# Project: Summarizing and Analyzing Research Papers

## Submission Template

**Learner Name**: Shrihari Vetal

**Learner Email**: shriharivetal55@gmail.com

**Topic**: **Environmental Science**

**Research Paper**: https://www.sciencedirect.com/science/article/pii/S0048969720312948

### Initial Prompt

**Description (50 words max)**: Climate change poses a growing threat to U.S. biodiversity and ecosystems, affecting species' behavior, morphology, and ranges. These changes disrupt ecosystem services and productivity, while increasing vulnerability to invasive species. Natural resource managers must adopt proactive, adaptive strategies to address these emerging challenges and mitigate long-term societal impacts.

**Generated Summary (100 words max)**: Climate change poses a significant threat to biodiversity and ecosystems, affecting species interactions and altering ecosystem structures and functions. Periodic assessments, such as the U.S. National Climate Assessment (NCA), are crucial for understanding current and future impacts on ecosystems and guiding adaptation efforts. Drawing from the Fourth NCA, this review examines climate change impacts on biodiversity, ecosystems, forests, oceans, coasts, and Indigenous communities. It provides a detailed analysis at multiple scales—species, ecosystems, and ecosystem services—highlighting the challenges climate change poses for natural resource management and offering examples of adaptation actions to support human well-being and vulnerable communities.

### Iteration 1

**Description (50 words max)**: [Climate change](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/climate-change) and non-climate stressors interact and affect ecological systems at multiple scales. These combined stressors affect individuals, populations, and species, as well as ecosystem processes and properties. The relative impact of climate change versus other stressors varies depending on the species or ecosystem. Diverse biological communities and functioning ecosystems are critical to maintaining the ecosystem services ([Millennium Ecosystem Assessment, 2005](https://www.sciencedirect.com/science/article/pii/S0048969720312948" \l "bb1025)) that support human well-being ([Díaz et al., 2019](https://www.sciencedirect.com/science/article/pii/S0048969720312948" \l "bb0425)). [Natural resource management](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/natural-resource-management) affects biodiversity, ecosystems and their services and can moderate or exacerbate climate change and non-climate stressors.

**Generated Summary (100 words max)**: Climate change impacts on individuals, populations, and species vary based on vulnerability, exposure, sensitivity, and adaptive capacity. Organisms respond by altering behavior , such as shifting feeding times and migration patterns, or through morphological changes like reduced body size. Phenological shifts, such as earlier migration and breeding in birds, are a key indicator of species response to climate change. In marine systems, altered timing of abiotic factors, like earlier spring temperatures and phytoplankton blooms, disrupt food webs. Asynchronous shifts among species may lead to reduced reproductive success, increased competition, and population declines, threatening ecosystem stability and resilience.

### Iteration 2

**Description (50 words max)**: The adaptive capacity of human communities to deal with changes in ecosystem services will partly determine the magnitude of impacts on well-being. While some human communities have been proactive in identifying and planning for changes, others are more vulnerable due to a reduced ability to adapt.

**Generated Summary (100 words max)**: Tribes and Indigenous peoples in the U.S. have led over 800 climate change initiatives and developed their own adaptation plans. Despite their leadership, uneven federal policies and barriers from state and local governments hinder their mitigation efforts. Land-reduction, treaty rights issues, and climate-driven species shifts further threaten Indigenous cultural and economic well-being. Coastal Indigenous communities face resettlement risks due to rising sea levels and erosion, while other vulnerable populations, including children, the elderly, and economically disadvantaged groups, also suffer disproportionately from climate change impacts. These challenges underscore the need for inclusive policies and support for vulnerable communities in adaptation efforts.

### Final Prompt

**Description (50 words max)**: Climate change poses a significant threat to U.S. biodiversity and ecosystems, affecting individual species through altered behavior, morphology, phenology, and range shifts. Ecosystem-level changes include disruptions in primary production, species interactions, and extreme events. These shifts threaten ecosystem services, impacting provisioning, regulating, supporting, and cultural benefits vital to human well-being.

**Generated Summary (100 words max)**: Climate change poses a growing threat to U.S. biodiversity, ecosystems, and the services they provide, affecting species through behavioral, morphological, phenological, and range shifts. At the ecosystem level, changes in primary production, species interactions, and extreme events impact provisioning, regulating, supporting, and cultural services, ultimately affecting human well-being. Effective natural resource management requires proactive, flexible approaches that address climate change impacts. Although some strategies are being implemented, widespread integration of climate considerations in management remains limited due to information gaps and institutional barriers. Demonstrative case studies and evaluations of successful adaptation efforts are needed to guide future climate-smart management practices.

### Insights and Applications

**Key Insights (150 words max)**: This section of the text explores ecosystem-level changes due to climate change, focusing on primary productivity, species interactions, and the impacts of extreme events on ecosystem resilience.

