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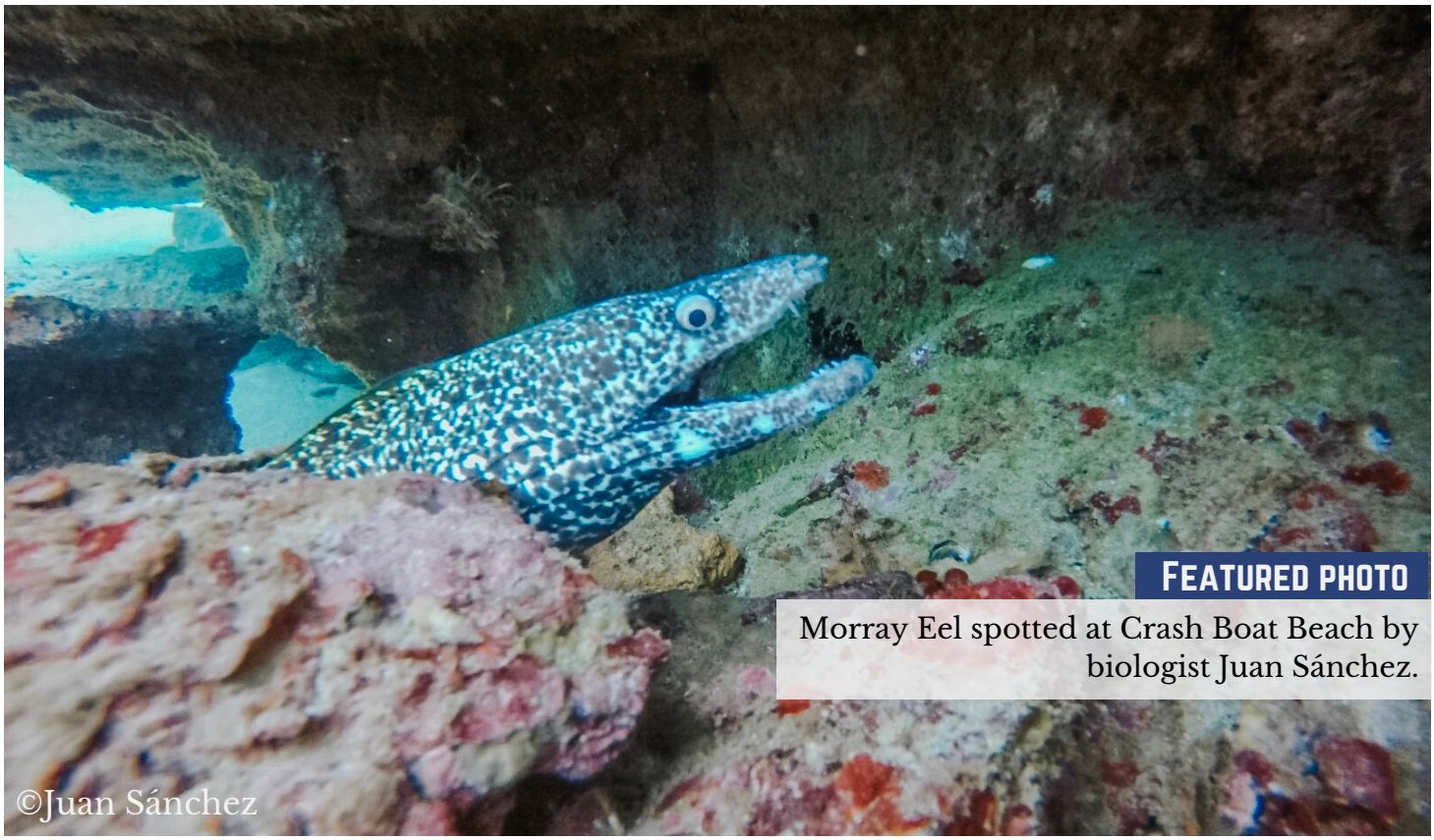
Puerto Rico Chapter

AMERICAN FISHERIES SOCIETY

Winter Newsletter | December 2019.



FEATURED PHOTO

Morray Eel spotted at Crash Boat Beach by biologist Juan Sánchez.

Inside the Issue

MOONLIGHT MAGIC: THE FANTASTIC CETÍ MIGRATIONS OF PUERTO RICO.

by Augustin Engman

As I write this, millions and millions of Sirajo Goby (*Sicydium* (spp.) are in the nearshore marine waters of Puerto Rico preparing for a migration that will change their lives forever. In less than a week the moon will be in its third or last-quarter phase,which will cue these tiny (~20-mm) fish to gather near a river mouth.

CONTINUED TO P. 04

Bonnie Myers trabajando en el ensamblaje de los tubos PVC para experimento de flujo.

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RESTORATION OF ARTIFICIAL STREAMS FOR USE IN FRESHWATER FISH AND FLOW EXPERIMENTS.

by Bonnie J.E. Myers, Thomas J. Kwak, Augustin C. Engman, Alonso Ramírez, and Ámbar Torres

Resilience to environmental disturbances is an important component of ecosystems, especially under a changing climate. Freshwater ecosystems and organisms worldwide are some of the most threatened. Understanding species' ability to be resilient to a changing climate and environment is an essential piece of developing appropriate management and conservation strategies. Low flow from drought and flooding events are common across Puerto Rico and has been shown to result in shifts in fish assemblages (see Ramírez et al. 2018). However, the mechanisms behind these assemblage shifts is relatively unknown. The Luquillo Long-Term Ecological Research Station artificial stream system can serve as a valuable and unique tool in experimentally testing species response to disturbance, particularly low and high flow conditions, to investigate if competition for ideal habitat may have a role in fish assemblage shifts.

