# Conquer Antarctica

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**Introduction:**

Penguins don't seem to fit the idea of bloodthirsty animals, seething for conquest do they? Well forget everything you know because in this scenario, two penguin species enter, and only one leaves! These penguins live across multiple islands of the Anvers Region, referring to the northwest peninsula of Antarctica. This duel, a 1v1 between two populations of penguins will answer: which species will win in a fight, Gentoo or Adelie? The two species are the closest relatives to each other, yet some bad blood came between our flightless friends and each side is trying to come out as "top-bird".

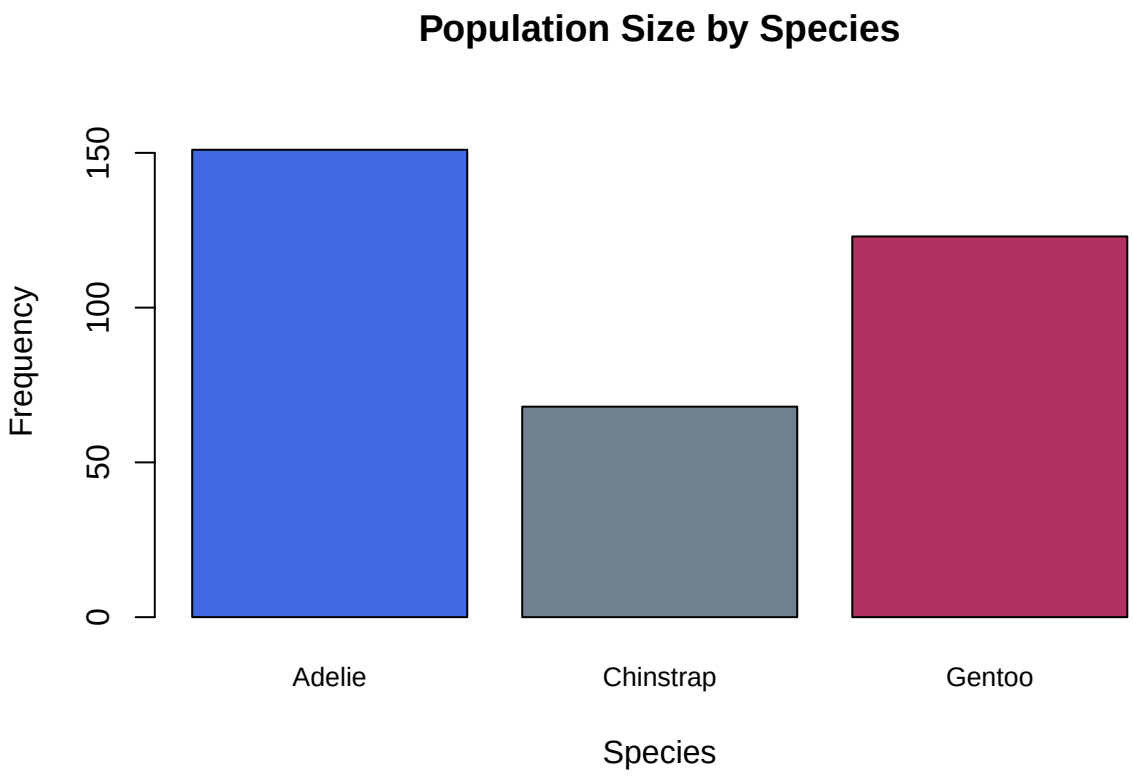
This takes into account beak length and depth, flipper length, mass, and total numbers. We are ignoring the Chinstraps because they have too small of a population in this data-set to get a grasp of their capabilities.

```
penguin.data <- read.csv("penguins_lter clean.csv")
#head(penguin.data)
```

Here's a look at the size of each penguin army, again it shows that Chinstraps have a much smaller population and therefore will be ignored.

```
barplot(table(penguin.data$Species),
        main = "Population Size by Species",
        col = c("royalblue", "slategray", "maroon"),
        names.arg = c("Adelie", "Chinstrap", "Gentoo"),
        ylab = "Frequency",
        xlab = "Species",
        ylim = c(0,165),
        cex.names = 0.8

        )
```




```
table(penguin.data$Species)
```

```
##
##       Adelie Penguin (Pygoscelis adeliae)
##                                       151
## Chinstrap penguin (Pygoscelis antarctica)
##                                        68
##         Gentoo penguin (Pygoscelis papua)
##                                       123
```

