Appendix 9.D. Intensive Submerged Aquatic Vegetation Monitoring in the Lower St. Johns River Basin

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Introduction

There has been recent interest in the effect potential increases in salinity would have on biological habitats within the Lower St. Johns River (LSJR). Specifically, submerged aquatic vegetation (SAV) habitat, which in the LSJR is made up of predominantly freshwater and brackish species, may be adversely impacted by upward shifts in salinity levels. In addition, the time-lag response of LSJR SAV to salinity fluctuations is unknown on a short temporal scale. In an effort to address these issues, an intensive monitoring program was designed and conducted by the St. Johns River Water Management District.

Methodology

The April to September SAV growing season was monitored on a weekly basis during 2008 and 2009 at a poikilohaline and a freshwater site (figure 1). A 10 by 10 point equidistant transect grid system was used to determine changes in grassbed condition. Starting from a fixed benchmark near shore and measuring out to edge of grassbed determined the length and width of the grid. Each transect was then divided into increments of ten to determine sample point spacing along a transect and between transects. At each point, canopy height, percent cover and water depth was measured. Water temperature, conductance, DO and pH were also collected. In addition, a USGS permanent monitoring station recorded conductivity every 15 minutes at a nearby bridge site. Salinity was calculated with conductivity values using a conversion from USGS (Schemel, 2001).

Statistical analysis included bivariate plots, and correlations. Graphs were first plotted showing average daily salinity versus average of the percent coverage. The percent cover was calculated by taking the percent cover at each individual point and then averaging them for one number per date. A second set of graphs show a comparison of the average daily salinity and the biomass index. The biomass index was calculated as the product of the average canopy height and the average percent cover at each point.

For each sampling event, an average of the percent cover was ranked using the Spearman Ranking Method. This rank was then correlated to the rank of the seven-day average salinity prior to and including the sampling date using a Pearson correlation test.

A second type of correlation used data from independent zones within the grassbed. Three zones were defined (see table 1) within the entire grassbed parallel to shore based on percent coverage. Zone 1 was closest to shore, zone 2 was the middle section and zone 3 was the outer edge of the grassbed. Averaged percent coverage within each zone was then correlated with salinity. The same procedure was applied to the biomass index as in the percent cover analysis.

Results

In 2008, salinity at Buckman averaged from five to 10 (figure 2). Following a tropical storm, salinity spiked rapidly on August 23rd reaching just over 16. Salinity rapidly declined to just under 1 where it leveled off for the rest of the sampling season. In response, the percent cover followed the salinity spike decreased just 2 weeks following the salinity spike. The biomass index (figure 3) followed the same pattern following the salinity spike in the later part of the season.

At Orangedale, the same tropical storm led to a lower spike in salinity (figure 4), in comparison to the downstream site, only reaching 1.5. Percent cover and biomass index (figure 5) both decreased very slightly following this event, although never dropping below the average of the sampling season.

At Buckman, statistical correlations (figures 10-17) showed there was no significant relationship between biomass and salinity, however in the overall percent cover of the grassbed there was a significant relationship ($p = 0.02$). At Orangedale, the overall percent cover was significantly related to salinity ($p = 0.03$). Zones one and two (shore and middle) were not significant; however zone 3 had a significant relationship ($p = 0.04$). With the exception of zone one, biomass at Orangedale (figures 18-25) was significantly correlated with salinity.

In 2009, salinity spikes occurred earlier in the growing season in late May reaching just over 25 at Buckman (figure 6 and 7) and 7.5 at Orangedale (figure 8, 9). There was no decrease in either percent cover or biomass following the salinity spike at Buckman; instead, SAV demonstrated a slow increase in both parameters.. However, at Orangedale, following the spike there was a decline in percent cover until the end of the growing season.

Correlations (Buckman figures 26-29 and Orangedale figures 34-37) show that percent cover was not significant, however in certain areas for biomass. At Buckman (figures 30-33), biomass was significant a p-value of 0.053 along with zones 2 and 3 (middle and outer edge) with p-values of 0.059 and 0.014 respectively. Orangedale biomass (figures 38-41) showed significance only at zone 1 with a p-value of 0.029

Discussion

Plots show a change in percent cover and biomass index following spikes in salinity in 2008. However, many other factors may have contributed to this decrease in coverage such as light, temperature and turbidity. This could account for the non-significant p-value in the majority of the correlations. The outer zones were marginally related to salinity, but SAV in zones closer to shore were not significantly related. This suggests that the deep, outer zone is more susceptible to stressful perturbations, including salinity and other water quality parameters.

It was interesting to note the magnitude of change in the SAV community over short intervals. For example, percent cover at the Buckman site changed by up to 50% within just a week (Fig. 2 & 6). Changes at the Orangedale site were similarly dramatic but of slightly smaller magnitude. Weekly percent cover changed by up to 35% (Fig. 4 & 8). Correlation coefficients suggest that up to 26% of this change was explained by abrupt changes in salinity, particularly in the deeper grassbed zone. The smaller magnitude changes in percent cover at Orangedale, where salinity was lower, reinforced the idea that salinity was causing some level of effect on the SAV. However, it is clear that salinity is not the only stressful perturbation influencing the SAV.

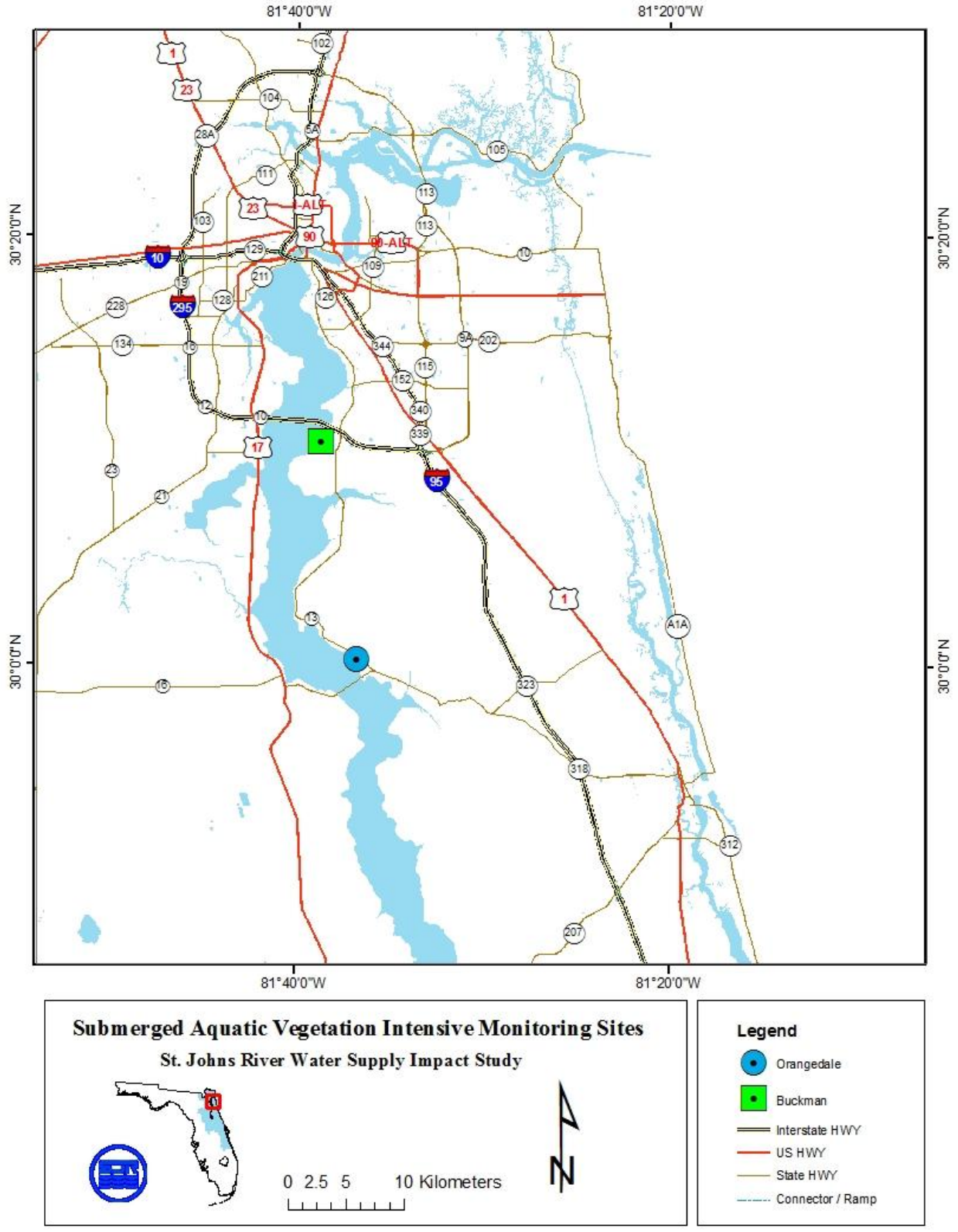

Figure 1. Submerged Aquatic Vegetation Intensive sampling sites.

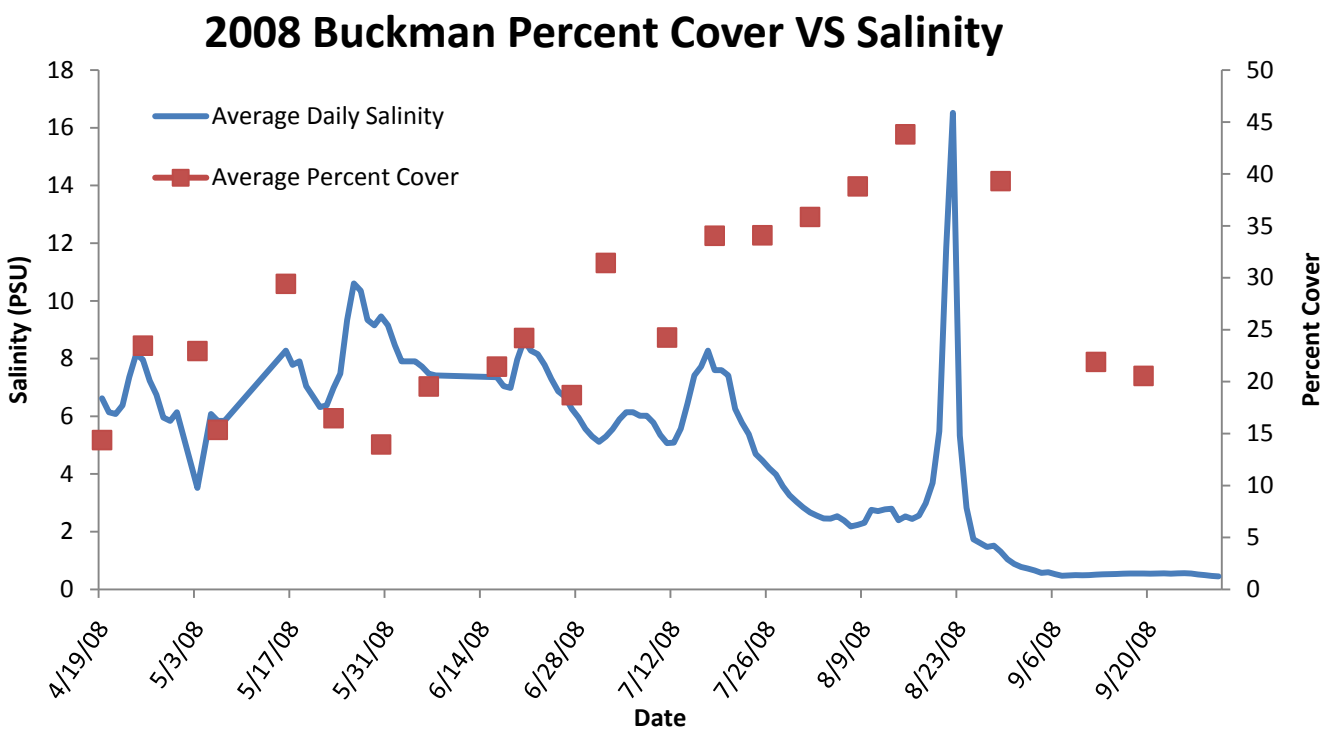

Figure 2. 2008 Buckman percent cover versus average daily salinity.

