

Predicting Dungeness Crab Growth with Linear Regression

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Abstract

There is a strong positive linear correlation between the size of a female Dungeness crab's shell post-molt and pre-molt. This means that the crab's post-molt size, if known, can be reasonably used to determine the size of her pre-molt shell.

Introduction

The Dungeness crabs found in the waters of North America's Pacific coast are threatened by overfishing. In an attempt to curb the destruction of the population, size restrictions are put in place to allow the crabs to reach an age of maturity that increases the likelihood that they have mated and reproduced at least once. Such size restrictions have been placed on male Dungeness crabs, but biologists are now looking to implement them for female crabs as well, in order to help stabilize the fluctuation in population caused by the fishing of the entire male population. In order to properly recommend the size at which to place the restriction, biologists must determine the size change that females' shells undergo after molting so that they can accurately assess pre-molt size and determine if a crab has reached an acceptable maturity. The data analyzed here is from 472 female Dungeness crabs that were caught and either measured in a laboratory or tagged and released, to be recaptured for measurement again following the molting season.

Method

The data collected from the 472 female Dungeness crabs were carapace (shell) size pre-molt and post-molt, the difference between pre- and post-molt size (increment), the capture year (for lab crabs), and whether the crab molted in the lab or was part of the capture-recapture program.

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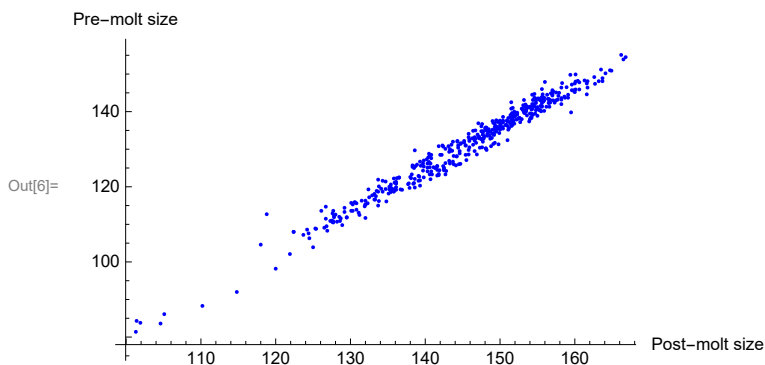
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```

Results

Plot of the pre-molt crab sizes versus the post-molt crab sizes:

```
In[6]:= p1 = ListPlot[crabdata, PlotStyle → Blue, AxesLabel → {"Post-molt size", "Pre-molt size"}]
```



Find the line of least squares best fit to the *crabdata* pairs:

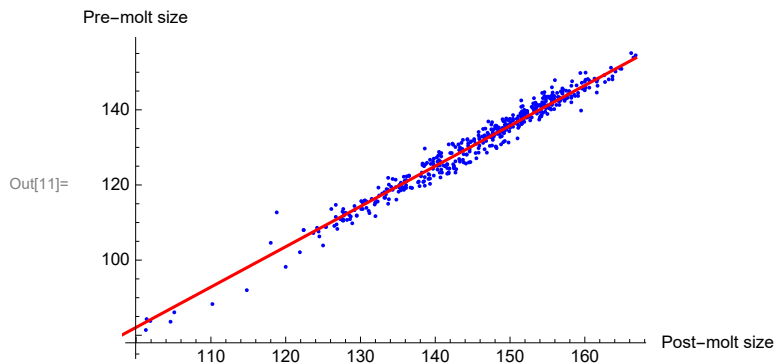
```
In[7]:= ClearAll[x];
lm = LinearModelFit[crabdata, x, x]
Normal[lm]
```

```
Out[8]= FittedModel[-25.2137 + 1.07316 x]
```

```
Out[9]= -25.2137 + 1.07316 x
```

Plot the linear model and show it on the same plot as the *crabdata*:

```
In[10]:= p2 = Plot[lm[x], {x, Min[crabdata[[All, 1]]], Max[crabdata[[All, 1]]]}, PlotStyle -> Red];
Show[p1, p2]
```



Based on preliminary visual observation, the Least Squares Fit Line appears to be a good fit for the data. The data has a very clear upward incline, and most of the data is clustered around the Best Fit Line.

Calculate Pearson's r -squared for the line of least squares best fit:

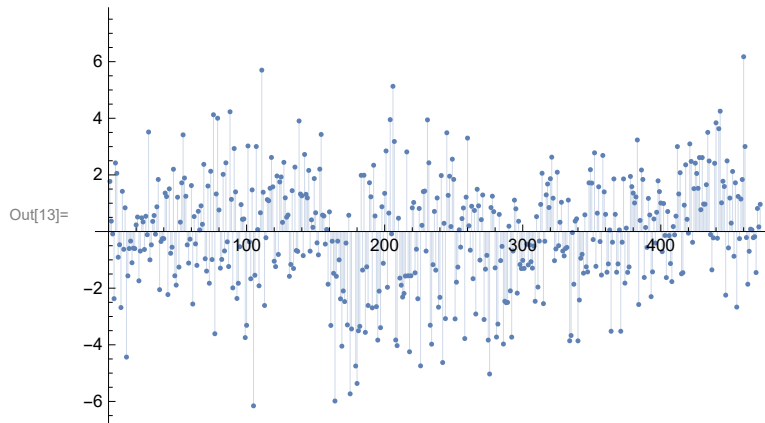
```
In[12]:= lm["RSquared"]
```

```
Out[12]= 0.980833
```

This r^2 value seems appropriate based on a visual observation of the linear model. The highest r^2 value is 1, and the r^2 for this model is about 0.98 so it's very close, indicating that most of the variation between the observed value of the carapace size and the value predicted by the model can be "explained" by the model.

Now plot the residuals - difference between pre-molt values, and predictions from the linear model:

```
In[13]:= ListPlot[Im["FitResiduals"], Filling -> Axis]
```



The residual variation seems to be mainly homoscedastic. This makes sense as most of the data is closely clustered together, and so the model isn't too far from the majority of the points. It would appear then that the model is fairly good for predicting values that are outside the data range here, however it may not be as effective if the new data were far outside range.

Conclusions

It is plainly visually observable that the Least Squares Best Fit line is a very good, if not the best, fit for the data given here. This observation is confirmed by the large r^2 value of the model. The residuals appear mostly homoscedastic, but do have some points of large variation, and so the model is best for predicting values within the data range given here. Overall we can conclude that, given the post-molt size of a female Dungeness crab's shell, biologists could make an accurate prediction of the size that crab's shell pre-molting, and can therefore set good recommendations for a size restriction that will allow for a more stable replenishment of the Dungeness crab population before the fishing season.