This removes the Chinstrap penguins from the data set.

```
penguin.data.duel <- penguin.data[penguin.data$Species == "Adelie Penguin (Pygoscelis adeliae)" |penguin
```

**Weight Classes:**

To make the analysis easier, the penguins will be separated into different weight classes, rather than the weight of each individual, based on the summary of the data. They will be the following (in grams):

Min to Q1: "Runts" = 2850-3600, Q1 to Median: "Lightweights" = 3600-4262, Median to Q3: "Heavyweights" = 4262-4950, Q3 to Max: "Absolute Units" = 4950-6300

```
summary(penguin.data.duel$Body.Mass..g.)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    2850    3600    4262    4318    4950    6300
```

```
breaks.for.weights <- c(2850, 3600, 4262, 4950, 6300)

penguin.data.duel$weight.classes <- cut(penguin.data.duel$Body.Mass..g., breaks = breaks.for.weights)

labels.weight <- c("Runt", "Lightweight", "Heavyweight", "Absolute Unit")
```

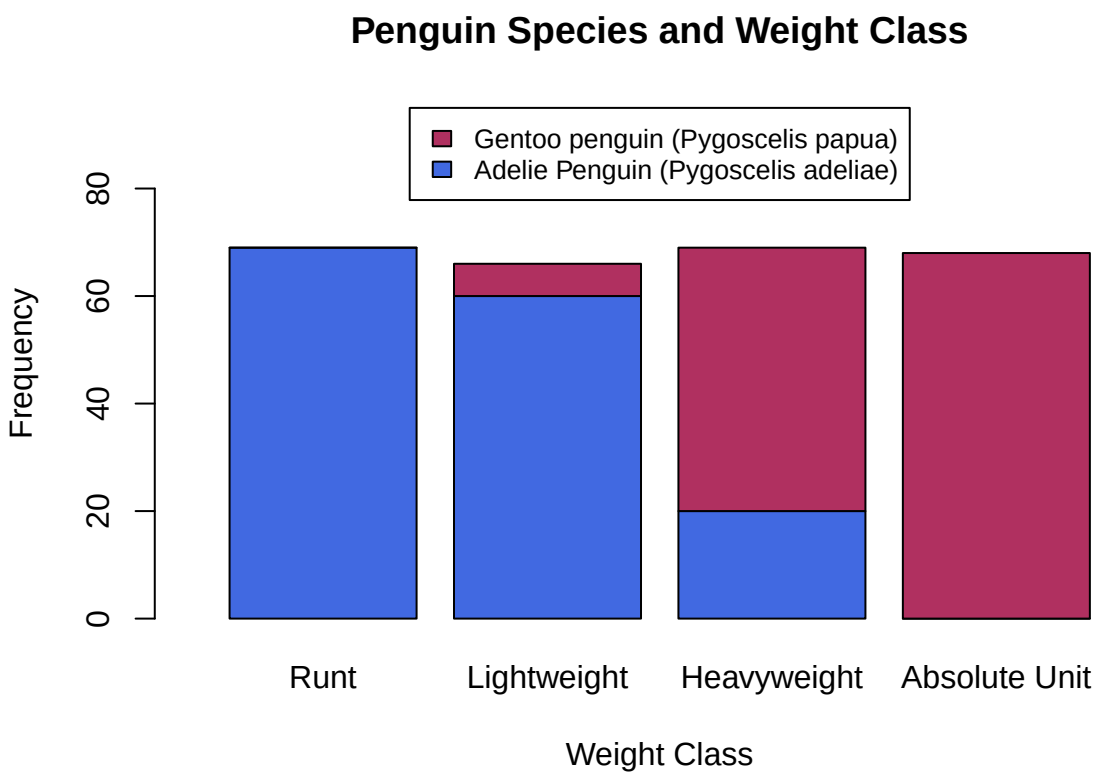
```
levels(penguin.data.duel$weight.classes) <- labels.weight

#head(penguin.data.duel)
```

With the weight classes created, we can see the numbers for each species.

```
barplot(table(penguin.data.duel$Species, penguin.data.duel$weight.classes),
        main = "Penguin Species and Weight Class",
        col = c("royalblue", "maroon", "maroon"),
        legend.text = T,
        ylab = "Frequency",
        xlab = "Weight Class",
        args.legend = list(cex=0.8, x = "top"),
        xlim = c(0,5),
        ylim = c(0, 95)

        )
```

