Effectiveness of grazing as a *Phragmites* control and wetland restoration approach: Project update 2016

Photo: B. Duncan

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Introduction

Phragmites australis (*Phragmites*) has been infamously described as a "super weed" due to its biological and physiological abilities to create highly resilient monocultures (K. Minogue 2012 and Kettenring et al. 2012). Because of its aggressive growth and broad distribution, commonly used methods for controlling *Phragmites* are expensive, time consuming, and not very effective (Silliman et al. 2014, Hazelton et al. 2014). The most common methods for *Phragmites* control include applying herbicide, burning, flooding, trampling, and mowing (Cronk and Fennessy 2001, Hazelton et al. 2014). Used on their own, none of these methods have been successful at completely eradicating the plant on a large scale. If herbicide is applied, additional methods have to be used to remove the dead *Phragmites* litter that results from herbicide application before other plants will grow. Burning as a litter removal strategy is almost impossible to employ in Great Salt Lake wetlands because of air quality issues and the strict weather conditions needed to burn safely. In addition, burning must be used in conjunction with another method such as herbicide or flooding to prevent re-sprouting (Hazelton et al. 2014). Mowing of *Phragmites* is best done in the winter when the wetlands are frozen, can result in substantial "wear and tear" of machinery even for a few acres mowed, and also should be used in combination with other methods that can specifically target rhizome mortality (Hazelton et al. 2014). Yearly maintenance is required to keep the plant at bay after any initial treatment (Hazelton et al. 2014). These complications make it nearly impossible to achieve *Phragmites* management goals in invaded northern Utah wetlands.

Grazing is a potentially attractive management tool for controlling *Phragmites* because it is inexpensive compared to other methods such as herbicide and involves very little effort on the part of managers. In many cases, the ranchers bid for the opportunity to graze cattle in wetlands, thereby providing income to local land management agencies. This system also creates a cheap source of naturally irrigated feed for cattle. Also cow pregnancy rates increase because animals are more concentrated than they would be in a drier area with less biomass. We know that grazing is effective at removing *Phragmites* biomass based on studies conducted in Europe, although grazing has not been well-studied in the U.S. (Hazelton et al. 2014). For example, in Finland, Jutila (1999) showed that grazing significantly decreased the frequency of *Phragmites* occurrence. Brundage et al. (2010) showed that grazing by goats in Maryland significantly reduced stem number and height after two rounds of grazing by goats, and *Phragmites* biomass decreased seven-fold in grazed verses ungrazed plots. This Brundage et al. (2010) manuscript is the single published study on grazing to control *Phragmites* in North America and was done with goats. It is unknown how controlled cattle grazing may impact *Phragmites* in North American wetlands. This project investigates the impacts of grazing on a large scale to control invasive *Phragmites* in wetlands around the Great Salt Lake.

To determine the impacts of grazing, we are measuring several different aspects of vegetation, soil, and water quality in multiple Great Salt Lake wetland sites. This report focuses mainly on the impacts of grazing on vegetation that have been observed after one season of grazing (2015). To determine if grazing is an effective tool, we are tracking: (1) decreases in live *Phragmites* cover, (2) decreases in dead *Phragmites* cover and litter, and (3) increases in native plant cover.

Methods

To evaluate the impacts of cattle grazing on *Phragmites* and native plant cover, we have established an experiment in five sites in Great Salt Lake sovereign wetlands: one site is near Farmington Bay Waterfowl Management Area (WMA), two sites are near Howard Slough WMA, and two sites are near Harold Crane WMA (**Figure 1**). At each site we established paired grazed and ungrazed plots for a total of five plot pairs across the five sites. To provide initial site access to the cattle in the impenetrable *Phragmites* stands, a one acre area was mowed in grazed plots (and a comparable area was mowed in the ungrazed plot for consistency) (**Figure 2**). Cattle were introduced into the grazed sites in summer 2015 and initially congregated in the 1 acre mowed area or followed the fence line. From there, the cattle dispersed into the dense *Phragmites* over the course of the growing season. The mowed area and the fence line received the greatest concentration of grazing and impact from cattle movements, and decreasing impacts of cattle radiated out from these areas (**Figure 2**). The grazing timeframe varied from 5-8 weeks across the five sites, depending on site water levels, plant growth, and cow escapes. Cow-calf pairs and yearling heifers were used to graze the plots at a rate of approximately 30 AUM (per the advice of Great Salt Lake wetland managers and their partner ranchers). An additional bull was placed in each plot to ensure that all females had mating opportunities.