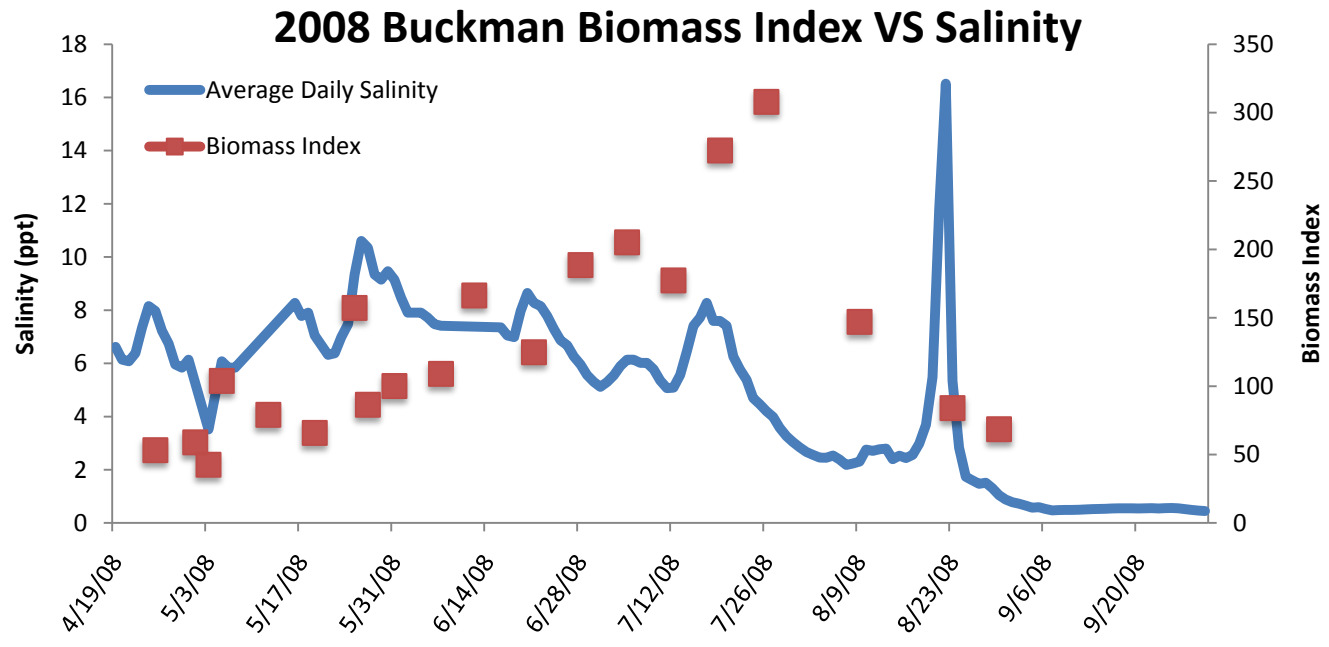

Figure 3. 2008 Buckman biomass index versus average daily salinity

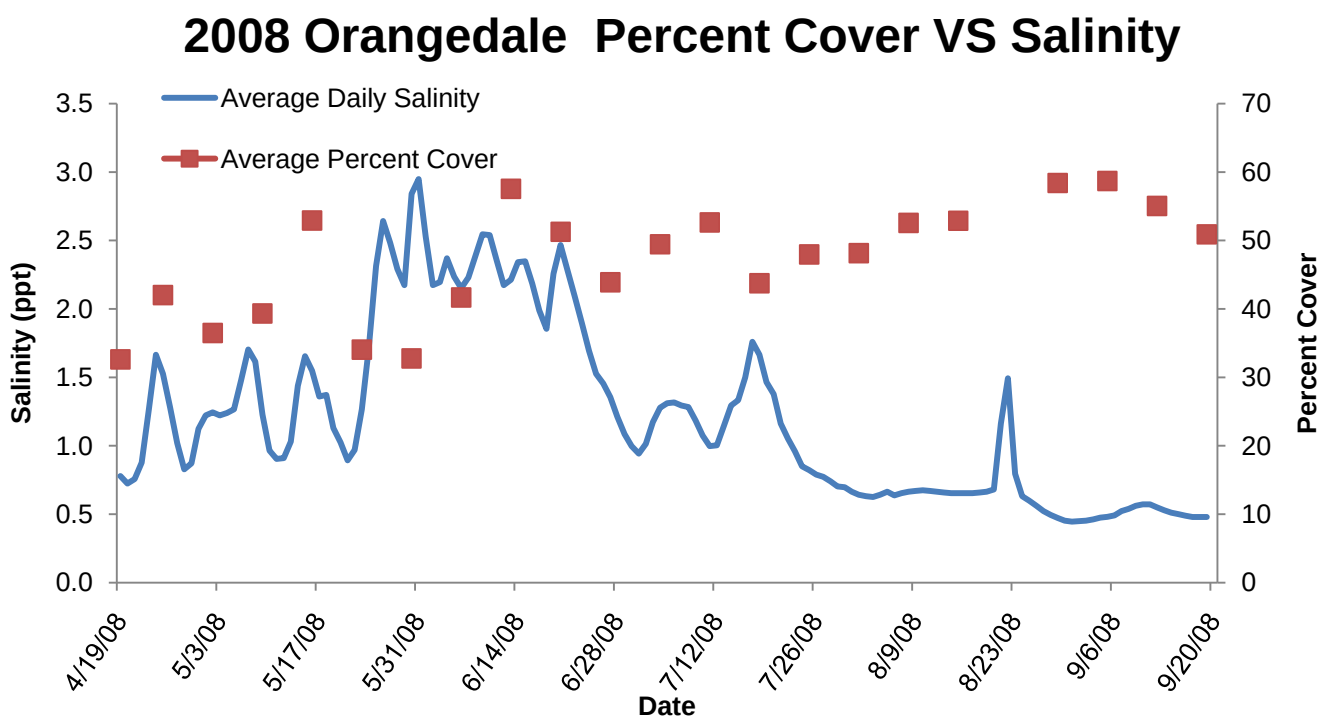

Figure 4. 2008 Orangedale percent cover versus average daily salinity.

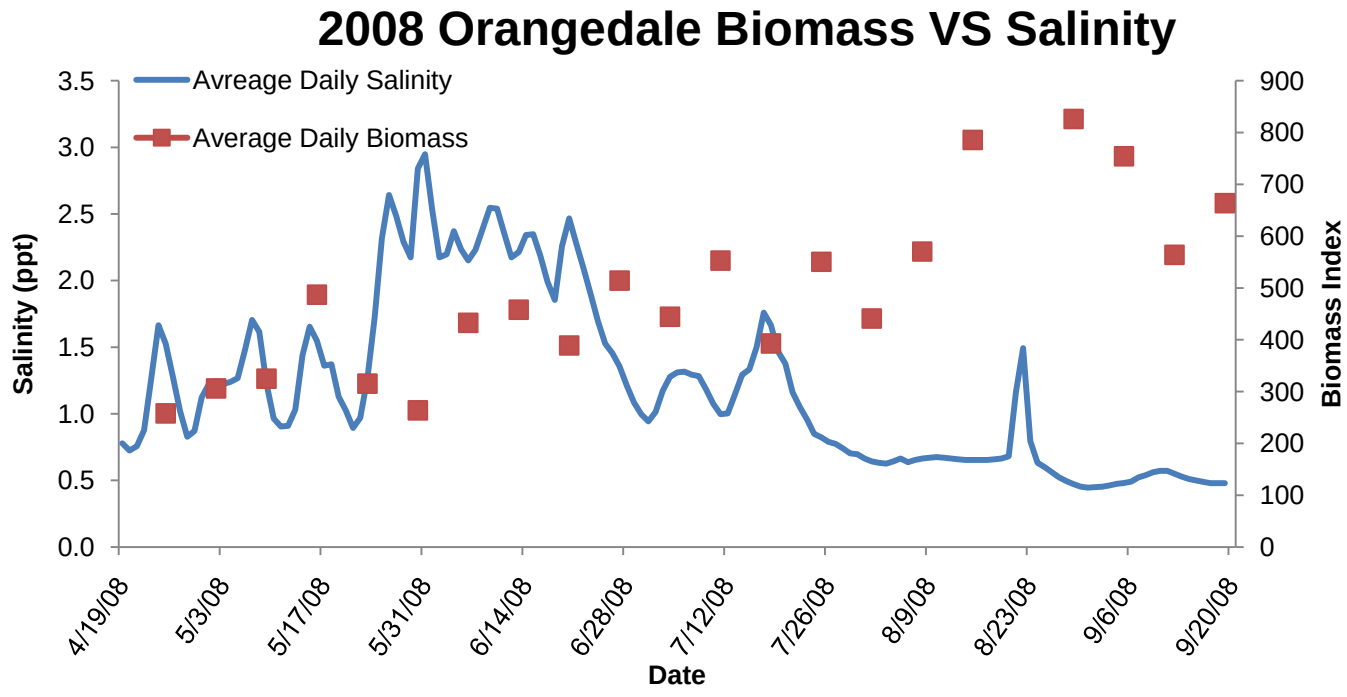

Figure 5. 2008 Orangedale biomass index versus average daily salinity.

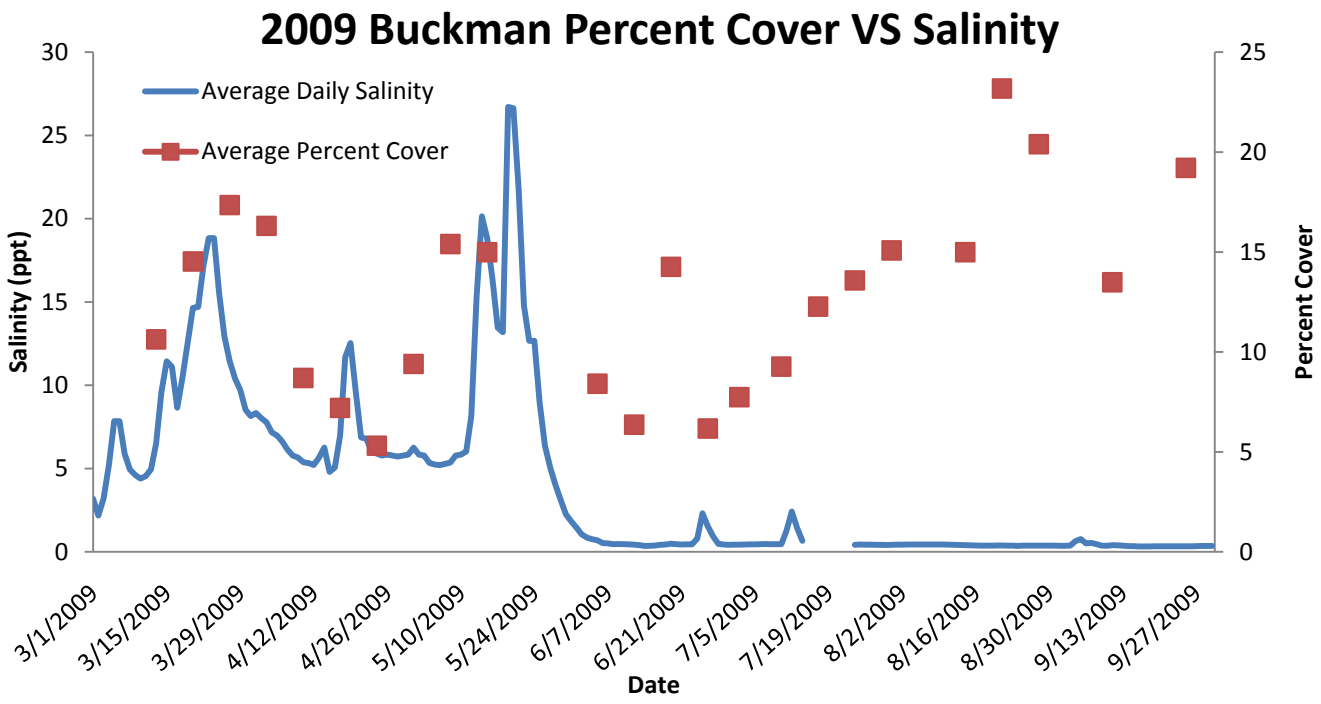

Figure 6. 2009 Buckman percent cover versus average daily salinity.

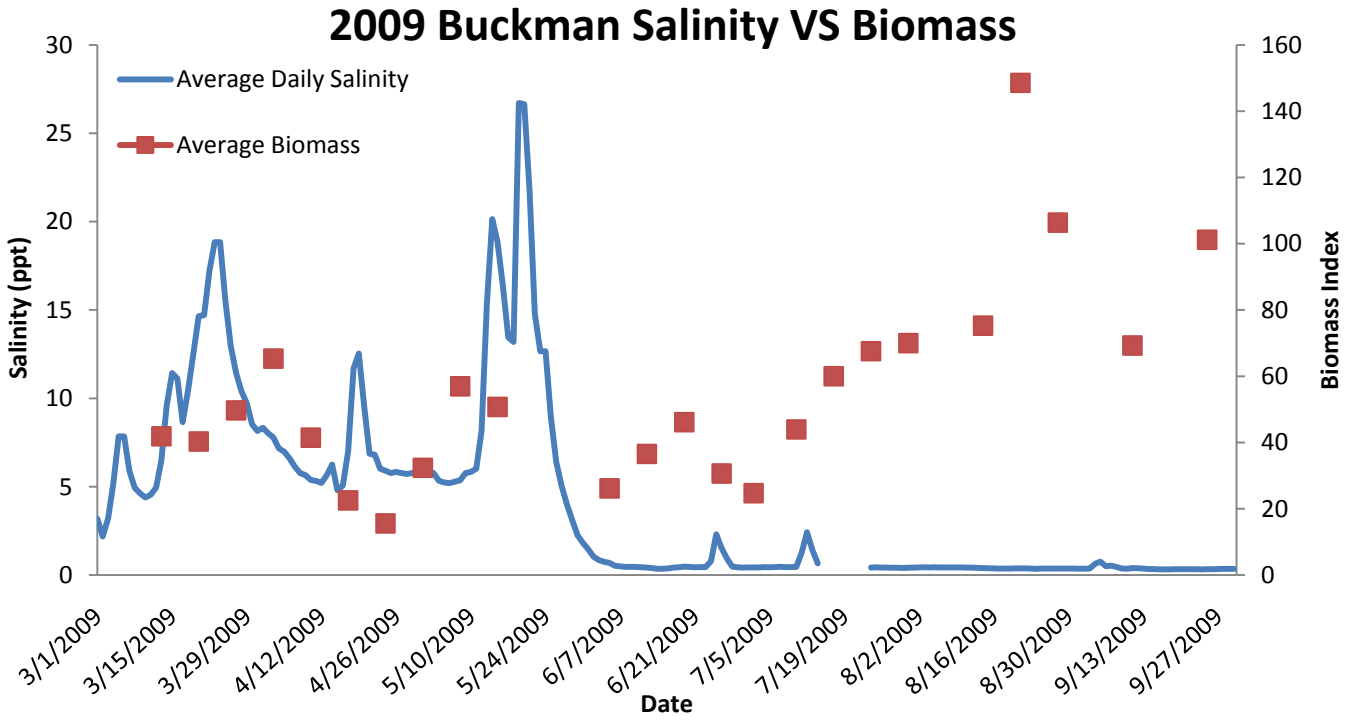

Figure 7. 2009 Buckman biomass index versus average daily salinity.

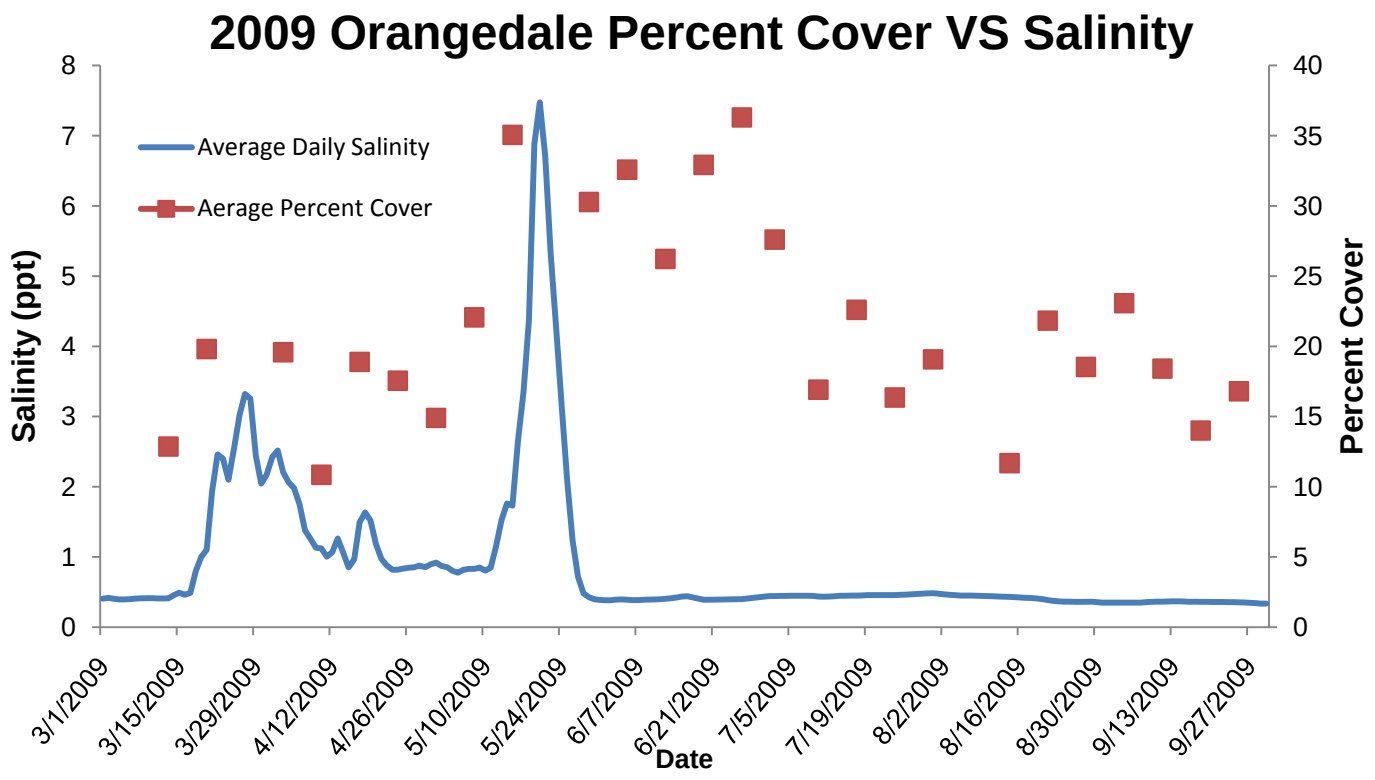

Figure 8.2009 Orangedale percent cover versus average daily salinity.

