

• 2.7 – [10 pts]

1. The individuals appear to be independent because the tanks were placed randomly and two treatments were not placed on a single tile. There is weak evidence for a non-constant variance (Levene's $p=0.0790$) and the residuals do not appear to be normally distributed (Anderson-Darling $p=0.0101$; **Figure B.4**). There is evidence for a significant outlier (outlier test $p=0.0001$). The assumptions do not appear to be met on the original scale.

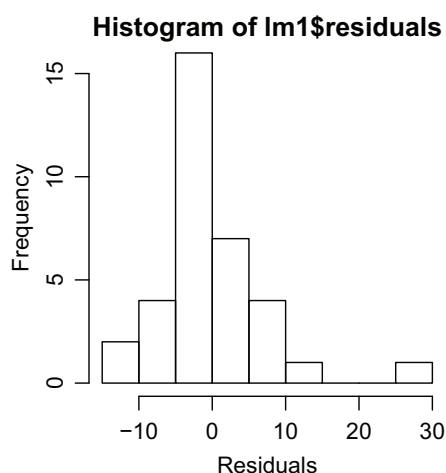


Figure B.4: Histograms of residuals from the one-way ANOVA of grazing level by treatment.

2. A log transformation for the response variable was selected through a trial-and-error method. With this transformation the variances are approximately equal (Levene's $p=0.5112$) and the residuals are approximately normal (Anderson-Darling $p=0.9172$) on this scale. In addition, there are no significant outliers on this scale (outlier test $p > 1$).
3. The one-way ANOVA results indicate strong evidence for a difference in mean natural log of algal biovolumes among the five treatments ($p=0.0017$; **Table B.11**).

Table B.11: Analysis of variance table for log-transformed crayfish grazing by treatment.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
group	4	7.2149	1.8037	9.1656	5.818e-05
Residuals	30	5.9038	0.1968		
Total	34	13.1187			

4. Dunnett's results show that all grazers, except for *Orconectes rusticus* ($p=0.0500$), significantly reduced the algal biovolume relative to the control treatment ($p \leq 0.0034$). It should be noted that *Orconectes rusticus* is just barely insignificant using an $\alpha = 0.05$.

Table B.12: Dunnett's multiple comparison results for the log-transformed crayfish levels by treatment.

	Estimate	Std. Error	t value	p value
Op - Control = 0	-0.8712119	0.2371216	-3.674115	3.446009e-03
Or - Control = 0	-0.6114657	0.2371216	-2.578701	4.997757e-02
Ov - Control = 0	-1.2460645	0.2371216	-5.254960	3.442947e-05
Am - Control = 0	-1.1904029	0.2371216	-5.020221	5.753114e-05

5. *Orconectes virilis* 0.63 and 1.86 more algal biovolume than the control group on average on the natural log scale. The ratio of mean algal biovolume for *Orconectes virilis* relative to the control treatment is between 0.16 and 0.53. Thus, the *Orconectes virilis* appears to have removed between 0.47 and 0.84% of the algal biovolume.

R commands

```
> data <- c(16.7, 59.2, 30.2, 20.2, 17.6, 24.3, 38.5, 10, 10.9, 10.2,
+         14.7, 16.5, 8.8, 9.4, 26.3, 6.5, 14.6, 16.8, 22.4, 11.8, 12.4, 3.3,
+         8.5, 5.1, 6.4, 13.3, 8.1, 16.4, 8.6, 15, 5.5, 4.3, 10.7, 6.2, 11.8)
> group <- rep(c("Control", "Op", "Or", "Ov", "Am"), each = 7)
> group <- factor(group, levels = c("Control", "Op", "Or", "Ov", "Am"))
> d <- data.frame(data, group)
> attach(d)
> lm1 <- lm(data ~ group)
> levene.test(lm1)
> residual.plot(lm1)
> ad.test(lm1$residuals)
> hist(lm1$residuals)
> trans.chooser(lm1)
> detach(d)
> d$logdata <- log(data)
> attach(d)
> lm2 <- lm(log.data ~ group)
> levene.test(lm2)
> residual.plot(lm2)
> ad.test(lm2$residuals)
> hist(lm2$residuals)
> outlier.test(lm2)
> anova(lm2)
> mc2 <- glht(lm2, mcp(group = "Dunnett"))
> confint(mc2)
```