Aspen, Elk, & Wolf Interactions on Yellowstone's Northern Range

Introduction

The growth of aspen (Populus tremuloides) within Yellowstone National Park (YNP) has experienced nearly a century of very limited overstory recruitment, Figure 1 (Ripple and Larsen 2000). Ripple and Larsen suggest the loss of an apex predator, the gray wolf (Canis lupus), may play a key role by altering the density and browsing behaviors of the park's herd of Rocky Mountain elk (Cervus canadensis nelson) on aspen (Ripple and Larsen 2001). During winter elk heavily browse young aspen stems and since the 1926 wolf extirpation from Yellowstone National Park there has been little to no recruitment of aspen stems into the overstory.

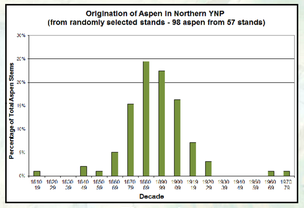


Figure 1

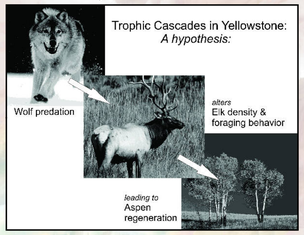


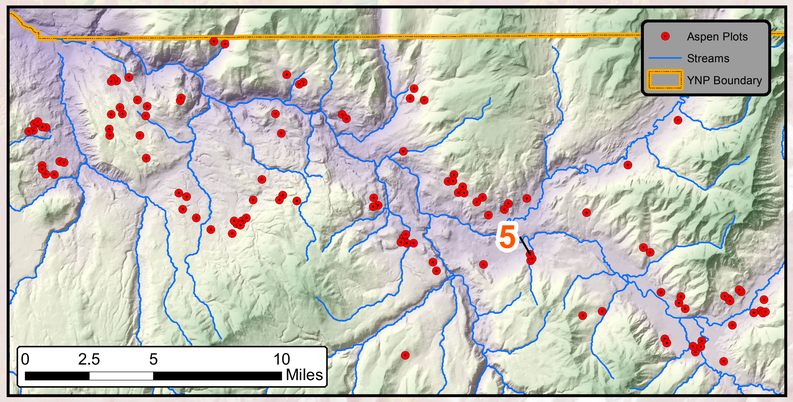
Figure 2

In 1995 the gray wolf was reintroduced to the park, and has since spread across the northern range. This has provided an opportunity to study the top-down effects predators can have upon the ecological interactions between carnivore, herbivore, and vegetation, also known as a "trophic cascade". A trophic cascade can be thought of as the traditional food chain, but moving from the top down. Predation of higher trophic level animals (wolf) affects the density, foraging behaviors, and spatial distribution of lower level herbivores (elk), which subsequently affects the growth and form of the vegetation (aspen).

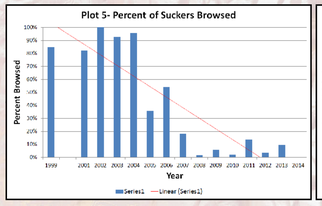
This study seeks to identify if YNP aspen growth has increased since the reintroduction of the wolf into the park. The poster represents our efforts to organize field data on aspen, elk and wolves, represent them spatially in a Geographic Information System (GIS) and use spatial analysis to look for ecological patterns in the data.

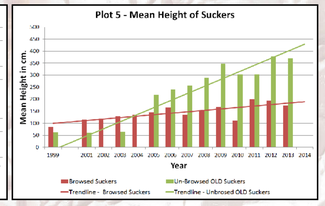
Aspen Plots

For the past 15 years we have been gathering data from 113 aspen stands on the northern range of Yellowstone National Park. We have measured browsing pressure and the height of aspen suckers (root sprouts) for each plot. Each of the plots consisted of a 1 x 20 meter belt transect, that would be measured annually noting the aspen sucker heights and the percentage of suckers browsed by elk.



The graphs below represent the browse pressure (left) and the mean sucker height (right) for aspen plot number 5, which can be located in the map above. Plot 5 exhibits characteristics of a plot that has seen aspen growth increase since 1999. There is a correlation between the reduction of browse pressure and the mean height of suckers, even with an increase in the number of browsed suckers.



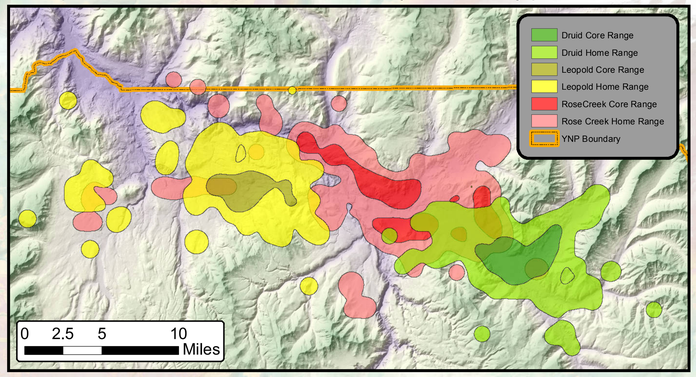


Kernel Density Estimation

Kernel Density Estimation (KDE) provides a probability estimate of an event occurring in space. For this study the Yellowstone Wolf Project provided coordinate data on wolf locations and elk kill locations. By using a KDE we were able to create raster surfaces showing the probability of wolf presence in particular locations and where areas with the greatest probabilities of elk predation (by wolves) were most likely to occur.

