SHRUB AND ASPEN BROWSE MONITORING ON THE ZUMWALT PRAIRIE PRESERVE

PROJECT STATUS REPORT – NOVEMBER 2012

Robert V. Taylor[1]

1 - Northeast Oregon Regional Ecologist, The Nature Conservancy, Enterprise, OR (rtaylor@tnc.org)

ABSTRACT

Monitoring of the effects of ungulate herbivory on aspen (*Populous tremuloides*), hawthorn (*Crataegus douglasii*), and serviceberry (*Amelanchier alnifolia*) was conducted on the Zumwalt Prairie Preserve from 2010-2012 in three different area types, each having a different suite of ungulate herbivores. Only areas where all ungulates (wild and domestic) were excluded had browse levels low enough to allow for aspen and shrub recruitment. In all areas where elk (*Cervus elaphus*) and mule deer (*Odocoileus hemonius*) had access, browse levels were intense and leader growth was insufficient to allow for shrub browth. Areas where domestic cattle (*Bos Taurus*) were grazed were mostly similar to those where they were excluded but for which elk and deer had access. Results indicate that elk and/or deer are primary cause of intense browse on the Zumwalt Prairie Preserve and are limiting recruitment of aspen and deciduous shrubs.

INTRODUCTION

In 2010 The Nature Conservancy conducted an assessment of aspen and shrub herbivory on the Zumwalt Prairie Preserve which revealed that over 95% of sites were subject to "intense browse" thereby limiting recruitment of these valuable plant communities (Taylor and Arends 2011). That same year a monitoring program was initiated to track aspen and shrub browse over time as a way of evaluating whether management actions being taken to reduce browse are effective (Taylor and Arends 2011). A key feature of this program is that monitoring is done in three types of areas, each of which is subject to a different suite of ungulate herbivores. In "complete" exclosures, tall fences (e.g., 6 rail buck and pole fences) were built in relatively small (0.1 – 2 ha) areas with the intent of excluding, or at least significantly deterring, entry by wild ungulates and cattle. Cattle-only exclosure areas are relatively large (10 – 200 ha) pastures fenced with 3-4 strand barbed wire or temporary electric fences; they are not grazed by livestock but are accessible to wild ungulates, primarily elk and mule deer. Areas having no exclosure ("un-exclosed") are similar to cattle-only areas, but these pastures are grazed by domestic cattle for up to 45 days in spring, summer, or fall as part of the Conservancy's livestock grazing program (Freeman 2008). In this report I present results from the three years

of browse monitoring conducted, discuss the implications of these findings as they pertain to browsing by livestock vs. wild ungulates and their effects on aspen and deciduous shrub communities, and make recommend a plan for future monitoring.

STUDY AREAS AND SURVEY SITES

To date 31 browse monitoring sites have been established of which 10 are un-exclosed, 11 are within cattle-only exclosures and 10 are completely exclosed (Figure 1). Fifteen sites were established and surveyed in 2010 (only one of which was a cattle-only exclosure). The following year 4 sites were added, all in cattle-only exclosures. In 2012 an additional 12 sites were added in a mix of exclosure types, and one site removed because it was located too close to a fence. There were thus a total of 30 sites surveyed in that year.

METHODS

I used the "Live-Dead Index" (LDI) method (Keigley et al. 2002) for assessing shrub browse on aspen (POTR5), hawthorn (CRDO2), serviceberry (AMAL2). At each site a field technician measured LDI on a maximum of 6 individuals of each of the three species. LDI values above zero indicate that a shrub has increasing in height as a result of terminal leader growth . Zero or negative values indicate the shrub is either unable to increase in height or is being reduced by intense ungulate browse. A detailed description of the methods can be found in Taylor and Arends (2011).

Data were analyzed by first averaging the LDI for each species at each survey site. A measure of LDI for a species within a given exclosure type is calculated by averaging the LDI values for that species across all survey sites of that type. To test whether there were differences in LDI values across exclosure types or across years the analysis of variance method (JMP 10.0 2012) was used. If overall differences were found, pairwise comparisons were made using the Tukey-Kramer HSD (honestly significant difference) test (JMP 10.0 2012). Differences were considered "significant" using the alpha value of 0.1, thus allowing only a 10% chance of reporting a difference when none actually existed.

