Nutrition Nuggets

INTEGRATING NUTRITIONAL ECOLOGY INTO WILDLIFE MANAGEMENT

By Jeffrey L. Beck, Brogan Holcombe, Marcella J. Kelly, Rachel Cook and John Cook

Integrating nutritional ecology into management is essential for developing strategies to support wildlife populations. By understanding how animals obtain, process and use nutrients within their environments, managers can gain insight into species' dietary needs, habitat preferences and overall population health. Wildlife managers can then identify critical food resources and alter habitats to meet species-specific nutritional requirements. Additionally, this information equips managers with the knowledge to mitigate challenges that arise from environmental changes. By incorporating nutritional ecology into management practices, decision-making becomes more informed, driving effective conservation efforts.

The snapshots below highlight current research using nutritional ecology to aid management and conservation decisions for a wide range of species.

Jeff Beck on sage-grouse and sagebrush reduction

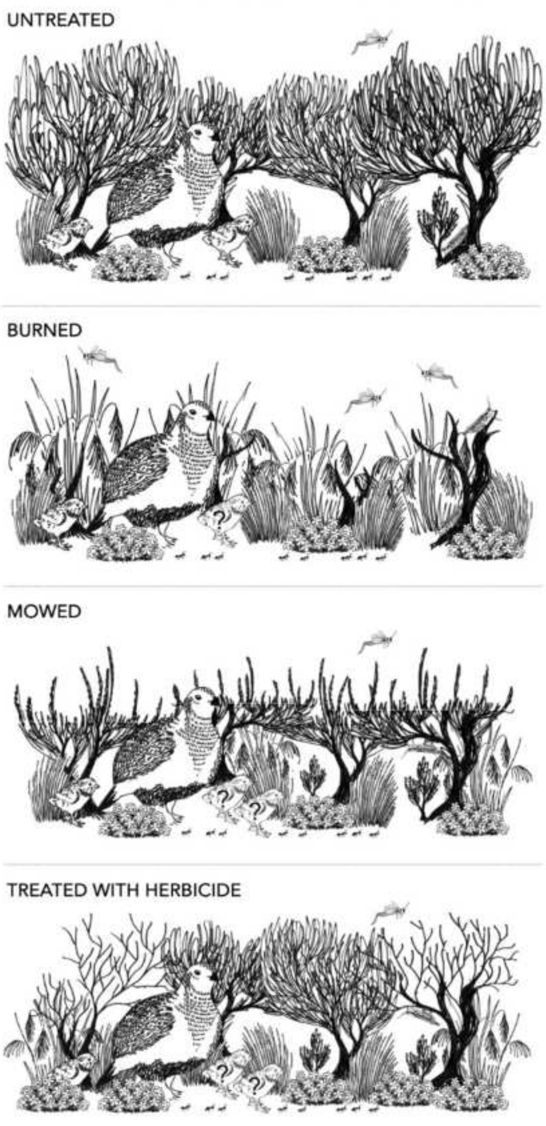
Sage-grouse, an iconic species dependent on the sagebrush rangelands in western North America, are declining. Understanding whether the birds are getting the proper nutrition is crucial in conserving their populations.

Sage-grouse depend on sagebrush year-round for food and cover. During the winter, sage-grouse (*Centrocercus* spp.) subsist entirely on sagebrush (*Artemisia* spp.) leaves, while in summer, forbs and insects form a large part of the adults' diets and most of the chicks' diets.

Researchers studying stable isotopes from chicks' feathers in central and north-central Wyoming found birds that consumed greater amounts of plant-derived nitrogen during the first week of life tended to weigh more by their fourth week. They also had longer wing chords—or the distance from the wrist joint of the wing to the end of the longest primary feather—by this time (Smith et al. 2019*b*). For chicks to obtain these resources, brood-rearing females select habitat patches that maintain high forb availability as summers progress and plants begin to senesce (Smith et al. 2019*b*).

Prescribed burning and wildfire kill sagebrush and lead to increases in grassy forage. Burning

Figure 1.



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Researchers looked at how treatments—including burning, mowing and aerial broadcasting of herbicide—affected sagebrush and the sage-grouse that rely on it for nutrition and cover.

also leads to sage-grouse declines (see Figure 1). Nevertheless, some land managers still implement sagebrush-reduction treatments, including burning, mowing and applying herbicides. They believe that releasing sunlight, water, soil nutrients and space for forbs and grasses will increase chick survival and bolster populations compared to leaving areas untreated.

