Creation of Defence Wall against Light Pollution for Saving the Invertebrate Ecosystem

***Abstract*—Light pollution is affecting nature's ecosystem in a very unfavourable way. This paper focuses on invertebrates and the main objective of this is to ensure their protection from the harmful effects of light pollution. Lights cause birds to become lost, which increases mortality, sea turtles' ability to navigate the ocean can be hampered by artificial light. Light pollution can affect food webs, lure invertebrates to artificial lights, disturb their circadian rhythms, and interfere with pollination, all of which can have detrimental consequences on ecosystems. More reviews on various studies that investigated the consequences of light pollution on a different invertebrate animals are provided here. This pollution harms invertebrate communities in various environments like streams, coral reefs. To prevent this and reduce the negative impact of light pollution on invertebrate biodiversity a number of strategies are being researched, including minimizing upward light transmission in the parking lot and street lighting design, exterior lighting preservation, a reduction in high-intensity emissions, the use of motion sensors to turn off the lights when not in use, and lowering or turning off the outside building and sign lighting if not needed.**

***Index Terms*—light pollution, invertebrate, artificial light, environment pollution**

I. Introduction

A phenomenon brought on by human activity on a worldwide scale, light pollution, has a considerable negative impact on invertebrates as well as other creatures of the natural world. Most land and marine species lack spines, which play essential roles in maintaining the cycles and functions of biological systems. However, artificial light during the evening disturbs their usual patterns of behavior, leading to altered action plans, multiplication, development, the living space organization, and correspondence.

Numerous studies that have looked at how light pollution affects diverse groups of invertebrates have underlined the necessity for mitigation measures to protect the invertebrate ecosystem. For instance, it has been found that street lights draw more scavengers and predators, emphasizing the importance of considering location and time when putting mitigating techniques into place. Environmental light pollution (ELP) also changes coral physiology, dramatically lowers coral cover and diversity, and upsets the ecological harmony of the reef ecosystem. This emphasizes the requirement for mitigation strategies such the use of shielded lighting fixtures, a reduction in the quantity and duration of artificial light, and the promotion of light-free zones in sensitive areas.

In order to protect the invertebrate ecosystem, this investigation aims to create a protective wall against light contamination. The impacts of light pollution on different invertebrate groups, such as mollusks, herbivores, marine organisms, and intertidal species, have been the subject of several researches. The study also points up the need for mitigating strategies to decrease the effects of ELP on communities of stream and riparian invertebrate species as well as Talitrid amphipods [1]. In the end, the study examines methods for lessening light pollution's negative effects on invertebrate biodiversity. These encompass activities in policy and education, behavioral adjustments by individuals, and technical solutions.

II. Problem Detection

Invertebrates, as well as other ecosystems, are significantly impacted by light pollution, an anthropogenic phenomenon. Invertebrates' natural physiology and behaviors can be impacted by light pollution, which can have a detrimental effect on their ability to survive and reproduce. Finding the issue and comprehending how it affects invertebrates are therefore crucial.

Behavioral observations are one technique for determining how light pollution affects invertebrates. To ascertain the effects of light pollution on invertebrates, researchers can observe how they behave under various lighting conditions. Researchers can determine how light pollution affects animals' natural behavior, for instance, by monitoring their activity patterns in locations with various light levels. Another method of determining the impact of artificial lighting on invertebrates is through physiological measurements. Researchers can check the levels of stress hormones in animals to determine how light pollution affects their physiology. The physiological impacts of light pollution on invertebrates can be better understood as a result. Another technique for examining how light pollution affects invertebrates is DNA analysis. Scientists have demonstrated how light pollution may impact the genetic variety via DNA analysis. For instance, a study that examined the impacts of light pollution on moths and employed DNA analysis to demonstrate how genetic diversity may be influenced by light pollution was published in the journal Molecular Ecology [2]. Another technique for researching how light pollution affects invertebrates is the use of light traps. Invertebrates can be caught and seen using light traps in locations with varying levels of light pollution [3]. This can help identify areas that are particularly affected by light pollution and shed light on how various species respond to various types of light. Field studies are another method by which scientists look into the negative affects of light pollution on invertebrates. The effects of different lighting levels on invertebrates can be studied in experimental plots that researchers can set up. Light Pollution's effects on invertebrates and their ecosys-

tems can be determined from this, which can yield useful information. Light pollution's effects on invertebrates can also be investigated in controlled laboratory studies. Invertebrates may be exposed to different lighting conditions while their responses, such as behavior, physiology, or gene expression, are monitored and recorded. The physiological and genetic effects of light pollution on invertebrates can be understood using this method, which can be very insightful. To sum up, it is critical to identify how light pollution affects invertebrates in order to safeguard these significant species and ecosystems they rely on. For determining how light pollution affects invertebrates, it is useful to use behavioral observations, physiological measurements, DNA analysis, light traps, field experiments, and laboratory studies. Researchers and decision-makers can create effective strategies to lessen the harmful effects of light pollution and promote sustainability by better understanding how invertebrates are impacted by it [16].