MESSAGE FROM THE CHAPTER'S PRESIDENT

by Miguel García

My deepest appreciation to all of you for being part of the Puerto Rico Chapter of the American Fisheries Society. It has been a very satisfying and emotive endeavor, which has included a few important milestones. First, the creation of a chapter, out of the United States of America was a phenomenal accomplishment. Likewise, keeping this group moving forward under the current financial and professional circumstance locally testifies that we are indeed a committed and resilient unit. As a matter of fact, having host a Southern Division AFS meeting in Puerto Rico, after a tremendous hurricane does epitomize ...¡*De qué estamos hechos*! We are a small, active and energetic chapter which keeps seeking to serve as an extended educational opportunity for most, and an opportunity to attract and develop new professionals in the field of fisheries. Last, but not least important—Let's welcome the new chapter members!

©Bonnie Myers

Ambar Torres, técnica de campo del estudio, sellando las pozas/charcas de las quebradas artificiales.

Se crearon los hábitats adecuados para peces dentro del estudio, ayudándoles como albergue ante el flujo de agua.

During summer 2018, we rehabilitated the artificial stream system, which had not been used for over 8 years. We plan to return in late spring 2020 to use the artificial streams to run behavioral experiments to compare native and non-native fish species competition for space and habitat under varying flow intensities (e.g, low, normal, and high). These experiments will entail timed observations of varying behavior, such as time spent associated with certain cover objects and interactions for space (see Fischer 2000). Ultimately, our goal is to test the hypothesis that competition for space and shelter changes with varying degrees of low to high flow intensities among native and non-native species.

Vista río arriba luego de la remoción de la represa Cambalache en el Río Grande de Arecibo.

Reconnecting the rivers of Puerto Rico.

CAMBALACHE DAM REMOVAL AT RÍO GRANDE DE ARECIBO.

by Alexandra Galindo

The U.S. Fish and Wildlife Service's Caribbean Ecological Services Field Office with the assistance from the R4 Southeast Aquatic Restoration Team, and Partners implemented during March 18-20, 2019, the first project in Puerto Rico aiming to restore aquatic connectivity via the removal of a physical barrier (Cambalache dam) at Río Grande de Arecibo. The Cambalache dam was made of multiple boulders attached to each other and to the riverbed with iron rods. The removal was conducted by mechanical means through the use of two 54-70k pound tracked excavators; one equipped with a hydraulic thumb, and the other with a 5,000-8,000 lbs hammer breaker. Upland vegetation was cleared prior to implementation. The Service's R4 Southeast Aquatic Restoration Team operated the heavy equipment and worked directly on top of the dam removing it from the river left to the river right.

Once the removal was completed, some of the boulders were cut into pieces with the pneumatic hammer and used to stabilize the riverbank.

The removal of the dam connected and restored 16 miles of riverine habitat to a more natural state, providing fish and other aquatic species with a healthier, free-flowing stream. It also rid the river of a safety hazard, decreased erosion and will boost recreational opportunities upstream of Río Grande de Arecibo. Moreover, the final outcomes of the project will be validated by an on-going research (Dr. Sean Locke-University of Puerto Rico at Mayagüez) on the impact of stream barriers on migratory native aquatic fauna (fish and crustaceans) by comparing the baseline data of the biotic assemblages upstream and downstream prior/post dam removal.

Repeated systematic surveys of the site will provide validation of the effectiveness of the management measure implemented on the stream biota; data of the physical-chemical parameters will also provide information on how the stream habitat has changed after the barrier removal.

As a result, we expect to improve aquatic habitat and ecosystem integrity for the benefit of the identified focal species and other native aquatic fauna. Removal of the dam will allow migratory fish such as the Sirajo goby and the American eel (Species of Greatest Conservation Need), to travel further upstream.

The Cambalache dam removal is the first in a series of aquatic restoration projects between the Service, the Puerto Rico Department of Natural and Environmental Resources, and other partners (Protectores de Cuencas, Inc., National Wildlife Refuge Association, and the University of Puerto Rico at Mayagüez) as part of the on-going Stream Connectivity Restoration Initiative in the U.S. Caribbean focused on the conservation, restoration and enhancement of aquatic habitats.

MOONLIGHT MAGIC:THE FANTASTIC 'CETÍ' MIGRATIONS OF PUERTO RICO.

by Augustin Engman

As I write this, millions and millions of Sirajo Goby (Sicydium spp.) are in the nearshore marine waters of Puerto Rico preparing for a migration that will change their lives forever. In less than a week the moon will be in its third or last-quarter phase, which will cue these tiny (~20-mm) fish to gather near a river mouth.They will wait for darkness, then make a mad dash through the estuary and up to the river or stream where they will live out the rest of their lives. If they manage to make it that is. Ahead of them is a gauntlet of hungry fish and bird predators and, at the mouth of some of Puerto Rico's rivers, skilled fishers plying fine-meshed nets.

