Objective 1

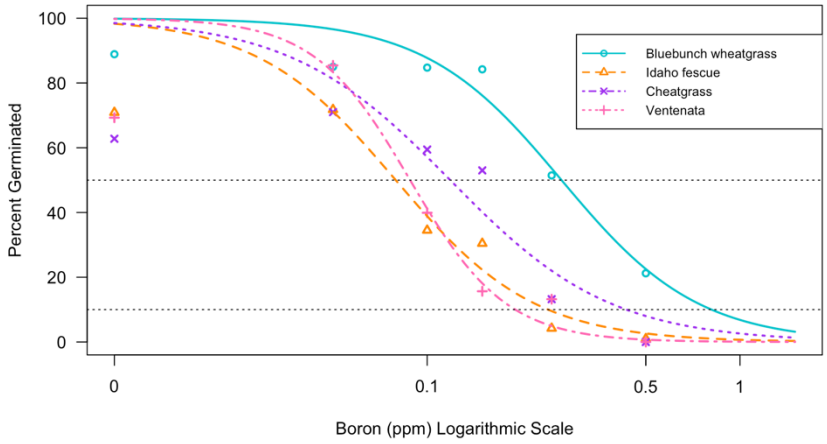

Figure 1: Impact of boron (NutraFix) applications on germination of native perennial grasses and non-native annual grasses, for two trials. Ten seeds were placed in a Petri dish and monitored for 21 days in a growth chamber (20°/15°C, 10/14 light dark hours). The percentage of the number of viable seeds that germinated was recorded. Dose response curves fit with an LL.4 model with horizontal lines representing ED50 (the dose where germination is reduced by 50%) and ED90 rates. Bluebunch wheatgrass was the least impacted by boron application, followed by cheatgrass, then ventenata and Idaho fescue which did not differ from each other.

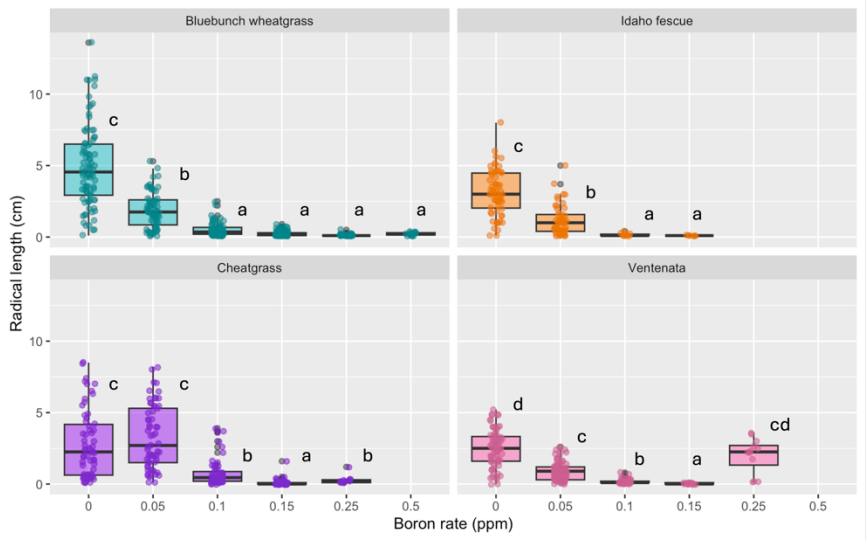

Figure 2: Impact of boron (NutraFix) applications on radical length (cm) of native perennial grasses and non-native annual grasses. Ten seeds were placed in a Petri dish and monitored for 21 days in a growth chamber (20°/15°C, 10/14 light dark hours) after which the length of each radical was measured. Compact letter display shows differences between rates within each species. A different letter signifies a difference in radical length due to boron application.

