Mortality (Catch Curves)

Preliminaries

Load Necessary Packages

```
> library(FSA)      # for filterD(), fact2num(), catchCurve()
> library(dplyr)    # for mutate(), group_by(), summarize()
```

Load Data

```
> # Set your working directory to where your external data files (and scripts) are located.
> setwd("C:/aaaWork/Web/GitHub/RcourseNunavut2016/Handouts")
> dSC <- read.csv("SawyerCo_reduced.csv")
> wae <- filterD(dSC,waterbody=="NELSON LAKE",species=="Walleye",!is.na(age),year==2014)
```

Create Age Frequency data.frame (2 Methods)

```
> d <- data.frame( xtabs(~age,data=wae))
> str(d)
'data.frame':   8 obs. of  2 variables:
 $ age : Factor w/ 8 levels "2","3","4","5",..: 1 2 3 4 5 6 7 8
 $ Freq: int  2 14 36 31 9 4 1 1
```

```
> d <- mutate(d,age=fact2num(age))
> str(d)
'data.frame':   8 obs. of  2 variables:
 $ age : num  2 3 4 5 6 7 8 9
 $ Freq: int  2 14 36 31 9 4 1 1
```

```
> d
  age Freq
1   2    2
2   3   14
3   4   36
4   5   31
5   6    9
6   7    4
7   8    1
8   9    1
```

```
> wae <- group_by(wae,age)
> d <- summarize(wae,Freq=n())
> str(d)
Classes 'tbl_df', 'tbl' and 'data.frame':   8 obs. of  2 variables:
 $ age : int  2 3 4 5 6 7 8 9
 $ Freq: int  2 14 36 31 9 4 1 1
```

```
> d <- as.data.frame(d)
> str(d)
'data.frame':   8 obs. of  2 variables:
 $ age : int  2 3 4 5 6 7 8 9
 $ Freq: int  2 14 36 31 9 4 1 1
```

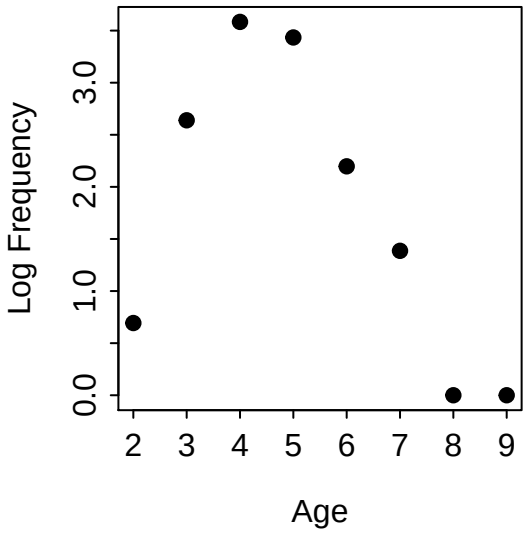
```
> d
  age Freq
1   2    2
2   3   14
3   4   36
4   5   31
5   6    9
6   7    4
7   8    1
8   9    1
```

```
> d <- mutate(d,logfreq=log(Freq))
```

Catch Curve Analysis

Identify Descending Limb

```
> plot(logfreq~age,data=d,xlab="Age",ylab="Log Frequency",pch=19)
```



From First Principles

```
> cc1 <- lm(logfreq~age,data=filterD(d,age>=5))
> anova(cc1)
Analysis of Variance Table

Response: logfreq
          Df Sum Sq Mean Sq F value   Pr(>F)
age        1 8.2178  8.2178    51.9 0.005513
Residuals  3 0.4750  0.1583
```

```
> ( cf <- coef(cc1) )
(Intercept)         age
  7.7491405  -0.9065199
```

```
> ( Z <- -cf["age"] )
      age
0.9065199
```

```
> ( A <- 1-exp(-Z) )
      age
0.5960725
```

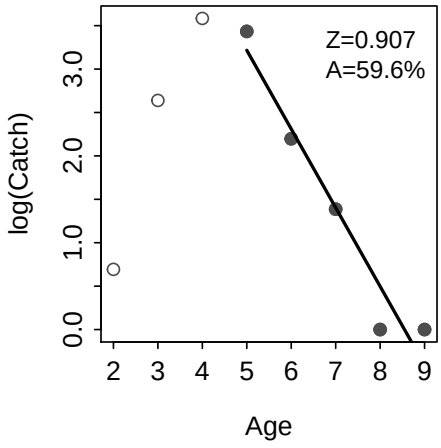
```
> plot(logfreq~age,data=d,xlab="Age",ylab="Log Frequency",pch=19)
> abline(cc1)
```

Convenience Function

```
> cc2 <- catchCurve(Freq~age,data=d,ages2use=5:9)
> summary(cc2)
    Estimate Std. Error  t value    Pr(>|t|)
Z  0.9065199  0.1258325 7.204181 0.005512948
A 59.6072511         NA       NA          NA
```

```
> confint(cc2)
     95% LCI   95% UCI
Z  0.5060648  1.306975
A 39.7136721 72.936249
```