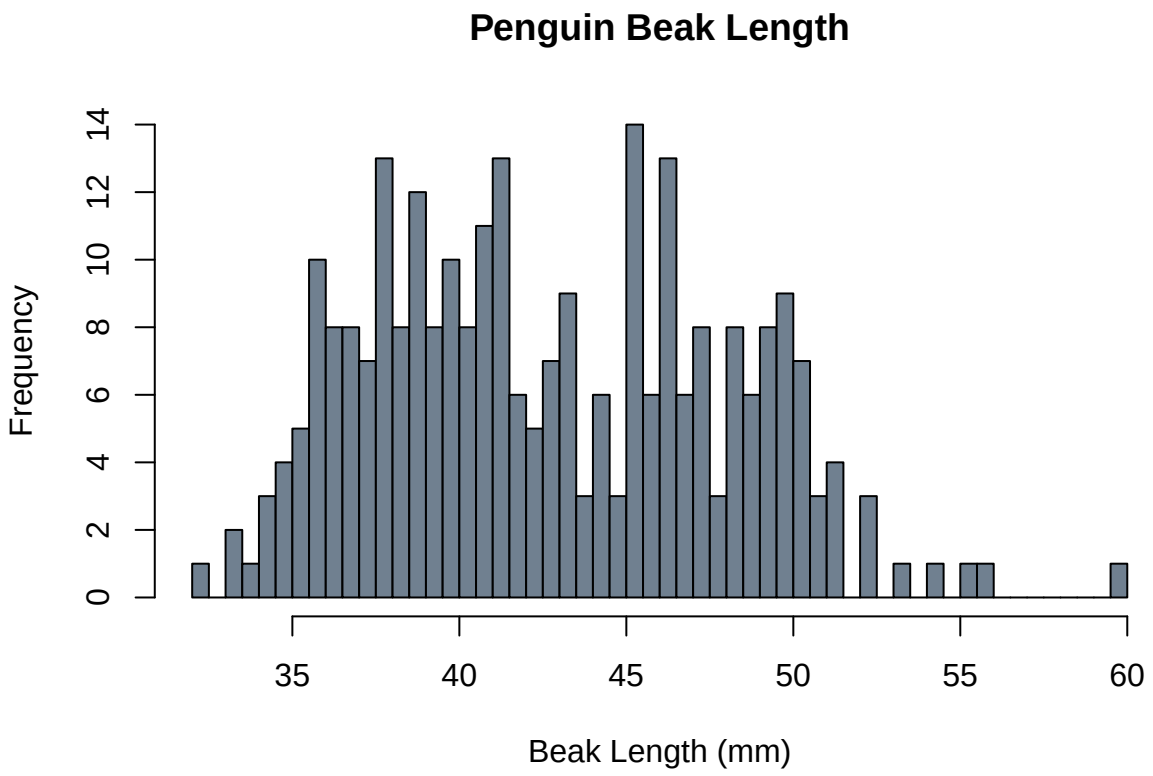



It is clear that the Gentoos carry a huge weight advantage over the Adelies with little overlap. However, weight does not determine lethality. Therefore each species' armament must be analyzed: beak size for pernicious pecks and flipper length for savage slaps.

**Beak Size (mm):**

The standard peck is a quick, precise attack, one of two conventional attacks available to a penguin. Naturally, a larger beak will do more damage to it's foe. Beak size is split into two variables: Culmen Length and Culmen Depth. The culmen refers to the upper ridge of a beak, so from a side profile perspective, culmen length is from the tip of the beak to the head which can be generally considered as beak length, while culmen depth is the height of the beak. Both variables are measured in millimeters.

```
hist(penguin.data.duel$Culmen.Length..mm.,
     breaks = 75,
     xlab = "Beak Length (mm)",
     col = "slategray",
     main = "Penguin Beak Length"
     )
```




```
summary(penguin.data.duel[penguin.data.duel$Species == "Adelie Penguin (Pygoscelis adeliae)",]$Culmen.L
```

