Pinniped Stranding Analysis Research Questions

Amanda Warlick, March 2017

## Changes in total annual strandings per year

* Are total annual combined strandings or of each species increasing or decreasing over time?

### Are total annual combined strandings or of each species increasing over time?   
  
##All strandings, combined species  
data\_by\_year <- pinnipeds\_data %>%   
 group\_by(Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# <--- Statistically significant change in all stranding cases combined over time   
timeseries\_all\_model <- glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = data\_by\_year)  
summary(lm(cnt ~ Year.of.Observation, data\_by\_year))

##   
## Call:  
## lm(formula = cnt ~ Year.of.Observation, data = data\_by\_year)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -341.7 -159.4 -22.1 123.2 502.8   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -50910.074 10279.001 -4.953 4.21e-05 \*\*\*  
## Year.of.Observation 25.692 5.134 5.004 3.69e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 207.8 on 25 degrees of freedom  
## Multiple R-squared: 0.5004, Adjusted R-squared: 0.4804   
## F-statistic: 25.04 on 1 and 25 DF, p-value: 3.69e-05

summary(timeseries\_all\_model)

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = data\_by\_year)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -15.775 -7.981 -1.029 5.052 17.006   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -94.837172 2.262797 -41.91 <2e-16 \*\*\*  
## Year.of.Observation 0.050462 0.001129 44.71 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 3924.8 on 26 degrees of freedom  
## Residual deviance: 1833.2 on 25 degrees of freedom  
## AIC: 2052  
##   
## Number of Fisher Scoring iterations: 4

#autoplot(timeseries\_all\_model)  
#slope of line = exp(0.050462) = 1.05  
  
#chow test?  
  
##All strandings, separate species  
##HELP: GLM poisson slopes are too similar to make sense, while lm slopes are closer to what I would expect based on the different volume of strandings per species  
  
all\_sp <- pinnipeds\_data %>%  
 group\_by(Year.of.Observation, Pinniped.Common.Name) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
  
summary(lm(cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name == 'Harbor seal'))) #y = 16x

##   
## Call:  
## lm(formula = cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name ==   
## "Harbor seal"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -168.04 -89.38 -20.35 100.69 202.32   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -33388.407 5608.140 -5.954 3.24e-06 \*\*\*  
## Year.of.Observation 16.831 2.801 6.008 2.83e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 113.4 on 25 degrees of freedom  
## Multiple R-squared: 0.5908, Adjusted R-squared: 0.5745   
## F-statistic: 36.1 on 1 and 25 DF, p-value: 2.825e-06

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = all\_sp %>% filter(Pinniped.Common.Name == 'Harbor seal')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = all\_sp %>% filter(Pinniped.Common.Name == "Harbor seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -9.472 -5.562 -2.763 5.598 10.150   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.084e+02 2.994e+00 -36.19 <2e-16 \*\*\*  
## Year.of.Observation 5.694e-02 1.493e-03 38.14 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 2611.1 on 26 degrees of freedom  
## Residual deviance: 1071.1 on 25 degrees of freedom  
## AIC: 1274.6  
##   
## Number of Fisher Scoring iterations: 4

# Estimate Std. Error z value Pr(>|z|)   
# (Intercept) -1.084e+02 2.994e+00 -36.19 <2e-16 \*\*\*  
# Year.of.Observation 5.694e-02 1.493e-03 38.14 <2e-16 \*\*\*  
# y = 1.1x  
  
summary(lm(cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name == 'California sea lion'))) # y = 7.9x

##   
## Call:  
## lm(formula = cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name ==   
## "California sea lion"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -78.83 -46.74 -14.08 15.05 254.89   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -15779.000 3946.714 -3.998 0.000498 \*\*\*  
## Year.of.Observation 7.930 1.971 4.023 0.000467 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 79.79 on 25 degrees of freedom  
## Multiple R-squared: 0.393, Adjusted R-squared: 0.3687   
## F-statistic: 16.18 on 1 and 25 DF, p-value: 0.0004673

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = all\_sp %>% filter(Pinniped.Common.Name == 'California sea lion')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = all\_sp %>% filter(Pinniped.Common.Name == "California sea lion"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -8.2041 -3.9873 -1.4871 0.8099 17.0088   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.732e+02 5.728e+00 -30.23 <2e-16 \*\*\*  
## Year.of.Observation 8.867e-02 2.854e-03 31.07 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 2043.08 on 26 degrees of freedom  
## Residual deviance: 942.02 on 25 degrees of freedom  
## AIC: 1108.9  
##   
## Number of Fisher Scoring iterations: 5

# Estimate Std. Error z value Pr(>|z|)   
# (Intercept) -1.732e+02 5.728e+00 -30.23 <2e-16 \*\*\*  
# Year.of.Observation 8.867e-02 2.854e-03 31.07 <2e-16 \*\*\*  
# y = 1.1x  
  
summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = all\_sp %>% filter(Pinniped.Common.Name == 'Northern fur seal')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = all\_sp %>% filter(Pinniped.Common.Name == "Northern fur seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.4951 -1.6273 -0.4785 0.6363 4.3876   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -90.9306 25.0734 -3.627 0.000287 \*\*\*  
## Year.of.Observation 0.0462 0.0125 3.695 0.000220 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 82.600 on 21 degrees of freedom  
## Residual deviance: 67.983 on 20 degrees of freedom  
## AIC: 142.57  
##   
## Number of Fisher Scoring iterations: 5

# Estimate Std. Error z value Pr(>|z|)   
# (Intercept) -90.9306 25.0734 -3.627 0.000287 \*\*\*  
# Year.of.Observation 0.0462 0.0125 3.695 0.000220 \*\*\*  
# y = 1.0x  
  
summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = all\_sp %>% filter(Pinniped.Common.Name == 'Northern elephant seal')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = all\_sp %>% filter(Pinniped.Common.Name == "Northern elephant seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -4.3361 -1.4863 -0.1182 1.3669 3.6981   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -39.277728 12.590964 -3.120 0.00181 \*\*   
## Year.of.Observation 0.020988 0.006285 3.339 0.00084 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 131.96 on 26 degrees of freedom  
## Residual deviance: 120.72 on 25 degrees of freedom  
## AIC: 243.5  
##   
## Number of Fisher Scoring iterations: 5

# Estimate Std. Error z value Pr(>|z|)   
# (Intercept) -39.277728 12.590964 -3.120 0.00181 \*\*   
# Year.of.Observation 0.020988 0.006285 3.339 0.00084 \*\*\*  
# y = 1.0x  
  
summary(lm(cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name == 'Steller sea lion'))) # y = 3.9x

##   
## Call:  
## lm(formula = cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name ==   
## "Steller sea lion"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -30.778 -16.344 -0.173 11.316 67.552   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -7840.2222 1058.6989 -7.406 9.32e-08 \*\*\*  
## Year.of.Observation 3.9341 0.5288 7.439 8.61e-08 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 21.4 on 25 degrees of freedom  
## Multiple R-squared: 0.6888, Adjusted R-squared: 0.6764   
## F-statistic: 55.34 on 1 and 25 DF, p-value: 8.607e-08

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = all\_sp %>% filter(Pinniped.Common.Name == 'Steller sea lion')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = all\_sp %>% filter(Pinniped.Common.Name == "Steller sea lion"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -4.4195 -2.5005 -0.9378 1.0399 9.9601   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -2.595e+02 1.083e+01 -23.97 <2e-16 \*\*\*  
## Year.of.Observation 1.312e-01 5.389e-03 24.34 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 1033.57 on 26 degrees of freedom  
## Residual deviance: 262.89 on 25 degrees of freedom  
## AIC: 392.66  
##   
## Number of Fisher Scoring iterations: 5

# Estimate Std. Error z value Pr(>|z|)   
# (Intercept) -2.595e+02 1.083e+01 -23.97 <2e-16 \*\*\*  
# Year.of.Observation 1.312e-01 5.389e-03 24.34 <2e-16 \*\*\*  
# y = 1.1x  
  
summary(lm(cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal'))) # not sig

##   
## Call:  
## lm(formula = cnt ~ Year.of.Observation, data = all\_sp %>% filter(Pinniped.Common.Name ==   
## "Guadalupe fur seal"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -14.091 -5.591 -4.182 -0.227 39.636   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -2728.273 2970.345 -0.919 0.382  
## Year.of.Observation 1.364 1.478 0.923 0.380  
##   
## Residual standard error: 15.5 on 9 degrees of freedom  
## Multiple R-squared: 0.08643, Adjusted R-squared: -0.01508   
## F-statistic: 0.8515 on 1 and 9 DF, p-value: 0.3802

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = all\_sp %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = all\_sp %>% filter(Pinniped.Common.Name == "Guadalupe fur seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -4.0949 -2.3670 -1.6172 0.0778 7.9863   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -219.76725 55.94694 -3.928 8.56e-05 \*\*\*  
## Year.of.Observation 0.11057 0.02782 3.975 7.05e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 139.59 on 10 degrees of freedom  
## Residual deviance: 123.21 on 9 degrees of freedom  
## AIC: 169.79  
##   
## Number of Fisher Scoring iterations: 5

# Estimate Std. Error z value Pr(>|z|)   
# (Intercept) -219.76725 55.94694 -3.928 8.56e-05 \*\*\*  
# Year.of.Observation 0.11057 0.02782 3.975 7.05e-05 \*\*\*   
# y = 1.1x

* Are total annual *number* of HI cases increasing over time?

# Are total annual human interaction cases increasing/decreasing over time for:  
  
# (a) combined species   
HI\_by\_year <- pinnipeds\_data %>%  
 filter(Findings.of.Human.Interaction == 'Y') %>%  
 group\_by(Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# <--- Yes, significant increase of all HI cases,   
timeseries\_HI\_model <- glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_by\_year)  
summary(timeseries\_HI\_model)

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_by\_year)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -5.6814 -2.3417 -0.0199 1.6290 4.9621   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -2.144e+02 8.034e+00 -26.69 <2e-16 \*\*\*  
## Year.of.Observation 1.089e-01 4.001e-03 27.23 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 1157.68 on 26 degrees of freedom  
## Residual deviance: 260.34 on 25 degrees of freedom  
## AIC: 410.55  
##   
## Number of Fisher Scoring iterations: 5

#regression equation: y = exp(0.1089)x = 1.11x  
  
# (b) certain HI types  
HI\_type\_by\_year <- pinnipeds\_data %>%  
 filter(Findings.of.Human.Interaction == 'Y' & Interaction.Type != 'NA') %>%  
 group\_by(Year.of.Observation, Interaction.Type) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
  
summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_type\_by\_year %>% filter(Interaction.Type == 'Gunshot')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_type\_by\_year %>% filter(Interaction.Type == "Gunshot"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -3.9112 -1.9333 -0.7278 1.3267 7.1309   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.717e+02 1.258e+01 -13.64 <2e-16 \*\*\*  
## Year.of.Observation 8.713e-02 6.269e-03 13.90 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 388.12 on 26 degrees of freedom  
## Residual deviance: 168.65 on 25 degrees of freedom  
## AIC: 292.3  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_type\_by\_year %>% filter(Interaction.Type == 'Fisheries')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_type\_by\_year %>% filter(Interaction.Type == "Fisheries"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.8344 -1.1641 -0.1946 1.0550 2.7052   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.763e+02 1.689e+01 -10.44 <2e-16 \*\*\*  
## Year.of.Observation 8.918e-02 8.416e-03 10.60 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 181.206 on 25 degrees of freedom  
## Residual deviance: 51.373 on 24 degrees of freedom  
## AIC: 157.7  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_type\_by\_year %>% filter(Interaction.Type == 'Boat')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_type\_by\_year %>% filter(Interaction.Type == "Boat"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.8704 -0.5548 -0.3188 0.5550 2.0632   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -189.92718 48.36681 -3.927 8.61e-05 \*\*\*  
## Year.of.Observation 0.09530 0.02407 3.959 7.53e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 35.052 on 16 degrees of freedom  
## Residual deviance: 16.980 on 15 degrees of freedom  
## AIC: 72.992  
##   
## Number of Fisher Scoring iterations: 4

# (c) for individual species?   
HI\_sp <- pinnipeds\_data %>%  
 filter(Findings.of.Human.Interaction == 'Y' & Interaction.Type != 'NA') %>%  
 group\_by(Year.of.Observation, Pinniped.Common.Name) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_sp %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_sp %>% filter(Pinniped.Common.Name == "Guadalupe fur seal"))  
##   
## Deviance Residuals:   
## 1 2 3 4 5 6   
## 1.20774 -0.05901 -0.89451 -0.68108 -0.74340 0.95955   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -722.8385 286.6015 -2.522 0.0117 \*  
## Year.of.Observation 0.3602 0.1426 2.527 0.0115 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 12.1369 on 5 degrees of freedom  
## Residual deviance: 4.1995 on 4 degrees of freedom  
## AIC: 24.472  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_sp %>% filter(Pinniped.Common.Name == 'Harbor seal')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_sp %>% filter(Pinniped.Common.Name == "Harbor seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -3.9815 -2.2235 0.1378 1.0160 5.4674   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -2.248e+02 1.143e+01 -19.67 <2e-16 \*\*\*  
## Year.of.Observation 1.138e-01 5.692e-03 19.99 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 633.92 on 26 degrees of freedom  
## Residual deviance: 142.87 on 25 degrees of freedom  
## AIC: 273.62  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_sp %>% filter(Pinniped.Common.Name == 'California sea lion')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_sp %>% filter(Pinniped.Common.Name == "California sea lion"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -3.5584 -1.3358 -0.1636 0.9518 4.4862   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -214.04947 16.48563 -12.98 <2e-16 \*\*\*  
## Year.of.Observation 0.10810 0.00821 13.17 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 298.753 on 24 degrees of freedom  
## Residual deviance: 92.404 on 23 degrees of freedom  
## AIC: 200.3  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_sp %>% filter(Pinniped.Common.Name == 'Steller sea lion')))

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_sp %>% filter(Pinniped.Common.Name == "Steller sea lion"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.6470 -1.1060 -0.1748 0.2483 4.3373   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -201.64410 27.58271 -7.311 2.66e-13 \*\*\*  
## Year.of.Observation 0.10154 0.01373 7.396 1.40e-13 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 116.621 on 18 degrees of freedom  
## Residual deviance: 43.771 on 17 degrees of freedom  
## AIC: 114.41  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_sp %>% filter(Pinniped.Common.Name == 'Northern fur seal'))) #Not sig

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_sp %>% filter(Pinniped.Common.Name == "Northern fur seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.3138 -0.6623 -0.2959 0.6979 1.2485   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)  
## (Intercept) -56.17795 51.45400 -1.092 0.275  
## Year.of.Observation 0.02842 0.02564 1.108 0.268  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 9.3943 on 11 degrees of freedom  
## Residual deviance: 8.0937 on 10 degrees of freedom  
## AIC: 42.939  
##   
## Number of Fisher Scoring iterations: 4

summary(glm(cnt ~ Year.of.Observation, family = poisson(link = log), data = HI\_sp %>% filter(Pinniped.Common.Name == 'Northern elephant seal'))) #Not sig

##   
## Call:  
## glm(formula = cnt ~ Year.of.Observation, family = poisson(link = log),   
## data = HI\_sp %>% filter(Pinniped.Common.Name == "Northern elephant seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.6963 -0.7265 -0.2289 0.8014 1.5813   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)  
## (Intercept) -42.22510 59.91512 -0.705 0.481  
## Year.of.Observation 0.02162 0.02983 0.725 0.469  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 11.636 on 9 degrees of freedom  
## Residual deviance: 11.079 on 8 degrees of freedom  
## AIC: 44.162  
##   
## Number of Fisher Scoring iterations: 5

* Is the *prevalence* of human interaction cases increasing or decreasing over time for certain species? Help: Poisson isn't for proportions, so use lm() or prop.trend.test()?

