



The Comprehensive Plan of Water Resources of Puerto Rico and Heritage Rivers

The Comprehensive Water Resources Plan of Puerto Rico (PIRA, in Spanish) is the public policy instrument that contains government strategies to protect, conserve and utilize this important natural resource. It is based on the principle that water, being a public good tied to our culture and recreational activities, is a heritage of all Puerto Ricans and should be used and managed sustainably for the benefit of all.

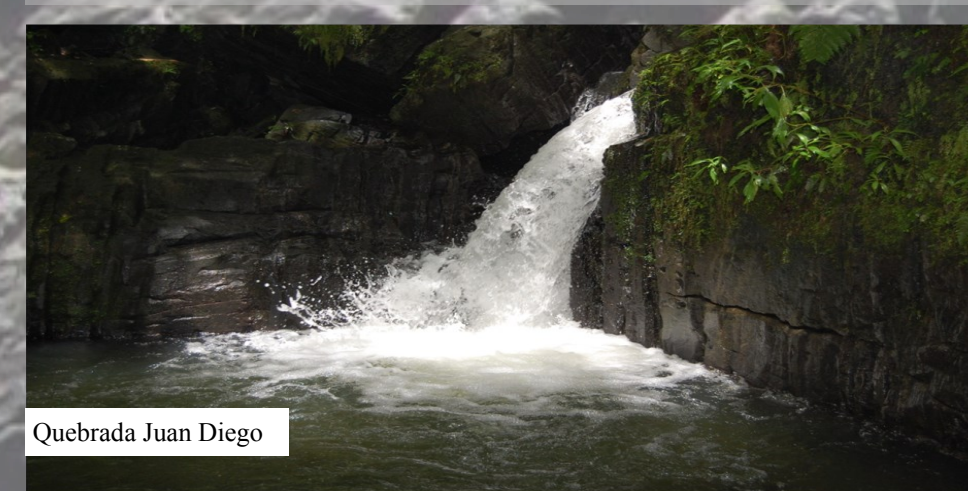
One element of the public policy contained in the PIRA is the protection of riverbeds and riparian areas, therefore several strategies were established to implement and advance this policy. Strategies, like the Heritage Rivers Project, which seek to protect rivers whose natural attributes are in good condition, as well as to promote the restoration processes of those rivers whose attributes are degraded and, due to their potential and value, deserve to be returned to their natural condition. It also pursues to minimize the impact on rivers so that their ecological integrity is ensured.

Heritage Rivers

This project began its first phase in 2009 with the selection of five (5) rivers of Puerto Rico to be studied (See Map of Puerto Rico). These rivers meet the following criteria: they have no water dammed (not higher than 40 feet) through its main channel or in the middle or lower part of the basin, their stream flows freely to the sea and they have no significant water quality problems.

The analysis conducted for a Heritage River designation goes beyond the concept of the river as a source of drinking water. For designation, ecological qualities and attributes are analyzed and described, as well as their recreational and cultural functions, among others. The purpose of this project is to protect rivers or sections of rivers that still have minimal altered features to ensure future generations the right to enjoy the fresh waters of the island of Puerto Rico.

To select the basin of the river or section to be designated as a Heritage River a matrix that assigned a score to a number of criteria and elements of prioritization was used. Natural value, hydrology, economic value and degree of threat (See Figure 1): A total of forty (40) elements within four (4) general criteria were evaluated.



