ESTIMATING FORAGE PRODUCTION AND WINTER SEVERITY ON THE NATIONAL ELK REFUGE, JACKSON, WY

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ABSTRACT

Each October through November, elk and bison migrate to the National Elk Refuge (NER) near Jackson, WY to feed on native forage produced on the Refuge. Usually by late January, standing forage has been utilized or becomes unavailable because of snow and ice, and NER staff then supplies supplemental feed in the form of alfalfa pellets. Supplemental feeding typically ends in early April, when elk and bison migrate back to summer ranges.

For the past 34 years, NER staff has estimated total annual forage produced on the Refuge by clipping vegetation within different plant community types. Average forage production in each plant community type is then accumulated by the number of acres represented by each type to obtain total forage produced on the Refuge.

Keetch Byram Drought Index (KBDI), and growing degree-days (GDD) based on daily average temperature threshold of 5^0 C have been calculated daily for Jackson and Moose climatological stations since 1949. Also, daily snow water equivalent (SWE) has been estimated for these stations using climatological records. Critical temperatures (-18^0 C for elk) have been summarized using departure from daily minimum temperatures. SWE, forage production, and critical temperatures are weighted and combined to determine Index of Winter Severity (IWS) for elk and bison.

Methods for calculating the IWS for elk and bison and how the IWS is used for Refuge operations will be presented. Average KBDI for different accumulations of GDD and spring precipitation are compared to production of grass and forbs on 34 different plant community groups. Methods and results for estimating forage production using KBDI, GDD, and precipitation are presented.

INTRODUCTION

Approximately 7500 elk and 1000 bison migrate from Yellowstone National Park, Grand Teton National Park and Bridger-Teton National Forest to the National Elk Refuge (NER) each winter. Usually, there is enough forage produced on the NER to support the animals until late January. When natural forage availability becomes limited or when ice and snow prevent the animals from obtaining the forage, feeding of alfalfa pellets is initiated. Supplemental feeding continues until animals begin foraging on green grass growth in the spring and move off the Refuge to their summer ranges. The amount of forage produced during the growing season may influence when supplemental feeding begins. NER staff clips forage plots each fall to obtain an estimate of forage produced on the Refuge. Forage produced on a high year is about twice that produced on a low year and is related to amount and timing of spring and summer precipitation. The Index of Winter Severity (IWS) allows Refuge managers to compare the relative severity of each winter and how it will impact the wintering animals and reproduction.

STUDY AREA

The National Elk Refuge is located adjacent to and north of Jackson, Wyoming in the upper Snake River drainage. The Refuge covers an area of approximately 10,120 hectares. Elevations vary from about 1890 meters to 1980 meters. Approximately 13,000 elk and 1000 bison currently inhabit the upper Snake River drainage with about 60 percent of the elk herd and almost all of the bison wintering on the NER. Snow typically covers the lower areas of the NER from December through March. Higher elevations are snow covered from about mid-November through mid-April. There are two National Weather Service climatological stations near the Refuge, one at Jackson, WY at 1899 meters elevation and the other at Moose, WY at 1972 meters elevation. Maximum and minimum

Paper presented Western Snow Conference 2007

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air temperatures, precipitation, snowfall and snow depths are recorded daily at both stations. There currently are 65 transects that encompass 34 community groups across the Refuge where forage was measured by clipping each fall. Over the past 34 years different methods have been used. The current method was used in 1995 and from 1998 through present.

METHODS

Daily snow water equivalent (SWE) is estimated using snow depth, precipitation,, and temperature from the climatological stations. The SWE is estimated to start the day snow depth starts. The SWE was equal to the accumulated precipitation until daily average temperatures exceed -2^0 C. Melt was determined using degree-day method and melt rates were determined from historic melt vs. degree-day relationships based on melt at nearby SNOTEL sites. Densities were capped at around 45 percent. Normal probabilities were run using period of record for maximum SWE for the season.

