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ForageAdapt Optimization Model for Studying Wildlife Feeding Strategies Under Resource Variability

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Key Words
Foraging ecology, Feeding strategies, Resource variability, Dietary flexibility, Behavioural adaptation, Wildlife ecology.

Abstract
The strategy of feeding in animals can be regarded as one of the most important elements of their survival and reproduction in a variety of environments. The ForageAdapt model for optimization is intended to help evaluate the feeding strategies employed by animals in accordance with the temporal and spatial changes of resources. This research incorporates existing animal science literature on the issues of foraging ecology, dietary flexibility, and metabolic adaptability to formulate an advanced conceptual model. This model stresses the interaction between environmental variability, physiological limitations, and behavioural adaptation in terms of the formation of feeding behaviour in a variety of animal species. It has a range of applications, such as predicting feeding behaviour in domesticated livestock and wild ungulates, and optimizing foraging in omnivores.

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Introduction

Foraging is among the costliest and behaviourally complicated activities in animals' lives. Resource availability in natural ecosystems shows great temporal and spatial variation; this creates selective pressure on feeding strategies that allows the use of plastic phenotypes and behaviour (Walker et al., 2023). Knowledge of how animals cope with heterogeneous environments can be obtained by combining ecological, physiological, and behavioural perspectives. The ability to change diet composition, foraging effort, and habitats depending on resource availability determines the efficiency of feeding and hence affects fitness (LaSharr et al., 2023). Observations on wild herbivorous, carnivorous, and omnivorous animals showed that feeding behaviour changes depending on the seasons, resource patches, and demography of the population. In traditional approaches to studying foraging behaviour, animals have been considered as passive consumers or just optimizers of one currency (energy gain). In recent animal science research, it is realized that foraging behaviour depends on several, often conflicting, selective pressures, such as energy gain, nutrition, safety from predators, and social dominance (Kohl et al., 2015). This research offers a new ForageAdapt optimization model as a framework for analysing this problem.

Key Contributions

- ForageAdapt model is presented as a tool for assessing wildlife feeding tactics in resource variable conditions.
- Biophysical approach that takes into account ecological, physiological, and behavioural components for modeling adaptive behaviour.
- Applies to wildlife management, conservation, and prediction of feeding behaviour in new environmental conditions.

The rest of this paper will be organized as follows. Section 2 deals with strategies for feeding and behaviour. Section 3 provides resource heterogeneity and environmental heterogeneity. Section 4 presents the ForageAdapt framework. Section 5 provides applications in wildlife management and conservation. Section 6 presents future research areas.

Wildlife Feeding Strategies and Behavioural Responses

Feeding adaptations in wildlife populations involve a wide array of behavioural and physiological approaches to resource acquisition. Herbivore species use adaptive browsing and grazing behaviours based on patch quality, digestibility of resources, and predator avoidance measures. Large herbivores such as ungulates have exhibited a significant variation in choice of plant species and bite rate due to temporal variation in quality and quantity of forage (Bakker et al., 2005). Carnivores utilize search tactics and prey handling behaviour depending on prey abundance, encounter rate, and the energy value of the available prey. Omnivores are the most flexible eaters, consuming multiple types of food items sequentially or concurrently depending on the availability of seasons and physiological condition. The smaller-sized organisms usually have a quick behavioural response to resource variations owing to the fast life cycle and high metabolism rates. Larger organisms show more tenacity in their feeding territories even when there is a limitation of resources due to the constraints in their life history and territorial behaviours (LaSharr et al., 2023). The physiological basis of dietary flexibility involves differential enzyme production, alteration in the morphology of digestive organs, and adaptation of metabolism to alternative foods.

Resource Variability and Environmental Heterogeneity

The variability in environmental resources occurs on different time and spatial scales, producing a variety of selective pressure factors influencing feeding behaviour. Regularly occurring seasonal changes in the productivity of plant life and prey availability influence the feeding behaviour of temperate and boreal animals and create selective pressure for the development of resource stockpiling mechanisms in organisms that can use it (Fynn & Provenza, 2023). Annual variations in resource productivity due to meteorological or climatic factors generate an unpredictable environment, which demands an appropriate behavioural response. The heterogeneity of resource distribution makes feeding costs, efficiency, and dietary choices vary from patch to patch. Availability of food items as well as the nutritional content of those food items, which is determined by the nature of vegetation and the land-use history, in addition to prey-predator interactions, restricts choices and influences the feeding efficiency of the consumer. Nutritional variation of the available food, in addition to the difficulty in digesting the available food, makes it necessary for animals to exhibit selective feeding behaviour in order to ensure adequate intake of minerals, vitamins, and proteins (Kohl et al., 2015). Competition among both conspecific and heterospecific species for scarce resources adds another dimension of variability to the food environment faced by the animal.