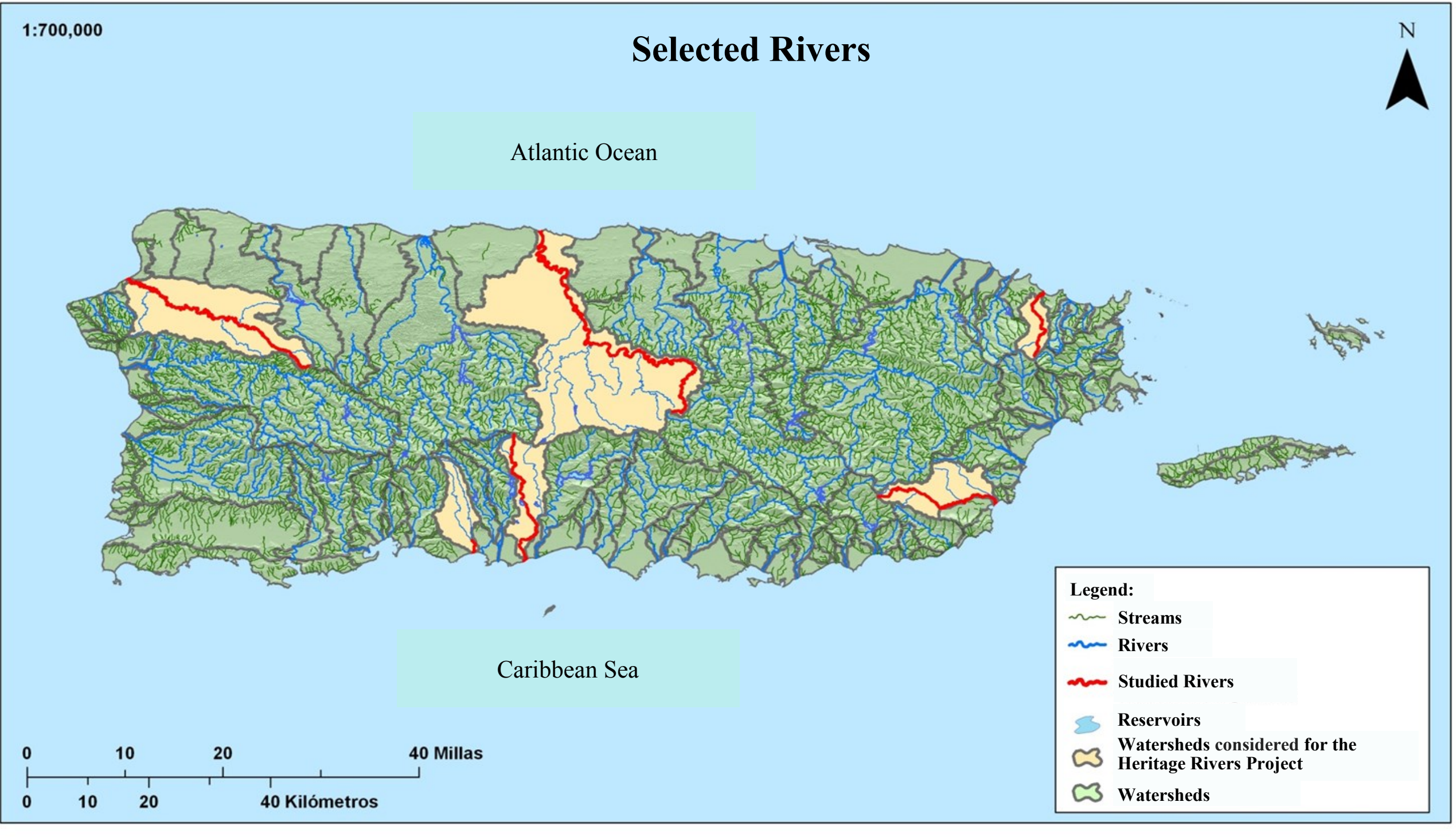
River Evaluation

Of the 5 rivers previously selected, the matrix was applied to each river: Rio Culebrinas, Rio Guayanés, Rio Grande de Manati (RGM), Rio Matilde and Rio Mameyes, each was assigned a score based on the level of compliance. Then we assessed whether these rivers met the necessary attributes to be considered as potential candidates for designation as a Heritage River. With these data prioritized intervention on a selected river was established.

Table 1: Score of each River

River	Score Obtained
Rio Culebrinas	51
Rio Guayanés	48
Rio Grande de Manati	60.5
Rio Mameyes	65
Rio Matilde/Canas	51.5

As shown in Table 1, the Rio Mameyes scored highest followed by the Rio Grande de Manati. Because the Rio Mameyes is protected in the upper part of the basin, the Rio Grande de Manati was chosen. As part of the Heritage Rivers project work concentrated on: conducting field visits, meetings with community groups, biodiversity studies and characterization of the rivers to measure their ecological value, identification of landscape areas and recreation areas. Six stations have been evaluated in the Rio Grande de Manati (See Table 2).



What we have studied in the Rio Grande de Manati?

Table 2: Sections Studied in the Rio Grande de Manati Watershed

Sector	Municipality	River
San Lorenzo	Morovis	Rio Grande de Manati
Naranjo Dulce	Ciales	Rio Grande de Manati
Dos Bocas	Ciales	Rio Toro Negro
Vaga I	Ciales	Rio Toro Negro
Pozas	Ciales	Rio Toro Negro
La Línea	Morovis	Rio Bauta

Each selected section has a length of one thousand (1,000) meters and is composed of three (3) study segments of a hundred (100) meters each.

"Hawaii Stream Visual Assessment Protocol" (HSVAP) Version 1.0

The HSVAP provides at a basic level, an assessment of the river water condition, based on various physical parameters.

In each study segment ten (10) variables were evaluated. These were: turbidity, plant growth, channel condition, altered channel flow, percent of compaction of the fine material, bank stability, canopy shade, condition of the riparian habitat available for native species and presence of trash and debris.

As a result, four (4) of the six (6) selected sections were classified as having good ecological status. Two (2) sections were classified with a regular ecological status (see Table 3). Two particular situations in these two sections were:

- A bridge is fully collapsed obstructing the free flow of water.
- The Toro Negro River at the Pozas sector has been significantly impacted by the recreational activity that takes place there.

