

Human Impacts on keystone species within the ecological food web

Abstract

The environment consists of different webs of lives, among which is the ecosystem. The ecosystem consists of arrays of lives that are vital for survival of other organisms within the ecosystem one of such referred to as “keystone species”. These are either terrestrial or aquatic species. This work had an overview introduction of the scheme, followed by a background inventory of some selected keystone species, related arguments, the role, impact and relationship with other species within the ecosystem. Furthermore, the work borrows insights from the concept of sustainability and resilience, applies them as a benchmark in development planning, and finally concludes with brief significance of the essay. Although much awareness and campaigns are already documented, from the essay point of view, most development planners pay little attention and rely on the environmental impact assessment report and fail to understand that an environmental impact assessment report is usually not ready at the beginning of every project. The impact of human activities within the environment has adverse effects on these species resulting in the extinction of some while; others are either threatened or endangered. The basic understanding of these species and their impact on the ecosystem is a useful tool to employ when carrying out developmental analysis that will serve as a “first aid” and as a reminder towards proffering strategies that will aid the mitigation principles. Additionally, as a development planner, understanding these species and others will give them the sense of right judgment to employ during project planning and administration, targeted at delivering a sustainable development practice aimed at a “win-win scenario” in development and the environment. Moreover, the in-depth understanding of this species and their role will equip the development planner the edge to study and include waste management scheme in their development schedule, as waste produced in-course of establishing a project within a particular location without proper management will constitute chaos to species at the dumpsite.

Keywords: environment, endangered species, keystone species, ecosystem, degradation, human impact and mitigation principle

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Introduction

The aim of this article is to point out the effect of KS to the ecosystem in one hand and the impact of its no presence or endangerment to the ecological food web. Some of these KS are decomposers like vultures and soldier ants; they can as well be engineers like rodents, earthworm and termites. Some other KS are producers like bees and warps. Vegetation is majorly the producers in the ecosystem. Animals like antelope, leopard etc. are also part of the ecosystem not forgetting human. What are impacts of these KS on the ecological food web? What does the environment gain by depleted or distorted the KS? These are the key issue that this article wishes to establish.

Keystone species (KS) are those species whose value, formation, and purpose are disproportionately large, compared to their abundance within an ecosystem. These species can be of any life variety, whose common significance influences their environment in greater cost than anticipated based on their biomass.^{1,2} Keystone species modify their community, despite their number or abundance, they fashion habitats and control the relationship between species in a given population.¹ In addition,² highlight that “the concept of the keystone species, originally proposed by the US zoologist and University of Washington professor Robert T. Paine, was a transformative notion in biology.” Some of the KS of interest includes Toad, Insects, like grasshopper, Earthworm and scatter trees. Snakes, Leopards and Wavier birds are also important KS in the tropical ecosystem. But this work will concern itself scatter trees and the engineers like earthworm and human activities that destabilize the ecosystem.

Following the definition of Paine, who coined and subsequently defined keystone, (see definition above) this definition has generated a substantial argument amongst ecologist.³ However, this argument has degenerated to the point that other groups of ecologist have emerged, one of such groups is the keystone cops; they did not discredit Paine definition. Nevertheless, they argued that Paine’s definition centered more on hypothetical principles that made them sort for definition referenced on proportional biomass of species within an ecosystem in relation to their population value.⁴ The Keystone Cops claimed that it is of essence to include a definition that has an operational impact. Moreover, they stated that the keystone species definition should be reproducible and precise. They define keystone species as the ones that have a large impact in a particular community and disproportionately large relative to its abundance.^{5,4} Following the introduction of another definition of Keystone species by the Keystone Cops, an ecologist,¹ has faulted their claim. He argued that the application of the keystone Cops’ principle did not yield as he applied it in his work titled “Power’s Keystone-Species concept applied to Prairie Dogs”,¹ claimed that their principle is invalid. However, he argued that the dichotomy is from the keystone Cops definition, whose concept is found on the dualism among keystone and non-keystone species. As an alternative, he added that the definition should be established on how overall and environmental significance vary with abundance, across spatial and temporal scale and under varied natural state. He did not stop there, instead postulated that there should be an inclusion of a third rule or principle in defining keystone species, thus keystone performs specific roles not executed by other species or processes.¹

Scholars in a bid to come to an acceptable single and simple definition of keystone species, some argue that the above definitions are right while others claim that the continuous debate will never end, rather the definition should include other species, which are not near the food web known as the “keystone mutualists” [6, 7]. With respect to the scope of this essay, the debate about the definition of keystone species is beyond the essay contest, the essay searches to find the relationship between keystone species, their impacts on other species, especially as it affects their extinction and the food web.