This ocean-to-river migration, or post larval recruitment, is the second and final transition between marine and freshwater environments in the Sirajo Goby's amphidromous life history. Sirajo Goby live and spawn in streams and rivers, after hatching, larvae drift to the ocean where they undergo a pelagic larval phase, which for Puerto Rico's gobies can last from one to four or more months. Next, they begin a multi-stage metamorphosis. Postlarvae approaching the river mouth have almost entirely transparent tissues, which makes the oxygen-rich red blood in their circulatory system clearly visible.

Pescadores del cetí en la desembocadura del Río Grande de Arecibo.

Their forward-facing mouths bely the life early life spent feeding in the water column that they are leaving behind but their pelvic fins have already fused, a part of the transition to the benthic stage that awaits. Amphidromous fishes in this early life-stage are collectively referred to as cetí in Puerto Rico and are fished in rivers of the North-Central and Northwest portions of the island. Once through the mouth and into freshwater, they quickly acquire coloration, the mouth migrates downward and the fused pelvic fins become even more robust and suction-cup-like, an adaptation that will allow them to surpass some obstacles that they encounter on their journey toupstream. Before reaching the fast-flowing riffles and high-elevation pools that are ideal adult habitats they must make the perilous passage through the river mouth, a pinch-point that makes them vulnerable to predation by birds like herons and egrets and fish, such as snooks (Centropomus spp.) and tarpon (Megalopsatlanticus). This predator gauntlet is hypothesized to have driven the evolution of synchronous ocean-to-river mass-migrations (i.e., recruitment), and it is these synchronous mass-migrations that make the last quarter moon phase (*luna menguante en español*) a magical time in Puerto Rico's rivers and estuaries. Sirajo Gobies recruit to rivers almost exclusively during three days of last-quarter moon phase. Recruitment is also synchronous on diel and annual timescales in these species, it is concentrated in post-midnight to sunrise hours and the months of June through January. River Goby (Awaous banana) and amphidromous shrimps join Sirajo Goby in these mass-recruitment episodes. The upstream migrating biomass can be so great that it is known to turn otherwise clear rivers, like the Río Grande de Arecibo, blood-red. Flooding the river with a huge pulse of recruits in a very short period of time is a form of predator swamping, a strategy to minimize individual prey mortality by confusing predators or satiating them. Sometimes you gotta take one for the team!

The people of Puerto Rico and many other Caribbean islands also take part in this magical monthly food bonanza. Cetí fishing is a fascinating, artisanal practice with roots in the indigenous cultures of the Caribbean.

In fact, the similarities in present-day names of goby postlarvae across the Caribbean (e.g. tri-tri in Dominica, tetí in Cuba, and ticky-ticky in Jamaica) are strong evidence that word cetí has its origins in the Taínolanguage. With ancient knowledge of synchronous recruitment times, fishersspend two-to-three nights and early mornings per month pulling fine meshed seines fashioned from mosquito bed netting through the water. The Río Grande de Arecibo, Río Grande de Manatí, and Río Grande de Añasco are the most well-known centers of cetí fishing in Puerto Rico but fishing occasionally occurs at allriver mouths in the Northwest corner of the island and may have been historically practiced throughout the island. Once the fishers capture the cetí they process their catch and sell it or bring it home forpersonal consumption. You too can have a taste of the moonlight magic by visiting restaurants in Arecibo and surrounding towns during the right seasonfor a delicious *empanada de cetí*, *salmorejo de cetí*, or even a *cetí pizza*!

Featured Photo

Sara Ramos, técnica de campo, separa el material orgánico de los insectos

©Rosa Sáez

A LOOK INTO THE TROPICAL STREAMS IN THE CENTRAL MOUNTAINS OF PUERTO RICO.

by Rosa Sáez Uribe

My first contact with a tropical stream was when I was around 8 or 9 years old. It was the Toro Negro River in a municipality called Orocovis, in the Central Mountain Range of Puerto Rico. For that time, I only knew that rivers served as places to have fun and be with family. I didn't know anything about life beyond the water surface such as aquatic insects, nor about water quality, I only knew about small fish that bit your feet and the precaution measures involved with these bodies of water. However, I never imagined to be doing my thesis research on stream water quality. Sometimes, life is an irony!

Around the 1940's Puerto Rico experienced an evident abandonment of intensive agriculture, letting vegetation to have a spontaneous regrowth through years[1]. Since this occurred around the whole island, it was expected that the Central Mountain Range area also had a forest resurgence, improving stream water quality through time. So, the main objective of my study was to evaluate the effect of land use legacies on the water quality and river health in some streams in the headwaters of the RGM basin, using biological, chemical, and physical parameters as proxies of water quality.

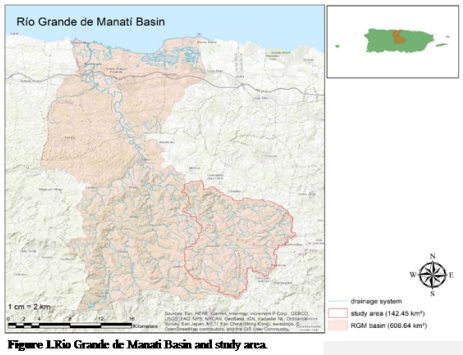


Figure 1.Río Grande de Manatí Basin and study area.