Study Area of Rio Grande de Manati Watershed

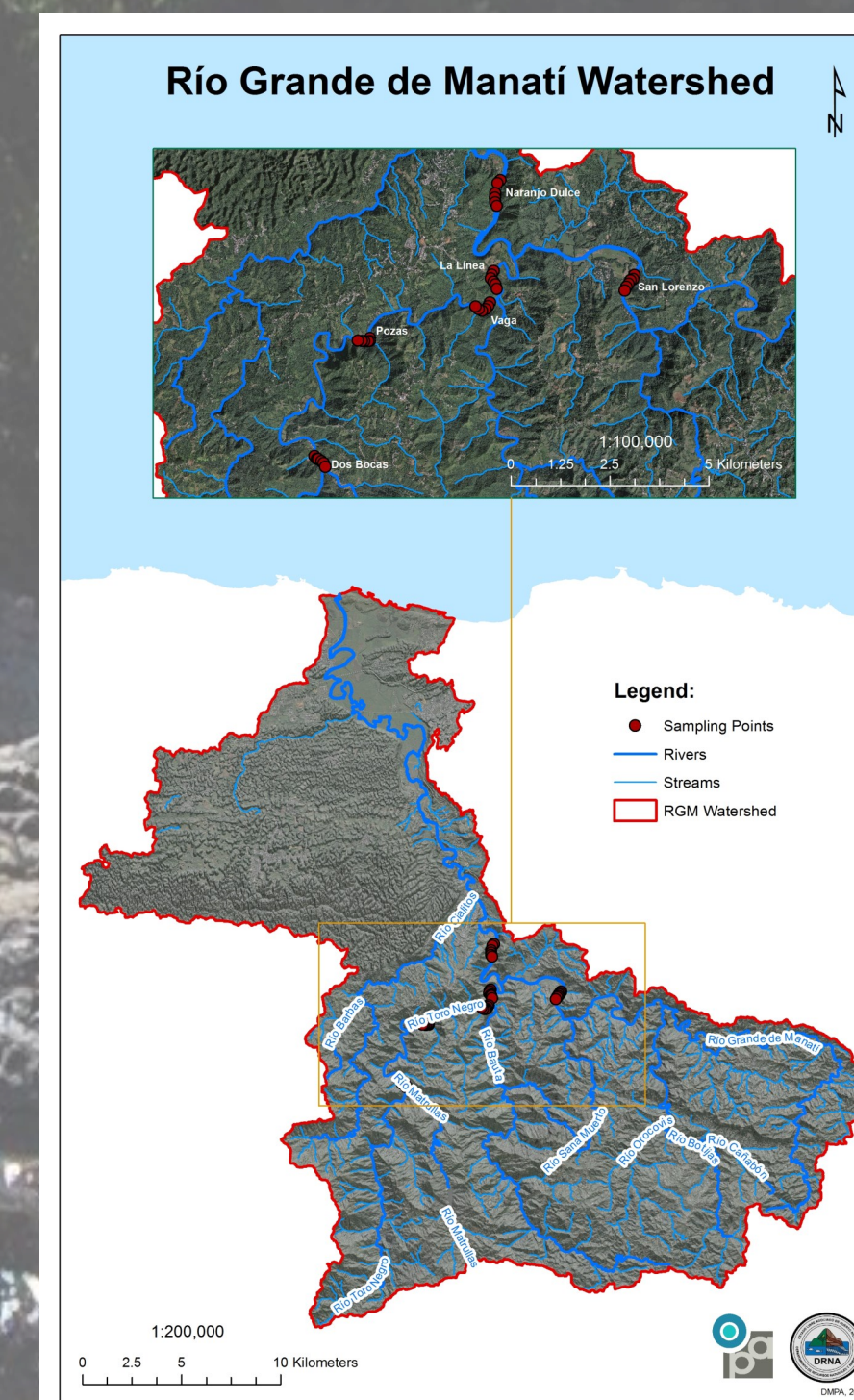


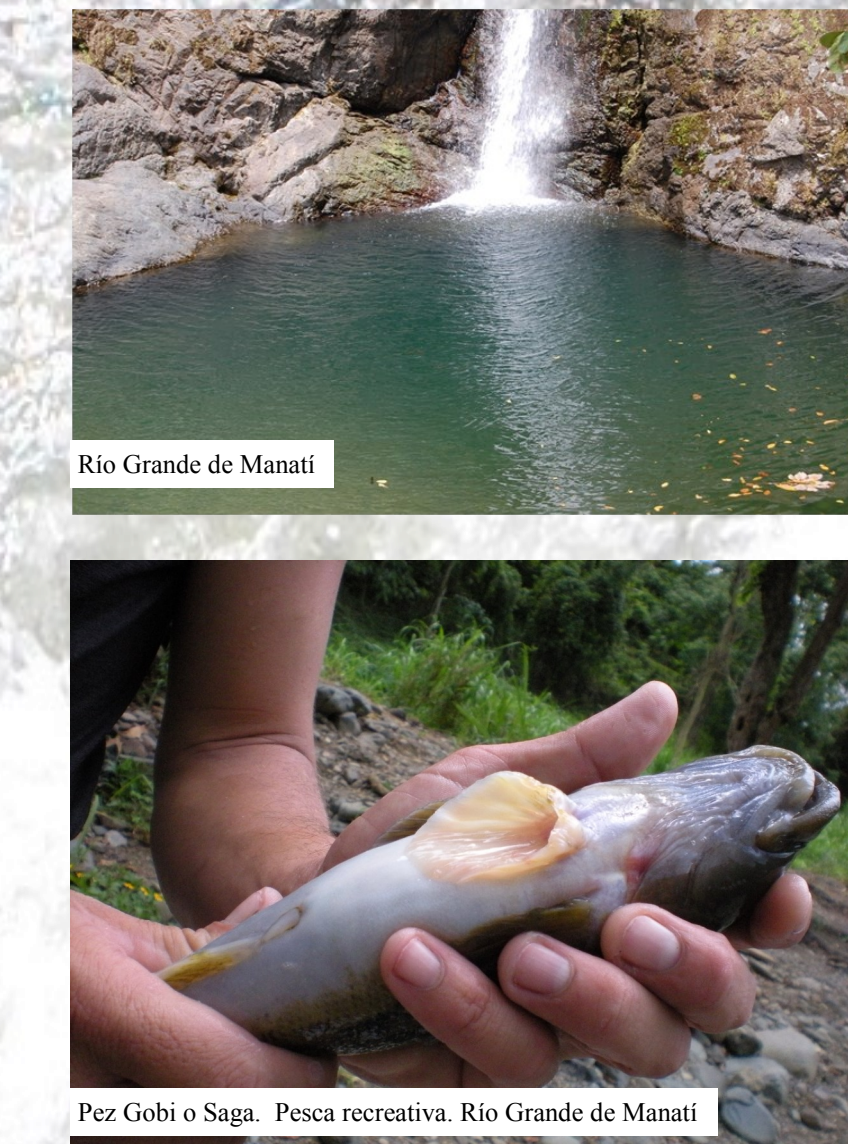
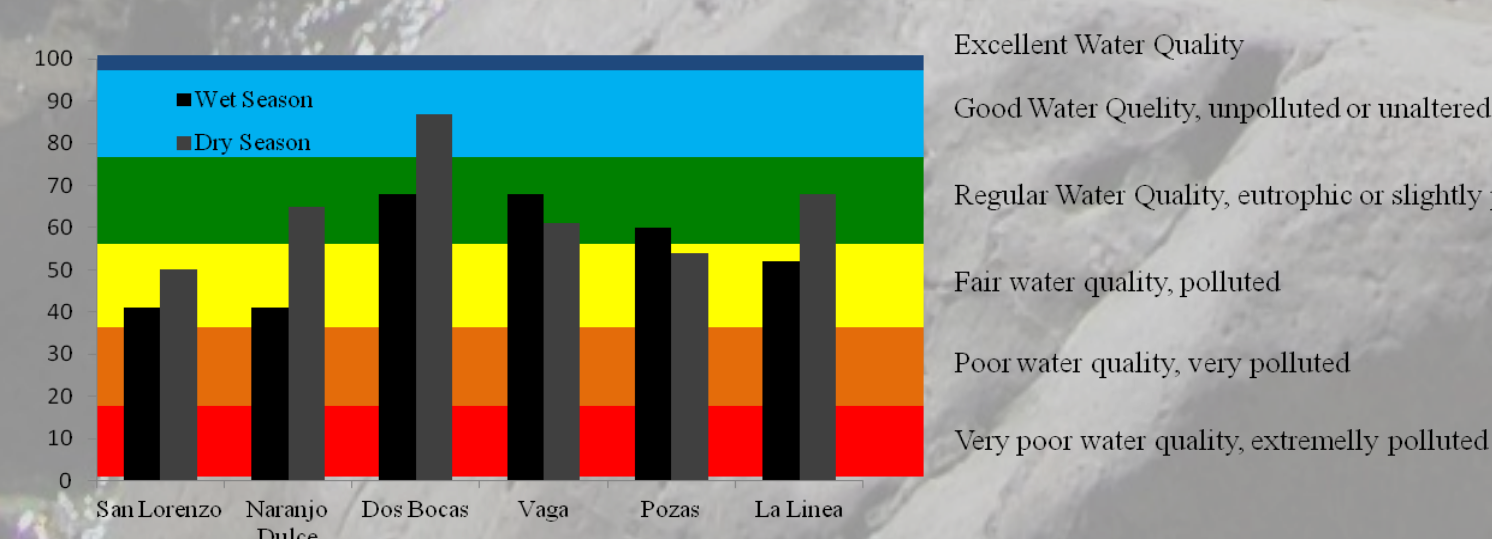
Table 3: Results of HSVAP used in the Rio Grande de Manati.

River Segment	Sector	Date	Punctuation	Classification	Average	Average Classification
Manati (1) San Lorenzo	San Lorenzo	27/05/2009	1.66	High	1.58	Good
Manati (2) San Lorenzo	San Lorenzo	27/05/2009	1.61	High		
Manati (3) San Lorenzo	San Lorenzo	27/05/2009	1.48	Medium		
Manati (1) Naranjo Dulce	Naranjo Dulce	29/05/2009	1.53	High	1.54	Good
Manati (2) Naranjo Dulce	Naranjo Dulce	29/05/2009	1.59	High		
Manati (3) Naranjo Dulce	Naranjo Dulce	29/05/2009	1.49	Medium		
Toro Negro (1) Dos Bocas	Dos Bocas	02/06/2009	1.56	High	1.63	Good
Toro Negro (2) Dos Bocas	Dos Bocas	02/06/2009	1.59	High		
Toro Negro (3) Dos Bocas	Dos Bocas	02/06/2009	1.73	High		
Toro Negro (1) Vaga I	Vaga I	18/06/2009	1.70	High	1.67	Good
Toro Negro (2) Vaga I	Vaga I	18/06/2009	1.73	High		
Toro Negro (3) Vaga I	Vaga I	18/06/2009	1.58	High		
Toro Negro (1) Pozas	Pozas	25/06/2009	1.12	Medium	1.44	Regular
Toro Negro (2) Pozas	Pozas	25/06/2009	1.59	High		