# Is the prevalence of human interaction cases increasing or decreasing over time for certain species?  
  
#All HI cases, species combined  
HI\_prev <- pinnipeds\_data %>%  
 group\_by(Year.of.Observation, Findings.of.Human.Interaction) %>%  
 summarize(cnt = n\_distinct(National.Database.Number)) %>%  
 dcast(Year.of.Observation ~ Findings.of.Human.Interaction, value.var = 'cnt')  
HI\_prev[is.na(HI\_prev)] <- 0  
HI\_prev <- HI\_prev %>%  
 transform(Prop.HI = round(Y/(Y+N+CBD), 2)) %>%  
 select(-c(CBD, N, Y))  
  
# <-- Shows increasing over time: y = 0.005x  
HIprev\_model\_lm <- lm(Prop.HI ~ Year.of.Observation, data = HI\_prev)  
summary(HIprev\_model\_lm)

##   
## Call:  
## lm(formula = Prop.HI ~ Year.of.Observation, data = HI\_prev)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.04657 -0.03403 -0.00258 0.02680 0.07251   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1.010e+01 1.772e+00 -5.701 6.15e-06 \*\*\*  
## Year.of.Observation 5.092e-03 8.851e-04 5.753 5.39e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.03582 on 25 degrees of freedom  
## Multiple R-squared: 0.5697, Adjusted R-squared: 0.5525   
## F-statistic: 33.1 on 1 and 25 DF, p-value: 5.393e-06

## Try with prop.trend.test  
# prop.trend.table <- HI\_by\_year %>%  
# merge(data\_by\_year, by = "Year.of.Observation") %>%  
# melt(id.vars = "Year.of.Observation") %>%  
# dcast(variable ~ Year.of.Observation)  
#   
# prop.yes <- prop.trend.table[1, 2:28]  
# tot <- prop.trend.table[2, 2:28]  
# prop.trend.test(prop.yes, tot, score = length(prop.yes))  
  
#All HI cases, separate species  
HI\_prev\_species <- pinnipeds\_data %>%  
 filter(Pinniped.Common.Name != 'Unidentified') %>%   
 group\_by(Pinniped.Common.Name, Year.of.Observation, Findings.of.Human.Interaction) %>%  
 summarize(cnt = n\_distinct(National.Database.Number)) %>%  
 dcast(Pinniped.Common.Name + Year.of.Observation ~ Findings.of.Human.Interaction, value.var = 'cnt')  
HI\_prev\_species[is.na(HI\_prev\_species)] <- 0  
HI\_prev\_species <- HI\_prev\_species %>%  
 transform(Prop.HI = round(Y/(Y+N+CBD), 2)) %>%  
 select(-c(CBD, N, Y))  
  
summary(lm(Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>% filter(Pinniped.Common.Name == 'Harbor seal')))

##   
## Call:  
## lm(formula = Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>%   
## filter(Pinniped.Common.Name == "Harbor seal"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.057208 -0.024131 -0.006439 0.024330 0.080484   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -9.1574074 1.7979176 -5.093 2.93e-05 \*\*\*  
## Year.of.Observation 0.0046154 0.0008981 5.139 2.60e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.03635 on 25 degrees of freedom  
## Multiple R-squared: 0.5137, Adjusted R-squared: 0.4943   
## F-statistic: 26.41 on 1 and 25 DF, p-value: 2.6e-05

# Estimate Std. Error t value Pr(>|t|)   
# (Intercept) -9.1574074 1.7979176 -5.093 2.93e-05 \*\*\*  
# Year.of.Observation 0.0046154 0.0008981 5.139 2.60e-05 \*\*\*  
# Multiple R-squared: 0.5137, Adjusted R-squared: 0.4943   
# F-statistic: 26.41 on 1 and 25 DF, p-value: 2.6e-05  
  
summary(lm(Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>% filter(Pinniped.Common.Name == 'California sea lion')))

##   
## Call:  
## lm(formula = Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>%   
## filter(Pinniped.Common.Name == "California sea lion"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.12219 -0.06725 -0.01777 0.03753 0.20732   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -9.801481 4.322210 -2.268 0.0322 \*  
## Year.of.Observation 0.004969 0.002159 2.302 0.0300 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.08738 on 25 degrees of freedom  
## Multiple R-squared: 0.1749, Adjusted R-squared: 0.1419   
## F-statistic: 5.298 on 1 and 25 DF, p-value: 0.02995

# Estimate Std. Error t value Pr(>|t|)   
# (Intercept) -9.801481 4.322210 -2.268 0.0322 \*  
# Year.of.Observation 0.004969 0.002159 2.302 0.0300 \*  
# Multiple R-squared: 0.1749, Adjusted R-squared: 0.1419   
# F-statistic: 5.298 on 1 and 25 DF, p-value: 0.02995  
  
summary(lm(Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>% filter(Pinniped.Common.Name == 'Northern elephant seal')))

##   
## Call:  
## lm(formula = Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>%   
## filter(Pinniped.Common.Name == "Northern elephant seal"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.12294 -0.06355 -0.02665 0.05457 0.21418   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -9.115556 4.454919 -2.046 0.0514 .  
## Year.of.Observation 0.004585 0.002225 2.060 0.0499 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.09006 on 25 degrees of freedom  
## Multiple R-squared: 0.1452, Adjusted R-squared: 0.111   
## F-statistic: 4.245 on 1 and 25 DF, p-value: 0.04991

# Estimate Std. Error t value Pr(>|t|)   
# (Intercept) -9.115556 4.454919 -2.046 0.0514 .  
# Year.of.Observation 0.004585 0.002225 2.060 0.0499 \*  
# Multiple R-squared: 0.1452, Adjusted R-squared: 0.111   
# F-statistic: 4.245 on 1 and 25 DF, p-value: 0.04991  
  
summary(lm(Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal'))) #Not sig

##   
## Call:  
## lm(formula = Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>%   
## filter(Pinniped.Common.Name == "Guadalupe fur seal"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.24818 -0.10864 -0.01909 0.06927 0.44473   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 46.18091 37.19032 1.242 0.246  
## Year.of.Observation -0.02291 0.01850 -1.238 0.247  
##   
## Residual standard error: 0.1941 on 9 degrees of freedom  
## Multiple R-squared: 0.1455, Adjusted R-squared: 0.05061   
## F-statistic: 1.533 on 1 and 9 DF, p-value: 0.247

summary(lm(Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>% filter(Pinniped.Common.Name == 'Northern fur seal'))) #Not sig

##   
## Call:  
## lm(formula = Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>%   
## filter(Pinniped.Common.Name == "Northern fur seal"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.2613 -0.2221 -0.1184 0.1298 0.7717   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -5.280111 15.566140 -0.339 0.738  
## Year.of.Observation 0.002753 0.007772 0.354 0.727  
##   
## Residual standard error: 0.2938 on 20 degrees of freedom  
## Multiple R-squared: 0.006234, Adjusted R-squared: -0.04345   
## F-statistic: 0.1255 on 1 and 20 DF, p-value: 0.7269

summary(lm(Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>% filter(Pinniped.Common.Name == 'Steller sea lion'))) #Not sig

##   
## Call:  
## lm(formula = Prop.HI ~ Year.of.Observation, data = HI\_prev\_species %>%   
## filter(Pinniped.Common.Name == "Steller sea lion"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.14009 -0.13054 -0.00590 0.05072 0.59821   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -1.5229630 7.7221870 -0.197 0.845  
## Year.of.Observation 0.0008303 0.0038572 0.215 0.831  
##   
## Residual standard error: 0.1561 on 25 degrees of freedom  
## Multiple R-squared: 0.00185, Adjusted R-squared: -0.03808   
## F-statistic: 0.04633 on 1 and 25 DF, p-value: 0.8313

#Separate HI types, combined species  
numberperyear <- pinnipeds\_data %>%   
 group\_by(Year.of.Observation) %>%  
 summarize(yr.cnt = n\_distinct(National.Database.Number))  
  
HIprev\_type <- pinnipeds\_data %>%  
 filter(Findings.of.Human.Interaction == 'Y') %>%  
 group\_by(Interaction.Type, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number)) %>%  
 dcast(Year.of.Observation ~ Interaction.Type, value.var = 'cnt')   
HIprev\_type[is.na(HIprev\_type)] <- 0  
HIprev\_type <- HIprev\_type %>%  
 merge(numberperyear, by = c('Year.of.Observation')) %>%  
 transform(Boat = (Boat/yr.cnt),   
 Fisheries = (Fisheries/yr.cnt),  
 Gunshot = (Gunshot/yr.cnt),  
 Other = (Other/yr.cnt)) %>%  
 select(Year.of.Observation, Boat, Gunshot, Fisheries, Other) %>%  
 melt(id.vars = c("Year.of.Observation"))   
  
# <-- All types increasing over time, with gunshot wounds increasing at the highest rate, boat at the lowest rate  
  
summary(lm(value ~ Year.of.Observation, data = HIprev\_type %>% filter(variable == 'Gunshot')))

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type %>%   
## filter(variable == "Gunshot"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.027006 -0.017003 -0.004211 0.013787 0.064224   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -2.3034144 1.1298514 -2.039 0.0522 .  
## Year.of.Observation 0.0011687 0.0005644 2.071 0.0489 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.02284 on 25 degrees of freedom  
## Multiple R-squared: 0.1464, Adjusted R-squared: 0.1123   
## F-statistic: 4.288 on 1 and 25 DF, p-value: 0.04885

# Estimate Std. Error t value Pr(>|t|)   
# (Intercept) -2.3034144 1.1298514 -2.039 0.0522 .  
# Year.of.Observation 0.0011687 0.0005644 2.071 0.0489 \*  
# Multiple R-squared: 0.1464, Adjusted R-squared: 0.1123   
# F-statistic: 4.288 on 1 and 25 DF, p-value: 0.04885  
  
summary(lm(value ~ Year.of.Observation, data = HIprev\_type %>% filter(variable == 'Fisheries')))

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type %>%   
## filter(variable == "Fisheries"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.0192590 -0.0060203 0.0000105 0.0042084 0.0180543   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1.3548977 0.4486126 -3.020 0.00575 \*\*  
## Year.of.Observation 0.0006864 0.0002241 3.063 0.00519 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.009069 on 25 degrees of freedom  
## Multiple R-squared: 0.2729, Adjusted R-squared: 0.2438   
## F-statistic: 9.383 on 1 and 25 DF, p-value: 0.005186

# Estimate Std. Error t value Pr(>|t|)   
# (Intercept) -1.3548977 0.4486126 -3.020 0.00575 \*\*  
# Year.of.Observation 0.0006864 0.0002241 3.063 0.00519 \*\*  
# Multiple R-squared: 0.2729, Adjusted R-squared: 0.2438   
# F-statistic: 9.383 on 1 and 25 DF, p-value: 0.005186  
  
summary(lm(value ~ Year.of.Observation, data = HIprev\_type %>% filter(variable == 'Boat')))

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type %>%   
## filter(variable == "Boat"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.0055262 -0.0017435 0.0004251 0.0011350 0.0077820   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -7.940e-01 1.448e-01 -5.483 1.07e-05 \*\*\*  
## Year.of.Observation 3.986e-04 7.233e-05 5.511 1.00e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.002927 on 25 degrees of freedom  
## Multiple R-squared: 0.5485, Adjusted R-squared: 0.5304   
## F-statistic: 30.37 on 1 and 25 DF, p-value: 1.001e-05

# Estimate Std. Error t value Pr(>|t|)   
# (Intercept) -7.940e-01 1.448e-01 -5.483 1.07e-05 \*\*\*  
# Year.of.Observation 3.986e-04 7.233e-05 5.511 1.00e-05 \*\*\*  
# Multiple R-squared: 0.5485, Adjusted R-squared: 0.5304   
# F-statistic: 30.37 on 1 and 25 DF, p-value: 1.001e-05  
  
#Separate HI types, separate species  
numberperyearperspecies <- pinnipeds\_data %>%   
 group\_by(Year.of.Observation, Pinniped.Common.Name) %>%  
 summarize(yr.cnt = n\_distinct(National.Database.Number))  
  
HIprev\_type\_species <- pinnipeds\_data %>%  
 filter(Findings.of.Human.Interaction == 'Y' & Pinniped.Common.Name != "Unidentified") %>%  
 group\_by(Interaction.Type, Year.of.Observation, Pinniped.Common.Name) %>%  
 summarize(cnt = n\_distinct(National.Database.Number)) %>%  
 dcast(Year.of.Observation + Pinniped.Common.Name ~ Interaction.Type, value.var = 'cnt')   
HIprev\_type\_species[is.na(HIprev\_type\_species)] <- 0  
HIprev\_type\_species <- HIprev\_type\_species %>%  
 merge(numberperyearperspecies, by = c('Year.of.Observation', 'Pinniped.Common.Name')) %>%  
 transform(Boat = (Boat/yr.cnt),   
 Fisheries = (Fisheries/yr.cnt),  
 Gunshot = (Gunshot/yr.cnt),  
 Other = (Other/yr.cnt)) %>%  
 select(Year.of.Observation, Pinniped.Common.Name, Boat, Gunshot, Fisheries, Other) %>%  
 melt(id.vars = c("Year.of.Observation", "Pinniped.Common.Name"))   
  
# Realized I shouldn't be putting all six species in the same model, so went on to do them separately below.  
# <--- NFS fisheries, GFS fisheries increasing, HS gunshot decreasing  
# HItype\_model\_sp\_lm <- lm(value ~ Pinniped.Common.Name\*variable, data = HIprev\_type\_species)  
# summary(HItype\_model\_sp\_lm)  
  
#Separate species models, is there a better way to do this if I'm really just asking the simple question of changes over time rather than a more complex best-fit model with more explanatory variables?  
summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'California sea lion' & variable == 'Boat')))

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "California sea lion" & variable ==   
## "Boat"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.0092216 -0.0030052 -0.0009508 0.0016393 0.0245884   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1.2749207 0.3597041 -3.544 0.00173 \*\*  
## Year.of.Observation 0.0006389 0.0001796 3.557 0.00168 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.006593 on 23 degrees of freedom  
## Multiple R-squared: 0.3549, Adjusted R-squared: 0.3269   
## F-statistic: 12.66 on 1 and 23 DF, p-value: 0.001676

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'California sea lion' & variable == 'Fisheries'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "California sea lion" & variable ==   
## "Fisheries"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.032457 -0.031947 -0.004931 0.023353 0.078952   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 1.171e-01 1.690e+00 0.069 0.945  
## Year.of.Observation -4.251e-05 8.437e-04 -0.050 0.960  
##   
## Residual standard error: 0.03097 on 23 degrees of freedom  
## Multiple R-squared: 0.0001104, Adjusted R-squared: -0.04336   
## F-statistic: 0.002539 on 1 and 23 DF, p-value: 0.9602

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'California sea lion' & variable == 'Gunshot'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "California sea lion" & variable ==   
## "Gunshot"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.08789 -0.05372 -0.01837 0.02610 0.23445   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -2.782114 4.189558 -0.664 0.513  
## Year.of.Observation 0.001436 0.002092 0.686 0.499  
##   
## Residual standard error: 0.07679 on 23 degrees of freedom  
## Multiple R-squared: 0.02007, Adjusted R-squared: -0.02253   
## F-statistic: 0.4711 on 1 and 23 DF, p-value: 0.4993

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Harbor seal' & variable == 'Boat')))

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Harbor seal" & variable ==   
## "Boat"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.0050761 -0.0024143 -0.0000496 0.0021186 0.0087222   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -8.963e-01 1.746e-01 -5.133 2.65e-05 \*\*\*  
## Year.of.Observation 4.499e-04 8.722e-05 5.158 2.48e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.00353 on 25 degrees of freedom  
## Multiple R-squared: 0.5155, Adjusted R-squared: 0.4961   
## F-statistic: 26.6 on 1 and 25 DF, p-value: 2.48e-05

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Harbor seal' & variable == 'Fisheries')))

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Harbor seal" & variable ==   
## "Fisheries"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.014955 -0.006443 -0.001031 0.005691 0.016023   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1.4408534 0.4409483 -3.268 0.00315 \*\*  
## Year.of.Observation 0.0007272 0.0002203 3.302 0.00289 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.008914 on 25 degrees of freedom  
## Multiple R-squared: 0.3036, Adjusted R-squared: 0.2758   
## F-statistic: 10.9 on 1 and 25 DF, p-value: 0.002894

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Harbor seal' & variable == 'Gunshot'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Harbor seal" & variable ==   
## "Gunshot"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.022128 -0.010260 -0.002709 0.009404 0.033629   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 0.7611633 0.6590124 1.155 0.259  
## Year.of.Observation -0.0003687 0.0003292 -1.120 0.273  
##   
## Residual standard error: 0.01332 on 25 degrees of freedom  
## Multiple R-squared: 0.04779, Adjusted R-squared: 0.009699   
## F-statistic: 1.255 on 1 and 25 DF, p-value: 0.2733

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal' & variable == 'Boat'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Guadalupe fur seal" & variable ==   
## "Boat"))  
##   
## Residuals:  
## 1 2 3 4 5 6   
## 0 0 0 0 0 0   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 0 0 NA NA  
## Year.of.Observation 0 0 NA NA  
##   
## Residual standard error: 0 on 4 degrees of freedom  
## Multiple R-squared: NaN, Adjusted R-squared: NaN   
## F-statistic: NaN on 1 and 4 DF, p-value: NA

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal' & variable == 'Fisheries'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Guadalupe fur seal" & variable ==   
## "Fisheries"))  
##   
## Residuals:  
## 1 2 3 4 5 6   
## 0.25466 -0.29721 -0.02551 0.03666 -0.03868 0.07008   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 125.11832 77.95635 1.605 0.184  
## Year.of.Observation -0.06217 0.03880 -1.602 0.184  
##   
## Residual standard error: 0.201 on 4 degrees of freedom  
## Multiple R-squared: 0.3909, Adjusted R-squared: 0.2386   
## F-statistic: 2.567 on 1 and 4 DF, p-value: 0.1844

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal' & variable == 'Gunshot'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Guadalupe fur seal" & variable ==   
## "Gunshot"))  
##   
## Residuals:  
## 1 2 3 4 5 6   
## 0.003049 0.001129 -0.002710 -0.004630 -0.006550 0.009712   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -3.854207 2.577048 -1.496 0.209  
## Year.of.Observation 0.001920 0.001283 1.497 0.209  
##   
## Residual standard error: 0.006644 on 4 degrees of freedom  
## Multiple R-squared: 0.359, Adjusted R-squared: 0.1988   
## F-statistic: 2.24 on 1 and 4 DF, p-value: 0.2088

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Northern fur seal' & variable == 'Boat'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Northern fur seal" & variable ==   
## "Boat"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## 0 0 0 0 0   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 0 0 NA NA  
## Year.of.Observation 0 0 NA NA  
##   
## Residual standard error: 0 on 10 degrees of freedom  
## Multiple R-squared: NaN, Adjusted R-squared: NaN   
## F-statistic: NaN on 1 and 10 DF, p-value: NA

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Northern fur seal' & variable == 'Fisheries'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Northern fur seal" & variable ==   
## "Fisheries"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.38431 -0.24208 -0.05015 0.13403 0.65125   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 18.135958 23.793042 0.762 0.464  
## Year.of.Observation -0.008889 0.011869 -0.749 0.471  
##   
## Residual standard error: 0.3337 on 10 degrees of freedom  
## Multiple R-squared: 0.05311, Adjusted R-squared: -0.04157   
## F-statistic: 0.5609 on 1 and 10 DF, p-value: 0.4711

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Northern fur seal' & variable == 'Gunshot'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Northern fur seal" & variable ==   
## "Gunshot"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.11277 -0.05217 -0.02551 -0.00369 0.42116   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 9.760750 10.345689 0.943 0.368  
## Year.of.Observation -0.004848 0.005161 -0.939 0.370  
##   
## Residual standard error: 0.1451 on 10 degrees of freedom  
## Multiple R-squared: 0.0811, Adjusted R-squared: -0.01079   
## F-statistic: 0.8825 on 1 and 10 DF, p-value: 0.3696