Most of the studies that deal with land use changes and its effects on streams and the environment are focused on the northeastern part of the island, specifically in El Yunque. Nevertheless, few studies are focused on river water quality and land use changes in the mountainous central area of Puerto Rico. So, I decided to focus my study on a micro watershed located in the Central Mountain Range of Puerto Rico. This micro watershed is a sub-watershed of the Rio Grande de Manati (RGM) basin, a basin that drains to the Atlantic Ocean.

©Rosa Saez

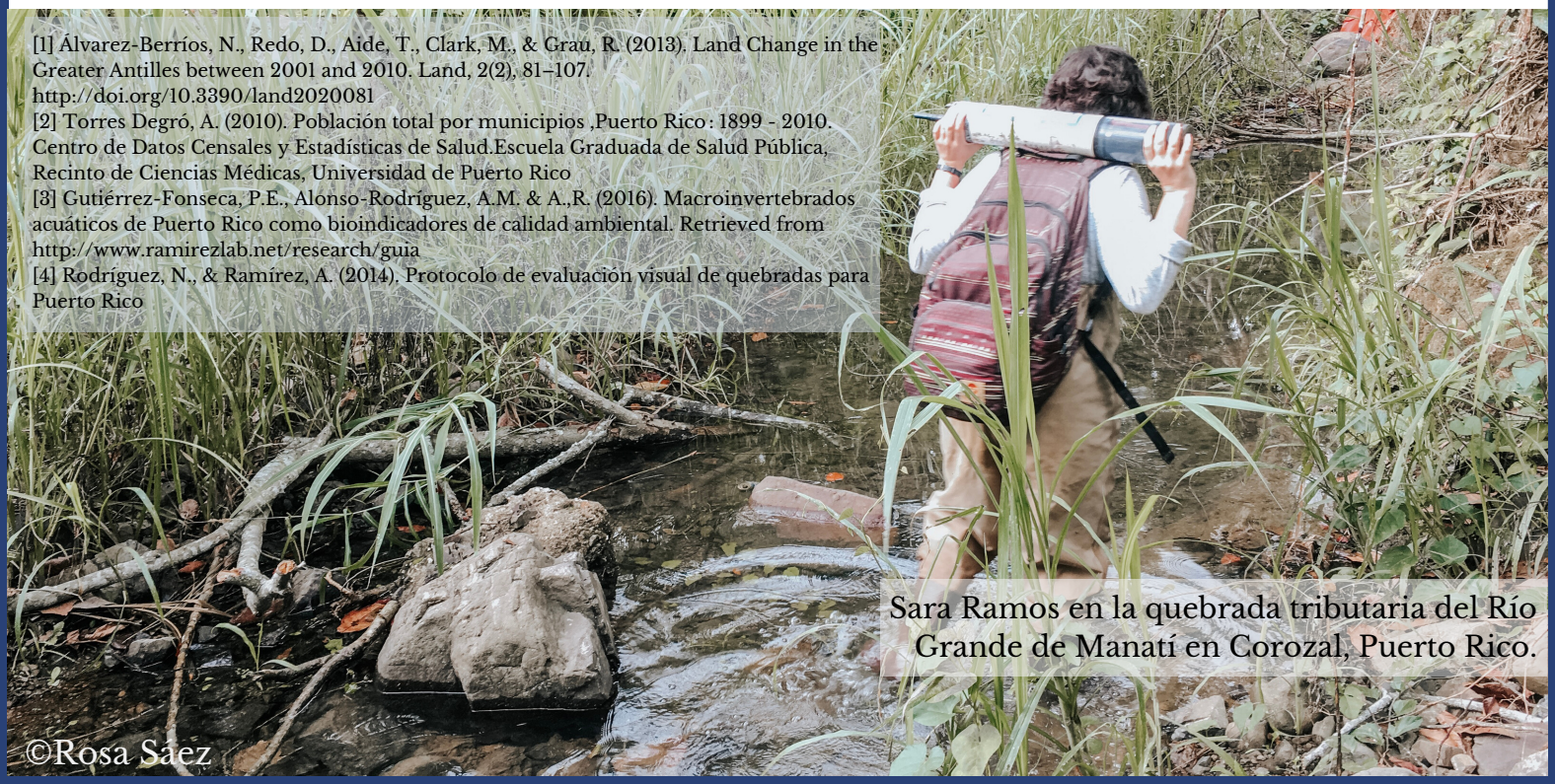
Larva de díptero

Spatial analysis was conducted using ArcGIS to evaluate land use change, to select sampling sites, and to evaluate population growth. Sampling stations were selected by comparing four a time series of land use maps (1977, 1991, 2000 and 2010) to detect major changes since 1977. The delineation of the small sub watersheds was done using the Soil and Water Assessment Tool (SWAT). For population growth, I used census data from 1970 to 2010 [2].For water quality evaluation I used three different methods in 15 streams during the summer of 2018 (starting on June 22 and ending on September 1): 1. Biomonitoring with macroinvertebrates and the application of the Biological Monitoring Working Party (BMWP) and the Biotic Index of Families (IBF) adapted to Puerto Rico [3], 2.The rapid visual assessment adapted to Puerto Rico[4], and 3. Measurements of physical-chemical parameters and collection of watersamples for nutrients analysis.