RESULTS AND DISCUSSION

When data were pooled across all years, significant differences were found between exclosure types for all species (Figure 1, Appendix 1). LDI values for serviceberry and hawthorn were significantly higher in complete exclosures than for un-exclosed areas or those with cattle-only exclosures. There was no difference between un-exclosed areas and cattle-only exclosures. For aspen, areas completely exclosed had significantly higher LDI values than un-exclosed areas but were not different from cattle exclosed areas. Aspen LDI values in cattle exclosed areas also did not differ from un-exclosed areas. These results suggest that, cattle contributed to aspen browse to some degree. However, the sample sizes used in these comparisons were quite small due to the fact that prior to 2012, none of the cattle-only exclosure sites had aspen within them and in 2012 data were available from only 3 sites.

I also examined data year by year, looking for trends in LDI over time (Figure 2). Because sample sizes of an individual species in a given year were small (between 1 and 11; Appendix 2a), observations of the three species were pooled and ANOVA used to test for differences among exclosure types by year. For all three years, ANOVA results suggested significant and consistent differences among site types concordant with the combined-year results for hawthorn and serviceberry . Complete exclosures had significantly higher LDI values than both cattle-only and un-exclosed sites whereas no differences in LDI values were found between cattle-only and un-exclosed sites (Figure 2; Appendix 2b). Though sample sizes are insufficient to rigorously test for trends in LDI values by species across years, examination of the data reveals possible increasing trends in LDI for aspen in the single, un-exclosed site that was monitored, though values for all years were below zero in 2012 indicating browse levels high enough to preclude recruitment. Average LDI values also increased for serviceberry and hawthorn in cattle-only exclosure areas from 2010 to 2012. It should be noted, however that only a single site was monitored in 2010 and 95% confidence intervals for all years overlap broadly. For hawthorn these estimates strongly suggest intense herbivory in the cattle-only exclosures whereas for serviceberry, actual LDI values were close to zero and may have been either positive or negative in these areas in both 2011 and 2012.

CONCLUSION AND MANAGEMENT IMPLICATIONS

Browse monitoring across the three exclosure types strongly suggest that browse levels were intense for aspen, hawthorn, and serviceberry in all areas of the ZPP except where tall, elk and deer resistant exclosures have been built. In areas grazed by cattle and also in areas where cattle have been excluded for several years, intense browse limits aspen and shrub growth and recruitment. Given these results, elk, given their high numbers relative to deer, are suspected of being the primary agent of intense browsing on the ZPP with cattle playing, perhaps, a secondary role for aspen. Because cattle management on the ZPP likely differs from other areas of the Zumwalt Prairie, the results presented here do not necessarily apply to other properties in the area. The Conservancy grazes cattle at relatively low stocking rates, rotates cattle among pastures, and generally limits late-season grazing in areas having significant amounts of aspen, deciduous shrub, or riparian vegetation. On ranchers where producers practice season long-grazing and cattle are stocked at higher rates, aspen and deciduous shrubs may experience negative impacts due to overbrowse by cattle (Parsons et al. 2003). For the ZPP, however, the results clearly suggest maintaining and enhancing aspen and shrub communities will require the installation wild ungulate resistant fencing or otherwise addressing elk and deer browse through increased hunting or other management actions.

REFERENCES

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APPENDIX 1 – LDI BY SPECIES (POOLED ACROSS ALL YEARS)

APPENDIX 1A – SUMMARY STATISTICS

PlantID	No Exclosure	Cattle-only	Complete
AMAL2	-6.3 ± 6.4 (n = 14)	-4.7 ± 7.4 (n = 9)	25.0 ± 18.6 (n = 20)
CRDO2	-11.4 ± 9.8 (n = 21)	-10.9 ± 7.1 (n = 17)	23.2 ± 20.8 (n = 22)
POTR5	-24.3 ± 24.7 (n = 3)	-0.4 ± 10.7 (n = 3)	26.6 ± 24.3 (n = 25)

APPENDIX 1A – STATISTICAL TESTS

AMAL2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Exclosure	2	10056.103	5028.05	26.6013	<.0001*
Error	40	7560.618	189.02		
C. Total	42	17616.721			

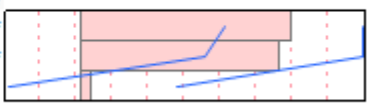
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 90%	Upper 90%
Un-exclosed	14	-6.315	3.6744	-12.50	-0.128
Cattle-only	9	-4.713	4.5828	-12.43	3.004
Complete	20	24.950	3.0742	19.77	30.127

Std Error uses a pooled estimate of error variance

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Complete	Un-exclosed	31.26548	4.790812	21.1438	41.38711	<.0001*
Complete	Cattle-only	29.66296	5.518378	18.0042	41.32173	<.0001*
Cattle-only	Un-exclosed	1.60251	5.873910	-10.8074	14.01242	0.9598



