King Salmon Sizes

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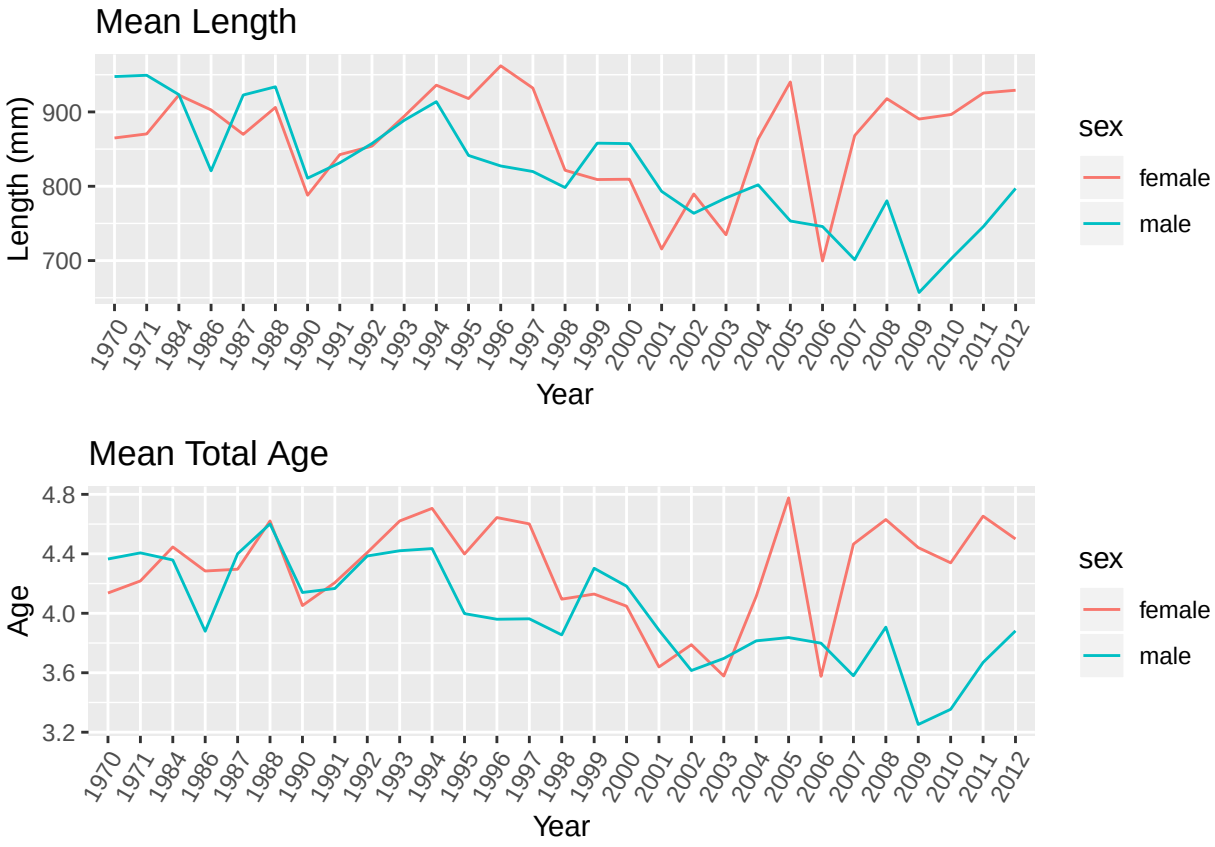
The Data

Chinook salmon are a pillar of the Cook Inlet sport fishery. As someone who is new to the area, I've heard a lot about the decline in size and numbers of the species. We will look at Chinook salmon age, sex, and length data collected from 1970 to 2012 in eastern Cook Inlet (District 244) by the commercial fish division of the ADFG to see if there are any trends and if forecasting future lengths is possible.

Step 1: Plotting and Data Exploration

As a first step in our time series analysis we will take a look at the raw data.

