

## TEACHING GUIDE

### OCELOTS Module

*How can turning rocks give us insights into land-use change impacts on animals in outcrop habitats?*

<https://www.learnkala.com/cases/between-a-rock-and-a-hard-place/>

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#### SUMMARY

The tropics are undergoing large-scale land-use change, especially for the purpose of meeting agricultural requirements. Understanding how this impacts biodiversity is important, especially in under-appreciated open ecosystems such as rock outcrops, home for many threatened species. We will evaluate how the movement of large rocks from the natural rock outcrop for paddy cultivation and subsequent abandonment, and orchard plantations are affecting rock-dwelling fauna. This case study demonstrates that agricultural land-use changes can affect the microhabitat availability (large rocks in this case), and change the animal occurrence. The study also shows that, depending on the type of land-use change, one particular endemic animal may benefit from the change, while others are negatively impacted, highlighting the context-specificity in species responses. This is one of the first studies to determine the impacts of agricultural conversion of rock outcrops, thereby emphasizing the conservation value of habitats that are often classified as wastelands. Let's explore under the rocks!

**SUGGESTED AUDIENCE:** Undergraduate and above

**ESTIMATED TIME:** 3 Hrs.

**4DEE Tags:** Core Ecological Concepts: Organisms, (Abiotic and biotic features of the environment; Resources and regulators; Habitat and niche: fundamental – realized) Community (Habitat types – terrestrial – marine – aquatic – wetlands – soil; Species diversity – biodiversity – dominance; Behavioral ecology) | **Ecology Practices:** Quantitative reasoning and computational thinking, Designing and critiquing investigations, Communicating and applying ecology | **Human-Environment Interactions:** Human dependence on the environment, Human accelerated environmental change, How humans shape and manage resources/ecosystems/the environment, Ethics | **Cross-cutting themes:** Structure & Function, Spatial scale, endemism

## KEY CONCEPTS

1. Data from time-constrained searches for rock-dwelling animals across land-use types can quantify how microhabitat availability and animal abundance are impacted by human disturbance in a neglected ecosystem.
2. Human-nature relationships and conservation issues are important in an under-studied tropical habitat.

## LEARNING OBJECTIVES

- a. Describe the ecology and human-nature relationship in a tropical rock outcrop system.
- b. Quantify the rock availability and rock-dwelling animal prevalence across various land-use types.
- c. Use rock-turning data to assess the impact of land-use change on the species occurrence using data visualization tools.
- d. Integrate research results with evidence-based literature to develop conservation recommendations for unique rock outcrop habitats.

## CURRICULUM CONNECTIONS

This module connects with themes common in ecology curriculum such as: species interactions, habitat ecology, and disturbance. This can also be used in any human-nature relationship modules in conservation courses. Other key topics that are connected with this module are habitat threats to biodiversity, agroecology, stakeholder analysis, and conservation recommendations.

## 4DEE INTEGRATION STATEMENT

This module integrates three components of the 4DEE: **Core Ecological Concepts** of habitat and species diversity; **Ecology Practices** of making observations and connections, field identification, study design, statistics, and evaluating claims; and **Human-Environment Interactions**, including land-use change, conservation biology and ecological stewardship.

## PRIOR KNOWLEDGE

Students should be familiar with:

- Basic animal and habitat ecology (habitat preferences, animal response to disturbance etc.)
- Basics of descriptive statistics (boxplots, barplots, visual interpretations)

## **MATERIALS**

The online materials and datasets are good enough for the module. No need for hand-outs or other printed materials.

## **BACKGROUND**

This research was conducted by Jithin *et al.* in the rock outcrops of the northern Western Ghats, a global biodiversity hotspot in India. The scientists are working in Indian non-governmental conservation organizations, and the research was supported by On the Edge- UK Conservation Grants and the Habitats Trust-India. The original study is published in *Global Ecology and Conservation* (<https://doi.org/10.1016/j.gecco.2023.e02582>), and the dataset is publicly available via Dryad data repository (<https://doi.org/10.5061/dryad.4j0zpc8j4>).

