Keystone Species – At the Centre of Our Ecosystems

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Introduction:

In many ecosystems, there dwell some organisms who may be small in abundance, but whose removal can cause large ripple effects throughout the ecosystem, resulting in a cascading series of events that completely reshape the ecosystem. These organisms are termed as keystone species. The earliest use of this concept dates back to 1969, when zoologist Robert T. Paine used it in a research paper explaining the role of Pisaster ochraceus, a starfish species living in the intertidal zone on the beaches of Seattle. When this starfish species was removed, (by literally hurling them into the sea), the ecosystem changed dramatically. Originally the ecosystem consisted of 15 species, but one of them, the Mytilus californianus, a mussel species quickly outgrew its competitors and in a span of ten years, became the only species in this ecosystem because the starfish which had kept them in check were all gone. Thus, the absence of one species can throw an entire ecosystem out of balance, and this is the importance of keystone species.

Impact of some keystone species on their surroundings: One of the most important aspects of any keystone species is the transformative effect it has on its environment. Some predator species keep prey populations from growing out of control and overgrazing, while some others may be keystone mutualists, who are often pollinators that maintain gene flow and gene dispersal throughout their ecosystems.

Among the different types of keystone species, one that stands out is the beaver species, specifically castor fiber. These are important as they perform the role of ecosystem engineers, i.e., they physically alter their environment to create new habitats for other organisms.

They alter their ecosystem by creating beaver dams, using timber from old trees. In this way, they not only pave the way for growth of new young trees which diversifies the ecosystem, but also convert woodland meadows into wetland areas where many different species can thrive. Beaver dams can form small, shallow ponds where fish, frogs, dragonflies, etc can survive without interference from larger aquatic species. When they mature , they may become prey for birds and bats, supporting larger food chains and food webs.

Predators are consumers, and help keep prey populations in check, preventing any single species from growing uncontrollably. Not all keystone species are predators, but a large number of predators perform the function of keystone species. Ecologically predation can be defined as the consumption of living organisms, regardless of the classification of the organism. Thus predation includes the consumption of plants by animals, i.e. herbivores. Therefore, both carnivores and herbivores count as predators. The absence or removal of predators from an ecosystem can cause a "trophic cascade" which means that herbivore populations explode out of control, which cascades into overgrazing and destruction of habitats. The Grey wolf, Canis Lupus hunted the Elks and bison of Yellowstone National Park, USA and kept their populations under control. When the US government hunted down the grey wolf population of Yellowstone, the Elk population exploded.

This caused Overgrazing and many species populations were affected due to losing their primary food resources. In the case of herbivores, we can take a look at elephants. They are a keystone species in Savannas like the Serengeti. Elephants feed on small shrubs and herbs like acacia that grow in the savanna. By doing this, the savanna ecosystem doesn't turn into forested woodland due to unchecked tree growth. Grazing animals like deer, wildebeests, and buffaloes can eat the grasses that grow there. And in turn act as prey for lions and hyenas who live in the savanna.

Keystone Mutualists: Some keystone species engage in mutualistic relationships where they are engaged in activities beneficial to both them and the ecosystem. For example, in the Patagonian forests, the invasive bee species, Bombus terrestris spread rapidly and caused negative impact on the flora, fauna and economy. The mutualistic interaction between the hummingbird *Sephanoides sephaniodes*, the mistletoe *Tristerix corymbosus* and a marsupial seed disperser *Dromiciops gliroides* improves the complexity of pollination networks, and protects the communities from the negative impacts of the invasive bumblebees by promoting the interactions between native pollinators.

Some Plants also act as keystone species: Mangroves protect shorelines from erosion, while kelps provide food and shelter to many marine organisms.

Different ecosystems and how keystone species affect them:

- **Terrestrial ecosystem:** Vegetation and plant growth patterns, as well as population of prey can be moderated by the presence of keystone species. Elephants and Tigers keep the forest ecosystems healthy by creating habitats for other species and by keeping prey populations in check.

- **Marine Ecosystems:** Starfish, sharks, and corals are keystone predators in marine ecosystems, regulating mussel populations and maintaining balance. Sharks control prey populations, while corals provide habitat and structure for marine species, supporting complex reef ecosystems in tropical seas.
- **Aquatic Ecosystems:** Aquatic keystone species influence water quality and habitat structure. Sea otters (Enhydra lutris) in the North Pacific help conserve kelp by eating sea urchins, which would otherwise over consume the kelp. Beavers in North America create wetlands that support diverse communities of plants and animals, enhancing biodiversity. Freshwater mussels in rivers worldwide filter water, improving clarity and quality, which benefits many aquatic organisms.

Source: UCSC

The Importance of Keystone species in our environment: Keystone species are essential for maintaining biodiversity and ecosystem stability by regulating populations and facilitating interactions among species and increasing species diversity.. Keystone species also enhance an ecosystem's resilience by enhancing stability and facilitating recovery from ecological disturbances. For example, reefs supported by keystone coral species are more resilient to environmental changes when their biodiversity is maintained. Studies show the profound impact of keystone species, such as the removal of wolves in Yellowstone, which led to overgrazing by elk, resulting in degradation of habitats and a decline in biodiversity. However, the introduction of wolves reversed these effects, demonstrating the essential role of keystone predators in ecosystem management.

Keystone Species at risk: The jaguar is a keystone species that plays a crucial role in maintaining balance in the food chain and preserving a healthy ecosystem. It preys on other mammals like deer, peccaries, and capybaras, which would overpopulate without jaguars, leading to the loss of thousands of species and causing devastating impacts on vegetation. Jaguar populations are facing threats, losing over 95% of their original range in Argentina and 40% in Panama due to urbanization, agriculture, infrastructure projects, and human-jaguar conflict. The IUCN Red List considers them "Near Threatened" and "Endangered" under Panamanian legislation.

Source: Earth.com, 2016

Coral degradation is a significant threat to ocean ecosystems, causing the loss of its vibrant colors and threatening the survival of keystone species like ivory tree coral. These corals, native to the Caribbean and Gulf of Mexico, provide essential food and shelter for thousands of invertebrate and fish species..

How we can help save keystone species:

By spreading awareness about the importance of keystone species and biodiversity restoration, we can help save the different keystone species around the world .Efforts by organizations like **Rewilding Argentina, Yaguara Panama Foundation, World Wide Fund for nature** etc. and many more organizations are helping to conserve and preserve the environment and its species. We can support their efforts to help preserve organisms all around the world.

Conclusion:

Keystone species play a crucial role in the health and stability of ecosystems worldwide, regulating populations, maintaining biodiversity, and enhancing resilience. Their complex interactions, facilitated by advanced biological mechanisms and interdisciplinary approaches, are essential for ecological dynamics. Conservation efforts should prioritize the protection and restoration of keystone species to ensure the sustainability of ecosystems and the services they provide. Global collaboration and innovative research can help us better understand and preserve these vital components of our natural world. Future research should continue to explore these interactions, to better understand and preserve these vital components of our natural world.

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