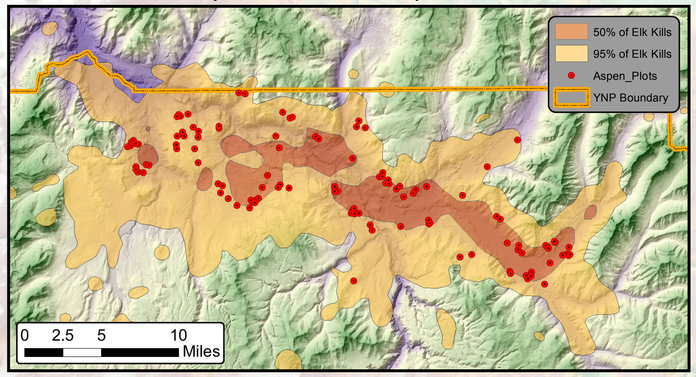
Wolf Pack Kernels

To determine the spatial extent of wolf packs in the northern range we obtained telemetry data gathered via radio collars on wolves in three packs; Leopold, Rose Creek and Druid. The telemetry data is a series of 1,439 UTM coordinates for the three packs. The KDE's in the image show the core and home ranges of the packs. The core range is 50% of the telemetry coordinate data for a given pack and represents the area the pack uses most intensively. The home range is 95% of the telemetry coordinates for a given pack and represents the areas pack members only occasionally patrol.



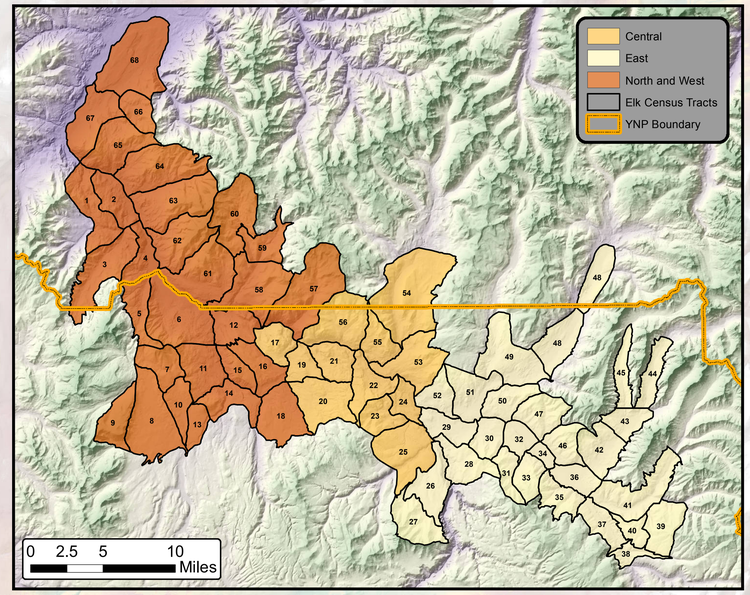
Elk Kill Kernels

Between 1996 and 2012, field scientists collected 5,211 known positions of where elk were killed by wolves on YNP's northern range. We used this data to develop a KDE map illustrating areas of high predation risk for elk on the northern range, showing where elk were most likely to have been killed by wolves.



The dark brown areas represent the 50% kernel, an area encompassing one-half of the elk kill data points and indicating the areas that elk were most likely to be killed during the period. The lighter brown area is the 95% kernel, illustrating a larger geographic area where most of the elk kills occurred. One of the hypotheses we are testing is whether or not aspen stands in high density kill areas will be avoided by elk. If elk alter their foraging patterns in the areas of highest predation risk from wolves we would expect to find a lower percentage of browsed aspen shoots, taller saplings and potential overstory replacement trees.

Elk Census



An elk census is conducted each January to estimate the size of the northern range elk herd. We worked with the 1999-2012 elk census data to help us gauge the impact of elk herd size and density on aspen growth. The size of the elk herd wintering on the northern range has decreased significantly over the period, from approximately 11,975 to 4,174, Figure 3. Additionally, the distribution of the elk on the landscape has been altered, both by wolf reintroduction and a reduction in elk permits for human hunters outside of YNP boundaries. Of the approximately 4,174 elk that now comprise the northern range herd, a much greater percentage of them winter on the western portion of the range Figure 4. The lower elevation areas in the western portion of the northern range mean elk can avoid the deeper snows which make escape from wolves more difficult and find better climatic and foraging conditions for severe Rocky Mountain winters. We hypothesize that the reduction in the overall elk population and the shift of the herd to lower elevation areas will allow a reduction in browse pressure on the aspen stands in the eastern and central portions of the northern range and make them better able to regenerate new overstory stems than stands in the western portion of the range.

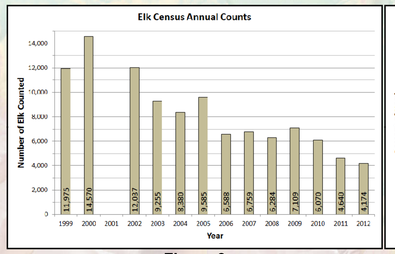


Figure 3

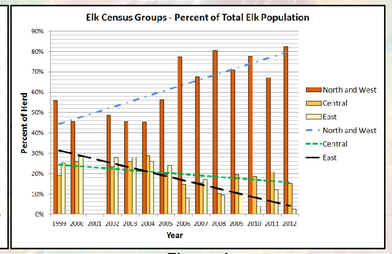


Figure 4

References

Ripple, W.J., Larsen, E.J., Renkin, R.A. & Smith, D.W. 2001. Trophic cascades among wolves, elk and aspen on Yellowstone National Park's northern range. Biol. Conserv., 102, 227–234.

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