The KS in very important part of the ecosystem, directly or indirectly their existence affect man in his day to day live. The quality of air we breathe the meat we eat, the house we stay in the food we eat even the games we watch are all product of KS. To reasonable extent, it also place food on peoples table. The hunter depends on games for survival, Honey can be sold, but without bees, it is impossible to get honey. The soils for agriculture are formed with aids of ecosystem engineers. At death the service of the KS are also required, however, human activities are not only putting pressure on the existent, but are endangering their existent. Man should understand that we need the KS and necessity is upon us to protect them.

Material and methods

Keystone species and their importance to the ecosystem

This section of the paper deals with few keystone species, their relevance and influence within the ecosystem. Keystone species belong to different categories, namely predators; prey, plant, link and ecosystem engineers,² the following are a few examples.

First the scatter trees will be discussed with its types and importance to the ecosystem and man, and then the ecosystem engineers will be treated. The interrelationship between KS and man is also established in diagrams.

Scatter trees; they are examples of keystone species due to their interaction with other ecological species. Some scholarly articles record that the importance of these trees cannot be overemphasized. Some examples include scatter trees, amongst others.

Scatter trees are more or less isolated trees in their communities such as the Venezuelan Trachypogon savanna, the Brazilian Cerrados, the arid savanna in the Northern America, the African savanna and the Forest-tundra transition zone of the boreal forest.⁸ adds that scatter trees are categories into distinctive two groups, namely natural/cultural and recently modified, because of their response to natural and synthetic manipulation brought about by the grouping. The natural/cultural scatter trees as the name implies, are those trees whose resilience outweighs human impact and are part of cultural heritage with a lifelong history of existence, while the recently modified scatter trees are not resilient enough to withstand human impact, hence they are diminishing. Scatter trees, flow from natural/cultural through recently modified, despite natural disturbance and human modification.

These trees are important in this essay, like every other keystone species, due to their ecological values. Scatter trees like other trees are significant in the role they play within their community. They are sources of home, shelter, song post, trap, and food to numerous ecological species and relaxation spots.^{9,10} Trees are source of furniture, doors, and other building materials. The vegetation or trees absorb carbon dioxide and releases oxygen. It also serves as wind breaker and sources of domestic fuel to many homes. Human

indiscriminate felling of trees in quest of unplanned development is inimical to the ecosystem.^{11,12}

Another important type of keystone species considered in the work includes the ecosystem engineers. Ecosystem engineers, Some keystone species are referred to as “ecosystem engineers”, they are fond of tunneling and burrowing and their acts transform the soil composition, aid seed dispersals and increase soil nutrient concentrations and water infiltration as well as lower bulk density.¹⁰ Their burrows are homes for a wide variety of lizards and small birds, the ecosystem engineers serve as the main prey for most of the predatory animals within their ecosystem.^{13,14} A typical example of an ecosystem engineer is the pika and earthworm.

Pika is a small mammal, a member of ecosystem engineers, a non-hibernating mammal (order *Lagomorpha*) and a member of family of *ochotonidae*¹⁵). They have a common Asiatic origin that dwells mostly in cold climates; except for about three different classes found in America such as American pika *ochotona princeps*, the western North America Mountain; the collared pika *ochotona collaris*, the west Ural Mountain Europe and steppe pika *ochotona pusilla*.¹⁵

Some other cases, some agriculturists have blamed the damages on agriculture and animal husbandry on these some ecosystem engineers, claiming that their burrowing is responsible for land degradation.¹⁴ As a result, these ecosystem engineers are referred to as “rodent” and often targeted for eradication, under some conservation laws and plans,¹⁴ argues that those claims by the agriculturist are wrong and posited that the causes of land degradation are subject to overgrazing and climate change. Considering the impact of these species on the food web, any attempt to eliminate this ecosystem engineers automatically eliminates those who depend on it for survival either as food or as a source of construction for their shelter. For instance snake does not bore hole, but rodents do. Elimination of rodents will mean that some species of snake would look for another habitat which may cross human inhabitation or other species, this will result to disorder in the ecosystem.

The food web diagram illustrates the interaction amongst a number of consumer prey species, their shared resources and shared predators. From Figure 1, below P stands for top predator, Na to Nz stands for the intermediate consumer-prey and R denotes their resources, which ultimately support the above community, the prey and the predator.¹⁶ The essay is only interested in the relationship between the consumer-prey and the predator within an ecosystem, from the food web diagram the extinction of the consumer-prey (the keystone species), will result in the extinction of the predator.