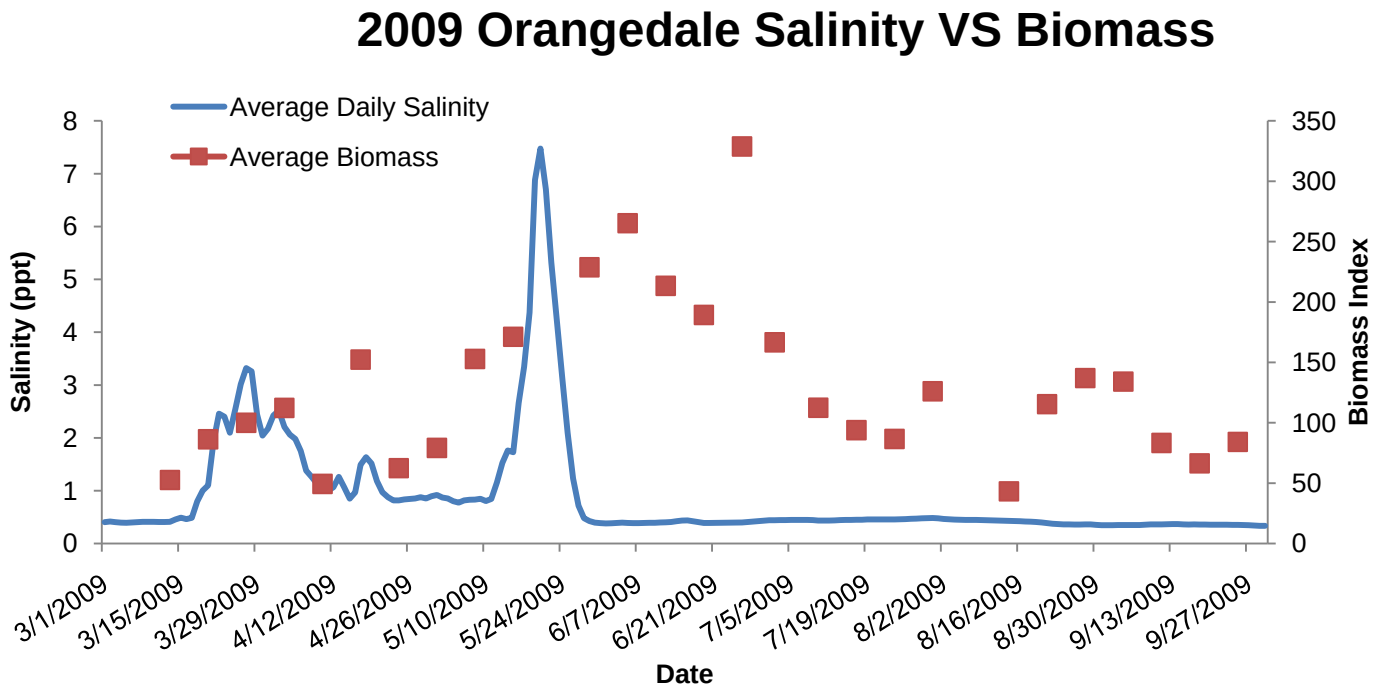

Figure 9. 2009 Orangedale biomass index versus average daily salinity.

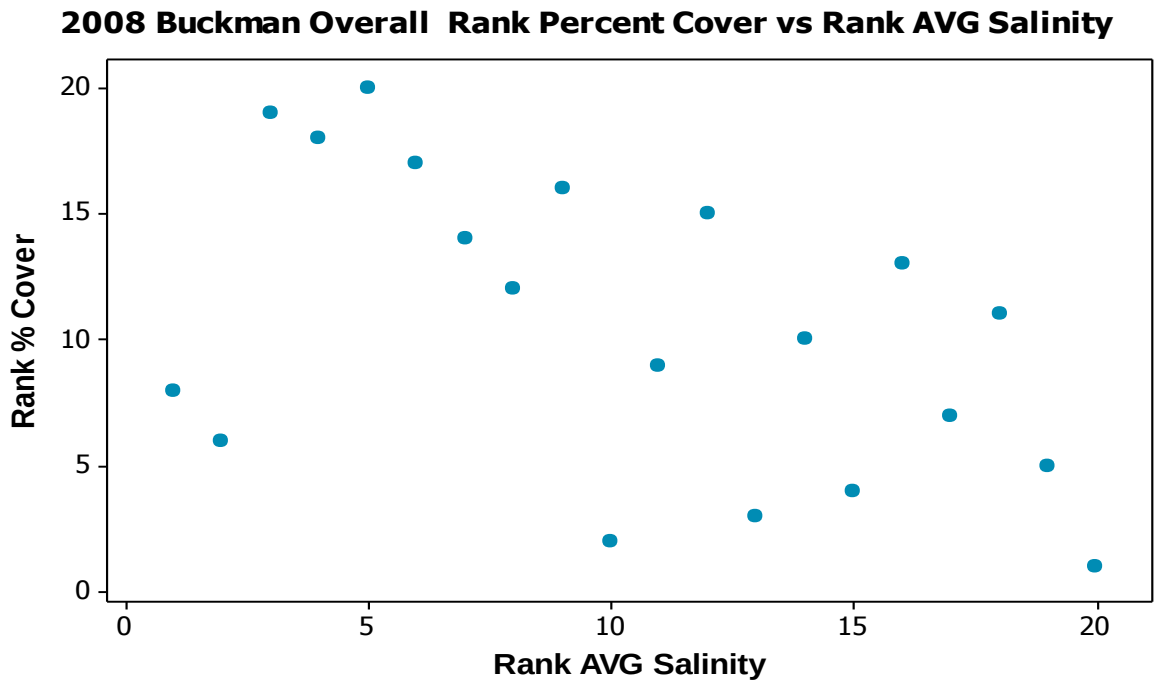

Figure 10. 2008 Buckman correlation on the rank of overall rank percent cover versus average seven day salinity. Pearson correlation r= -0.508, p= 0.022

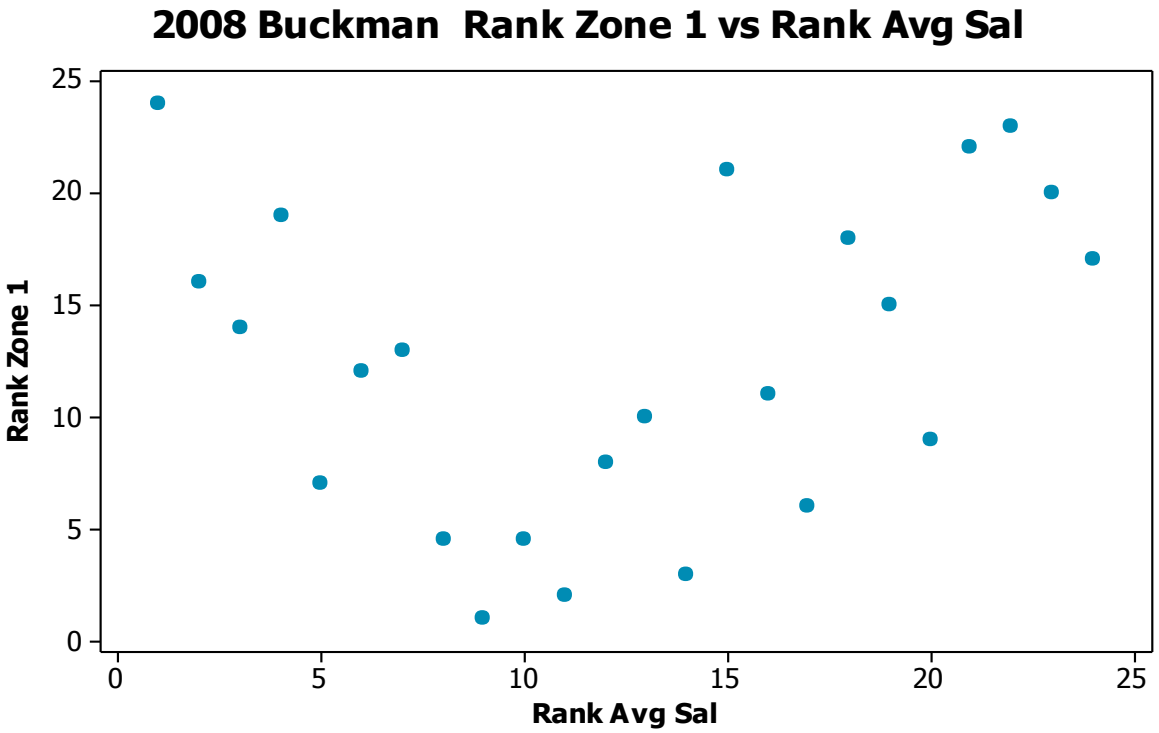

Figure 11. 2008 Buckman correlation on the rank of zone 1 rank percent cover versus average seven day salinity. Pearson correlation r= -0.146, p= 0.539

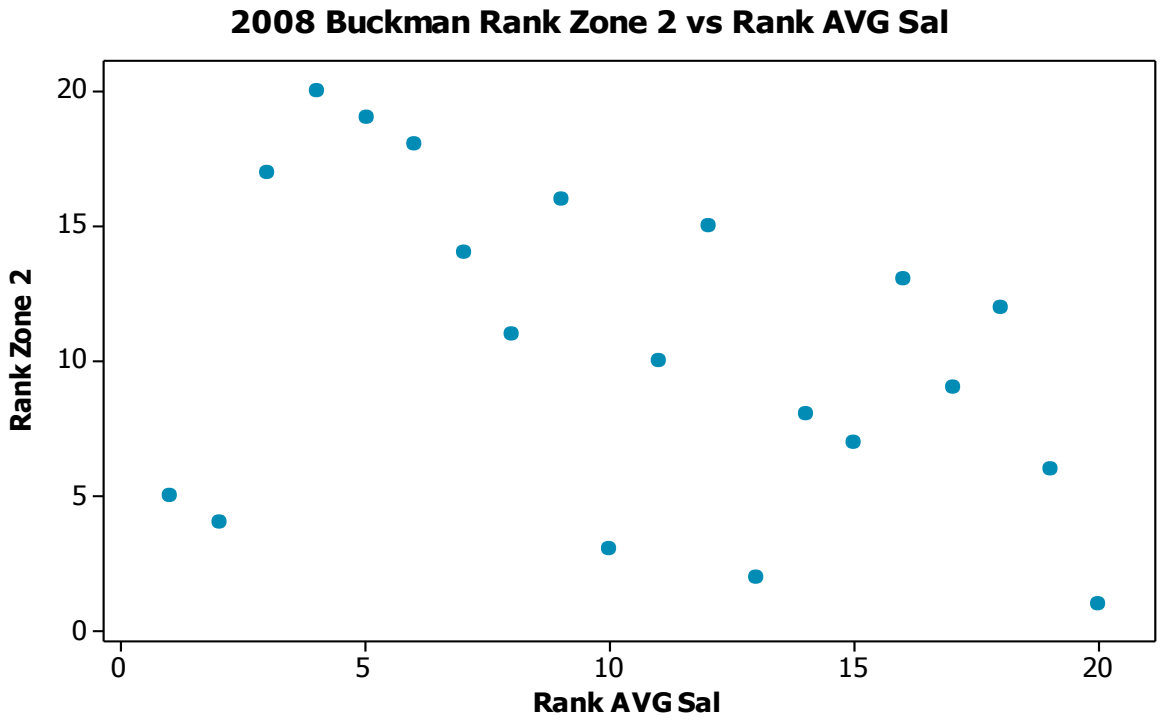

Figure 12. 2008 Buckman correlation on the rank of zone 2 rank percent cover versus average seven day salinity. Pearson correlation r= -0.382, p= 0.097

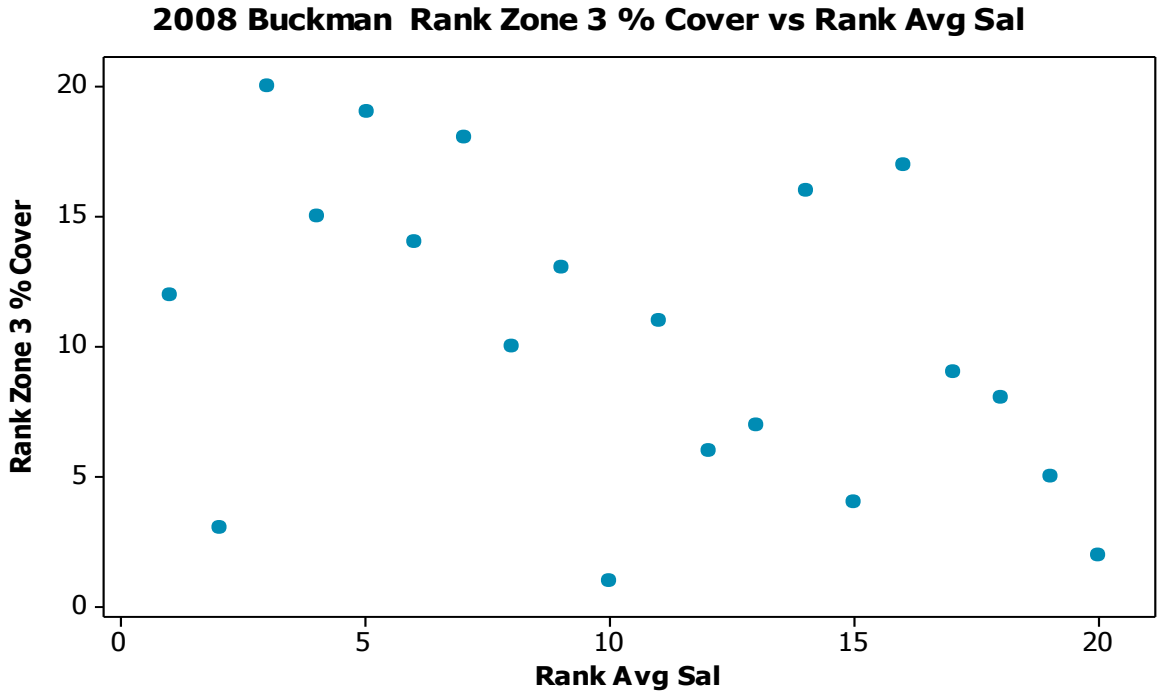

Figure 13. 2008 Buckman correlation on the rank of zone 3 rank percent cover versus average seven day salinity. Pearson correlation r= 0.426, p= 0.061