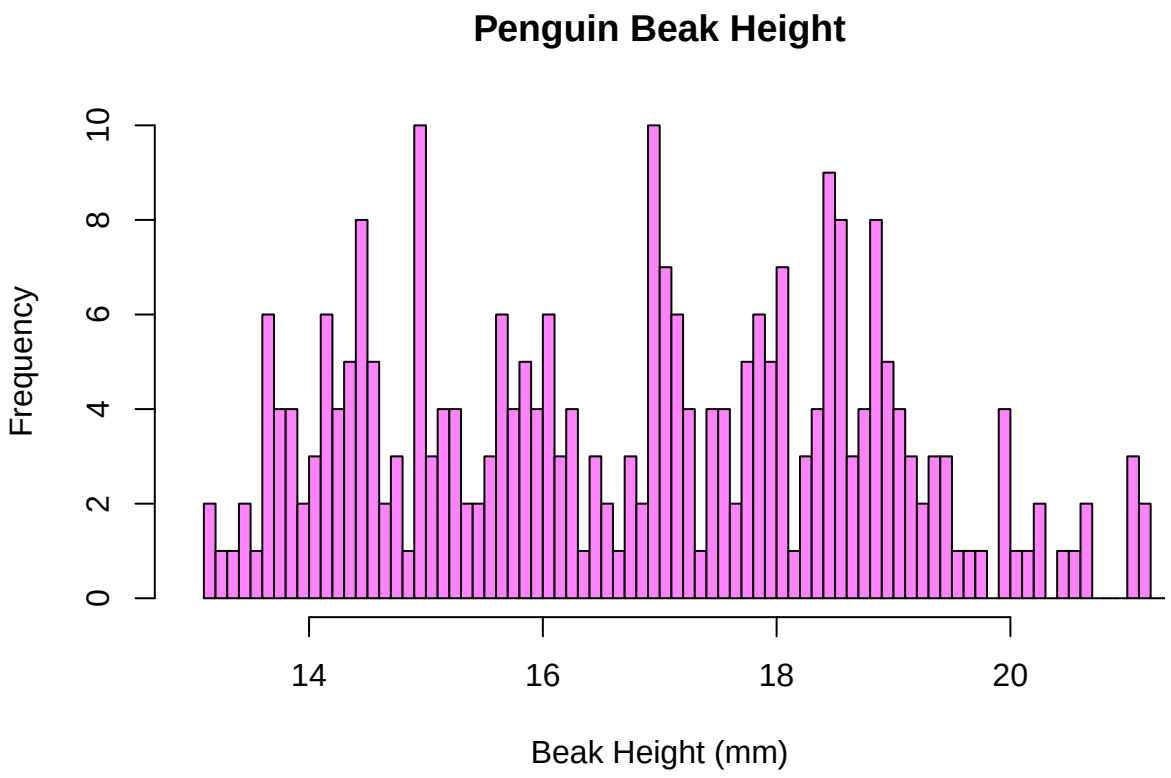
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   32.10   36.75   38.80   38.79   40.75   46.00
```

```
summary(penguin.data.duel[penguin.data.duel$Species == "Gentoo penguin (Pygoscelis papua)",]$Culmen.Leng
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   40.90   45.30   47.30   47.50   49.55   59.60
```

The histogram and different medians by species of culmen length show that the data is bimodal and that Gentoo penguins tend to have the longer beak lengths. Can the Adelies make it up with beak height?

```
hist(penguin.data.duel$Culmen.Depth..mm.,
     breaks = 75,
     xlab = "Beak Height (mm)",
     col = "orchid1",
     main = "Penguin Beak Height" ,
     xlim = c(13,21)
     )
```




```
summary(penguin.data.duel[penguin.data.duel$Species == "Adelie Penguin (Pygoscelis adeliae)",]$Culmen.D
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   15.50   17.50   18.40   18.35   19.00   21.50
```