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Northern elephant seal' & variable == 'Boat'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Northern elephant seal" &   
## variable == "Boat"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.01948 -0.01840 -0.01688 -0.01136 0.11948   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -0.8523810 4.5663447 -0.187 0.857  
## Year.of.Observation 0.0004329 0.0022746 0.190 0.854  
##   
## Residual standard error: 0.04563 on 8 degrees of freedom  
## Multiple R-squared: 0.004507, Adjusted R-squared: -0.1199   
## F-statistic: 0.03622 on 1 and 8 DF, p-value: 0.8538

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Northern elephant seal' & variable == 'Fisheries'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Northern elephant seal" &   
## variable == "Fisheries"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.01411 -0.01337 -0.01229 -0.00788 0.06162   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -0.6555765 2.7585254 -0.238 0.818  
## Year.of.Observation 0.0003325 0.0013741 0.242 0.815  
##   
## Residual standard error: 0.02757 on 8 degrees of freedom  
## Multiple R-squared: 0.007267, Adjusted R-squared: -0.1168   
## F-statistic: 0.05856 on 1 and 8 DF, p-value: 0.8149

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Northern elephant seal' & variable == 'Gunshot'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Northern elephant seal" &   
## variable == "Gunshot"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.05914 -0.04874 -0.01948 0.03745 0.12625   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -0.3462658 6.6279065 -0.052 0.960  
## Year.of.Observation 0.0002014 0.0033016 0.061 0.953  
##   
## Residual standard error: 0.06624 on 8 degrees of freedom  
## Multiple R-squared: 0.0004649, Adjusted R-squared: -0.1245   
## F-statistic: 0.003721 on 1 and 8 DF, p-value: 0.9529

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Steller sea lion' & variable == 'Boat'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Steller sea lion" & variable ==   
## "Boat"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.0031816 -0.0025408 -0.0018999 -0.0006765 0.0191436   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -0.2316006 0.3301425 -0.702 0.492  
## Year.of.Observation 0.0001165 0.0001647 0.707 0.489  
##   
## Residual standard error: 0.005859 on 17 degrees of freedom  
## Multiple R-squared: 0.02858, Adjusted R-squared: -0.02856   
## F-statistic: 0.5002 on 1 and 17 DF, p-value: 0.489

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Steller sea lion' & variable == 'Fisheries'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Steller sea lion" & variable ==   
## "Fisheries"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.024384 -0.021731 -0.008376 0.006871 0.062992   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) -0.4825039 1.6457821 -0.293 0.773  
## Year.of.Observation 0.0002527 0.0008213 0.308 0.762  
##   
## Residual standard error: 0.02921 on 17 degrees of freedom  
## Multiple R-squared: 0.005538, Adjusted R-squared: -0.05296   
## F-statistic: 0.09467 on 1 and 17 DF, p-value: 0.7621

summary(lm(value ~ Year.of.Observation, data = HIprev\_type\_species %>% filter(Pinniped.Common.Name == 'Steller sea lion' & variable == 'Gunshot'))) #Not sig

##   
## Call:  
## lm(formula = value ~ Year.of.Observation, data = HIprev\_type\_species %>%   
## filter(Pinniped.Common.Name == "Steller sea lion" & variable ==   
## "Gunshot"))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.19947 -0.08142 -0.02644 0.06313 0.51627   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 11.907533 8.930247 1.333 0.200  
## Year.of.Observation -0.005866 0.004456 -1.316 0.206  
##   
## Residual standard error: 0.1585 on 17 degrees of freedom  
## Multiple R-squared: 0.09249, Adjusted R-squared: 0.03911   
## F-statistic: 1.733 on 1 and 17 DF, p-value: 0.2055

## Seasonality

* Is there a seasonal peak in strandings and HI cases for certain species?
* Help confirm multivariate coefficient interpretation.

# Is there a seasonal peak evident across all data?   
monthly\_all <- pinnipeds\_data %>%  
 filter(Observation.Status == 'ALIVE' | Observation.Status == 'FRESH DEAD') %>%  
 group\_by(Month.of.Observation, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# <-- Yes, May through October is different from the rest of the year  
kruskal.test(monthly\_all)

##   
## Kruskal-Wallis rank sum test  
##   
## data: monthly\_all  
## Kruskal-Wallis chi-squared = 795.28, df = 2, p-value < 2.2e-16

kruskalmc(monthly\_all$cnt ~ monthly\_all$Month.of.Observation)

## Multiple comparison test after Kruskal-Wallis   
## p.value: 0.05   
## Comparisons  
## obs.dif critical.dif difference  
## JAN-FEB 11.759259 85.86359 FALSE  
## JAN-MAR 2.296296 85.86359 FALSE  
## JAN-APR 41.111111 85.86359 FALSE  
## JAN-MAY 99.444444 85.86359 TRUE  
## JAN-JUN 117.518519 85.86359 TRUE  
## JAN-JUL 188.111111 85.86359 TRUE  
## JAN-AUG 156.296296 85.86359 TRUE  
## JAN-SEP 135.962963 85.86359 TRUE  
## JAN-OCT 87.018519 85.86359 TRUE  
## JAN-NOV 18.370370 85.86359 FALSE  
## JAN-DEC 20.666667 85.86359 FALSE  
## FEB-MAR 9.462963 85.86359 FALSE  
## FEB-APR 52.870370 85.86359 FALSE  
## FEB-MAY 111.203704 85.86359 TRUE  
## FEB-JUN 129.277778 85.86359 TRUE  
## FEB-JUL 199.870370 85.86359 TRUE  
## FEB-AUG 168.055556 85.86359 TRUE  
## FEB-SEP 147.722222 85.86359 TRUE  
## FEB-OCT 98.777778 85.86359 TRUE  
## FEB-NOV 30.129630 85.86359 FALSE  
## FEB-DEC 8.907407 85.86359 FALSE  
## MAR-APR 43.407407 85.86359 FALSE  
## MAR-MAY 101.740741 85.86359 TRUE  
## MAR-JUN 119.814815 85.86359 TRUE  
## MAR-JUL 190.407407 85.86359 TRUE  
## MAR-AUG 158.592593 85.86359 TRUE  
## MAR-SEP 138.259259 85.86359 TRUE  
## MAR-OCT 89.314815 85.86359 TRUE  
## MAR-NOV 20.666667 85.86359 FALSE  
## MAR-DEC 18.370370 85.86359 FALSE  
## APR-MAY 58.333333 85.86359 FALSE  
## APR-JUN 76.407407 85.86359 FALSE  
## APR-JUL 147.000000 85.86359 TRUE  
## APR-AUG 115.185185 85.86359 TRUE  
## APR-SEP 94.851852 85.86359 TRUE  
## APR-OCT 45.907407 85.86359 FALSE  
## APR-NOV 22.740741 85.86359 FALSE  
## APR-DEC 61.777778 85.86359 FALSE  
## MAY-JUN 18.074074 85.86359 FALSE  
## MAY-JUL 88.666667 85.86359 TRUE  
## MAY-AUG 56.851852 85.86359 FALSE  
## MAY-SEP 36.518519 85.86359 FALSE  
## MAY-OCT 12.425926 85.86359 FALSE  
## MAY-NOV 81.074074 85.86359 FALSE  
## MAY-DEC 120.111111 85.86359 TRUE  
## JUN-JUL 70.592593 85.86359 FALSE  
## JUN-AUG 38.777778 85.86359 FALSE  
## JUN-SEP 18.444444 85.86359 FALSE  
## JUN-OCT 30.500000 85.86359 FALSE  
## JUN-NOV 99.148148 85.86359 TRUE  
## JUN-DEC 138.185185 85.86359 TRUE  
## JUL-AUG 31.814815 85.86359 FALSE  
## JUL-SEP 52.148148 85.86359 FALSE  
## JUL-OCT 101.092593 85.86359 TRUE  
## JUL-NOV 169.740741 85.86359 TRUE  
## JUL-DEC 208.777778 85.86359 TRUE  
## AUG-SEP 20.333333 85.86359 FALSE  
## AUG-OCT 69.277778 85.86359 FALSE  
## AUG-NOV 137.925926 85.86359 TRUE  
## AUG-DEC 176.962963 85.86359 TRUE  
## SEP-OCT 48.944444 85.86359 FALSE  
## SEP-NOV 117.592593 85.86359 TRUE  
## SEP-DEC 156.629630 85.86359 TRUE  
## OCT-NOV 68.648148 85.86359 FALSE  
## OCT-DEC 107.685185 85.86359 TRUE  
## NOV-DEC 39.037037 85.86359 FALSE

posthoc.kruskal.nemenyi.test(cnt ~ Month.of.Observation, data = monthly\_all, dist = "Chisquare")

##   
## Pairwise comparisons using Nemenyi-test with Chi-squared   
## approximation for independent samples   
##   
## data: cnt by Month.of.Observation   
##   
## JAN FEB MAR APR MAY JUN JUL AUG   
## FEB 1.00000 - - - - - - -   
## MAR 1.00000 1.00000 - - - - - -   
## APR 0.99501 0.96017 0.99197 - - - - -   
## MAY 0.17234 0.06036 0.14344 0.91902 - - - -   
## JUN 0.03073 0.00711 0.02358 0.62289 1.00000 - - -   
## JUL 9.6e-08 4.9e-09 5.5e-08 0.00048 0.35579 0.74226 - -   
## AUG 9.1e-05 8.9e-06 5.9e-05 0.03979 0.93229 0.99705 0.99954 -   
## SEP 0.00275 0.00042 0.00194 0.24124 0.99830 1.00000 0.96412 1.00000  
## OCT 0.38979 0.18143 0.34277 0.98708 1.00000 0.99970 0.15123 0.76669  
## NOV 1.00000 0.99973 0.99999 0.99998 0.51956 0.17634 6.3e-06 0.00205  
## DEC 0.99999 1.00000 1.00000 0.88148 0.02277 0.00197 4.3e-10 1.3e-06  
## SEP OCT NOV   
## FEB - - -   
## MAR - - -   
## APR - - -   
## MAY - - -   
## JUN - - -   
## JUL - - -   
## AUG - - -   
## SEP - - -   
## OCT 0.97816 - -   
## NOV 0.03047 0.77797 -   
## DEC 8.5e-05 0.08500 0.99686  
##   
## P value adjustment method: none

# Is there a seasonal peak in stranding cases for certain species?   
monthly\_species <- pinnipeds\_data %>%  
 filter(Observation.Status == 'ALIVE' | Observation.Status == 'FRESH DEAD') %>%  
 filter(Pinniped.Common.Name != 'Unidentified') %>%  
 group\_by(Month.of.Observation, Pinniped.Common.Name, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# Again, had species combined, then separated them out below.  
# <--- Help - check interpretation of multi-factor regressions coefficients?  
# <--- CSL low in Feb, high in May and Aug-Nov; GFS high June, HS low in Nov, high Apr - Sep; NES high in Apr, low Sep-Nov; Stellers lower Sep-Oct; NFS high in May  
# monthly\_all\_model\_sp <- glm(cnt ~ Month.of.Observation\*Pinniped.Common.Name, family = poisson(link = log), data = monthly\_species)  
# summary(monthly\_all\_model\_sp)  
  
summary(glm(cnt ~ Month.of.Observation, family = poisson(link = log), data = monthly\_species %>% filter(Pinniped.Common.Name == 'Harbor seal'))) #Apr - Oct

##   
## Call:  
## glm(formula = cnt ~ Month.of.Observation, family = poisson(link = log),   
## data = monthly\_species %>% filter(Pinniped.Common.Name ==   
## "Harbor seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -8.2931 -1.7402 -0.2819 1.2101 9.7819   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 1.85630 0.07906 23.481 < 2e-16 \*\*\*  
## Month.of.ObservationFEB -0.21049 0.11573 -1.819 0.06893 .   
## Month.of.ObservationMAR -0.01634 0.11015 -0.148 0.88209   
## Month.of.ObservationAPR 0.31170 0.10241 3.044 0.00234 \*\*   
## Month.of.ObservationMAY 0.85422 0.09334 9.151 < 2e-16 \*\*\*  
## Month.of.ObservationJUN 1.18469 0.08955 13.229 < 2e-16 \*\*\*  
## Month.of.ObservationJUL 2.07553 0.08352 24.850 < 2e-16 \*\*\*  
## Month.of.ObservationAUG 1.74658 0.08520 20.500 < 2e-16 \*\*\*  
## Month.of.ObservationSEP 1.35365 0.08800 15.382 < 2e-16 \*\*\*  
## Month.of.ObservationOCT 0.92780 0.09240 10.041 < 2e-16 \*\*\*  
## Month.of.ObservationNOV 0.14830 0.10692 1.387 0.16544   
## Month.of.ObservationDEC -0.18482 0.11734 -1.575 0.11523   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 4709.7 on 318 degrees of freedom  
## Residual deviance: 1596.6 on 307 degrees of freedom  
## AIC: 2966.9  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Month.of.Observation, family = poisson(link = log), data = monthly\_species %>% filter(Pinniped.Common.Name == 'Northern fur seal'))) #Nov

##   
## Call:  
## glm(formula = cnt ~ Month.of.Observation, family = poisson(link = log),   
## data = monthly\_species %>% filter(Pinniped.Common.Name ==   
## "Northern fur seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.3644 -0.4348 0.0000 0.1594 1.7195   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 0.5390 0.2887 1.867 0.06188 .   
## Month.of.ObservationFEB 0.1542 0.3819 0.404 0.68646   
## Month.of.ObservationMAR -0.1335 0.6455 -0.207 0.83611   
## Month.of.ObservationAPR -0.5390 0.7638 -0.706 0.48037   
## Month.of.ObservationMAY -0.5390 0.5000 -1.078 0.28104   
## Month.of.ObservationJUN -0.5390 0.5323 -1.013 0.31125   
## Month.of.ObservationJUL -0.5390 0.6455 -0.835 0.40371   
## Month.of.ObservationAUG -0.5390 1.0408 -0.518 0.60456   
## Month.of.ObservationNOV 1.1658 0.4174 2.793 0.00523 \*\*  
## Month.of.ObservationDEC -0.1335 0.4410 -0.303 0.76203   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 35.294 on 41 degrees of freedom  
## Residual deviance: 18.472 on 32 degrees of freedom  
## AIC: 133.44  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Month.of.Observation, family = poisson(link = log), data = monthly\_species %>% filter(Pinniped.Common.Name == 'Guadalupe fur seal'))) #June

##   
## Call:  
## glm(formula = cnt ~ Month.of.Observation, family = poisson(link = log),   
## data = monthly\_species %>% filter(Pinniped.Common.Name ==   
## "Guadalupe fur seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.4858 -0.9928 -0.3022 0.3290 5.6047   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -2.920e-15 1.000e+00 0.000 1.0000   
## Month.of.ObservationMAY 2.877e-01 1.118e+00 0.257 0.7969   
## Month.of.ObservationJUN 1.768e+00 1.012e+00 1.746 0.0807 .  
## Month.of.ObservationJUL 9.808e-01 1.061e+00 0.925 0.3551   
## Month.of.ObservationOCT 2.350e-15 1.414e+00 0.000 1.0000   
## Month.of.ObservationNOV 2.949e-15 1.414e+00 0.000 1.0000   
## Month.of.ObservationDEC 2.877e-01 1.118e+00 0.257 0.7969   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 82.710 on 18 degrees of freedom  
## Residual deviance: 55.454 on 12 degrees of freedom  
## AIC: 118.03  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Month.of.Observation, family = poisson(link = log), data = monthly\_species %>% filter(Pinniped.Common.Name == 'Northern elephant seal'))) #June

##   
## Call:  
## glm(formula = cnt ~ Month.of.Observation, family = poisson(link = log),   
## data = monthly\_species %>% filter(Pinniped.Common.Name ==   
## "Northern elephant seal"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.3717 -0.5278 -0.1147 0.2952 2.6458   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 0.57054 0.20851 2.736 0.00621 \*\*  
## Month.of.ObservationFEB 0.04256 0.29180 0.146 0.88404   
## Month.of.ObservationMAR 0.12260 0.30574 0.401 0.68842   
## Month.of.ObservationAPR 0.54749 0.25042 2.186 0.02879 \*   
## Month.of.ObservationMAY 0.38043 0.25730 1.479 0.13927   
## Month.of.ObservationJUN 0.47400 0.24899 1.904 0.05695 .   
## Month.of.ObservationJUL -0.09362 0.27922 -0.335 0.73740   
## Month.of.ObservationAUG 0.20265 0.28625 0.708 0.47899   
## Month.of.ObservationSEP -0.21387 0.37879 -0.565 0.57233   
## Month.of.ObservationOCT -0.25209 0.36659 -0.688 0.49166   
## Month.of.ObservationNOV -0.57054 0.54174 -1.053 0.29226   
## Month.of.ObservationDEC -0.34740 0.37879 -0.917 0.35907   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 112.04 on 145 degrees of freedom  
## Residual deviance: 85.75 on 134 degrees of freedom  
## AIC: 476.54  
##   
## Number of Fisher Scoring iterations: 5

summary(glm(cnt ~ Month.of.Observation, family = poisson(link = log), data = monthly\_species %>% filter(Pinniped.Common.Name == 'California sea lion'))) #May, Aug-Nov

##   
## Call:  
## glm(formula = cnt ~ Month.of.Observation, family = poisson(link = log),   
## data = monthly\_species %>% filter(Pinniped.Common.Name ==   
## "California sea lion"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -3.4293 -1.5365 -0.8695 0.2160 12.3248   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 1.33702 0.10050 13.303 < 2e-16 \*\*\*  
## Month.of.ObservationFEB -0.35121 0.15820 -2.220 0.0264 \*   
## Month.of.ObservationMAR 0.15105 0.14441 1.046 0.2956   
## Month.of.ObservationAPR -0.06073 0.14741 -0.412 0.6803   
## Month.of.ObservationMAY 0.35364 0.13112 2.697 0.0070 \*\*   
## Month.of.ObservationJUN -0.03774 0.14651 -0.258 0.7967   
## Month.of.ObservationJUL 0.21179 0.15034 1.409 0.1589   
## Month.of.ObservationAUG 0.25561 0.13629 1.875 0.0607 .   
## Month.of.ObservationSEP 0.64811 0.12488 5.190 2.11e-07 \*\*\*  
## Month.of.ObservationOCT 0.86982 0.12201 7.129 1.01e-12 \*\*\*  
## Month.of.ObservationNOV 0.53478 0.12656 4.225 2.39e-05 \*\*\*  
## Month.of.ObservationDEC -0.05609 0.14564 -0.385 0.7002   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 1449.4 on 285 degrees of freedom  
## Residual deviance: 1280.1 on 274 degrees of freedom  
## AIC: 2184.1  
##   
## Number of Fisher Scoring iterations: 6

summary(glm(cnt ~ Month.of.Observation, family = poisson(link = log), data = monthly\_species %>% filter(Pinniped.Common.Name == 'Steller sea lion'))) #Mar

