Impact Factor 2.147

ISSN 2349-638x

Refereed And Indexed Journal

AAYUSHI INTERNATIONAL INTERDISCIPLINARY RESEARCH JOURNAL (AIIRJ)

Monthly Publish Journal

VOL-III ISSUE-XI Nov. 2016

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CHIEF EDITOR – PRAMOD PRAKASHRAO TANDALE

A review on Biodiversity loss and its impact on humanity

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Abstract

The present communication highlights on the biodiversity loss and impacts on humanity. The most unique feature of Earth is the existence of life, and the most extraordinary feature of life is its diversity. Approximately 9 million types of plants, animals, protists and fungi inhabit the Earth. So, too, do 7 billion people. Two decades ago, at the first Earth Summit, the vast majority of the world's nations declared that human actions were dismantling the Earth's ecosystems, eliminating genes, species and biological traits at an alarming rate. This observation led to the question of how such loss of biological diversity will alter the functioning of ecosystems and their ability to provide society with the goods and services needed to prosper.

Key words: - Diversity, plants, animals, protists and fungi, Earth, traits.

In the past 20 years remarkable progress has been made towards understanding how the loss of biodiversity affects the functioning of ecosystems and thus affects society. Soon after the 1992 Earth Summit in Rio de Janeiro, interest in understanding how biodiversity loss might affect the dynamics and functioning of ecosystems and the supply of goods and services, grew dramatically. Major international research initiatives formed; hundreds of experiments were performed in ecosystems all over the globe; new ecological theories were developed and tested against experimental results. Here we review two decades of research that has examined how biodiversity loss influences ecosystem functions, and the impacts that this can have on the goods and services ecosystems provide. We begin with a brief historical introduction. We then summarize the major results from research that has provided increasingly rigorous answers to the question of how and why the Earth's biological diversity influences the functioning of ecosystems. After this, we consider the closely related issue of how biodiversity provides specific ecosystem services of value to humanity. We close by considering how the next generation of biodiversity science can reduce our uncertainties and better serve policy and management initiatives. A brief history During the 1980s, concern about the rate at which species were being lost from ecosystems led to research showing that organisms can influence the physical formation of habitats (ecosystem engineering, fluxes of elements in biogeochemical cycles (for example, ecological stoichiometry, and the productivity of ecosystems (for example, via trophic cascades and keystone species. Such research suggested that loss of certain life forms could substantially alter the structure and functioning of whole ecosystems. By the 1990s, several international initiatives were focused on the more specific question of how the diversity of life forms impacts upon ecosystems. The Scientific Committee on Problems of the Environment (SCOPE) produced an influential book reviewing the state of knowledge on biodiversity and ecosystem functioning.

By the mid-1990s, BEF studies had manipulated the species richness of plants in laboratory and field experiments and suggested that ecosystem functions, like biomass production and nutrient cycling, respond strongly to changes in biological diversity. Interpretation of these studies was initially controversial, and by the late 1990s BEF researchers were involved in a debate over the validity of experimental designs, the mechanisms responsible for diversity effects, and the relevance of results to non-experimental systems. This controversy helped to create a decade of research that, by 2009, generated several hundred papers reporting results of .600 experiments that manipulated more than 500 types of organisms in freshwater, marine and terrestrial ecosystems. As the field of BEF developed, a related body of research began to form an agenda for biodiversity and ecosystem services (BES) research built on the idea that ecosystems provide essential benefits to humanity. Although BES did not evolve separately from BEF, it took a distinctly different direction. The main focus of BES was on large-scale patterns across landscapes more relevant to economic or cultural evaluation. For many BES applications, biodiversity was considered an ecosystem service in-and-of itself. When biodiversity was viewed as an underlying factor driving ecosystem services, the term was often used loosely to mean the presence/absence of entire habitats or groups of organisms (for example, impact of mangrove forests on flood protection or of all native pollinators on pollination).

Increasing the complexity and realism of experiments, however, will not be enough to move biodiversity research towards better forecasting. We also need sets of models and statistical tools that help us move from experiments that detail local biological processes to landscape-scale patterns where management and policy take place . One fruitful approach may be to use data from BEF experiments to assign parameters to local models of species interactions that predict how biodiversity has an impact on ecosystem processes based on functional traits. These local models could then be embedded into spatially explicit meta-community and ecosystem models that incorporate habitat heterogeneity, dispersal and abiotic drivers to predict relationships between biodiversity and ecosystem services at the landscape level18. Statistical tools like structural equation modelling might then be used to assess whether predictions of these landscape models agree with observations from natural systems, and to disentangle effects of biodiversity from other covarying environmental factors.

Initiatives like these represent opportunities to assess and refine our ability to predict biodiversity–ecosystem service relationships on realistic scales in situations where stake holders are expecting positive returns. For example, BEF and BES researchers have amassed substantial experimental evidence showing that species diversity of plants and algae increase uptake of nutrient pollutants from soil and water. We have statistical models that quantify the functional form of these effects and extensive data on the functional traits that influence such processes in different habitats.

Valuing biodiversity Economists have developed a wide array of tools to estimate the value of natural and managed ecosystems and the market and non-marketed services that they provide94. Although there are good estimates of society’s willingness to pay for a number of non-marketed ecosystem services, we still know little about the marginal value of biodiversity (that is, value associated with changes in the variation of genes, species and functional traits) in the production of those services. The economic value of biodiversity loss derives from the value of the affected services. Estimating this value requires calibration of ecosystem service ‘production’ functions that link biodiversity, ecosystem processes and ecosystem services. The derivative of such functions with respect to biodiversity defines the marginal physical product of biodiversity (for example, carbon sequestration or water purification), and when multiplied by the value of the service, yields the marginal value of biodiversity change. Researchers in the BEF and BES fields need to work more closely to estimate the marginal value of biodiversity for ecosystem services. In doing so, at least three challenges require attention. First, ecosystems deliver multiple services, and many involve trade-offs in that increasing the supply of one reduces the supply of another. For example, carbon sequestration through afforestation or forest protection may enhance timber production but reduce water supplies. The value of biodiversity change to society depends on the net marginal effect of the change on all ecosystem services. Future work needs to quantify the marginal benefits of biodiversity (in terms of services gained) relative to marginal costs (in terms of services lost).

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