Each species has different critical temperature. This is the point where increased metabolism is needed in order to maintain body temperature. For elk, the critical temperature is -18^0 C and for bison it is -34^0 C. The difference between daily minimum temperatures and the critical temperature were accumulated for the winter.

Forage has been determined by clipping plots on the NER since 1973. Clipping was generally done in September. Different methods have been used over time to determine total herbaceous forage. Double-mass analysis has been used to adjust these different methods to current methods. Relationships have been established to develop an estimate of forage production using spring and summer precipitation and Keetch Byram Drought Index (KBDI) (as surrogate for soil moisture deficit) and growing degree-days (GDD) and are discussed later in this paper. Normal probabilities were run for total herbaceous forage production for the previous fall for use in the IWS.

The IWS was scaled from – 4 to + 4. The following equation was used to scale the normal probability, in percent, (1 to 99 with 50 being average) to the index. A separate index was developed for SWE, critical temperatures, and available forage.

$$\text{Index} = \frac{\text{Probability} - 50}{12.25}$$

In general, an IWS of + 4 is the mildest winter of record, a – 4 is the worst and 0 is about average. For single birth species, values above 0 are similar in their effect. An IWS of 0 to – 2 generally effects reproduction and – 2 to – 4 generally indicates mortality. For multiple birth species, 0 to + 2 relates to the number of successful births while an IWS of 0 to – 4 represent similar effects as for single birth species.

Forage available on the NER has been determined by clippings since 1973. Methods have been changed over time. Since 1995, 65 transects have been clipped annually. These transects cover 34 different community type with most being some combination of grasses and a few are predominately forbs. Different combinations of KBDI and growing degree-days (based on average daily temperature threshold of 5^0 C) were correlated with forage production. Also, the May-July and May-August precipitation were correlated with total forage production.

RESULTS AND DISCUSSION

The IWS for elk was weighted as 45 % for SWE, 35 % for critical temperature, and 20 % for forage. The IWS based on Jackson, WY climatological station plus one-half Moose, WY climatological station for elk is shown in Figure 1. For bison, the weightings are 70 % for SWE and 30 % for forage. The critical temperature for bison is so low that there are only a few days each year that it is exceeded and it is not used in the IWS for bison. The IWS for bison based on Jackson plus one-half of Moose is shown in Figure 2. The Jackson station represents a large portion of the Refuge but the Moose station represents the northern portion. Therefore, all of the weightings use Jackson plus one-half of Moose values.

The highest correlation of herbaceous forage production on the NER was using the May through August precipitation at Jackson and Moose (Figure 3). The best combination using KBDI was the average KBDI plus 0.3 times maximum KBDI for the first 1100 GDD for Jackson and Moose (Figure 4).