##   
## Call:  
## glm(formula = cnt ~ Month.of.Observation, family = poisson(link = log),   
## data = monthly\_species %>% filter(Pinniped.Common.Name ==   
## "Steller sea lion"))  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.2507 -0.5766 -0.3100 0.2746 2.9218   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 0.49248 0.23570 2.089 0.0367 \*  
## Month.of.ObservationFEB 0.03362 0.31782 0.106 0.9158   
## Month.of.ObservationMAR 0.54362 0.29633 1.834 0.0666 .  
## Month.of.ObservationAPR 0.13613 0.29814 0.457 0.6480   
## Month.of.ObservationMAY 0.37252 0.28613 1.302 0.1929   
## Month.of.ObservationJUN 0.20067 0.29149 0.688 0.4912   
## Month.of.ObservationJUL -0.12957 0.31470 -0.412 0.6805   
## Month.of.ObservationAUG -0.04619 0.30912 -0.149 0.8812   
## Month.of.ObservationSEP -0.35895 0.34359 -1.045 0.2962   
## Month.of.ObservationOCT -0.14417 0.33820 -0.426 0.6699   
## Month.of.ObservationNOV 0.09531 0.33333 0.286 0.7749   
## Month.of.ObservationDEC 0.09531 0.33333 0.286 0.7749   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 108.35 on 161 degrees of freedom  
## Residual deviance: 92.93 on 150 degrees of freedom  
## AIC: 501.98  
##   
## Number of Fisher Scoring iterations: 5

# Seasonal peak for human interactions cases?   
  
monthly\_species\_HI <- pinnipeds\_data %>%  
 filter(Observation.Status == 'ALIVE' | Observation.Status == 'FRESH DEAD') %>%  
 filter(Pinniped.Common.Name != 'Unidentified') %>%  
 filter(Findings.of.Human.Interaction == 'Y') %>%  
 group\_by(Month.of.Observation, Pinniped.Common.Name, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# Combined species  
# <--- same as above, if correct, HS only one showing seasonal peak for HI cases June - Oct, by exp(2.1) = ~8/month  
monthly\_HI\_model\_sp <- glm(cnt ~ Month.of.Observation\*Pinniped.Common.Name, family = poisson(link = log), data = monthly\_species\_HI)  
summary(monthly\_HI\_model\_sp)

##   
## Call:  
## glm(formula = cnt ~ Month.of.Observation \* Pinniped.Common.Name,   
## family = poisson(link = log), data = monthly\_species\_HI)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -3.2820 -0.6741 -0.2076 0.2024 5.6197   
##   
## Coefficients: (16 not defined because of singularities)  
## Estimate  
## (Intercept) 0.58779  
## Month.of.ObservationFEB -0.36464  
## Month.of.ObservationMAR 0.21659  
## Month.of.ObservationAPR -0.12825  
## Month.of.ObservationMAY 0.16252  
## Month.of.ObservationJUN -0.04124  
## Month.of.ObservationJUL -0.07696  
## Month.of.ObservationAUG -0.32542  
## Month.of.ObservationSEP -0.38712  
## Month.of.ObservationOCT 0.10536  
## Month.of.ObservationNOV -0.15247  
## Month.of.ObservationDEC -0.30010  
## Pinniped.Common.NameGuadalupe fur seal -0.28768  
## Pinniped.Common.NameHarbor seal -0.44469  
## Pinniped.Common.NameNorthern elephant seal -0.43532  
## Pinniped.Common.NameNorthern fur seal -0.28768  
## Pinniped.Common.NameSteller sea lion -0.58779  
## Month.of.ObservationFEB:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAY:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationJUN:Pinniped.Common.NameGuadalupe fur seal 0.02882  
## Month.of.ObservationJUL:Pinniped.Common.NameGuadalupe fur seal 0.47000  
## Month.of.ObservationAUG:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameHarbor seal 0.50922  
## Month.of.ObservationMAR:Pinniped.Common.NameHarbor seal 0.25342  
## Month.of.ObservationAPR:Pinniped.Common.NameHarbor seal 0.34183  
## Month.of.ObservationMAY:Pinniped.Common.NameHarbor seal 0.30052  
## Month.of.ObservationJUN:Pinniped.Common.NameHarbor seal 1.28444  
## Month.of.ObservationJUL:Pinniped.Common.NameHarbor seal 2.07738  
## Month.of.ObservationAUG:Pinniped.Common.NameHarbor seal 1.77683  
## Month.of.ObservationSEP:Pinniped.Common.NameHarbor seal 1.58586  
## Month.of.ObservationOCT:Pinniped.Common.NameHarbor seal 0.98628  
## Month.of.ObservationNOV:Pinniped.Common.NameHarbor seal 0.65996  
## Month.of.ObservationDEC:Pinniped.Common.NameHarbor seal 0.77604  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern elephant seal 0.21217  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern elephant seal -0.36905  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern elephant seal -0.02421  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern elephant seal 0.09048  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern elephant seal -0.11123  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern elephant seal -0.07551  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern elephant seal 0.17295  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern elephant seal 0.23465  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern elephant seal -0.25783  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern fur seal 0.35222  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern fur seal -0.17185  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern fur seal -0.46262  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern fur seal -0.25886  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern fur seal -0.22314  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern fur seal -0.14764  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameSteller sea lion 0.51879  
## Month.of.ObservationMAR:Pinniped.Common.NameSteller sea lion 0.81303  
## Month.of.ObservationAPR:Pinniped.Common.NameSteller sea lion 0.82140  
## Month.of.ObservationMAY:Pinniped.Common.NameSteller sea lion 0.12516  
## Month.of.ObservationJUN:Pinniped.Common.NameSteller sea lion 0.17477  
## Month.of.ObservationJUL:Pinniped.Common.NameSteller sea lion 0.07696  
## Month.of.ObservationAUG:Pinniped.Common.NameSteller sea lion 0.32542  
## Month.of.ObservationSEP:Pinniped.Common.NameSteller sea lion 0.38712  
## Month.of.ObservationOCT:Pinniped.Common.NameSteller sea lion 0.11778  
## Month.of.ObservationNOV:Pinniped.Common.NameSteller sea lion 0.37561  
## Month.of.ObservationDEC:Pinniped.Common.NameSteller sea lion 0.30010  
## Std. Error  
## (Intercept) 0.19245  
## Month.of.ObservationFEB 0.37019  
## Month.of.ObservationMAR 0.25170  
## Month.of.ObservationAPR 0.29945  
## Month.of.ObservationMAY 0.25459  
## Month.of.ObservationJUN 0.29945  
## Month.of.ObservationJUL 0.37019  
## Month.of.ObservationAUG 0.33758  
## Month.of.ObservationSEP 0.35770  
## Month.of.ObservationOCT 0.31549  
## Month.of.ObservationNOV 0.30961  
## Month.of.ObservationDEC 0.34694  
## Pinniped.Common.NameGuadalupe fur seal 1.04083  
## Pinniped.Common.NameHarbor seal 0.32203  
## Pinniped.Common.NameNorthern elephant seal 1.02899  
## Pinniped.Common.NameNorthern fur seal 0.64550  
## Pinniped.Common.NameSteller sea lion 0.42414  
## Month.of.ObservationFEB:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAY:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationJUN:Pinniped.Common.NameGuadalupe fur seal 1.17727  
## Month.of.ObservationJUL:Pinniped.Common.NameGuadalupe fur seal 1.29743  
## Month.of.ObservationAUG:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameHarbor seal 0.57333  
## Month.of.ObservationMAR:Pinniped.Common.NameHarbor seal 0.41435  
## Month.of.ObservationAPR:Pinniped.Common.NameHarbor seal 0.45424  
## Month.of.ObservationMAY:Pinniped.Common.NameHarbor seal 0.40222  
## Month.of.ObservationJUN:Pinniped.Common.NameHarbor seal 0.41090  
## Month.of.ObservationJUL:Pinniped.Common.NameHarbor seal 0.45891  
## Month.of.ObservationAUG:Pinniped.Common.NameHarbor seal 0.43376  
## Month.of.ObservationSEP:Pinniped.Common.NameHarbor seal 0.45385  
## Month.of.ObservationOCT:Pinniped.Common.NameHarbor seal 0.42940  
## Month.of.ObservationNOV:Pinniped.Common.NameHarbor seal 0.45388  
## Month.of.ObservationDEC:Pinniped.Common.NameHarbor seal 0.51377  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern elephant seal 1.46929  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern elephant seal 1.25902  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern elephant seal 1.45308  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern elephant seal 1.19161  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern elephant seal 1.14519  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern elephant seal 1.28795  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern elephant seal 1.46142  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern elephant seal 1.18310  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern elephant seal 1.45648  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern fur seal 0.87560  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern fur seal 1.21215  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern fur seal 0.97183  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern fur seal 1.21215  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern fur seal 1.23153  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern fur seal 1.21470  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameSteller sea lion 0.65019  
## Month.of.ObservationMAR:Pinniped.Common.NameSteller sea lion 0.52691  
## Month.of.ObservationAPR:Pinniped.Common.NameSteller sea lion 0.69464  
## Month.of.ObservationMAY:Pinniped.Common.NameSteller sea lion 0.57678  
## Month.of.ObservationJUN:Pinniped.Common.NameSteller sea lion 0.59793  
## Month.of.ObservationJUL:Pinniped.Common.NameSteller sea lion 1.13132  
## Month.of.ObservationAUG:Pinniped.Common.NameSteller sea lion 0.76821  
## Month.of.ObservationSEP:Pinniped.Common.NameSteller sea lion 0.87795  
## Month.of.ObservationOCT:Pinniped.Common.NameSteller sea lion 0.66513  
## Month.of.ObservationNOV:Pinniped.Common.NameSteller sea lion 0.66236  
## Month.of.ObservationDEC:Pinniped.Common.NameSteller sea lion 0.71640  
## z value  
## (Intercept) 3.054  
## Month.of.ObservationFEB -0.985  
## Month.of.ObservationMAR 0.861  
## Month.of.ObservationAPR -0.428  
## Month.of.ObservationMAY 0.638  
## Month.of.ObservationJUN -0.138  
## Month.of.ObservationJUL -0.208  
## Month.of.ObservationAUG -0.964  
## Month.of.ObservationSEP -1.082  
## Month.of.ObservationOCT 0.334  
## Month.of.ObservationNOV -0.492  
## Month.of.ObservationDEC -0.865  
## Pinniped.Common.NameGuadalupe fur seal -0.276  
## Pinniped.Common.NameHarbor seal -1.381  
## Pinniped.Common.NameNorthern elephant seal -0.423  
## Pinniped.Common.NameNorthern fur seal -0.446  
## Pinniped.Common.NameSteller sea lion -1.386  
## Month.of.ObservationFEB:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAY:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationJUN:Pinniped.Common.NameGuadalupe fur seal 0.024  
## Month.of.ObservationJUL:Pinniped.Common.NameGuadalupe fur seal 0.362  
## Month.of.ObservationAUG:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameHarbor seal 0.888  
## Month.of.ObservationMAR:Pinniped.Common.NameHarbor seal 0.612  
## Month.of.ObservationAPR:Pinniped.Common.NameHarbor seal 0.753  
## Month.of.ObservationMAY:Pinniped.Common.NameHarbor seal 0.747  
## Month.of.ObservationJUN:Pinniped.Common.NameHarbor seal 3.126  
## Month.of.ObservationJUL:Pinniped.Common.NameHarbor seal 4.527  
## Month.of.ObservationAUG:Pinniped.Common.NameHarbor seal 4.096  
## Month.of.ObservationSEP:Pinniped.Common.NameHarbor seal 3.494  
## Month.of.ObservationOCT:Pinniped.Common.NameHarbor seal 2.297  
## Month.of.ObservationNOV:Pinniped.Common.NameHarbor seal 1.454  
## Month.of.ObservationDEC:Pinniped.Common.NameHarbor seal 1.510  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern elephant seal 0.144  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern elephant seal -0.293  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern elephant seal -0.017  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern elephant seal 0.076  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern elephant seal -0.097  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern elephant seal -0.059  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern elephant seal 0.118  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern elephant seal 0.198  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern elephant seal -0.177  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern fur seal 0.402  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern fur seal -0.142  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern fur seal -0.476  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern fur seal -0.214  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern fur seal -0.181  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern fur seal -0.122  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameSteller sea lion 0.798  
## Month.of.ObservationMAR:Pinniped.Common.NameSteller sea lion 1.543  
## Month.of.ObservationAPR:Pinniped.Common.NameSteller sea lion 1.182  
## Month.of.ObservationMAY:Pinniped.Common.NameSteller sea lion 0.217  
## Month.of.ObservationJUN:Pinniped.Common.NameSteller sea lion 0.292  
## Month.of.ObservationJUL:Pinniped.Common.NameSteller sea lion 0.068  
## Month.of.ObservationAUG:Pinniped.Common.NameSteller sea lion 0.424  
## Month.of.ObservationSEP:Pinniped.Common.NameSteller sea lion 0.441  
## Month.of.ObservationOCT:Pinniped.Common.NameSteller sea lion 0.177  
## Month.of.ObservationNOV:Pinniped.Common.NameSteller sea lion 0.567  
## Month.of.ObservationDEC:Pinniped.Common.NameSteller sea lion 0.419  
## Pr(>|z|)  
## (Intercept) 0.002256  
## Month.of.ObservationFEB 0.324610  
## Month.of.ObservationMAR 0.389513  
## Month.of.ObservationAPR 0.668430  
## Month.of.ObservationMAY 0.523238  
## Month.of.ObservationJUN 0.890454  
## Month.of.ObservationJUL 0.835308  
## Month.of.ObservationAUG 0.335053  
## Month.of.ObservationSEP 0.279142  
## Month.of.ObservationOCT 0.738415  
## Month.of.ObservationNOV 0.622403  
## Month.of.ObservationDEC 0.387042  
## Pinniped.Common.NameGuadalupe fur seal 0.782244  
## Pinniped.Common.NameHarbor seal 0.167316  
## Pinniped.Common.NameNorthern elephant seal 0.672257  
## Pinniped.Common.NameNorthern fur seal 0.655832  
## Pinniped.Common.NameSteller sea lion 0.165798  
## Month.of.ObservationFEB:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationMAY:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationJUN:Pinniped.Common.NameGuadalupe fur seal 0.980469  
## Month.of.ObservationJUL:Pinniped.Common.NameGuadalupe fur seal 0.717160  
## Month.of.ObservationAUG:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameGuadalupe fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameHarbor seal 0.374437  
## Month.of.ObservationMAR:Pinniped.Common.NameHarbor seal 0.540800  
## Month.of.ObservationAPR:Pinniped.Common.NameHarbor seal 0.451735  
## Month.of.ObservationMAY:Pinniped.Common.NameHarbor seal 0.454982  
## Month.of.ObservationJUN:Pinniped.Common.NameHarbor seal 0.001772  
## Month.of.ObservationJUL:Pinniped.Common.NameHarbor seal 5.99e-06  
## Month.of.ObservationAUG:Pinniped.Common.NameHarbor seal 4.20e-05  
## Month.of.ObservationSEP:Pinniped.Common.NameHarbor seal 0.000475  
## Month.of.ObservationOCT:Pinniped.Common.NameHarbor seal 0.021626  
## Month.of.ObservationNOV:Pinniped.Common.NameHarbor seal 0.145936  
## Month.of.ObservationDEC:Pinniped.Common.NameHarbor seal 0.130920  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern elephant seal 0.885180  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern elephant seal 0.769424  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern elephant seal 0.986705  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern elephant seal 0.939476  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern elephant seal 0.922628  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern elephant seal 0.953250  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern elephant seal 0.905793  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern elephant seal 0.842785  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern elephant seal 0.859491  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern elephant seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern fur seal 0.687490  
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern fur seal 0.887259  
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern fur seal 0.634049  
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern fur seal 0.830893  
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern fur seal 0.856217  
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern fur seal 0.903262  
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern fur seal NA  
## Month.of.ObservationFEB:Pinniped.Common.NameSteller sea lion 0.424924  
## Month.of.ObservationMAR:Pinniped.Common.NameSteller sea lion 0.122828  
## Month.of.ObservationAPR:Pinniped.Common.NameSteller sea lion 0.237014  
## Month.of.ObservationMAY:Pinniped.Common.NameSteller sea lion 0.828205  
## Month.of.ObservationJUN:Pinniped.Common.NameSteller sea lion 0.770060  
## Month.of.ObservationJUL:Pinniped.Common.NameSteller sea lion 0.945764  
## Month.of.ObservationAUG:Pinniped.Common.NameSteller sea lion 0.671850  
## Month.of.ObservationSEP:Pinniped.Common.NameSteller sea lion 0.659264  
## Month.of.ObservationOCT:Pinniped.Common.NameSteller sea lion 0.859443  
## Month.of.ObservationNOV:Pinniped.Common.NameSteller sea lion 0.570657  
## Month.of.ObservationDEC:Pinniped.Common.NameSteller sea lion 0.675284  
##   
## (Intercept) \*\*   
## Month.of.ObservationFEB   
## Month.of.ObservationMAR   
## Month.of.ObservationAPR   
## Month.of.ObservationMAY   
## Month.of.ObservationJUN   
## Month.of.ObservationJUL   
## Month.of.ObservationAUG   
## Month.of.ObservationSEP   
## Month.of.ObservationOCT   
## Month.of.ObservationNOV   
## Month.of.ObservationDEC   
## Pinniped.Common.NameGuadalupe fur seal   
## Pinniped.Common.NameHarbor seal   
## Pinniped.Common.NameNorthern elephant seal   
## Pinniped.Common.NameNorthern fur seal   
## Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationFEB:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationMAR:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationAPR:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationMAY:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationJUN:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationJUL:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationAUG:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationSEP:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationOCT:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationNOV:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationDEC:Pinniped.Common.NameGuadalupe fur seal   
## Month.of.ObservationFEB:Pinniped.Common.NameHarbor seal   
## Month.of.ObservationMAR:Pinniped.Common.NameHarbor seal   
## Month.of.ObservationAPR:Pinniped.Common.NameHarbor seal   
## Month.of.ObservationMAY:Pinniped.Common.NameHarbor seal   
## Month.of.ObservationJUN:Pinniped.Common.NameHarbor seal \*\*   
## Month.of.ObservationJUL:Pinniped.Common.NameHarbor seal \*\*\*  
## Month.of.ObservationAUG:Pinniped.Common.NameHarbor seal \*\*\*  
## Month.of.ObservationSEP:Pinniped.Common.NameHarbor seal \*\*\*  
## Month.of.ObservationOCT:Pinniped.Common.NameHarbor seal \*   
## Month.of.ObservationNOV:Pinniped.Common.NameHarbor seal   
## Month.of.ObservationDEC:Pinniped.Common.NameHarbor seal   
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern elephant seal   
## Month.of.ObservationFEB:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationMAR:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationAPR:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationMAY:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationJUN:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationJUL:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationAUG:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationSEP:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationOCT:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationNOV:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationDEC:Pinniped.Common.NameNorthern fur seal   
## Month.of.ObservationFEB:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationMAR:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationAPR:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationMAY:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationJUN:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationJUL:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationAUG:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationSEP:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationOCT:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationNOV:Pinniped.Common.NameSteller sea lion   
## Month.of.ObservationDEC:Pinniped.Common.NameSteller sea lion   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 876.45 on 406 degrees of freedom  
## Residual deviance: 485.63 on 351 degrees of freedom  
## AIC: 1601.2  
##   
## Number of Fisher Scoring iterations: 5

## Spatial Patterns

* Is there a statistical difference in strandings and HI across counties? (WA)

# Is there a statistical difference in strandings/HI across counties?   
# Ideally, would show which are different from the "baseline" of overall stranding cases in those counties, but struggled with this.  
  