During pre- and post-grazing treatments, we tracked changes in *Phragmites* and other plant species (**Table 1**). Vegetation was tracked more intensively in grazed plots, so was also sampled during grazing. Measurements to determine a decrease in live *Phragmites* included % cover of live *Phragmites*, stem height, stem diameter, and stem density. Measurements to detect changes in dead *Phragmites* include % cover of lodged dead/litter and litter/lodged *Phragmites* depth. Percent cover of native plants was the primary measurement in detecting changes in native plants. These measurements were taken in three 1m x 1m quadrats placed along each of 12-19 transects scattered throughout each plot to capture high and low grazing intensity (**Figure 2)**.

Results

Changes in live Phragmites biomass

Although statistically significant differences in *Phragmites* metrics between grazed and ungrazed plots after this first growing season were not detected, some contrasting patterns are emerging (**Figure 3**). Overall there was a downward trend in *Phragmites* in the grazed plots for % cover of *Phragmites* (**Figure 3-A1, A2**), stem height (**Figure 3-B1, B2**), and stem density (**Figure 3-C1, C2**). In the ungrazed control plots, there was an increase in *Phragmites* cover and stem height between the early growing season vs. late season sampling. For stem density, the control plots experienced a decrease similar to the grazed plots, although not as extensive.

Changes in dead Phragmites litter cover and litter depth

A non-significant increase in % litter cover occurred over time in the control plots, whereas litter decreased slightly in the grazed plots (**Figure 4-A1, A2**). There was a large amount of variation in % litter cover between plots, especially in the post grazing treatment (**Figure 4-A1**). In all cases, the average % litter cover was very high (between 80% and 90% in all plots). Lodged *Phragmites*/litter depth also decreased over time in the grazed plots (**Figure 4-B1, B2**). While the litter depth increased on average about 10 cm in the control, there was an average decrease in litter depth of 10 cm in the grazed plots. Here, litter is used roughly to include lodged, dead *Phragmites*, and the smaller fragments beneath.

Changes in native plants

Preliminary results indicate very few native plants both before and after grazing (**Figure 5-A1, A2**; <1% cover in all cases); the control showed a very slight increase in cover, while the grazed shows an even slighter decrease (**Figure 5-A1, A2**). It will take more time and monitoring to see if there is any recovery of native species.

Discussion

Overall, although we are not yet seeing dramatic results to date, trends in the data are in the direction we expected. We are observing decreases in *Phragmites* and litter associated with cattle grazing. Additionally, the fact that our initial "pre" *Phragmites* measurements were taken before the plants were fully grown may be partially masking some meaningful patterns. Even though *Phragmites* cover and height did not decrease dramatically over time in grazed plots in this first year of the study, the fact that *Phragmites* cover and height *increased* over time in ungrazed plots, suggests that cattle were in fact reducing *Phragmites*. Stems in grazed plots were roughly 85 cm shorter than they would have been without grazing. Stem counts were interesting because they appeared to decrease slightly over time in both the grazed and ungrazed plots; this may reflect smaller sprouts being out competed by larger more successful sprouts, though further monitoring is needed.

Litter appeared to increase over time in control plots, but decrease in grazed plots. Litter likely increases over time as stems die off, but there may have been less dead matter in grazed plots. It should be noted that, because cattle trampling was so patchy, lodged and litter depth measurements may not have fully captured cattle effects. We are investigating using remote imagery to assess lodged *Phragmites* and litter in our 2016 sampling.

Native plants were generally very low in cover in all plots, though they increased over time in ungrazed plots. It is possible that some native plant cover was lost in grazed plots due to cattle consumption and/or trampling, but longer-term monitoring is required to elucidate patterns with *Phragmites* removal.

