

INTERACTIVE ECOLOGY OF PLANTS AND LARGE MAMMAL HERBIVORES
IN THE NORTHERN RANGE OF YELLOWSTONE NATIONAL PARK

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The number of elk and bison that should occupy Yellowstone's northern range is strictly a value decision that rests in the hands of park management and, ultimately, public opinion, and is beyond the scope of this study. The objective here is to place elk and bison herbivory in the northern range in an ecosystem context, so that their affect can be understood in a mechanistic fashion. Specifically, we will address their influence on energy and nutrient flows in the system. With this information, park managers will be able to weigh management alternatives in an ecosystem process framework.

Methods

The methodology includes measuring rates of transfer between ecosystem compartments. The following are rates of interest:

1. Rate of primary production: from small exclosures to measure productivity under a grazing regime; and from traditional, permanent exclosures in selected heavily grazed sites to measure productivity in the absence of grazing.
2. Rate of transfer from living to standing dead: from marked shoots (Wiegert and Evans 1964).
3. Rate of consumption by grazers: from movable exclosures (McNaughton 1985, Sharrow and Motazedian 1983).
4. Rate of transfer of nutrients from soil to plants: from harvested shoots and elemental analyses.

Standing crop will be measured in movable and permanent exclosures and unprotected vegetation. The double sampling method (NRC 1962) or a canopy intercept technique (McNaughton 1979) will be used to conserve species level information. In addition, because of its speed, a radiance ratio method will be employed to measure total green biomass. All of these techniques require calibration with clipped plots. The coordinated use of either the double sampling or canopy intercept methods with the radiance ratio method will provide a combination of species and total biomass information over a wide range of sites.

Results

The 1987 field season was preliminary in nature with four major objectives: 1) selection of sites, 2) installation of permanent exclosures, 3) precision testing of the biomass estimation methods, and 4) determination of required sample size of movable exclosures to estimate consumption. In addition, results of a preliminary survey of elemental concentrations in various forage species will be presented.

Selection of sites: Because of the diversity and vastness of the northern range, subsampling is required. The following four sites have been selected on the basis of accessibility and consistent heavy ungulate use according to park personnel (M. Meager, F. Singer; pers. comm.):

1. Crystal Bench: a heavy elk winter use area located southeast of the confluence of Crystal Creek and the Lamar River.
2. Lower Cache-Calfee Ridge: a spring, and possibly fall, elk and bison use area located on the toe of the ridge separating Cache and Calfee Creeks (Cache - Calfee Ridge).
3. Upper Cache-Calfee Ridge: a summer and fall elk and bison use area.
4. Lamar Valley bottom: a site that may receive elk and/or bison use during any season.

Productivity and consumption will be measured in each of the major plant communities at each of the four sites. Other sites will be included during the 1989 field season as resources permit.

Permanent exclosures: Permanent exclosures were erected in heavily grazed plant communities at Crystal Bench, lower Cache-Calfee, and upper Cache-Calfee. Three exclosures were installed per community. All exclosures were constructed of field fencing stapled to 2 x 2 lumber and wired to fencing posts driven into the ground. At Crystal Bench, lodgepole rounds were used for corner posts for added support.

Biomass estimation: Two nondestructive methods to estimate biomass were tested, double sampling and canopy intercept. Both methods appear to provide acceptable levels precision. However, because inadequate samples were collected for calibrations, further testing will be required before one of these techniques can be selected.

Sample sized: In an effort to determine the appropriate number of exclosures to estimate consumption, a trial was performed in an elk-grazed meadow on Mt. Norris. This site was selected for it represented, perhaps, the most difficult conditions under which to measure grazing in the northern range - light, patchy grazing in a species rich community. Five exclosures were left in place for 24 days (July 27 - August 20).

Biomass of grazed species was estimated with the double sampling method at the beginning and end of the trial in .5m² quadrats marked with rebar inside and outside each enclosure. Results suggest seven enclosures will be required to measure grazing on common species. For rare or uncommon species, more enclosures will be needed.

Elemental analyses: Samples from common graminoid (n=37) and forb (n=21) species were collected from sites across the northern range. Concentrations of 19 elements (Al, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Se, V, Zn) were assayed with the Leeman Labs inductively coupled plasma spectrometer using the methods of Spiers et. al. (1983). Nitrogen analyses will be performed this winter.

Results suggest two things. First, forage may be deficient for several elements; particularly Na, Ca and Cu (using standards for domestic livestock reviewed in McDowell 1985). Second, concentrations of B, Ca, Cd, Co, Cu, Fe, K, Mg, Na, P, V and Zn are significantly greater (ANOVA, P<.05) in forbs than graminoids.

Discussion

Our intent was to use the 1987 field season to select study sites, install permanent enclosures, test proposed methods and explore a sampling protocol to assay elemental concentrations of plant tissues. In all respects we were successful. Information on adequate sample sizes required to measure consumption will allow us to better allocate resources to accommodate both intensive (species level) and extensive (range diversity) objectives of the study.

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