Review Article

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How can we predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife protected area?

Abstract

Knowledge and insights on the ecological carrying capacity of a predator species is crucial for the conservation and management of an enclosed wildlife protected area. The objective of this review was to suggest and discuss the relevant factors and formulate quantitative statistical model that helps accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system. To accurately predict and determine the ecological carrying capacity of a predator species, theoretical and empirical quantitative models should consider as many relevant factors as possible by which reliable and valid estimations can be made. Having considered several imperative factors, this review suggested and formulated a quantitative statistical model that helps accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system. It is recommended that wildlife conservation researchers should consider the various essential factors in an integrated fashion while testing their hypotheses through experimental and/or observational scientific studies. More importantly, the application of multiple hypotheses testing will help improve the accuracy in making reliable and valid estimations on the ecological carrying capacity of a predator species in a complex natural system.

Keywords: complex natural system, conservation and management, predators, prediction, theoretical and empirical quantitative models

Volume 4 Issue 1 - 2020

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Received: November 13, 2019 | **Published:** January 02, 2020

Introduction

Prey-predator interaction is among the major evolutionarily and ecological forces which play imperative role to determine the distribution, abundance, habitat selection, behaviour, fitness, and population dynamics of different species in a biotic community.[1–5] Such kinds of interaction are crucial to understanding the ecological and evolutionarily relationships, pathways, and co-evolution between prey and predator species in an ecological system. Moreover, it can increase our insights to discern the attributes of ecosystems, including structure, function, interactions-interdependence, heterogeneity, complexity, spatial, and temporal dynamics. It is also relevant to develop an insight on how natural selection shapes the morphology, behaviour, anatomy, and physiology of prey versus predator species. On top of these, such kinds of knowledge are important to understand how energy flows and matter cycles through the various trophic levels in an ecosystem.[6,7] All these insights and knowledge in turn help conserve and manage wildlife, including saving the endangered species from extinction, and also to sustainably utilize the biodiversity found in an area.

Ecological carrying capacity can be arbitrarily defined as the optimum number of individuals (i.e. all sex-age classes) of a species that an environment can support over time through the provision of essential habitat requirements, including space, energy, water, nutrients, oxygen, food, cover, nesting site, and the like. Therefore, knowledge and insights on the ecological carrying capacity of a predator species is crucial for the conservation and management of an enclosed wildlife protected area.[8] An enclosed wildlife protected area is to mean that the wildlife reserve is self-sustaining and there is no influx of wild animals to come from outside or losses to the outside. There are various theoretical and empirical quantitative models that help predict and determine the ecological carrying capacity of a predator species in an enclosed system.[8–18] However, a central challenge in wildlife ecology is to develop quantitative model that faithfully captures all important mechanistic details of natural systems that are required in making reliable and valid predictions on the ecological carrying capacity of a predator species in an enclosed system. This is because the ecosystem where predator and prey species interact and co-exist is naturally very complex.

Hence, predicting and determining the ecological carrying capacity of a predator species in an enclosed system needs careful and objective insights and judgments in making reliable and valid estimations.[8,17] To accurately predict and determine the ecological carrying capacity of a predator species, quantitative models should consider as many relevant factors as possible by which reliable and valid estimations can be made. The objective of this review was to suggest and discuss the relevant factors and formulate quantitative statistical model that helps accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife reserve. Therefore, the goal of this paper is to highlight existing concerns about the ecological carrying capacity of a predator species in an enclosed system, which may assist wildlife decision- and policy-makers, researchers, managers, and conservationists to optimally conserve and manage predator species in an enclosed wildlife reserve.

Testable hypotheses

A summary of the relevant factors that help formulate the plausible hypotheses, their expected effects, and intensities to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife protected area was presented in Table 1. Factor refers to the process input that a researcher manipulates to cause a change in the output. Effect implies how changing the setting of a factor changes the response. Intensity refers to the measurable amount of the strength of a factor on the ecological carrying capacity of a predator species in an enclosed wildlife protected area. Each of the relevant factors, their expected effects, and intensities on the ecological carrying capacity of a predator species in an enclosed system were thoroughly discussed as followed.