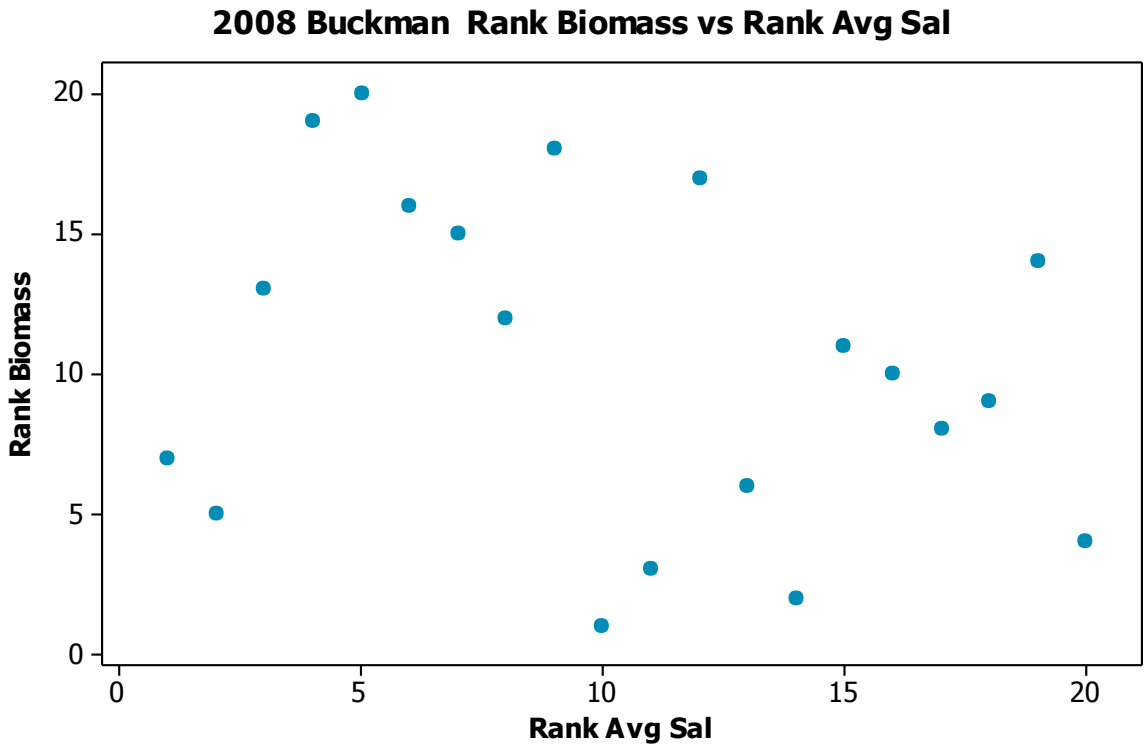

Figure 14. 2008 Buckman correlation on the rank of overall rank biomass versus average seven day salinity. Pearson correlation r= -0.289, p= 0.217

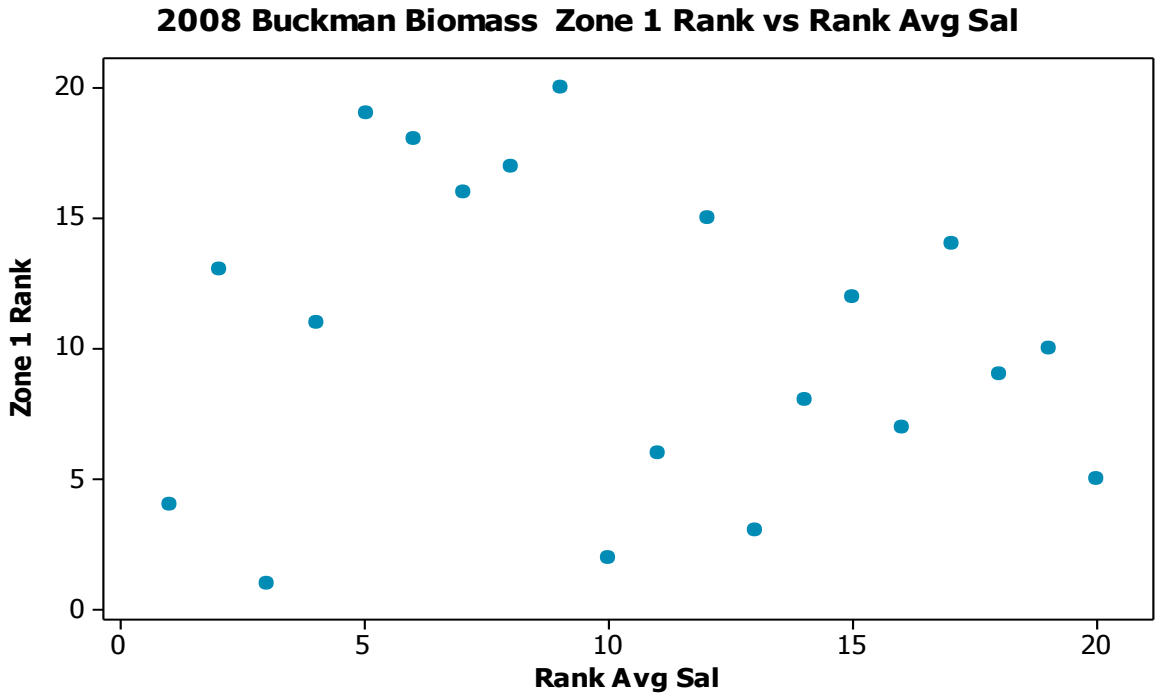

Figure 15. 2008 Buckman correlation on the rank of zone 1 biomass rank percent cover versus average seven day salinity. Pearson correlation r= -0.147, p= 0.535

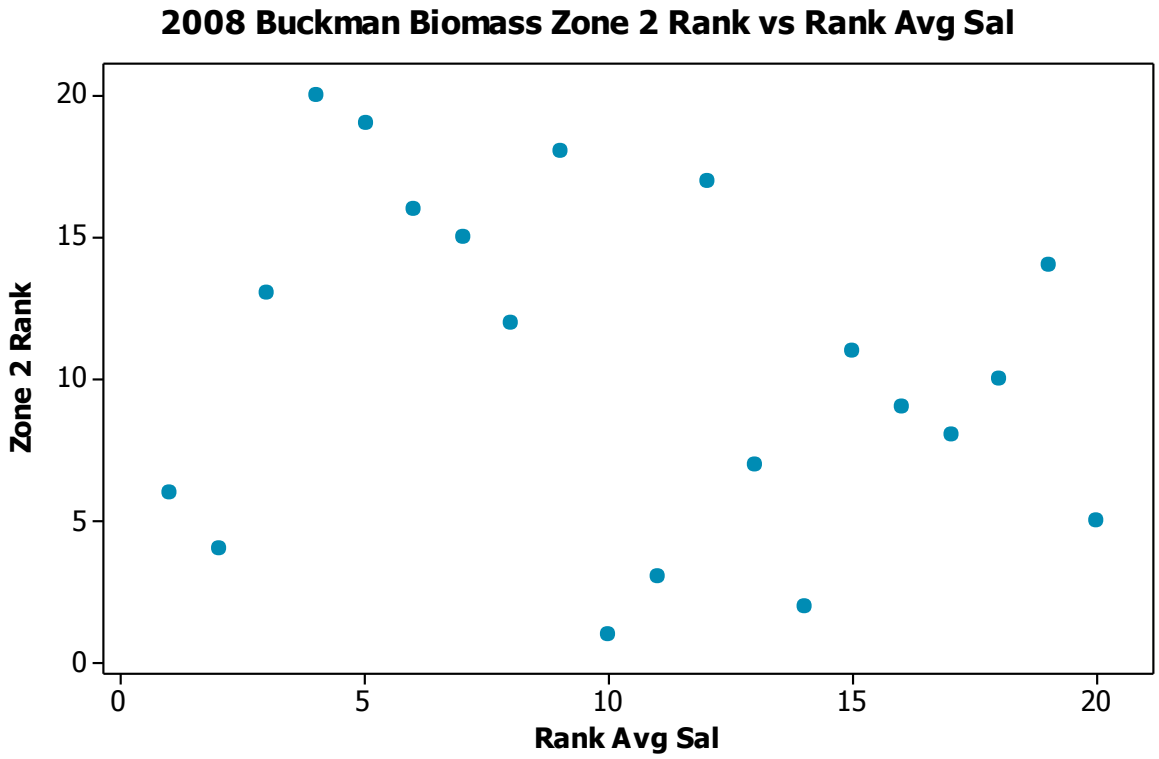

Figure 16. 2008 Buckman correlation on the rank of zone 2 biomass rank versus average seven day salinity. Pearson correlation r= -0.242, p= 0.304

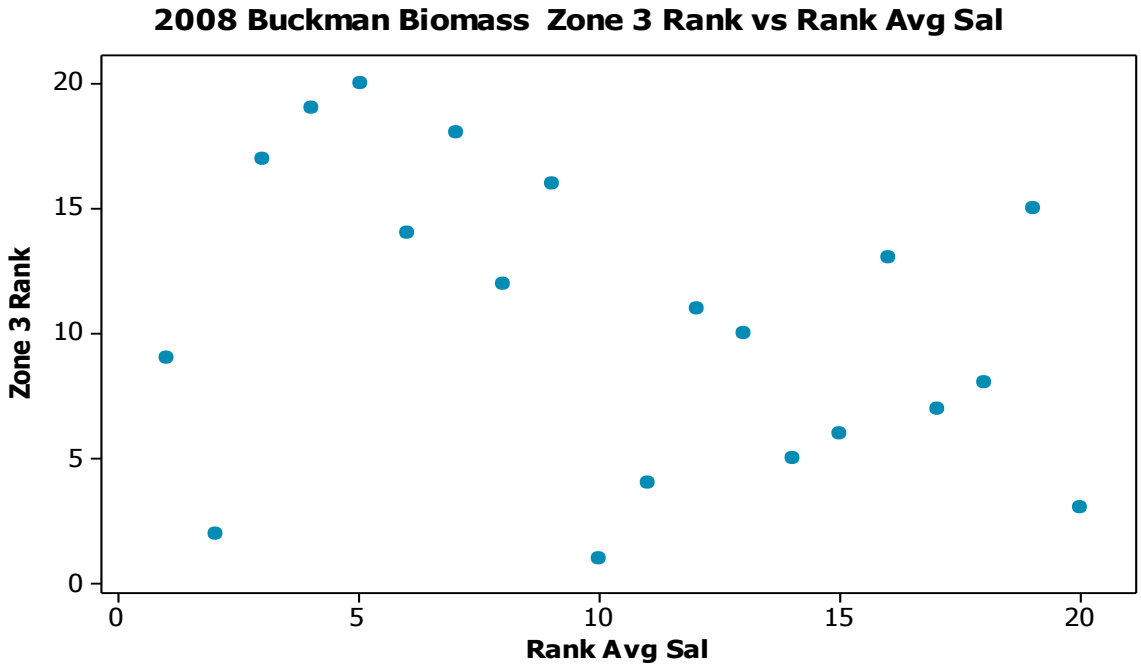

Figure 17. 2008 Buckman correlation on the rank of zone 3 biomass versus average seven day salinity. Pearson correlation r= -0.355, p= 0.148

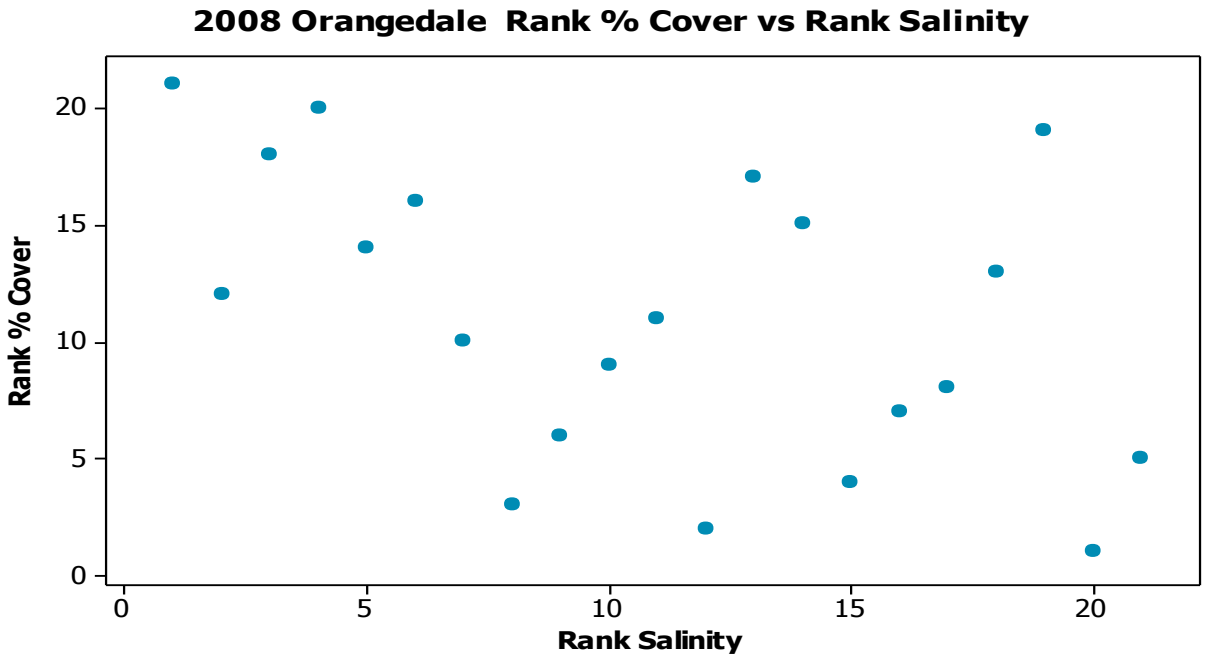

Figure 18. 2008 Orangedale correlation on the rank of overall rank percent cover versus average seven day salinity. Pearson correlation r = -0.460, p= 0.036

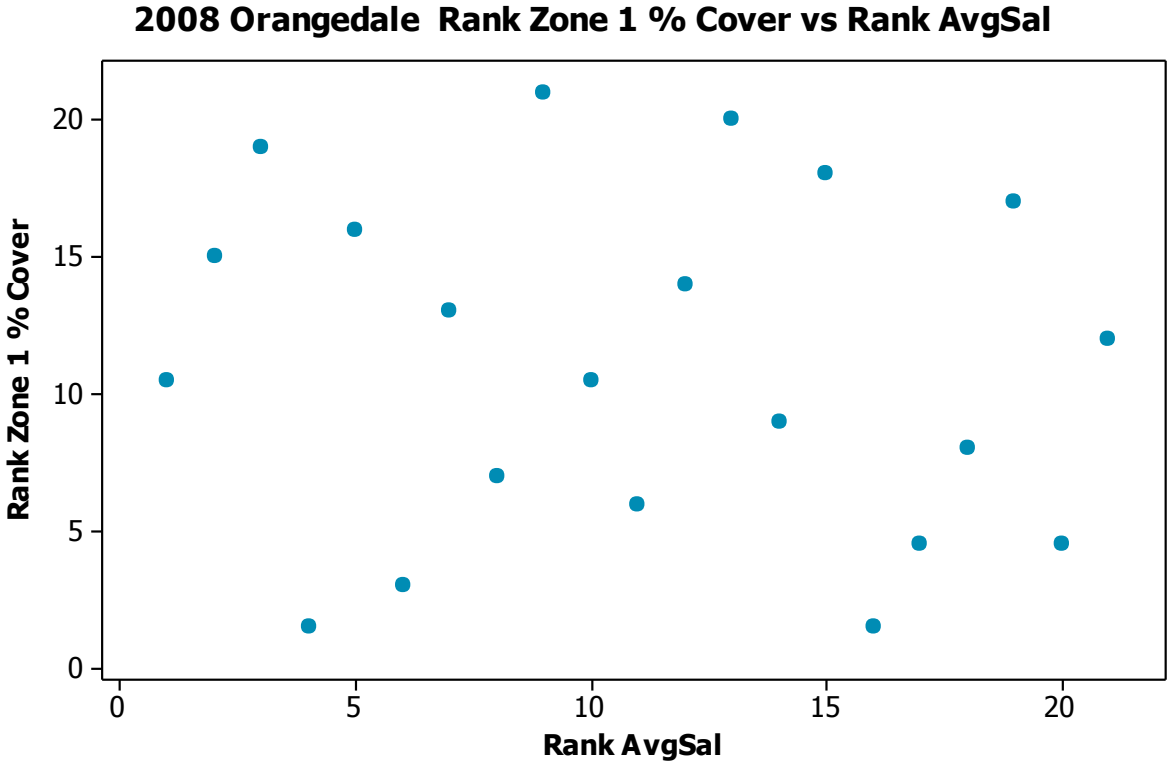

Figure 19. 2008 Orangedale correlation on the rank of zone 1 rank percent cover versus average seven day salinity. Pearson correlation r= -0.129, p= 0.578

