

Ungulate Populations Models and Carrying Capacity

Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintroduction

By Francis Singer

A workshop to reconsider the subject of elk and bison carrying capacities in Yellowstone NP and to predict the effects of the dramatic events of 1988-90 was held in the park April 5-7, 1990. The "dramatic events" included the burning of 30 to 50 percent of the park's ungulate winter ranges during the large fires of 1988. The fires and drought of 1988, followed by a severe winter, precipitated a large migration of elk and bison from the park, large harvests of both elk and bison in Montana, and large winterkills. Approximately 24 to 26 percent of the northern elk herd winterkilled and 14 to 16 percent of the elk herd was harvested.

Public concern over the extent of the winterkill prompted a large fund raising effort by the Rocky Mountain Elk Foundation. In cooperation with the USFS and the NPS, 7,100 acres of private lands on historic winter ranges were purchased (Fig. 1) with a combination of private and federal appropriated funds. In 1987, the Northern Rocky Mountain Wolf Recovery Plan proposed restoring wolves to Yellowstone and adjacent public lands. The USFWS and NPS were directed by Congress to determine how wolves would affect their prey in the park and big game hunting in areas around the park (Wolves for Yellowstone? 1990).

The Concept of Ungulate Carrying Capacity in Yellowstone

During the droughts of the 1930s, Yellowstone Park managers calculated carrying capacity for elk of the northern herd at 7,000 to 11,700, based upon range methods used for domestic livestock. These criteria have since been abandoned for use with free-ranging, native ungulates. The concept of *economic* carrying capacity or the level of plant/animal ratios that produce the most gain in animal productivity prevailed in the early thinking. Early perceptions that elk numbers exceeded estimates of carrying capacity prompted herd reductions in the period 1932 to 1968. Douglas Houston (Houston, 1982) applied the concept of *ecological* carrying capacity – the dynamic equilibrium between native ungulates and their vegetative food base – to the northern elk herd. Based on the herd's 1968-1975 population growth curves, he estimated an ecological carrying capacity of 17,000; on 1969-1976 populations, 15,000. Merrill and Boyce (Merrill et al, 1990), using methods similar to Houston's, calculated an average carrying capacity of 15,000 elk for the period 1968 to 1988. Any number established for carrying capacity is beset with pitfalls for the unwary, since carrying capacity levels may be modified by winter severity, climate, and habitat changes.

During the workshop, 15 speakers and 112 participants addressed the subject of ungulate carrying capacity and the effects of fires, new winter range, and the proposed reintroduction of wolves.

Participants in the workshop reported the following conclusions regarding the events of the 1980s:

New Winter Range

Several speakers concluded that the increased migrations of elk north of the park boundary since about 1978 combined with mild winters probably explained the increases in both elk and bison numbers during the decade of the 1980s. New winter range

acquisitions since 1988 (Fig. 1) have received high use by elk, particularly on the new Dome Mountain Wildlife Management Area in Montana (Fig. 1). Mike Coughenour (Colorado State University) and Francis Singer (NPS) reported progress on a nutritionally based model of elk carrying capacity to predict the effects of the winter range acquisitions (and the fires of 1988).

The Fires of 1988

The large fires of 1988 are predicted to result in elk population increases – some researchers predict a large increase, others, a minor one. Monica Turner (Oak Ridge National Laboratory) and others reported on the progress of model effort to predict the effects of fire size and spatial heterogeneity on ungulate survival. The Coughenour model will predict the changes in elk population size from the fires of 1988.

Human Activities

Mary Meagher (NPS) reported the carrying capacity of bison winter ranges has been enhanced by the grooming of interior park roads. Bison move more easily to distant parts of the winter ranges on the groomed roads.

Proposed Reintroduction of Wolves

If wolves were reintroduced to Yellowstone, E.O.

Garton and others (University of Idaho) predicted 75 wolves in about 9 packs would inhabit the park's northern winter range. These authors predicted the northern elk would decline no more than 10 percent after wolf reoccupation (Fig. 3). They predicted negligible effects on elk harvests.