The abundance and availability of preferred prey species

Prey-predator interaction serves as a basis in predicting and determining the prey-specific biomass intake of a predator species which can in turn be used to estimate the ecological carrying capacity of a predator species in an enclosed wildlife reserve.[8] The prey preferences of predators affect prey-predator interaction. Understanding the processes behind such kinds of phenomena is essential in predicting and determining the dynamics of biotic assemblage.[17,18] Hence, a predator species that preys on a readily surveyed prey species can have its ecological carrying capacity predicted and determined based on the abundance and availability of its preferred prey species.[8] For example, previous studies predicted that the abundance of a predator species is positively correlated with the abundance and availability of preferred prey species.[8,9,16–18] Accordingly, I hypothesize that the abundance and availability of preferred prey species have positive effect and strong intensity to accurately predict and determine the ecological carrying capacity of a predator species (Table 1). Hence, understanding such kinds of phenomena in turn helps in accurately predicting and determining the ecological carrying capacity of a predator species in an enclosed system.

The body size and biomass of preferred prey species

Knowledge on body size and biomass of individuals of preferred prey species is important because a single predator species may have more than one preferred prey species whose biomass largely varies with the body size of an individual of a prey species. To meet their nutritional and energy requirements, large body sized predators proportionally need to prey on large body sized prey.[8] One of the probabilistic models used to quantify such kind of relationship was the simplistic model developed by Carbone and Gittleman.[9] This model stated that 10,000 kg of prey will support 90 kg of a given predator species. Other studies also noted that prey body size is an important determinant of prey preference for large body sized African predators, such as cheetah (*Acinonyx jubatus*), leopard (*Panthera pardus*), African lion (*Panthera leo*), spotted hyena (*Crocuta crocuta*), and African wild dog (*Lycaon pictus*).[10–14,17,19] Accordingly, I hypothesize that body size and biomass of an individual of preferred prey species have positive effect and strong intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife protected area (Table 1). Hence, it is possible to predict that body size and biomass of an individual of a prey species will affect predator body size and biomass which ultimately influence the ecological carrying capacity of a predator species in an enclosed system.

The prey behaviour

Predators directly affect their prey by killing and consuming them. Nonetheless, this is not the only way they can affect them. Non-lethal effects, such as fear and apprehension generated from the possibility of being attacked, may be enough to change prey behaviour.[4,20–25] This suggests that non-lethal effects can affect the fitness of prey individuals because the prey's options are constrained and the behavioural response may be costly,[21,22] and even physiologically stressful when it is at its extreme case.[25] For example, previous studies on invertebrates,[26–28] and amphibians,[29] have shown that non-lethal effects may be larger than lethal effects in determining the habitat section, patch use, foraging behaviour, morphology, survival and reproductive rates, activity density, time budgets and distribution of animals over a range of trophic levels.[22,25] Due to the potentially high costs of avoiding predation and the tendency for large portions of populations to respond to risk of predation, the risk effects of predators can have impacts on individuals of prey species that may even surpass those of direct predation.[30] This is because effects of predation risk can exist even when direct rate of predation is zero.[31] Risk-sensitive behaviour resulting from non-lethal causes may ultimately affect the foraging behaviour, habitat use, change ecological processes, and potentially affect the structure of the biodiversity and the function of an ecosystem.

To reduce the negative impacts of predation risk, individuals of prey species may develop different behavioural strategies. For example, prey develop anti-predator behaviour, such as spending more time being vigilant and less time feeding, using apprehension or restricting their feeding to certain times, feeding in larger groups,[32] using sociality to enhance group defense, and avoiding exploitation of risky habitats.[22,33,34] Moreover, individuals of prey species may develop morphological adaptations (e.g. size, structure, such as presence of horns, spikes, hard hooves, camouflage, and coloration) as defensive mechanisms against predators' attack.[18] For example, an analysis of cheetah (*Acinonyx jubatus*) kills throughout South Africa revealed that the presence of prey horns significantly interacted with prey size to affect the cheetah's prey preference.[18] As a result, cheetah avoided large body sized and horned prey from their kills, suggesting that large body size and presence of horns have evolved as anti-predator defensive structures in prey species. Lima and Dill,[35] also noted that predation has long been implicated as a major selective force in the evolution of several morphological and behavioral characteristic of prey species. Thus, individuals of prey species need to protect themselves from risk of predation.[4,36–38] This suggests that predation can affect the fitness of individuals of prey species in a biotic community, including the abundance and availability of preferred prey species, and the availability and abundance of alternative prey species, which in turn, affects the ecological carrying capacity of a predator species in an enclosed ecological system. It is hypothesized that prey behaviour has negative effect and strong intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system (Table 1). Hence, wildlife researchers should consider the prey behaviour to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife reserve.