```
summary(penguin.data.duel[penguin.data.duel$Species == "Gentoo penguin (Pygoscelis papua)",]$Culmen.Dep
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   13.10   14.20   15.00   14.98   15.70   17.30
```

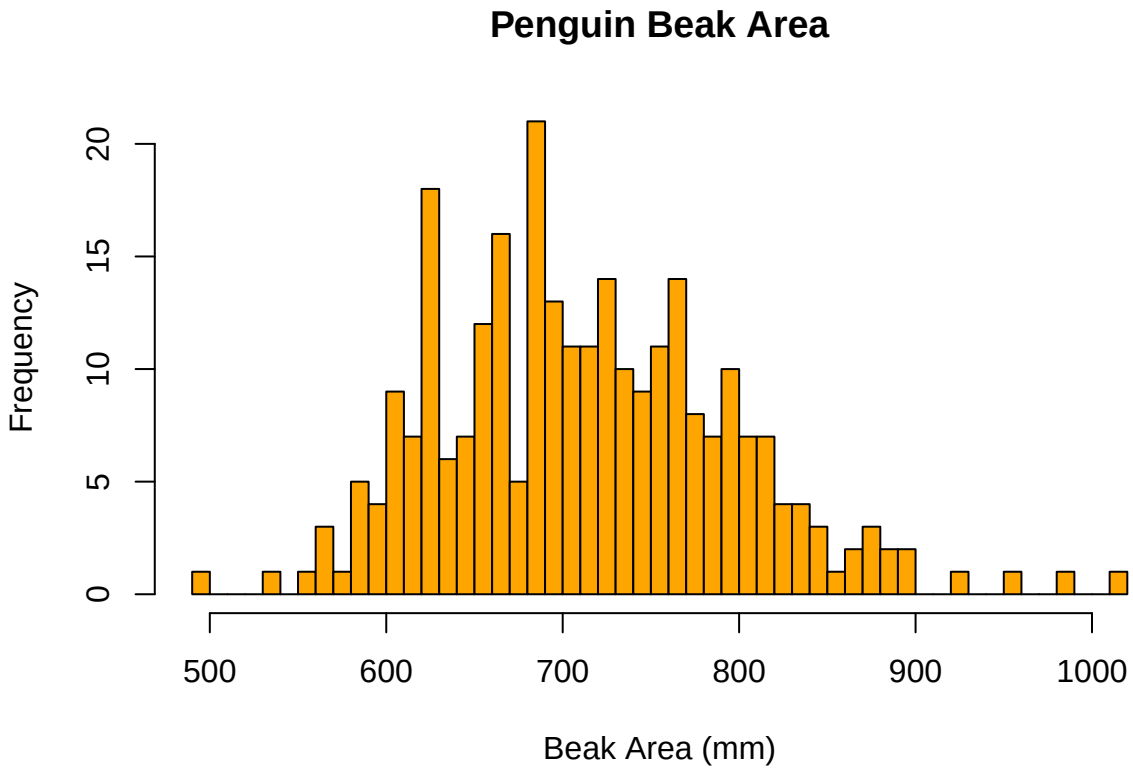
This histogram coupled with the medians show that the Adelies can make up shorter beaks with larger beak height! They have taller beaks than the Gentoos which makes means further work must be done to get a grasp of which species actually has the weapon advantage.

While beaks are not perfect rectangles, multiplying the length by the depth/height of the culmen can give a rough estimate of the total area of the beak to best represent its total power in combat by taking into account the pros and cons of each beak style (long vs. tall).

```
penguin.data.duel$beak.area.mm <- penguin.data.duel$Culmen.Length..mm. * penguin.data.duel$Culmen.Depth