Mark Boyce (University of Wyoming) predicted a moderately high probability of wolf extinction if fewer than 10 wolves were reintroduced. He recommended a seed of 30 wolves. His models predicted 15 to 25 percent fewer elk and 5 to 15 percent fewer bison on the northern range after complete wolf recovery. Variance in ungulate numbers due to climatic variations should decrease; 15 to 25 wolves might leave the park each year.

David Vales and James Peek (University of Idaho) predicted slightly lower total elk harvest after wolf recovery in the Gallatin and Sand Creek elk herds. Hunter harvest must be directed primarily at bulls in heavily harvested elk herds.

Francis Singer (NPS) predicted Yellowstone Park could support the territories of 8 to 11 wolf packs and portions of the territories of another 3 to 4 packs. Wolves were predicted to kill ungulates in the order: elk > bison > mule deer > moose > pronghorns > bighorns. Wolves should have only minor impacts on ungulate distributions. Mostly adult female ungulates with very young have been observed to alter their habits when wolves are present. Coyotes are predicted to decline and red foxes to increase after wolf recovery. Visitors would see about as many ungulates after wolf recovery. Visitors would be minimally affected by some closures of a few square miles near active wolf dens from about April 1 to June 15.

Researchers utilized a wide variety of predictive techniques. To those, Merrill/Boyce added summer grassland phytomass. Predator-prey models were then constructed from knowledge from the literature of wolf densities, wolf predation rates, wolf consumption rates, and known or simulated functional and numeri-

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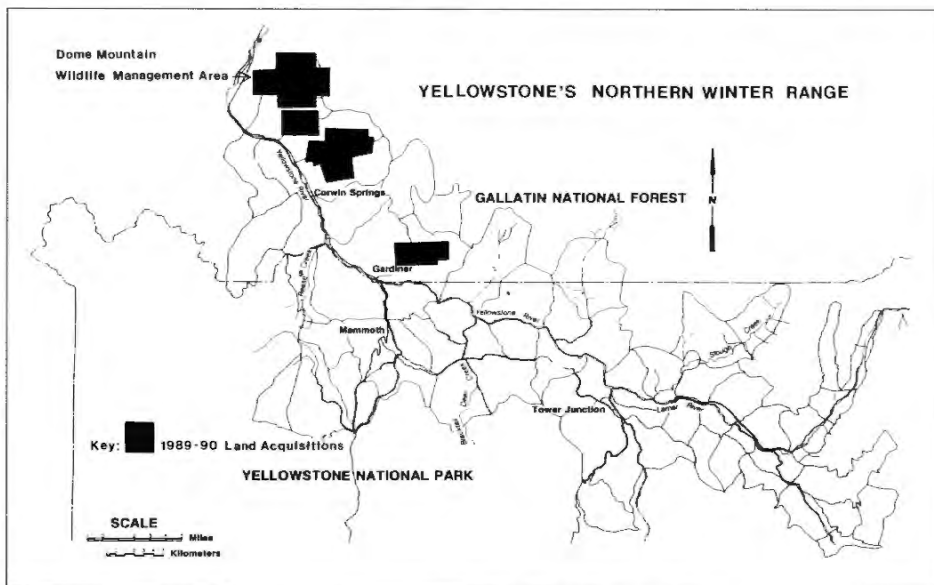


Figure 1. Winter range acquisitions north of Yellowstone National Park, 1989-90.

