavior in the presence of construction mainly focused on the immediate effects, which tend to be centered around noise pollution rather than long-term impacts. For this reason, some of the information in this theme overlaps with content from the *Noise Pollution* sections.

Over a span of three years during construction and two years after completion, researchers Smith & Van Daele (1990) conducted a study to examine the effects of the Terror Lake hydroelectric project construction on brown bears. This site can be found in Kodiak, Alaska. The research found that the noise generated by helicopters used in the construction process caused bears to avoid alpine habitats and instead move to mid-slope and lowland areas (Smith & Van Daele, 1990). Interestingly, home ranges following relocation were not affected by project activities; no evidence of major changes to movement patterns. Additionally, disruptions to denning patterns, premature emergence, and den abandonment did not occur given that their traditional denning areas were relatively remote from the construction area. Likewise, potential denning habitat was not lost due to the project. Neither population nor reproduction declined in

direct correlation to the project (Smith & Van Daele, 1990). It was also mentioned that bears shifted to nocturnal feeding patterns to avoid anthropogenic disturbances. It can be inferred that the dense shrub and vegetative cover in this area helped bears feel safe in making this transition despite the intensive construction activity during the day. These results may have been impacted by a short monitoring period following the completion of construction, and from having a small sample size of bears.

A separate study looked at the short-term effects of mine development and found that generally, bears shifted their activity patterns further away from the mine development site as construction continued (Schoen & Beier, 1982). For example, during the construction period, notable changes were observed in the behavior of brown bears. Firstly, den sites shifted significantly, moving from 3.4 kilometers in the first year of construction to 11.7 kilometers in the second year (Schoen & Beier, 1982). Additionally, bears relocated to a different salmon stream as a result of the construction activities. Moreover, the intensive road construction involving blasting and heavy equipment operation led to two bears ceasing their use of the local drainage and moving to a different one (Schoen & Beier, 1982). The authors concluded that most of the bears monitored remained in their home ranges even though they relocated—they mainly shifted their movements away from active development. However, whether these changes were attributed to noise pollution or displacement from the physical mine site remains unknown.

3. Conclusion and Recommendations

Although these findings give us insight into the short-term impacts of human disturbances, the long-term impacts have yet to be discussed. With increasing urbanization, there is a greater need to investigate how habitat fragmentation and industrial developments permanently fragment the corridors that link a home range for a bear. Furthermore, when evaluating the effects of habitat range reduction on brown bears, it is essential to investigate its impact on nutritional availability as well.

It is also important to note that the studies incorporated in this review date back to the 1980's, 1990's, and early 2000's. Since then, newer technology has been and continues to be developed to make monitoring bears more accurate and overall less invasive. For example, the Bear ID project is being designed to adapt to a deep learning human face recognition algorithm but for bears. The Bear ID system automatically examines images and videos obtained from camera traps and identifies the presence of bears within the collected data. This technology could eventually replace older camera traps, making it easier for researchers to monitor population density and activity in a given area without having to rely on aerial aircraft surveys which we know can disrupt a bear's behavior.

The themes explored in this review are similar in the sense that some of the behavioral responses of brown bears were the same across different types of human disturbances. Both *Land-Use Overlap* and *Industrial Developments* caused brown bears to transition to a nocturnal feeding pattern, ultimately altering the timing of their foraging behavior. Further, studies within the *Noise Pollution* and *Industrial Developments* sections showed that brown bears were forced to relocate to areas further away from sound disturbances in order to find a different foraging site or den site clear from human presence.

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