Relationship between tripped livestock triggers and *Lepidium papilliferum* abundance

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Abstract We analyzed abundance data for *Lepidium papilliferum* (slickspot peppergrass) from the years 2005-2008, comparing slickspots with tripped livestock triggers (penetrating livestock trampling constituting more than 10% of a slickspot) to nearby slickspots without tripped livestock triggers. We did not find any statistically significant difference in abundance of slickspot peppergrass in any comparison between slickspots with tripped triggers and slickspots without tripped triggers. Nor did we find any statistically significant difference in the magnitude of change in slickspot peppergrass abundance among years between slickspots with and without tripped livestock triggers. We conclude that any differences in abundance of slickspot peppergrass in slickspots with and without tripped livestock triggers is most readily explained as the variability inherent in ecological systems and not by any real effect of different levels of livestock trampling.

Lepidium papilliferum (slickspot peppergrass) is an annual or biennial plant that is typically restricted to clay pans (slickspots) in some soil types of the lower Snake River Plain of southwestern Idaho. A 2003 Candidate Conservation Agreement (CCA) identified threats to the species and defined thresholds, or triggers, for each. A trigger is considered to be tripped when a potential threat is present at a level greater than, or lower than, the threshold, or trigger. Trampling of slickspots by livestock is one threat identified by the CCA. The overarching research question we addressed was: *Is there a relationship between tripped livestock triggers (penetrating livestock trampling constituting more than 10% of a slickspot) and slickspot peppergrass abundance?*

Materials and Methods

We analyzed slickspot peppergrass data from 2005 through 2008. We obtained 1) data for 2005 through 2007 and 2) data for 2008 separately and give details below.

Slickspot peppergrass data for 2005 through 2007

Data for 2005 through 2007 was obtained directly from the Idaho Conservation Data Center (CDC) after completing their Limited Use Agreement for Digital Data. These data were delivered to the author on a DVD titled *2007 Rangewide Habitat Integrity and Population Monitoring of Slickspot Peppergrass Lepidium papilliferum* and dated *2008*. We did not analyze data from years prior to 2005 as plant abundance was estimated, rather than counted, prior to this.

We first combined all data in the 239 individual files located in the AppendixE_Data/LEPA_HIP_raw_data_2004_2007 folder on the data disc into one data file. We then compared these data with the same data in the data file AppendixE_Data/LEPA_HIP_summarized_data_2004_2007/2007 DATA SUMMARY /analysis_stuff/2004-2007_counts.xls on the data disc. The only difference we found between our combined data and the CDC's combined data was for eight of the ten slickspots on transect HIP 715 in 2005. We contacted Ms. Beth Colket at the CDC and she sent us the correct data for transect HIP 715 in 2005. Finally, we added information on tripped livestock triggers from individual Management Area (MA) worksheets (pages) in each year's LEPA-HIP-summary file located in the AppendixE_ Data/LEPA_HIP_summarized_data_2004_2007 folder of the data disc. As per detailed

instructions from Ms. Beth Colket, we noted a tripped livestock trigger for each slickspot with a rating of ≥ 17.5 for parameter 14A, 'Livestock print cover-Penetrating (silt crust)'.

Slickspot peppergrass data for 2008

When 2008 data became available they were obtained directly from the Idaho CDC after submitting a formal data request. These data were delivered to the author on a CD titled *2008 LEPA HIP Data, Report Pending* and dated *12/11/2008*. We analyzed slickspot peppergrass abundance data located in individual MA worksheets in the file AppendixE_Data_reportpending_draft121108/LEPA_HIP_summarized_data_2004_2008/2008 DATA SUMMARY/LEPA-HIP-summary-2008_reportpending_draft-121108.xls. We noted a tripped livestock trigger for each slickspot with a rating of ≥ 17.5 for parameter 14A, 'pen LS-m1' on these same worksheets.

Data analyses, 2005 through 2008

Before undertaking any analysis of these data, all slickspots that contained no slickspot peppergrass plants throughout the period 2005 to 2008 were eliminated from the dataset. With a single exception, every slickspot in which ≥1 LEPA was recorded over the period of the study was included in the analyses. Our research focused on describing the changes in slickspot peppergrass abundance; including slickspots having no slickspot peppergrass plants during the period of the study would have provided no information apropos to the research questions.

All data were tested for normality and homogeneity of variance. These are two critical assumptions of normal parametric statistics (eg., Analysis of Variance [ANOVA]).

