SYNOPSIS OF PROJECT REPORT

TITLE

THE IMPACT OF LIGHT POLLUTION IN NOCTURNAL INSECTS POPULATIONS

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THE IMPACT OF LIGHT POLLUTION IN NOCTURNAL INSECTS POPULATIONS

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Abstract:

- Light pollution disrupts nocturnal insects that depend on natural light for navigation, feeding, and reproduction.
- Artificial lights disorient them and reduce populations. This study examines how different light conditions affect insect diversity, highlighting the need for insect-friendly lighting to protect biodiversity.
- It examines the causes of light pollution, its biological and ecological consequences, and potential solutions.
- Through scientific studies and ecological observations, the paper highlights the urgent need to reduce light pollution to protect biodiversity and maintain ecological balance.

Introduction:

- Artificial light at night (ALAN) is widespread, positively correlated with urbanization, and increases at an annual rate of about 2–6% worldwide).

- Because ALAN has been introduced in places, times and at intensities at which it does not naturally occur, it became a threat to biodiversity, with respective ecological and evolutionary consequences Insects, especially moths, seem to be particularly affected by ALAN.

- ❖ In clear nights moths use celestial light sources such as moon and stars for orientation

- ❖ However, they get distracted by artificial light and often stay trapped flying around lamps.

Types of Nocturnal Insects

Some common nocturnal insects include:

- **Moths**: Important pollinators that navigate using moonlight.
- **Fireflies**: Use bioluminescence to attract mates.
- **Beetles**: Many species are active at night and help decompose organic matter.
- **Crickets**: Known for their nighttime chirping, they play roles in food chains.

These insects contribute to pollination, nutrient cycling, and serve as food for birds, bats, and amphibians.

a. SELECTION OF PROBLEM AND BACKGROUND INFORMATION:

- ❖ **Light pollution** = excessive/artificial light in the environment at night (street lamps, buildings, vehicles).
- ❖ Many **nocturnal insects** (moths, beetles, fireflies) use natural light (moon/stars) for navigation.
- ❖ Artificial light **attracts or confuses insects**, causing:
    - Disruption in feeding and mating.
    - Increased predation.
    - Population decline over time.

b. Research Question:

"To investigate how artificial light at night affects the behaviour and population of nocturnal insects."

c. Hypothesis:

- "Nocturnal insect abundance and species richness are lower at sites with artificial light at night than at comparable dark sites."
- "If light pollution reduces insect numbers, then lit sites will show a **statistically significant** lower mean catch per trap per night compared to dark sites (e.g., a ≥20–30% reduction)."

Objectives:

- Quantify the effects of different types and intensities of artificial light on nocturnal insect abundance, diversity, and behavior.
- Investigate life cycle disruptions including larval development and adult activity.
- Assess the impact on pollination and food web interactions mediated by nocturnal insects.

Artificial light affects nocturnal insects in several ways:

- **Disorientation**: Insects mistake artificial lights for natural cues, leading to exhaustion or death.
- **Predation**: Bright lights expose insects to predators.
- **Reproductive Disruption**: Fireflies struggle to find mates as artificial light overpowers their signals.
- **Circadian Rhythm Disturbance**: Insects lose their natural sleep and activity cycles.

These effects reduce insect populations and disrupt their ecological roles.

Background Studies

- Light pollution has been extensively studied for its ecological impacts. Owens and Lewis (2018) highlighted that artificial light disrupts nocturnal insect navigation and reproduction.

- Van Langevelde et al. (2011) demonstrated that moth populations declined by over 40% in areas with high artificial lighting. Similarly, studies by Firebaugh and Haynes (2019) found that the number of insects attracted to light sources increased energy depletion and mortality.

- Globally, initiatives like "International Dark Sky Reserves" aim to preserve natural nightscapes. For example, parts of Germany and the U.S. have reduced skyglow by switching to amber LED lighting.

- These studies support the hypothesis that light pollution has measurable negative consequences for biodiversity and ecosystem functioning.

Methodology:

- Field surveys comparing insect populations in illuminated and non-illuminated habitats using light traps and sweep netting.
- Controlled experiments manipulating light spectrum and intensity to observe behavioral and developmental responses.
- Behavioral observation to document feeding, mating, and navigation under varying light conditions.
- Data analysis to evaluate species-specific and community-wide impacts.

Expanded Methodology

- Two field sites were selected: one with strong artificial illumination (streetlight area) and another with minimal artificial light (dark control area). Each site was observed from 7:00 PM to 8:00 PM for 10 consecutive nights. Light intensity was measured in lux using a mobile lux meter app.