According to preliminary data, although Puerto Rico population growth has decreased from 2000 year, the population of the municipalities that conforms the study area, has increased, and at the same time, forest regrowth had increase by 35%. Urban expansion increased in approximately 5% and agriculture and pastures decreased by 30% since 1977 to 2010. On the other hand, stream water quality seems to not change significantly from one site to another. However, the distribution of nutrients seems to be related with the slope of every site. In addition, nutrients that were thought to be the limiting nutrients such as phosphates and nitrates, were the ones with the lowest concentrations. On the other hand, nutrients such as Sodium, Chloride, Calcium and Sulfate, were the ones with the highest concentrations in all sites.

In the future, I would like to integrate a social component because, during my field trips, I noticed that people living next to streams know a great deal of land use history as well as flood risks which would be of great interest to the scientific community. People may not know about what pH is or about nutrients, or salinity, or dissolved oxygen, but they know about fecal coliforms, illegal discharges and where they can find good drinking water. People are really interested in knowing more about their environment in a scientific way to validate what they think is happening. I think Science is a great asset in our day by day life to build bridges between non-scientific communities and cooperate with them in the process of having a better understanding of the different process that happen in our environment.

[1] Álvarez-Berríos, N., Redo, D., Aide, T., Clark, M., & Grau, R. (2013). Land Change in the Greater Antilles between 2001 and 2010. Land, 2(2), 81–107. http://doi.org/10.3390/land2020081
[2] Torres Degró, A. (2010). Población total por municipios ,Puerto Rico : 1899 - 2010. Centro de Datos Censales y Estadísticas de Salud.Escuela Graduada de Salud Pública, Recinto de Ciencias Médicas, Universidad de Puerto Rico
[3] Gutiérrez-Fonseca, P.E., Alonso-Rodríguez, A.M. & A.,R. (2016). Macroinvertebrados acuáticos de Puerto Rico como bioindicadores de calidad ambiental. Retrieved from http://www.ramirezlab.net/research/guia
[4] Rodríguez, N., & Ramírez, A. (2014). Protocolo de evaluación visual de quebradas para Puerto Rico



Sara Ramos en la quebrada tributaria del Río Grande de Manatí en Corozal, Puerto Rico.

James y voluntarios adicionales ayudaron a construir un tablado de 100 pies en madera que sirve de acceso a la popular playa de Jobos Beach en Isabela, Puerto Rico.

AFS HUTTON JUNIOR FISHERIES BIOLOGY SCHOLARS FROM PUERTO RICO SHARE THEIR EXPERIENCES!

Hutton Scholar experience during the summer of 2019.

by James Lebron

What began as confused observation of wooden pallets embedded in the sands of an Isabela shoreline ended in my decision to apply for the Hutton Scholars Program , all thanks to the motivation of a close friend and the persuasion by my high school science teacher. Thankfully, I got accepted and subsequently connected with **Vida Marina** where I would gladly learn and work in diverse fields and activities related to ecology. At first, I did not know how the program would work, however, I found myself wonderfully surprised and satisfied with the position I would occupy and the projects I would be involved in. Interestingly, I was both an active student in a restoration ecology summer course taught by my mentor, Prof. Robert Mayer. Later on, when the course ended, I became a staff member for the Center for **Conservation and Ecological Restoration: Vida Marina**, also run by Mayer, all on campus at the University of Puerto Rico in Aguadilla. My work during the summer was an accurate portrait of what tasks concern the organization– largely, the improvement of the unique sand dune systems that run from Isabela to Loíza in both environmental and community aspects. The fluidity and unpredictability of Vida Marina's operations, at least from my perspective, made it always an intriguing experience. Days usually started at the university with diligent mass cultivation of a native dune-crawling vine, C*anavalia rosea*, equipment maintenance, and simple woodwork were conducted; a typical day could evolve into field excursions involving the installation of signs at beach entrances, identification and seed collecting of the incredibly diverse flora found in the sea-tended gardens of the sand dune (an aspect that increased my appreciation for an often forgotten ecosystem),

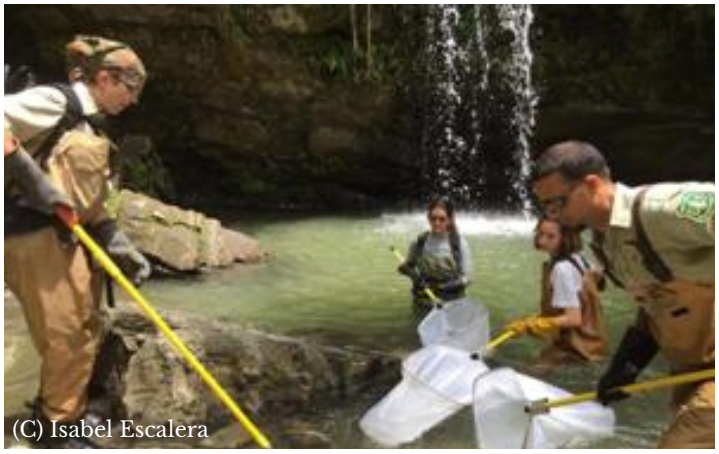
FIND OUT MORE IN THE NEXT PAGE!