The availability and abundance of alternative prey species

Natural ecosystems are mostly complex entities because they are composed of biotic and abiotic factors that interact in space and time.[7] Although it is frequently convenient and useful to examine the movement of energy along a single trophic chain, such knowledge generally does not provide an adequate understanding and insights on the energy relationships in the whole ecosystem. This is because trophic classification is one of the functions, but not of species as such. For example, a given predator species may occupy one, or more than one, trophic level according to the source of energy actually assimilated.[6] Therefore, simple food chains rarely exist in nature by themselves because: one animal may feed on several different types of food at the same trophic level; one animal, such as an omnivore eats different kinds of plants and animals at several trophic levels; one organism may be eaten by several animals of its higher trophic levels; the type of food an animal feeds on may change with age (e.g. larva versus adults); food preferences are violated or ignored during shortage and deviations are common; according to the second law of thermodynamics, energy quality and quantity decreases as we go to the higher trophic levels (i.e. the greater the number of steps in a food chain, the greater is the loss of usable energy).[6,7] Therefore, because of these more complex eating and being eaten patterns and processes, natural ecosystems consist of interconnected networks of many feeding relationships called food webs.

Based on the above explanation, it is suggested that it is not only the abundance, availability, and biomass of the individuals of the preferred prey species that will help accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system, but also the availability and abundance of alternative prey species can potentially affect the abundance of predator species.[6,7] Such kinds of knowledge and understanding help accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife protected area. Accordingly, I hypothesize that the availability and abundance of alternative prey species have positive effect and moderate intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system (Table 1).

Table 1 A summary of the relevant factors that help formulate the plausible hypotheses, their expected effects, and intensities to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife protected area. "Positive" indicates that a given factor has an increasing effect on the ecological carrying capacity of a predator species whereas "negative" illustrates that a given factor has a decreasing effect on the ecological carrying capacity of a predator species in an enclosed system. Strong intensity indicates that a given factor has a substantial amount of strength to affect the ecological carrying capacity of a predator species. However, moderate intensity implies that a given factor has a medium amount of strength to influence the ecological carrying capacity of a predator species in an enclosed system

Serial Number	Factors	Expected effect of a factor on the ecological carrying capacity of a predator species in an enclosed system	Expected intensity of a factor on the ecological carrying capacity of a predator species in an enclosed system
1	Abundance and availability of preferred prey species	Positive	Strong
2	Body size and biomass of preferred prey species	Positive	Strong
3	Prey behavior	Negative	Strong
4	Availability and abundance of alternative prey species	Positive	Moderate
5	Type and abundance of other predator species	Negative	Moderate
6	Predators' social structure	Positive	Strong
7	Sex-age structure of prey versus predator species	Positive or negative	Strong
8	Human impacts	Positive or negative	Strong
9	Seasons of a year	Positive or negative	Strong
10	Habitat types	Positive or negative	Moderate

The type and abundance of other predator species

When there are more than one predator species in an enclosed system, there will be antagonistic interactions between or among the individuals of the different predator species, mainly including inter-specific competitions and producer–scrounger games.[39] For example, previous studies suggested that inter-specific competition is one of the natural selective forces that influence the ecological niche breadth, distribution, abundance, habitat selection, resource access and utilization, and fitness of organisms in a biotic community.[1,5,28,36] In a recent study, Murray-Berger and Gese,[40] found that the interference competition imposed by wolves limit the distribution and abundance of coyotes, suggesting that coexisting predator species may adversely influence each other due to their limiting effect on shared resources.

Mills and Gorman,[41] also found that the density and distribution of African hunting dogs are negatively affected by the presence of African lions and spotted hyena, suggesting that dominant predator species can negatively affect the ecological carrying capacity of subordinate predator species through aggressive behaviour.

