

# Find a Balance: Using our stream water sustainably

By Jessica Chappell

*Puerto Rican communities rely on a source of freshwater, which often comes from streams. In the El Yunque National Forest in Puerto Rico, over 30 low-head dams have been built throughout the forest to withdraw stream water. However, these dams can block the movement of migratory animals, including freshwater shrimp, which are an integral part of the stream community and provide important benefits to people. If too much stream water is removed, the connection between streams and the ocean can be broken and shrimp populations will go extinct. My research is focused on identifying which shrimp habitat is most vulnerable to this lost connectivity and during which time periods. To offer more realistic conservation solutions, I am also examining how water governance functions on the island. Specifically, I am interested in which agencies are accountable for equitable allocation, water use efficiency, and maintaining ecosystem integrity. A better understanding of the political situation allows my ecological results to be more beneficial.*

## Introduction

Freshwater is limited on the planet, but all of our human communities depend on a continuous supply to meet our domestic, agricultural, and industrial needs. In many cases, dams are used to store water until it is needed. However, the benefit of having a reliable supply of freshwater due to dams comes with several costs. These dams can impact the migration of aquatic animals. This is especially an issue for stream animals that rely on a connection from the ocean to the stream to fully develop. In Puerto Rico, freshwater shrimp migration can be affected not by the height of the dam, but by the amount of water removed. However, there are times when streams become naturally dry, such as dry seasons or drought years. Are these naturally dry periods becoming more frequent due to human withdrawals of freshwater? Freshwater shrimp have been resilient to periods of lost connectivity in the past, but with the increased pressure of human withdrawals, the shrimp, as well as other migratory animals, may be in jeopardy.

**Significance:** Assisting forest managers meet freshwater ecological and social needs

**Contribution to Ecology:** Historically, connectivity was considered to be static through time. Recently, however, we recognize connectivity fluctuations should be considered when making management decisions. With long-term stream discharge data in Puerto Rico, I can evaluate the consequences of thinking about connectivity as static or dynamic through time and see if using different connectivity values alter how managers prioritize watersheds for conservation. Additionally, I am examining the cumulative effects of multiple barriers within a watershed. Although this issue exists throughout the world, it is beneficial to fully explore these impacts in Puerto Rico as the smaller size of these watersheds makes this endeavor much more tangible.

**Contribution to Water Governance:** Although the term accountability is defined frequently, the simplest definition being "liable to be called into account", not many have attempted to identify accountability within a system, especially in the context of water governance. As I am using an accountability framework to examine how water governance works in Puerto Rico, I will be able to provide insight to ecological researchers in El Yunque National Forest as to who is accountable for what aspect of water management. This will help ensure researchers are talking to the actors that have the most influence in water governance.

## Methods

My research uses a variety of methods. To determine how river connectivity fluctuates through time, I use data supplied by USGS gages located throughout the El Yunque National Forest. I then apply an index of connectivity developed by a colleague, which quantifies connectivity from a shrimp's perspective. We essentially use known life history traits of shrimp to determine the accessibility of habitat in a variety of watersheds over the past 60 years. Additionally, we are also developing connectivity indices for other migratory species in Puerto Rico, including the American eel and snails. To determine how water governance functions on the island, I am using an accountability framework and a two-step approach to identify accountability. This approach focuses on identifying de jure and de facto accountability. De jure accountability is examined by reading the statutes, regulations, and court cases of Puerto Rico which outline which agencies are responsible for which aspects of water management. To determine how water management is operationalized, or the de facto, I interviewed key individuals from a variety of federal and state agencies which are involved in water management. This approach allowed me to understand both how water quantity fluctuates in this system and which actors can influence management decisions.

## Results

Preliminary results for my ecological research seem to indicate that using either a static or dynamic measurement of connectivity has the ability to impact which watershed managers prioritize for shrimp conservation. While some watersheds may have a high average connectivity, these same watersheds may also experience the lowest connectivity overall. Additionally, we have identified trends in connectivity over all watersheds. Connectivity tends to decrease during the dry season and in drought years. However, the magnitude of the decrease in connectivity differs between watersheds, with some watersheds more affected by lower rainfall than others. Overall, the watersheds identified as being the most impacted by lower connectivity tend to also have the largest water withdrawn closer to the mouth of the river.



*Low head dam with all the water blocked. This means there is no connection from above the dam to the ocean, so shrimp populations upstream could go extinct.*

Results from my social research reveal there are a variety of actors which play different roles in water management. Additionally, the type of accountability which exists differs between the de jure and de facto. Examining the system from the de facto perspective, all actors seem to be accountable to the governor of Puerto Rico. This is, in part, due to how the agencies in Puerto Rico are designed by law. However, it is important to recognize that state agencies seem to be accountable to the governor, which has implications for how researchers can influence conservation efforts. Additionally, the economic conditions in Puerto Rico cannot be ignored when making conservation suggestions.

## Conclusion

While the ecological research side of my project has found there are predictable trends in lowered connectivity, any management recommendations I may make as an ecologist must be informed by the results of my social research. Past ecologists in this area have suggested changes to how water is managed in streams in order to protect migratory species, such as shrimp; however, these suggestions have not been effectively used throughout the island. By focusing on the ecology of the system, as well as the social dimensions of water management, I hope my management recommendations will be more beneficial for both the stream organisms and local communities that depend on freshwater.



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