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Urban Resilience and Adaptation for India and Mongolia

Curricula, capacity, ICT and stakeholder collaboration to support green & blue infrastructure and nature-based solution

Report on:

Lecture Material

Introduction to Ecology and Landscape

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NIRMA UNIVERSITY
INSTITUTE OF ARCHITECTURE & PLANNING
NAAC ACCREDITED 'A+' GRADE

Partner number: P12

Nirma University, Gujarat, India

Disclaimer

Course Name: Laws, Policies and Guidelines promoting Green and Blue Infrastructure

Number of credits: 3 ECTS

Period: Fall/spring semester

Coordinator	**Prof. Sneha Ramani and Prof Shweta Suhane**
Credits	3 ECTS
Lecturers	**Prof. Sneha Ramani and Prof Shweta Suhane**
Level	Online course open for all
Host institution	Nirma University
Course duration	15 Weeks

Summary

This is a 3 ECTS online course which will be open to all students or professionals from various departments like architecture, planning, design, engineering, etc. This course will introduce various laws and policies to encourage blue and green infrastructure in our built environment.

Target student audiences Bachelors in Architecture (Sem III)

Prerequisites NA

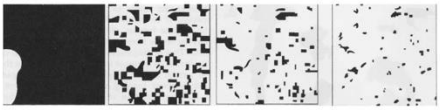
Aims and objectives

The main course objective is to introduce basic concepts of ecology and landscapes to students to build a strong foundation for future courses. The focus will be more on the role of ecology and landscape in an ecosystem. The main objectives are:

- To define the ecology and landscape.
- To identify the significance of ecology and landscape to humans, and the built environment.
- To inculcate knowledge about natural selection, ecology, community, biodiversity, climate change and sustainability.

HABITAT FRAGMENTATION

It is the **disruption of large continuous chunks of habitat, which have become divided and subdivided into smaller 'fragments' of habitat, which are either completely isolated from each other or destroyed altogether through additional development.** Once the habitat is lost, it cannot be restored to what it once was, meaning it can no longer fill the same ecological purpose.



None > High

Extent of Fragmentation

Schematic representation of changes in the extent of fragmentation

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Causes of habitat fragmentation

- Humans produce habitat fragmentation through clearing native vegetation for **agriculture, urbanization, pollution, deforestation and introduction of alien species**
- Human caused **wildfires** as well as the systematic practice of fire suppression can also create habitat fragmentation.
- Long term changes caused by **geologic processes** or **climate fluctuations** contributed to habitat fragmentation.

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Effects of habitat fragmentation

- Plants and animals are often directly affected as a result of fragmentation.
- It is often the speed at which we change the environment that makes it impossible for those species left to adapt. **Species unable to adapt to these changes in their environment have no choice but to either migrate to a more suitable habitat, or face a reduced population, which in some cases could lead to extinction.**
- Habitat fragmentation can effect **occupancy, reproduction, inbreeding** or **even survival in a particular species.**
- Additionally some species require more than one habitat type, and part of their survival relies upon seasonal migration. Any physical barrier (e.g. roads, fields of crops, housing developments, industrial construction, towns, or even fences) can **preventing their normal pattern of movement for seasonal migration; and lead to extinction of a species.**
- Those species which are more mobile, retreat into these patches of habitat. However, this causes additional pressures in the form of increased competition, and a reduced gene pool. Smaller fragments of habitat support smaller populations which are therefore more vulnerable to extinction. These smaller fragments also exhibit what is known as the **"edge effect".**

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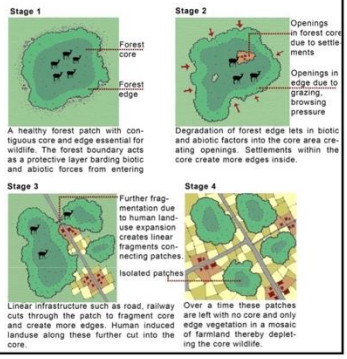
Edge Effect

Edge effect reduces the amount of suitable habitat remaining in a fragment. For example, **the edge of a woodland offers quite a different habitat than the center of a woodland**, and may not be suitable for some species, largely due to an increased threat of predation. Other factors which may make the edge inhospitable to some species may include the amount of light, temperature, wind, and even noise that they experience.



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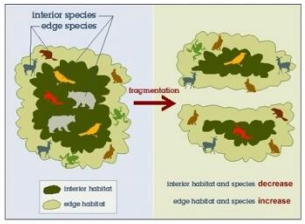
Edge Effect

Edge effect reduces further the amount of suitable habitat remaining in a fragment. For example, the edge of a woodland offers quite a different habitat than the center of a woodland, and may not be suitable for some species, largely due to an increased threat of predation. Other factors which may make the edge inhospitable to some species may include the amount of light, temperature, wind, and even noise that they experience.



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Conservation implications for Habitat fragmentation

- Since habitat fragmentation breaks the original habitat into **smaller, isolated patches, movement between these patches can become dangerous**. This is especially true if animals now have to cross something like a busy road. To make passage safer, **wildlife corridors** may be created.
- But in order to create wildlife corridors a **complete understanding of the habitat and movement pattern of the wildlife** needs to be understood completely.

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Landscape and Urban Planning 36 (1996) 59–77

LANDSCAPE
AND
URBAN PLANNING

Ecological consequences of habitat fragmentation: implications for landscape architecture and planning

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Abstract

Habitat loss and isolation associated with land conversion for human activities constitute the most serious threat to the Earth's biological diversity. The study of habitat fragmentation provides an important link between the concepts and principles of landscape ecology and the practice of landscape architecture and planning. Here I review ecological literature to examine current understanding of the ecological consequences of habitat fragmentation, and briefly suggest ways in which the results of these studies may guide decision-making by landscape architects and planners. Two theoretical developments in ecology have informed studies of habitat fragmentation and have provided testable hypotheses for empirical studies: island biogeography theory and metapopulation dynamics. Ecologists have examined the influences of habitat fragment size, shape, degree of isolation, context, and habitat quality or heterogeneity on plant and animal population persistence, community composition, and ecosystem processes.