Mathot and Giraldeau,[39] noted that when different predator species are found in the same enclosed system, individuals can either search for food by themselves (i.e. producer tactic) or they can search for and join other individuals that have located the food (i.e. scrounger tactic). The scrounger tactic may provide greater benefits than the producer tactic because the scroungers do not need to chase and capture the prey; however, the producers need to locate, chase, capture and kill the prey which in turn adds costs of foraging for the producers, including facing risks from the prey due to defensive attack while trying to capture and kill the prey.[42] Thus, such kinds of antagonistic interactions between or among the different predator species will reduce the availability and abundance of preferred prey species for the producer species. This in turn suggests that the survival and reproductive fitness of a predator species will be compromised and reduced, which ultimately affects the ecological carrying capacity of a predator species in an enclosed system. Hence, it is hypothesized that the type and abundance of other predator species have negative effect and moderate intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife reserve (Table 1).

The predators' social structure

Predators' social structure (e.g. sex and sociality - group hunters) have evolved to increase the preferences and success of prey capture by predator species.[18,43–45] For example, a field study conducted by Clements et al.[18] in South Africa revealed that cheetahs that hunt in groups (i.e. predator sociality) have access to a broader body mass range of prey than does a solitary cheetah, which may infer higher fitness benefits by way of expanded resource options. Similarly, sociality favored both African lion (i.e. lions hunting in pride can subdue even adult buffalos and elephants),[45,46] and African hunting dog (i.e. hunting in pack facilitates subduing even adult plain zebra and wildebeest),[43] to bring down larger body sized prey species than their own, suggesting that group hunting has evolved to increase the hunting success of many predator species, which may be achieved through the formation of social structure. For example, Creel and Creel,[43] noted that hunting success, individual prey biomass and the probability of multiple kills increased with number of adults in African hunting dogs. In another study, the individual prey weight range accessible to male African lion is wider than that accessible to female African lion,[45] suggesting that, in the absence of cooperative hunting, the larger body size of the male African lion may infer the hunting advantage that resulted from the evolution of sexual dimorphism (i.e. sex structure).[18,45,47,48]

Such kinds of information provide insight on the predation pressures driving the evolutionary selection strategy for large body size and expanded resource access leading to predator sociality favored in African hunting dogs,[43,44] though cooperative hunting does not favor sociality in African lions.[45] However, in a recent study, Mosser and Packer,[49] found that African lions living in larger prides were significantly more likely to maintain control of disputed area, which helps improve the quality of their territories, suggesting that sociality increases the ecological carrying capacity of predator species in an enclosed system. Accordingly, I hypothesize that the predators' social structure (e.g. sex and sociality - group hunters) have positive effect and strong intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system (Table 1).

The sex-age structure of prey versus predator species

Various studies noted that sex-age biased prey preferences have been observed in several large body-size predator species.[50–54] Previous studies also demonstrated that the behaviours of prey species are generally affected by their sex-age structure.[55–61] In line with those studies, it was found that the behavioural responses of prey species (i.e. activity time-budget allocated to vigilance, feeding and moving), habitat use, distribution, and abundance should vary with sex-age class. It is also predicted that adult females should more strongly select habitats with lower risk of predation than do adult males of their con-specific species. This should be true especially for females with young because bearing and raising young during the calving season may increase the predation cost to females and thereby limit their use of habitat types with high predation risk.[59–61] In contrast, in several prey species, males have larger body size than con-specific females, suggesting that sexual dimorphism in prey species have evolved as an anti-predator defensive mechanism where males are less susceptible to risks of predation than do females of the same species.[58–60,62–64]

Young prey individuals are less experienced in defending themselves from predator's attack and/or they may not have good defensive structure against predators (e.g. absence of horns or smaller body size), suggesting that they are more prone to be affected by predators.[58,59,60] These in turn will have consequences on the fitness of the individuals of a given prey species in a biotic community. In contrast, male predators are larger in body size than their con-specific females, suggesting that, in the absence of cooperative hunting, the larger body size in male predators implies the hunting advantage that resulted from the evolution of sexual dimorphism (i.e. sex structure) in predator species.[16,18,45,47,48] Radloff and Du-Toit,[65] also noted that the body size of a predator species determines its prey size range, suggesting that the predator and its prey body sizes are positively correlated. In contrast, young predators are less experienced to have lower hunting success than do adults of the same predator species.[18] Accordingly, it is hypothesized that the sex-age structure of prey versus predator species has positive or negative effects and strong intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system (Table 1). Hence, such kinds of sex-age structure (i.e. the social structure) of prey versus predator species are essential in accurately predicting and determining the ecological carrying capacity of a predator species in an enclosed wildlife reserve.