CRDO2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Exclosure	2	16486.740	8243.37	39.6543	<.0001*
Error	57	11849.199	207.88		
C. Total	59	28335.939			

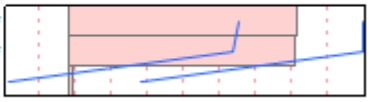
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 90%	Upper 90%
Un-exclosed	21	-11.406	3.1463	-16.67	-6.14
Cattle-only	17	-10.936	3.4969	-16.78	-5.09
Complete	22	23.201	3.0739	18.06	28.34

Std Error uses a pooled estimate of error variance

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Complete	Un-exclosed	34.60631	4.398659	25.3938	43.81887	<.0001*
Complete	Cattle-only	34.13703	4.655899	24.3857	43.88835	<.0001*
Cattle-only	Un-exclosed	0.46928	4.703972	-9.3827	10.32128	0.9945



POTR5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Exclosure	2	8196.526	4098.26	7.3741	0.0027*
Error	28	15561.352	555.76		
C. Total	30	23757.878			

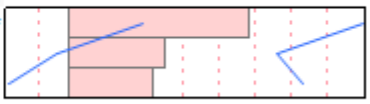
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 90%	Upper 90%
Un-exclosed	3	-24.306	13.611	-47.46	-1.152
Cattle-only	3	-0.389	13.611	-23.54	22.765
Complete	25	26.597	4.715	18.58	34.617

Std Error uses a pooled estimate of error variance

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Complete	Un-exclosed	50.90222	14.40433	20.0840	81.72042	0.0040*
Complete	Cattle-only	26.98556	14.40433	-3.8326	57.80375	0.1651
Cattle-only	Un-exclosed	23.91667	19.24859	-17.2659	65.09921	0.4388



APPENDIX 2 – LDI BY SPECIES AND BY YEAR

APPENDIX 2A – SUMMARY STATISTICS

PlantID	Yr	No Exclosure	Cattle-only	Complete
AMAL2	2010	-8.6 ± 10.0 (n = 3)	-19.0 ± 0.0 (n = 1)	20.9 ± 17.5 (n = 6)
	2011	-1.8 ± 4.3 (n = 2)	-6.6 ± 5.7 (n = 3)	34.5 ± 21.8 (n = 6)
	2012	-6.6 ± 5.6 (n = 9)	-0.8 ± 4.5 (n = 5)	20.8 ± 16.5 (n = 8)
CRDO2	2010	-10.5 ± 8.6 (n = 6)	-17.5 ± 0.0 (n = 1)	20.1 ± 21.8 (n = 8)
	2011	-11.5 ± 14.3 (n = 5)	-11.2 ± 7.5 (n = 5)	20.4 ± 20.7 (n = 8)
	2012	-11.9 ± 9.0 (n = 10)	-10.2 ± 7.3 (n = 11)	31.1 ± 21.4 (n = 6)
POTR5	2010	-52.6 ± 0.0 (n = 1)	no data	26.9 ± 29.0 (n = 8)
	2011	-7.3 ± 0.0 (n = 1)	no data	21.3 ± 17.6 (n = 8)
	2012	-13.0 ± 0.0 (n = 1)	-0.4 ± 10.7 (n = 3)	31.1 ± 26.6 (n = 9)

APPENDIX 2B – STATISTICAL TESTS

2010

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Exclosure	2	11025.443	5512.72	12.9854	<.0001*
Error	31	13160.460	424.53		
C. Total	33	24185.903			

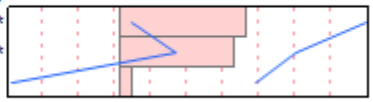
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Un-exclosed	10	-14.133	6.516	-27.42	-0.84
Cattle-only	2	-18.250	14.569	-47.96	11.46
Complete	22	22.814	4.393	13.86	31.77

Std Error uses a pooled estimate of error variance

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Complete	Cattle-only	41.06439	15.21717	3.6121	78.51673	0.0292*
Complete	Un-exclosed	36.94773	7.85811	17.6074	56.28803	0.0001*
Un-exclosed	Cattle-only	4.11667	15.95991	-35.1637	43.39701	0.9640



2011

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Exclosure	2	10427.152	5213.58	18.8895	<.0001*
Error	35	9660.138	276.00		
C. Total	37	20087.290			

