*Results and Discussion*

During this correlational study, I wanted to test if temperature, a known contributor of avalanche activity, influence Coastal Alaskan Mountain Goat (Oreamnos americanus) mortality in avalanche related incidents. Through some light researching, I hypothesized that rising temperatures, would lead to more avalanches, which would thus lead to more mountain goat deaths. After all, rising temperatures affect a multitude of different factors that could lead to avalanches. According to US Fish & Wildlife official, J. Berger, “A changing climate now brings new challenges for arctic species; warming temperatures are altering air velocity and the extent and duration of sea ice, all of which conflate to modify ocean currents and the timing and intensity of precipitation” . I had conducted this experiment by taking Individual goat mortality rates from a 2024 study, which would differentiate which out of the 258 goat deaths were caused by avalanche, compared the cumulative deaths by year. After conducting a GLM analysis on this, the correlation was statistically significant with a p value of 2.07 x10-12 and an AIC value of 123.18.

A similar GLM analysis was conducted on the annual average temperature in the testing site of Juneau Alaska, from the years 2005-2022, when the mountain goats were being observed. By plotting average temperature per year, this yielded a p value of 0.0649 and an AIC of 112.4, which is nearly close to being considered statistically significant.

When comparing the combined data set, that being the life ratio of the goats (cumulative deaths over the total number of deceased goats, 258) compared against increasing temperatures. It should be noted that the temperatures at the testing site did not steadily increase as years went on, which could have led to issues in determining the significance of this correlation. Had I had the opportunity to redo this study, I would have compared temperatures to cumulative deaths within each year, rather than total cumulative deaths. I had noticed that largest increases in life ratio happened between the years of 2016/2017 and 2019/2020 where the temperature dropped by 3.4 and 1.8 degrees, respectively, as seen in table 1. This is congruent with research proposed by the Research Unit on Torrent Erosion, Snow, and Avalanches, known by the acronym, ETNA, in their native language of French, findings that “we show evidence that winter warming of +1.35 °C induced a sevenfold reduction in the number of avalanches, as well as a reduction of their magnitude and shortening of the avalanche season”.(Giacona, 2021). Meaning that perhaps a decrease in temperature could have caused more avalanche related deaths because increasing temperatures seem to have little effect. The GLM analysis run on this correlation resulted in a p value of 0.0836 and an AIC of 142.51, which are not statistically significant.

According to Whites study on mountain goat mortality due to avalanche related reasons, “we show that avalanches caused 23−65% of all mortality, depending on area.” Which, is quite interesting, but I believe there is more at play. Throughout the observed time, average temperature is fluctuating rapidly, and it is believed that “increases of temperature affect plant phenology and nutritional quality. Cold-adapted plants occurring at lower elevations will shift to higher ones, if available” (Lovari, 2020). Therefore, I believe these fluctuating temperature changes could be shifting the herbivory of mountain goats that could be leading to their fatalities. In fact, Alaskan avalanche incidents have actually decreased by nearly 2% per decade (Peitzsch, 2021) and researchers at the Research Unit on Torrent Erosion, Snow, and Avalanches (ETNA)found “winter warming of +1.35 °C induced a sevenfold reduction in the number of avalanches” (Giacona, 2021).

In summation, the correlation between avalanche related mountain goat fatalities compared to average annual temperature, cannot be considered statistically significant for a number of reasons. Firstly, the combined dataset did not pass relevant significance tests, avalanche incidents have been on a steady decline, and temperature has proven itself to be an unfit indicator of avalanche activity.

Table 1 – Average temperature and life ratio of *Oreamnos americanus* values annually

|  |  |  |
| --- | --- | --- |
| Year | Annual Average Temperature (deg F) | Life Ratio (%) |
| 2005 | 43.4 | 0.00 |
| 2006 | 40.2 | 0.39 |
| 2007 | 40.9 | 0.76 |
| 2008 | 40.1 | 1.55 |
| 2009 | 41.2 | 1.94 |
| 2010 | 42.7 | 3.49 |
| 2011 | 40.6 | 5.43 |
| 2012 | 40.2 | 7.75 |
| 2013 | 42.4 | 11.24 |
| 2014 | 43.0 | 13.18 |
| 2015 | 44.4 | 15.12 |
| 2016 | 44.8 | 16.28 |
| 2017 | 41.4 | 21.32 |
| 2018 | 42.8 | 24.42 |
| 2019 | 44.2 | 25.58 |
| 2020 | 42.4 | 30.23 |
| 2021 | 41.7 | 33.33 |
| 2022 | 43.0 | 36.05 |

Figure 1 – Cumulative deaths of *Oreamnos americanus* plotted per year

A graph with blue dots

Description automatically generated

Figure 2 – Average temperature of Juneau, Alaska per year

A graph with blue dots

Description automatically generated

Figure 3 – Linear Regression Analysis of the life ratio of *Oreamnos americanus* compared to increasing temperatures in Juneau, Alaska

A graph with a red line

Description automatically generated

Confidence interval is depicted by the grey area surround the red trendline of the graph.

*References*

Berger, J., Hartway, C., Gruzdev, A. et al., 2018. Climate Degradation and Extreme Icing Events Constrain Life in Cold-Adapted Mammals. Sci Rep 8, 1156.

F. Giacona, et al., 2021. Upslope migration of snow avalanches in a warming climate, Proc. Natl. Acad. Sci. U.S.A. 118 (44) e2107306118.

Lovari, S., et al., 2020. Climatic changes and the fate of mountain herbivores. Climatic Change 162, 2319–2337.

Peitzsch, E.H., et al., 2021. Climate drivers of large magnitude snow avalanche years in the U.S. northern Rocky Mountains. Sci Rep 11, 10032.

White, K.S., et al., 2024 Snow avalanches are a primary climate-linked driver of mountain ungulate populations. Commun Biol 7, 423.