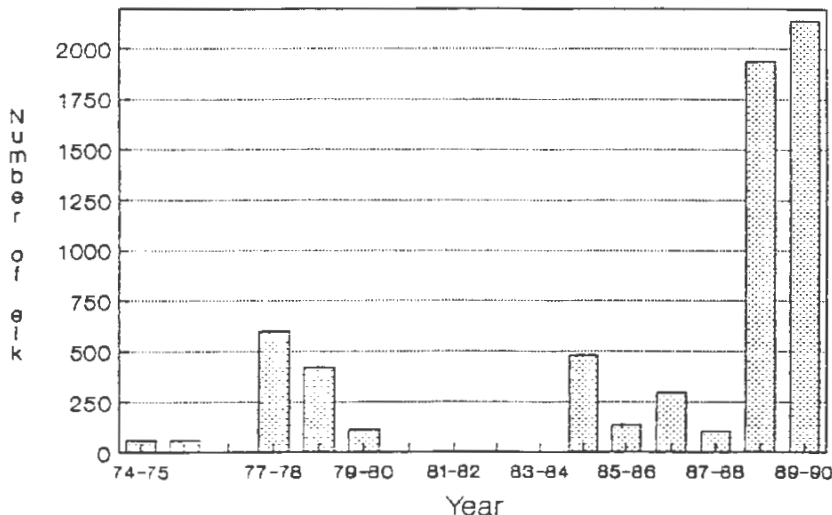


Figure 2. Maximum number of elk counted during the winter on the Dome Mountain-Stands Basin area from 1974-75 to 1989-90. Data from Chrest and Herbert (1980), Chrest and Peterson (1979), and NPS files. Missing bars indicate no data were obtained.

Yellowstone Elk Projections

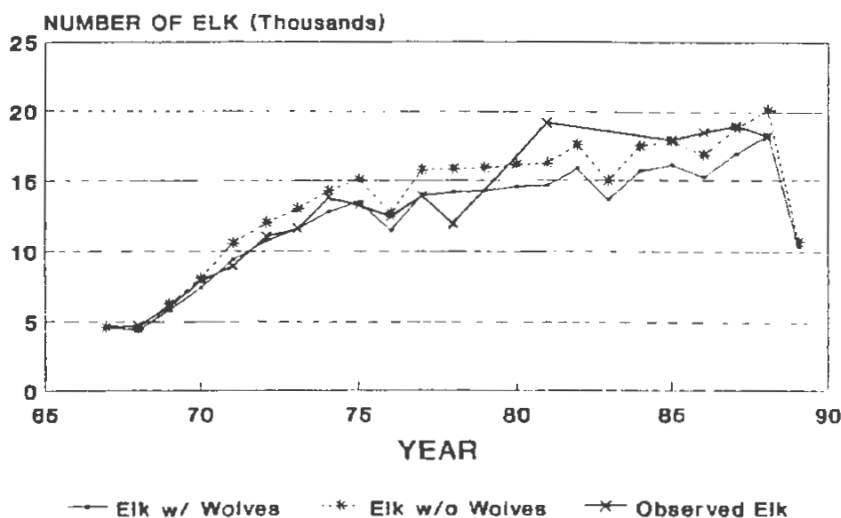


Figure 3. Slightly fewer elk are predicted for the northern Yellowstone elk herd in the presence of wolves (figure courtesy of E.O. Garten).

cal responses. Garton's model varied from the Boyce model principally in that wolf predation was apportioned by wolf social class. Vales and Peek utilized Leslie matrix and balance models. Singer, Servheen and Knight (not present) based their predictions on literature reviews, interviews and correspondence, while Koth and others (not present) used the Delphi survey method. Larry Roop (Wyoming Game and Fish) reported on the use of Pop-II models to predict effects of hunter harvests on ungulates, and Tom Hobbs (Colorado Division of Wildlife) described the interface between population and plant-based models of carrying capacity.

Conclusions

A consensus was reached that the mild winters of the 1980s were primarily responsible for recent increases in ungulate numbers. Both the fires of 1988 and purchases of the new winter ranges will result in larger numbers of elk, but winter severity will continue

to have a strong influence on elk numbers. Managers and interpreters should be prepared for the elk increases. Researchers concluded that the presence of wolves would result in <10 percent to <25 percent fewer elk and 5 to 15 percent fewer bison. The workshop participants recommended that more information be gathered over the next few years on ungulate response to the large fires of 1988. A period of accelerated data collection on ungulates and other predators should precede any wolf reintroduction.

Singer is a Research Ecologist at Yellowstone NP.

Suggested Reading

- Wolves for Yellowstone? 1990. A report to the U.S. Congress. U.S. Fish and Wildlife Service and National Park Service, PO Box 168, Yellowstone NP, Wyoming 82190.
- Houston, D.B. 1982. The northern Yellowstone elk. MacMillan and Co., NY, NY. 500 pp.
- Merrill, E.H., and M.S. Boyce. 1990. Grassland Phytomass, climatic variation and ungulate population dynamics in Yellowstone NP. In M.S. Boyce and R. Keiter, eds. Examining the Greater Yellowstone. Yale Univ. Press.