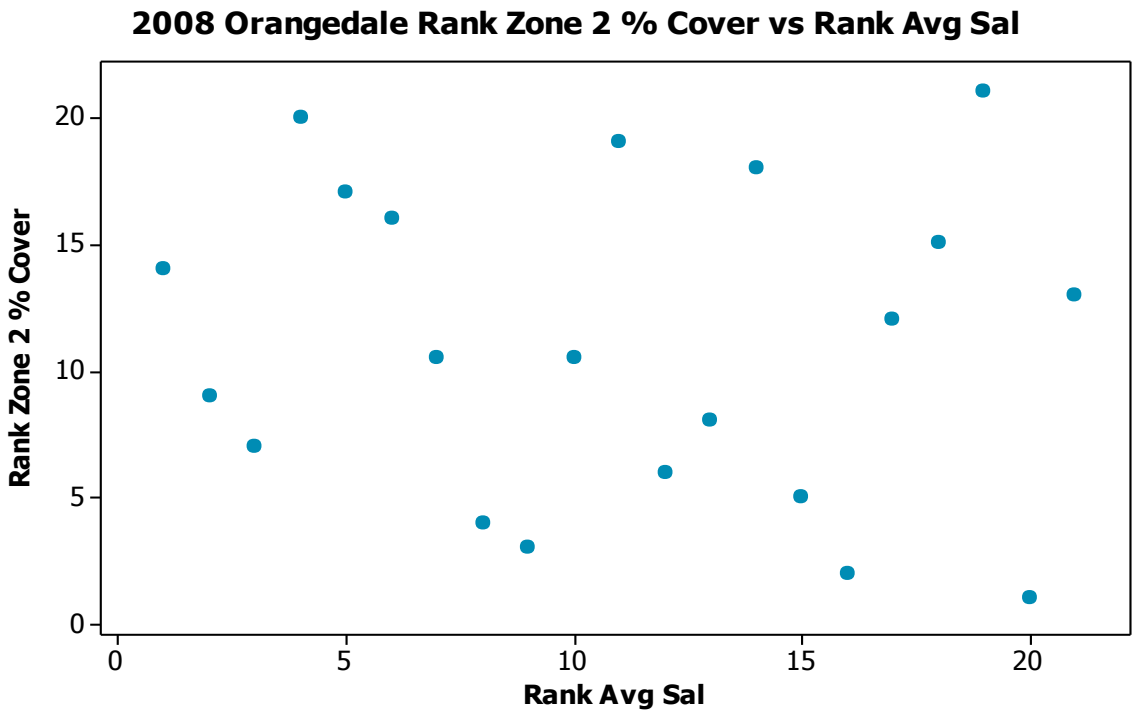

Figure 20. 2008 Orangedale correlation on the rank of zone 2 rank percent cover versus average seven day salinity. Pearson correlation r= -0.103, p= 0.656

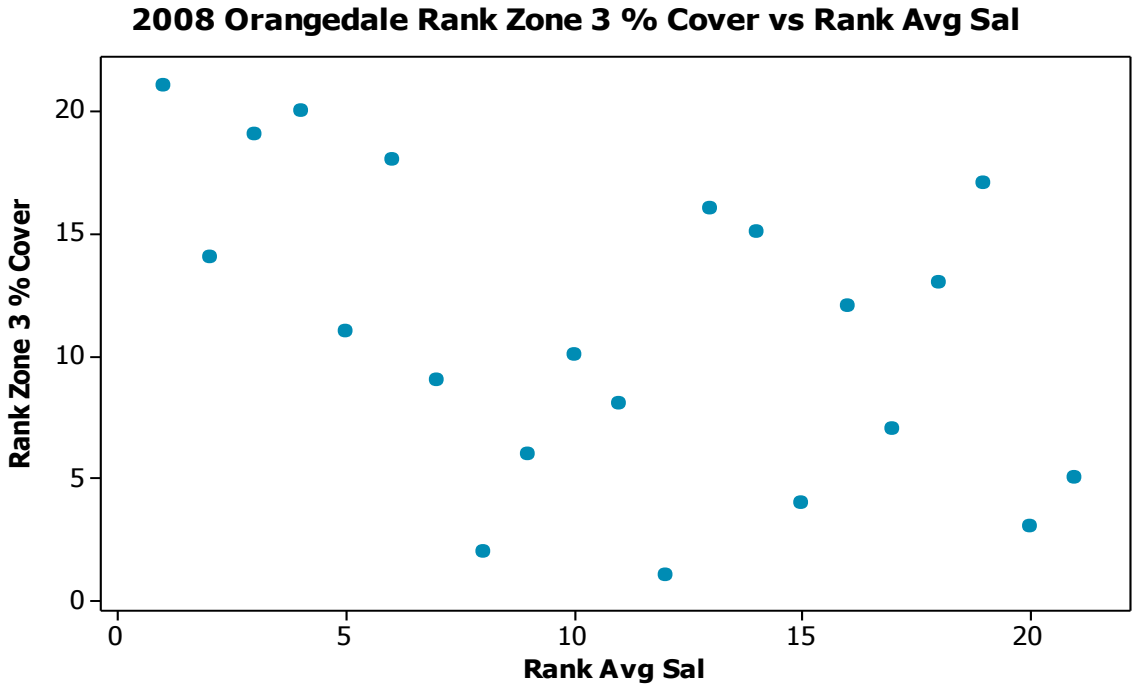

Figure 21. 2008 Orangedale correlation on the rank of zone 3 rank percent cover versus average seven day salinity. Pearson correlation r= -0.452, p= 0.040

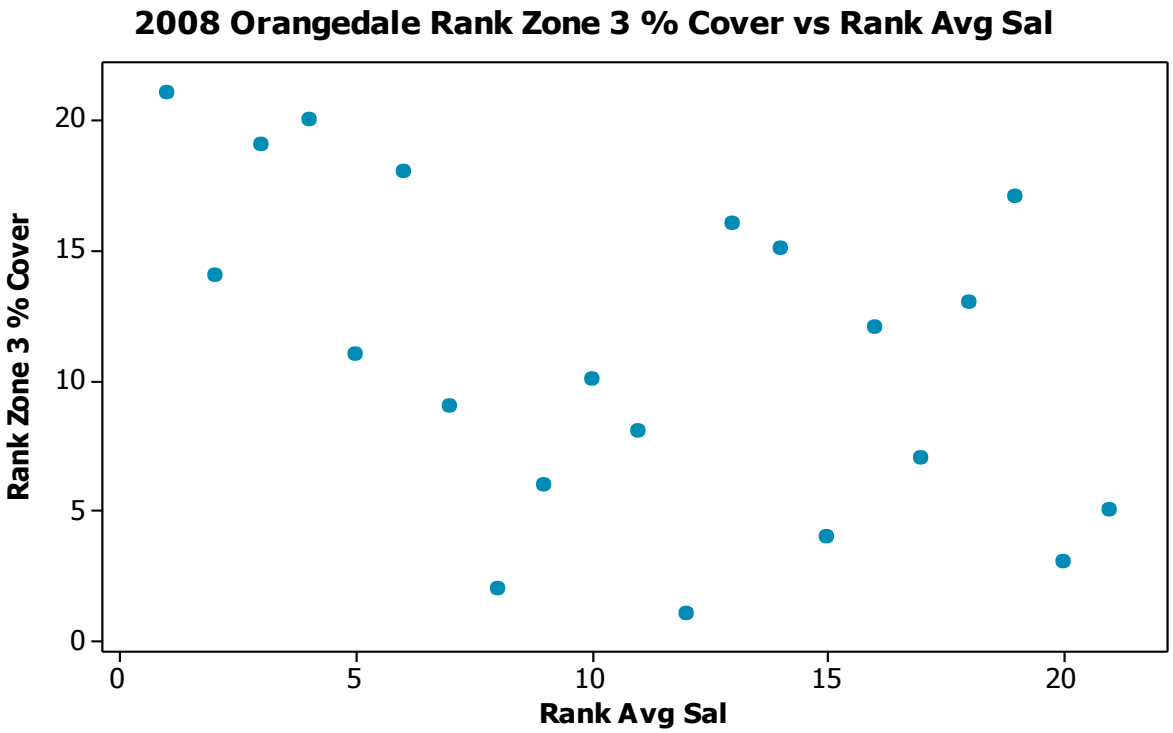

Figure 22. 2008 Orangedale correlation on the rank of zone 3 rank percent cover versus average seven day salinity. Pearson correlation r= -0.592, p= 0.005

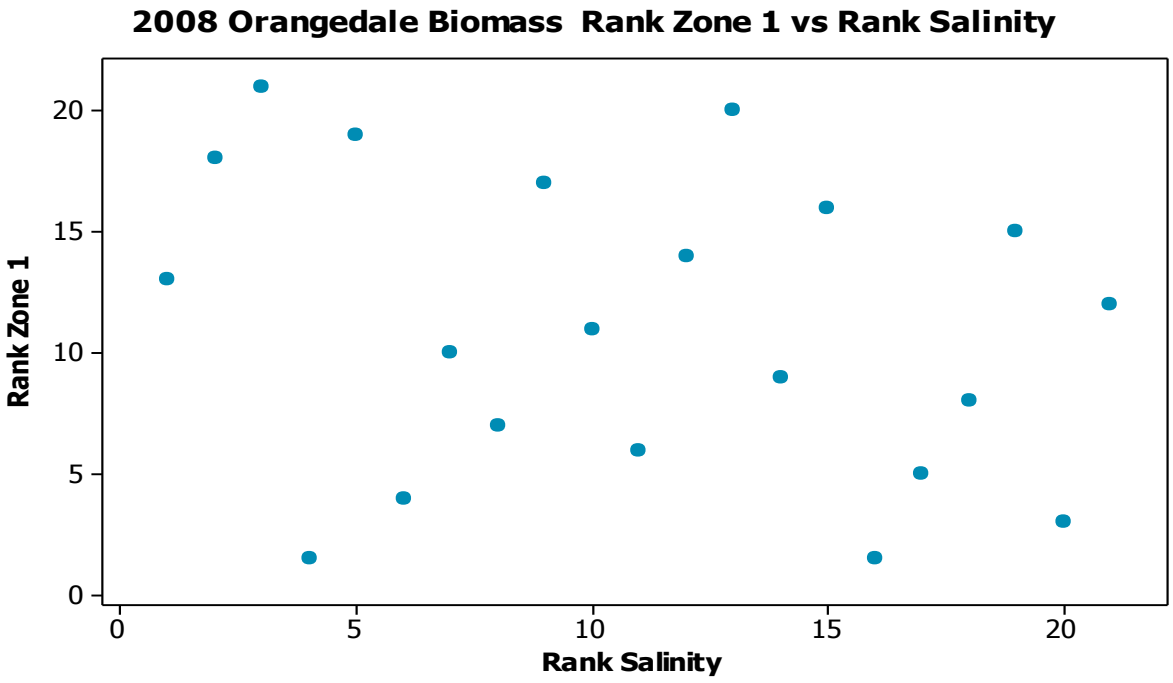

Figure 23. 2008 Orangedale correlation on the rank of zone 1 biomass versus average seven day salinity. Pearson correlation r= -0.266, p= 0.243

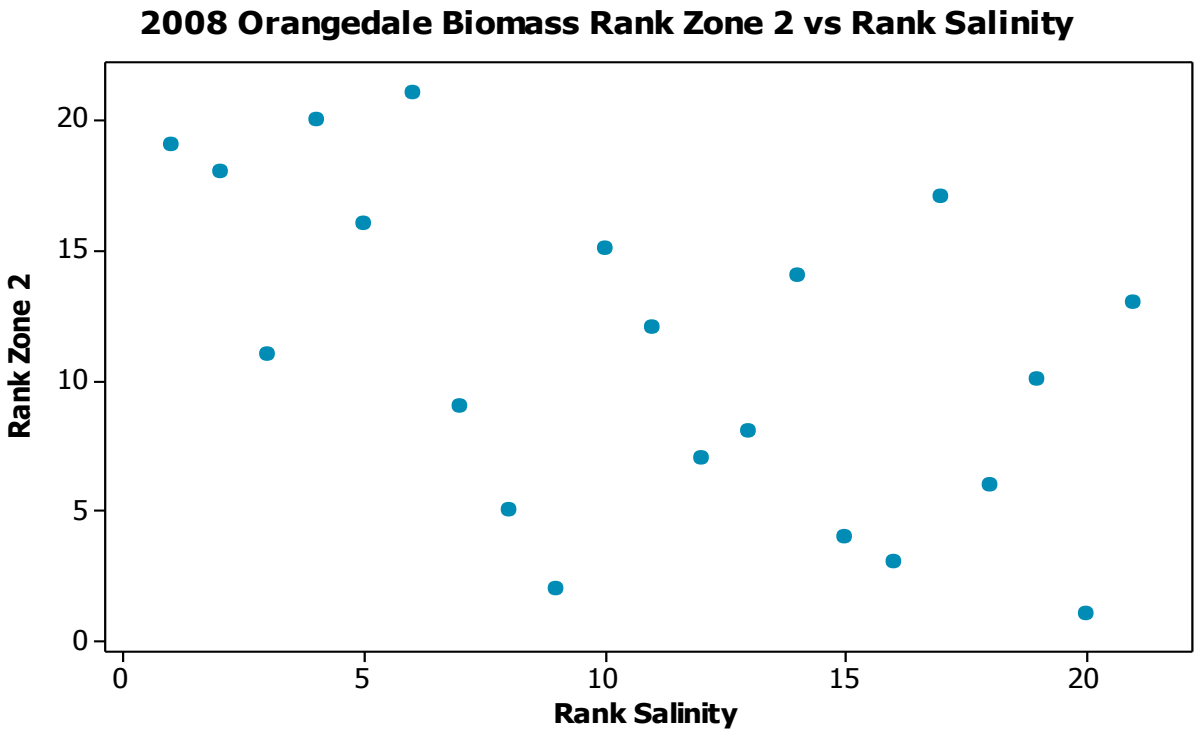

Figure 24. 2008 Orangedale correlation on the rank of zone 2 biomass versus average seven day salinity. Pearson correlation r= -0.509, p= 0.018