The keystone species have a direct or indirect impact on humanity, their relationship with other species within the ecosystem (Figure 2). Additionally, human food web and that of other species are in cyclic form, which goes back to the keystone species. The diagram illustrates that the environment hosts species, human; predators, keystone, and they are all interdependent. The human as well as animal predator prey on keystone species, while human uses the predator, and other species within the environment as a source of food and other purposes. Whereas every other member of the ecosystem, human, keystone and their predator, in natural course; at the expiration of their lifespan returns to the environment and forms other organisms that the keystone species use either as food or home. Note this view is on terrestrial environment since man greatest impact is on land.

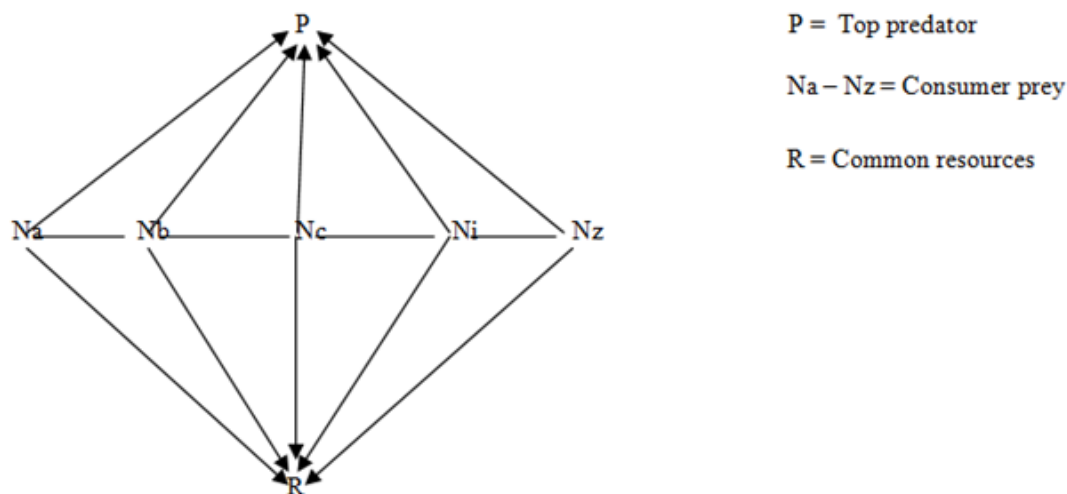


Figure 1 Simple food web diagram adopted from Liebold (1996:789).

Discussion

Keystones and food web

The food web diagram illustrates the interaction amongst a number of consumer prey species, their shared resources and shared predators. From Figure 1, above P stands for top predator, Na to Nz stands for the intermediate consumer-prey and R denotes their resources, which ultimately support every member of the community, the prey and the predator.¹⁶ The essay is only interested in the relationship between the consumer-prey and the predator within an ecosystem, from the food web diagram the extinction of the consumer-prey (the keystone species), will result in the extinction of the predator. If snakes feeds on lizards and rats at extinction of the pries as a result of fumigation, the predictor will either migrate or die of starvation.

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Impacts of Man on the ecosystem

The activities of man in their quest for development targeted at job creation and solving their immediate problems have resulted¹⁷ in the pollution of water bodies, air, desertification and deforestation; these acts have created negative impacts on other species. These continuous human induced activities create an unsafe environment for these species, which resulted in some going on extinction, being threatened and endangered. Adds that human modification of the earth is extensive and rising human activities have altered, between one-third and one-half of the earth's surfaces. The carbon dioxide (CO₂)

concentration in the atmosphere has amplified by almost 30 percent since the era of the Industrial Revolution. Significantly, civilization has fixed impact on the atmosphere, compared to the impact of all natural terrestrial forms combined. Additionally, the human race has put to use more than half of all available surface fresh water.¹⁷ These human activities had extinct a good number of species, about one-quarter of the bird species, creeping and other flying species on earth. By these and other standards, it is obvious that all species and man exist on a human dominated globe.¹⁷

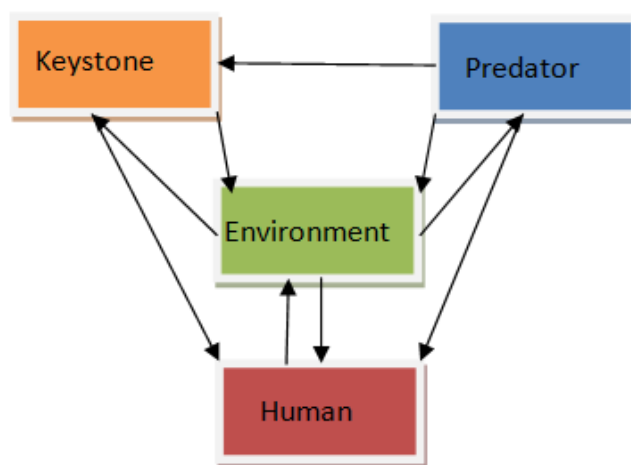


Figure 2 Human food web diagram.