#All strandings, WA  
allWA\_bycounty <- pinnipeds\_data %>%   
 filter(County != 'NA' & County != 'Unknown' & State == 'WA') %>%  
 transform(County = factor(County)) %>%  
 group\_by(County, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# <--- Overall, yes, county is a significant predictor. Pairwise shows San Juan dif from Mason, Pacific, Clark, Cowlitz, Thurston  
kruskal.test(allWA\_bycounty)

##   
## Kruskal-Wallis rank sum test  
##   
## data: allWA\_bycounty  
## Kruskal-Wallis chi-squared = 796.1, df = 2, p-value < 2.2e-16

#kruskalmc(allWA\_bycounty$cnt ~ allWA\_bycounty$County)   
posthoc.kruskal.nemenyi.test(cnt ~ County, allWA\_bycounty, dist = "Chisquare")

##   
## Pairwise comparisons using Nemenyi-test with Chi-squared   
## approximation for independent samples   
##   
## data: cnt by County   
##   
## Clallam Clark Cowlitz Grays Harbor Island Jefferson  
## Clark 0.97012 - - - - -   
## Cowlitz 0.97621 1.00000 - - - -   
## Grays Harbor 1.00000 0.86319 0.88243 - - -   
## Island 0.99958 0.54793 0.58201 1.00000 - -   
## Jefferson 1.00000 0.99751 0.99823 0.99991 0.95122 -   
## King 0.96527 0.28528 0.31425 0.99963 1.00000 0.62872   
## Kitsap 0.99759 0.45800 0.49203 1.00000 1.00000 0.88718   
## Lewis 1.00000 1.00000 1.00000 0.99997 0.99964 1.00000   
## Mason 0.99954 0.99997 0.99998 0.96199 0.50486 1.00000   
## Pacific 1.00000 0.97662 0.98159 1.00000 0.99929 1.00000   
## Pierce 0.99915 0.51370 0.54797 1.00000 1.00000 0.93136   
## San Juan 0.06220 0.01091 0.01334 0.37341 0.92143 0.00261   
## Skagit 0.96637 1.00000 1.00000 0.68060 0.12234 0.99979   
## Skamania 1.00000 1.00000 1.00000 0.99997 0.99964 1.00000   
## Snohomish 1.00000 0.99763 0.99831 0.99992 0.95538 1.00000   
## Thurston 1.00000 0.99925 0.99949 0.99908 0.87788 1.00000   
## Wahkiakum 0.99473 1.00000 1.00000 0.97032 0.85441 0.99959   
## Whatcom 1.00000 0.94347 0.95359 1.00000 0.99997 1.00000   
## King Kitsap Lewis Mason Pacific Pierce San Juan  
## Clark - - - - - - -   
## Cowlitz - - - - - - -   
## Grays Harbor - - - - - - -   
## Island - - - - - - -   
## Jefferson - - - - - - -   
## King - - - - - - -   
## Kitsap 1.00000 - - - - - -   
## Lewis 0.99840 0.99940 - - - - -   
## Mason 0.11825 0.35057 1.00000 - - - -   
## Pacific 0.95543 0.99634 1.00000 0.99980 - - -   
## Pierce 1.00000 1.00000 0.99956 0.44468 0.99862 - -   
## San Juan 0.99799 0.96908 0.97016 2.0e-05 0.05457 0.94347 -   
## Skagit 0.01073 0.06207 1.00000 1.00000 0.97913 0.09575 1.4e-07   
## Skamania 0.99840 0.99940 1.00000 1.00000 1.00000 0.99956 0.97016   
## Snohomish 0.64773 0.89561 1.00000 1.00000 1.00000 0.93694 0.00326   
## Thurston 0.45616 0.77013 1.00000 1.00000 1.00000 0.84172 0.00082   
## Wahkiakum 0.68130 0.80607 1.00000 0.99999 0.99591 0.83704 0.16137   
## Whatcom 0.99100 0.99970 0.99999 0.99667 1.00000 0.99992 0.13688   
## Skagit Skamania Snohomish Thurston Wahkiakum  
## Clark - - - - -   
## Cowlitz - - - - -   
## Grays Harbor - - - - -   
## Island - - - - -   
## Jefferson - - - - -   
## King - - - - -   
## Kitsap - - - - -   
## Lewis - - - - -   
## Mason - - - - -   
## Pacific - - - - -   
## Pierce - - - - -   
## San Juan - - - - -   
## Skagit - - - - -   
## Skamania 1.00000 - - - -   
## Snohomish 0.99982 1.00000 - - -   
## Thurston 0.99999 1.00000 1.00000 - -   
## Wahkiakum 1.00000 1.00000 0.99961 0.99987 -   
## Whatcom 0.90473 0.99999 1.00000 0.99999 0.98937   
##   
## P value adjustment method: none

#HI strandings, WA  
WAHI\_bycounty <- pinnipeds\_data %>%   
 filter(County != 'NA' & State == 'WA' &   
 Findings.of.Human.Interaction == 'Y' &   
 Interaction.Type != 'NA') %>%   
 transform(County = factor(County)) %>%  
 group\_by(County, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# <--- County is a significant predictor overall. K-W shows higher in Pacific  
kruskal.test(WAHI\_bycounty)

##   
## Kruskal-Wallis rank sum test  
##   
## data: WAHI\_bycounty  
## Kruskal-Wallis chi-squared = 542.83, df = 2, p-value < 2.2e-16

kruskalmc(WAHI\_bycounty$cnt ~ WAHI\_bycounty$County)

## Multiple comparison test after Kruskal-Wallis   
## p.value: 0.05   
## Comparisons  
## obs.dif critical.dif difference  
## Clallam-Clark 7.6000000 151.70500 FALSE  
## Clallam-Cowlitz 30.1500000 181.71591 FALSE  
## Clallam-Grays Harbor 29.2529412 80.83008 FALSE  
## Clallam-Island 3.6833333 79.60717 FALSE  
## Clallam-Jefferson 19.7785714 85.38313 FALSE  
## Clallam-King 7.0047619 76.55594 FALSE  
## Clallam-Kitsap 14.5052632 78.49683 FALSE  
## Clallam-Mason 25.2000000 94.89804 FALSE  
## Clallam-Pacific 72.7333333 83.69220 FALSE  
## Clallam-Pierce 50.6631579 78.49683 FALSE  
## Clallam-San Juan 21.2750000 74.18521 FALSE  
## Clallam-Skagit 19.6000000 91.97740 FALSE  
## Clallam-Snohomish 22.6526316 78.49683 FALSE  
## Clallam-Thurston 11.1500000 89.47073 FALSE  
## Clallam-Whatcom 45.9937500 82.18411 FALSE  
## Clark-Cowlitz 37.7500000 223.67683 FALSE  
## Clark-Grays Harbor 36.8529412 153.44104 FALSE  
## Clark-Island 3.9166667 152.80036 FALSE  
## Clark-Jefferson 12.1785714 155.88755 FALSE  
## Clark-King 0.5952381 151.23314 FALSE  
## Clark-Kitsap 22.1052632 152.22484 FALSE  
## Clark-Mason 17.6000000 161.29565 FALSE  
## Clark-Pacific 80.3333333 154.96785 FALSE  
## Clark-Pierce 58.2631579 152.22484 FALSE  
## Clark-San Juan 28.8750000 150.04698 FALSE  
## Clark-Skagit 12.0000000 159.59477 FALSE  
## Clark-Snohomish 15.0526316 152.22484 FALSE  
## Clark-Thurston 18.7500000 158.16340 FALSE  
## Clark-Whatcom 53.5937500 154.15861 FALSE  
## Cowlitz-Grays Harbor 0.8970588 183.16773 FALSE  
## Cowlitz-Island 33.8333333 182.63136 FALSE  
## Cowlitz-Jefferson 49.9285714 185.22201 FALSE  
## Cowlitz-King 37.1547619 181.32216 FALSE  
## Cowlitz-Kitsap 15.6447368 182.15012 FALSE  
## Cowlitz-Mason 55.3500000 189.79608 FALSE  
## Cowlitz-Pacific 42.5833333 184.44864 FALSE  
## Cowlitz-Pierce 20.5131579 182.15012 FALSE  
## Cowlitz-San Juan 8.8750000 180.33402 FALSE  
## Cowlitz-Skagit 49.7500000 188.35274 FALSE  
## Cowlitz-Snohomish 52.8026316 182.15012 FALSE  
## Cowlitz-Thurston 19.0000000 187.14146 FALSE  
## Cowlitz-Whatcom 15.8437500 183.76926 FALSE  
## Grays Harbor-Island 32.9362745 82.86763 FALSE  
## Grays Harbor-Jefferson 49.0315126 88.43089 FALSE  
## Grays Harbor-King 36.2577031 79.94095 FALSE  
## Grays Harbor-Kitsap 14.7476780 81.80156 FALSE  
## Grays Harbor-Mason 54.4529412 97.64928 FALSE  
## Grays Harbor-Pacific 43.4803922 86.79936 FALSE  
## Grays Harbor-Pierce 21.4102167 81.80156 FALSE  
## Grays Harbor-San Juan 7.9779412 77.67360 FALSE  
## Grays Harbor-Skagit 48.8529412 94.81342 FALSE  
## Grays Harbor-Snohomish 51.9055728 81.80156 FALSE  
## Grays Harbor-Thurston 18.1029412 92.38374 FALSE  
## Grays Harbor-Whatcom 16.7408088 85.34619 FALSE  
## Island-Jefferson 16.0952381 87.31449 FALSE  
## Island-King 3.3214286 78.70422 FALSE  
## Island-Kitsap 18.1885965 80.59339 FALSE  
## Island-Mason 21.5166667 96.63943 FALSE  
## Island-Pacific 76.4166667 85.66170 FALSE  
## Island-Pierce 54.3464912 80.59339 FALSE  
## Island-San Juan 24.9583333 76.40018 FALSE  
## Island-Skagit 15.9166667 93.77304 FALSE  
## Island-Snohomish 18.9692982 80.59339 FALSE  
## Island-Thurston 14.8333333 91.31568 FALSE  
## Island-Whatcom 49.6770833 84.18890 FALSE  
## Jefferson-King 12.7738095 84.54189 FALSE  
## Jefferson-Kitsap 34.2838346 86.30337 FALSE  
## Jefferson-Mason 5.4214286 101.45027 FALSE  
## Jefferson-Pacific 92.5119048 91.05441 TRUE  
## Jefferson-Pierce 70.4417293 86.30337 FALSE  
## Jefferson-San Juan 41.0535714 82.40125 FALSE  
## Jefferson-Skagit 0.1785714 98.72366 FALSE  
## Jefferson-Snohomish 2.8740602 86.30337 FALSE  
## Jefferson-Thurston 30.9285714 96.39259 FALSE  
## Jefferson-Whatcom 65.7723214 89.67022 FALSE  
## King-Kitsap 21.5100251 77.58096 FALSE  
## King-Mason 18.1952381 94.14187 FALSE  
## King-Pacific 79.7380952 82.83380 FALSE  
## King-Pierce 57.6679198 77.58096 FALSE  
## King-San Juan 28.2797619 73.21543 FALSE  
## King-Skagit 12.5952381 91.19701 FALSE  
## King-Snohomish 15.6478697 77.58096 FALSE  
## King-Thurston 18.1547619 88.66829 FALSE  
## King-Whatcom 52.9985119 81.30979 FALSE  
## Kitsap-Mason 39.7052632 95.72686 FALSE  
## Kitsap-Pacific 58.2280702 84.63084 FALSE  
## Kitsap-Pierce 36.1578947 79.49683 FALSE  
## Kitsap-San Juan 6.7697368 75.24254 FALSE  
## Kitsap-Skagit 34.1052632 92.83230 FALSE  
## Kitsap-Snohomish 37.1578947 79.49683 FALSE  
## Kitsap-Thurston 3.3552632 90.34935 FALSE  
## Kitsap-Whatcom 31.4884868 83.13977 FALSE  
## Mason-Pacific 97.9333333 100.03132 FALSE  
## Mason-Pierce 75.8631579 95.72686 FALSE  
## Mason-San Juan 46.4750000 92.22432 FALSE  
## Mason-Skagit 5.6000000 107.05943 FALSE  
## Mason-Snohomish 2.5473684 95.72686 FALSE  
## Mason-Thurston 36.3500000 104.91373 FALSE  
## Mason-Whatcom 71.1937500 98.77301 FALSE  
## Pacific-Pierce 22.0701754 84.63084 FALSE  
## Pacific-San Juan 51.4583333 80.64783 FALSE  
## Pacific-Skagit 92.3333333 97.26494 FALSE  
## Pacific-Snohomish 95.3859649 84.63084 TRUE  
## Pacific-Thurston 61.5833333 94.89804 FALSE  
## Pacific-Whatcom 26.7395833 88.06165 FALSE  
## Pierce-San Juan 29.3881579 75.24254 FALSE  
## Pierce-Skagit 70.2631579 92.83230 FALSE  
## Pierce-Snohomish 73.3157895 79.49683 FALSE  
## Pierce-Thurston 39.5131579 90.34935 FALSE  
## Pierce-Whatcom 4.6694079 83.13977 FALSE  
## San Juan-Skagit 40.8750000 89.21619 FALSE  
## San Juan-Snohomish 43.9276316 75.24254 FALSE  
## San Juan-Thurston 10.1250000 86.62966 FALSE  
## San Juan-Whatcom 24.7187500 79.08170 FALSE  
## Skagit-Snohomish 3.0526316 92.83230 FALSE  
## Skagit-Thurston 30.7500000 102.27949 FALSE  
## Skagit-Whatcom 65.5937500 95.97037 FALSE  
## Snohomish-Thurston 33.8026316 90.34935 FALSE  
## Snohomish-Whatcom 68.6463816 83.13977 FALSE  
## Thurston-Whatcom 34.8437500 93.57073 FALSE

posthoc.kruskal.nemenyi.test(cnt ~ County, WAHI\_bycounty, dist = "Chisquare")

##   
## Pairwise comparisons using Nemenyi-test with Chi-squared   
## approximation for independent samples   
##   
## data: cnt by County   
##   
## Clallam Clark Cowlitz Grays Harbor Island Jefferson King  
## Clark 1.00 - - - - - -   
## Cowlitz 1.00 1.00 - - - - -   
## Grays Harbor 1.00 1.00 1.00 - - - -   
## Island 1.00 1.00 1.00 1.00 - - -   
## Jefferson 1.00 1.00 1.00 1.00 1.00 - -   
## King 1.00 1.00 1.00 1.00 1.00 1.00 -   
## Kitsap 1.00 1.00 1.00 1.00 1.00 1.00 1.00  
## Mason 1.00 1.00 1.00 1.00 1.00 1.00 1.00  
## Pacific 0.82 1.00 1.00 1.00 0.78 0.55 0.66  
## Pierce 0.99 1.00 1.00 1.00 0.98 0.89 0.95  
## San Juan 1.00 1.00 1.00 1.00 1.00 1.00 1.00  
## Skagit 1.00 1.00 1.00 1.00 1.00 1.00 1.00  
## Snohomish 1.00 1.00 1.00 0.99 1.00 1.00 1.00  
## Thurston 1.00 1.00 1.00 1.00 1.00 1.00 1.00  
## Whatcom 1.00 1.00 1.00 1.00 0.99 0.95 0.99  
## Kitsap Mason Pacific Pierce San Juan Skagit Snohomish  
## Clark - - - - - - -   
## Cowlitz - - - - - - -   
## Grays Harbor - - - - - - -   
## Island - - - - - - -   
## Jefferson - - - - - - -   
## King - - - - - - -   
## Kitsap - - - - - - -   
## Mason 1.00 - - - - - -   
## Pacific 0.97 0.62 - - - - -   
## Pierce 1.00 0.91 1.00 - - - -   
## San Juan 1.00 1.00 0.99 1.00 - - -   
## Skagit 1.00 1.00 0.68 0.94 1.00 - -   
## Snohomish 1.00 1.00 0.33 0.73 1.00 1.00 -   
## Thurston 1.00 1.00 0.99 1.00 1.00 1.00 1.00   
## Whatcom 1.00 0.96 1.00 1.00 1.00 0.98 0.88   
## Thurston  
## Clark -   
## Cowlitz -   
## Grays Harbor -   
## Island -   
## Jefferson -   
## King -   
## Kitsap -   
## Mason -   
## Pacific -   
## Pierce -   
## San Juan -   
## Skagit -   
## Snohomish -   
## Thurston -   
## Whatcom 1.00   
##   
## P value adjustment method: none