Toro Negro (3) Pozas	Pozas	25/06/2009	1.61	High		
Bauta (1) Sector La Línea	La Línea	04/06/2009	1.60	High	1.45	Regular
Bauta (2) Sector La Línea	La Línea	04/06/2009	1.40	Medium		
Bauta (3) Sector La Línea	La Línea	04/06/2009	1.35	Medium		

Biodiversity of Aquatic Insects: Index of Biodiversity

Index	Rainy Season			Dry Season		
	Shannon - Wiener	Simpson	Family Richness	Shannon - Wiener	Simpson	Family Richness
San Lorenzo	1.80	0.20	9	1.49	0.37	14
Naranjo Dulce	1.14	0.46	9	1.40	0.40	18
Dos Bocas	1.34	0.46	17	2.10	0.12	16
Vaga I	1.99	0.20	16	1.68	0.26	15
Pozas	2.15	0.14	13	2.18	0.13	13
La Línea	2.00	0.15	12	1.77	0.24	15

"Biological Monitoring Working Party" Index adapted for Puerto Rico (BMW-PP)



A Need for this Project:

This project comes in recognition of the value and heritage of rivers, integrating nature and cultural heritage of people. This is a long-term project, since its intention is to identify those river segments, which due to their current status and heritage value require prioritizing their protection or restoration to recover its value and function. Furthermore, it seeks to provide an answer to the question:

What rivers we want for present and future generations?