Because the raw data failed these tests, we transformed these data by taking the natural log after adding 1 (transformed data = LN[raw data + 1]). Adding 1 to each data point preserved 0 data, as LN(0) is undefined. This is standard practice when analyzing biological data.

In analyzing the data, we compared the abundance of slickspot peppergrass in slickspots with tripped livestock triggers with all slickspots on the same transect that did not have tripped livestock triggers, except for the exception noted immediately below. See Diagram 1 for details of analyses.

Although transect and slickspots HIP 717, SS 5 and HIP 717, SS 6 experienced tripped livestock triggers, all other slickspots on this transect had been eliminated, as they contained no slickspot peppergrass in any of the three years. However, two nearby (< 500m away) transects contained slickspots that we were able to compare with the slickspots on transect HIP 717.

We were unable to analyze one transect (HIP 60) although it contained a single slickspot with a tripped livestock trigger, as 1) all other slickspots on this transect had been eliminated due to the absence of slickspot peppergrass in any of the three years and 2) there were no other transects nearby for comparison.

We looked for differences between slickspot peppergrass abundance in slickspots with and without tripped livestock triggers using the one-way ANOVA procedure. This analysis tests for a difference between groups by comparing variability within groups to variability in the data as a whole. We used a significance level of alpha (a) = 0.05 (5%) as a

statistically significant difference between slickspots with and without tripped livestock triggers. This is the significance level commonly used when analyzing biological data. An *a* level of 0.05 indicates a 5% chance of making a Type I error. A Type I error occurs when we conclude that there is a difference between groups being compared when any difference seen is actually due to sampling error, a reflection of the randomness inherent in biological systems.

In all cases, we analyzed differences between abundances of natural log (LN)-transformed 1) total slickspot peppergrass plants, 2) rosettes, and 3) reproductive plants in slickspots with and without tripped livestock triggers, to see if plants at different life stages responded differently to these events. See Diagram 1 for details of analyses.

Diagram 1. Analysis design of three hypothetical transects.

O = slickspot with at least one plant in at least one of the years 2005 through 2008
X = slickspot without any plants in any of the years 2005 through 2008
T = slickspot with tripped trigger
T1 = one year after a tripped trigger
T2 = two years after a tripped trigger
T3 = three years after a tripped trigger

Abundance of slickspot peppergrass in each slickspot with a tripped trigger (T) was compared with the abundance of slickspot peppergrass in all other slickspots on the same transect that did not have tripped triggers and were not excluded from the analyses for lacking slickspot peppergrass in all years (O).

Year	Transect 1	Transect 2	Transect 3
2005	X O O X O O O X O O	O O O X T O O O X O	O O O O X O O O O O
2006	X T O X O O O X O O	O O O X T1 O O O X O	O O O O X O O O O O
2007	X T1 O X O O O X O O	O O O X T2 O O O X O	O O O O X O O T O O
2008	X T2 O X O O O X O O	O O O X T3 O O O X O	O O O O X O O T1 O O

Research questions investigated:

Question 1. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, in the same year as a tripped trigger? This analysis was performed on data from all years, 2005 to 2008.

Question 2A. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, in the year following a tripped trigger? This analysis was performed on data for tripped triggers in 2005, 2006, and 2007 and data for slickspot peppergrass abundance in

2006, 2007, and 2008, respectively. This question was posed to address the duration of impacts, if any were detected in Question 1.

Question 2B. Is there a difference in the magnitude of the change (either up or down) in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, between the year of a tripped trigger and the following year? Looking at the magnitude of the change in abundance is more informative than looking at the difference in abundance itself over time, as abundance of slickspot peppergrass varies greatly from year to year (Unnasch 2008).

Question 3A. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, two years following a tripped trigger? This analysis was performed on data for tripped triggers in 2005 and 2006 and data for slickspot peppergrass abundance in 2007 and 2008, respectively. Again, this question was posed to address the duration of impacts, if any were detected in Question 1.

Question 3B. Is there a difference in the magnitude of the change (either up or down) in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, between the year of a tripped trigger and two years later? Looking at the magnitude of the change in abundance is more informative than looking at the difference in abundance itself over time, as abundance of slickspot peppergrass varies greatly from year to year (Unnasch 2008).