Conclusion

Although we are not seeing many significant changes yet, we are still in the early phases of the study. After the next year of grazing (2016), we expect to see clearer results. Much of the variability on the plot scale comes from different water levels at each site, different lengths of grazing at each site, and different amounts of litter that impeded cattle more at some sites than at other sites. As we go further into the statistical testing and as statistical trends become stronger, we should be able to tease out some of this variability.

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Table 1. Response variables used to track grazing impacts of wetland vegetation. The green cells are the measurements covered in this report. We will report on the additional metrics in subsequent reports.

Measurements	Pre-grazing	During (grazed plots only)	Post-grazing
% live *Phragmites* cover	X	X	X
% cover *Phragmites* lodged dead/litter	X	X	X
% cover standing dead *Phragmites*	X	X	X
% cover native plants	X		X
% cover bare ground	X	X	X
% cover open water	X	X	X
Phragmites stem height	X	X	X
Phragmites stem diameter	X		X
Phragmites stem density	X		X
Soil bulk density	X		X
Soil water moisture	X		X
Leaf samples for nutrients	X		X
Soil samples for nutrients	X		X
Water samples for nutrients (FB only)		X	X
Cow dung samples for nutrients		X	

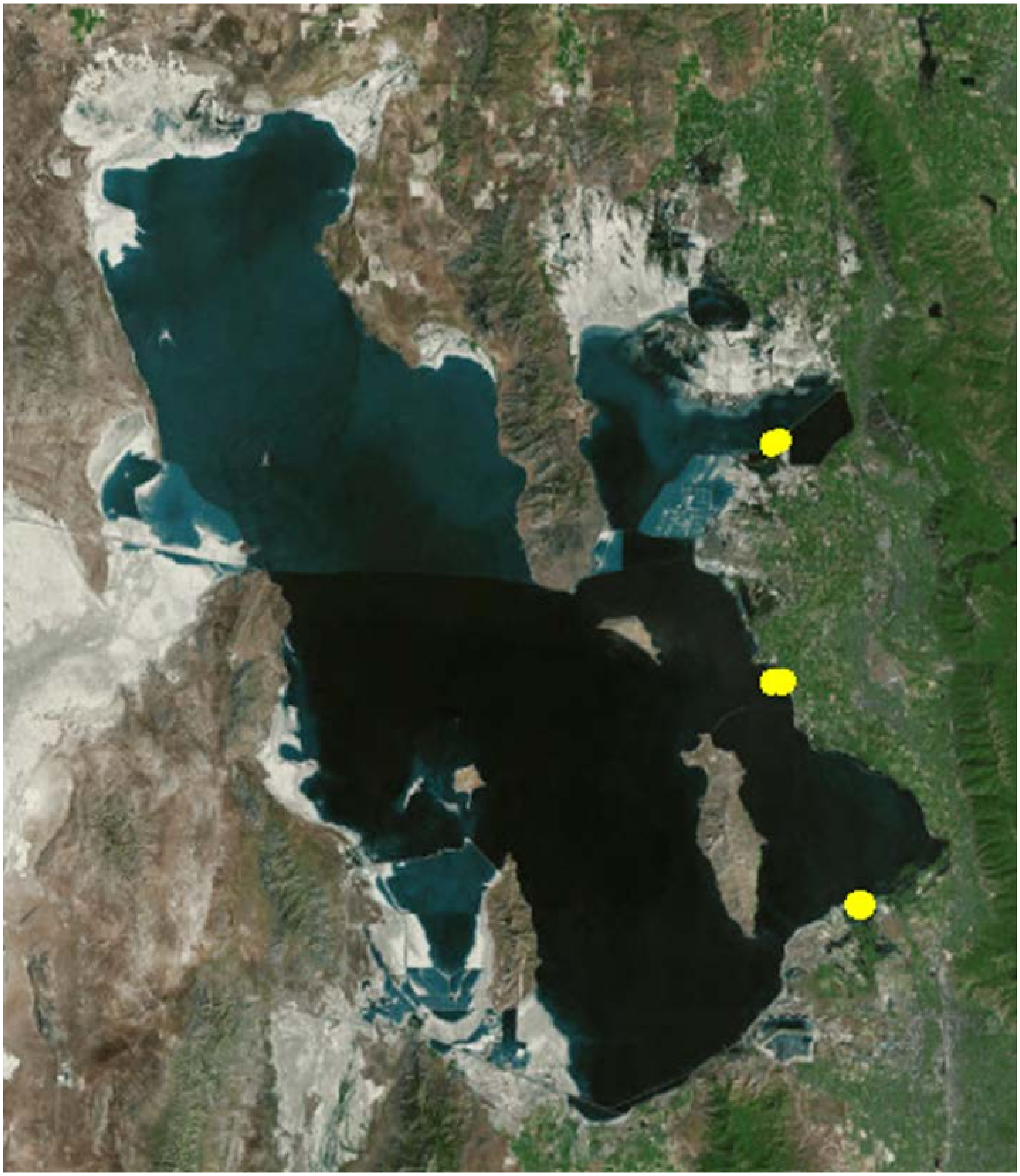

Figure 1. Location of plots around the Great Salt Lake. From north to south: we installed two paired plots at Harold Crane, two paired plots at Howard Slough, and one pair of plots at Farmington Bay. Map courtesy of Google Earth.

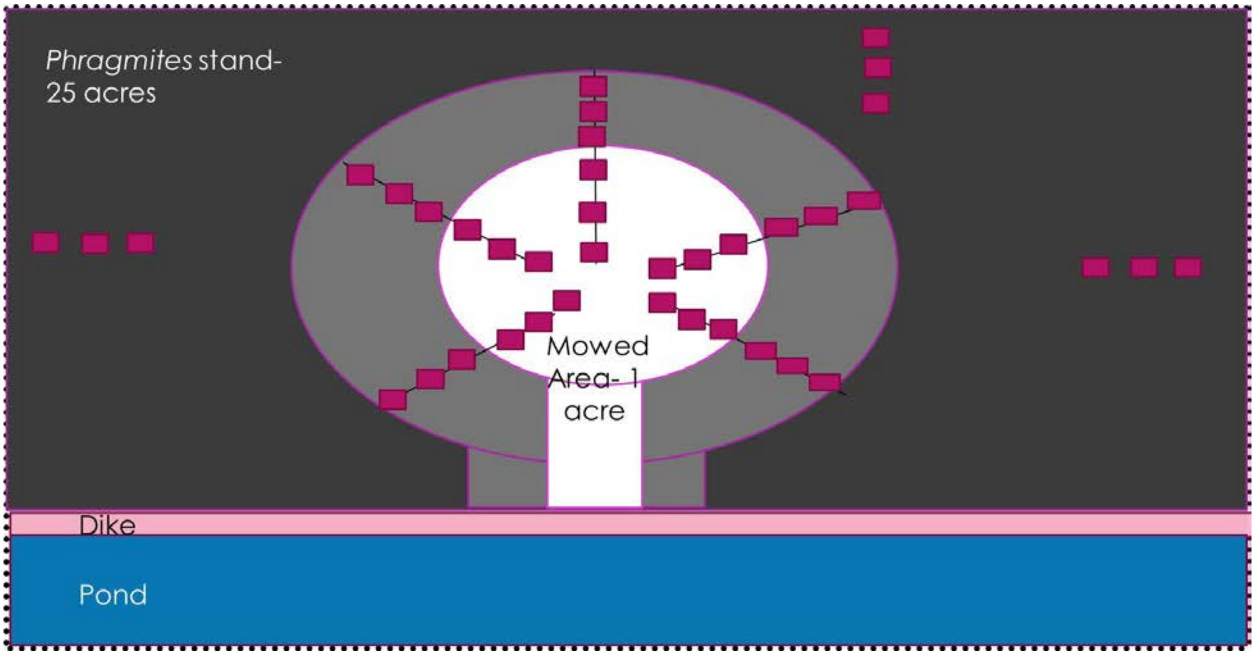

Figure 2. Sampling layout at each plot. Each plot is about 25 acres with a mowed entry pathway ~100m long (white) and a 1 acre mowed central, circular area (white). The short, black lines represent transects. Each transect had 3 – 1m x 1m quadrats evenly spaced along the transect. Transects were placed in the mowed area with potentially highest grazing (white), moderately grazed area (light gray), and lightly grazed area (dark gray).