#head(penguin.data.duel)
```

```
hist(penguin.data.duel$beak.area.mm,
     breaks = 50,
     xlab = "Beak Area (mm)",
     col = "orange",
     main = "Penguin Beak Area"
     )
```

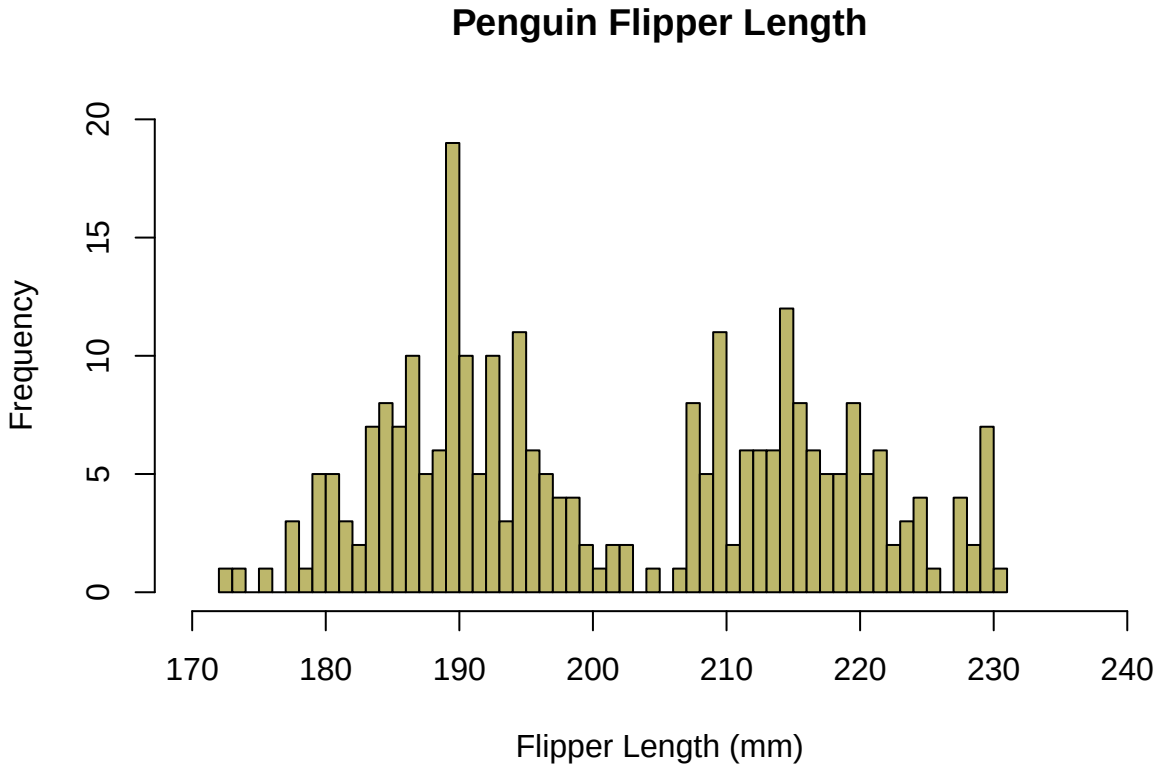



A unimodal histogram shows that all the penguins, regardless of species have similar beak areas, meaning no side has a distinct advantage, in spite of the differences in length and depth. I made graphs of each species separately to be certain there was negligible difference based on species, which are not included for the sake of brevity.

**Flipper Length (mm):**

Beaks are not the only weapon at a penguin's disposal. For a more blunt attack, nothing beats a flipper of a penguin. Having longer flippers would grant the user a longer reach and thus a more effective slap.

```
hist(penguin.data.duel$Flipper.Length..mm.,
     breaks = 50,
     main = "Penguin Flipper Length",
     xlab = "Flipper Length (mm)",
     ylim = c(0,20),
     xlim = c(170,240),
     col = "darkkhaki")
```




Looking at the means and medians of each species' flipper length (shown below), the Gentoos have the higher mode of this bimodal histogram and the Adelies have the lower mode. Therefore, with larger flippers, the slapping power of the Gentoos clearly outclasses the Adelies.

```
summary(penguin.data.duel[penguin.data.duel$Species == "Adelie Penguin (Pygoscelis adeliae)",]$Flipper.
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     172     186     190     190     195     210
```

```
summary(penguin.data.duel[penguin.data.duel$Species == "Gentoo penguin (Pygoscelis papua)",]$Flipper.Le
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   203.0   212.0   216.0   217.2   221.0   231.0
```

Things aren't looking good for the Adelies, yet their main advantage is numbers. The Adelies have 28 more bodies, yet is that enough to make a difference? Therefore, we will look at the total weight of both populations by species to see if the extra 28 can raise the total body mass of the Adelie army to overcome the, on average, heavier and slappier Gentoos.

**Total Mass (grams):**

```
sum(penguin.data.duel[penguin.data.duel$Species == "Adelie Penguin (Pygoscelis adeliae)",]$Body.Mass..g
```

```
## [1] 558800
```

Total Adelie mass = 558.8 kg

```
sum(penguin.data.duel[penguin.data.duel$Species == "Gentoo penguin (Pygoscelis papua)",]$Body.Mass..g.)
```

```
## [1] 624350
```

Total Gentoo mass = 624.35 kg

Even with the numbers advantage, the Adelies fail to match up against the Gentoo penguins by 65.5 kg deficit.

**Conclusion:**

According to The World Wide Fund for Nature Inc (linked below), Adelie penguins are audacious and often take on larger foes. However in this scenario, they may have bit off more than they can regurgitate. The Gentoos have larger flippers, larger mass per individual, and enough total mass to mitigate a numbers disadvantage. Both populations have similar enough beak sizes to not give any side a flipper up. Gentoos are also known to be the fastest swimming species of penguin so there will be no escape for the Adelies who can now only hope to make peace with their genetic cousins.

Website link: https://www.wwf.org.uk/learn/fascinating-facts/adelie-penguins