Case Study 15.1: Haddock retention in a trawl

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Problem

The experiment consisted of observing the number of fish at given fork lengths that entered a trawl codend, and the number of those fish that were retained by it.

In dataframe `Haddock.df`, `codend` is the number retained in the codend and `cover` is the number that escaped the codend into the cover region. The total number of fish is therefore `codend + cover`.

The variables of interest were:

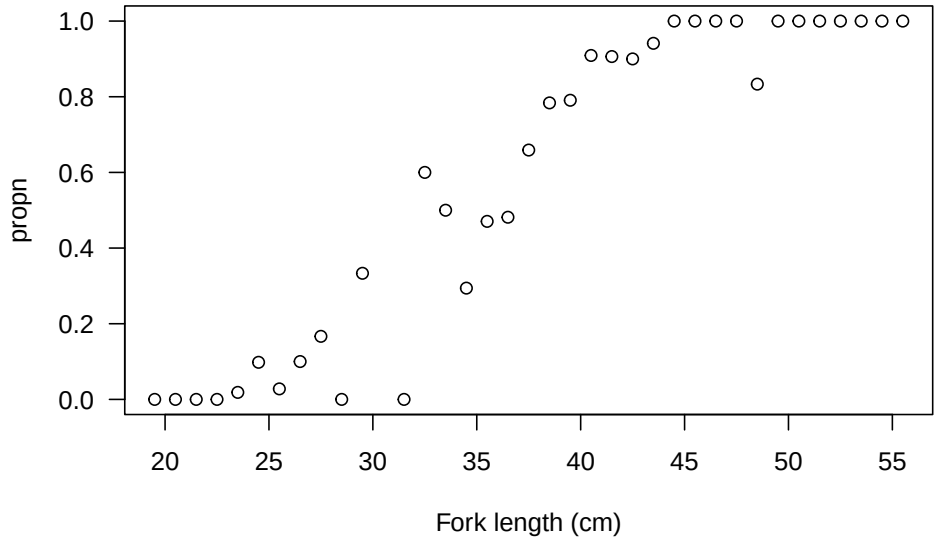
- `propn`: The proportion of fish caught in the trawl codend.
- `forklen`: The fork length of the fish (in cm). (This is the length measured from snout to the end of tail fin rays.)

Question of Interest

How does the length of the fish affect the odds of it being caught in the trawl codend?

Read in and Inspect the Data

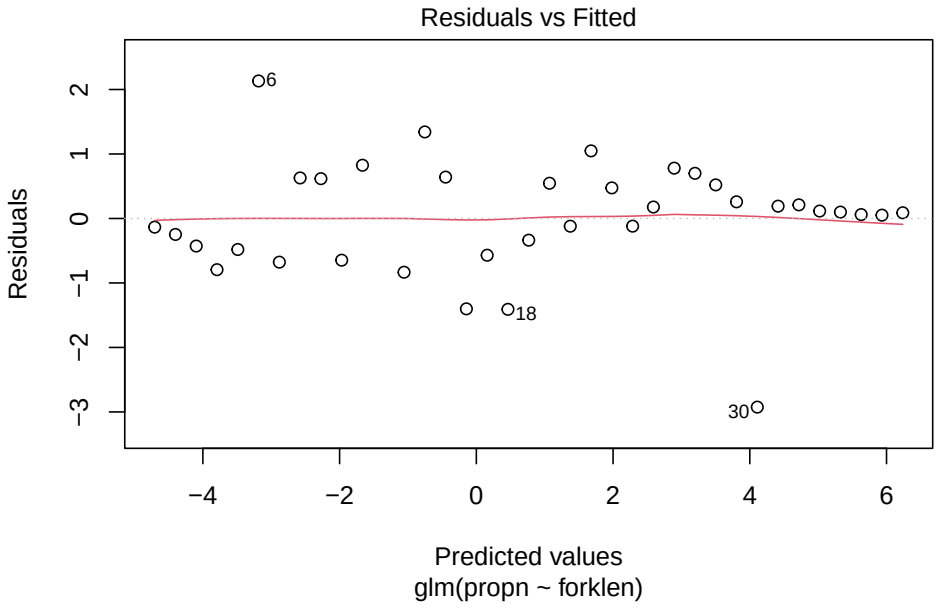
```
Haddock.df = read.table("Haddock.txt", head = T)
Haddock.df$n = with(Haddock.df, codend + cover)
Haddock.df$propn = with(Haddock.df, codend/n)
plot(propn ~ forklen, data = Haddock.df, xlab = "Fork length (cm)", las = 1)
```



We can see that as the length of the fish increases, the proportion of fish caught in the trawl codend increases. Notably, it follows a S-shaped curve.

Model Building and Check Assumptions

```
Haddock.glm = glm(propn ~ forklen, family = binomial, weight = n, data = Haddock.df)
plot(Haddock.glm, which = 1)
```



```
summary(Haddock.glm)
```

```
##
## Call:
## glm(formula = propn ~ forklen, family = binomial, data = Haddock.df,
##     weights = n)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.7344  -0.5293   0.1322   0.5701   1.8084
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -10.63219    0.86468  -12.30   <2e-16 ***
## forklen       0.30396    0.02363   12.86   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 432.464  on 35  degrees of freedom
## Residual deviance:  23.436  on 34  degrees of freedom
##   (1 observation deleted due to missingness)
## AIC: 79.75
##
## Number of Fisher Scoring iterations: 5
```

```
1 - pchisq(23.436, 34)
```

```
## [1] 0.9133009
```

```
exp(confint(Haddock.glm))
```

```
## Waiting for profiling to be done...
```

```
##                    2.5 %      97.5 %
## (Intercept) 3.893019e-06 0.000117379
## forklen     1.297561e+00 1.424118770
```

```
100*(exp(confint(Haddock.glm))-1)
```

```
## Waiting for profiling to be done...
```

```
##                  2.5 %    97.5 %
## (Intercept) -99.99961 -99.98826
## forklen      29.75615  42.41188
```

Methods and assumption Checks

The data recorded the number of fish that entered the codend and the number of those fish that were retained, for fish of different fork lengths. We therefore fitted a Binomial GLM with a single predictor of fork length (numeric). The response was treated as grouped data, with each group corresponding to a specific value of fork length.

Taking into account the fact that we expect small positive residuals from length classes with high retention probability, the residual plot from fitting the binomial model showed no strong trends. There was no evidence of overdispersion ($P\text{-}value = 0.91$) so we can trust the results from this binomial model.

Our final model was

$$\log(\text{Odds}_i) = \beta_0 + \beta_1 \times \text{length}_i,$$

where Odds_i is the odds of retention for fish at the ith value of fork length.

Executive Summary

We aimed to investigate the relationship between fish fork length and the odds that the fish is retained in the trawl codend after entering it.

We estimate that for every 1 cm increase in the fork length of a haddock, the odds that it is retained in the codend increase by between 30% and 42%.