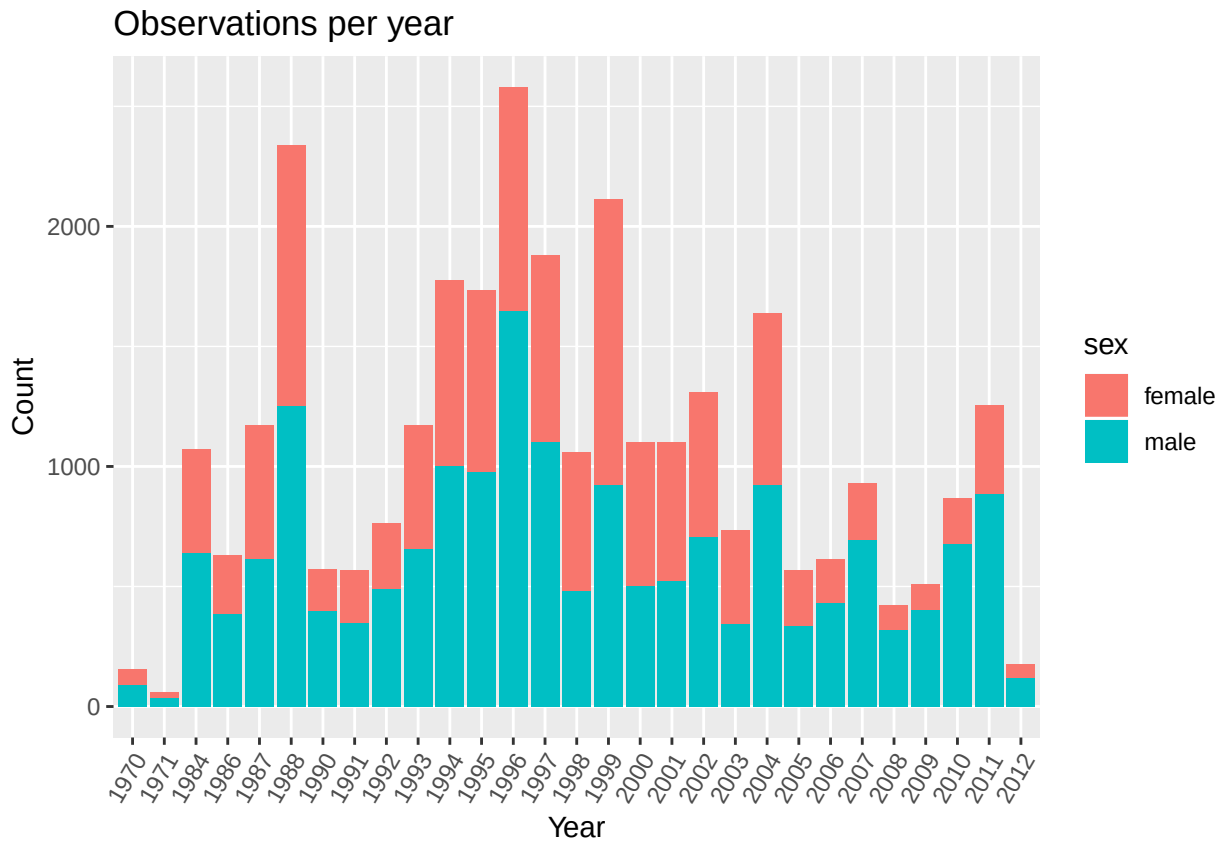


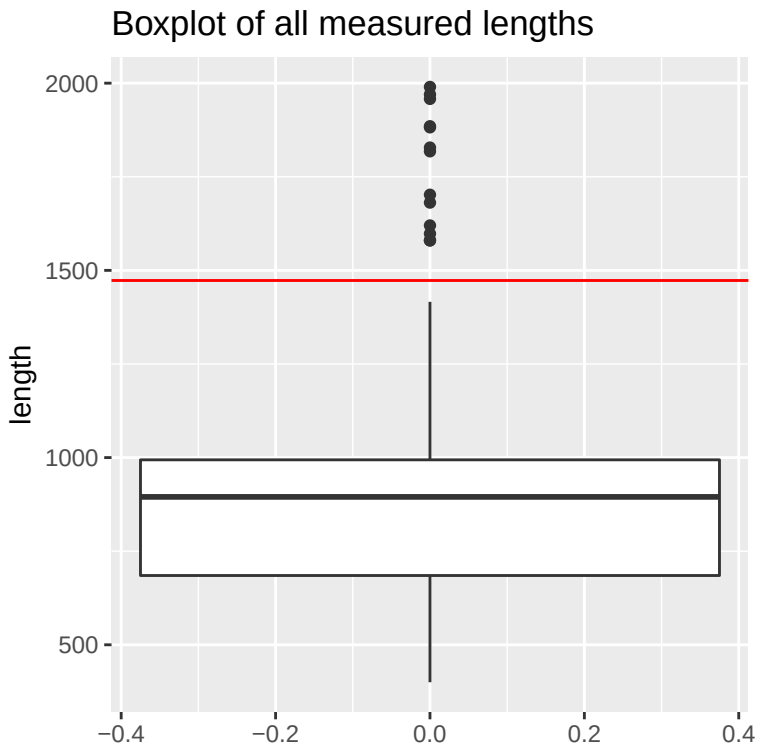
Comments on plots

By visually inspecting the data we can see that there seems to be a very strong correlation between length and age, which is to be expected. We also see that male and female fish seem to be following different trends. Both males and females seemed to decline in age and size in the late 90s and early 2000s. Since then, females have recovered back to their long run average, and males have continued to decline.

The decline in size and age of males appears to be quite significant. Compared to the 1980s, male chinook salmon appear to be 6 months to 1 year younger and 100mm - 200mm smaller, on average.

Data Quality Check





The current world record caught on the Kenai in 1985 was 58 inches, represented by the red line above. 