ForageAdapt Optimization Framework

Five fundamental factors of animal foraging include resource assessment, dietary selection, foraging intensity, spatial mobility, and physiological adaptations. Resource assessment involves sensory systems that allow animals to determine the quality, quantity, and timing of available resources. The forage nutrient value is assessed by herbivores using vision, smell, and taste, while the prey density and vulnerability are assessed by carnivores using observational learning and experience gained from earlier contacts (Bakker et al., 2005). Dietary selection refers to the composition of foods eaten, based on the need for nutrients, digestibility, and palatability. Foraging intensity refers to the time spent and energy expended in foraging activities. It is inversely related to resource density and quality. The first component is spatial mobility, where movements among different patches and habitats are considered, with the frequency and distance increasing in line with the progression of resource scarcity in the area. The second component is physiological adaptation, which involves changes in metabolism, digestion, and energy storage in preparation for potential resource shortages in the future. All these components are interconnected in a decision process that depends on the body condition, reproductive state, age, and social ranking of individuals within the population.

Applications in Wildlife Management and Conservation

The ForageAdapt framework offers the ability to predict animal responses to environmental changes and resource availability. In the case of grazing animals, the ForageAdapt framework can predict how cattle and sheep respond to changes in pasture seasonally and changes in vegetation community composition and stock densities (Xu et al., 2026). For wild herbivores, the use of the ForageAdapt model can help understand carrying capacities, viability of populations under changing environments, and impact on feeding habits and demographic patterns caused by changes in habitats. Feeding adaptations in predator populations can give information about population stability and dietary responses to changes in prey populations (Fynn & Provenza, 2023). It is particularly helpful in cases of omnivores like bears, primates, and squids because of their complicated feeding behaviours, which change greatly seasonally and annually. It has uses in conservation where it helps predict reactions of threatened species to scarcity of resources, habitat fragmentation, and changes in resource phenology due to climate change. When applied to threatened species whose ranges are shifting or whose habitats are deteriorating, ForageAdapt helps to determine what kind of resources will be crucial for survival of the populations and areas that could suffer from resource scarcity. Also, knowledge of feeding behaviour flexibility helps manage human and wildlife conflicts in shared environments.

Discussion and Future Directions

The ForageAdapt optimization model integrates the current knowledge about the ecology of feeding into an integrated model that is applicable to the study of animal sciences and to wildlife management. The key point of this model is that it explicitly accepts the idea that the feeding behaviour of animals is the result of evolutionary adaptations to the various selection pressures exerted on animals at the ecological, physiological, and social level. Instead of considering foraging as one optimized behaviour, the ForageAdapt model assumes that animals balance among conflicting requirements, with different behaviours being optimal in different conditions (Gunn et al., 2022). The future development of ForageAdapt requires accounting for differences in foraging phenotypes on an individual basis through heterogeneity in terms of body size, previous experience, social rank, and personality, which affect the adoption of foraging strategies. The quantitative parameterization of different aspects of the framework for different animal species, ecological settings, and food sources can improve the predictive power of the approach for practical problems of wildlife management. Linking ForageAdapt to population models will allow predicting the consequences of individual differences in feeding strategy at the population level.

References

[1] Bakker, E. S., R. C. Reiffers, H. Olff, and JM16049716 Gleichman. "Experimental manipulation of predation risk and food quality: effect on grazing behaviour in a central-place foraging herbivore." *Oecologia* 146, no. 1 (2005): 157-167. https://doi.org/10.1007/s00442-005-0180-7

[2] Fynn, Richard WS, and Frederick D. Provenza. "Functional adaptive resources for large herbivores in African savannas: an ecological-gradient based framework." *Frontiers in Conservation Science* 4 (2023): 1133329. https://doi.org/10.3389/fcosc.2023.1133329

[3] Gunn, Rachel L., Ian R. Hartley, Adam C. Algar, Petri T. Niemelä, and Sally A. Keith. "Understanding behavioural responses to human-induced rapid environmental change: a meta-analysis." *Oikos* 2022, no. 4 (2022): e08366. https://doi.org/10.1111/oik.08366

[4] Kohl, Kevin D., Sean CP Coogan, and David Raubenheimer. "Do wild carnivores forage for prey or for nutrients? Evidence for nutrient-specific foraging in vertebrate predators." *BioEssays* 37, no. 6 (2015): 701-709. https://doi.org/10.1002/bies.201400171

[5] LaSharr, Tayler N., Samantha PH Dwinnell, Rhiannon P. Jakopak, Jill Randall, Rusty C. Kaiser, Mark Thonhoff, Brandon Scurlock et al. "Behavior, nutrition, and environment drive survival of a large herbivore in the face of extreme winter conditions." *Ecosphere* 14, no. 7 (2023): e4601. https://doi.org/10.1002/ecs2.4601

[6] Walker, Reena H., Matthew C. Hutchinson, Arjun B. Potter, Justine A. Becker, Ryan A. Long, and Robert M. Pringle. "Mechanisms of individual variation in large herbivore diets: roles of spatial heterogeneity and state-dependent foraging." *Ecology* 104, no. 2 (2023): e3921. https://doi.org/10.1002/ecy.3921

[7] Xu, Shiying, Xilong Zhu, Hang Ren, Xiangxiang Yan, Xiangyang Fang, Sazal Ahmed, and Qiuhua Wang. "How Can Grazing Mitigate Wildfires? A Review of Fuel Management, Ecological Trade-Offs, and Adaptive Frameworks." *Sustainability* 18, no. 2 (2026): 718. https://doi.org/10.3390/su18020718