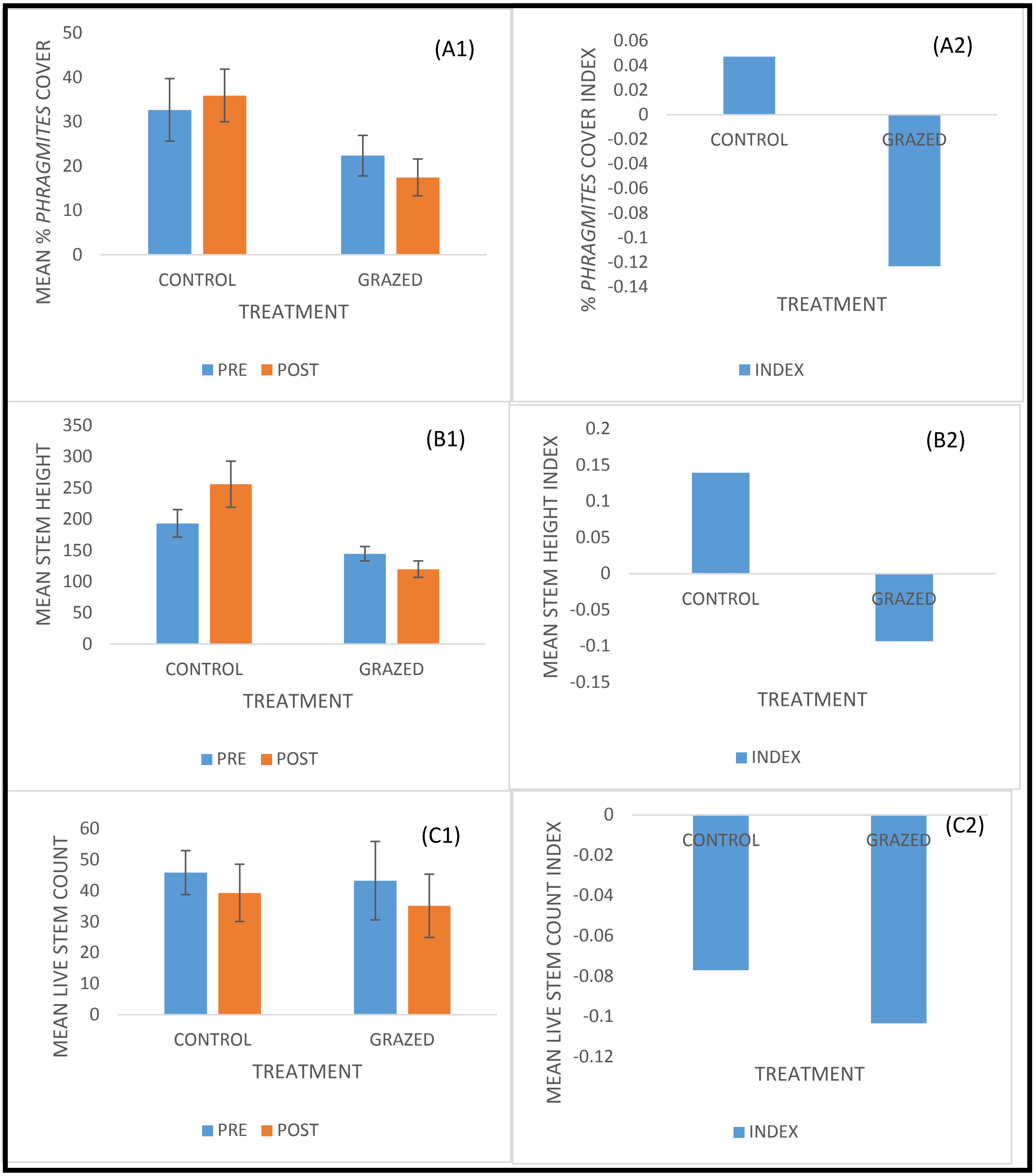

Figure 3. Changes in live *Phragmites* for **(A1)** % *Phragmites* cover, **(B1)** *Phragmites* stem height in cm, and **(C1)** *Phragmites* stem count. Error bars are ± 1 SE. For the left column of graphs, blue is pre-treatment and orange is post-treatment for cattle grazing. In the right column of graphs, an index of change over time in the control and the grazed plots is presented. This index is a relative number and was calculated using the following formula: Index= (POST-PRE)/(POST+PRE). The y-axis ranges from 1 to -1. Zero means no change in the metric;

positive numbers indicate an increase, and negative numbers indicate a decrease. **(A2)** % *Phragmites* cover index, **(B2**) *Phragmites* stem height index, and **(C2)** Live stem count index.