This largely untested idea led my lab and research collaborators to conduct observational and experimental research in Wyoming big sagebrush (*A. tridentata wyomingensis*) in central Wyoming and in the Bighorn Basin of north-central Wyoming. We wanted to dig deeper on the effects of these treatments in these particular areas. Could these strategies people employ be increasing or decreasing optimal nutrition for sage-grouse?

We conducted our research in Wyoming big sagebrush, the largest in spatial extent of the big sagebrush subspecies, which typically occurs in drier sites at lower elevations. Mountain big sagebrush (*A. t. vaseyana*), which occurs at mesic sites at higher elevations, likely responds differently to sagebrush-reduction treatments than Wyoming big sagebrush (Beck et al. 2012). Our observational research in the Bighorn Basin indicated that mowing and prescribed burning in Wyoming big sagebrush did not increase forb mass, insect mass or protein in forbs and did not enhance soil carbon and nitrogen in north-central Wyoming (Hess and Beck 2014).

We found that after 19 years of burning and nine years of mowing, sagebrush did not meet the minimum recommended height for breeding in the majority of cases we evaluated (Hess and Beck 2012). In a separate study spanning the Wyoming Basins, including both mountain and Wyoming big sagebrush, we found only chemicals—primarily herbicides—had a positive effect on male lek attendance, but only 11 years after treatment. Wildfire had an immediate and persistent negative effect on annual population change (Smith and Beck 2018).

In our experimental study, we evaluated the effects of sagebrush-reduction treatments on habitat characteristics as well as sage-grouse habitat selection and survival in Wyoming big sagebrush habitats in central Wyoming. Thinning sagebrush by mowing or aerially applying Spike® 20P—an herbicide with the active ingredient of tebuthiuron—did not increase food and cover for sage-grouse six years post treatment (Smith et al. 2019*a*, 2023). These two treatments also did not change nest, brood or adult female survival but sometimes caused adult females to avoid treated areas.

We also evaluated nutritional quality in mowed and tebuthiuron-treated Wyoming big sagebrush through lab analysis of crude protein and plant compounds that deter herbivory, including coumarins, terpenes and total phenolics. Mowing and tebuthiuron treatments slightly increased crude protein without immediate changes in plant anti-quality compounds. This provided a slight increase in protein for sage-grouse, but these treatments overall resulted in a large loss of sagebrush biomass, creating a significant trade-off for wintering sage-grouse and other wildlife for the benefit of a slight increase in protein (Smith et al. 2018).

We concluded that sagebrush-reduction treatments are not an effective way to bolster sage-grouse populations in Wyoming big sagebrush. We recommend other practices to managers, such as removing pinyon pine (*Pinus monophylla*) and juniper (*Juniperus* spp.) expanding into sagebrush (Miller et al. 2017). We also suggest implementing techniques, such as grazing management in riparian areas and installing Zeedyk structures—hand-built structures that restore hydrologic function—and beaver dam analogs in stream channels to improve hydrologic function in mesic areas (Silverman et al. 2019). These methods show more promise in providing the food and cover that sage-grouse need.

Brogan Holcombe taps into foraging ecology for a cryptic species

Foraging ecology is challenging to study in cryptic species like the American black bear (*Ursus americanus*). Their secretive nature and the dense habitat they reside in can make it difficult for researchers to directly observe what the animals are eating.

Recent technological advances have allowed scientists to monitor the species remotely. For example, camera collars can provide new insight into American black bear behavior and foraging ecology by recording videos on a set interval. This allows for the collection of random samples of black bear behavior.

As part of the Virginia Appalachian Carnivore Study, camera collars were deployed on 15 black bears that recorded 20-second videos every 20 to 30 minutes during daylight as they roamed the Appalachian Mountains of western Virginia. We recorded all diet items we saw the bears consume in the video, including plant species and parts (*i.e.*, berries, leaves, roots, etc.). Then, we conducted a foraging analysis. We built diet profiles for each black bear to examine individual differences and to compare males to females. Each video also had an associated GPS point, so we could link habitat variables from the locational information to determine where black bears foraged on the landscape and what might drive their foraging decisions.

Credit: Data as part of the Virginia Appalachian Carnivore Study in Bath County, Virginia in 2018-2019

▲ A view from high-resolution, camera collars, used to identify species consumed by 15 black bears: A) white-tailed deer (*Odocoileus virginianus*) fawn, B) pokeweed (*Phytolacca decandra*), C) anthropogenic foods (*Zea mays*) and D) autumn olive (*Elaeagnus umbellata*), an invasive species.