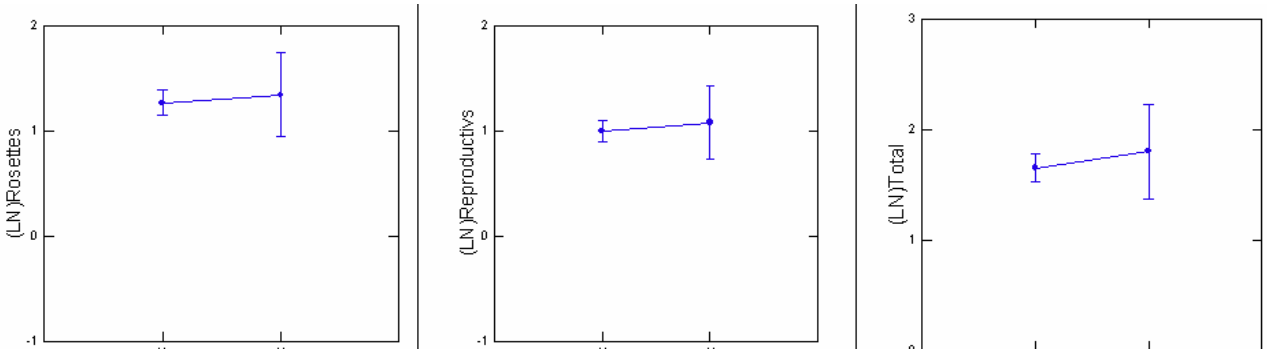
Question 4. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, three years following a tripped trigger? This analysis was performed on 2008 data from slickspots that had had tripped triggers in 2005. Again, this question was posed to address the duration of impacts, if any were detected in Question 1.

Results

We present sample sizes (n) and probability (*p*-values) in tabular form for each analysis. At our significance level of a=0.05, analyses with p values of $\leq$0.05 are considered to be statistically significantly different and analyses with p values of >0.05 are considered not to be statistically significantly different. We present means and 95% confidence intervals graphically for each analysis; data are presented as natural logs (LN). If these 95% confidence intervals overlap, there is no statistically significant difference between the groups at the a=0.05 confidence level.

Question 1. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, in the same year as a tripped trigger? This analysis was performed on data from all years, 2005 to 2008. Natural logs of numbers of rosettes, reproductives, and total plants are presented.

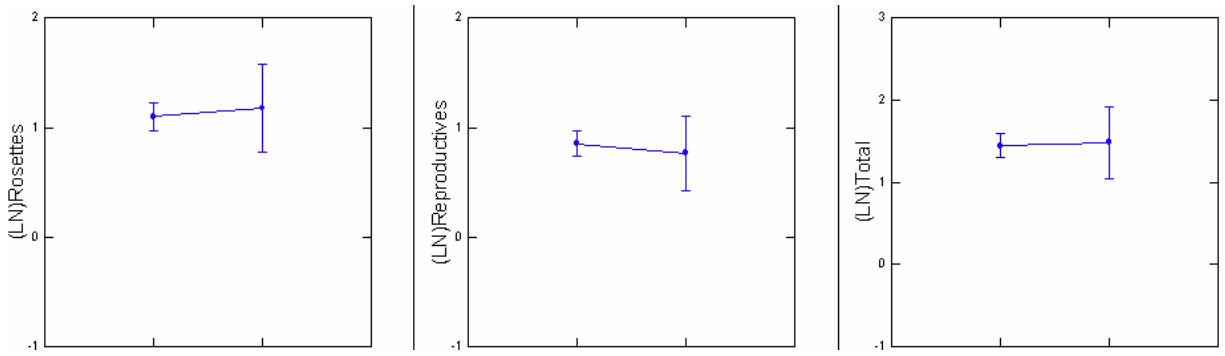
Life stage	n	*p*
Rosettes	532	0.716
Reproductives	532	0.683
All plants	532	0.509



Conclusion: There is no detectable difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots without tripped triggers, in the same year as a tripped trigger.

Question 2A. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, in the year following a tripped trigger? This analysis was performed on data for tripped triggers in 2005, 2006, and 2007 and for slickspot peppergrass abundance in 2006, 2007, and 2008, respectively. Natural logs of numbers of rosettes, reproductives, and total plants are presented.