Disruption of continuous habitat usually results in an increase in the length of the boundary between fragments and their surrounding habitats. Newly created edges experience shifts in microclimatic characteristics, which may significantly alter the native plant and animal communities present. The size of a habitat fragment markedly influences the ecological processes occurring therein, largely due to the changes induced by these habitat edges. In general, species richness declines as fragment area decreases. Vegetated corridors may facilitate the movement of plants and animals among habitat fragments, however, more information is needed regarding the efficacy of corridors in reducing species loss from fragmented habitats. Fragments with highly irregular, convoluted boundaries will likely have greater exchange of nutrients, materials, and organisms with adjacent habitats than will those with less convoluted boundaries. Adjacent habitat types, land management regimes, and intensity of human activities influence boundary permeability and thus flow among habitat fragments. Large fragments are likely to be more heterogeneous than small fragments; they contain a greater variety of soil types, greater topographic variation, and a greater number of habitat types. An integrated view of the spatial characteristics of habitat fragments and their ecological consequences improves our ability to predict the outcomes of, and to design, particular patterns of land conversion.

Keywords: Habitat fragmentation; Biological diversity; Environmental planning

1. Introduction

Landscape architecture and planning are disciplines focused on landscape change. Ecological con-

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RESEARCH ARTICLE

APPLIED ECOLOGY

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Habitat fragmentation and its lasting impact on Earth's ecosystems

Nick M. Haddad,[1]* Lars A. Brudvig,[2] Jean Clobert,[3] Kendi F. Davies,[4] Andrew Gonzalez,[5] Robert D. Holt,[6] Thomas E. Lovejoy,[7] Joseph O. Sexton,[8] Mike P. Austin,[9] Cathy D. Collins,[10] William M. Cook,[11] Ellen I. Damschen,[12] Robert M. Ewers,[13] Bryan L. Foster,[14] Clinton N. Jenkins,[15] Andrew J. King,[9] William F. Laurance,[16] Douglas J. Levey,[17] Chris R. Margules,[18,19] Brett A. Melbourne,[4] A. O. Nicholls,[9,20] John L. Orrock,[12] Dan-Xia Song,[8] John R. Townshend[8]

We conducted an analysis of global forest cover to reveal that 70% of remaining forest is within 1 km of the forest's edge, subject to the degrading effects of fragmentation. A synthesis of fragmentation experiments spanning multiple biomes and scales, five continents, and 35 years demonstrates that habitat fragmentation reduces biodiversity by 13 to 75% and impairs key ecosystem functions by decreasing biomass and altering nutrient cycles. Effects are greatest in the smallest and most isolated fragments, and they magnify with the passage of time. These findings indicate an urgent need for conservation and restoration measures to improve landscape connectivity, which will reduce extinction rates and help maintain ecosystem services.

INTRODUCTION

Destruction and degradation of natural ecosystems are the primary causes of declines in global biodiversity (*1*, *2*). Habitat destruction typically leads to fragmentation, the division of habitat into smaller and more isolated fragments separated by a matrix of human-transformed land cover. The loss of area, increase in isolation, and greater exposure to human land uses along fragment edges initiate long-term changes to the structure and function of the remaining fragments (*3*).

Ecologists agree that habitat destruction is detrimental to the maintenance of biodiversity, but they disagree—often strongly—on the extent to which fragmentation itself is to blame (*4*, *5*). Early hypotheses based on the biogeography of oceanic islands (*6*) provided a theoretical framework to understand fragmentation's effect on extinction in terrestrial landscapes composed of "islands" of natural habitat scattered across a "sea" of human-transformed habitat. Central to the controversy has been a lingering uncertainty about the role of decreased fragment size and increased isolation relative to the widespread and pervasive effects of habitat loss in explaining declines in biodiversity and the degradation of ecosystems (*7*). Observational studies of the effects of fragmentation have often magnified the controversy because inference from nonmanipulative studies is limited to correlation and because they have individually often considered only single aspects of fragmentation (for example, edge, isolation, and area) (*8*). However, together with these correlative observations, experimental studies reveal that fragmentation has multiple simultaneous effects that are interwoven in complex ways and that operate over potentially long time scales (*9*).

Here, we draw on findings of the world's largest and longest-running fragmentation experiments that span 35 years and disparate biomes on five continents. Their rigorous designs and long-term implementation overcome many limitations of observational studies. In particular, by manipulating and isolating individual aspects of fragmentation while controlling for others, and by doing so on entire ecosystems, they provide a powerful way to disentangle cause and effect in fragmented landscapes. Here, we present experimental evidence of unexpected long-term ecological changes caused by habitat fragmentation.

Highlighting one ecosystem type as an example, we first present a global analysis of the fragmentation of forest ecosystems, quantifying for the first time the global hotspots of intensive historical fragmentation. We then synthesize results from the set of long-term experiments conducted in a wide variety of ecosystems to demonstrate consistent impacts of fragmentation, how those impacts change over time, and how they align with predictions from theory and observation. Finally, we identify key knowledge gaps for the next generation of fragmentation experiments.

GLOBAL ANALYSIS OF THE EXTREME MAGNITUDE AND EXTENT OF FRAGMENTATION

New satellite data sets reveal at high resolution how human activities are transforming global ecosystems. Foremost among these observations are those of forest cover because of the high contrast between forest

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