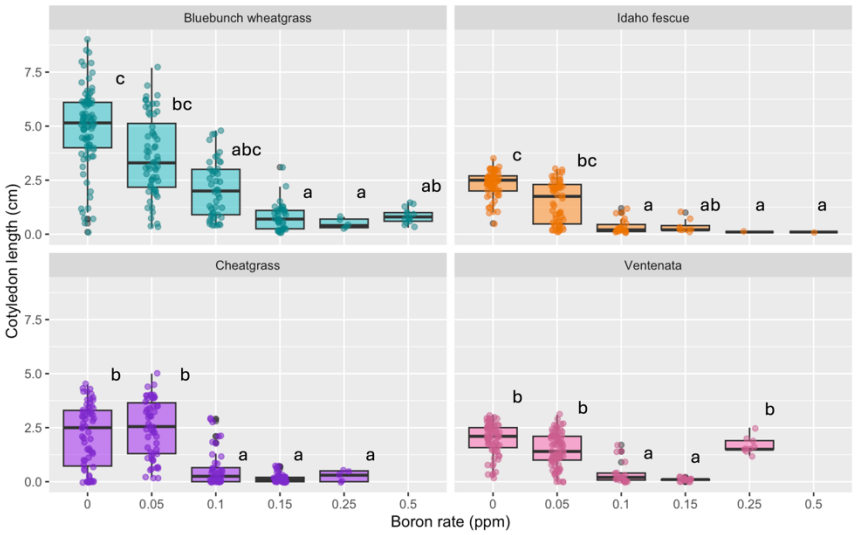

Figure 3: Impact of boron (NutraFix) applications on cotyledon length (cm) of native perennial grasses and non-native annual grasses. Ten seeds were placed in a Petri dish and monitored for 21 days in a growth chamber (20°/15°C, 10/14 light dark hours) after which the length of each cotyledon was measured. Compact letter display shows differences between rates within each species. A different letter signifies a difference in cotyledon length due to boron application.

Objective 3

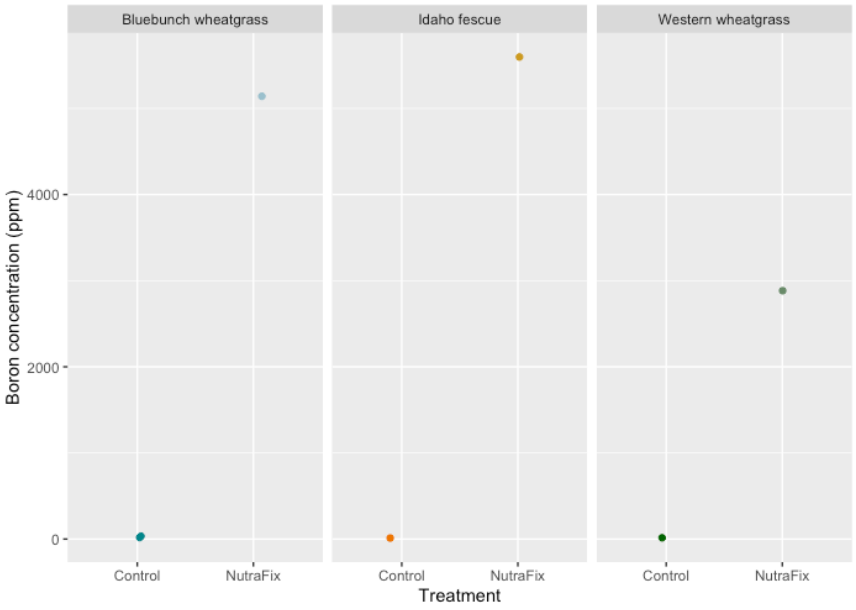

Figure 4: Above-ground biomass of perennial grass species had higher concentrations of boron (ppm) than non-treated controls. Individual plants were grown in a controlled environment for a total of 34 weeks, aboveground biomass was harvested eight weeks post treatment and assessed for boron content, but insufficient biomass was produced to allow for statistical analysis.

