An Overview of Brown Bear Hunting Activity of Pacific Salmon in Katmai National Park & Preserve, AK USA

Abstract

Both brown bears (*Ursus arcotos)* and Pacific salmon (*Oncorhynchus spp.)* play an important role in riparian forests, and salmon make up a large portion of brown bears diets. Katmai National Park, AK, USA, is a particular region of interest due to the waterfalls that create a barrier and ultimately result in high salmon density. This observational study monitored the hunting activity of brown bears in Katmai National Park and recorded the number of attempts and successes at salmon capture by bears over several weeks between October and November 2020. This data was then consolidated to analyze the total hunting activity and successful captures in the morning, afternoon, and evening, as well as at peak and non-peak hunting hours. It was found that the number of hunting actions did not vary by daytime period, or between peak and non-peak hours, nor did the number of salmon successfully caught between daytimes periods. However, the number of successful captures was statistically different at peak vs. non-peak times.

Introduction

The brown bear (*Ursus arcotos*) and pacific salmon (*Oncorhynchus spp.)* have been described as keystone species for riparian forests, which are forest regions in wooded land areas adjacent to a body of water (Helfield and Naiman 167). Keystone species is a term used to describe organisms that play an important role in their ecosystem, disproportionately to other species (Helfield and Naiman 167). The brown bear and Pacific salmon are coined as keystone species due to their role in nutrient transportation from oceans to rivers and riparian ecosystems (Helfield and Naiman 167). In addition, Helfield and Naiman (2017) state that salmon are an important dietary component for coastal bears and typically make up a large portion of their food consumption. Density of brown bears is high many coastal habitats within Alaska, and it is predicted that this is due to the abundance of salmon available during the spawning season (Miller and White 1997). It is important to note that in North America, the populations of brown bears are called grizzly bears ("Brown Bear").

Katmai National Park and Preserve, AK, USA, is an example of a riparian ecosystem. Brooks Falls is a hotspot for bear feeding within the national park, due to the waterfalls that create a barrier for salmon swimming upstream and thus, facilitates hunting (Explore.org). The falls are available for online observation through live stream on Explore.org, which was utilized for this study.

Salmon spawn in the park during August, September, and October. (Katmai National Park & Preserve: Katmai's Fish Species). Furthermore, some bears begin to enter their dens for hibernation as early as September, while some adults may remain until December (Katmai National Park & Preserve). Since this study was conducted during October and November, it is thus assumed fishing activity will be elevated as the bears prepare for hibernation.

Footage accessed on the Brooks Falls Brown Bears Live Camera is either completely live footage or is a live stream of "Live Cam Highlights". The highlight footage is assumed to show the most active times of day for an unknown period of time; therefore, it was assumed more fish

would be caught in these conditions and any observations from this footage was categorized as "Peak Times" for bear activity. This definition allowed the live footage to be classified as "Non-Peak Times" footage, as the likelihood of observing bears catching salmon at the random viewing time was mainly due to chance.

This observational study will serve to monitor bear activity and salmon hunting behaviour at Brooks Falls – Katmai National Park, using the aforementioned live stream. Total hunting activity will be monitored by recording the total number of attempts or successes made by bears to catch salmon. This data will be compared by time of day, and at peak vs. non-peak times, where peak times are considered occasions where both bears and salmon are highly active. We will also compare the number of successful salmon captures throughout the day, and at peak vs. non-peak times.

The null hypothesis for this observational study was: (1) That the mean number of total hunting action per time of day was the same between all intervals, (2) that the mean number of successful salmon captures at all times of day were the same, and (3) that the mean number of salmon caught at Peak vs. Non-Peak times were the same.

Methods

Bears were observed virtually over the course of 28 days through the live cameras accessed on Explore.org (Accessed 2020). From 17 October 2020 – 13 November 2020, observations typically occurred twice daily, varying between morning, afternoon, and evening. Morning observations were categorized by any observation occurring between 08:00 - 11:59 AKST (Alaska Standard Time), afternoon observations were categorized between 12:00 - 17:00 AKST, and evening times as between 17:00 - 23:59.