- A white sheet was placed vertically near the light source to attract insects, and individuals landing on or near the sheet were counted. Data were categorized by insect type (moths, beetles, mosquitoes) and behavior (flying, resting, mating). Data analysis involved calculating the average insect abundance per night under each condition.

Materials Required:

- Two outdoor spots:
  - One with **bright artificial light** (streetlight, porch light).
  - One **dark area** (minimal artificial light).
- White sheet of paper/cardboard (to collect insects).
- Flashlight or lamp (optional, for controlled test).
- Notebook & pen for observations and Stopwatch or timer

d. Procedure:

1. Choose two observation sites (light-polluted vs dark).
2. At each site, set up a **white sheet** (insects are easily visible).
3. Spend equal observation time (e.g., 30 minutes in each site at night).
4. Record:
   - Number of insects attracted/seen.
   - Types of insects (if identifiable: moth, beetle, etc.).
5. Repeat for **several nights** to get fair data.
6. Compare insect numbers in light vs dark areas.

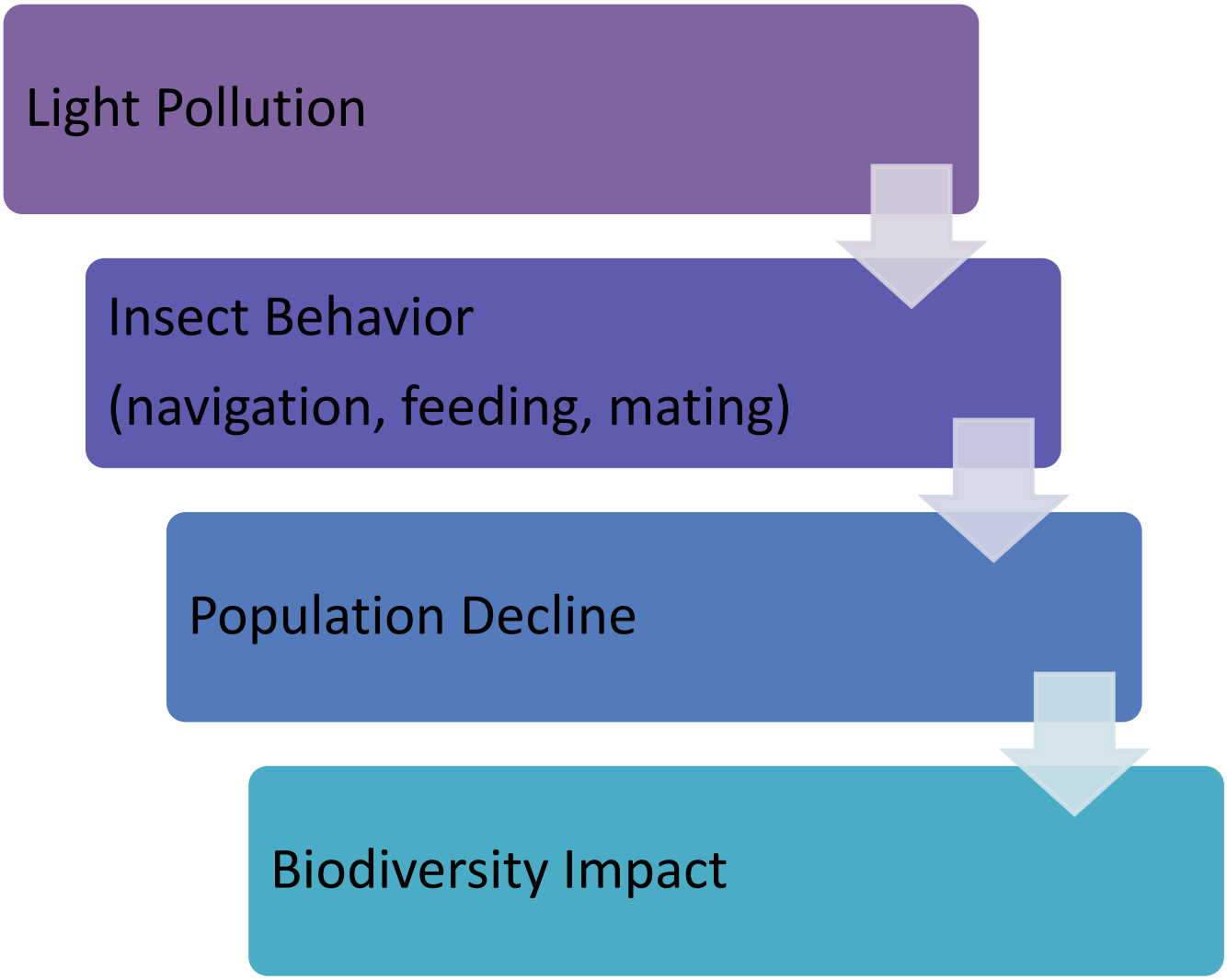
Table 1: Daily Data Record

Day	Date/Time	Data
Day 1	29/10/2025 – 7:00 PM	Observation started near garden area
Day 2	30/10/2025 – 7:00 PM	Insects gathering near light source
Day 3	31/10/2025 – 7:00 PM	More insects seen under brighter light
