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Wildlife as a bioindicator-a review

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SUMMARY

Living organisms are bioindicators such as invertebrate, plants, herptile, mammals and birds, which are utilized to screen the health of the natural ecosystem in the environment. They are used for assessing environmental health and biogeographic changes taking place in the environment. Each organic entity inside a biological system provides an indication regarding the health of its surroundings such as plankton responding rapidly to changes taking place in the surrounding environment and serving as an important biomarker for assessing the quality of water as well as an indicator of water pollution. Even the health of aquatic flora is best reflected by plankton, which acts as an early warning signal. In this review we have tried to explain the concept behind Bioindicators and plankton, with particular emphasis on their potential to be used as Bioindicators for water quality assessment and outcomes relating to this.

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INTRODUCTION

Naturally occurring bioindicators are used to assess the health of the environment and are also an important tool for detecting changes in the environment, either positive or negative, and their subsequent effects on human society. There are a certain factors which govern the presence of Bioindicators in environment such as transmission of light, water, temperature, and suspended solids. Through the application of Bioindicators we can predict the natural state of a certain region or the level/degree of contamination (Khatri and Tyagi, 2015).

The expression "Bioindicator" is used as an aggregate term referring to all sources of biotic and abiotic reactions to ecological changes. Instead of simply working as gauges of natural change, taxa are utilized to show the impacts of natural surrounding changes, or environmental change. They are used to detect changes in natural surroundings as well as to indicate negative or positive impacts. They can also detect changes in the environment due to the presence of pollutants which can affect the biodiversity of the environment, as well as species present in it (Holt and Miller, 2011). The condition of the environment is effectively monitored by the use of bioindicator species due to their resistance to ecological variability. Researchers

utilized the moss i.e. *Hylocomium splendens* as a natural indicator of heavy metals in the remote tundra environment of northwestern Alaska. Here, the ore of mineral is mined from Red Dog Mine, the world's largest creator of zinc, and is carried to a singular street to storage spaces on the Chukchi Sea. Researchers inspected whether this overland transport was influencing the encompassing physical biota. The contents of heavy metals inside the moss tissue were analyzed at different distances from the street. The concentrations of metals in moss tissue were most prominently adjacent to the haul street and reduced with distance, therefore supporting the theory that over land transport was infect modifying the encompassing environment. In this study, lichens were utilized as biomonitors by utilizing the quantitative estimation of metal concentrations inside individual lichen (Thakur *et al.*, 2013).

Natural, biological, and biodiversity markers can be found in various organisms occupying different types of environments. Lichens (a symbiosis among Cyano-bacteria, algae, and/or fungi) and Bryophytes (liverworts) are frequently used to monitor air contamination. Both, Lichens and Bryophytes are powerful Bioindicators of air quality on the grounds that they have no roots, no fingernail skin, and acquire all their supplements from immediate introduction to the climate. Their high surface region to volume ratio further supports the theory of their use as a bioindicator, or supports their ability to capture contaminates from the air (Holt and Miller, 2011). Cynophyta, a type of phytoplankton, is one particularly powerful bioindicators which is known to indicate rapid eutrophication of water bodies such as reservoirs, lakes, etc. via the creation of bloom formations (Thakur *et al.*, 2013).

DIFFERENT KINDS OF BIOINDICATORS

Plant indicators

Plants are used as very sensitive tools for prediction and recognition of environmental stresses. In recent time, due to industrialization and urbanization the problem of contamination of water and water pollution has intensified (Burger, 2006). Marine plants provide valuable information to predict the status of oceanic environment, as they are immobile and rapidly obtain equilibrium with their natural surrounding (Lange, 1994). The presence or absence of some specific plants or other vegetation provides ample information about environmental health. Lichens generally found on the trunks of trees and rocks are composed of algae and fungi both. They react to ecological changes in forests, including changes in the structure of the forest, air quality, and climate. Environmental stress can be indicated by the disappearance of lichen in forests, as caused by changes such as increases in the level of sulfur dioxide (SO2), pollutants of sulfur and nitrogen (N2) (Khatri and Tyagi, 2015). *Wolffia globosa* is an important tool for showing cadmium sensitivity and also used for indicating cadmium contamination. Changes in the diversity of species of phytoplankton, including *Euglena clastica, Phacus tortus, and Trachelon anas*, indicate the pollution of marine ecosystems (Phillips and Rainbow, 2013).

Invertebrate as indicators

Since planktons are profoundly sensitive to natural change they are best markers of water quality and particularly lake conditions. One of the reasons planktons are being considered in lakes is to monitor the water quality of the lake when there are high

centralizations of phosphorus and nitrogen; these centralizations may be indicated by certain planktons reproducing at an increased rate. This is evidence of poor water quality that may influence other organisms living in the water body. In addition to being a health indicator, planktons are also the fundamental sustenance for many larger organisms in the lake. Thus the plankton is key to the marine organisms, as both an indicator of water quality and as the main food source for many fish (Thakur *et al.*, 2013).

Plankton also plays an important role in biological deterioration organic matter; but if plankton populations are too large this creates other problems in managing the water body. Fish at this critical stage of ecological process play an important role by grazing the planktons. The two roles played by fish are very crucial as they help in maintaining the proper balance of planktons in the pond and convert the nutrient available in wastewater into a form which is consumable by humans. Additionally, certain planktons such as cyanobacteria produce toxins which are harmful for fish growth. Thus planktons can be termed as useful or harmful, with respect to waste water fed production of fishes (Pradhan *et al.*, 2008).