Increase in population, driven by the quest for wealth, affluence and accumulation of resources, the use of technology,¹⁸ has aided the increase in human activities within the limited environment. These activities seen as human enterprises, in form of agriculture, industrial, recreational and international commerce, have an impact on the environment, including an increase in land transformation, land clearing, forestry, grazing, global biogeochemistry, synthetic chemical, the addition of other elements in form of carbon, nitrogen and water, biotic, additions and losses, invasion, hunting and

fishing.¹⁵ The aforementioned human impact result in the depletion of the ecosystem, climate change, enhanced greenhouse, aerosols and land cover, loss of biological diversity, extension of species and population, loss of ecosystem and total collapse if not mitigated.¹⁷ The quest for self-centered development by man and un-catered nature exhibited through their developmental stride within the ecosystem have negative impact as state above, moreover the understanding of the usefulness of incorporating these species in development planning will be of significance to man and the environment. The essay seeks to employ the following sustainability and resilience principles which when integrated into development will give the development planner a form of leverage in carrying out his/her task.

Employing the concept of Sustainability and resilience

The consciousness of sustainability and resilience should serve as a reference point and be incorporated in every development in planning and implementation. This is of significance in this work, as the understanding of the usefulness of sustainability and resilience in everyday planning removes the much negative impact of unsustainable practices and creates room for best practices. This literature finds it useful to bring the fore the definition of sustainability and resilience as a tool to reckon with while sorting a mitigation scenario. Thus,¹⁹ posits that, when referring to resilience and sustainable development, you are referring to two highly abstract and intricate concepts. Nonetheless, defined and interpreted in a unique way, general and at the same time, most widely accepted.

The²⁰ defines sustainability as a dynamic symmetry in the processes of communication amongst a population and the carrying capacity of an environment, such that the population develops to enjoy its full potential without infringing on the carrying capacity of the environment, upon which it relies.^{21,22} Additionally, resilience is the measure of interruption that can be absorbed before the structure changes its arrangement by altering the variables and processes that manages behaviour.¹⁹

These concepts are an important factor to employ before completing development planning, where the effect of the development on the environment, which is the central, source of livelihood for species, significantly, on the keystone species, planning and development activities within an ecosystem should not exceed its carry capacity. The integration of social and environmental impact on keystone species and others, connected in the food web into planning, considering that, every activity produces waste in the form of either gas, liquid and solid substances. Understanding the carrying capacity of such environment becomes an important factor in order to create a balance within the ecosystem while carrying out the development.

Conclusion

Keystone species plays a major role within their community, just as the “keystone” in arch holds the arch together, its removal will result in total collapse of the arch, so as the ecological keystone holds the ecosystem together.⁴

Following the definition and the argument associated with keystone species, which have revealed the significance of keystone species, not just for ecologist, but also to environmentalist, development planners and those who care about saving the ecosystem as a single non-renewable resource, it is significant to have an all-inclusive development and planning strategies.

In development planning, it is important to have knowledge of

these species, especially the keystone species; these species often seem less important to developers. Most development planners relatively sort to answer the questions given to them by their client; and base their considerations only on the impact of the environment on their project however, and fail to consider the possible impact of their project on the environment and other species that depend on the environment for habitation and survival. The real practice should be to apply Newton’s third law; action and reaction are equal and opposite. The Lack of Understanding of the relationships that exist between these species, their impact and relationship within their immediate environment, their impact on the food web within the ecosystem, by the development planners might eventually result in total collapse of the system. In addition, it is of significance to understand these species and sort out means of creating a mitigation strategy, which will be the development planner’s guide before the arrival of complete and comprehensive EIA report. According to,²³ the loss of keystone species triggers the loss of secondary species in a given community, while,¹³ states that the loss of keystone species in an ecosystem will result in a greater than average change in other species population. The loss of KS is in fact distortion of the biodiversity. Most of this has triggered hunger and loss of income for some of the indigenous people. It is also denial of the future generation to enjoy at least the sight of some species.

Over grazing, road constructions and extended farming in the northern part of Nigeria has resulted to the incessant struggle and fighting between herdsmen and farmers and the movement of the herdsmen down south, were development has also reduced the grasses; the seemingly helplessness of herders has turned some of them into warmongers in quest to survive. The neglect of KS in the West African sub region is not only affecting the ecosystem, but also man. The danger is that the food web is changing, some animals have started eating what they do not eat heitherto.

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Conflicts of interest

All author listed here declare no conflict of interest exists.

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