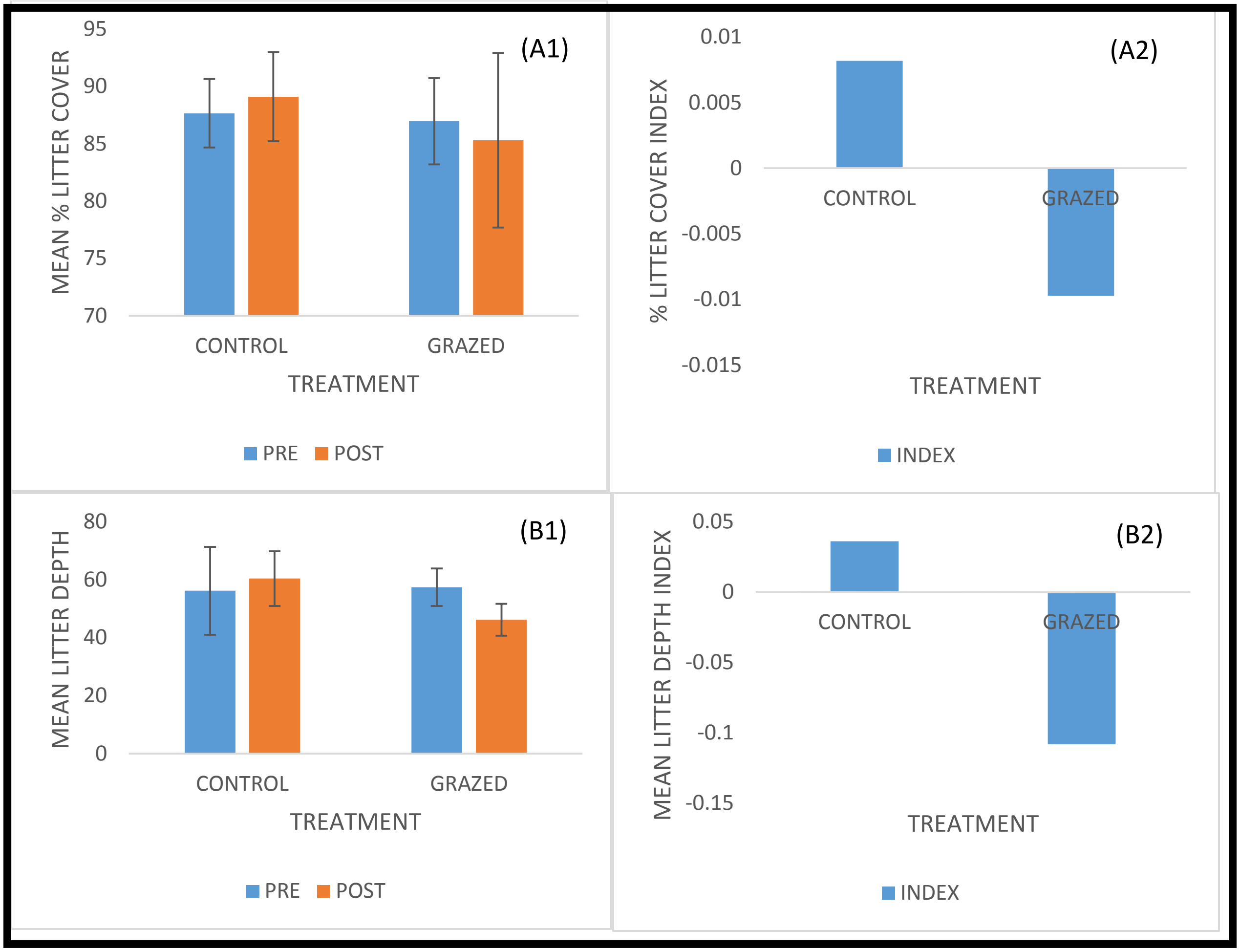

Figure 4. Changes in dead *Phragmites* cover and litter. The graphs in the left column display means of **(A1**) percent litter cover and **(B1)** litter depth (cm). Error bars are ± 1 SE. For the left column of graphs, blue is pre-treatment and orange is post-treatment. In the right column of graphs, an index of change over time in the control and the grazed plots is presented. This index is a relative number and was calculated using the following formula: Index= (POST-PRE)/(POST+PRE). The y-axis ranges from 1 to -1. Zero means no change in the metric; positive numbers indicate an increase and negative numbers indicate a decrease. **(A2)** % litter cover index and **(B2)** litter depth index.