Measurement times were initially set to occur for the live footage only, at 9am AKT and 9pm AKT, in order to observe the number of salmon caught in the morning vs. evening. However, due to seasonal restriction of viewing hours, the live footage was typically unavailable at these times and it was unknown when they would be turned on. For this reason, it was decided to include the highlight footage, which then also allowed for approximation of bear activity during Peak and Non-Peak hours. As mentioned, observation at Peak Times was obtained from the live streamed "Highlight" footage, and non-peak times using the truly live footage.

Both attempts and successes at catching salmon were recorded. Attempts were categorized by any effort to try and catch a salmon that was ultimately unsuccessful, and successes were recorded only if salmon was obtained. Attempts therefore do not included successes.

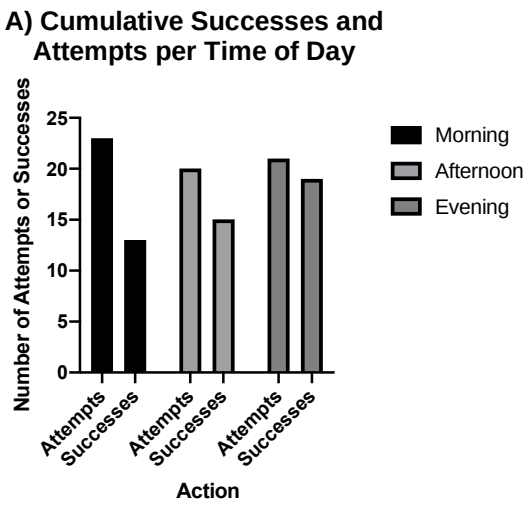
Due to the virtual observational nature of this study, it was important to differentiate what hunting behaviour was deemed as in order to define what an "attempt" at catching a salmon looked like. The bears would commonly appear to be searching by walking with their heads under water, sometimes successfully obtaining salmon. By succeeding at catching the fish in this method, it was assumed that any similar behaviour could be constituted as searching. Furthermore, it is said that this behaviour is known as "snorkeling" and is among common

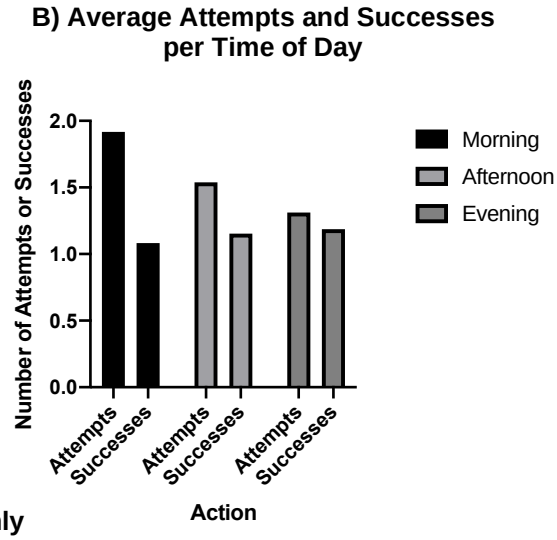
fishing styles for these bears (Katmai National Park & Preserve: Brown Bear FAQ). When a bear demonstrated snorkeling, then suddenly increased effort rapidly (jump, leap, etc.) it was assumed to be an attempt at catching salmon. Other fishing behaviours include standing (or sitting) and waiting, dash and grab (chasing and pinning with their paw in the water), pirating (stealing from other bears), diving, and begging from other bears (Katmai National Park & Preserve: Brown Bear FAQ).

Data collection ceased on 13 November 2020, as the live cameras appeared to be turned off for the winter and a sufficient amount of "Highlight Footage" was obtained.

Statistical analyses were conducted using the computer software, Prism. To analyze whether the mean actions or successes were different between the three times of day, one-way ANOVA was conducted. To analyze whether the mean actions or successes at Peak vs. Non-Peak times, an unpaired t-test was utilized.