## **TEACHING PLAN**

The module is designed with a flow through the research framework. The students are made aware of the study area and system, and key concepts needed for understanding the interpretations in the beginning. As students follow the text, multiple questions are posed to allow for student reflection as they progress through the module. These questions are suggested for student group discussions, followed by the instructor's review.

Statistical parts are kept to the very minimum to allow students to complete the research story easily. Further statistical tests and analyses in 'R' software is recommended (see section 5), if the student group is equipped with necessary skills. Full datasets and codes are made available for this. Students might need instructor's help to use the HHMI Data Explorer facility in this section.

Please follow the sequence of the module, which is written in a way that reinforces key concepts and revising important study details.

Discussions on the *Edge Notes* need to be guided by the instructors, especially if the concepts are new to students.

### **Detailed instructions for each section:**

The first section – *Rock Outcrops: A neglected, critical open habitat* – introduces the students to the ecosystem, and key concepts such as monsoon, formation of lateritic rocks, microhabitats,

and endemism. It also encourages students to explore about the region, people, and its cultural heritage.

The second section – *Land-use change in rock outcrops: The people's perspective* – prepares the students to explore the human dimension of the rock outcrops, especially the agriculture practices and associated land-use changes.

The third section – *Rocks, people and rock-dwelling fauna in the outcrops* – links the concepts of microhabitats in animal ecology, with agricultural ecology aspects and human dimensions to highlight the importance of large loose rocks for both human and animal use. This section introduces the students to the three focal animals in the study, along with their ecology in brief.

The fourth section – summarizes the contents so far, to make it easy for the students to design a study to explore the impact of agricultural land-use change on the microhabitat availability and animal responses. This section contains critical ideas such as hypothesis and predictions in Ecology. The instructor might have to take extra efforts for this section, if the students are unfamiliar with these concepts.

The fifth section – *The rock-turning data: Activity based data exploration* – is an activity page, where the instructor needs to assist the students to use HHMI Data Explorer facility to visualize the dataset downloaded from the module page. If the students are unfamiliar with violin and box plots, instructor may need to explain these using the *Edge Notes* provided.

**NOTE:** Additional statistical analyses can be carried out following the details in the original paper (Jithin *et al.*, 2023), using the full-dataset. The last card in the fifth section gives some hints on this. The students can be exposed to statistical tools such as generalised linear models (GLMs), Chi-Square test, Non-metric Multidimensional Scaling (NMDS), and permutational multivariate analysis of variance (PERMANOVA) here. Since the data structure requires additional care (for example, while choosing error structure, and for using mixed bias-reduction adjusted scores approach in GLM), students might need scaffolding during these analyses. If planning to carry out these analyses, the instructor may need to familiarize with these analyses beforehand.

Before moving to the sixth section – Interpreting the data: *How do animals respond to the land-use change* – the instructor can have a guided discussion with the students to interpret the results using the visualizations without the pointers given in the section. Then, this section can be used to summarize the interpretations. In the end of this section, some key questions are given which will make students think about the concepts of habitat preferences, and design of a study. Guided/ group discussions can be helpful in answering these questions (see suggestions below).

The last section – *Thinking Towards Conservation Measures: Biodiversity Heritage Sites* – tries to bring back the students to the larger context of the study and conservation issues of the landscape. Advanced concepts such as ‘protected areas’, and ‘habitat restoration’ are discussed here. Interested students can utilize the *Edge Notes* to further explore these concepts. There is an activity given at the end of this section, to suggest a few conservation measures for the plateaus, focusing on the endemic caecilian and gecko. This will need guided discussion by the instructor (see suggestions below).

The final assessment follows-up from the last section, and asks the students to think about the nature-people relationship in the landscape. The pointers can be used to assess the students’ understanding of the advanced concepts introduced in the module.