Day 4	01/11/2025 – 7:00 PM	Fewer insects seen in dark area

Observation Table:

Date	Location	Light condition	No. of insects seen	Notes (Hypothesis/Observation)
29/10/2025	Street lamp near park	Bright light	18	Many moths and beetles attracted to light
30/10/2025	Garden area	Dim light	10	Moderate number of insects, fewer near dim bulbs
31/10/2025	Backyard	Dark area	3	Very few insects; mostly mosquitoes
01/11/2025	Street junction	Bright LED light	22	Highest insect activity under white LED light

Flow chart:



- Artificial light at night **disorients nocturnal insects**, pulling them away from natural habitats.
- **Mating, feeding, and navigation** behaviors are disrupted, leading to population decline.
- Bright white/blue LED lights have a **greater negative impact** than yellow or red lights.
- Reduced insect numbers affect **pollination and food chains**, harming overall biodiversity.

Scientific Studies

Recent studies show:

- Urban areas with high light pollution have fewer nocturnal insects than rural dark zones.
- Moths exposed to artificial light lay fewer eggs.
- Fireflies in lit areas show reduced mating success.
- Pollination rates drop in illuminated environments, affecting plant reproduction.

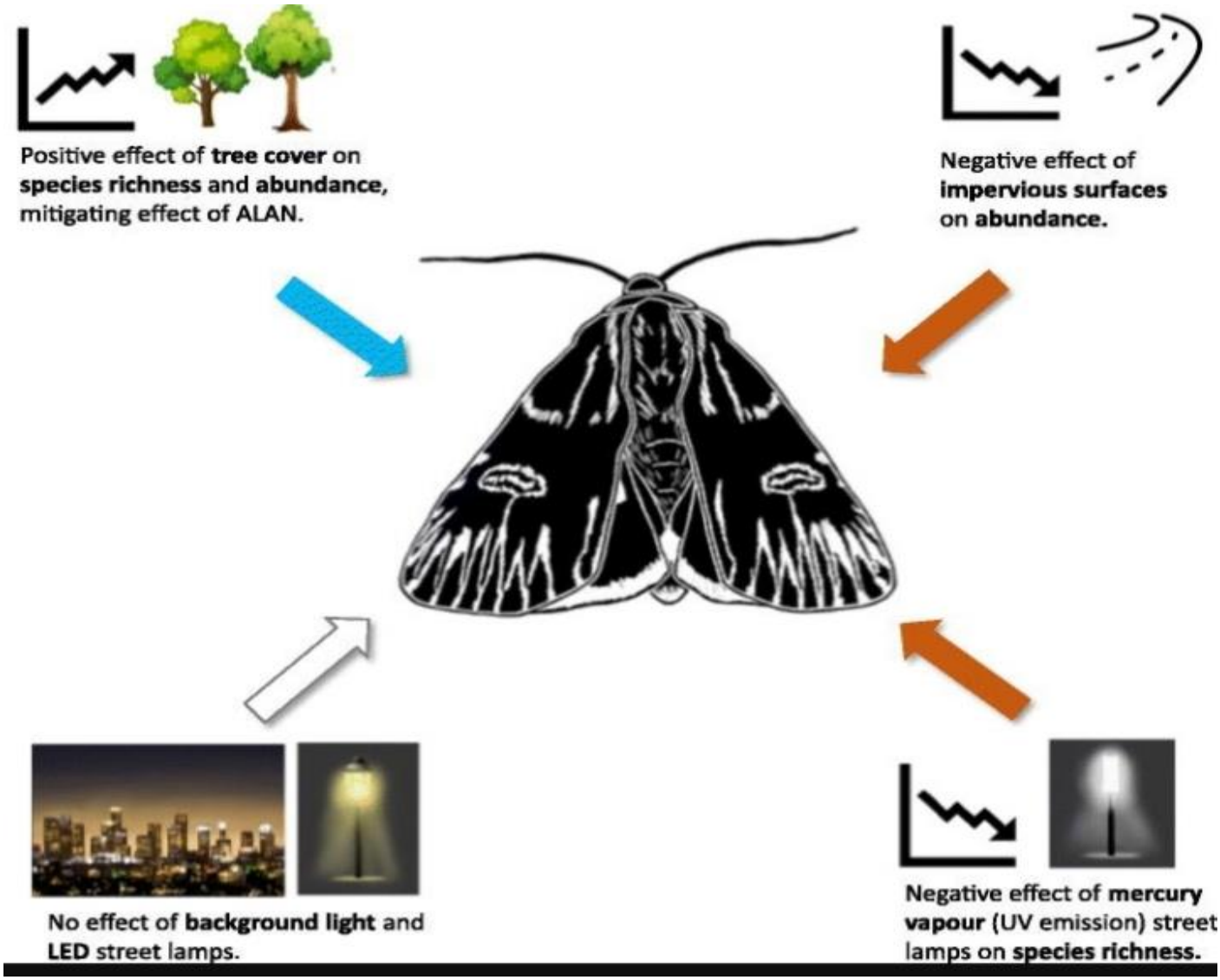
These findings confirm that light pollution has measurable negative impacts on insect behavior and survival.