Results





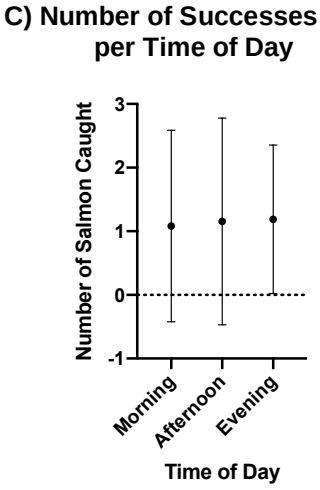


Figure 1. Bear hunting activity by time of day. Bear activity was monitored through live cameras accessed at explore.org. Sample size was varied between time of day, with morning (n = 12), afternoon (n = 13), evening (n = 16). The number of attempts and successes at catching salmon was observed at random times, twice daily, for 10 minutes at a time. (A) The total number of attempts and successes measured for each time of day across all observations. (B) The average number of attempts and successes at catching salmon for each time of day. (C) The mean number of successful catches per time of day. One-way ANOVA found no significant difference in the mean number of successes between any time of day (p = 0.9816). Statistical analyses were conducted using Prism.

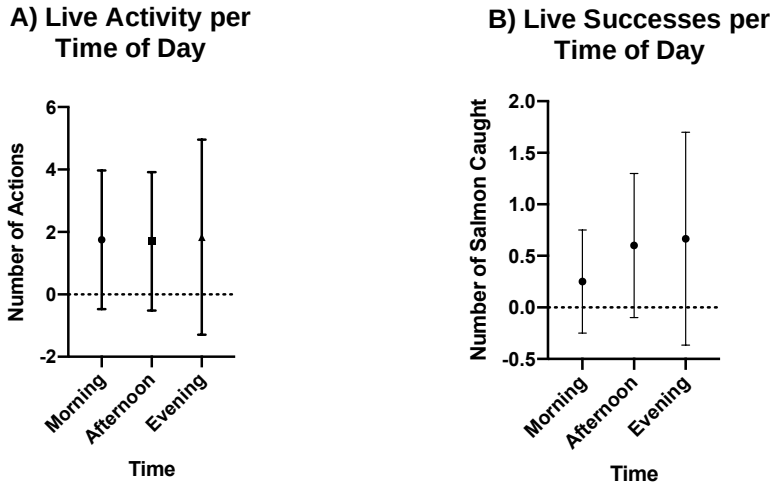
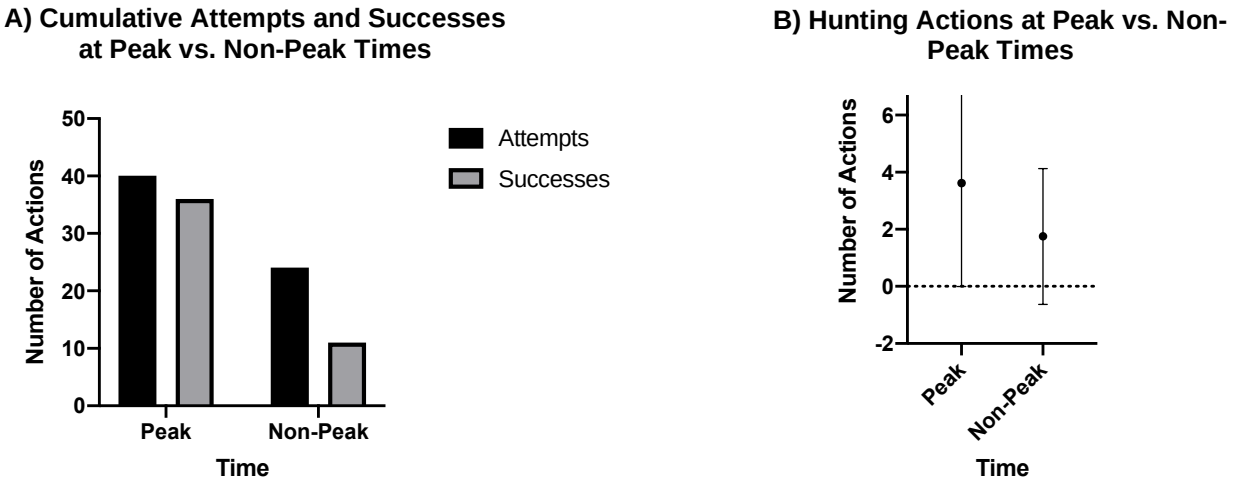