* Is there a statistical difference in strandings and HI across counties? (OR)

#All strandings, OR  
allOR\_bycounty <- pinnipeds\_data %>%   
 filter(County != 'NA' & County != 'Unknown' & State == 'OR') %>%   
 transform(County = factor(County)) %>%  
 group\_by(County, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# <--- K-W show strandings higher in Lincoln  
kruskal.test(allOR\_bycounty)

##   
## Kruskal-Wallis rank sum test  
##   
## data: allOR\_bycounty  
## Kruskal-Wallis chi-squared = 389.05, df = 2, p-value < 2.2e-16

posthoc.kruskal.nemenyi.test(cnt ~ County, allOR\_bycounty, dist = "Chisquare")

##   
## Pairwise comparisons using Nemenyi-test with Chi-squared   
## approximation for independent samples   
##   
## data: cnt by County   
##   
## Clackamas Clatsop Columbia Coos Curry Douglas Lane   
## Clatsop 0.41964 - - - - - -   
## Columbia 1.00000 0.32357 - - - - -   
## Coos 0.64209 0.99992 0.53815 - - - -   
## Curry 0.86914 0.97226 0.79817 0.99973 - - -   
## Douglas 0.99914 0.30216 0.99703 0.65655 0.96083 - -   
## Lane 0.93464 0.85483 0.88660 0.99109 1.00000 0.99357 -   
## Lincoln 0.00545 0.22055 0.00278 0.02799 0.00197 7.0e-06 0.00016  
## Multnomah 1.00000 0.04643 1.00000 0.16105 0.49418 0.99368 0.67154  
## Tillamook 0.74054 0.99844 0.64442 1.00000 1.00000 0.81495 0.99912  
## Lincoln Multnomah  
## Clatsop - -   
## Columbia - -   
## Coos - -   
## Curry - -   
## Douglas - -   
## Lane - -   
## Lincoln - -   
## Multnomah 1.2e-06 -   
## Tillamook 0.01058 0.26501   
##   
## P value adjustment method: none

#HI strandings, OR  
ORHI\_bycounty <- pinnipeds\_data %>%   
 filter(County != 'NA' & State == 'OR' &   
 Findings.of.Human.Interaction == 'Y' &   
 Interaction.Type != 'NA') %>%   
 transform(County = factor(County)) %>%  
 group\_by(County, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
  
# <--- K-W shows Clatsop, Lincoln  
kruskal.test(ORHI\_bycounty)

##   
## Kruskal-Wallis rank sum test  
##   
## data: ORHI\_bycounty  
## Kruskal-Wallis chi-squared = 248.63, df = 2, p-value < 2.2e-16

posthoc.kruskal.nemenyi.test(cnt ~ County, ORHI\_bycounty, dist = "Tukey")

##   
## Pairwise comparisons using Tukey and Kramer (Nemenyi) test   
## with Tukey-Dist approximation for independent samples   
##   
## data: cnt by County   
##   
## Clackamas Clatsop Columbia Coos Curry Douglas Lane   
## Clatsop 0.69116 - - - - - -   
## Columbia 0.99996 0.01800 - - - - -   
## Coos 1.00000 0.02212 0.93890 - - - -   
## Curry 0.99999 0.00014 1.00000 0.80442 - - -   
## Douglas 0.99996 0.01800 1.00000 0.93890 1.00000 - -   
## Lane 1.00000 0.00042 0.99992 0.98097 0.99993 0.99992 -   
## Lincoln 0.75802 1.00000 0.02447 0.02706 0.00016 0.02447 0.00044  
## Multnomah 1.00000 0.02294 1.00000 0.98550 1.00000 1.00000 1.00000  
## Tillamook 1.00000 0.07271 0.92033 1.00000 0.77513 0.92033 0.97038  
## Unknown 0.99947 1.00000 0.96696 0.99990 0.96868 0.96696 0.99292  
## Lincoln Multnomah Tillamook  
## Clatsop - - -   
## Columbia - - -   
## Coos - - -   
## Curry - - -   
## Douglas - - -   
## Lane - - -   
## Lincoln - - -   
## Multnomah 0.03115 - -   
## Tillamook 0.09452 0.97754 -   
## Unknown 1.00000 0.98704 0.99996   
##   
## P value adjustment method: none

* Are specific types of HI cases increasing or decreasing in certain counties?

# Are gunshot, entanglements, or boat collisions increasing in certain counties?   
  
#Washington  
WAHI\_type\_yr <- pinnipeds\_data %>%   
 filter(County != 'NA' & State == 'WA' &   
 Findings.of.Human.Interaction == 'Y' &   
 Interaction.Type != 'NA') %>%   
 transform(County = factor(County)) %>%  
 group\_by(County, Year.of.Observation, Interaction.Type) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# <--- Shows increasing in Grays, Pacific, Pierce, CLallam, Whatcom?  
WAHI\_yr\_model <- glm(cnt ~ County + Year.of.Observation, family = poisson(link = log), WAHI\_type\_yr)  
summary(WAHI\_yr\_model)

##   
## Call:  
## glm(formula = cnt ~ County + Year.of.Observation, family = poisson(link = log),   
## data = WAHI\_type\_yr)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.2666 -0.8764 -0.3983 0.2066 9.8069   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -6.830e+01 1.018e+01 -6.707 1.98e-11 \*\*\*  
## CountyClark 3.019e-04 4.299e-01 0.001 0.9994   
## CountyCowlitz 2.973e-01 4.307e-01 0.690 0.4900   
## CountyGrays Harbor 7.045e-01 1.669e-01 4.221 2.43e-05 \*\*\*  
## CountyIsland -1.422e-02 1.949e-01 -0.073 0.9418   
## CountyJefferson 2.179e-01 2.102e-01 1.037 0.3000   
## CountyKing 2.898e-01 1.800e-01 1.610 0.1075   
## CountyKitsap 2.307e-01 1.799e-01 1.282 0.1997   
## CountyMason -2.557e-01 2.657e-01 -0.962 0.3358   
## CountyPacific 7.491e-01 1.594e-01 4.699 2.61e-06 \*\*\*  
## CountyPierce 8.177e-01 1.552e-01 5.270 1.36e-07 \*\*\*  
## CountySan Juan 2.582e-01 1.729e-01 1.493 0.1354   
## CountySkagit -1.495e-01 2.516e-01 -0.594 0.5524   
## CountySnohomish -2.212e-01 2.158e-01 -1.025 0.3054   
## CountyThurston 9.594e-02 2.029e-01 0.473 0.6363   
## CountyWhatcom 3.254e-01 1.706e-01 1.908 0.0564 .   
## Year.of.Observation 3.431e-02 5.071e-03 6.766 1.32e-11 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 808.85 on 401 degrees of freedom  
## Residual deviance: 638.39 on 385 degrees of freedom  
## AIC: 1681.1  
##   
## Number of Fisher Scoring iterations: 5

# (Intercept) -6.830e+01 1.018e+01 -6.707 1.98e-11 \*\*\*  
# CountyGrays Harbor 7.045e-01 1.669e-01 4.221 2.43e-05 \*\*\* y = 2.02x  
# CountyPacific 7.491e-01 1.594e-01 4.699 2.61e-06 \*\*\* y = 2.1x  
# CountyPierce 8.177e-01 1.552e-01 5.270 1.36e-07 \*\*\* y = 2.3x  
# Year.of.Observation 3.431e-02 5.071e-03 6.766 1.32e-11 \*\*\* y = 1.0x  
  
# <--- Shows only "other" increasing in Pierce?  
WAHI\_type\_yr\_model <- glm(cnt ~ County\*Interaction.Type, family = poisson(link = log), WAHI\_type\_yr)  
summary(WAHI\_type\_yr\_model)

##   
## Call:  
## glm(formula = cnt ~ County \* Interaction.Type, family = poisson(link = log),   
## data = WAHI\_type\_yr)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -3.1371 -0.6741 -0.3022 0.3417 8.1211   
##   
## Coefficients: (10 not defined because of singularities)  
## Estimate Std. Error z value  
## (Intercept) 0.40547 0.57735 0.702  
## CountyClark 0.23361 0.46829 0.499  
## CountyCowlitz 0.63908 0.46829 1.365  
## CountyGrays Harbor 0.47427 0.24148 1.964  
## CountyIsland 0.28768 0.67700 0.425  
## CountyJefferson -0.40547 0.91287 -0.444  
## CountyKing 0.12338 0.26972 0.457  
## CountyKitsap 0.28768 0.25036 1.149  
## CountyMason -0.22314 0.38490 -0.580  
## CountyPacific -0.40547 1.15470 -0.351  
## CountyPierce -0.18232 0.73030 -0.250  
## CountySan Juan -0.11778 0.64550 -0.182  
## CountySkagit -0.40547 0.91287 -0.444  
## CountySnohomish -0.40547 1.15470 -0.351  
## CountyThurston -0.40547 0.81650 -0.497  
## CountyWhatcom 0.20067 0.65134 0.308  
## Interaction.TypeFisheries -0.25131 0.69007 -0.364  
## Interaction.TypeGunshot 0.05407 0.62126 0.087  
## Interaction.TypeOther 0.40547 0.60858 0.666  
## CountyClark:Interaction.TypeFisheries NA NA NA  
## CountyCowlitz:Interaction.TypeFisheries NA NA NA  
## CountyGrays Harbor:Interaction.TypeFisheries 0.06473 0.60650 0.107  
## CountyIsland:Interaction.TypeFisheries -0.15415 0.85217 -0.181  
## CountyJefferson:Interaction.TypeFisheries 1.45529 1.03740 1.403  
## CountyKing:Interaction.TypeFisheries 0.36910 0.51306 0.719  
## CountyKitsap:Interaction.TypeFisheries 0.11778 0.52627 0.224  
## CountyMason:Interaction.TypeFisheries 0.35667 0.73553 0.485  
## CountyPacific:Interaction.TypeFisheries 1.55060 1.23355 1.257  
## CountyPierce:Interaction.TypeFisheries 0.43364 0.86189 0.503  
## CountySan Juan:Interaction.TypeFisheries 0.65678 0.79433 0.827  
## CountySkagit:Interaction.TypeFisheries 0.25131 1.10733 0.227  
## CountySnohomish:Interaction.TypeFisheries 0.25131 1.26538 0.199  
## CountyThurston:Interaction.TypeFisheries 0.85745 0.94891 0.904  
## CountyWhatcom:Interaction.TypeFisheries -0.20067 0.84259 -0.238  
## CountyClark:Interaction.TypeGunshot NA NA NA  
## CountyCowlitz:Interaction.TypeGunshot NA NA NA  
## CountyGrays Harbor:Interaction.TypeGunshot 0.43144 0.36362 1.187  
## CountyIsland:Interaction.TypeGunshot -0.14108 0.74594 -0.189  
## CountyJefferson:Interaction.TypeGunshot -0.05407 1.04210 -0.052  
## CountyKing:Interaction.TypeGunshot 0.21560 0.41879 0.515  
## CountyKitsap:Interaction.TypeGunshot -0.37252 0.42167 -0.883  
## CountyMason:Interaction.TypeGunshot -0.05407 0.60617 -0.089  
## CountyPacific:Interaction.TypeGunshot 1.77278 1.18214 1.500  
## CountyPierce:Interaction.TypeGunshot 0.28241 0.79598 0.355  
## CountySan Juan:Interaction.TypeGunshot 0.30488 0.71897 0.424  
## CountySkagit:Interaction.TypeGunshot -0.05407 1.37330 -0.039  
## CountySnohomish:Interaction.TypeGunshot 0.19725 1.22355 0.161  
## CountyThurston:Interaction.TypeGunshot 0.63908 0.91886 0.696  
## CountyWhatcom:Interaction.TypeGunshot -0.11366 0.72767 -0.156  
## CountyClark:Interaction.TypeOther NA NA NA  
## CountyCowlitz:Interaction.TypeOther NA NA NA  
## CountyGrays Harbor:Interaction.TypeOther NA NA NA  
## CountyIsland:Interaction.TypeOther -0.81093 0.76073 -1.066  
## CountyJefferson:Interaction.TypeOther 0.69315 0.95812 0.723  
## CountyKing:Interaction.TypeOther NA NA NA  
## CountyKitsap:Interaction.TypeOther NA NA NA  
## CountyMason:Interaction.TypeOther NA NA NA  
## CountyPacific:Interaction.TypeOther 0.16508 1.18905 0.139  
## CountyPierce:Interaction.TypeOther 1.45083 0.76073 1.907  
## CountySan Juan:Interaction.TypeOther 0.35282 0.69335 0.509  
## CountySkagit:Interaction.TypeOther 0.35667 0.96801 0.368  
## CountySnohomish:Interaction.TypeOther 0.02985 1.19549 0.025  
## CountyThurston:Interaction.TypeOther 0.55962 0.86679 0.646  
## CountyWhatcom:Interaction.TypeOther 0.37469 0.69319 0.541  
## Pr(>|z|)   
## (Intercept) 0.4825   
## CountyClark 0.6179   
## CountyCowlitz 0.1723   
## CountyGrays Harbor 0.0495 \*  
## CountyIsland 0.6709   
## CountyJefferson 0.6569   
## CountyKing 0.6474   
## CountyKitsap 0.2505   
## CountyMason 0.5621   
## CountyPacific 0.7255   
## CountyPierce 0.8029   
## CountySan Juan 0.8552   
## CountySkagit 0.6569   
## CountySnohomish 0.7255   
## CountyThurston 0.6195   
## CountyWhatcom 0.7580   
## Interaction.TypeFisheries 0.7157   
## Interaction.TypeGunshot 0.9306   
## Interaction.TypeOther 0.5053   
## CountyClark:Interaction.TypeFisheries NA   
## CountyCowlitz:Interaction.TypeFisheries NA   
## CountyGrays Harbor:Interaction.TypeFisheries 0.9150   
## CountyIsland:Interaction.TypeFisheries 0.8565   
## CountyJefferson:Interaction.TypeFisheries 0.1607   
## CountyKing:Interaction.TypeFisheries 0.4719   
## CountyKitsap:Interaction.TypeFisheries 0.8229   
## CountyMason:Interaction.TypeFisheries 0.6277   
## CountyPacific:Interaction.TypeFisheries 0.2087   
## CountyPierce:Interaction.TypeFisheries 0.6149   
## CountySan Juan:Interaction.TypeFisheries 0.4083   
## CountySkagit:Interaction.TypeFisheries 0.8205   
## CountySnohomish:Interaction.TypeFisheries 0.8426   
## CountyThurston:Interaction.TypeFisheries 0.3662   
## CountyWhatcom:Interaction.TypeFisheries 0.8118   
## CountyClark:Interaction.TypeGunshot NA   
## CountyCowlitz:Interaction.TypeGunshot NA   
## CountyGrays Harbor:Interaction.TypeGunshot 0.2354   
## CountyIsland:Interaction.TypeGunshot 0.8500   
## CountyJefferson:Interaction.TypeGunshot 0.9586   
## CountyKing:Interaction.TypeGunshot 0.6067   
## CountyKitsap:Interaction.TypeGunshot 0.3770   
## CountyMason:Interaction.TypeGunshot 0.9289   
## CountyPacific:Interaction.TypeGunshot 0.1337   
## CountyPierce:Interaction.TypeGunshot 0.7227   
## CountySan Juan:Interaction.TypeGunshot 0.6715   
## CountySkagit:Interaction.TypeGunshot 0.9686   
## CountySnohomish:Interaction.TypeGunshot 0.8719   
## CountyThurston:Interaction.TypeGunshot 0.4867   
## CountyWhatcom:Interaction.TypeGunshot 0.8759   
## CountyClark:Interaction.TypeOther NA   
## CountyCowlitz:Interaction.TypeOther NA   
## CountyGrays Harbor:Interaction.TypeOther NA   
## CountyIsland:Interaction.TypeOther 0.2864   
## CountyJefferson:Interaction.TypeOther 0.4694   
## CountyKing:Interaction.TypeOther NA   
## CountyKitsap:Interaction.TypeOther NA   
## CountyMason:Interaction.TypeOther NA   
## CountyPacific:Interaction.TypeOther 0.8896   
## CountyPierce:Interaction.TypeOther 0.0565 .  
## CountySan Juan:Interaction.TypeOther 0.6108   
## CountySkagit:Interaction.TypeOther 0.7125   
## CountySnohomish:Interaction.TypeOther 0.9801   
## CountyThurston:Interaction.TypeOther 0.5185   
## CountyWhatcom:Interaction.TypeOther 0.5888   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 808.85 on 401 degrees of freedom  
## Residual deviance: 494.56 on 348 degrees of freedom  
## AIC: 1611.3  
##   
## Number of Fisher Scoring iterations: 6

# Oregon  
ORHI\_type\_bycounty <- pinnipeds\_data %>%   
 filter(County != 'NA' & State == 'OR' &   
 Findings.of.Human.Interaction == 'Y' &   
 Interaction.Type != 'NA') %>%   
 transform(County = factor(County)) %>%  
 group\_by(County, Interaction.Type, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
#Increasing just in Clallam and Clatsop, not changing either way anywhere else  
ORcounty\_HI\_model <- glm(cnt ~ County + Year.of.Observation, family = poisson(link = log), ORHI\_type\_bycounty)  
summary(ORcounty\_HI\_model)