Aquatic insects, an important component of aquatic ecosystems are very abundant and diverse group that inhabits a variety of aquatic environments (Zborowski and Storey, 1995). They play an important role in ecosystem functioning (Yen and Butcher, 1997) and are used as bioindicator. These bioindicators have the advantage of monitoring anthropogenic stress of an ecosystem over a long period of time (Resh and Rosenberg, 1993). The north-east Indian biogeographic zone is most significant as it represents the transition zone between the Indian, Indo-Malay and Indo-Chinese biogeographic regions, as well as a meeting-place of Himalayan Mountains (Myers *et al.*, 2000).

Fish as indicators

The water of rivers is contaminated due to anthropogenic activities, domestic waste, industrial effluents, and other pollutants which adversely impacted the aquatic diversity, human and animal health. Nowadays the main source of pollution is wastewater form plastic, tanneries, mining, and cements industries. As a consequence, these industrial pollutants enter into the aquatic ecosystem. Many types of pollutants showed mutagenic and clastogenic properties (Waters *et al.*, 1999; Tchounwou *et al.*, 2012). The toxic heavy metals discharged in the environment are zinc, copper, nickel, mercury, cadmium, lead, and chromium (Fu and Wang, 2011). Heavy metals pollution is considered to be a serious world problem (Islam *et al.*, 2014) due to bioaccumulation and bio magnifications in the food web and trophic level (Sharma *et al.*, 2007). Fish act as a biological indicator of water quality (Al-Ghanim *et al.*, 2016) because of their affinity to accumulate the metals in their muscles (Zhao *et al.*, 2012) that cause alterations in physiological, biochemical and genetic parameters in their body (Javed and Usmani, 2019).

Herpetofauna as indicators

Intensive agriculture, climate change and urbanization accompanied by a collection of other factors which directly or indirectly cause documented decline of wide range of native fauna and flora. Clearing of forested lands alters terrestrial habitats and results

in variation of watershed hydro-dynamics such as decrease of natural storage of water, replacement of native species with invasive species, change in resource availability, increased sediment loads and nutrient inputs, chemical and light pollution, etc. in receiving waters. Even though, many vertebrate and invertebrate taxa have been proposed as indicators for environmental quality, taxa with longest life-history requirements with trees or moisture are more vulnerable to riparian damages and other unfavorable water quality conditions than terrestrial-based taxa. Amphibians are considered as surrogate taxa for ecological quality and stresses. Urban watersheds have significantly lesser amphibian diversity than other watershed types as urbanization in watersheds alters small streams from closed canopy shallow water features of the forest landscape favored by amphibians to features associated with open vegetation and deeper, warmer waters. occurrence of amphibians were determined by physical habitat factors which correlates with the watershed health such as water temperature, blank-full discharge, flashiness, substrate embeddedness and canopy cover. Use of amphibians as indicator species for assessing environmental stresses are superior to conventional measures such as species richness which combine species with different responses to the stress gradient (Sumanasekara *et al.*, 2015).

The detrimental effects of environmental contamination and pollution (e.g. heavy metals, organochlorines, radionuclides) on wildlife are generally not well known or understood. Research is providing baseline information for various groups of animals, usually because of their sensitivity to changes in their environment (e.g. fish, amphibians), but also where there is a potential conservation threat (e.g. marine mammals). Little research has been directed at reptiles, which may be good bioindicators of their environment. Crocodilians in particular, because of their position in the food chain, aquatic habits and longevity (Webb and Manolis, 1989) may reflect changes in an area over longer periods (Burger *et al.*, 2000).

Mammal as indicators

Environmental pollution can be determined by sources of biological approaches, with the support of bio-indicator animals that give knowledge on their environmental quality. Among the numerous pollutants present in the environments, heavy metals are known for their ability to bio accumulates within living tissues and bio magnify along a food chain. Also they possess toxic properties when present in large amounts (Pandey and Madhuri, 2014).

Heavy metals are one of the most persistent groups of toxins that threat the well being of the living systems. While the most common methods applied for determining the accumulation of heavy metals in living organisms involves killing the animal for tissue analysis, the current study concentrated on alternative methods for heavy metal analysis. Fecal matter was employed as a tool for detecting day to day exposure to air borne heavy metals in captive animals. Three species i.e. chinkara (*Gazelle bennetti*), Indian long eared hedgehog (*Hemiechinus collaris*), and grey partridge (*Perdix perdix*) were selected for this purpose. Fecal samples were collected from each animal kept in captivity at Captive Breeding and Research Centre, University of veterinary and animal Sciences. Water and soil samples were also collected from each enclosure (Sidra *et al.*, 2019).

Bird indicators as indicators

Birds are good indicators because they are very easy to detect and their presence is easy to observe in any environment or if the habitat does not fulfill the ecological requirements, as they are equipped with the ability of flight so that they will leave the environment (Khan *et al.*, 2021). Apart from that, in classification individual species are easy to identify with their wide distribution. Heavy metals are essential elements for organisms but may be toxic with high level, affecting productive function and behavioural features and equally heavy metals can easily be accumulated and biomagnified through food or food web. Therefore, using birds as bioindicators is a function of properties of interest and resources available for ecological evaluation which promotes conservation of bird species for impending generation (Egwumah *et al.*, 2017).

CONCLUSION

The many-fold advantages of Bioindicators have outweighed their restrictions. The bioindicator is helpful, objective, straightforward, and reproducible. Bioindicators can be utilized at various scales, from the cell to the environmental level, for assessing the changes taking place in a specific biological community. Planktonic monitors unite biological, physical, chemical factors, and are utilized as an important part for evaluating health status of water-bodies. The conclusion can be drawn that bioindication and biomonitoring have become promising methods for studying the impacts of external factors on an ecosystem and its development and for differentiating polluted and unpolluted areas.

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