2000 mm is roughly 6.5 feet. Did someone accidently add a zero to a few observations? Perhaps, but this is commericial fishing data dating back to the 70s. All of the 1500+mm fish were supposedly caught between 1984 and 1988.

Research Questions:

Is the apparent decline in sizes of males statistically significant? Could it reasonably be attributed to noise?

Can we take advantage of any lagged linear relationships to accurately forecast the direction of future declines?

Stationarity

First we will check both the time series for males and females to see if the data is stationary.

```
##
##  KPSS Test for Trend Stationarity
##
## data:  ts_male$mean_len
## KPSS Trend = 0.054103, Truncation lag parameter = 2, p-value = 0.1
```

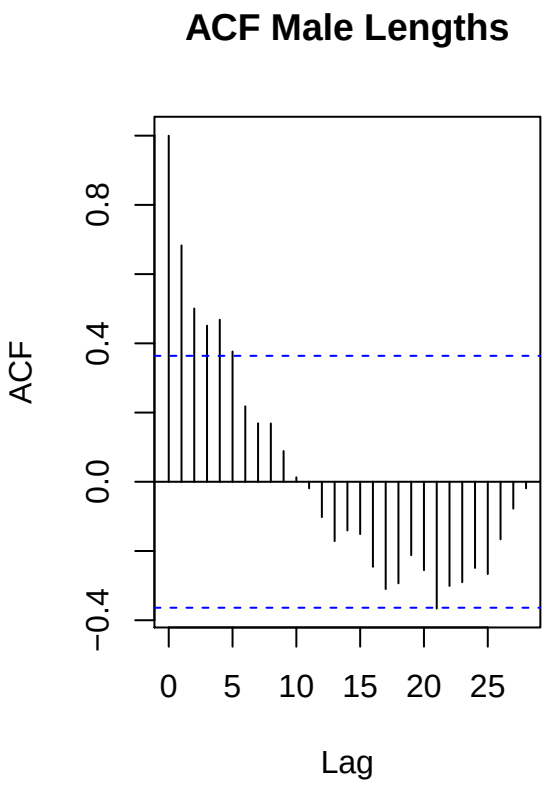
```
##
##  KPSS Test for Trend Stationarity
##
## data:  ts_fem$mean_len
## KPSS Trend = 0.11158, Truncation lag parameter = 2, p-value = 0.1
```