### 1. ****Primary Productivity****

Primary producers, such as photosynthetic organisms, form the foundation of most food webs and play a crucial role in oxygen production and carbon cycling. Climate change has led to varied effects on primary production, influenced by factors like increased atmospheric CO2, nutrient availability, and growing seasons. Terrestrial primary productivity increased in the late 20th century due to higher CO2 levels and human activities, but these trends are inconsistent across regions due to water deficits, nutrient availability, and air pollution. The effects are more pronounced in forests, where climate change alters growth rates depending on forest type and water availability.

Marine primary production, driven by phytoplankton, is also highly affected by climate change. In temperate and tropical oceans, warming leads to stratification, reducing nutrient upwelling, while in polar regions, reduced ice cover boosts phytoplankton growth. These changes influence the marine food web, particularly fisheries.

### 2. ****Biological Invasions****

Species interactions are significantly altered by climate change, with shifts in distributions and phenologies leading to changes in food webs and community structures. Higher trophic levels are particularly sensitive to these changes due to altered predatory behavior and encounter rates. Emergent ecosystem properties, such as new or hybrid ecosystems, arise from these altered interactions. However, predicting these outcomes is challenging due to the complex interplay of species and environmental factors.

Additionally, climate change facilitates the spread of non-native invasive species, which exploit disturbed environments and outcompete native species. These invasions can alter ecosystem functions, reduce biodiversity, and increase extinction risks. In some cases, invasive species might provide unexpected benefits to native species or even diminish due to climate impacts.

### 3. ****Extreme Events and Ecosystem Resilience****

Climate change is intensifying extreme events like droughts, wildfires, and storms, which greatly affect ecosystem resilience. Droughts weaken forests, making them more susceptible to other disturbances, while warming and changing precipitation patterns have increased the severity and frequency of wildfires in many regions. Fire-prone forests are experiencing longer fire seasons and increased burned areas. Meanwhile, in marine systems, rising ocean temperatures are driving extreme events like marine heatwaves, leading to coral bleaching and ecosystem disruption.

These extreme events, combined with ongoing climate changes, challenge the ability of ecosystems to recover and maintain their functionality.

**Potential Applications (150 words max)**: The research findings emphasize how climate change affects biodiversity, ecosystems, and ecosystem services at various scales. These insights have several important applications. First, they provide a foundation for more targeted conservation and management efforts by highlighting species and ecosystems that are particularly vulnerable. Natural resource managers can use this data to develop climate-resilient strategies, such as habitat restoration, species relocation, and assisted evolution programs. Second, the findings underline the importance of ongoing monitoring and assessment to track ecological shifts and anticipate further impacts, informing adaptive governance and policy frameworks. For industries like agriculture and fisheries, understanding climate-driven changes in productivity offers a chance to innovate more sustainable practices. Lastly, the research can guide climate adaptation efforts, especially in supporting Indigenous communities and vulnerable populations that rely directly on ecosystem services, by integrating traditional ecological knowledge with scientific approaches. This holistic understanding fosters more resilient and sustainable ecosystems.

### Evaluation

**Clarity (50 words max)**: The final summary and insights are clear and effectively convey the complex relationships between climate change, biodiversity, and ecosystems. The synthesis across multiple scales—from individual species to human communities—is well-articulated, providing a holistic overview that helps readers understand and anticipate ecological changes for better adaptation.

**Accuracy (50 words max)**: The text provides a comprehensive review of climate change impacts on biodiversity, ecosystems, and ecosystem services, particularly in the United States, using insights from the Fourth National Climate Assessment. It highlights how climate change affects species behavior, morphology, and phenology, and how these changes cascade to disrupt ecosystem structures and processes. A critical focus is on the variability of these responses across species, habitats, and ecosystems.

**Relevance (50 words max)**: The insights provided emphasize the intricate effects of climate change on ecosystems and biodiversity. Understanding species-level responses, including behavioral, morphological, and phenological changes, is essential for adaptive resource management. This information supports developing strategies that help mitigate climate impacts on ecosystems, benefiting both biodiversity and human communities.

### Reflection

**(250 words max)**: In my learning experience with prompt engineering, I learned techniques like zero-shot, few-shot and chain-of-thought prompting. I learned different style of prompting such as directive prompt, , creative prompt and Iterative Prompts. I learned how to use Chat-Gpt and other AI tools in our educational challenges. One of the challenges I encountered was maintaining clarity and precision while staying within word limits. I adapted my prompts based on feedback and applied self-consistency, which helped improve the accuracy of the responses. Although I didn’t formally apply techniques like prompt chaining, I modified my prompts iteratively based on previous outputs to better target the desired information.