##   
## Call:  
## glm(formula = cnt ~ County + Year.of.Observation, family = poisson(link = log),   
## data = ORHI\_type\_bycounty)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.7282 -0.7325 -0.2628 0.3502 6.6315   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -83.417260 14.821791 -5.628 1.82e-08 \*\*\*  
## CountyClatsop 1.420888 0.582208 2.441 0.0147 \*   
## CountyColumbia -0.307965 0.763899 -0.403 0.6868   
## CountyCoos 0.310173 0.600156 0.517 0.6053   
## CountyCurry -0.174284 0.652260 -0.267 0.7893   
## CountyDouglas -0.150888 0.764627 -0.197 0.8436   
## CountyLane 0.050448 0.622751 0.081 0.9354   
## CountyLincoln 0.720656 0.586127 1.230 0.2189   
## CountyMultnomah -0.041561 0.707788 -0.059 0.9532   
## CountyTillamook 0.184420 0.606191 0.304 0.7610   
## CountyUnknown 1.020158 0.836164 1.220 0.2224   
## Year.of.Observation 0.041630 0.007356 5.660 1.52e-08 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 515.85 on 200 degrees of freedom  
## Residual deviance: 330.90 on 189 degrees of freedom  
## AIC: 848.19  
##   
## Number of Fisher Scoring iterations: 5

# CountyClatsop 1.420888 0.582208 2.441 0.0147 \* y = 4.1x  
# Year.of.Observation 0.041630 0.007356 5.660 1.52e-08 \*\*\* y = 1.0x  
  
# <--- Shows none are significant  
ORHI\_type\_yr\_model <- glm(cnt ~ County\*Interaction.Type, family = poisson(link = log), ORHI\_type\_bycounty)  
summary(ORHI\_type\_yr\_model)

##   
## Call:  
## glm(formula = cnt ~ County \* Interaction.Type, family = poisson(link = log),   
## data = ORHI\_type\_bycounty)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -3.5128 -0.5583 -0.2076 0.2502 5.3271   
##   
## Coefficients: (14 not defined because of singularities)  
## Estimate Std. Error z value  
## (Intercept) -0.25783 0.89400 -0.288  
## CountyClatsop 1.03102 0.93604 1.101  
## CountyColumbia -0.40547 1.15470 -0.351  
## CountyCoos 0.18492 0.86352 0.214  
## CountyCurry -0.37469 1.00378 -0.373  
## CountyDouglas -0.37469 1.29393 -0.290  
## CountyLane -0.37469 1.08362 -0.346  
## CountyLincoln 0.48097 0.83621 0.575  
## CountyMultnomah -0.18232 0.73030 -0.250  
## CountyTillamook -0.08701 0.65134 -0.134  
## CountyUnknown -0.40547 1.15470 -0.351  
## Interaction.TypeFisheries 1.35644 1.40211 0.967  
## Interaction.TypeGunshot 0.66329 0.68258 0.972  
## Interaction.TypeOther 0.63252 0.35355 1.789  
## CountyClatsop:Interaction.TypeFisheries -1.06179 1.44017 -0.737  
## CountyColumbia:Interaction.TypeFisheries -0.69315 1.68325 -0.412  
## CountyCoos:Interaction.TypeFisheries -0.77271 1.40677 -0.549  
## CountyCurry:Interaction.TypeFisheries -0.72392 1.58353 -0.457  
## CountyDouglas:Interaction.TypeFisheries -0.72392 1.95982 -0.369  
## CountyLane:Interaction.TypeFisheries -0.52325 1.55943 -0.336  
## CountyLincoln:Interaction.TypeFisheries -0.48097 1.37152 -0.351  
## CountyMultnomah:Interaction.TypeFisheries -0.91629 1.64317 -0.558  
## CountyTillamook:Interaction.TypeFisheries -0.50078 1.28747 -0.389  
## CountyUnknown:Interaction.TypeFisheries NA NA NA  
## CountyClatsop:Interaction.TypeGunshot 0.80548 0.74100 1.087  
## CountyColumbia:Interaction.TypeGunshot NA NA NA  
## CountyCoos:Interaction.TypeGunshot -0.38972 0.70940 -0.549  
## CountyCurry:Interaction.TypeGunshot -0.03077 0.93501 -0.033  
## CountyDouglas:Interaction.TypeGunshot -0.03077 1.35680 -0.023  
## CountyLane:Interaction.TypeGunshot 0.15155 1.00378 0.151  
## CountyLincoln:Interaction.TypeGunshot -0.59876 0.63842 -0.938  
## CountyMultnomah:Interaction.TypeGunshot NA NA NA  
## CountyTillamook:Interaction.TypeGunshot NA NA NA  
## CountyUnknown:Interaction.TypeGunshot NA NA NA  
## CountyClatsop:Interaction.TypeOther -0.79958 0.49737 -1.608  
## CountyColumbia:Interaction.TypeOther NA NA NA  
## CountyCoos:Interaction.TypeOther NA NA NA  
## CountyCurry:Interaction.TypeOther NA NA NA  
## CountyDouglas:Interaction.TypeOther NA NA NA  
## CountyLane:Interaction.TypeOther NA NA NA  
## CountyLincoln:Interaction.TypeOther NA NA NA  
## CountyMultnomah:Interaction.TypeOther NA NA NA  
## CountyTillamook:Interaction.TypeOther NA NA NA  
## CountyUnknown:Interaction.TypeOther NA NA NA  
## Pr(>|z|)   
## (Intercept) 0.7730   
## CountyClatsop 0.2707   
## CountyColumbia 0.7255   
## CountyCoos 0.8304   
## CountyCurry 0.7089   
## CountyDouglas 0.7721   
## CountyLane 0.7295   
## CountyLincoln 0.5652   
## CountyMultnomah 0.8029   
## CountyTillamook 0.8937   
## CountyUnknown 0.7255   
## Interaction.TypeFisheries 0.3333   
## Interaction.TypeGunshot 0.3312   
## Interaction.TypeOther 0.0736 .  
## CountyClatsop:Interaction.TypeFisheries 0.4610   
## CountyColumbia:Interaction.TypeFisheries 0.6805   
## CountyCoos:Interaction.TypeFisheries 0.5828   
## CountyCurry:Interaction.TypeFisheries 0.6476   
## CountyDouglas:Interaction.TypeFisheries 0.7118   
## CountyLane:Interaction.TypeFisheries 0.7372   
## CountyLincoln:Interaction.TypeFisheries 0.7258   
## CountyMultnomah:Interaction.TypeFisheries 0.5771   
## CountyTillamook:Interaction.TypeFisheries 0.6973   
## CountyUnknown:Interaction.TypeFisheries NA   
## CountyClatsop:Interaction.TypeGunshot 0.2770   
## CountyColumbia:Interaction.TypeGunshot NA   
## CountyCoos:Interaction.TypeGunshot 0.5828   
## CountyCurry:Interaction.TypeGunshot 0.9737   
## CountyDouglas:Interaction.TypeGunshot 0.9819   
## CountyLane:Interaction.TypeGunshot 0.8800   
## CountyLincoln:Interaction.TypeGunshot 0.3483   
## CountyMultnomah:Interaction.TypeGunshot NA   
## CountyTillamook:Interaction.TypeGunshot NA   
## CountyUnknown:Interaction.TypeGunshot NA   
## CountyClatsop:Interaction.TypeOther 0.1079   
## CountyColumbia:Interaction.TypeOther NA   
## CountyCoos:Interaction.TypeOther NA   
## CountyCurry:Interaction.TypeOther NA   
## CountyDouglas:Interaction.TypeOther NA   
## CountyLane:Interaction.TypeOther NA   
## CountyLincoln:Interaction.TypeOther NA   
## CountyMultnomah:Interaction.TypeOther NA   
## CountyTillamook:Interaction.TypeOther NA   
## CountyUnknown:Interaction.TypeOther NA   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for poisson family taken to be 1)  
##   
## Null deviance: 515.85 on 200 degrees of freedom  
## Residual deviance: 239.44 on 171 degrees of freedom  
## AIC: 792.73  
##   
## Number of Fisher Scoring iterations: 5

## Categorical/Basic Species, Age and Sex Classes

* Is there a difference in species of strandings and HI cases?

#all strandings  
species <- pinnipeds\_data %>%  
 group\_by(Pinniped.Common.Name) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# <--- Yes, species are different  
kruskal.test(species)

##   
## Kruskal-Wallis rank sum test  
##   
## data: species  
## Kruskal-Wallis chi-squared = 9.8, df = 1, p-value = 0.001745

#HI cases  
species\_HI <- pinnipeds\_data %>%  
 filter(Findings.of.Human.Interaction == 'Y') %>%  
 group\_by(Pinniped.Common.Name) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
# <--- Yes, species are different  
kruskal.test(species\_HI)

##   
## Kruskal-Wallis rank sum test  
##   
## data: species\_HI  
## Kruskal-Wallis chi-squared = 9.8, df = 1, p-value = 0.001745

* Is there a difference in sex of strandings and HI cases?

# Is there a difference in sex of strandings/HI cases?   
   
#All strandings  
Sex\_all\_yr <- pinnipeds\_data %>%  
 filter(Sex == 'Male' | Sex == 'Female') %>%  
 group\_by(Sex, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# <--- Yes, males different (higher) from females  
kruskal.test(Sex\_all\_yr)

##   
## Kruskal-Wallis rank sum test  
##   
## data: Sex\_all\_yr  
## Kruskal-Wallis chi-squared = 115.48, df = 2, p-value < 2.2e-16

kruskalmc(Sex\_all\_yr$cnt ~ Sex\_all\_yr$Sex)

## Multiple comparison test after Kruskal-Wallis   
## p.value: 0.05   
## Comparisons  
## obs.dif critical.dif difference  
## Female-Male 10.44444 8.392064 TRUE

#HI strandings  
Sex\_HI\_yr <- pinnipeds\_data %>%  
 filter(Sex == 'Male' | Sex == 'Female') %>%  
 filter(Findings.of.Human.Interaction == 'Y' & Interaction.Type != 'NA') %>%  
 group\_by(Sex, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# <-- Yes, males different (higher) from females  
kruskal.test(Sex\_HI\_yr)

##   
## Kruskal-Wallis rank sum test  
##   
## data: Sex\_HI\_yr  
## Kruskal-Wallis chi-squared = 114.14, df = 2, p-value < 2.2e-16

kruskalmc(Sex\_HI\_yr$cnt ~ Sex\_HI\_yr$Sex)

## Multiple comparison test after Kruskal-Wallis   
## p.value: 0.05   
## Comparisons  
## obs.dif critical.dif difference  
## Female-Male 10.24593 8.244169 TRUE

# sex\_HI\_model <- glm(cnt ~ Sex, family = poisson(link = log), Sex\_HI\_yr)  
# summary(sex\_HI\_model)

* Is there a difference in sex of strandings across months of the year?

# Is there a difference in sex of strandings in different seasons?  
  
#All strandings  
Sex\_all\_mo <- pinnipeds\_data %>%  
 filter(Sex == 'Male' | Sex == 'Female') %>%  
 group\_by(Sex, Month.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
Sex\_all\_mo\_male <- pinnipeds\_data %>%  
 filter(Sex == 'Male') %>%  
 group\_by(Year.of.Observation, Month.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
Sex\_all\_mo\_fem <- pinnipeds\_data %>%  
 filter(Sex == 'Female') %>%  
 group\_by(Year.of.Observation, Month.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# <--- For females, July is different from Jan through May, whereas for males, July is different from only Jan, Feb (males stranding more in late spring, so broader peak?)  
kruskal.test(Sex\_all\_mo\_fem)

##   
## Kruskal-Wallis rank sum test  
##   
## data: Sex\_all\_mo\_fem  
## Kruskal-Wallis chi-squared = 580.14, df = 2, p-value < 2.2e-16

posthoc.kruskal.nemenyi.test(cnt ~ Month.of.Observation, Sex\_all\_mo\_fem, dist = "Chisquare")

##   
## Pairwise comparisons using Nemenyi-test with Chi-squared   
## approximation for independent samples   
##   
## data: cnt by Month.of.Observation   
##   
## JAN FEB MAR APR MAY JUN JUL AUG   
## FEB 1.00000 - - - - - - -   
## MAR 1.00000 1.00000 - - - - - -   
## APR 1.00000 1.00000 1.00000 - - - - -   
## MAY 1.00000 0.99999 1.00000 1.00000 - - - -   
## JUN 0.85255 0.64235 0.86042 0.66362 0.92620 - - -   
## JUL 0.00351 0.00040 0.00246 0.00020 0.00326 0.64900 - -   
## AUG 0.50482 0.25526 0.49982 0.24926 0.60806 1.00000 0.91802 -   
## SEP 0.93387 0.78556 0.94058 0.80967 0.97610 1.00000 0.41644 0.99989  
## OCT 0.98754 0.93427 0.99028 0.95110 0.99779 1.00000 0.26248 0.99798  
## NOV 1.00000 1.00000 1.00000 1.00000 1.00000 0.76268 0.00082 0.36108  
## DEC 0.99958 0.99998 0.99859 0.99973 0.98603 0.17141 3.7e-06 0.02765  
## SEP OCT NOV   
## FEB - - -   
## MAR - - -   
## APR - - -   
## MAY - - -   
## JUN - - -   
## JUL - - -   
## AUG - - -   
## SEP - - -   
## OCT 1.00000 - -   
## NOV 0.87939 0.97332 -   
## DEC 0.27952 0.53465 0.99964  
##   
## P value adjustment method: none

kruskal.test(Sex\_all\_mo\_male)

##   
## Kruskal-Wallis rank sum test  
##   
## data: Sex\_all\_mo\_male  
## Kruskal-Wallis chi-squared = 641.89, df = 2, p-value < 2.2e-16

posthoc.kruskal.nemenyi.test(cnt ~ Month.of.Observation, Sex\_all\_mo\_male, dist = "Chisquare")

##   
## Pairwise comparisons using Nemenyi-test with Chi-squared   
## approximation for independent samples   
##   
## data: cnt by Month.of.Observation   
##   
## JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV   
## FEB 1.000 - - - - - - - - - -   
## MAR 1.000 1.000 - - - - - - - - -   
## APR 1.000 1.000 1.000 - - - - - - - -   
## MAY 0.965 0.913 0.968 0.999 - - - - - - -   
## JUN 0.940 0.866 0.945 0.998 1.000 - - - - - -   
## JUL 0.048 0.020 0.052 0.243 0.885 0.916 - - - - -   
## AUG 0.849 0.727 0.858 0.990 1.000 1.000 0.973 - - - -   
## SEP 0.943 0.872 0.948 0.999 1.000 1.000 0.912 1.000 - - -   
## OCT 0.985 0.956 0.987 1.000 1.000 1.000 0.807 1.000 1.000 - -   
## NOV 1.000 0.999 1.000 1.000 1.000 1.000 0.407 0.998 1.000 1.000 -   
## DEC 1.000 1.000 1.000 1.000 0.992 0.983 0.110 0.942 0.984 0.997 1.000  
##   
## P value adjustment method: none

* Is there a difference in age class of strandings and HI cases?

# Is there a difference in age class strandings/HI cases?   
  
#all strandings  
age\_all <- pinnipeds\_data %>%  
 group\_by(Age.Class, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# <--- Yes, pups and adults (not different from each other) are different from subadults and yearlings (not different from each other). p < 0.05, difs amount to ~38 animals/yr  
kruskal.test(age\_all)

##   
## Kruskal-Wallis rank sum test  
##   
## data: age\_all  
## Kruskal-Wallis chi-squared = 219.28, df = 2, p-value < 2.2e-16

kruskalmc(age\_all$cnt ~ age\_all$Age.Class)

## Multiple comparison test after Kruskal-Wallis   
## p.value: 0.05   
## Comparisons  
## obs.dif critical.dif difference  
## Pup-Yearling 38.01428571 25.74572 TRUE  
## Pup-Subadult 38.08571429 25.74572 TRUE  
## Pup-Adult 9.93333333 25.29793 FALSE  
## Pup-Unid 12.63333333 22.31068 FALSE  
## Yearling-Subadult 0.07142857 26.18585 FALSE  
## Yearling-Adult 28.08095238 25.74572 TRUE  
## Yearling-Unid 25.38095238 22.81717 TRUE  
## Subadult-Adult 28.15238095 25.74572 TRUE  
## Subadult-Unid 25.45238095 22.81717 TRUE  
## Adult-Unid 2.70000000 22.31068 FALSE

#posthoc.kruskal.nemenyi.test(cnt ~ Age.Class, age\_all, dist = "Chisquare")  
  
#HI strandings  
age\_HI <- pinnipeds\_data %>%  
 filter(Findings.of.Human.Interaction == 'Y') %>%  
 group\_by(Age.Class, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))   
  
# <--- Yes, yearlings significantly different (lower). p < 0.05, difs amount to ~38 animals/yr  
kruskal.test(age\_HI)

##   
## Kruskal-Wallis rank sum test  
##   
## data: age\_HI  
## Kruskal-Wallis chi-squared = 191.31, df = 2, p-value < 2.2e-16

kruskalmc(age\_HI$cnt ~ age\_HI$Age.Class)

## Multiple comparison test after Kruskal-Wallis   
## p.value: 0.05   
## Comparisons  
## obs.dif critical.dif difference  
## Pup-Yearling 30.108333 25.89099 TRUE  
## Pup-Subadult 20.888095 24.84233 FALSE  
## Pup-Adult 8.897619 24.84233 FALSE  
## Pup-Unid 14.011111 21.52782 FALSE  
## Yearling-Subadult 9.220238 26.29874 FALSE  
## Yearling-Adult 39.005952 26.29874 TRUE  
## Yearling-Unid 16.097222 23.19331 FALSE  
## Subadult-Adult 29.785714 25.26702 TRUE  
## Subadult-Unid 6.876984 22.01654 FALSE  
## Adult-Unid 22.908730 22.01654 TRUE

#posthoc.kruskal.nemenyi.test(cnt ~ Age.Class, age\_HI, dist = "Chisquare")

* Is there a difference between ages and sexes?
* Help: would like non-parametric test for multiple categorical variables?