Our results indicated that the plants the bears consumed varied based on the season. We observed bears consuming more herbaceous and leafy material during spring months as they emerged from hibernation. The bears shifted to eating fruiting species as they became available on the landscape in the summer into the fall. They also began to consume hard mast—or acorns—in the fall as those items appeared on the landscape.

When it came to the consumption of white-tailed deer (*Odocoileus virginianus*), individual bears ate different amounts, and this was dependent on the bears' sex. Specifically, we analyzed black bears' methods of acquiring fawns like hunting and scavenging during the spring and summer. We found that certain individuals consumed more meat items than others did and that females tended to hunt fawns more often in the spring and summer. Males, on the other hand, more often scavenged white-tailed deer in the summer and fall. Further, we documented bears consuming human foods, which in our study area was surprisingly low. We most often observed bears consuming agricultural products (*i.e.*, corn, apples) or bird seed, but this occurred more often closer to human settlements, even considering the rural nature of the study area.

Our research is one of the first studies to use remote video camera collars to study black bear diet. It's also one of the few studies to monitor bears' foraging ecology and diet composition. The typical method of scat sampling only provides a snapshot of a species' diet.

Moving forward, we hope to understand bears' caloric intake by learning the nutritional values of the plant species they consume. Finally, we can potentially link movement data obtained via accelerometers on collars to further study black bear energy expenditure across the landscape, particularly as it relates to foraging patterns.

Rachel Cook and John Cook discuss improving forage resources for ungulates

Traditionally, if wild ungulate populations have shown evidence of nutritional limitations—reduction in reproduction, body fat or juvenile growth—managers have often assumed that the population has outgrown the food resources and the amount of food available for each individual animal is inadequate. In response, managers often reduce populations' numbers to increase the amount of forage resources available for each individual to improve the population's performance. But this management strategy may not be an option for threatened populations or due to public opposition.

What's more, recent research has shown that in some ecoregions, ungulates can be faced with high forage abundance, but it's of poor quality. The available forage may have inadequate levels of energy or nutrients for meeting requirements, high levels of plant secondary metabolites that either reduce digestion or are toxic to animals or high fiber content that reduces passage rate, digestion and total daily intake. In these settings, nutritional limitations can occur regardless of population size (*e.g.*, Cook et al. 2016, DeYoung et al. 2019), and reducing ungulate density may not significantly improve populations' productivity. As a result, managers also need to understand how to enhance nutrition through habitat management, either on its own or in combination with reducing the density of animals to benefit ungulates.

But to do this effectively, scientists must better understand the mechanistic links between habitat attributes and the performance of herbivores. This is especially important since the composition, quality and quantity of plants within any given

Credit: Deborah Monzingo

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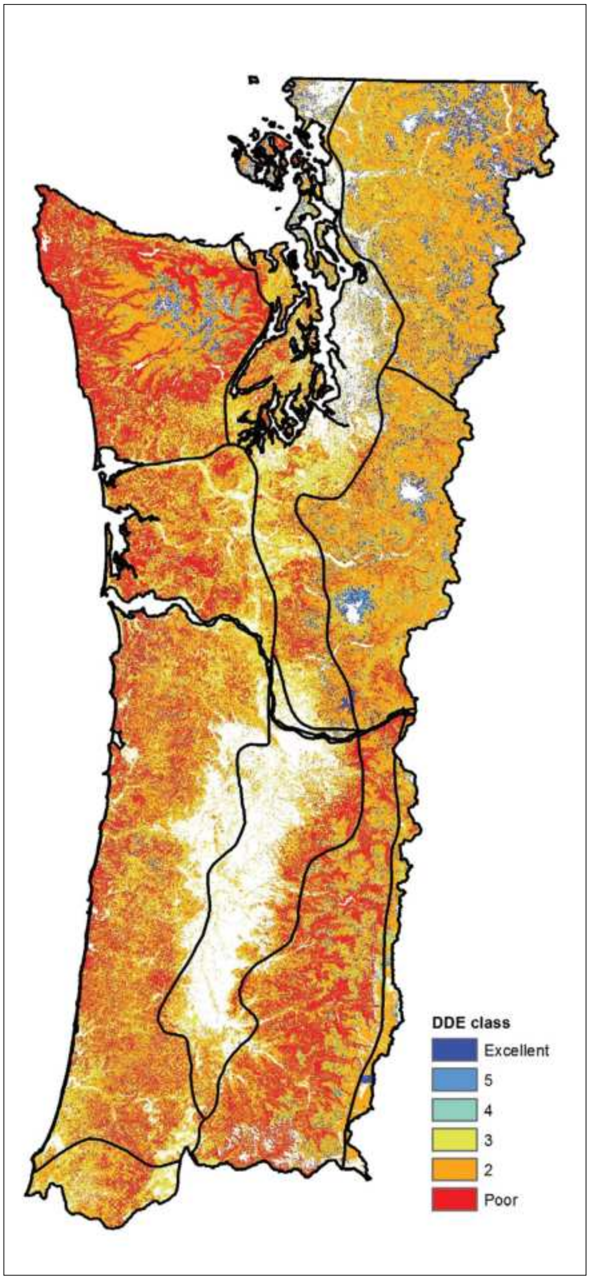
▲ These two photos demonstrate the importance of accounting for site productivity. Both stands are early seral (*e.g.*, <15 years old) but differ in site productivity and response to disturbance. The top photo depicts a high-elevation, unproductive site, mostly nonresponsive to disturbance and with very little forage suitable for elk or deer (*e.g.*, <100 kg/ha); while the bottom photo depicts a more productive site that produces ample forage suitable for elk and deer after disturbance (*e.g.*, 500 kg/ha) (Monzingo et al. 2023).