Due to the high degree of developed area and population density of Puerto Rico, people demand to meet other needs beyond the economic sphere. From this perspective, the rivers are not only a usable resource in economic activities, but are also an invaluable natural heritage for a better quality of life meeting the needs of emotional wellbeing. These needs are recreation, contemplation, reflection and spaces for cultural activities (e.g. artisanal fishing, picnics, festivals and rituals) that have an intrinsic value to the natural biodiversity of the island.

Where are we?

The Heritage Rivers project had, since its inception, the active participation of sectors interested in the river or river sections that would be considered for designation as a heritage. On October 29, 2014, Act No. 180-2014 was signed for "Creating the Heritage Rivers Program, High Nature Value Rivers and Recreational Rivers of Puerto Rico in the Department of Natural and Environmental Resources". The goal of this Act is to recognize the value of rivers, since nature is closely linked to the heritage of the people, set limits to stop the deterioration of their functions and of their intrinsic values. It also provides the DNER with a mechanism to protect fresh water bodies.

Since 2009, the Rio Grande de Manati watershed is being studied to document the degree of compliance with this criteria and attributes set for designation as a Heritage River. For this study, techniques to identify aquatic biodiversity, flora and fauna has been used. In addition, working with other features of the site, such as: classification of the channel, recreational value, natural value of the channel and other social and economic components. Citizen participation, municipal government, universities, charities and non-profit community or environmental organizations collaborate and are essential to achieve the designation of a river as River Estate.



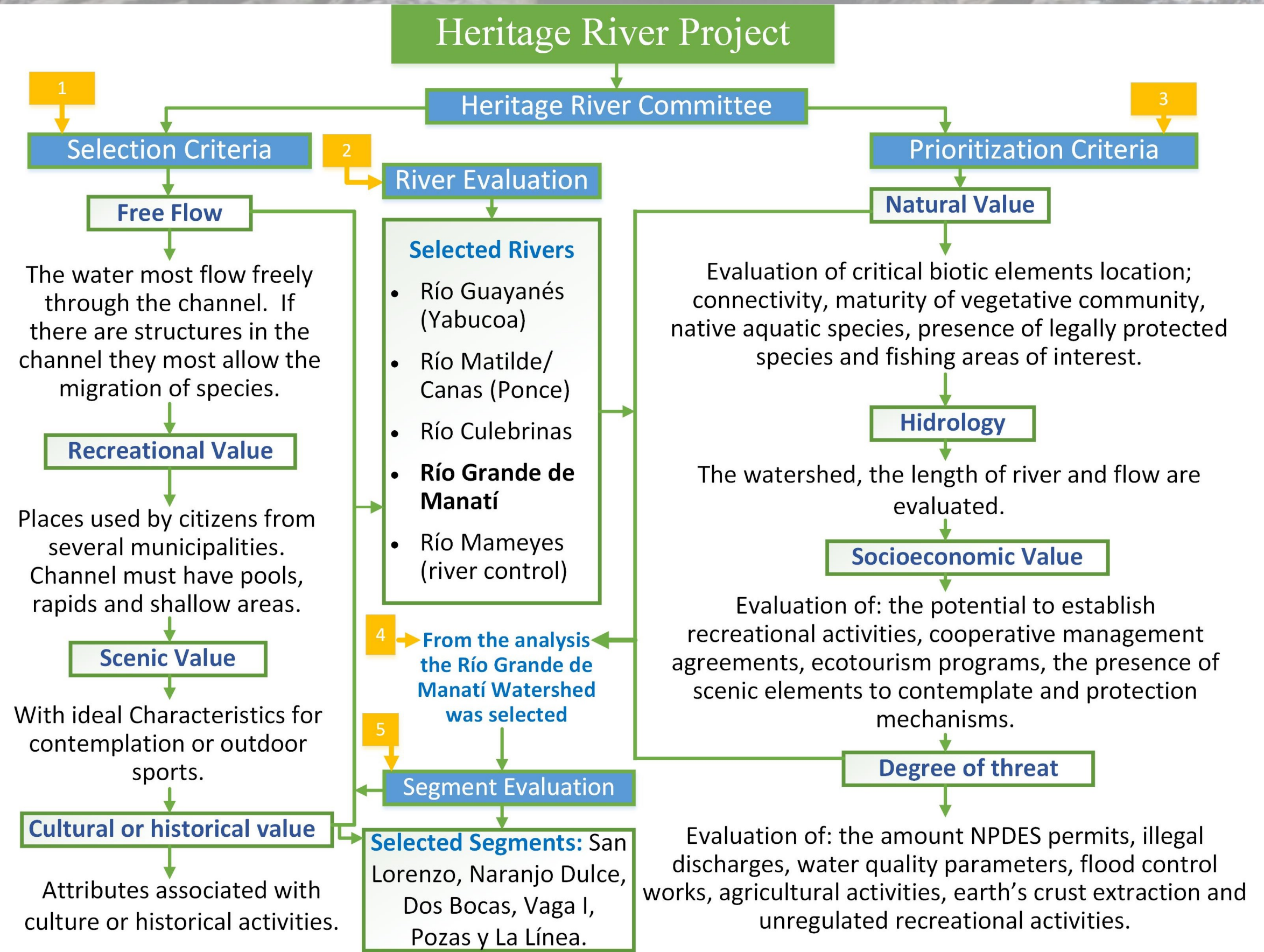
In the long term:

Once this law enters into force, the development of other projects that support and give continuity to this program will begin. Among these are:

- Shared management agreements with communities.
- Development of local tourism industries.
- Restoring impacted sections (channels).
- Educational initiatives in communities and schools.
- Promoting scientific research.