The human impacts

Human impacts can have positive or negative effects on predators and their respective prey species. For example, provisioning of foods and water, habitat management (i.e. manipulating the types, amount, or arrangement of food, water, cover, nesting and breeding sites within a habitat for the purpose of making the habitat more suitable for predators and their associated prey species), law enforcement, restocking of predators and their preferred prey species, control of competing predators, game farming, establishment of refuges, control of overharvests, preventing and/or controlling wildlife diseases and parasites have positive effects on prey and their predators. Hence, positive human impacts help increase the ecological carrying capacity of a predator species in an enclosed wildlife reserve.

However, poaching, introduction of invasive alien species, habitat destruction, mass tourism, pollution, deforestation, human-wildlife conflicts, war, introduction of wildlife diseases and parasites, stress, accidents, fossil burning, uncontrolled burning, desertification, flood, over grazing, poisoning, land degradation, drought, illegal settlement, urbanization, agricultural land expansion, starvation, and malnutrition have negative effects on prey and their predators. Maximizing the negative effects of those factors will reduce the habitat quality (e.g. decreases the availability of essential habitat resources), prey availability and later have negative impacts on the populations of predator species. Therefore, these kinds of human impacts ultimately reduce the ecological carrying capacity of a predator species in an enclosed wildlife reserve. Accordingly, I hypothesize that human impacts have positive or negative effects and strong intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system (Table 1). So, explicitly introducing the positive and negative impacts of humans into the quantitative model will help increase the accuracy in predicting and determining the ecological carrying capacity of a predator species in an enclosed system.

The seasons of a year

The distribution and abundance of prey species will vary depending on the seasons of a year.[66] For example, habitat essentials, such as food, water, cover, nesting, and breeding sites are more available in the wet than in the dry season. Hence, prey distribution and abundance are more aggregated in the wet than in the dry season.[59,60,67] Moreover, group fusion in prey species is a common phenomenon in the wet season, but group fission is widely seen in many prey species in the dry season.[60] Accordingly, depending on the seasons of a year, the distribution and abundance of predator species follow a similar pattern to that of their corresponding prey species. Therefore, the ecological carrying capacity of a predator species is affected by the seasons of a year. In another instance, prey species may need high quality and quantity of food during their peak reproductive season.[64,68] However, pregnant and/or lactating adult females may be highly sensitive to risk of predation during their peak reproductive season.[63] Some previous studies demonstrated that prey species use time allocation and apprehension to avoid risk of predation so as to meet their high physiological demands of food during their peak reproductive season.[69] This in turn affects the prey availability and later the ecological carrying capacity of a predator species in a given ecological system. Therefore, it is hypothesized that the seasons of a year have positive or negative effects and strong intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife reserve (Table 1).

The habitat types

Through their different mechanisms of adaptation, organisms may value habitats differently.[70] For example, habitat selection by individuals of a species is governed by the presence of quality habitat essentials (i.e. food, water, cover, and nesting site),[71] freedom of extreme competition from associated species,[72] suitability of escape terrains for avoidance of predation risk,[5,71] human nuisance,[73–75] and livestock disturbance.[62,75–77] Previous studies demonstrated that habitat quality and characteristics influence temporal activity patterns, foraging behaviour, anti-predator behaviours, and other social organization of a species.[5,67,78–81]

