### What is the effect size?

#### Example: Experimental data on degree days until 125 of 150 Chinook salmon fry volitionally emerge

```r
fivec <- c(1156.2, 1145.8, 1156.2, 1176.6, 1156.2, 1135.6)
tenc  <- c(1153.8, 1132.6, 1146.7, 1203.7, 1160.8, 1146.7, 1153.8)
dayseas <- c(1167.5, 1167.5, 1133.3, 1151.4, 1121.2, 1142.9, 1121.2, 1121.2)
doubledaily <- c(1184.8, 1193.2, 1176.3, 1201.5, 1159.4, 1167.8, 1150.8, 1150.8)
flipflop <- c(1175.3, 1182.3, 1182.3, 1222.0, 1168.1, NA, 1144.3, 1125.3)
```

#### Calculate the mean of each and the difference

```r
mean5 <- mean(fivec)
mean10 <- mean(tenc)
dif.mean <- mean5 - mean10
```

#### Traditional effect size

Need standard deviation (shared)

```r
var.shared <- var(c(mean5, mean10))
sd.shared <- sqrt(var.shared)
trad.effect.size <- dif.mean / sd.shared
```

#### Bootstrap a confidence interval!

#### Calculate difference in the means as above

Create a new data set for each treatment with properties of the old data set

```r
boot.samp5 <- sample(fivec, 8, replace=TRUE)
boot.samp10 <- sample(tenc, 8, replace=TRUE)
```

#### Calculate a bootstrapped difference in the means

```r
boot.dif <- mean(boot.samp5) - mean(boot.samp10)
```

#### Repeat 1000 times

```r
boot.dif <- rep(0, 1000)
for (b in 1:1000){
    boot.samp5 <- sample(fivec, 8, replace=TRUE)
    boot.samp10 <- sample(tenc, 8, replace=TRUE)
    boot.dif[b] <- mean(boot.samp5) - mean(boot.samp10)
}
hist(boot.dif)
abline(v=dif.mean, lty=2, lwd=3)
```

#### Find the upper and lower bounds of 95% of the data

95% confidence interval

```r
sort(boot.dif)[25]
sort(boot.dif)[975]
```

# sort just put all the data in order - look at it

```r
sort(boot.dif)
```

# [25] pulls out the 25th one (so 24 values are lower - 2.5% of the data)
#[975] pulls out the 975th one (only 25 values are higher - 2.5% of the data)
std.err.diff=sqrt(var((boot.dif)))
hist(boot.dif)
abline(v=sort(boot.dif)[25], lty=2, lwd=2)
abline(v=sort(boot.dif)[975], lty=2, lwd=2)
abline(v=dif.mean, lty=1, lwd=5)

parametric.bounds=1.96*std.err.diff

## plot one effect - two ways
par(mfrow=c(1,1), lwd=2)
symbols (1, dif.mean, circles=parametric.bounds, ylim=c(-50,50), xlim=c(-50,50), inches=FALSE)
abline(h=0, lty=2)
#note some folks like the size to be inversely proportional to the standard error

## install package - gplots
library(gplots)
plotCI(dif.mean, ui=sort(boot.dif)[975], li = sort(boot.dif)[25], err="y", barcol="black", ylim=c(-30, 30))
abline(h=0, lty=4, col="Grey40")

####EXERCISE
##compare either stable at 5C or stable at 10C to one of the variable treatment (dayseas, doubledaily, flipflop)
##calculate the difference in means
##bootstrap a 95% confidence interval around that difference
##plot either (a) just the new effect size or (b) both effects on one graph
##Which effect is estimated to be the largest?
##Which effects might not exist at all?
##Is the largest effect size always the most important?

####GoingBeyond
##Simulate some data from a weird distribution
##Simulate some more data from another or similar distribution (more fun if the means are different)
##Simulate the difference between the means of a sample from each distribution of size 40 (as in the CLT but for the difference between two means)
##Calculate the standard error for this random variable - the difference in the two means
##Take one sample of size 40 from each population and pretend those are the results of your experiment
##Calculate a bootstrapped confidence interval for the difference in the means, the effect size
##How similar is the true distribution of the difference in the two means to the bootstrapped CI from your one sample?
##Why might these distributions be different? How similar should they be?

##### Extra4Experts
Run the bootstrap experiment 1000 times to see how different your estimates of the variance around that parameter might be.

##### Extra4Experts
##The parametric bootstrap involves estimating the parameters of a distribution from a sample and then using those estimated parameters to draw bootstrap simulations from the distribution
##Try creating a parametric bootstrap estimate of these two effect sizes and compare.