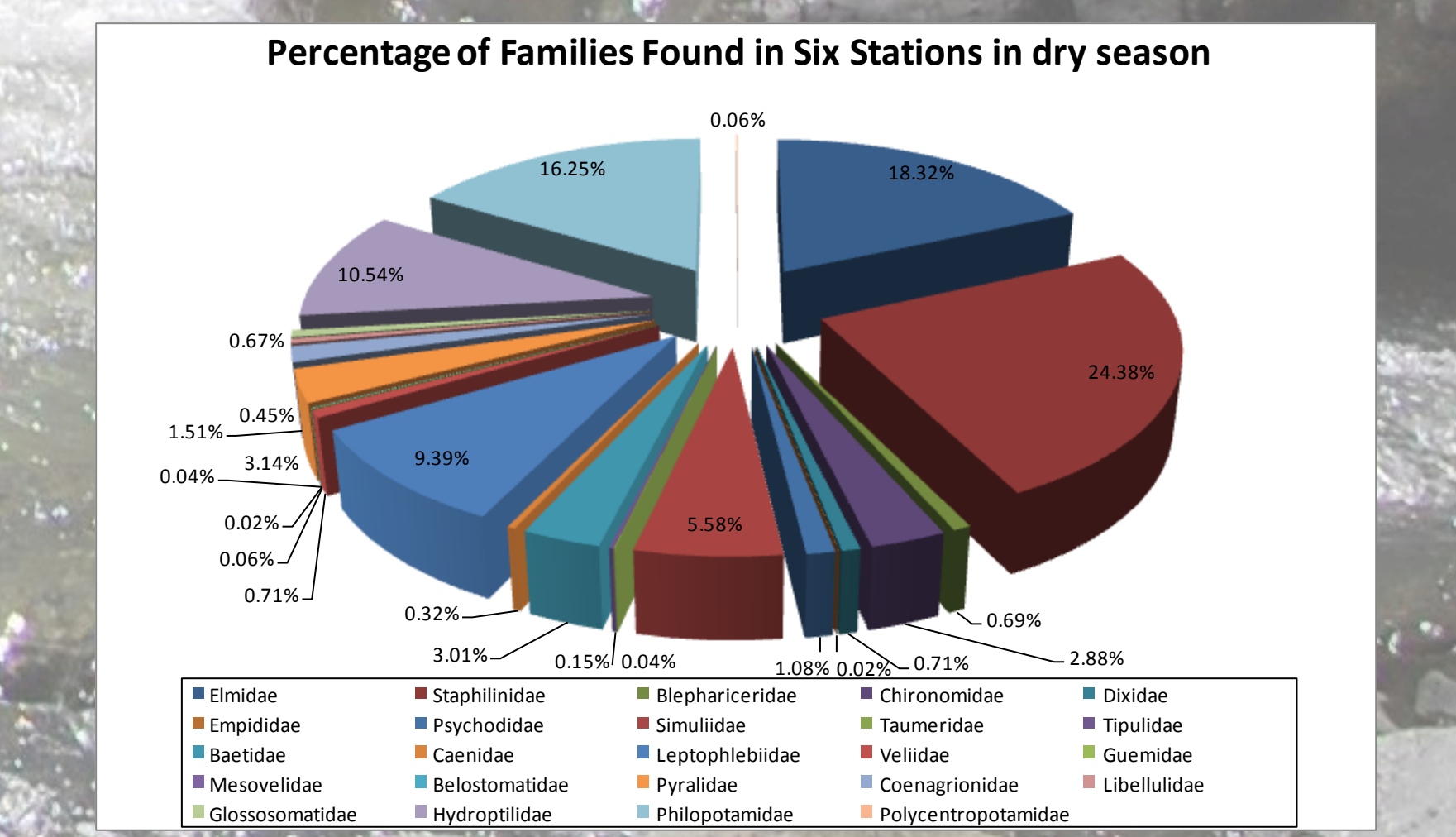
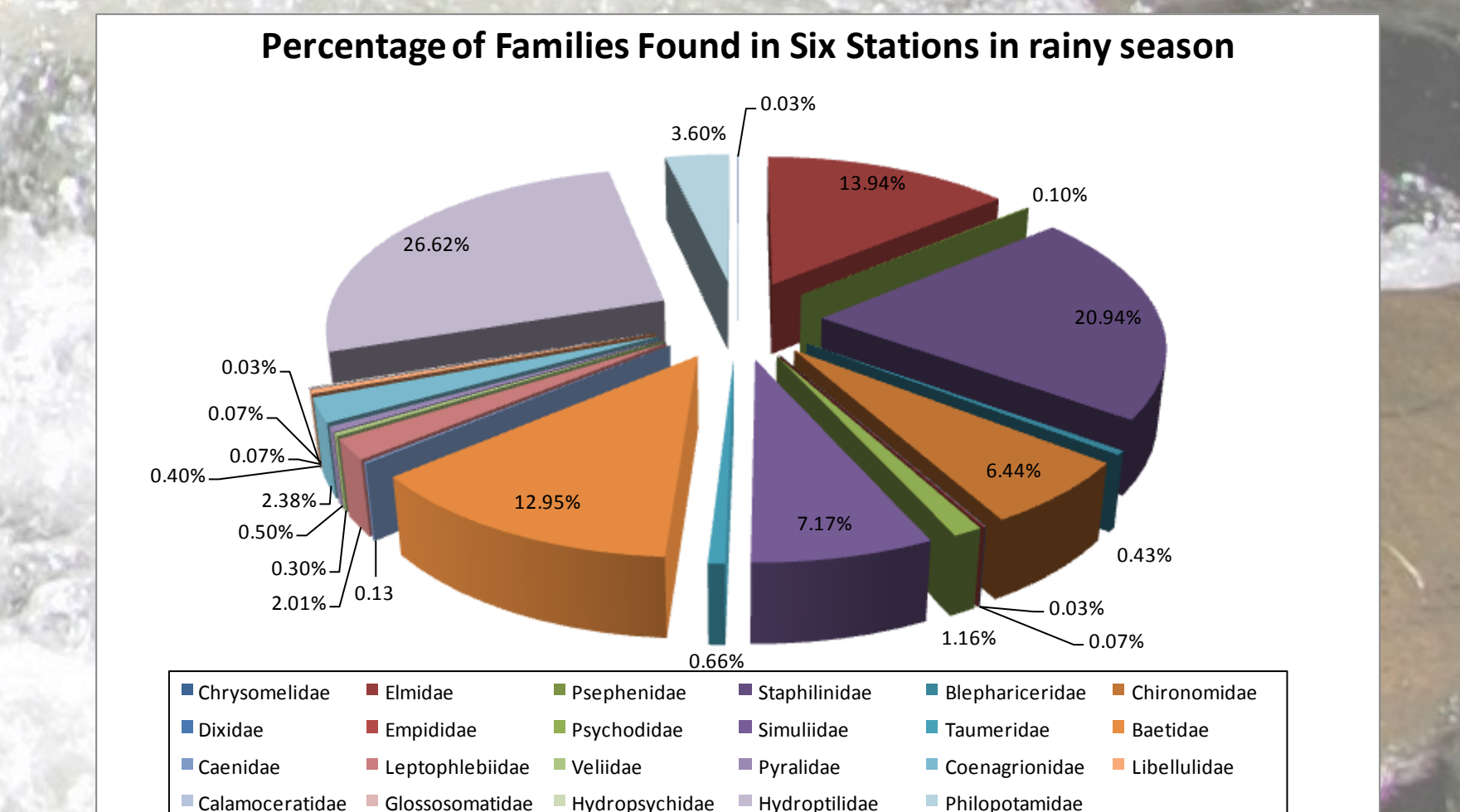