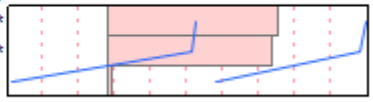
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Un-exclosed	8	-8.523	5.8737	-20.45	3.401
Cattle-only	8	-9.469	5.8737	-21.39	2.456
Complete	22	24.549	3.5420	17.36	31.740

Std Error uses a pooled estimate of error variance

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Complete	Cattle-only	34.01799	6.859018	17.2321	50.80390	<.0001*
Complete	Un-exclosed	33.07216	6.859018	16.2863	49.85807	<.0001*
Un-exclosed	Cattle-only	0.94583	8.306683	-19.3829	21.27458	0.9929



2012

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Exclosure	2	18248.013	9124.01	42.0127	<.0001*
Error	59	12813.194	217.17		
C. Total	61	31061.208			

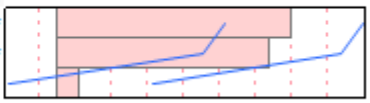
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Un-exclosed	20	-9.567	3.2952	-16.16	-2.97
Cattle-only	19	-6.171	3.3808	-12.94	0.59
Complete	23	27.493	3.0728	21.34	33.64

Std Error uses a pooled estimate of error variance

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Complete	Un-exclosed	37.05942	4.505656	26.2267	47.89215	<.0001*
Complete	Cattle-only	33.66381	4.568637	22.6796	44.64796	<.0001*
Cattle-only	Un-exclosed	3.39561	4.721100	-7.9551	14.74633	0.7531



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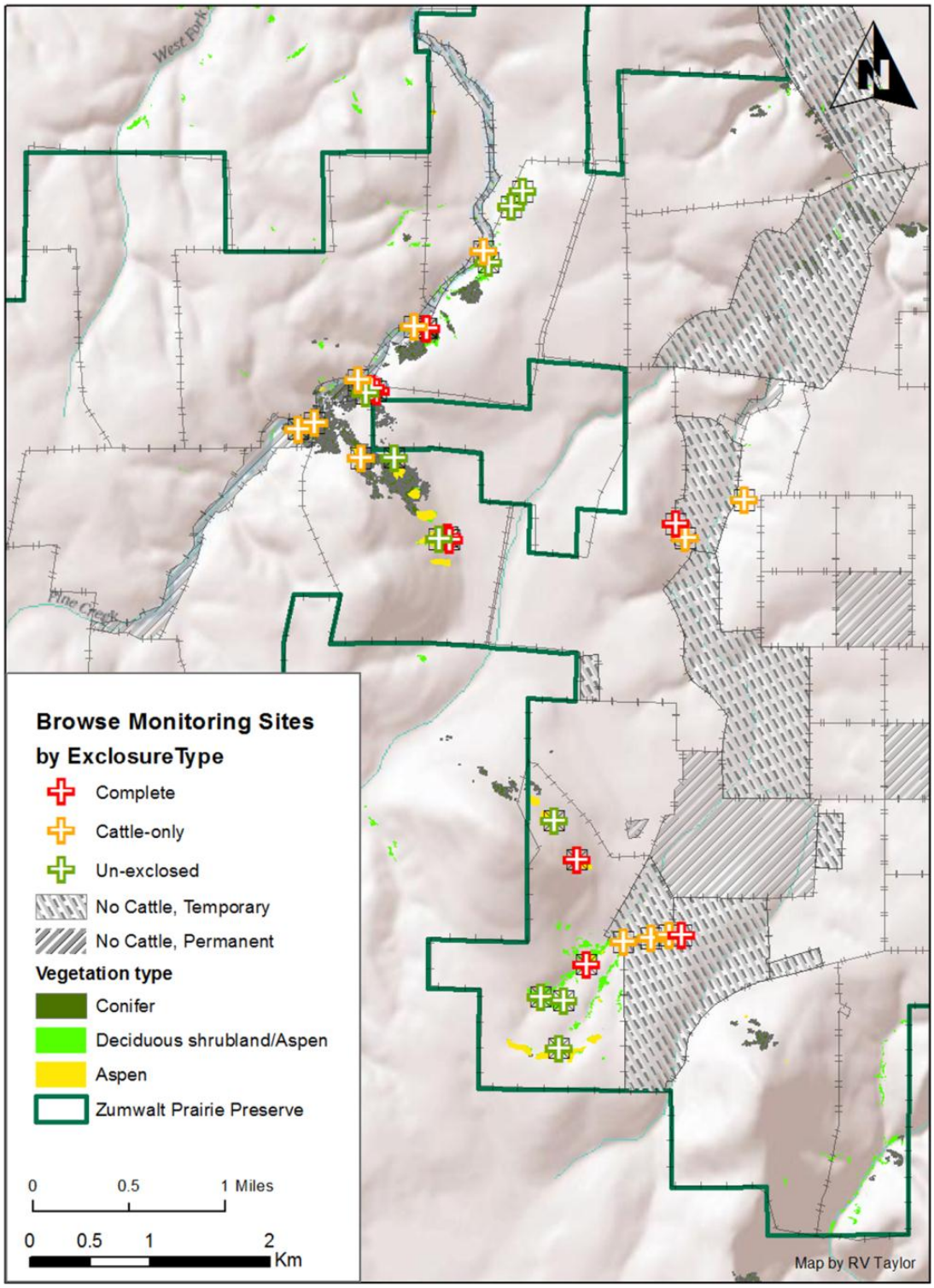