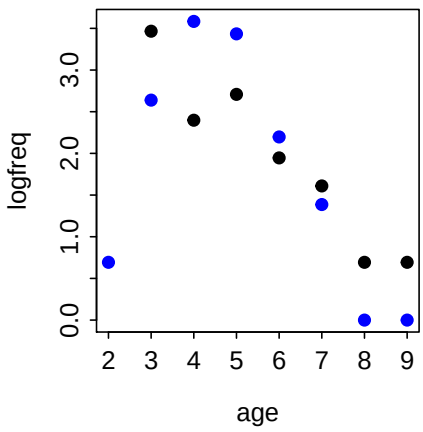
```
> plot(cc2)
```



Compare Mortality Rates

```
> wae2 <- filterD(dSC,waterbody %in% c("LAKE CHIPPEWA","NELSON LAKE"),
                  species=="Walleye",!is.na(age),year==2014)
> wae2 <- group_by(wae2,waterbody,age)
> d3 <- summarize(wae2,Freq=n())
> d3 <- mutate(d3,logfreq=log(Freq))
> ( d3 <- as.data.frame(d3) )
       waterbody age Freq   logfreq
1  LAKE CHIPPEWA   3   32 3.4657359
2  LAKE CHIPPEWA   4   11 2.3978953
3  LAKE CHIPPEWA   5   15 2.7080502
4  LAKE CHIPPEWA   6    7 1.9459101
5  LAKE CHIPPEWA   7    5 1.6094379
6  LAKE CHIPPEWA   8    2 0.6931472
7  LAKE CHIPPEWA   9    2 0.6931472
8    NELSON LAKE   2    2 0.6931472
9    NELSON LAKE   3   14 2.6390573
10   NELSON LAKE   4   36 3.5835189
11   NELSON LAKE   5   31 3.4339872
12   NELSON LAKE   6    9 2.1972246
13   NELSON LAKE   7    4 1.3862944
14   NELSON LAKE   8    1 0.0000000
15   NELSON LAKE   9    1 0.0000000
```

```
> clr1 <- c("black","blue")
> plot(logfreq~age,data=d3,col=clr1[waterbody],pch=19)
```




```
> ( d4 <- rbind(filterD(d3,waterbody=="LAKE CHIPPEWA",age>=3),
                filterD(d3,waterbody=="NELSON LAKE",age>=5)) )
       waterbody age Freq   logfreq
1  LAKE CHIPPEWA   3   32 3.4657359
2  LAKE CHIPPEWA   4   11 2.3978953
3  LAKE CHIPPEWA   5   15 2.7080502
4  LAKE CHIPPEWA   6    7 1.9459101
5  LAKE CHIPPEWA   7    5 1.6094379
6  LAKE CHIPPEWA   8    2 0.6931472
7  LAKE CHIPPEWA   9    2 0.6931472
8    NELSON LAKE   5   31 3.4339872
9    NELSON LAKE   6    9 2.1972246
10   NELSON LAKE   7    4 1.3862944
11   NELSON LAKE   8    1 0.0000000
12   NELSON LAKE   9    1 0.0000000
```

```
> cc2 <- lm(logfreq~age*waterbody,data=d4)
> anova(cc2)
Analysis of Variance Table

Response: logfreq
              Df  Sum Sq Mean Sq  F value    Pr(>F)
age            1 13.4145 13.4145 113.5256 5.276e-06
waterbody      1  0.0065  0.0065   0.0553  0.820022
age:waterbody  1  1.4819  1.4819  12.5409  0.007605
Residuals      8  0.9453  0.1182
```

```
> ccC <- catchCurve(Freq~age,data=filterD(d3,waterbody=="LAKE CHIPPEWA"),ages2use=3:9)
> coef(ccC)
        Z         A
 0.458067 36.74949
```

```
> confint(ccC)
     95% LCI    95% UCI
Z  0.3090801  0.6070538
A 26.5878029 45.5045956
```

```
> ccN <- catchCurve(Freq~age,data=filterD(d3,waterbody=="NELSON LAKE"),ages2use=5:9)
> coef(ccN)
         Z         A
 0.9065199 59.60725
```

```
> confint(ccN)
     95% LCI   95% UCI
Z  0.5060648  1.306975
A 39.7136721 72.936249
```

```
> plot(logfreq~age,data=d3,col=clr1[waterbody],xlab="Age",ylab="Log Frequency")
> points(logfreq~age,data=filterD(d3,waterbody=="LAKE CHIPPEWA",age>=3),pch=19,col=clr1[1])
> points(logfreq~age,data=filterD(d3,waterbody=="NELSON LAKE",age>=5),pch=19,col=clr1[2])
> abline(ccC$lm,col=clr1[1],lwd=2)
> abline(ccN$lm,col=clr1[2],lwd=2)
> legend("bottomleft",levels(d3$waterbody),col=clr1,pch=19,lwd=1,bty="n",cex=0.7)
```