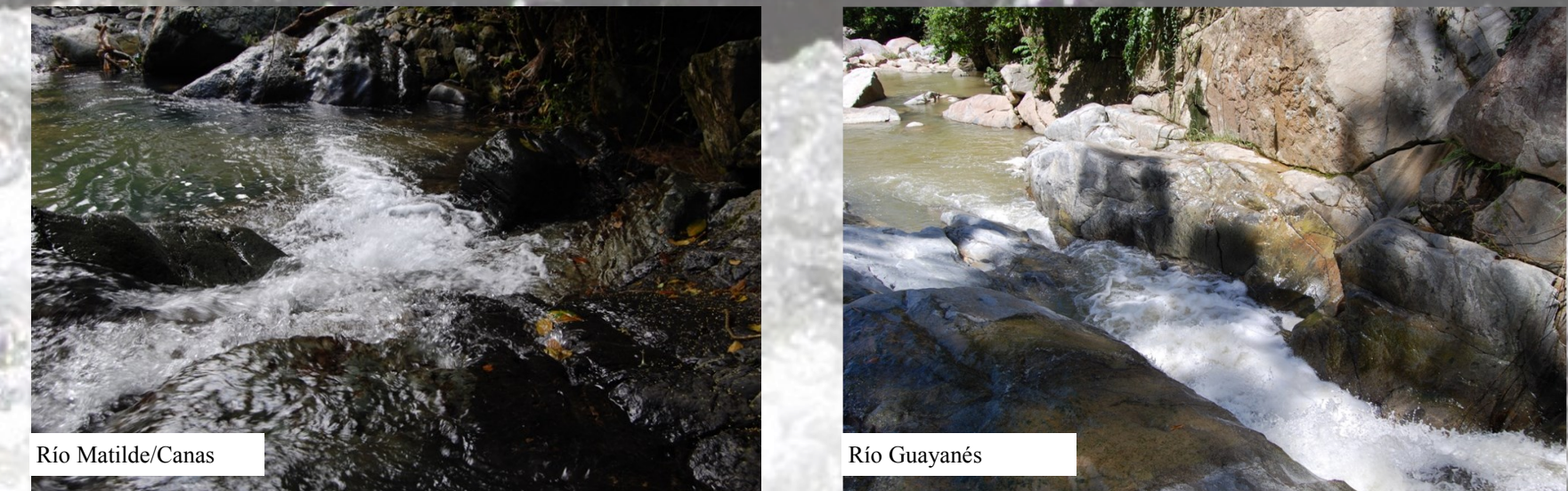
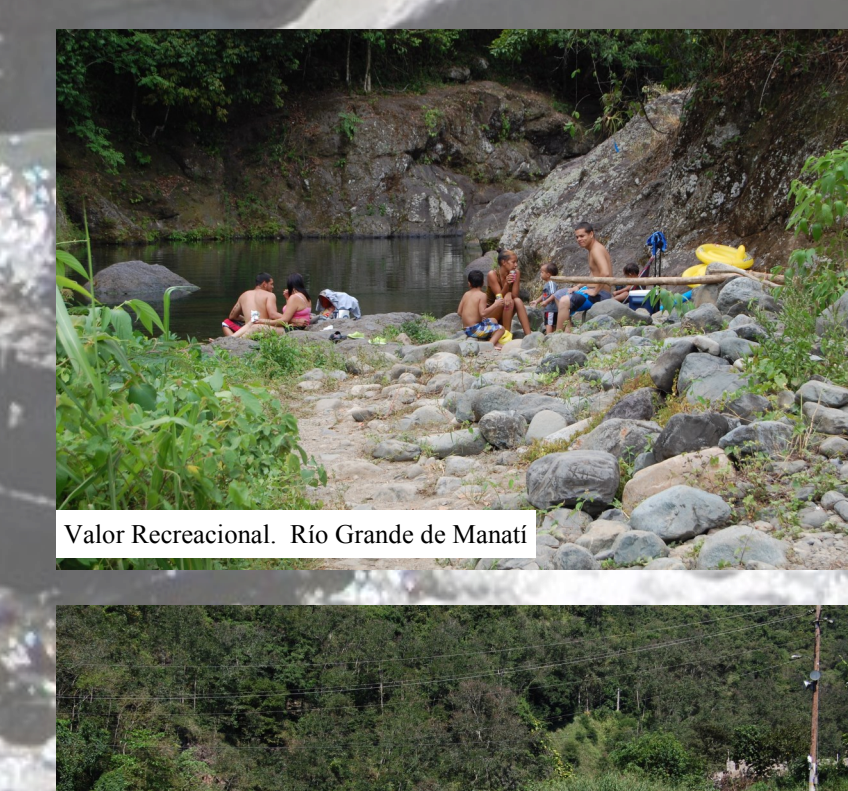
Heritage Rivers