Figure 1. Map of the survey sites on the Zumwalt Prairie Preserve

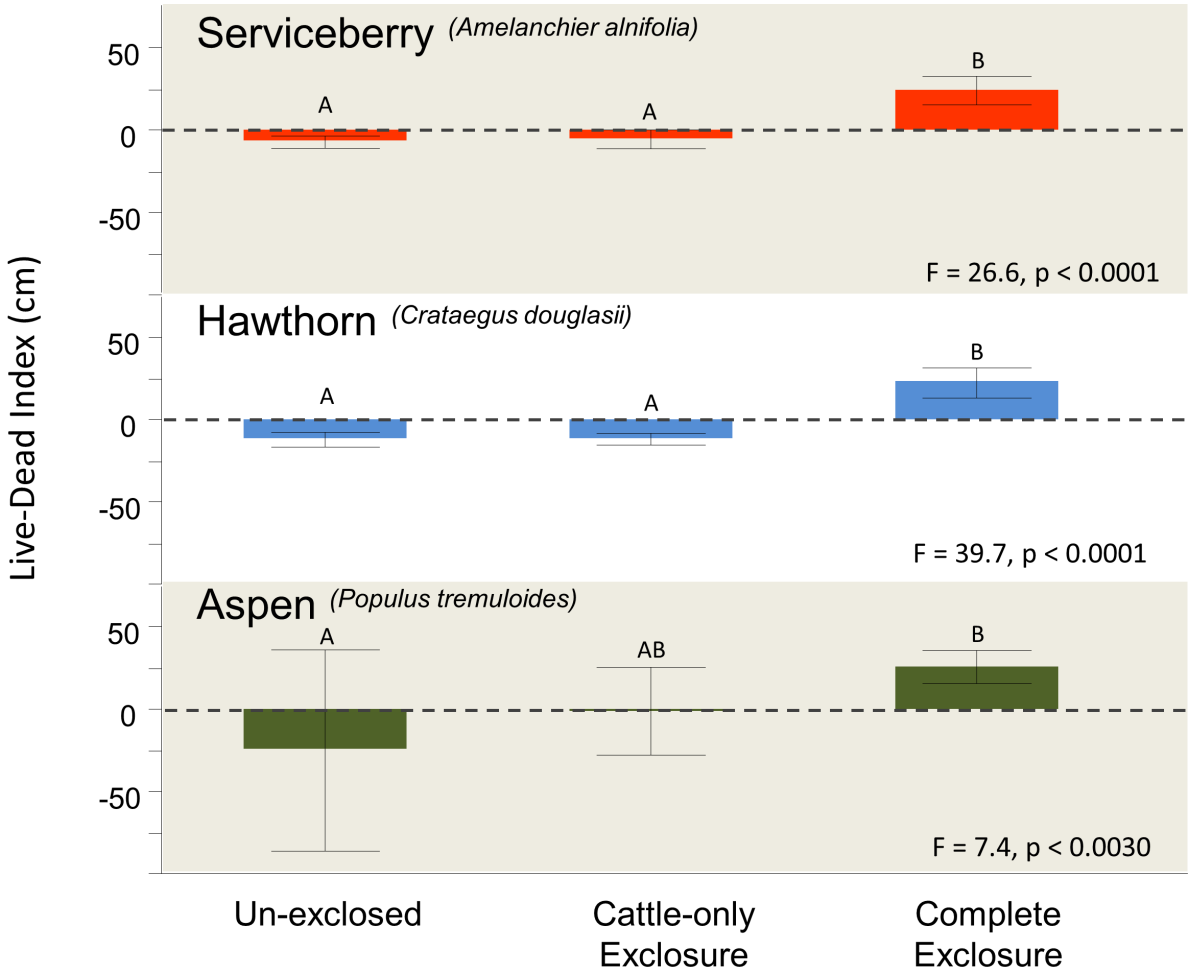

Figure 2. Summary of browse intensity pooled across years (2010-2012). Error bars span the 95% confidence interval of the mean; ANOVA (1 way); means compared using Tukey-Kramer HSD, a = 0.10 (JMP 10.0)