Figure 2. Live footage activity per time of day. Bear activity from the live footage only was compared per time of day. (A) The cumulative number of attempts and successes combined to represent total bear activity / actions for each interval of time. One-way ANOVA found no statistically significant difference between the mean number of actions performed at any time of day (p = 0.9948). (B) The mean number of successes only for each time of day. One-way ANOVA found no statistically significant difference between the mean number of salmon caught for any times of day. Statistical analyses performed using Prism.



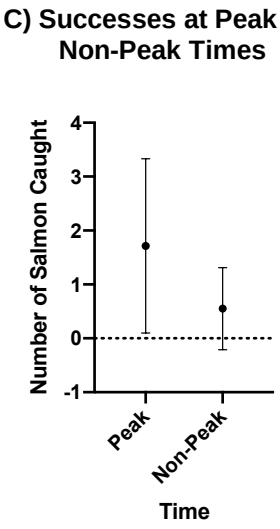


Figure 3. Bear activity at peak vs. non-peak times. The number of attempts and successes at catching salmon was observed at random times, twice daily, for 10 minutes at a time. Peak time observations were retrieved from Live-Cam Highlight clips, whereas Non-Peak times are from the live footage. (A) The total cumulative number of attempts and successes at catching at salmon at Peak vs. Non-Peak times, where actions represent either the attempt or success at catching salmon, depending on the data being viewed. (B) The total number of hunting actions at Peak vs. Non-Peak times, where an attempt or success are both considered a single action. Unpaired t-test found no significant different between the mean number of actions at Peak or Non-Peak times ($p = 0.0596$). (C) Successes at catching salmon at Peak vs. Non-Peak times. Unpaired t-test found a significant difference between the mean number of salmon caught at Peak vs. Non-Peak times ($p = 0.0057$). Statistical analyses were conducted using Prism.

Discussion

The present observational study served to provide an overview of the hunting activity of Grizzly Bears in Katmai National Park, AK, USA. Cumulative bear activity and the average number of salmon caught was compared between times of day (morning, afternoon, and evening), as well as the average bear activity during Peak vs. Non-Peak times of day. As previously discussed, peak times of day were defined as any observation occurring from live camera highlight footage, as it is assumed to only show the busiest times at Brooks Falls.

After statistical analyses were performed, there was no significant difference found between the mean number of bear hunting actions between morning, afternoon, and night. Therefore, we fail to reject the null hypothesis that the mean number actions were the same and it is assumed that any variation in these values is due to chance. In addition, it was reported that there was no significant difference in the number of successful salmon captures between these three-time intervals, and we fail to reject the null hypothesis that the mean number of successful captures during morning, afternoon, and night, were the same. To ensure no variation truly existed in live captures in the three time periods, both the cumulative actions and successful captures observed solely from live footage (discluding highlights / peak times) were analyzed, and no statistical results were produced. This further supports the failure to reject the null hypotheses that that the mean number of actions and successful captures during morning, afternoon, and night, were the same.

A possible explanation for these results is due to seasonal variation in activity. For instance, this study collected data through mid-October and early November, which coincides with the time when Alaskan bears are preparing for hibernation (Katmai National Park & Preserve). This could mean that bears are hunting more consistently, in order to prepare for the winter, minimizing variation throughout the day.