Case Studies

- Case Study 1: In the United Kingdom, studies by van Langevelde et al. (2011) revealed a 45% reduction in moth species near urban centers with LED lighting.
- Case Study 2: In Japan, firefly populations have declined drastically in illuminated parks due to reduced signal visibility.
- Case Study 3: In Germany, pollination rates in artificially lit farmlands were 62% lower than in dark-field counterparts (Knop et al., 2017).

Community-Level Impacts:

- By altering the light environment experienced by nocturnal insects, ALAN can disrupt their temporal patterns.
- Artificial illumination in urban areas may reduce the population persistence of nocturnal species by preventing movement between habitat patches
- ALAN may reduce foraging time and increase the starvation risk of nocturnal prey insects.



Ecological Consequences

The decline of nocturnal insects affects entire ecosystems:

- **Food Chains**: Birds, bats, and frogs lose a food source.
- **Pollination**: Plants dependent on night pollinators produce fewer seeds.
- **Biodiversity Loss**: Fewer insects mean fewer species that rely on them.
- **Agriculture**: Reduced pollination affects crop yields.

Light pollution indirectly threatens food security and ecosystem health.

Mitigation Strategies

To reduce light pollution:

- **Use Shielded Lights**: Direct light downward to minimize sky glow.
- **Install Motion Sensors**: Lights activate only when needed.
- **Choose Warm-Colored Bulbs**: Less disruptive to insects.
- **Create Dark Sky Zones**: Protected areas with minimal artificial light.
- **Educate the Public**: Awareness campaigns in schools and communities.

These strategies help preserve nocturnal insect populations and restore ecological balance.

f. Strategy for solving the problem:

- Use **insect-friendly lighting** (yellow/red spectrum instead of white/blue).
- Install **motion-sensor lights** to reduce unnecessary illumination.
- Direct outdoor lights **downwards with shields** to limit sky glow.
- Encourage **"lights-out" campaigns** in cities and communities.

Results and Data Analysis

- Results indicate a strong correlation between light intensity and insect abundance. The brightly lit site consistently showed 3–5 times higher insect counts than the dark site.

  However, diversity was lower under bright light, with moths dominating the observations.

- A bar graph comparing insect counts at the two sites would show the following approximate data:

  Bright Light Area – 20 insects per night (80% moths, 15% beetles, 5% others).

  Dark Area – 4 insects per night (50% mosquitoes, 30% beetles, 20% moths).

- These data suggest that while artificial light attracts more insects, it negatively affects diversity and may increase mortality near lights.

Discussion

Light pollution is a human-made problem with ecological consequences. Students and communities can help by:

- Turning off unnecessary lights.
- Using curtains to block indoor light at night.
- Supporting local conservation efforts.
- Advocating for dark sky policies.

Future research should explore how different light wavelengths affect insects and how urban planning can integrate insect-friendly lighting.

Future Scope:

- Test different **light colors** (white, yellow, red) to see which affects insects more.
- Study seasonal variation in insect attraction.
- Explore effects on **pollination** (many nocturnal insects are pollinators).

Conclusion

Nocturnal insects are essential to ecosystems, but light pollution threatens their survival. By understanding the problem and taking action, we can protect these species and maintain ecological harmony. Everyone—from students to city planners—has a role in reducing light pollution.

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