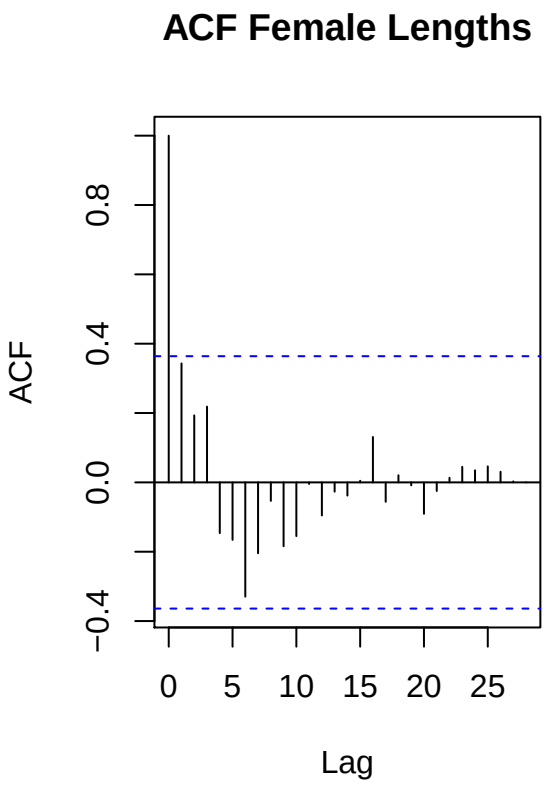
The null null hypothesis for both tests is that the time series is trend stationary. With p-values $> .1$, we fail to reject the null hypothesis.

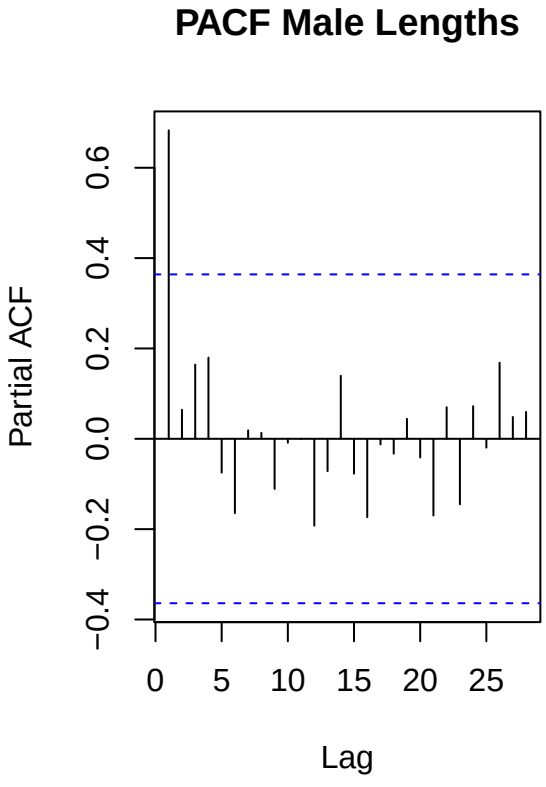
Model Order

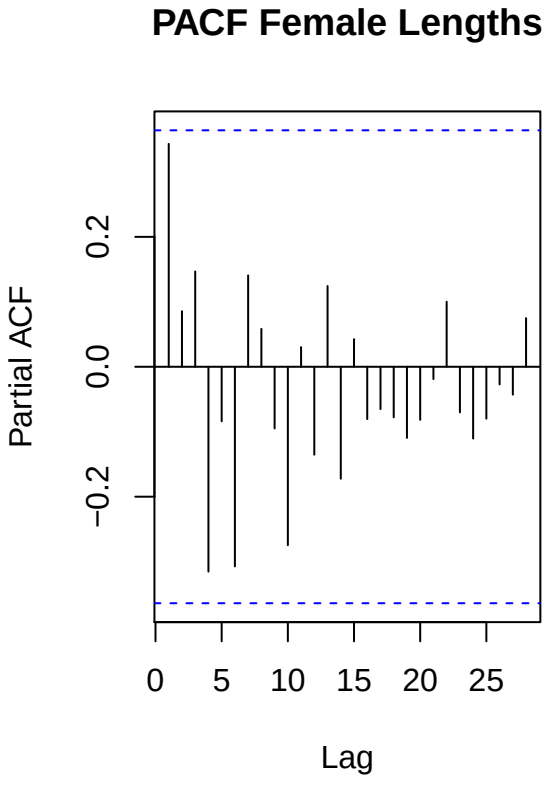
To explore possible lagged relationships, we will take a look at ACF, PACF, and CCF plots.