planting of the aforementioned vines in areas requiring stabilization, and installation of vertical planks to pile up sand in depleted areas, a technique known as *dune biomimicry*. These common restoration activities often were accompanied by volunteer events in which I had the opportunity to communicate with large groups and aid in the educational process of Vida Marina, once I had sufficient experience to explain our methods well. One can gain a great deal from frequent opportunities to teach large groups and increase public awareness on projects. For example, as part of a field excursion at a delicate wetland in Camuy, I learned how to educate and motivate locals about the removal of the severely invasive *Casuarina* tree species, who did not see it as harmful. Also, I had the opportunity to work with a group of volunteers to install a 100 foot wooden beach access boardwalk near the popular Jobos beach at Isabela.

This is a major facet of coastal restoration, benefiting both the dunes and beach goers in a myriad of ways. Snorkelers, fishermen, and many others use these accesses. The eroded passages through the dunes were replaced with elevated wooden platforms, as a result, the natural development of dunes can progress undisturbed. These accounts were just a small selection of what I had taken part in, thanks to the AFS Hutton Junior Scholar Internship Program and Vida Marina. This program was highly conducive for my understanding of coastal onshore ecosystems and the structure of organizations tasked to improve these beaches for both nature and man.

AFS HUTTON SCHOLARS SUMMER INTERNSHIP EXPERIENCE

(C) Keislamarí Cintrón


(C) Isabel Escalera

by Camila M. Díaz Grajales

This summer I was selected by the Hutton Junior Biology Program to participate in their eight-week internship for High School Juniors and Seniors. One of the main objectives of this program is to educate students about what the fisheries profession really is, and also to encourage more women to join the field. Living in Puerto Rico, we are privy to an incredible volume of ecosystems to explore and question—always leaving more to learn and teach. I worked alongside my mentor, Miriam Salgado Herrera, in the Sabana Field Research Station in Luquillo, P.R. We spent most of our field time in El Yunque National Rainforest, conducting weekly water sampling as well as leading new projects. Being raised in a very biology-centered family sparked this love that I now have for the natural sciences, but the dedication and drive to pursue a career in this field is something I only recently developed. From the very beginning, I have always been adamant about choosing a career I genuinely see myself doing in the next 25 years, without growing tired of it. However, I had an opportunity not many students my age get to

have which was real-life experience in the field they are interested in. The variety of projects I worked on this summer helped me see what I liked and what I didn't like about field and laboratory work. Throughout the duration of my internship, I participated in an electrofishing session for a shrimp survey, assisted in DNA extraction process for microbial communities from river water, and weekly river water sampling for a long-standing project of nearly 30 years.

The Hutton Program helped me narrow down what I want to study from half a dozen possibilities—ranging from the arts to education down to biology, and effectively increased my interests in everything that falls under fisheries and hydrology. This was an eight-week internship, where I worked an average of seven hours a day and got a taste of what my future could be. This has been a defining moment in my academic experience as well as my future career life. Despite being a sixteen-year-old intern, I wasn't treated any differently than the students that were working on their undergraduate and graduate degrees. This professional environment also helped make this experience so unique. However, to say this was easy would be untruthful. I had to manage around a school-like schedule when most my peers were sleeping-in until noon, and had the freedom of spontaneity that I would have had if I hadn't been working. Be that as it may, the hard work I put into this internship is nevertheless important and an investment for the future—one I do not regret taking. The investigations, surveys and projects I've worked on have been a privilege and have truly affected what I want to do with my life in a positive way. It paved the road for a future career in this field, therefore, I am incredibly grateful for the opportunity the Hutton Scholar Program provided for me, and for the people at the Sabana Field Research Station for their unfaltering support and encouragement for my success and growth as a student and as a person. Especially so, for my mentor, Miriam Salgado Herrera, who did everything and more, so I could have the best experience possible. Unforgettable is a word I would most definitely use to describe this internship.

James, planting beach bean (*Canavalia rosea*), originally cultivated at UPR Aguadilla, over a bare dune. Overgrown sand dunes provide a protective barrier for coastal communities, ecological and human.

SPECIAL FEATURE IN THE JOURNAL WETLANDS FOCUSES ON LANDSCAPE APPROACHES TO WETLAND MANAGEMENT WITH MAJOR EMPHASIS ON PUERTO RICO.