When analyzing the mean successful captures of salmon at peak vs. non-peak times, an unpaired t-test found a statistically significant difference. This demonstrated that more salmon were caught during peak than non-peak times, therefore, we reject the null hypothesis that the mean number of salmon caught at these two time periods times was the same. Since peak hours were approximated using the highlight footage from the live cameras, and because we define peak hours as being when both bears and salmon are highly active, this result makes sense. We assume that when more bears are present at the falls and demonstrating hunting behaviour, more salmon would be caught. Furthermore, when salmon are increasingly active, it is more likely that a bear will succeed in its capture.

Sources of error throughout this observational study may exist due to the small sample size and / or data limitations. For instance, observations for morning, afternoon, and evening had a sample size of n = 12, 13, and 16, respectively. These sample sizes were even more reduced when solely analyzing successful fish captures (n = 4, 10, 6, respectively). Since these values were determined by the number of attempts and/or successes observed, future studies may choose to increase observation time per day as well as longitudinally.

Conclusion

This observational study monitored the hunting activity of brown bears residing in Katmai National Park, AK, USA. The bears hunted Pacific salmon, and the number of attempts and successes at capture were recorded. The data was divided into two different comparison groups: the first being morning, afternoon, and evening, the second being at peak and non-peak hours. The study ultimately reported that the total number of successful salmon captures of salmon differed significantly between peak and non-peak hours only.

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Appendix

Table 1. Bear Activity, Raw Data

Date	Time of Day	Time	Live or Highlights	Number of Bears	Nun
17-Oct	Afternoon	12:10:00	Live	3	
18-Oct	Afternoon	12:20:00	Live	3	
18-Oct	Afternoon	15:10:00	Live	Unknown	
19-Oct	Afternoon	13:22:00	Live	4	
19-Oct	Afternoon	15:51:00	Live	Unknown	
20-Oct	Afternoon	12:45:00	Live	1	
20-Oct	Afternoon	12:24:00	Live	Unknown	
21-Oct	Afternoon	15:30:00	Live	2	
21-Oct	Afternoon	13:00:00	Live	2	
22-Oct	Afternoon	12:30:00	Live	2	
22-Oct	Afternoon	12:20:00	Highlights	3	
23-Oct	Afternoon	16:20:00	Highlights	Unknown	
24-Oct	Afternoon	14:20:00	Highlights	2	
24-Oct	Evening	21:00:00	Highlights	4	
25-Oct	Evening	21:03:00	Highlights	Unknown	
25-Oct	Evening	21:46:00	Highlights	Unknown	
26-Oct	Evening	21:15:00	Highlights	Unknown	
27-Oct	Evening	22:20:00	Highlights	Unknown	
27-Oct	Evening	18:40:00	Live	1	
28-Oct	Evening	18:30:00	Live	2	
28-Oct	Evening	17:40:00	Live	1	
29-Oct	Evening	17:50:00	Live	Unknown	
29-Oct	Evening	17:30:00	Highlights	Unknown	
30-Oct	Evening	17:20:00	Live	1	
31-Oct	Evening	17:30:00	Highlights	Unknown	
01-Nov	Evening	16:00:00	Live	Unknown	
01-Nov	Evening	20:07:00	Highlights	8	
02-Nov	Evening	17:50:00	Highlights	3	
02-Nov	Evening	18:30:00	Highlights	2	
03-Nov	Morning	09:00:00	Highlights	1	
04-Nov	Morning	00:10:00	Highlights	Unknown	
04-Nov	Morning	09:01:00	Highlights	Unknown	
06-Nov	Morning	23:10:00	Live	Unknown	
08-Nov	Morning	11:30:00	Live	3	

10-Nov	Morning	10:55:00	Live	1
10-Nov	Morning	11:00:00	Highlights	Unknown
11-Nov	Morning	09:30:00	Highlights	Unknown
11-Nov	Morning	11:30:00	Live	1
12-Nov	Morning	10:40:00	Highlights	7
12-Nov	Morning	11:20:00	Highlights	Unknown
13-Nov	Morning	08:30:00	Highlights	2