ACF and PACF Plots





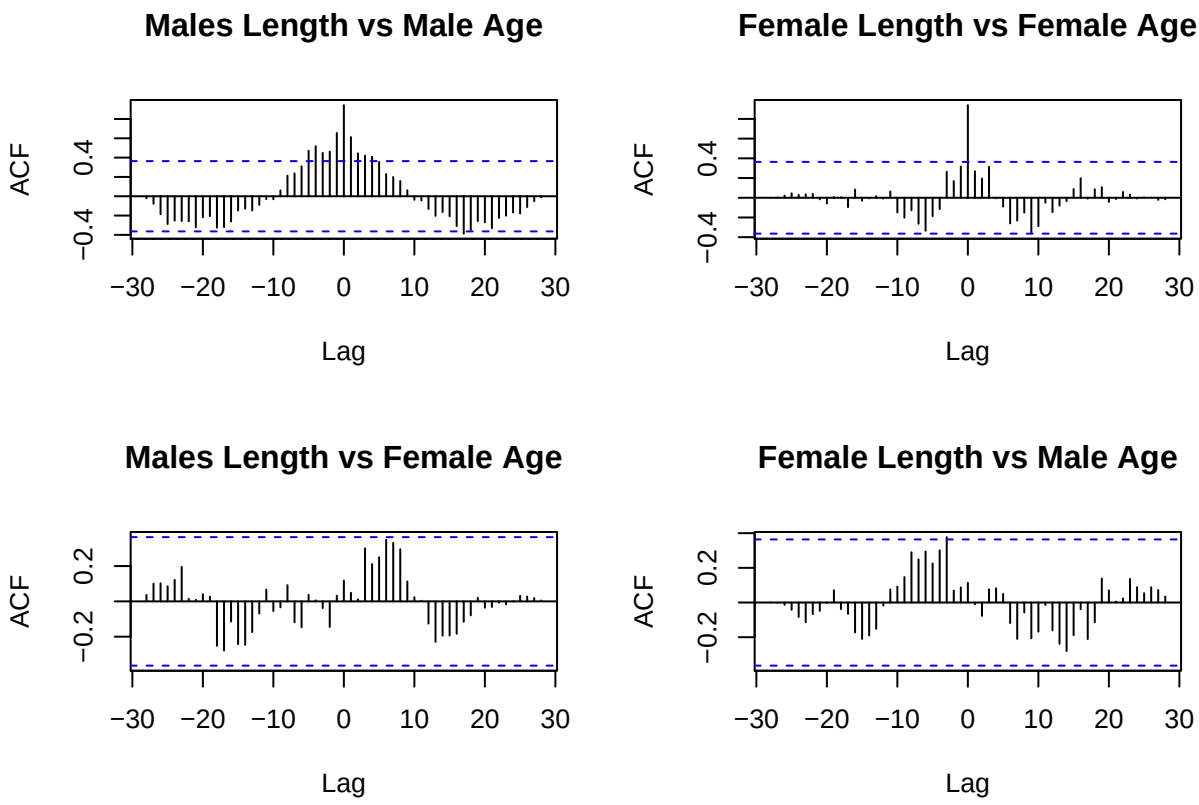




Interpretation of ACF and PACF plots

For males, we see the ACF plot tailing off, and the PACF abrubtly cut off after a lag of 1. This may be a sign that an AR(1) model could be a good model for this time series. For female Chinook, there appears to be no discernable lagged relationship.

CCF Plots



We see from the CCF plot there is a clear and strong correlation between age and length. There may also be some ability to forecast future male lengths using previous values of their age.