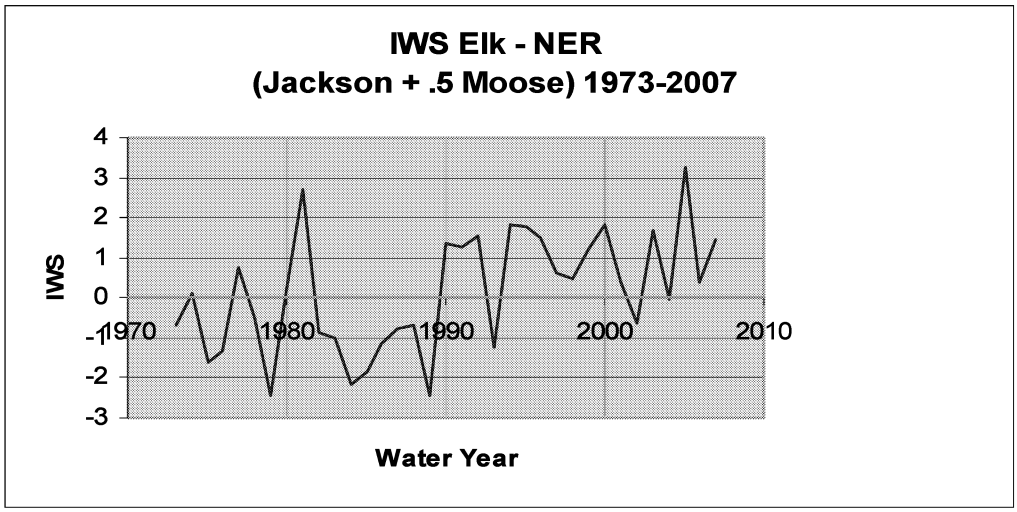

Figure 1. IWS for elk on National Elk Refuge 1973-2007

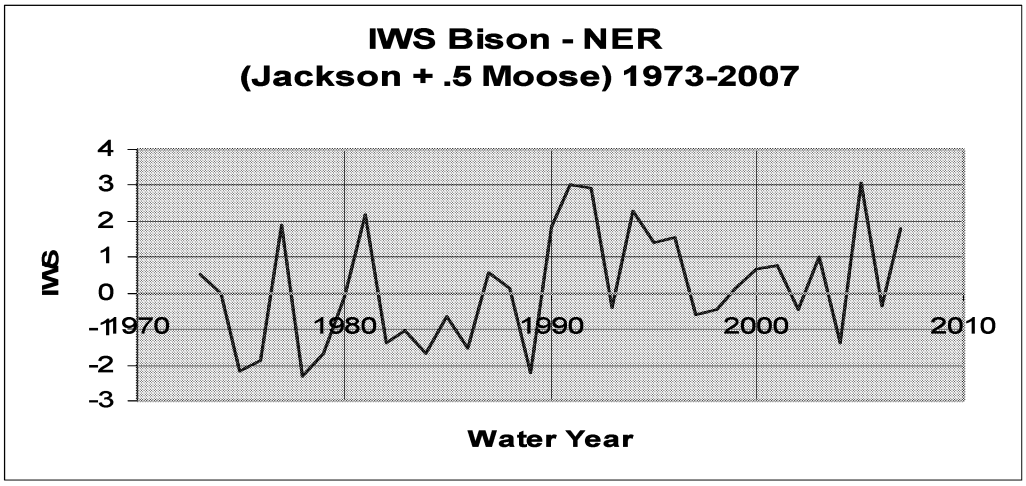

Figure 2. IWS for bison on National Elk Refuge 1973-1007

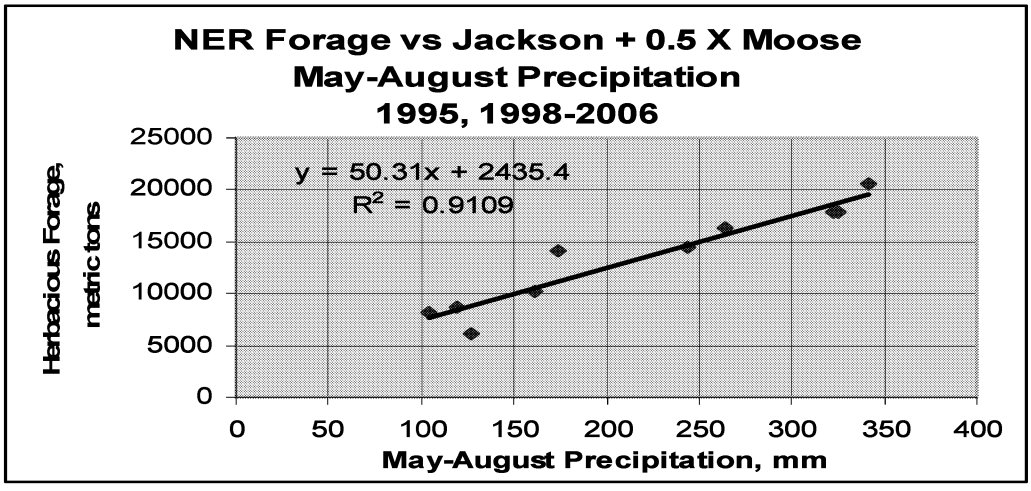

Figure 3. Forage produced on National Elk Refuge compared to May through August precipitation at Jackson plus ½ of Moose for years where 36 plant community types were clipped.