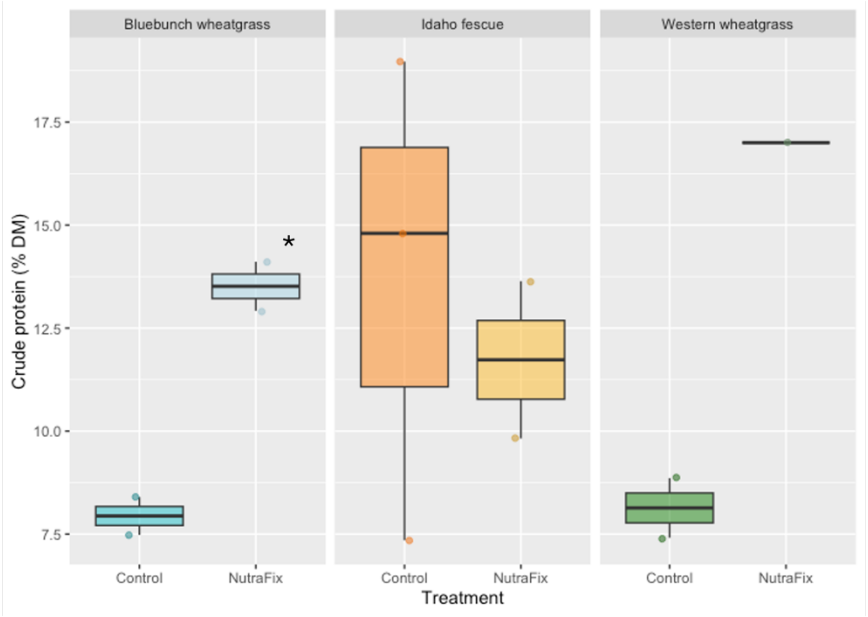

Figure 5: Crude protein (% dry matter) was higher in bluebunch and western-wheatgrass plants treated with aqueous boron, but Idaho fescue plants did not differ. Individual plants were grown in a controlled environment for a total of 34 weeks, aboveground biomass was harvested eight weeks post treatment and assessed for boron content. Asterisk signifies a statistically significant difference.

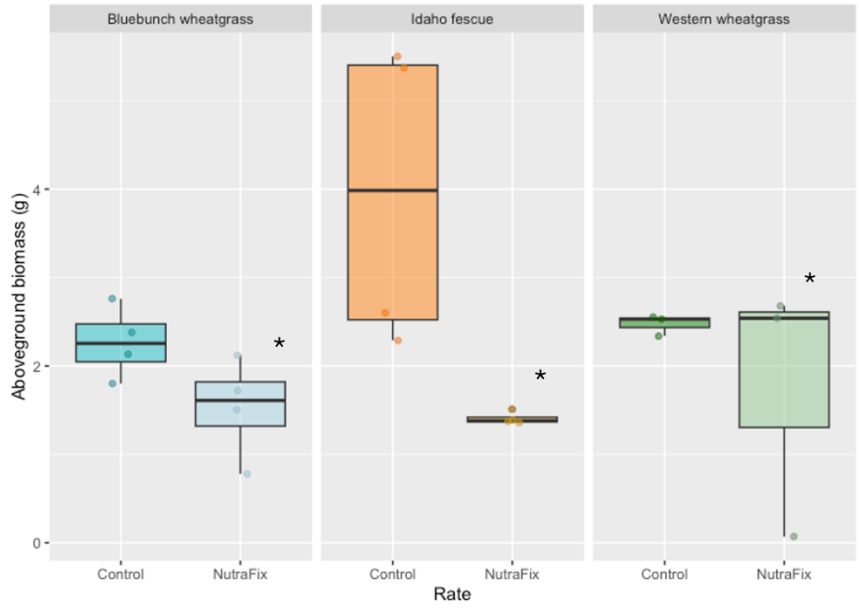

Figure: 6: Aboveground biomass (g) trended higher in perennial grasses not treated with the aqueous boron. Individual plants were grown in a controlled environment for a total of 34 weeks, aboveground biomass was harvested eight weeks post treatment and assessed for boron content. Asterisks signify a statistically significant difference.