Credit: Map reprinted with permission (Rowland et al. 2018).

▲ An example of a spatially explicit foodscape for western Oregon and Washington, developed using foraging trials of tractable elk placed in native habitats and intensive vegetation surveys (DDE = digestible energy of elk diets; Cook et al. 2018).

habitat could be the difference between ungulate populations thriving or merely surviving.

Over several decades, researchers from the National Council for Air and Stream Improvement Inc. (NCASI) Large Ungulate Program used tractable elk (*Cervus canadensis*) and caribou (*Rangifer tarandus*) to help them understand the link between plants and ungulate performance. To do this, they conducted controlled feeding trials in natural environments combined with intensive vegetation surveys, as well as body fat and pregnancy data collected from wild ungulate populations.

This research has identified nutritional requirements and helped the team understand the effects of nutritional deficiencies on key life processes like lactation and growth (Cook et al. 2004). Scientists have been able to rigorously validate techniques used to measure the body condition of free-ranging ungulates (*e.g.*, Cook et al. 2001) and evaluate the extent and seasonality of nutritional limitations in wild populations (*e.g.*, Cook et al. 2013, Cook et al. 2021). Through their research, NCASI scientists and their collaborators have been able to pinpoint causes of nutritional deficiencies (Cook et al. 2016, Denryter et al. 2022) and what management actions could be used to improve nutritional resources (*e.g.*, Monzingo et al. 2023).

In addition, forage resources vary across space and time depending on site productivity, weather or disturbance. For example, fire, silviculture, grazing and insect outbreaks can all impact forage abundance and quality across space and time. Accurately depicting nutritional resources across landscapes—commonly referred to as foodscapes—using nutrition metrics that are relevant to the foraging ungulate is critical for land-use planning; forecasting how nutritional resources can change through space and time in response to habitat management; and understanding how nutrition may interact with factors such as predation, disease and human activities.

NCASI scientists and their collaborators have developed foodscapes for elk based on data from tractable animals in western Oregon and Washington (Cook et al. 2018), eastern Oregon (Cook et al. unpublished data) and northern Idaho (Cook et al. unpublished data) and for caribou in northern Ontario (Walker 2023).

Managers have used these foodscapes—often in concert with habitat use models that include additional factors like roads, topography or predation risk that may affect ungulate behavior—in several ways. For example, foodscapes have helped managers prioritize habitat management areas and protect key areas on behalf of elk across four national forests in Oregon, Washington and Idaho and by at least four tribal, state and federal organizations (*e.g.*, Vales et al. 2018; Rowland et al. 2018; Wisdom et al. 2018). Scientists have also used them to demonstrate strong correlations between high dietary-digestible energy and body fat and pregnancy rates of wild elk herds (Cook et al. 2018). Foodscapes have also been used to help disentangle interactions between nutrition, animal state, time of year and predation risk on resource selection for caribou (Walker 2023).

These kinds of tools have considerable value for habitat management, and the need for them will likely increase as climate change and other anthropogenic activities increase. ■

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