#Differences between ages and sexes?   
age\_sex\_all <- pinnipeds\_data %>%  
 group\_by(Sex, Age.Class, Year.of.Observation) %>%  
 summarize(cnt = n\_distinct(National.Database.Number))  
  
#Need non-parametric version of this, for multiple comparisons :( help  
TukeyHSD(aov(cnt ~ Sex\*Age.Class, data = age\_sex\_all))

## Tukey multiple comparisons of means  
## 95% family-wise confidence level  
##   
## Fit: aov(formula = cnt ~ Sex \* Age.Class, data = age\_sex\_all)  
##   
## $Sex  
## diff lwr upr p adj  
## Male-Female 25.71694 10.01289 41.42100 0.0004266  
## Unid-Female 53.83743 38.13337 69.54148 0.0000000  
## Unid-Male 28.12048 12.61152 43.62945 0.0000821  
##   
## $Age.Class  
## diff lwr upr p adj  
## Yearling-Pup -69.301033 -94.88195 -43.720118 0.0000000  
## Subadult-Pup -70.176006 -95.59479 -44.757224 0.0000000  
## Adult-Pup -17.976744 -43.09110 7.137611 0.2849719  
## Unid-Pup -25.405286 -47.52362 -3.286952 0.0153465  
## Subadult-Yearling -0.874973 -26.75483 25.004882 0.9999830  
## Adult-Yearling 51.324289 25.74337 76.905204 0.0000009  
## Unid-Yearling 43.895747 21.24905 66.542449 0.0000023  
## Adult-Subadult 52.199262 26.78048 77.618045 0.0000005  
## Unid-Subadult 44.770720 22.30732 67.234121 0.0000011  
## Unid-Adult -7.428542 -29.54688 14.689792 0.8876265  
##   
## $`Sex:Age.Class`  
## diff lwr upr  
## Male:Pup-Female:Pup -0.9619048 -5.492600e+01 53.0021870  
## Unid:Pup-Female:Pup 60.1428571 5.256235e+00 115.0294789  
## Female:Yearling-Female:Pup -59.5054945 -1.154377e+02 -3.5733194  
## Male:Yearling-Female:Pup -50.3516484 -1.062838e+02 5.5805268  
## Unid:Yearling-Female:Pup -39.0000000 -9.388662e+01 15.8866217  
## Female:Subadult-Female:Pup -64.8571429 -1.197438e+02 -9.9705211  
## Male:Subadult-Female:Pup -35.3516484 -9.128382e+01 20.5805268  
## Unid:Subadult-Female:Pup -51.3571429 -1.062438e+02 3.5294789  
## Female:Adult-Female:Pup -31.9285714 -8.681519e+01 22.9580503  
## Male:Adult-Female:Pup 53.9714286 7.336785e-03 107.9355204  
## Unid:Adult-Female:Pup -22.0000000 -7.688662e+01 32.8866217  
## Female:Unid-Female:Pup -48.0952381 -9.693097e+01 0.7404915  
## Male:Unid-Female:Pup -36.8730159 -8.469874e+01 10.9527077  
## Unid:Unid-Female:Pup 64.8306878 1.700496e+01 112.6564114  
## Unid:Pup-Male:Pup 61.1047619 7.140670e+00 115.0688537  
## Female:Yearling-Male:Pup -58.5435897 -1.135708e+02 -3.5164131  
## Male:Yearling-Male:Pup -49.3897436 -1.044169e+02 5.6374331  
## Unid:Yearling-Male:Pup -38.0380952 -9.200219e+01 15.9259965  
## Female:Subadult-Male:Pup -63.8952381 -1.178593e+02 -9.9311463  
## Male:Subadult-Male:Pup -34.3897436 -8.941692e+01 20.6374331  
## Unid:Subadult-Male:Pup -50.3952381 -1.043593e+02 3.5688537  
## Female:Adult-Male:Pup -30.9666667 -8.493076e+01 22.9974251  
## Male:Adult-Male:Pup 54.9333333 1.907819e+00 107.9588476  
## Unid:Adult-Male:Pup -21.0380952 -7.500219e+01 32.9259965  
## Female:Unid-Male:Pup -47.1333333 -9.492989e+01 0.6632193  
## Male:Unid-Male:Pup -35.9111111 -8.267522e+01 10.8529968  
## Unid:Unid-Male:Pup 65.7925926 1.902848e+01 112.5567005  
## Female:Yearling-Unid:Pup -119.6483516 -1.755805e+02 -63.7161765  
## Male:Yearling-Unid:Pup -110.4945055 -1.664267e+02 -54.5623304  
## Unid:Yearling-Unid:Pup -99.1428571 -1.540295e+02 -44.2562354  
## Female:Subadult-Unid:Pup -125.0000000 -1.798866e+02 -70.1133783  
## Male:Subadult-Unid:Pup -95.4945055 -1.514267e+02 -39.5623304  
## Unid:Subadult-Unid:Pup -111.5000000 -1.663866e+02 -56.6133783  
## Female:Adult-Unid:Pup -92.0714286 -1.469581e+02 -37.1848069  
## Male:Adult-Unid:Pup -6.1714286 -6.013552e+01 47.7926632  
## Unid:Adult-Unid:Pup -82.1428571 -1.370295e+02 -27.2562354  
## Female:Unid-Unid:Pup -108.2380952 -1.570738e+02 -59.4023656  
## Male:Unid-Unid:Pup -97.0158730 -1.448416e+02 -49.1901495  
## Unid:Unid-Unid:Pup 4.6878307 -4.313789e+01 52.5135542  
## Male:Yearling-Female:Yearling 9.1538462 -4.780469e+01 66.1123853  
## Unid:Yearling-Female:Yearling 20.5054945 -3.542668e+01 76.4376696  
## Female:Subadult-Female:Yearling -5.3516484 -6.128382e+01 50.5805268  
## Male:Subadult-Female:Yearling 24.1538462 -3.280469e+01 81.1123853  
## Unid:Subadult-Female:Yearling 8.1483516 -4.778382e+01 64.0805268  
## Female:Adult-Female:Yearling 27.5769231 -2.835525e+01 83.5090982  
## Male:Adult-Female:Yearling 113.4769231 5.844975e+01 168.5040998  
## Unid:Adult-Female:Yearling 37.5054945 -1.842668e+01 93.4376696  
## Female:Unid-Female:Yearling 11.4102564 -3.859770e+01 61.4182103  
## Male:Unid-Female:Yearling 22.6324786 -2.638963e+01 71.6545839  
## Unid:Unid-Female:Yearling 124.3361823 7.531408e+01 173.3582876  
## Unid:Yearling-Male:Yearling 11.3516484 -4.458053e+01 67.2838235  
## Female:Subadult-Male:Yearling -14.5054945 -7.043767e+01 41.4266806  
## Male:Subadult-Male:Yearling 15.0000000 -4.195854e+01 71.9585392  
## Unid:Subadult-Male:Yearling -1.0054945 -5.693767e+01 54.9266806  
## Female:Adult-Male:Yearling 18.4230769 -3.750910e+01 74.3552521  
## Male:Adult-Male:Yearling 104.3230769 4.929590e+01 159.3502536  
## Unid:Adult-Male:Yearling 28.3516484 -2.758053e+01 84.2838235  
## Female:Unid-Male:Yearling 2.2564103 -4.775154e+01 52.2643642  
## Male:Unid-Male:Yearling 13.4786325 -3.554347e+01 62.5007377  
## Unid:Unid-Male:Yearling 115.1823362 6.616023e+01 164.2044414  
## Female:Subadult-Unid:Yearling -25.8571429 -8.074376e+01 29.0294789  
## Male:Subadult-Unid:Yearling 3.6483516 -5.228382e+01 59.5805268  
## Unid:Subadult-Unid:Yearling -12.3571429 -6.724376e+01 42.5294789  
## Female:Adult-Unid:Yearling 7.0714286 -4.781519e+01 61.9580503  
## Male:Adult-Unid:Yearling 92.9714286 3.900734e+01 146.9355204  
## Unid:Adult-Unid:Yearling 17.0000000 -3.788662e+01 71.8866217  
## Female:Unid-Unid:Yearling -9.0952381 -5.793097e+01 39.7404915  
## Male:Unid-Unid:Yearling 2.1269841 -4.569874e+01 49.9527077  
## Unid:Unid-Unid:Yearling 103.8306878 5.600496e+01 151.6564114  
## Male:Subadult-Female:Subadult 29.5054945 -2.642668e+01 85.4376696  
## Unid:Subadult-Female:Subadult 13.5000000 -4.138662e+01 68.3866217  
## Female:Adult-Female:Subadult 32.9285714 -2.195805e+01 87.8151931  
## Male:Adult-Female:Subadult 118.8285714 6.486448e+01 172.7926632  
## Unid:Adult-Female:Subadult 42.8571429 -1.202948e+01 97.7437646  
## Female:Unid-Female:Subadult 16.7619048 -3.207382e+01 65.5976344  
## Male:Unid-Female:Subadult 27.9841270 -1.984160e+01 75.8098505  
## Unid:Unid-Female:Subadult 129.6878307 8.186211e+01 177.5135542  
## Unid:Subadult-Male:Subadult -16.0054945 -7.193767e+01 39.9266806  
## Female:Adult-Male:Subadult 3.4230769 -5.250910e+01 59.3552521  
## Male:Adult-Male:Subadult 89.3230769 3.429590e+01 144.3502536  
## Unid:Adult-Male:Subadult 13.3516484 -4.258053e+01 69.2838235  
## Female:Unid-Male:Subadult -12.7435897 -6.275154e+01 37.2643642  
## Male:Unid-Male:Subadult -1.5213675 -5.054347e+01 47.5007377  
## Unid:Unid-Male:Subadult 100.1823362 5.116023e+01 149.2044414  
## Female:Adult-Unid:Subadult 19.4285714 -3.545805e+01 74.3151931  
## Male:Adult-Unid:Subadult 105.3285714 5.136448e+01 159.2926632  
## Unid:Adult-Unid:Subadult 29.3571429 -2.552948e+01 84.2437646  
## Female:Unid-Unid:Subadult 3.2619048 -4.557382e+01 52.0976344  
## Male:Unid-Unid:Subadult 14.4841270 -3.334160e+01 62.3098505  
## Unid:Unid-Unid:Subadult 116.1878307 6.836211e+01 164.0135542  
## Male:Adult-Female:Adult 85.9000000 3.193591e+01 139.8640918  
## Unid:Adult-Female:Adult 9.9285714 -4.495805e+01 64.8151931  
## Female:Unid-Female:Adult -16.1666667 -6.500240e+01 32.6690629  
## Male:Unid-Female:Adult -4.9444444 -5.277017e+01 42.8812791  
## Unid:Unid-Female:Adult 96.7592593 4.893354e+01 144.5849828  
## Unid:Adult-Male:Adult -75.9714286 -1.299355e+02 -22.0073368  
## Female:Unid-Male:Adult -102.0666667 -1.498632e+02 -54.2701140  
## Male:Unid-Male:Adult -90.8444444 -1.376086e+02 -44.0803365  
## Unid:Unid-Male:Adult 10.8592593 -3.590485e+01 57.6233672  
## Female:Unid-Unid:Adult -26.0952381 -7.493097e+01 22.7404915  
## Male:Unid-Unid:Adult -14.8730159 -6.269874e+01 32.9527077  
## Unid:Unid-Unid:Adult 86.8306878 3.900496e+01 134.6564114  
## Male:Unid-Female:Unid 11.2222222 -2.951703e+01 51.9614794  
## Unid:Unid-Female:Unid 112.9259259 7.218667e+01 153.6651831  
## Unid:Unid-Male:Unid 101.7037037 6.218082e+01 141.2265885  
## p adj  
## Male:Pup-Female:Pup 1.0000000  
## Unid:Pup-Female:Pup 0.0173056  
## Female:Yearling-Female:Pup 0.0249943  
## Male:Yearling-Female:Pup 0.1301828  
## Unid:Yearling-Female:Pup 0.4907500  
## Female:Subadult-Female:Pup 0.0060136  
## Male:Subadult-Female:Pup 0.6878140  
## Unid:Subadult-Female:Pup 0.0943830  
## Female:Adult-Female:Pup 0.7995896  
## Male:Adult-Female:Pup 0.0499294  
## Unid:Adult-Female:Pup 0.9887755  
## Female:Unid-Female:Pup 0.0584216  
## Male:Unid-Female:Pup 0.3470118  
## Unid:Unid-Female:Pup 0.0005420  
## Unid:Pup-Male:Pup 0.0111639  
## Female:Yearling-Male:Pup 0.0249896  
## Male:Yearling-Male:Pup 0.1332630  
## Unid:Yearling-Male:Pup 0.5050405  
## Female:Subadult-Male:Pup 0.0058326  
## Male:Subadult-Male:Pup 0.7046826  
## Unid:Subadult-Male:Pup 0.0960107  
## Female:Adult-Male:Pup 0.8150723  
## Male:Adult-Male:Pup 0.0340840  
## Unid:Adult-Male:Pup 0.9913866  
## Female:Unid-Male:Pup 0.0576627  
## Male:Unid-Male:Pup 0.3538004  
## Unid:Unid-Male:Pup 0.0002505  
## Female:Yearling-Unid:Pup 0.0000000  
## Male:Yearling-Unid:Pup 0.0000000  
## Unid:Yearling-Unid:Pup 0.0000003  
## Female:Subadult-Unid:Pup 0.0000000  
## Male:Subadult-Unid:Pup 0.0000017  
## Unid:Subadult-Unid:Pup 0.0000000  
## Female:Adult-Unid:Pup 0.0000029  
## Male:Adult-Unid:Pup 1.0000000  
## Unid:Adult-Unid:Pup 0.0000612  
## Female:Unid-Unid:Pup 0.0000000  
## Male:Unid-Unid:Pup 0.0000000  
## Unid:Unid-Unid:Pup 1.0000000  
## Male:Yearling-Female:Yearling 0.9999998  
## Unid:Yearling-Female:Yearling 0.9953038  
## Female:Subadult-Female:Yearling 1.0000000  
## Male:Subadult-Female:Yearling 0.9811423  
## Unid:Subadult-Female:Yearling 0.9999999  
## Female:Adult-Female:Yearling 0.9340803  
## Male:Adult-Female:Yearling 0.0000000  
## Unid:Adult-Female:Yearling 0.5922309  
## Female:Unid-Female:Yearling 0.9999787  
## Male:Unid-Female:Yearling 0.9608078  
## Unid:Unid-Female:Yearling 0.0000000  
## Unid:Yearling-Male:Yearling 0.9999951  
## Female:Subadult-Male:Yearling 0.9998988  
## Male:Subadult-Male:Yearling 0.9998786  
## Unid:Subadult-Male:Yearling 1.0000000  
## Female:Adult-Male:Yearling 0.9984638  
## Male:Adult-Male:Yearling 0.0000001  
## Unid:Adult-Male:Yearling 0.9189658  
## Female:Unid-Male:Yearling 1.0000000  
## Male:Unid-Male:Yearling 0.9997984  
## Unid:Unid-Male:Yearling 0.0000000  
## Female:Subadult-Unid:Yearling 0.9538120  
## Male:Subadult-Unid:Yearling 1.0000000  
## Unid:Subadult-Unid:Yearling 0.9999819  
## Female:Adult-Unid:Yearling 1.0000000  
## Male:Adult-Unid:Yearling 0.0000013  
## Unid:Adult-Unid:Yearling 0.9992162  
## Female:Unid-Unid:Yearling 0.9999984  
## Male:Unid-Unid:Yearling 1.0000000  
## Unid:Unid-Unid:Yearling 0.0000000  
## Male:Subadult-Female:Subadult 0.8924210  
## Unid:Subadult-Female:Subadult 0.9999465  
## Female:Adult-Female:Subadult 0.7615006  
## Male:Adult-Female:Subadult 0.0000000  
## Unid:Adult-Female:Subadult 0.3256766  
## Female:Unid-Female:Subadult 0.9976188  
## Male:Unid-Female:Subadult 0.7927010  
## Unid:Unid-Female:Subadult 0.0000000  
## Unid:Subadult-Male:Subadult 0.9996797  
## Female:Adult-Male:Subadult 1.0000000  
## Male:Adult-Male:Subadult 0.0000074  
## Unid:Adult-Male:Subadult 0.9999628  
## Female:Unid-Male:Subadult 0.9999180  
## Male:Unid-Male:Subadult 1.0000000  
## Unid:Unid-Male:Subadult 0.0000000  
## Female:Adult-Unid:Subadult 0.9967168  
## Male:Adult-Unid:Subadult 0.0000000  
## Unid:Adult-Unid:Subadult 0.8817804  
## Female:Unid-Unid:Subadult 1.0000000  
## Male:Unid-Unid:Subadult 0.9993900  
## Unid:Unid-Unid:Subadult 0.0000000  
## Male:Adult-Female:Adult 0.0000127  
## Unid:Adult-Female:Adult 0.9999989  
## Female:Unid-Female:Adult 0.9983785  
## Male:Unid-Female:Adult 1.0000000  
## Unid:Unid-Female:Adult 0.0000000  
## Unid:Adult-Male:Adult 0.0002470  
## Female:Unid-Male:Adult 0.0000000  
## Male:Unid-Male:Adult 0.0000000  
## Unid:Unid-Male:Adult 0.9999735  
## Female:Unid-Unid:Adult 0.8825565  
## Male:Unid-Unid:Adult 0.9991802  
## Unid:Unid-Unid:Adult 0.0000002  
## Male:Unid-Female:Unid 0.9997939  
## Unid:Unid-Female:Unid 0.0000000  
## Unid:Unid-Male:Unid 0.0000000

# kruskalmc(age\_sex\_all$cnt ~ age\_sex\_all$Age.Class\*age\_sex\_all$Sex)  
# posthoc.kruskal.nemenyi.test(cnt ~ Age.Class + Sex, age\_sex\_all, dist = "Chisquare")