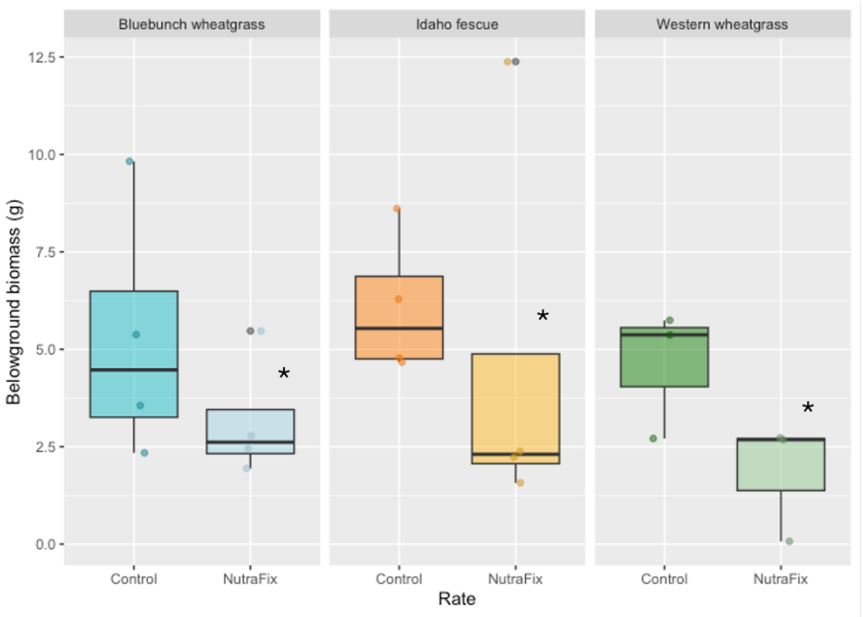

Figure 7: Belowground biomass (g) trended higher in perennial grasses not treated with the aqueous boron. Individual plants were grown in a controlled environment for a total of 34 weeks, aboveground biomass was harvested eight weeks post treatment and assessed for boron content. Asterisks signify a statistically significant difference.

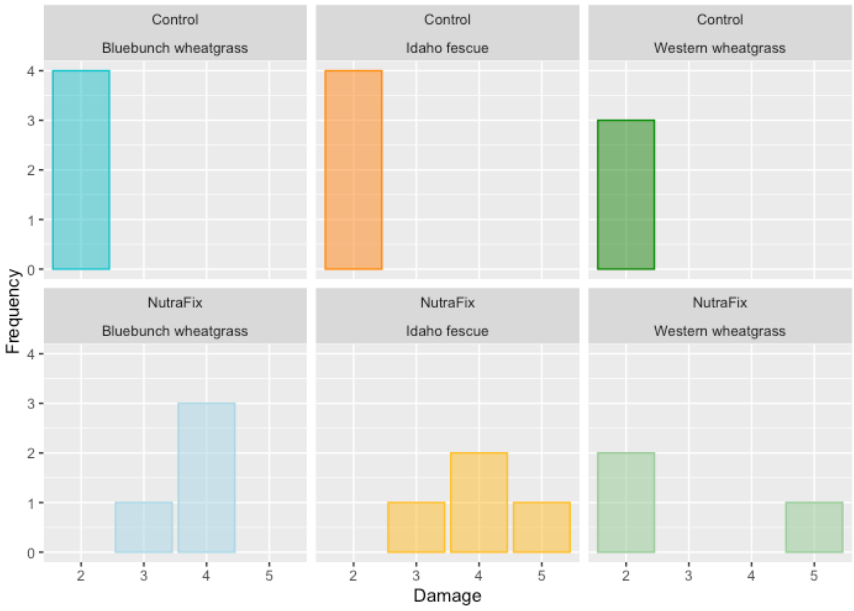

Figure 8: Distribution of observed damage of perennial grasses treated with the aqueous boron (NutraFix) and non-treated controls. Individual plants were grown in a controlled environment for a total of 34 weeks, aboveground biomass was harvested eight weeks post treatment and assessed for boron content. Damage values range from 1-5 (1: not damaged– 5: very damaged).

