

JAMES RENNIE BEQUEST

REPORT ON EXPEDITION / PROJECT / CONFERENCE

Expedition/Project/

Conference Title: Investigation into Water Scarcity and Waste Management in a Peruvian Coastal Desert Ecosystem

Travel Dates: 18/08/2025 - 08/09/2025

Location: Lobitos, Peru

Group member(s): Tania Dajani, Issy Ward

Aims: The primary aims of this project were: 1. To investigate the hydro-geological conditions required to support ecosystem restoration in the arid community of Sichez by identifying a sustainable groundwater source. 2. To assess the biological functionality and microbial health of a community-scale anaerobic biodigester, diagnosing the ecological factors contributing to its failure. 3. To research and propose nature-based, ecologically integrated solutions for wastewater treatment to mitigate pollution in the local marine and terrestrial environments.

Photography consent form attached:

(please refer to your award letter)

☒ Yes

☐ No

OUTCOME

Thanks to the generous support of the James Rennie Bequest, I was able to spend three weeks in the unique coastal desert of Lobitos, Peru, applying my biological studies to critical environmental challenges. The internship with the NGO Ecoswell focused on two key areas: the link between water availability and ecosystem restoration, and the microbiological processes of waste management.

The Search for Water: A Foundation for Ecosystem Restoration

The region around Lobitos is an arid ecosystem, and water scarcity is the primary limiting factor for biodiversity and community development. Our main project was to assist the goat-herding community of Sichez in locating a viable groundwater source, which is the essential first step toward their goal of ecological regeneration through "Holistic Management". This management practice aims to restore the landscape to have "green fields and vigorous trees" and support both livestock and wild animals.

We used a geophysical technique, Vertical Electrical Sounding (VES), to probe the subsurface for water. By measuring the ground's electrical resistivity, we could differentiate between dry soil and porous, water-bearing layers. Over a week and a half, we conducted surveys at eight sites across the dry riverbed (*quebrada*).

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Figure 1: Map of the eight Vertical Electrical Sounding (VES) sites in Sichez. Our analysis led us to recommend site SEV 1.2, near a historic well, as the most promising location for drilling.

The results consistently revealed a deep, low-resistivity layer, confirming the presence of a significant aquifer. Based on our analysis of the water table depth (2.61 m) and estimated conductivity (2.7 mS/cm), we recommended a specific location, SEV 1.2, to the community at a workshop on September 5th. This recommendation provides the scientific basis for a drilling project that could transform the landscape. Access to this water is intended to support the restoration of the native dry forest and enable sustainable grazing, demonstrating a direct link between geological investigation and biological restoration.



Figure 2: The current arid landscape of Sichez (left) and an AI-generated image representing the community's long-term biological vision for a restored, verdant ecosystem (right).

The Biodigester: A Case Study in Applied Microbiology

Our second project involved diagnosing a non-functional community biodigester at the Lobitos Fishermen's Guild. A biodigester is an artificial ecosystem designed to facilitate **anaerobic digestion**, a process where microorganisms break down organic waste in the absence of oxygen to produce biogas and a nutrient-rich fertiliser.

Upon investigation, we discovered the ecosystem within the digester had collapsed. The plastic lid was warped and open to the air, allowing oxygen to enter, which is toxic to the

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essential methanogenic archaea. The failed system had been colonised by opportunistic species, including numerous spiders and, alarmingly, a black widow spider, providing a stark indicator of its biological failure.



Figure 3: The team, with help from local fishermen, working to open the concrete sludge chamber to diagnose the biodigester's failure.

With the help of local fishermen, we accessed the adjoining sludge chamber and opened the connecting valve. Only a small amount of sludge came out, indicating a severe blockage that had halted the flow-through process and poisoned the microbial environment. We were, however, able to remove some of the dried sludge—a safe, nutrient-rich compost—for use as a soil amendment, demonstrating the potential of a functioning system to contribute to a circular nutrient economy.

Developing Nature-Based Solutions for Waste Management

The failure of the biodigester reflects a wider ecological issue in Lobitos. According to a previous study, 89% of the town's wastewater is unsafely managed, often discharged directly into the environment. This poses a significant risk of pathogen contamination and nutrient pollution (eutrophication) to the terrestrial and near-shore marine ecosystems. My research focused on identifying robust, biologically-integrated solutions. This included exploring constructed wetlands and vetiver grass systems, which use the natural phytoremediation capabilities of plants to treat wastewater. The ultimate goal is to create a "microgrid" system where household waste is treated in neighbourhood-scale biodigesters. The treated liquid effluent could irrigate reforestation projects, and the solid compost could enrich the soil, creating a closed-loop system that turns a pollution problem into a biological resource.

In conclusion, this expedition provided an unparalleled opportunity to engage in hands-on biological fieldwork. From probing the earth for the water needed to restore an ecosystem to dissecting the microbial failures of a sanitation system, I was able to directly apply my academic knowledge to real-world conservation and sustainability challenges. I am immensely grateful to the James Rennie Bequest for making this invaluable experience possible.