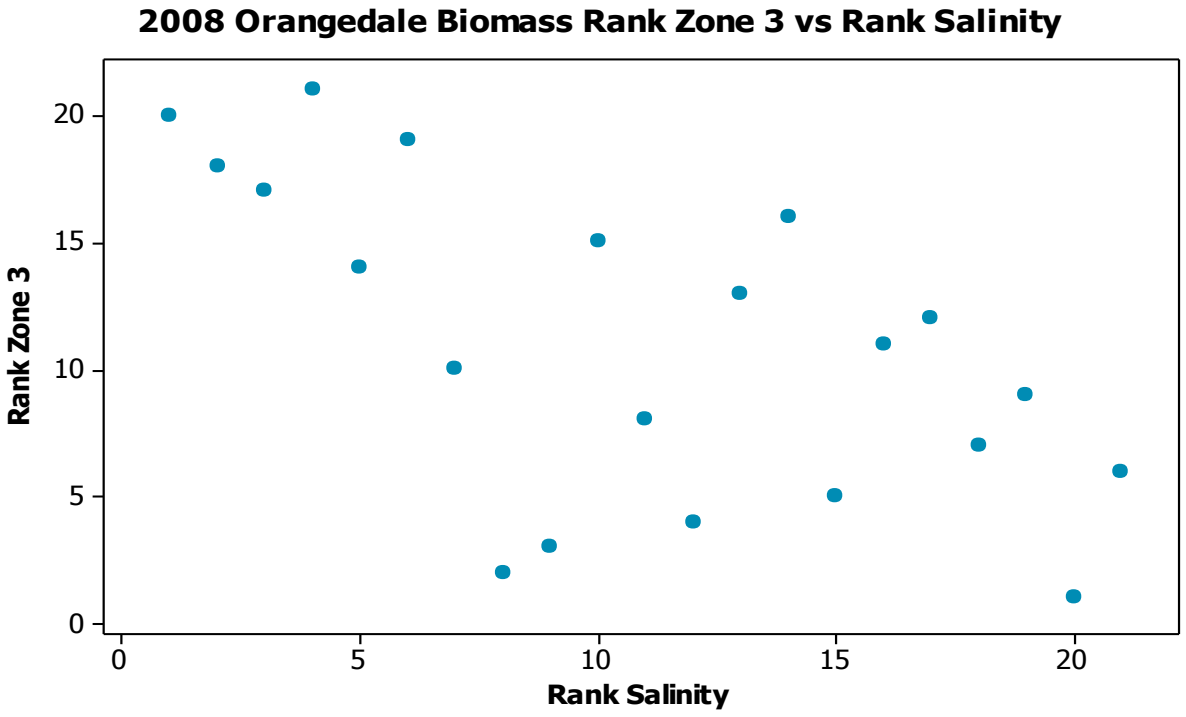

Figure 25. 2008 Orangedale correlation on the rank of zone 3 biomass versus average seven day salinity. Pearson correlation r= -0.618, p= 0.003

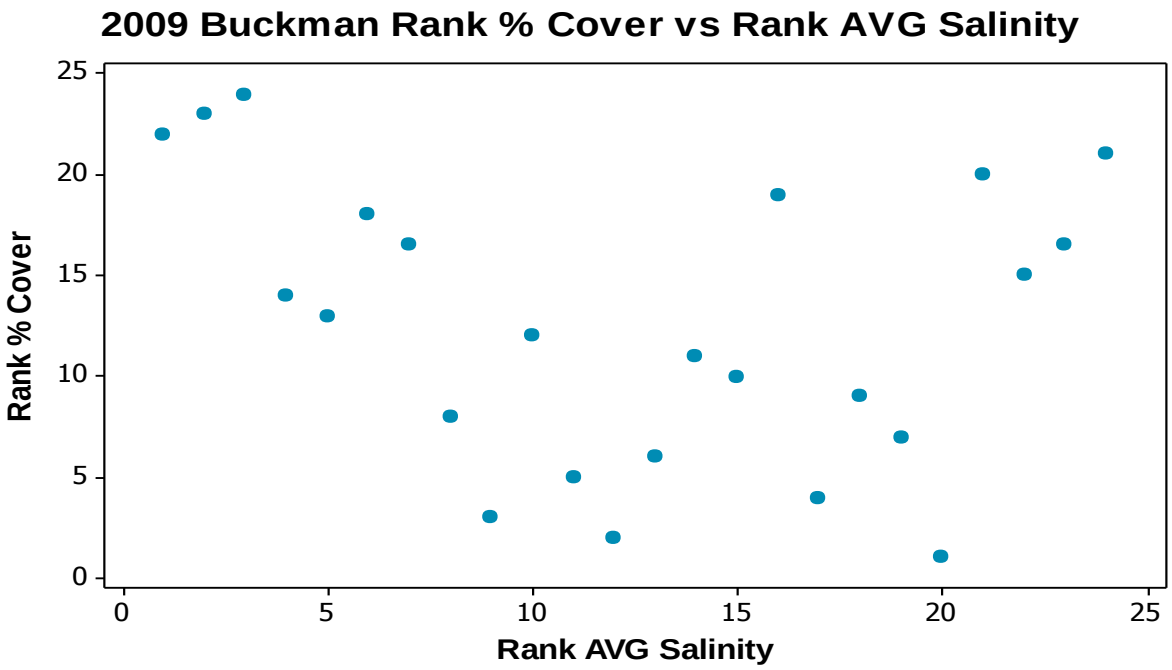

Figure 26. 2009 Buckman correlation on the rank of overall percent cover versus average seven day salinity. Pearson correlation r= -0.237, p= 0.264

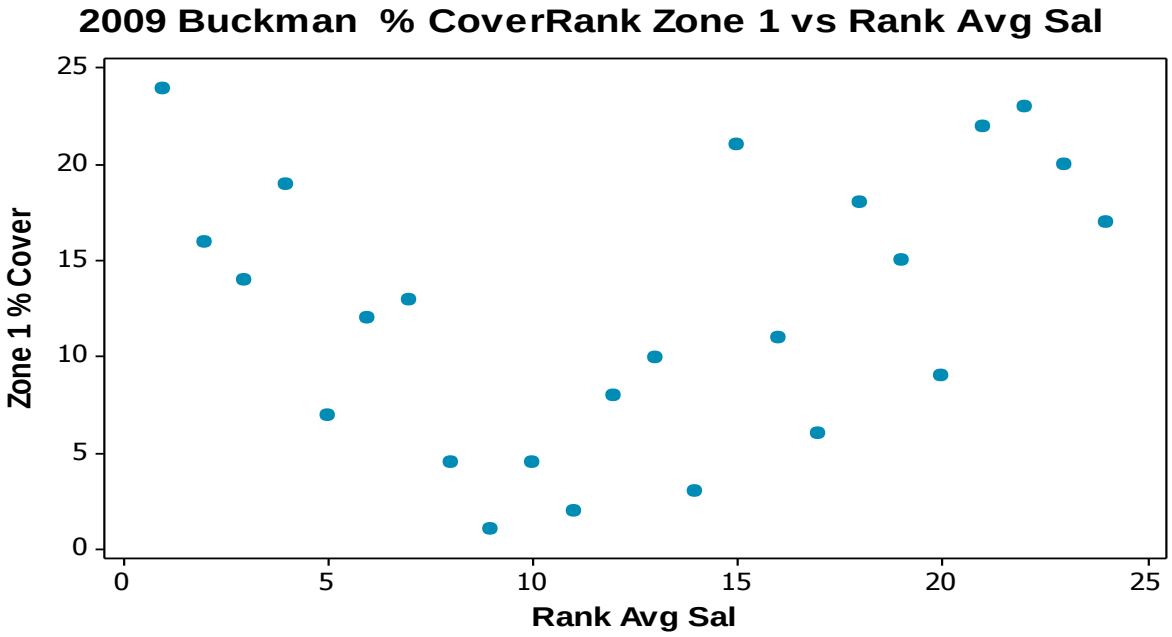

Figure 27. 2009 Buckman correlation on the rank of zone 1 percent cover versus average seven day salinity. Pearson correlation r= 0.191, p= 0.370

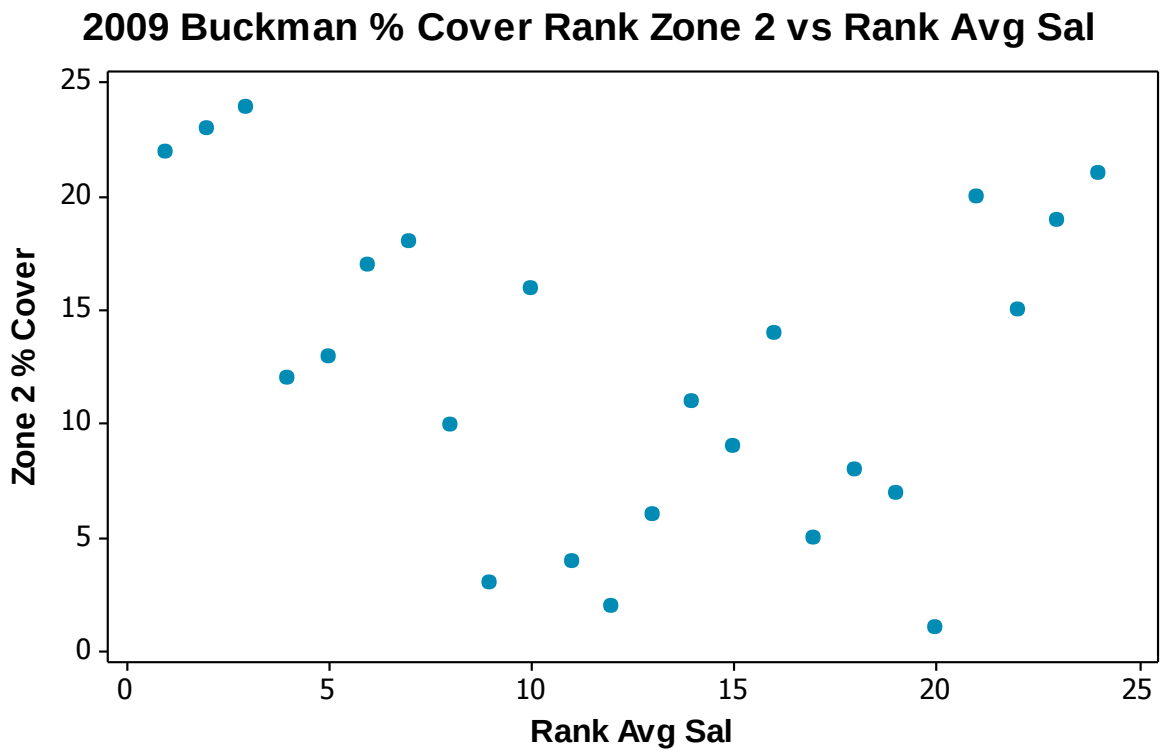

Figure 28. 2009 Buckman correlation on the rank of zone 2 percent cover versus average seven day salinity. Pearson correlation r= -0.235, p= 0.269

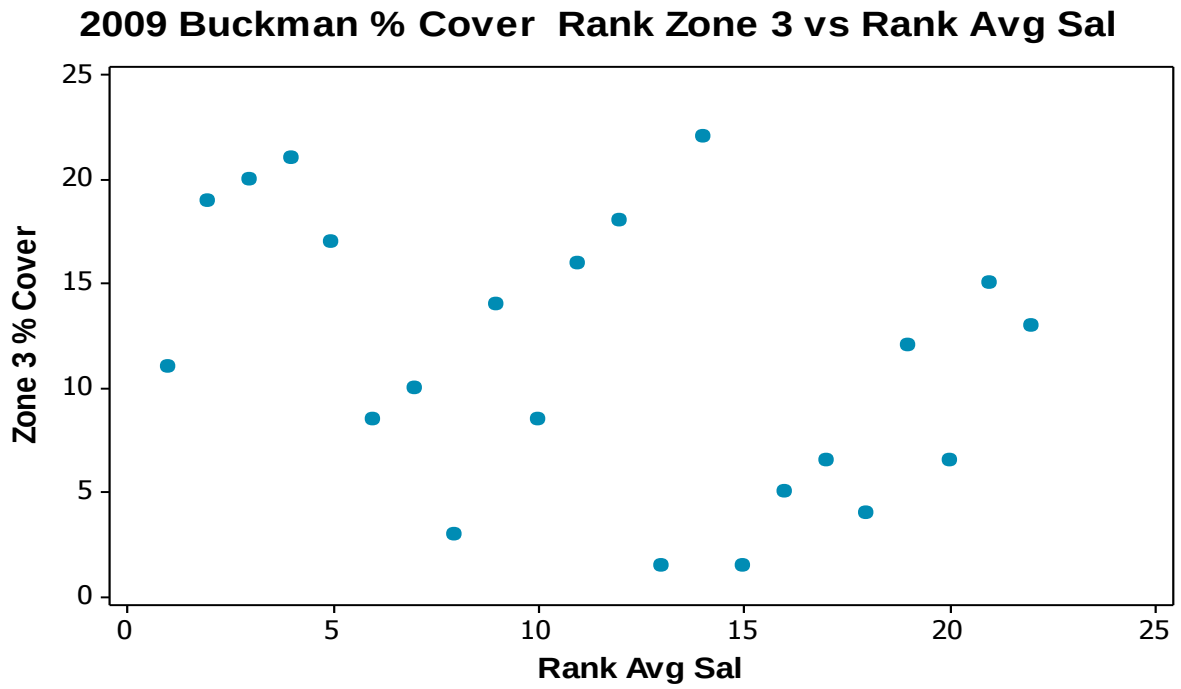

Figure 29. 2009 Buckman correlation on the rank of zone 3 percent cover versus average seven day salinity. Pearson correlation r= -0.353, p= 0.107

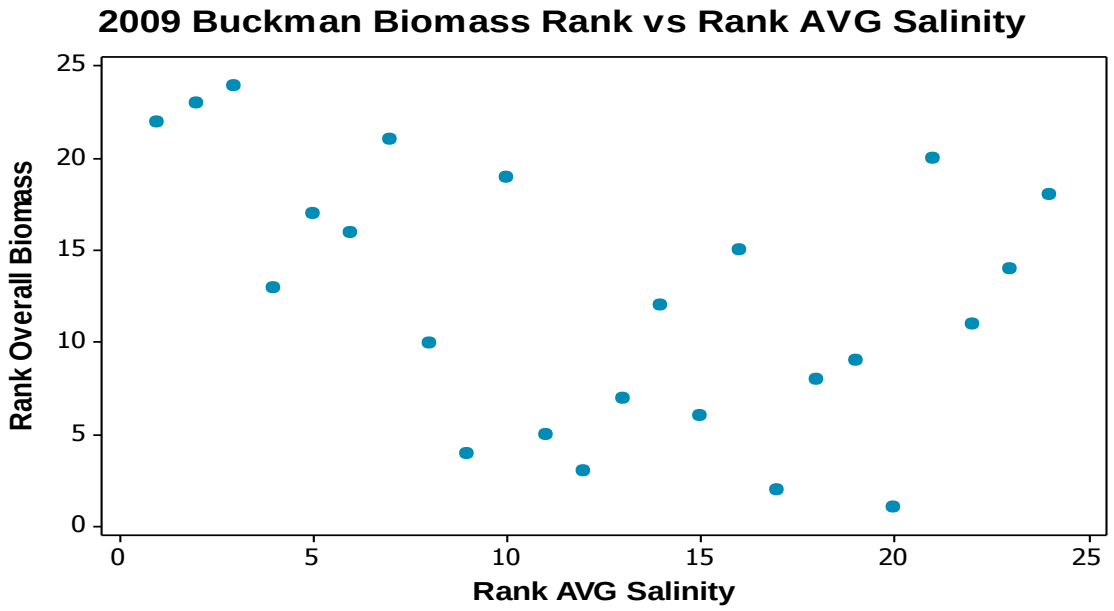

Figure 30. 2009 Buckman correlation on the biomass rank versus rank of average seven day salinity. Pearson correlation r= -0.399, p=0 .053