III. Applied Method

Light pollution is a growing problem that affects not only people but also other animals like invertebrates in many parts of the world. They are particularly vulnerable to light pollution because many invertebrates have evolved to rely on natural light cues for vital life processes like reproduction and navigation. Light pollution can make these procedures more difficult, which will be bad for invertebrate populations. By using shields, hoods, and other types of lighting fixtures that direct light downward and reduce upward or outward light dispersion, invertebrates can be protected from the harmful effects of light pollution [4]. This is essential for outdoor lighting, like streetlights and parking lot lights, which significantly adds to light pollution.

Invertebrates may be less negatively affected by light pollution if lights are used at lower intensities or for shorter periods of time. This can be achieved by using more energy-efficient lighting equipment, such as LED bulbs, or by turning off lights when not in use [5]. Invertebrates will be less affected by light pollution if red or amber lights are used instead of lights that are outside of that color spectrum. Invertebrates are less likely to be attracted to and sensitive to particular light colors, which explains this. Light pollution will be reduced overall and nighttime darkness will be maintained with the installation of motion sensors that only turn on lights when necessary. This is particularly useful for outdoor lighting in areas with little traffic or activity [13].

Using a timer to turn lights off at specific times, such as after work hours, can help lessen the impact of light pollution on invertebrates. When nighttime illumination is an option, this is especially beneficial in commercial and industrial settings [6]. Promoting responsible outdoor lighting use and informing people about how light pollution harms invertebrates are two ways to reduce light pollution. This might entail working with local businesses and organizations to promote the adoption of the best practices for outdoor lighting as well as educating the public about how light pollution affects animals.

IV. Research Objective

The research mainly aims to find out a defensive method to mitigate light pollution and save the ecological balance of the ecosystem. The existing defensive methods of light pollution are not quite active to solve the arising issue. So a unique protective system should be built up against the light pollution to save the lives of invertebrates. The objectives of research are as follows:

A. Analyzing the ways of occurrence of light pollution.

B. Finding out the specific types of light pollution affecting invertebrates.

C. To fix the issue of the defensive method against light pollution.

D. Finding out a unique defensive system to save the ecosystem of invertebrates by minimizing light pollution.

V. Literature Review

Artificial light is the outcome of removing the whole darkness of the world.It has been studied by ecologists that the effects of natural light on living species regulate the biological interactions but it failed to investigate how the intensity of these light at high rate can bring a life threatening risk for invertebrate living organisms.In past few centuries the intensity of light increased in such way which badly harming the ecological balance of invertebrate wild.After a research process it had been mentioned that these artificial light causes light pollution.This light pollution is quite responsible for catastrophic consequences for both invertebrates in terrestrial and aquatic environment [12].

Currently many researchers are working to defend the light pollution to save the ecosystem of the animal kingdom. Before defending, it is being studied about the bad effects of light intensity and how it changes the biological clock of the interactions of invertebrates by observing the different behavioral patterns of each living organism [4].

Artificial light has now become life threatening to living organisms."For many astronomers, light pollution has been a disaster." It actually disrupts the normal cycles of a variety of life-based ecosystems. Mollusks actually refer to a class of the animal kingdom under this class that includes snails, squid, cuttlefish, clams, scallops, oysters, chitons, etc.By analyzing light pollution, it is determined how ambient light conditions primarily affect reproduction, energy storage and neural activity in snails. This indicates the widespread use of artificial light 6% per year. Direct lighting may be used to achieve this.Light pollution is another danger to ecosystems that would significantly increase with the use of artificial lighting at night. Numerous studies have shown that nighttime lighting has an impact on animals, plants, fish, amphibians, reptiles, birds, and mammals. Biodiversity also refers to the transformation of one organism's normal life cycle into another.Light primarily provides environmental information about the season, time of day, and seasonal changes.Based on this organism, they change their behavioral patterns to adapt to diverse environments. With the help of sunlight, the organism's photoreceptor cells

begin to function well, but cease to function in the presence of artificial light.The occurrence of light pollution in mollusks can be observed in various ways firstly reproduction Reproduction is another essential process that can be impacted by changes in natural light patterns in various ways. One of the reproductive parameters that is frequently impacted by light levels and light pollution is egg-laying behavior. Light pollution has an impact on growth as well. Many research works have been done to detect the causes of light pollution and how it actually affecting badly the biological perspectives or nature of invertebrates animals. It demonstrates the sensitivity of artificial light affecting reproduction, growth, survival and developmental success [7].

