

Lesson Plan: Pond Ecosystems and Climate Change

As an **Undergraduate Biological Sciences** teacher, you can use this set of computer based tools to enable students to develop a comprehensive understanding about the **structure and function of an ecosystem**, with a focus on **hydrological ecosystem**, and **biotic** and **abiotic** components of the ecosystem. You can do this through a study of ponds and pond ecosystems and its comparison with freshwater and saline water ecosystems.

In this lesson plan, students will learn that increasing temperatures may alter the patterns of several ecological roles performed by ponds such as – **water storage, habitats for plants and animals, water quality (filtration), groundwater recharge, and shifts in cycling of nutrients (biogeochemical cycles)**. They will learn about the correlation between climate change and reduction of biodiversity in pond ecosystems, through an activity that focuses on dissolution of carbon dioxide and its impacts.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in **Biological Sciences**.

Use this Lesson Plan to help the students to understand and find answers to:

1. What is an Ecosystem? Give physiognomic characteristics of different hydrological ecosystems.
2. Explain various factors affecting the productivity and sustainability of freshwater ecosystems?
3. What are the direct and indirect impacts of climate change on pond ecosystems?
4. Discuss some of the threats to freshwater ecosystems.

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About the Lesson Plan

Grade Level	High School, Undergraduate
Discipline	Biological Sciences, Environmental Sciences
Topic(s) in Discipline	Ecology, Biodiversity, Ecosystems, Hydrological Ecosystems, Freshwater Ecosystems, Pond Ecosystems, Biotic, Abiotic, CO ₂ dissolution
Climate Topic	Climate Change and the Biosphere; Climate Change and the Hydrosphere; Climate Change and Food Security
Location	Global
Access	Online
Language(s)	English
Approximate Time Required	75-85 min

Contents

1.	Video/ Micro lecture (31 min)	A video to introduce different types of ecosystems, their components, food chain, food web, ecological pyramids, and energy flow in the ecosystem. This can be accessed here .
2.	Video/ Micro lecture (11 min)	A micro lecture to understand freshwater ecosystem, zonation in pond ecosystem and adaptation in aquatic plants towards salinity. This can be accessed here .
3.	Reading (20 min)	A reading to study the impact of climate change on the hydrological cycles, pond ecosystem, and its biodiversity. This can be accessed here .
4.	Classroom/Laboratory Activity (5 min)	A classroom/laboratory activity to determine the relation between acidity and pond ecosystem through the study of carbon dioxide dissolution. This can be accessed here .
5.	Classroom/Laboratory Activity (Nature Walk) (10 - 20 min)	A classroom/laboratory activity to explain the theoretical aspects taught in the classroom by recreation of a pond ecosystem for the conservation of aquatic organisms.

Step-by-step User Guide

(Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.)

1	Introduce the topic by playing a video lecture	This introduction video titled “Ecosystem What is an Ecosystem? Different Types of Ecosystem” briefly defines ecosystems, its types and explains different biotic (living) and abiotic (non- living) components interaction. It further explains different types of ecosystems present on the earth. Use this lecture to help students to understand the dynamics of an ecosystem that includes statistics of its productivity, rate of decomposition and energy flow at various trophic levels in food chains/ food webs flourishing in the ecosystem. The lecture further describes how a change in temperature will often affect the type of plants found and impact its population dynamics. This can be accessed here
2	Discuss the topic further by playing a video micro-lecture	This video lecture titled, “Freshwater Ecosystem” presented by Mexus Education explains freshwater ecosystems through a simple case study of a pond ecosystem. The lecture explains the different types of hydrophytic plants such as submerged, rooted–submerged, and free floating, that can be found in different zones of a pond ecosystem. It also describes the