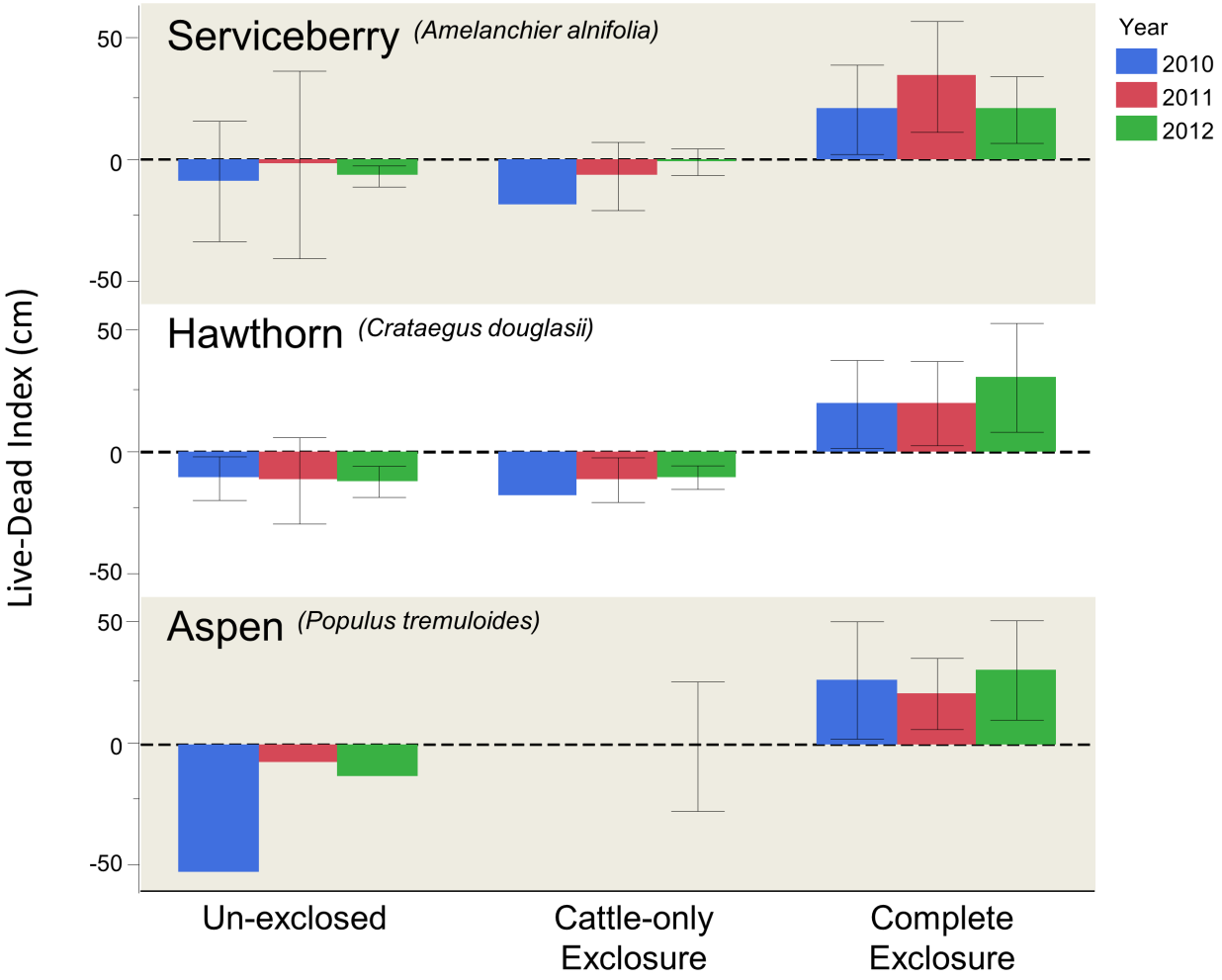

Figure 3. Changes in browse intensity over time (2010-2012). span the 95% confidence interval of the mean.