by Brent Murry

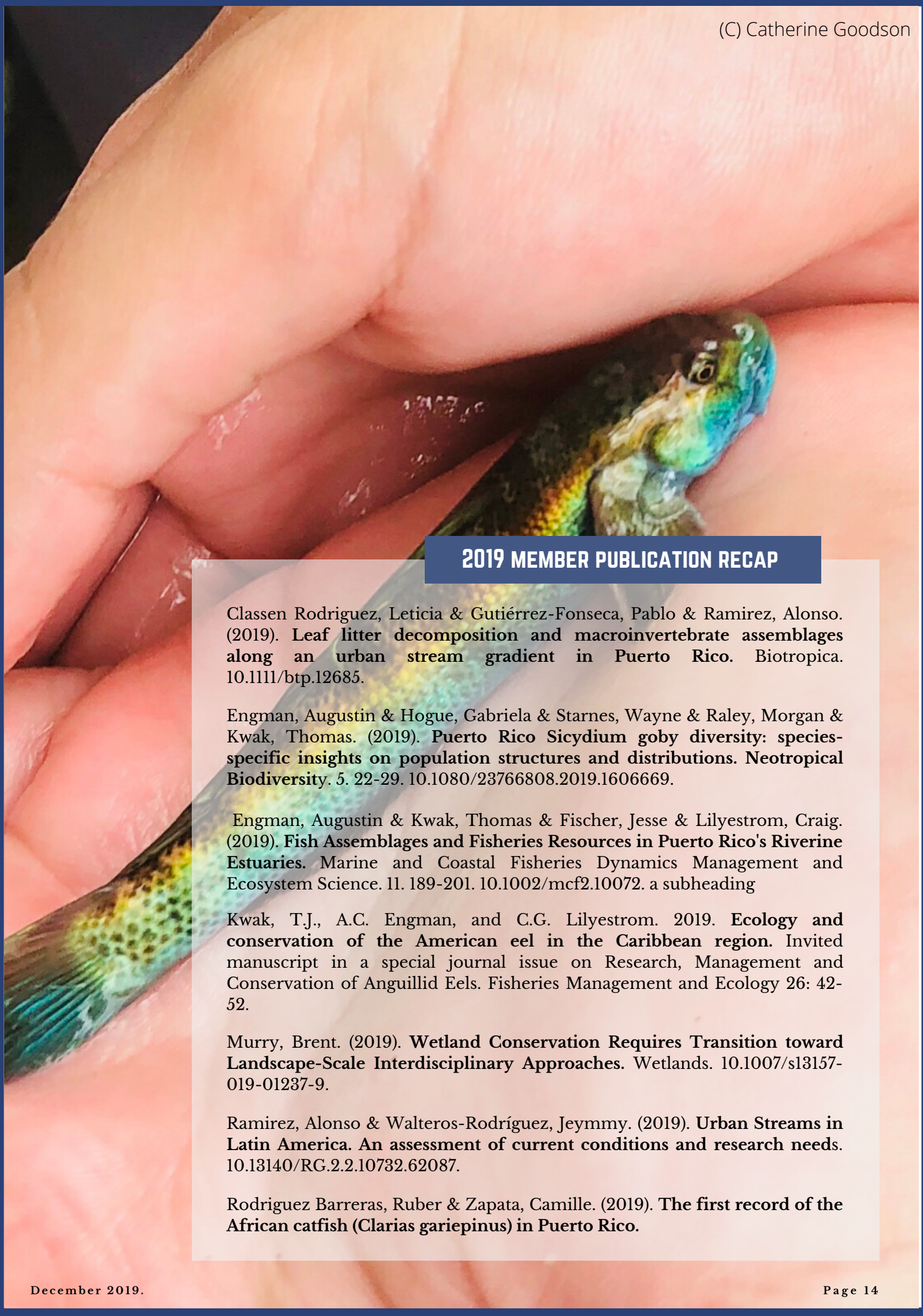
Large-landscape conservation is an emerging paradigm responding to the growing effects of landscape-scale stressors on the environment with the goal to balance multiple socio-ecological objectives. Wetlands provide a disproportionate wealth of ecosystem services given their generally diminutive composition across the landscape. A challenge for wetland scientists is to develop science to support this evolving landscape conservation approach and to integrate wetland services and benefits explicitly into regional conservation and adaptation planning. The special feature arose from a symposium held at the 2017 Society of Wetland Scientists meeting in San Juan, Puerto Rico, USA entitled, "Wetland Conservation in the 21st Century: Landscape Scale Interdisciplinary Approaches Addressing Multiple Objectives." The nine papers that are included stem from that symposium and collectively provide examples of wetland science that address human well-being, ecological functioning, and future forecasting to support long-term landscape conservation planning. The special feature celebrates the critical role wetlands play in maintaining biodiversity and human well-being as well as the valuable role wetland scientists play by informing landscape conservation decisions. The Special Feature is due for release in December 2019 and can be found on-line. membership may be required, check your local academic library or federal partners may also have access. The first of the nine articles (Table 1) of this special feature provides a complete illustration of the landscape conservation planning process focused on decision optimization in response to projected future conditions that balance species conservation with water use for production of electricity in Puerto Rico (Collazo et al. this issue). Next, Wilkins et al. (this issue) provide a landmark survey of public perception of wetlands across the continental United States that provides insight into how societal demands can be woven into large-landscape conservation efforts that include wetlands. Two papers follow that address wetlands and human-health implications, from wetlands mitigating vector-borne-disease impacts (de Jesus-Crespo et al. this issue) to mental well-being and natural disaster response (Sutton-Grier and Sandifer this issue). Next, and continuing the human-well-being theme, Colón-López and Restrepo (this issue) explore linkages between disadvantaged communities and water quality across the landscape and provide insights into the importance of lifting disadvantaged communities in support of landscape resilience. Recognizing that landscape conservation requires science supported policy growth, the following two papers align wetland conservation to economic development, water use, and climate change. Sheehan et al. (this issue) provides a review of the restoration of Tampa Bay, Florida, USA where blue carbon served as an economic incentive for landscape-scale wetland restoration. Then Murry et al. (this issue) provide an examination of the likely effectiveness of existing water-use policies under future climate scenarios at providing sustainable water to people while maintaining wetland integrity (Murry et al. this issue). The final two papers address critical components of large-landscape conservation planning, (1) a threat assessment, and specifically for coastal wetlands from sea level rise (Yu et al. this issue), and (2) monitoring and evaluation, with an overview and expected applications of a landscape scale wetlands monitoring program across the Laurentian Great Lakes (Uzarski et al. this issue).