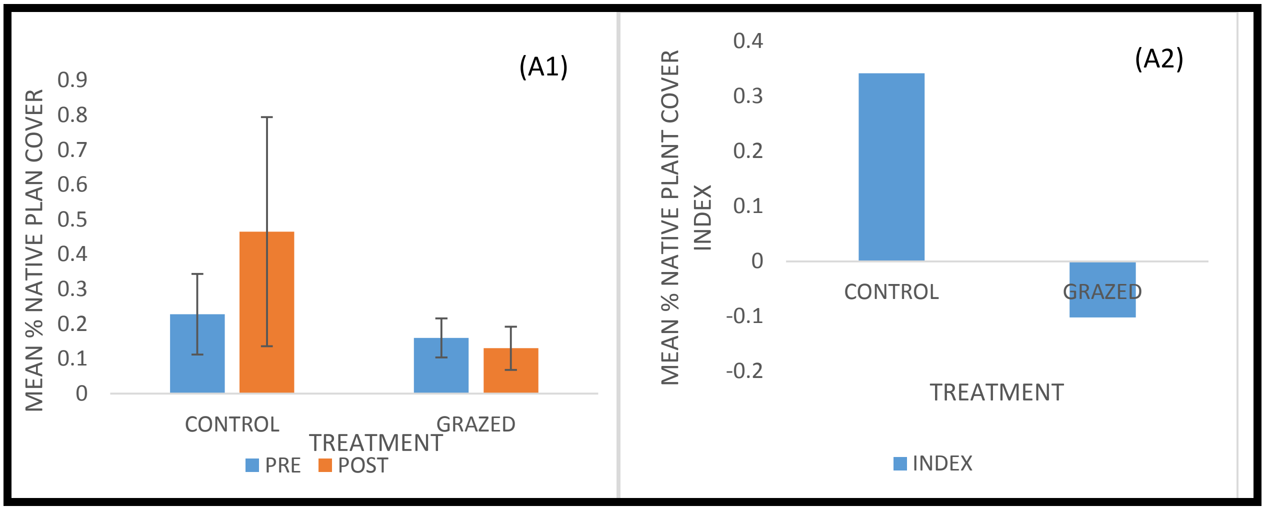

Figure 5. Changes in native plant cover. The graph on the left displays the mean **(A1**) percent native plant cover. Error bars are ± 1 SE. In graph A1, blue is pre-treatment and orange is post-treatment. In graph A2, an index of change over time in the control and the grazed plots is presented. This index is a relative number and was calculated using the following formula: Index= (POST-PRE)/(POST+PRE). The y-axis ranges from 1 to -1. Zero means no change in the metric; positive numbers indicate an increase and negative numbers indicate a decrease. **(A2)** % native plant cover index.