Life stage	n	*p*
Rosettes	399	0.724
Reproductives	399	0.627
All plants	399	0.871



Rosettes Reproductives All plants

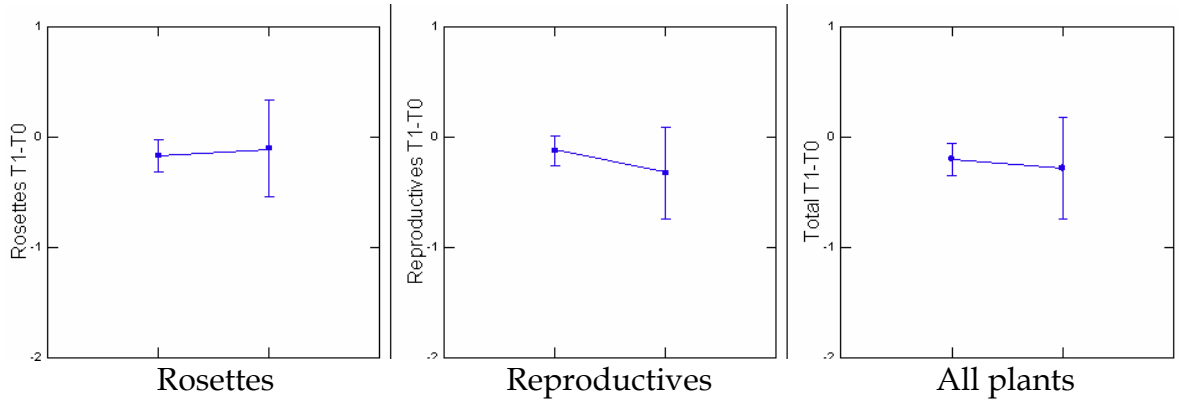
Tripped trigger →

No Yes No Yes No Yes

Conclusion: There is no detectable difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots without tripped triggers, the year following a tripped trigger.

Question 2B. Is there a difference in the magnitude of the change (either up or down) in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, between the year of a tripped trigger and the following year? This analysis was performed on data for tripped triggers in 2005, 2006, and 2007 and for slickspot peppergrass abundance in 2006, 2007, and 2008, respectively. Natural logs of numbers of rosettes, reproductives, and total plants are presented.

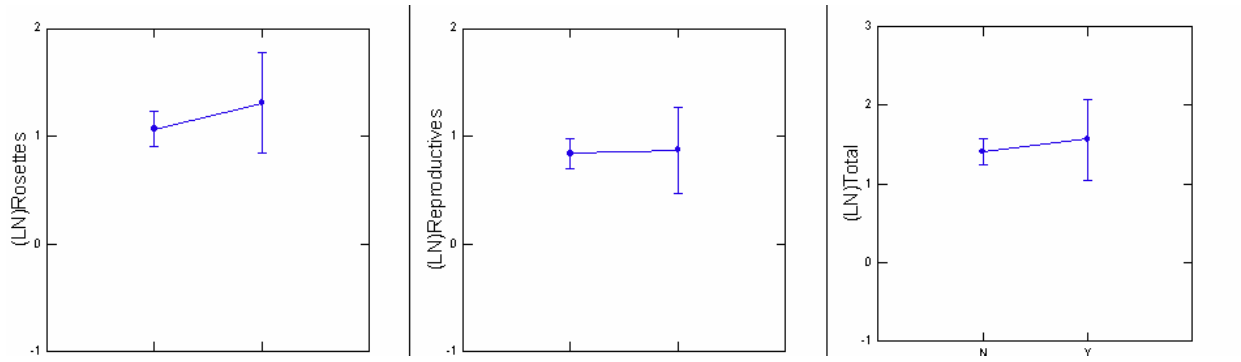
Life stage	n	*p*
Rosettes	399	0.784
Reproductives	399	0.355
All plants	399	0.745



Conclusion: There is no detectable difference in the magnitude of change in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots without tripped triggers, the year following a tripped trigger.

Question 3A. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, two years following a tripped trigger? This analysis was performed on data for tripped triggers in 2005 and 2006 and data for slickspot peppergrass abundance in 2007 and 2008, respectively. Natural logs of numbers of rosettes, reproductives, and total plants are presented.