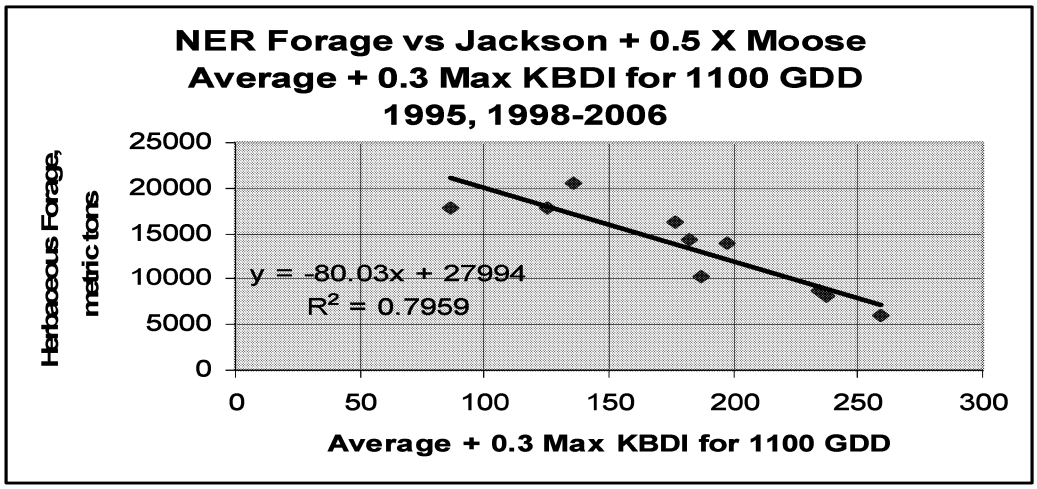

Figure 4. Forage produced on National Elk Refuge compared to average plus 0.3 times maximum KBDI for the first 1100 GDD for years where 36 plant community types were clipped.

CONCLUSIONS

The IWS provides Refuge managers with a numerical scale of how severe or mild any given winter might be and provides a reference to similar years. It also provides some continuity between biologists through their observations and narrative reports

Determining the amount of native forage produced on the Refuge and wintering conditions are important components for managing elk and bison on the NER. If a satisfactory method for estimating forage can be developed using climatic data, it may be possible to reduce the manual clipping at plots and would provide a method to estimate forage production since 1949. This would expand the number of years with data for both production and IWS. Also, it would provide a method to relate the three or four different methods used to determine total forage produced using clipping data since 1973. Retrospective analysis of historic IWS values and historic supplemental feeding initiation dates may allow Refuge managers to predict when supplemental feeding will be necessary based on early weather conditions.

REFERENCES

Cole, E. K. 2006. Forage production survey and related analysis. On file National Elk Refuge, Jackson,WY. 17 p.

Cole, E. K. 2005. Use of historic data to evaluate winter severity and feeding initiation date on the National Elk Refuge. On file National Elk Refuge, Jackson,WY. 3 p.

Farnes, P. E. 1991. A scaled index of winter severity. Proceedings: Western Snow Conference, Juneau, AK. April 12-15. pp 134-137.

Farnes, P., C. Heydon and K. Hansen. 2002. Snowpack distribution in Grand Teton National Park and Snake River drainage above Jackson, Wyoming: Final Report. Department of Earth Sciences, Montana State University, Bozeman, MT. May 2002. 68 p.

Farnes, P. E., and W. H. Romme. 1993. Estimating localized SWE on the Yellowstone northern range. Proceedings: Western Snow Conference, Quebec City, Quebec. June 8-10. pp 59-65.

Keetch, J. J., and G. M. Byram. 1988. A drought index for forest fire control. USDA Forest Service Research Paper. Ashland, SC: Southern Forest Experiment Station SE-38. 32 p.

Shafer, B. A., and L. E. Dezman. 1982. Development of a surface water supply index (SWSI) to assess the severity of drought conditions in snowpack runoff areas. Proceedings: Western Snow Conference. Reno, NV. April 19-23. pp 164-175.