Figure 1: Selection process for prioritization as Heritage River.



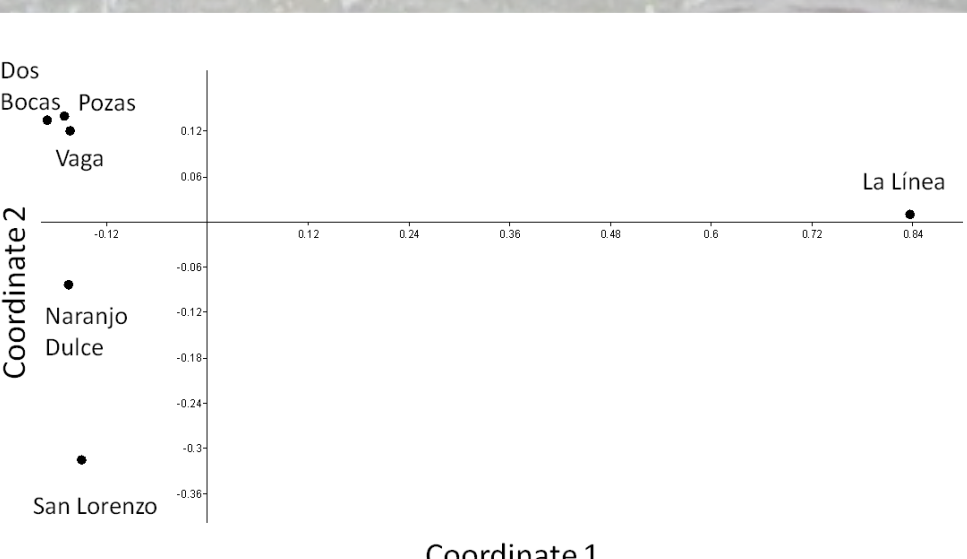
Hydrology

River	Watershed (Km ²)	River Length (Km)	Flow (MGD)
Grande de Manati	608.17	91.39	246.22
Mameyes	40.35	15.29	83.06
Culebrinas	267.59	60.02	259.78
Guayanés	101.60	30.57	100.97
Matilde (Canas)	67.86	22.85	24.54



Diversity of Insects using the physicochemical based on the Multidimensional Scaling Analysis

- An ordination analysis was performed for physicochemical parameters, including: temperature, dissolved oxygen, pH, turbidity, and salinity using PAST version 2.01. Bray Curtis was used as the similarity measure.
- Similar physicochemical sites tend to be grouped together.
- In this case, Dos Bocas, Pozas and Vaga, sectors have very similar physicochemistry properties.



Correlation analysis

- Correlations between physical chemistry and diversity were performed.
- No significant correlations between the physical chemical and diversity of aquatic insects was found.

Conclusion

According to HSVAP stations Pozas and La Línea sectors were classified as regular, while the other 4 were classified as good. In terms of diversity of aquatic insects, the greatest richness of insects was observed in Dos Bocas, La Línea and Vaga for the dry and rainy seasons. Future studies include Rosgen Classification and an inventory of aquatic vegetation. These studies will be used to prepare a Heritage River designation under Act 180 of 2014, which will come into force on July 1, 2015.