Life stage	n	*p*
Rosettes	266	0.343
Reproductives	266	0.888
All plants	266	0.577



Rosettes Reproductives All plants

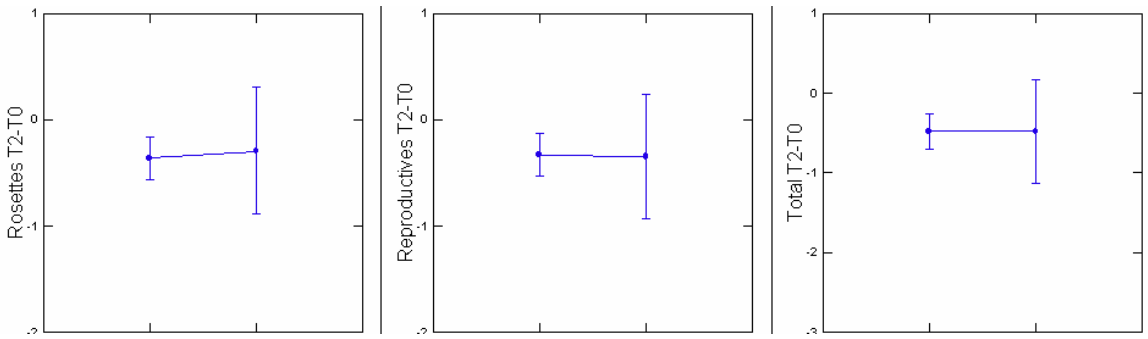
Tripped trigger →

No Yes No Yes No Yes

Conclusion: There is no detectable difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots without tripped triggers, two years following a tripped trigger.

Question 3B. Is there a difference in the magnitude of the change (either up or down) in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, two years following a tripped trigger? This analysis was performed on data for tripped triggers in 2005 and 2006 and data for slickspot peppergrass abundance in 2007 and 2008, respectively. Natural logs of numbers of rosettes, reproductives, and total plants are presented.

Life stage	n	*p*
Rosettes	266	0.832
Reproductives	266	0.956
All plants	266	0.994



Rosettes Reproductives All plants

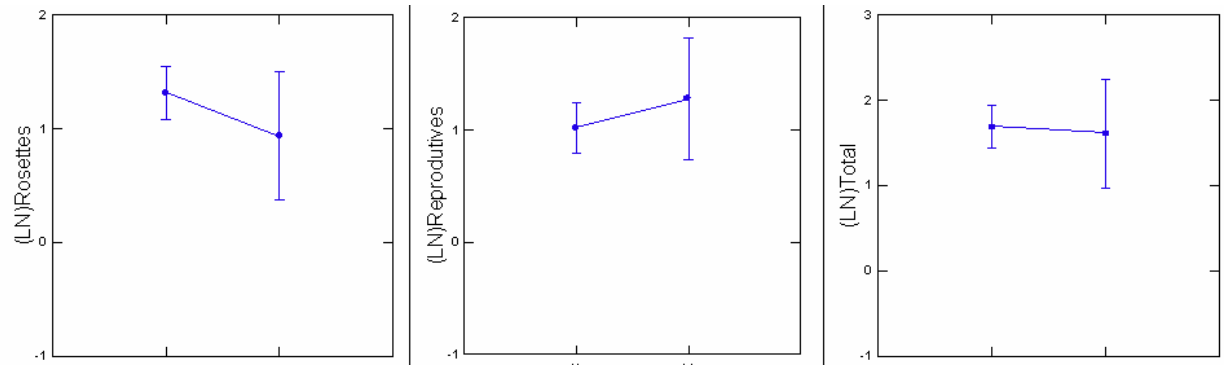
Tripped trigger →

No Yes No Yes No Yes

Conclusion: There is no detectable difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots without tripped triggers, three years following a tripped trigger.

Question 4. Is there a difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots on the same transect without tripped triggers, three years following a tripped trigger? This analysis was performed on data for tripped triggers in 2005 and slickspot peppergrass abundance in 2008 only. Natural logs of numbers of rosettes, reproductives, and total plants are presented.

Life stage	n	*p*
Rosettes	133	0.218
Reproductives	133	0.380
All plants	133	0.828



Conclusion: There is no detectable difference in slickspot peppergrass abundance in slickspots with tripped livestock triggers and in slickspots without tripped triggers, three years following a tripped trigger.

Discussion

In our analyses of this data set, we did not find any statistically significant difference in abundance of slickspot peppergrass in any comparison between slickspots with tripped livestock triggers and slickspots without tripped livestock triggers. Nor did we find any statistically significant difference in the magnitude of change in slickspot peppergrass abundance among years between slickspots with and without tripped livestock triggers. We conclude that any difference in abundance of slickspot peppergrass in slickspots with and without tripped livestock triggers is most readily explained as the variability inherent in ecological systems and not by any real effect of different levels of livestock trampling.

Literature Cited

Unnasch, R.S. 2008. *Lepidium papilliferum* (Slickspot peppergrass): Evaluation of Trends 2004-2007. Final Report Prepared for Idaho Department of Fish and Game Idaho Conservation Data Center.