Objective 4

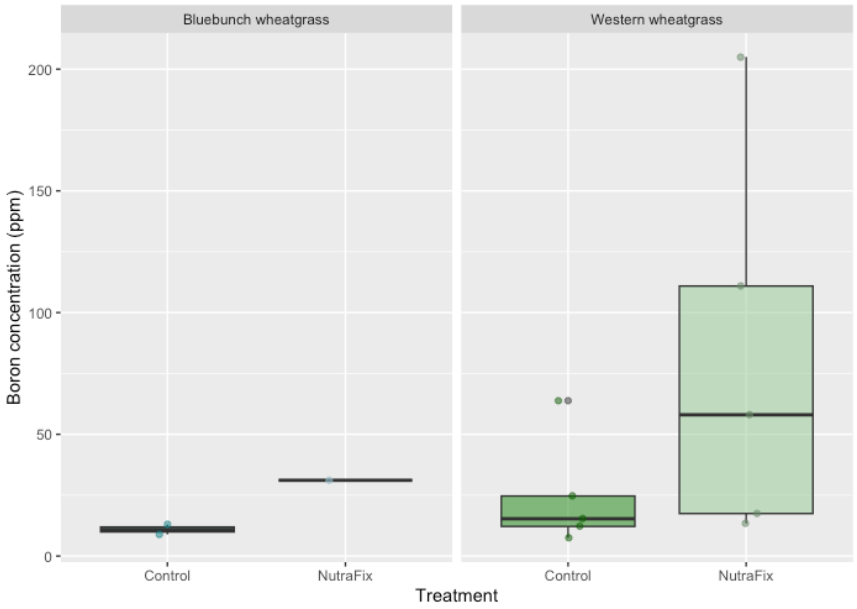

Figure 9: Boron concentration (ppm) trended higher in perennial grasses treated with NutraFix and non-treated controls under field conditions. Plots were established at two semi-arid rangelands in the fall of 2020 and sampled in mid-July of 2024. Each site contained 5 treatment replicates, and all were sampled, however not all plots contained the target species. All aboveground biomass of western wheatgrass or bluebunch wheatgrass individuals present were collected from each plot (3.125 m^2).

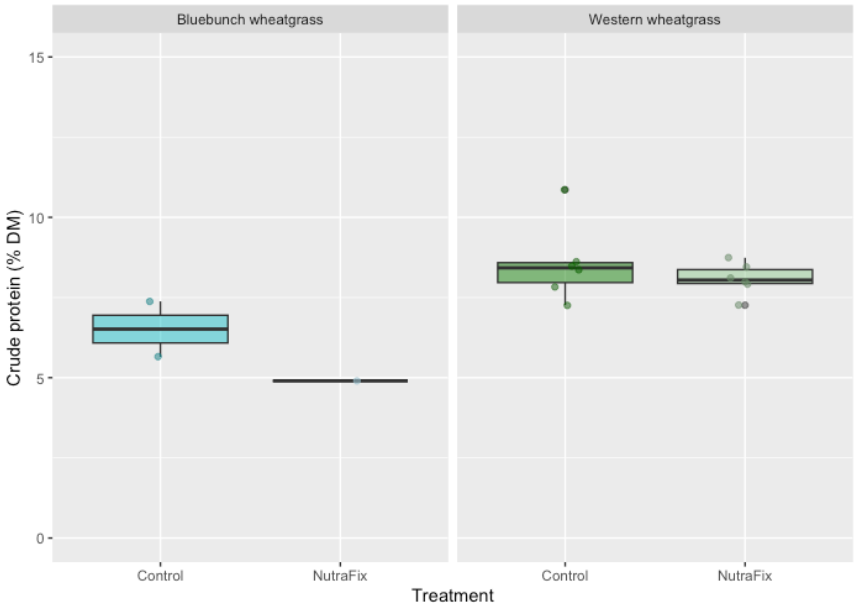

Figure 10: Crude protein content (% dry matter) of perennial grasses treated with NutraFix and non-treated controls under field conditions. Plots were established at two semi-arid rangelands in the fall of 2020 and sampled in mid-July of 2024. Each site contained 5 treatment replicates, and all were sampled, however not all plots contained the target species. All aboveground biomass of western wheatgrass or bluebunch wheatgrass present were collected from each plot (3.125 m^2).

Table 1: Mean values of soil analysis for each management treatment collected four years post treatment application. Results are averaged over site, only boron showed a difference at the $p<0.05$ level.

	Nitrate (#/acre)	Phosphorous (ppm)	Potassium (ppm)	Sulfur (#/acre)	Boron (ppm)	Zinc (ppm)	Iron (ppm)	Manganese (ppm)	Copper (ppm)	Magnesium (ppm)	Calcium (ppm)	Sodium (ppm)	OM (%)	pH
Control	2.5	9.7	334.1	14.6	**0.2**	1.3	46.3	32.9	0.7	211.4	1880.1	10.4	2.5	6.9
NutraFix	3.6	9.7	335.4	14.7	**0.7***	1.6	33.7	27.7	0.8	218.4	1875.4	9.8	2.9	6.8