Coefficients of Productivity for Yellowstone's Grizzly Bear Habitat

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Executive Summary

This report describes methods for calculating coefficients used to depict habitat productivity for grizzly bears in the Yellowstone ecosystem (see Appendix 1 for scientific names). Calculations based on these coefficients are used in the Yellowstone Grizzly Bear Cumulative Effects Model (CEM) to map the distribution of habitat productivity and account for the impacts of human facilities. The coefficients of habitat productivity incorporate detailed information that was collected over a 20-year period (1977–96) on the foraging behavior of Yellowstone's bears and include records of what bears were feeding on, when and where they fed, the extent of that feeding activity, and relative measures of the quantity consumed. The coefficients also incorporate information, collected primarily from 1986 to 1992, on the nutrient content of foods that were consumed, their digestibility, characteristic bite sizes, and the energy required to extract and handle each food. This information on foraging behavior and energetics was used to estimate the average digestible energy obtained from foods at a given type of feedsite, subtracting the energy that was expended. This estimate of net digested energy was then coupled with an estimate of the density of bear activity in each of 18 habitat types to produce, in turn, a relative measure of the total net digested energy obtained by grizzly bears from each habitat type.

Coefficients were calculated for different time periods and different habitat types, specific to different parts of the Yellowstone ecosystem. For example, habitat type coefficients were calculated for each of four regions (north, east, south, and west), distinguishing Bear Management Units (BMUs) with substantial numbers of bison from those without. This distinction was desirable partly because sampling effort varied substantially among the four regions, and partly because specific features of individual habitat types and bear use differed from one part of the ecosystem to another. Coefficients were also calculated for each of four seasons of bear activity (spring, estrus, early hyperphagia, late hyperphagia), for years when ungulate carrion and whitebark pine seed crops were abundant versus not, for areas adjacent to (<100 m) or far away from forest/nonforest edges, and for areas inside or outside of ungulate winter ranges. These stratifications allow managers to track often substantial changes in the distribution of habitat productivity by season and by whether ungulate carrion or whitebark pine seed crops are abundant or not. Because of the way these coefficients were calculated, values can be compared within regions and among seasonal and annual time periods. For the time being, comparisons among regions are potentially problematic because the density of bear activity in each region is assumed to be the same. Because of known differences in habitat, this assumption is questionable. This problem can be easily remedied, however, as estimates of relative bear densities for each ecosystem region become available.

Densities of bear activity in each region, habitat type, and time period were estimated by logistic regression (LR) models. Statistical criteria were used to determine whether the effects of forest/nonforest edge should be included in each model. The same approach was taken to determine whether the effects of winter range should be included but only for models applicable to spring. The LR models were used to estimate the sometimes substantial effects that distance to a human facility (e.g., roads and recreational facilities) had on the numbers of radio-marked bears that were located. Densities of locations varied with distance to human facilities, presumably because of the behavior of both bears and bear researchers. At the same time that some bears were most likely avoiding human facilities, bear researchers were probably oversampling bears that used areas near roads or other human-related features. The densities used here for calculating coefficients of habitat productivity were those obtained by removing the effects of distance to human facilities. Our interest was in estimating the productivity of grizzly bear

habitat, independent of the effects of sampling bias and other human-induced effects. Within CEM operations, once habitat productivity is estimated, it is then reduced by coefficients of habitat effectiveness (see Appendix 2) if an area is within the zone-of-influence of some human-related feature.

The coefficients described here and associated estimates of grizzly bear habitat productivity are unique among many efforts to model the conditions of bear habitat. A number of studies have calculated the biomass and nutrient content of bear foods in different habitats. Several of these studies have tested to what extent the use of these habitats by radio-marked bears corresponded to the abundance and quality of foods. In all instances the results were equivocal. No doubt, bears use their habitat and foods based upon a number of considerations in addition to available energy. Our approach has the advantage of letting the bears directly inform us through their foraging behavior about when and where they used various foods, and the energetics of the foods that they chose to use. This was possible because no other bear study, either of black bears or grizzly bears, has produced the amount or kind of detailed information on foraging behavior or energetics that has been produced by the Yellowstone ecosystem grizzly bear study. Other analyses have also portrayed the relative use of different habitat types by bears either as indices of habitat selection or as probabilities or proportions of use (e.g., LR-type analyses for the latter). Both approaches merely report the extent to which bears used various habitat types and do not inform managers about the type of activity in which the bear was engaged or its relative or absolute value. This latter type of information is relevant because, for example, the energetic values associated with different bear telemetry locations can vary by many orders of magnitude (e.g., the difference between traveling and excavating pine seeds from a red squirrel midden or the difference between eating a bull bison and excavating ants from a log). While it is important to know the extent to which bears will likely use a given piece of their habitat, this is only part of the germane information needed to judge the efficacy or impacts of management. Detailed knowledge about bear foraging behavior and use of foods is also necessary to interpret the distributions of bears. Our approach has the advantage of including not only information on bear distribution in the Yellowstone ecosystem but also information on the energetics of their behavior, removing to the extent possible the often ambiguous effects of human facilities.