## ASSESSMENT TYPE

A few broad, open-ended questions are given on the last page of the module for the final assessment (see above). Instructors can assess the student responses based on their critical thinking and research-designing skills. Apart from this, a small quiz is provided for quick assessments. Some pointers for the instructor to assist discussions in other sections are given below:

The pointers below include more detail than would be provided by most students. They are meant to give teachers additional information that they may want to discuss with their students.

### Section 6:

- Why do you think the caecilian is more prevalent in the abandoned paddy than in less-disturbed plateaus and orchards?

***Gegeneophis seshachari is a habitat generalist found in synanthropic habitats. The most common prey item of Gegeneophis are termites and earthworms. The fossorial caecilian is generally found in loose soil under boulders, and agricultural soil of approximately 10 cm depth. Paddy is prepared on the rock outcrops by dumping soil from the neighboring areas and lining it with loose rocks. The muddy soils of the abandoned paddy may have provided increased opportunity for burrowing and more amenable microhabitat conditions that may reduce water loss of the endemic and fossorial caecilian.***

- What might have caused the complete absence of gecko and saw-scaled viper in the abandoned paddy, even though paddy contained the highest number of large rocks?

***The presence of large rocks alone need not necessarily influence the occurrence of different animals. The viper and gecko preferred large rocks, yet they were not detected in abandoned paddy fields with the highest numbers of large rocks among the three land-use types. As the substratum under rocks is modified from hard rock to muddy soil with modification to paddy, micro-climate under large rocks there can be unsuitable to some animals. Webb and Whiting (2006) found that the probability of occurrence of snakes was higher under boulders on rock substrate than on soil substrate. This presents a good example of the need to consider many factors when trying to understand an ecological question.***

- What different inference we would have made if we had just counted the number of all animals together under the rocks, without identifying the animals, or classifying the rocks according to their size?

***Differential responses of animal species wouldn't have been detected. In the above question, we saw how variable can be species response to the same microhabitat change. Similarly, we found that large rocks are critical habitats, compared to medium and small ones. The caecilian, gecko, and viper consistently preferred large rocks and invertebrates were frequently encountered under large- and medium-sized rocks but were relatively rarer under small rocks (Jithin et al., 2023), highlighting the value of large rocks as important refuges on the open lateritic plateaus. We would have missed out on this information if we hadn't collected the appropriate data.***

- In the original study, only one observer turned the rocks and collected the data. What additional care needs to be taken if more people are sampling, and what are its advantages?

***If there are more observers, we need to account for the detection bias between the observers using appropriate bias-reduction procedures. Teachers can also discuss about the advantages of multi-observer sampling such as more area coverage.***

### **Section 7:**

- Imagine you are being asked to suggest a few conservation measures for the plateaus, focusing on the endemic caecilian and gecko. Can you write a few suggestions?

***Habitat restoration in plateaus, where large rocks have been heavily depleted, can be explored through the introduction of aptly designed artificial rocks (Croak et al., 2013). Manipulative experiments involving rock addition could be carried out on disturbed plateaus to determine species recovery and plan restoration or management of these habitats. Farmland***

***abandonment has varying consequences for biodiversity as demonstrated in this study. Whether to restore the abandoned paddy habitats is a question that needs to be addressed with further research. Moving the relatively large rocks from abandoned paddy to plateaus may benefit species such as geckos and vipers, but may have the opposite effect for caecilians.***

## **REFERENCES**

Croak, Benjamin M., Jonathan K. Webb, and Richard Shine. "The benefits of habitat restoration for rock-dwelling velvet geckos *Oedura lesueurii*" *Journal of Applied Ecology* 50, no. 2 (2013): 432-439.

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Webb, Jonathan K., and Martin J. Whiting. "Does rock disturbance by superb lyrebirds (*Menura novaehollandiae*) influence habitat selection by juvenile snakes?" *Austral Ecology* 31, no. 1 (2006): 58-67.

## **CREDITS**

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## **GET IN TOUCH**

Please feel free to contact Jithin Vijayan ([jithinvjyothis@gmail.com](mailto:jithinvjyothis@gmail.com)) for further inquiries and questions related to the module.