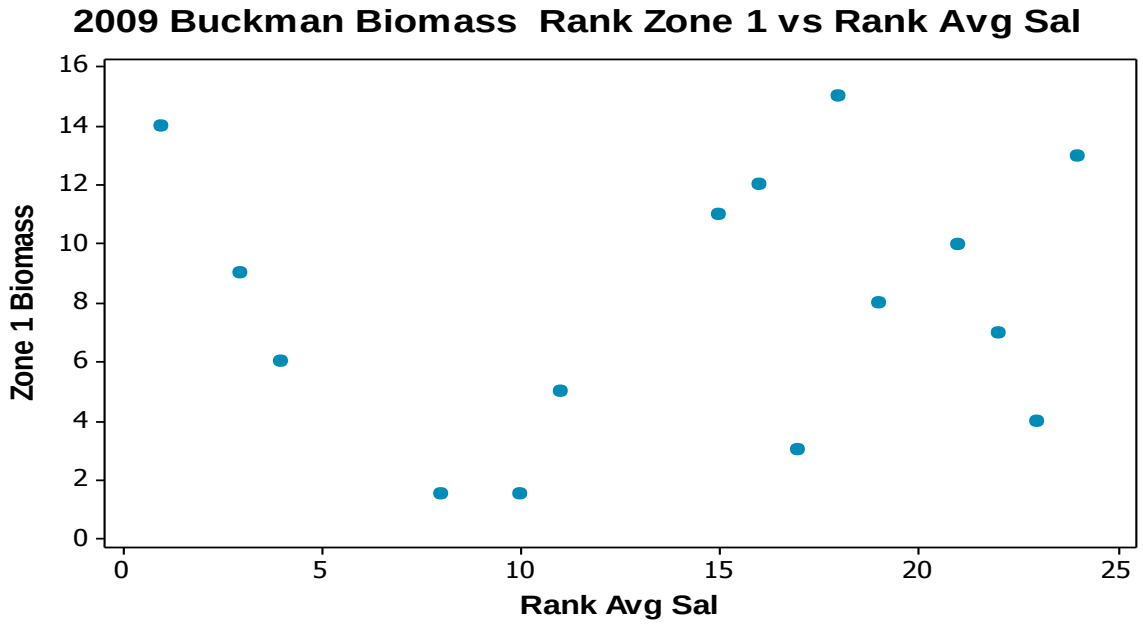

Figure 31. 2009 Buckman correlation on the rank of zone 1 biomass versus average seven day salinity. Pearson correlation r= 0.104, p=0 .713

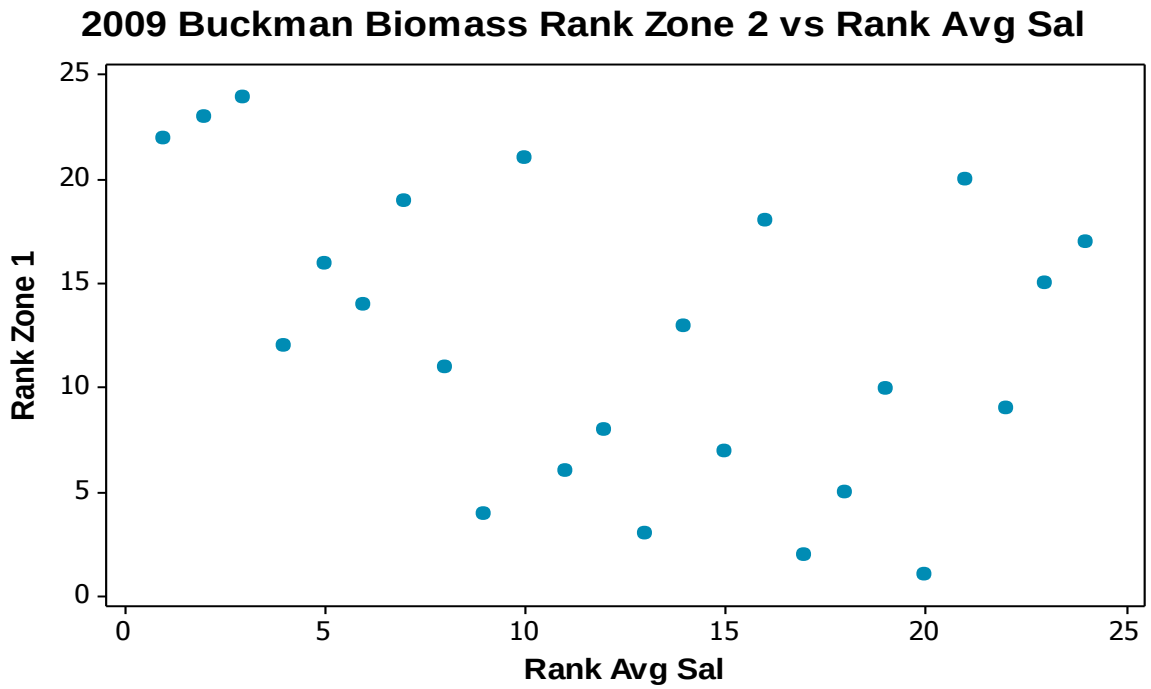

Figure 32. 2009 Buckman correlation on the rank of zone 2 biomass versus average seven day salinity. Pearson correlation r= -0.391, p= 0.059

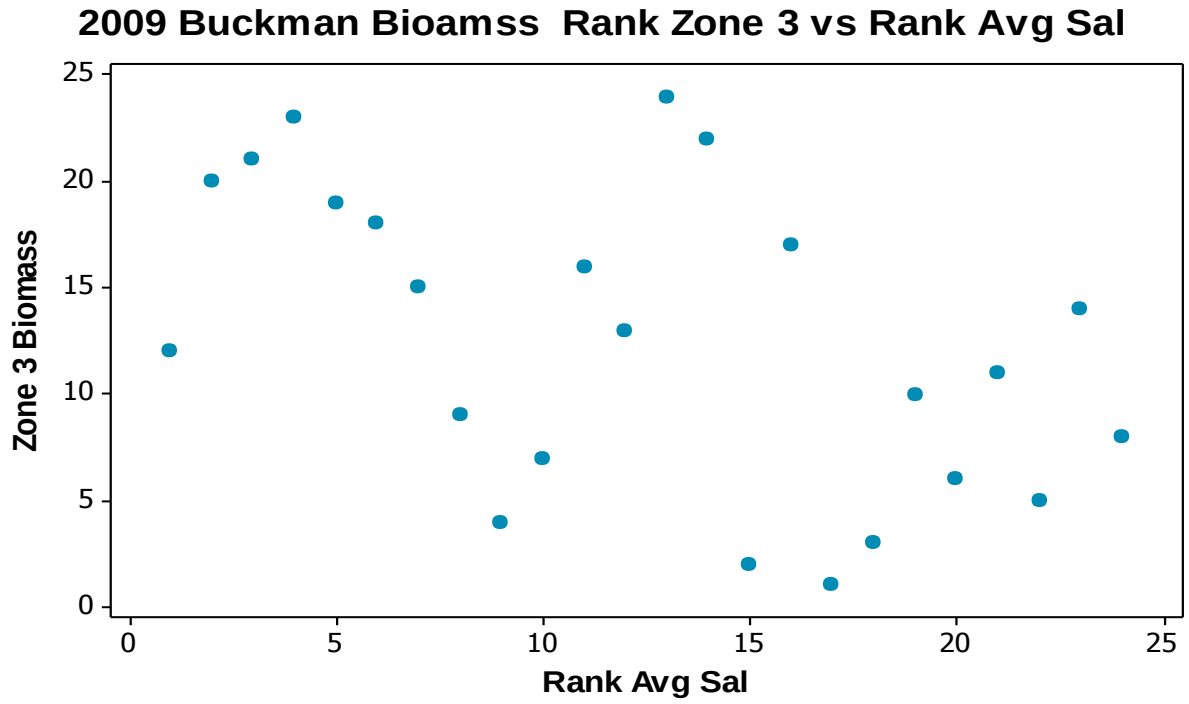

Figure 33. 2009 Buckman correlation on the rank of zone 3 biomass versus average seven day salinity. Pearson correlation r= -0.493, p= 0 .014

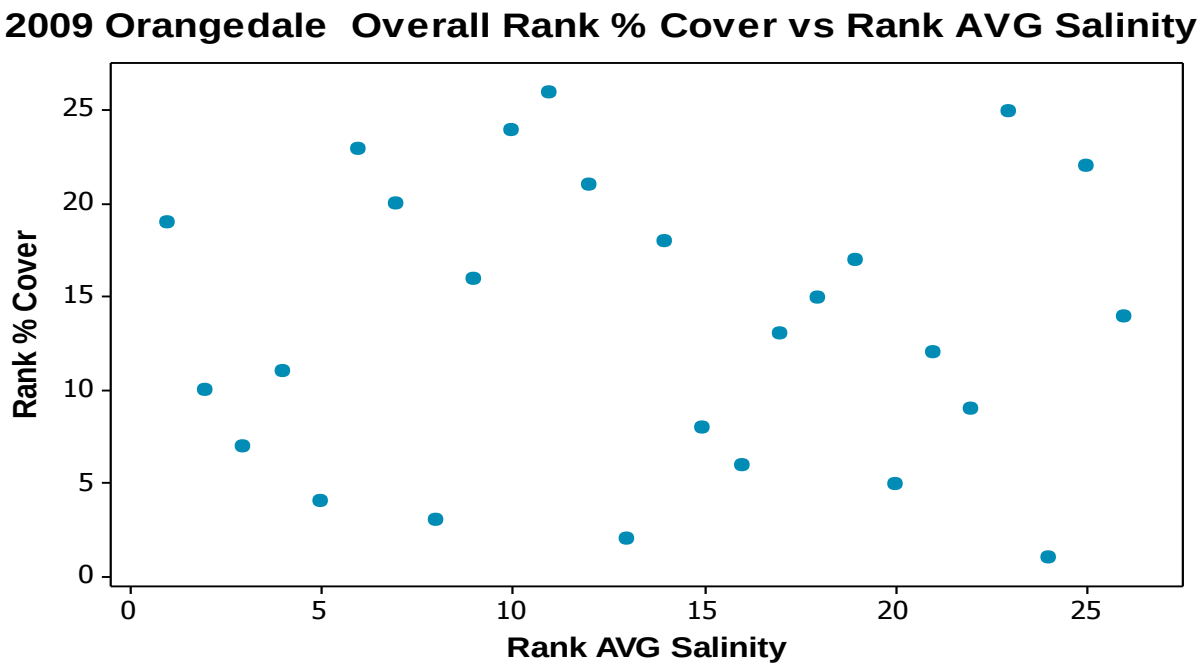

Figure 34. 2009 Orangedale correlation on the rank of overall percent cover versus average seven day salinity. Pearson correlation r= -0.013, p=0 .948

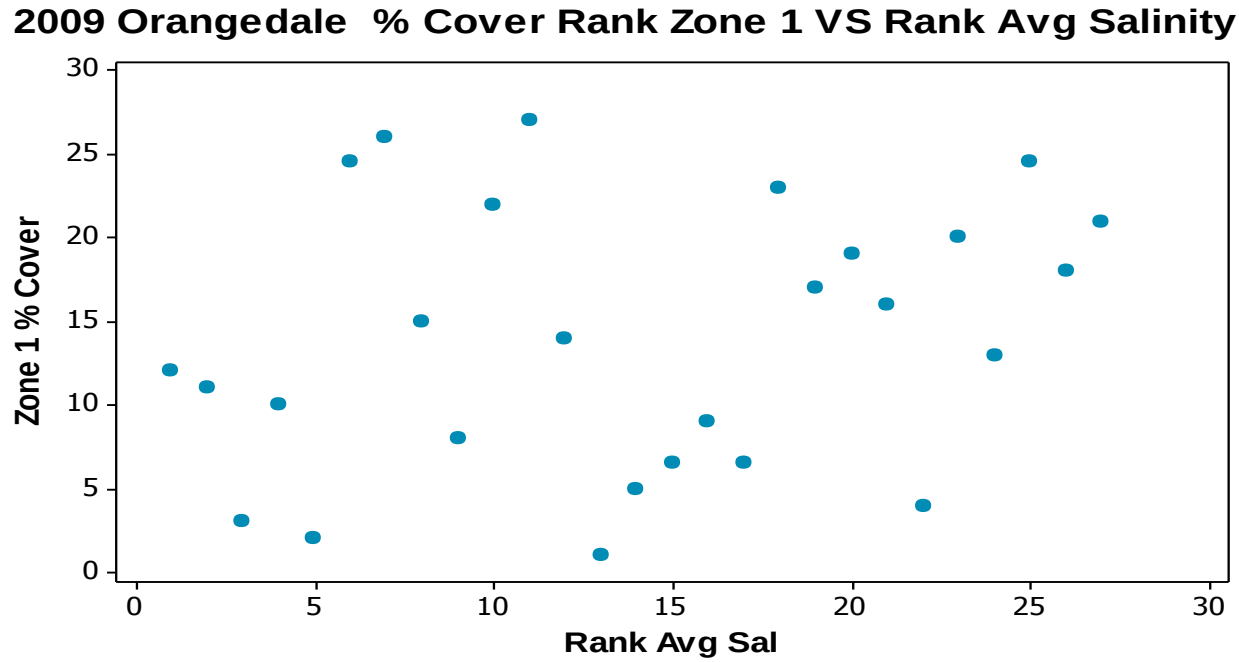

Figure 35. 2009 Orangedale correlation on the rank of zone 1 percent cover versus average seven day salinity. Pearson correlation r= 0.246, p= 0.217

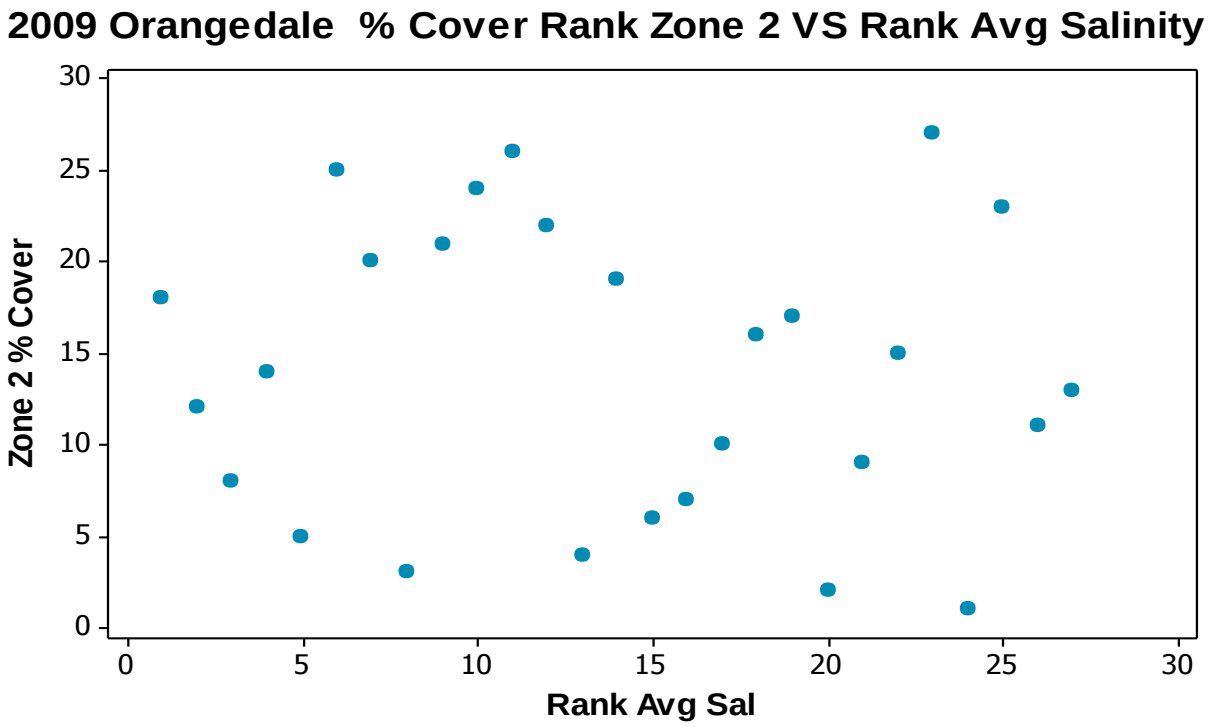

Figure 36. 2009 Orangedale correlation on the rank of zone 2 percent cover versus average seven day salinity. Pearson correlation r= -0.082, p=0 .683