Furthermore, an experiment was done by the grassland ecosystem to investigate top-down and bottom-up effects of artificial light at night.In addition vegetation sampling had been performed to cover the plant species. From this method data is analyzed based on presence and absence of herbivorous and predator and light factors result is obtained.So based on results and data analysis three principles of light designs were proposed mentioning avoiding any illumination around natural and semi natural ecosystems,making the limitation of light intensity and applied according to the demands and lastly controlling the emission of lighting spectrum [8].

While there is significant research into how artificial light pollution negatively affects human health, societal attitudes, scientific endeavors, and biological processes on land, there is little information on how it affects marine ecosystems. The article provides an overview of the extent of marine light pollution, discusses how it changes the physical environment, and explores its potential role in shaping marine ecosystems.After detection of light pollution,initiatives to preserve naturally lit landscapes and expand them to include ”marine dark sky parks” are proposed [11].

Light pollution was also found on the invertebrates dwelling on ground. For finding the light pollution a method named pitfall traps had been applied.The study mainly deals with this method and experimental analysis. In this method two samples have been applied to the time factor mentioning nocturnal and diurnal.The study also aims to investigate the effects of ELP on coral reefs and the implications for their sustainability.In addition the study found that light pollution had the strongest negative impact on bat activity, followed by impervious surfaces and intensive agriculture.Furthermore study was also been conducted on sea dwellers of invertebrate class.Field experiments were conducted on two sandy beaches in Chile, with one array of containers exposed to an artificial light system to provide an average ground-level light intensity of 60 lux, and the other array left in ambient conditions. Laboratory experiments were also conducted under controlled conditions to contrast the field results [9].

Mainly previous research had mainly focused on the detection of light pollution, the causes of light pollution, and how it affected the biological, and physical patterns of living invertebrate organisms. Experiments had been done to find out a way to visualize the light intensity and nature of it. It had not been mentioned about the failure of the researchers to find a defense against light pollution. So we will be working by focusing mainly on detecting preventive measures to minimize light pollution and save the ecosystem. In addition, the previously applied method did not work well to defend against light pollution. So mainly a unique algorithm will be generated based on pattern recognition and a defensive AI model will be trained under this algorithm. So the AL model will detect the occurrence of light pollution and then stop it. So this future work will be more effective to save the ecological imbalance in environment [10].

VI. Future Work

Research on the consequences of light pollution is necessary to comprehend how artificial light affects natural ecosystems. It is crucial to look how light pollution affects an organism's ability to reproduce, grow, and survive in its natural environment. Such research is crucial for maximizing the impacts of natural light on these procedures and encouraging successful development. The physiological and ecological mechanisms by which various species are harmed by light pollution must be considered in order to achieve this. This requires looking into the consequences of light pollution in all of its forms, such as sky glow, glare, and light trespass, among others [20]. We can create effective conservation strategies to safeguard vulnerable species and their habitats by investigating these effects. For instance, reducing artificial light source duration and intensity can help to lessen coral reef effects from excessive light pollution. Such actions can help coral reefs, which are essential to the wellbeing of many marine ecosystems, grow and survive. Similar to how the proper use of soil minerals can help shield the ecosystem from light pollution's harmful effects. In conclusion, it is essential to conduct research into light pollution's effects in order to comprehend how it affects natural ecosystems and create successful conservation plans. Developmental success can be achieved by enhancing the impact of natural light on reproductive, growth, and survival processes by examining the physiological and ecological pathways of light pollution [15].

VII. Conclusion

The effects of the street lighting on ground-dwelling invertebrates, and they have revealed important ecological implications have been the subject of numerous studies. Due to these areas' proximity to the light source, predators and scavengers are drawn there, which is one of the major effects of the use of HPS street lights in urban areas. This may result in some species becoming more dominant while others become less so in ground-dwelling invertebrate communities. By inhibiting the activity of the photoreceptors in the organisms that inhabit an environment, the intensity of synthetic light can also upset the ecological balance of that environment. Changes in the interactions and behavior of various species can have cascading effects throughout the food chain, contributing to further ecological imbalances. A concerted effort must be made to understand the environmental and physiological mechanisms

underlying the effects of artificial light on the environment as well as how various species react to them. Coral reefs and sandy beach ecosystems are just two examples of the many ecosystems that are at risk from ecological light pollution because there are currently no legal measures in place to help mitigate its effects. Numerous other factors, such as the careless use of synthetic chemicals, coming into contact with toxic minerals, oil spills, and acid rain catastrophes, already pose a threat to animal ecosystems. For instance, it has been demonstrated that nighttime lighting affects the intertidal fauna, which can have a significant impact on the interactional equilibrium necessary for community structuring. No matter how their physical development or body mass changed, birds exposed to artificial light at night were found to suffer negative effects, with a notable decline in initial nitric oxide levels being noticed. Overall, in order to reduce its negative effects and safeguard the environment, it is crucial to understand how artificial night lighting has bad effects on the ecosystem's functions and the preservation of biodiversity.

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