"Wetlands provide habitat for many important economic and recreational fisheries, especially critical spawning and nursery habitat."

Click here to view the special feature

Table 1. Contents of the Special Feature of the journal Wetlands (Society of Wetlands Scientists), due to be released in December 2019. Bolded titles are either by PR-AFS members and/or about Puerto Rico and may be of special interest of PR-AFS members.

Article #	Title	Authors (last names only)
1	**Wetland Conservation Requires Transition toward Landscape-Scale Interdisciplinary Approaches**	Murry
2	**Toward a Resilience-Based Conservation Strategy for Wetlands in Puerto Rico: Meeting Challenges Posed by Environmental Change**	Collazo, Terando, Engman, Fackler, Kwak
3	Does Proximity to Wetlands Matter? A Landscape-Level Analysis of the Influence of local Wetlands on the Public's Concern for Ecosystem Services and Conservation Involvement	Wilkins, Sinclair, Miller, Schuster
4	**Linking Wetland Ecosystem Services to Vector-borne Disease: Dengue Fever in the San Juan Bay Estuary, Puerto Rico**	De Jesus Crespo, Mendez Lazaro, Yee
5	Conservation of Wetlands and Other Coastal Ecosystems: a Commentary on their Value to Protect Biodiversity, Reduce Disaster Impacts, and Promote Human Health and Well-Being	Sutton-Grier and Sandifer
6	**Water quality and socio-economic indicators are linked in a tropical watershed: Emerging implications for the sustainable management of waterscapes**	López and Restrepo
7	Blue Carbon: an Additional Driver for Restoring and Preserving Ecological Services of Coastal Wetlands in Tampa Bay (Florida, USA)	Sheehan, Sherwood, Radabaugh, Moyer, Simpson
8	**Perspective: Developing Flow Policies to Balance the Water Needs of Humans and Wetlands Requires a Landscape Scale Approach Inclusive of Future Scenarios and Multiple Timescales**	Murry, Bowden, Branoff, Garcia-Bermudez, Middleton, Ortiz-Zayas, Restrepo, Terando
9	**Landscape-Level Consequences of Rising Sea-Level on Coastal Wetlands: Saltwater Intrusion Drives Displacement and Mortality in the Twenty-First Century**	Yu, Riveria-Ocasio, Heartsill-Scalley, Davilla-Casanova, Rios-Lopez, Gao
10	Leveraging a Landscape-Level Monitoring and Assessment Program for Developing Resilient Shorelines throughout the Laurentian Great Lakes	Uzarski, Wilcox, Brady, Cooper, Albert, Cibrowski, Danz, Garwood, Gatham, Gehring, Grabas, Howe, Johnson, Lamberti, Moerke, Niemi, Redder, Ruetz, Steinman, Tozer, O-Donnell



(C) Catherine Goodson

2019 MEMBER PUBLICATION RECAP

Classen Rodriguez, Leticia & Gutiérrez-Fonseca, Pablo & Ramirez, Alonso. (2019). **Leaf litter decomposition and macroinvertebrate assemblages along an urban stream gradient in Puerto Rico.** Biotropica. 10.1111/btp.12685.

Engman, Augustin & Hogue, Gabriela & Starnes, Wayne & Raley, Morgan & Kwak, Thomas. (2019). **Puerto Rico Sicydium goby diversity: species-specific insights on population structures and distributions. Neotropical Biodiversity**. 5. 22-29. 10.1080/23766808.2019.1606669.

Engman, Augustin & Kwak, Thomas & Fischer, Jesse & Lilyestrom, Craig. (2019). **Fish Assemblages and Fisheries Resources in Puerto Rico's Riverine Estuaries.** Marine and Coastal Fisheries Dynamics Management and Ecosystem Science. 11. 189-201. 10.1002/mcf2.10072. a subheading

Kwak, T.J., A.C. Engman, and C.G. Lilyestrom. 2019. **Ecology and conservation of the American eel in the Caribbean region.** Invited manuscript in a special journal issue on Research, Management and Conservation of Anguillid Eels. Fisheries Management and Ecology 26: 42-52.

Murry, Brent. (2019). **Wetland Conservation Requires Transition toward Landscape-Scale Interdisciplinary Approaches.** Wetlands. 10.1007/s13157-019-01237-9.

Ramirez, Alonso & Walteros-Rodríguez, Jeymmy. (2019). **Urban Streams in Latin America. An assessment of current conditions and research needs**. 10.13140/RG.2.2.10732.62087.

Rodriguez Barreras, Ruber & Zapata, Camille. (2019). **The first record of the African catfish (Clarias gariepinus) in Puerto Rico.**