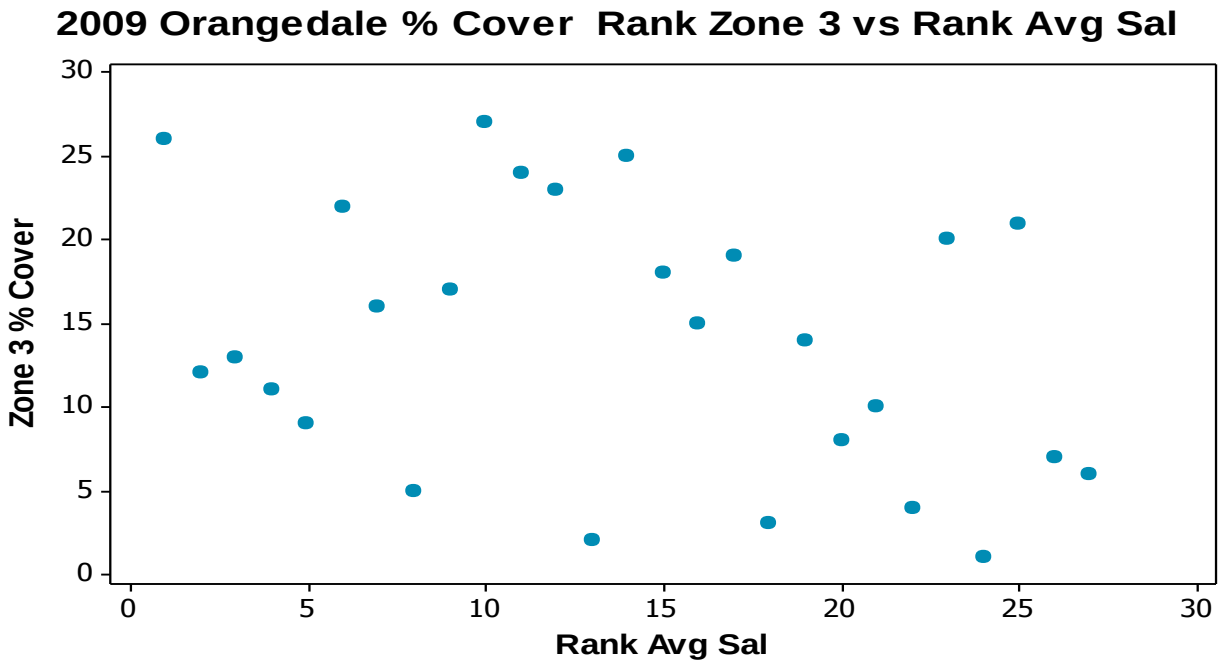

Figure 37. 2009 Orangedale correlation on the rank of zone 3 percent cover versus average seven day salinity. Pearson correlation r= -0.322, p= 0 .102

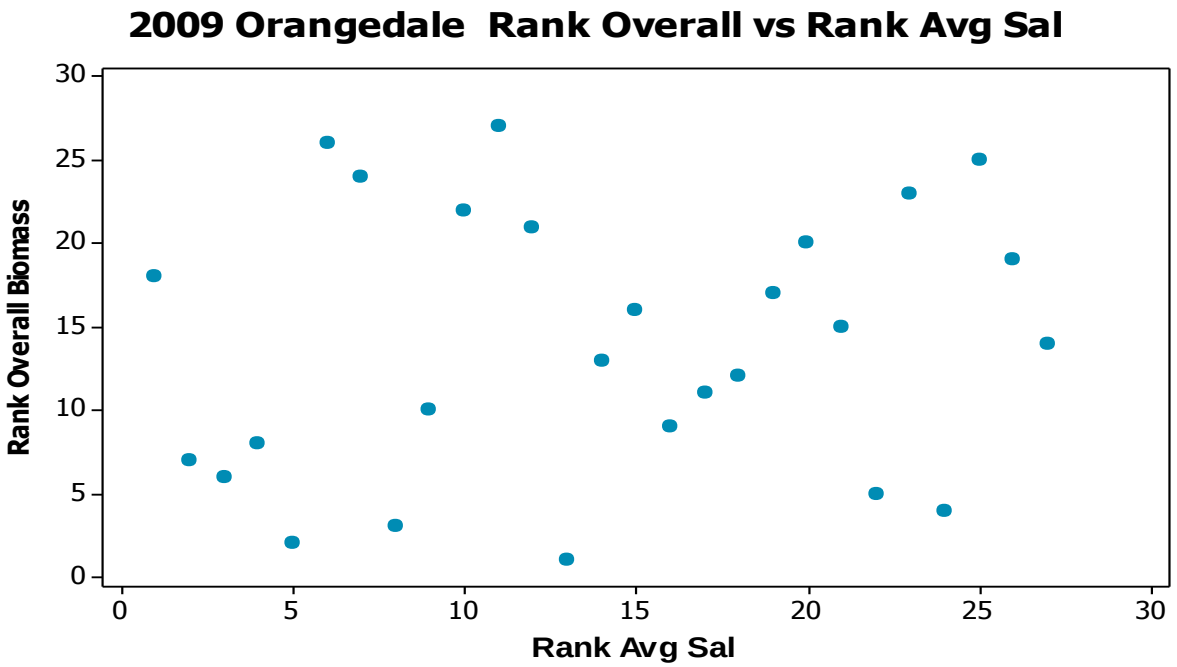

Figure 38. 2009 Orangedale correlation of the overall biomass rank versus the rank on average seven day salinity. Pearson correlation r= 0.158, p= 0.431

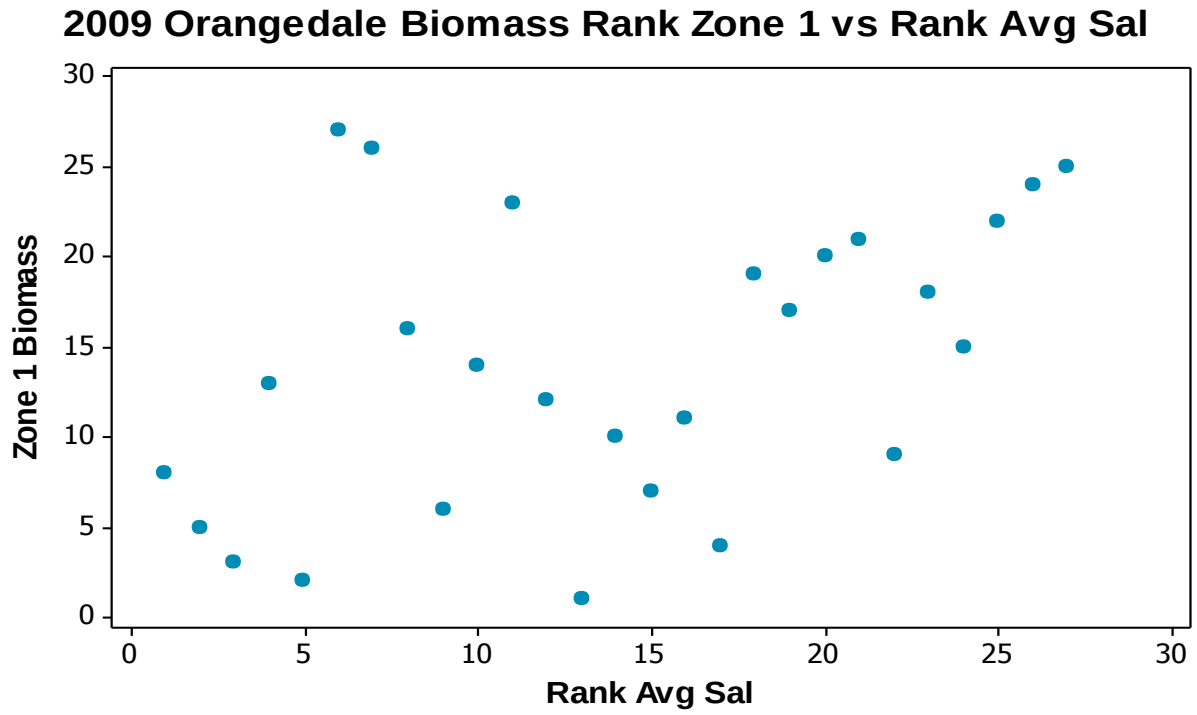

Figure 39. 2009 Orangedale correlation on the rank of zone 1 biomass versus average seven day salinity. Pearson correlation r= 0.421, p=0. 029

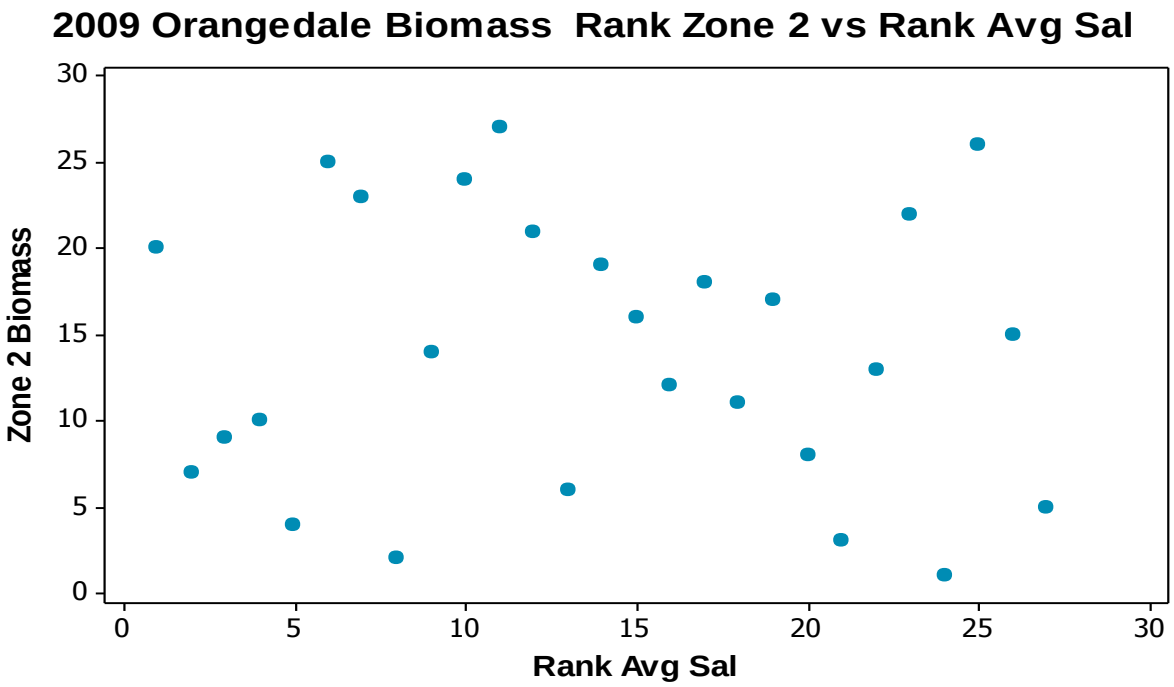

Figure 40. 2009 Orangedale correlation on the rank of zone 2 biomass rank versus average seven day salinity. Pearson correlation r= -0.068, p= 0.735

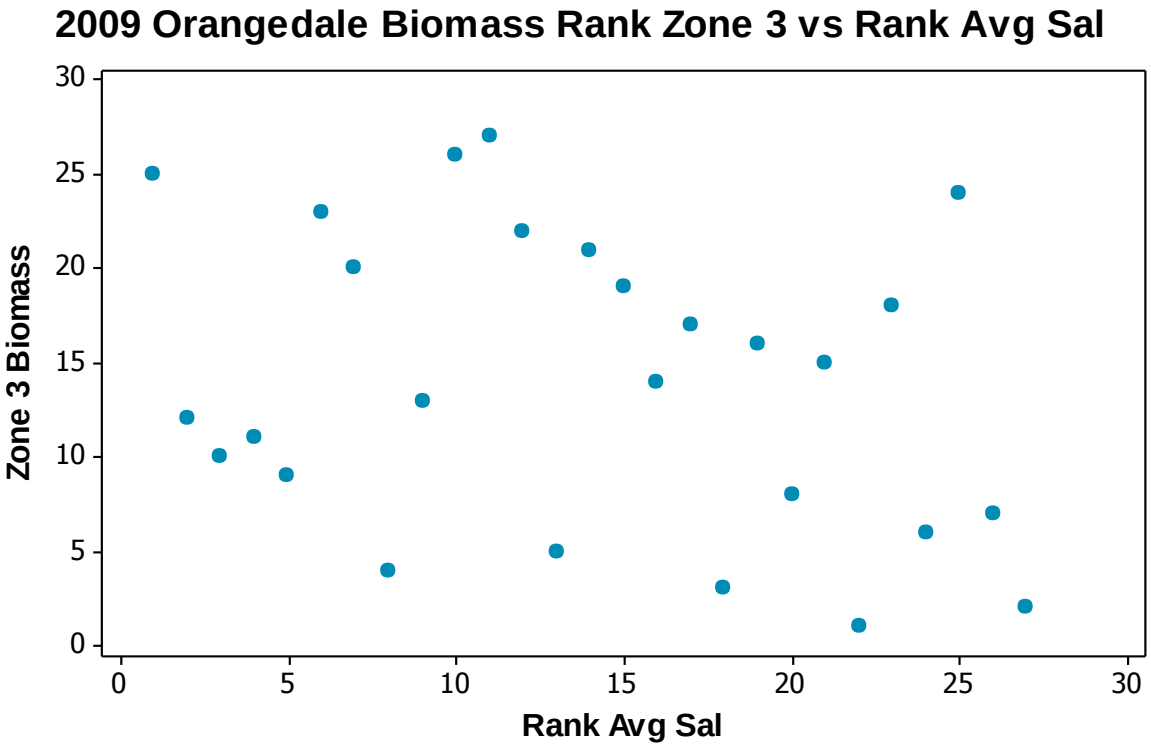

Figure 41. 2009 Orangedale correlation on the rank of zone 3 biomass rank versus average seven day salinity. Pearson correlation r= -0.287, p= 0.147

Table1. Zone descriptions of SAV sites 2008 and 2009

Site	Zone	Distance from benchmark	Notes
Zone Descriptions 2008			shore line to 7 meter from zone were 0%cover—did not include this section into any zones
Buckman	1	7-13	majority of percent cover fell between 0-30 %cover
	2	14-55	Thickest area-ranges from 0-100% cover—majority within 55-75% cover
	3	56-87	Outer edge of grassbed—majority within the 25-35% cover
Orangedale	1	0-4	Shore line ranged from 0-100 % cover, however, majority rested in the are of 10-15%
	2	5-36	Ranged from 0-100 % with majority within the 55-65 range
	3	37-113	0-100% with majority within the 35-45 range
Zone Descriptions 2009			shore line to 6 meter from zone were 0%cover—did not include this section into any zones
Buckman	1	6-17	majority of percent cover fell between 0-30 %cover
	2	18-57	Thickest area-ranges from 0-100% cover—majority within 55-75% cover
	3	57-67	Outer edge of grassbed—majority within the 25-35% cover
Orangedale	1	0-11	Shore line ranged from 0-100 % cover, however, majority rested in the are of 0-10%
	2	12-49	Ranged from 0-100 % with majority within the 40-65 range
	3	50-85	0-100% with majority within the 10-25 range

References

Schemel, L.E. 2001. Simplified conversions between specific conductance and salinity units for use with data from monitoring stations. IEP Newsletter, v. 14, no. 1, p. 17−18