Several studies revealed that behaviours of prey species are generally affected by the type of habitat (e.g. poor versus rich habitats, risky versus safe habitats, open versus closed habitats).[67,69,78,82] Prey species trade-off between food acquisition and safety.[35,60] For example, prey species prefer to spend more time in safe than in risky habitat.[59,60,69] In line with this, it is noted that the behavioural responses of prey species (i.e. activity time-budget allocated to vigilance, feeding, moving, and resting) should vary with habitat types. For example, it is predicted that prey species should spend more time on vigilance or moving in habitats with high risk of predation.[59,60,69] In contrast, they should spend more time on feeding or resting in habitats with low risk of predation. This may increase the predation cost and thereby limit the use of habitat type by prey species with high predation risk.[61] When the abundance, availability, habitat selection, distribution, and fitness of prey species are affected by habitat types as explained above, it likely affects the distribution and abundance of predator species and ultimately influences the ecological carrying capacity of a predator species in an enclosed system. Previous studies also noted that the hunting success of a predator species is affected by habitat types.[15,41,78,80] Therefore, I hypothesize that habitat types have positive or negative effects and moderate intensity to accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife reserve (Table 1).

Quantitative statistical model

To accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife reserve, theoretical and empirical quantitative models should consider as many essential factors as possible. Hence, this review paper suggested and formulated the following quantitative statistical model that helps accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system. So, the ecological carrying capacity of a predator species in an enclosed system should be predicted and determined as functions of: abundance and availability of preferred prey species + body size and biomass of preferred prey species – prey behaviour + availability and abundance of alternative prey species–type and abundance of other predator species + predators' social structure±sex-age structure of prey versus predator species±human impacts±seasons of a year±habitat types. "+"indicates a positive change in the ecological carrying capacity of a predator species in an enclosed system, "–" indicates a negative change in the ecological carrying capacity of a predator species in an enclosed system, and "±" indicates positive or negative change in the ecological carrying capacity of a predator species in an enclosed system.

Once the data on the aforementioned relevant factors are made available, multiple hypotheses testing can be done. Hence, to test the effects and intensities of the independent variables on the dependent variable, Generalized Linear Model (GLM) with multivariate tests can be used. In the same analysis, univariate tests will follow the multivariate ones for better interpretation of the multivariate results.[59,60,83] The independent variables which will be entered into the GLM should include the followings: abundance and availability of preferred prey species, body size and biomass of preferred prey species, prey behaviour, availability and abundance of alternative prey species, type and abundance of other predator species, predators' social structure, sex-age structure of prey versus predator species, human impacts, seasons of a year, and habitat types. For the vector of the dependent variable, the ecological carrying capacity of a predator species in an enclosed system will be used.

Conclusion

To accurately predict and determine the ecological carrying capacity of a predator species in an enclosed wildlife reserve, theoretical and empirical quantitative models should consider as many essential factors as possible. To realize such phenomena, some of the most relevant factors may include: abundance and availability of preferred prey species; body size and biomass of preferred prey species; prey behaviour (e.g. distribution, anti-predator behaviours, such as vigilance, apprehension, time allocation, avoiding exploitation of risky habitats, and sociality (e.g. enhancing group defense or the many eyes or dilution effect), prey morphological adaptations (e.g. the presence of horns, spikes, and hard hooves as defensive mechanisms against predator attack or the use of camouflage and coloration to reduce detection by predators)); availability and abundance of alternative prey species; type and abundance of other predator species (e.g. competitors and scroungers); predators' social structure (e.g. solitary versus group hunters); sex-age structure (i.e. social structure) of prey versus predator species; human impacts; seasons of a year (e.g. dry versus wet seasons, breeding versus non-breeding seasons); and habitat types (e.g. risky versus safe habitats, closed versus open habitats, quality versus poor habitats). This review paper suggested and formulated a quantitative statistical model that helps accurately predict and determine the ecological carrying capacity of a predator species in an enclosed system. Therefore, it is recommended that wildlife conservation researchers should consider the various relevant factors in an integrated fashion while testing their hypotheses through experimental and/or observational scientific studies. More importantly, the application of multiple hypotheses testing will help improve the accuracy in making reliable and valid estimation on the ecological carrying capacity of a predator species in a complex natural system because one hypothesis may complement the shortcomings of the others and vice versa.

Funding

The author declares that no funding assistance was received for this review work.

Acknowledgments

None.

Conflicts of interest

Author declares that there is no conflict of interest.

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