		<p>physiological and biochemical adaptations by the freshwater organisms with changing salinity. It also mentions how changes in pH of water can impact fish populations in freshwater ecosystems.</p> <p>This can be accessed here.</p>
3	Demonstrate how it related to Climate Change through this Reading	<p>A reading titled 'Climate change and freshwater ecosystems: Impacts across multiple levels of organization' by Guy Woodward, Daniel M. Perkins and Lee E. Brown (2010), The Royal Society Publishing, discusses the effects of climate change on freshwater ecosystem services. This reading states how the different components of climate change affects complex trophic structures and may interact with other stress factors, such as salinity and dissolved carbon dioxide, to impact the functional behavior of the ecosystem. Through this reading, students will understand the impact of global warming on freshwater ecosystem biota, that potentially changes their behavior, thermoregulation and migration.</p> <p>This can be accessed here.</p>
4	Laboratory Activity: To determine the free CO ₂ in the given water samples by titration method	<p>A laboratory activity titled, "Free CO₂ Estimation" that shows how aquatic plants depend on CO₂ for various metabolic activities for growth and development. This activity exhibits how CO₂ concentration above 1000-1300 ppm can induce stress in aquatic plants. As a result, acidic pH affects photosynthetic rate, transpiration efficiency and various physiological activities of aquatic plants. This laboratory activity will help students to carry out comparative analysis of different water samples. They will understand the differences in 1. the quality (smell of water sample, type of hydrophytes present); 2. Determine the pH; and 3. Presence of CO₂ in water samples which will help them assess the Biological oxygen demand (BOD).</p> <p>This can be accessed here.</p>
5	Field Activity (optional)	<p>To better understand the structure and functioning of the pond ecosystem, students can construct an artificial or man-made pond to help drain fields during rain, recycle nutrients, and reduce the amount of nitrates and phosphates. Students would be able to critically analyze the pond ecology, and how alterations due to human activities impacts the aquatic ecosystem. This can be used to come up with conservation strategies to maintain ecological balance and prevent acidification of the pond.</p>

Learning Outcomes:

The tools in this lesson plan will enable students to:

- Learn the core concepts of ecosystem, biotic and abiotic interactions in ecological pyramids, more specifically in the context of hydrological ecosystems.
- Understand the importance of pond ecosystems in maintaining ecological balance.
- Critically analyze pond ecology, and the impact of human activities in altering the aquatic ecosystem. They will also learn effective measures for the recreation of a pond ecosystem.
- Further discuss the role of pond ecosystems in food security

Additional Resources

(If you or your students would like to explore the topic further, these additional resources will be useful.)

1.	Reading (60 min)	<p>This reading discusses extreme events, seasonal changes in ecosystems, trends over decadal-scale time periods, mitigation strategies and ecosystem recovery. It also states how hydrophysical, hydrochemical and ecological change are used as early indicators of climate change in aquatic ecosystems. Additionally, it addresses the implications of climate change for freshwater ecosystem management.</p> <p>This can be accessed here.</p>
2.	Reading (10 min)	<p>This reading focuses on the functional aspects, such as impacts on the number of taxa and significance of Shannon index for freshwater ecosystems.</p> <p>This can be accessed here.</p>
3.	Reading (10 min)	<p>This reading provides insight into extreme climate change induced fluctuations that affect biological processes such as reproductive success, population dynamics, migration patterns and interactions between fish populations.</p> <p>This can be accessed here.</p>
4.	Reading (5 min)	<p>This reading consists of an experiment that details the methodologies used to determine dissolved CO₂.</p> <p>This can be accessed here.</p>
5.	Reading (15 min)	<p>This reading states impacts of climate change on fisheries and aquaculture.</p> <p>This can be accessed here.</p>
6.	Reading	<p>This reading states how an increase in pond temperatures could accelerate climate change.</p> <p>This can be accessed here.</p>
7.	Reading	<p>This case study shows how climate change is rapidly warming lakes around the world.</p> <p>This can be accessed here.</p>
8.	Reading	<p>This reading helps with the construction of an artificial pond.</p> <p>This can be accessed here.</p>

Credits / Copyrights:

1.	Video “Ecosystem”	by Gyan Gallery, YouTube
2.	Video “Freshwater Ecosystem”	By Iken Edu, Mexus Education
3.	Reading “Climate change and freshwater ecosystems: impacts	By Guy Woodward, Daniel M. Perkins and Lee E. Brown, The Royal Society Publishing

	across multiple levels of organization”	
4.	Reading “ Experiment – Estimation of free CO ₂ in water sample”	By Narendra Kumar Lal, CM Science College , Dharbhanga, Bihar
5.	Additional Resources	Research Gate Scientific Reports, Nature Articles ClimeFish Wiley Food and Agricultural Organization, United Nations PHY.org NASA.org Natural Resource Enterprises, Mississippi State University