COMMUNITY ASSEMBLAGE PATTERNS OF INLAND FISHES IN SOUTHERN REGIONS OF THE DOMINICAN REPUBLIC

by

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To all of you…… grax

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Abstract

Arlen Marmolejo. Community Assemblage Patterns of Inland Fishes in Southern Regions of the Dominican Republic. 58 pages, 3 tables, 3 appendices, 7 figures, 2011.

Fish community assemblages patterns were sampled for selected lagoons and rivers (-30 to 735 m of altitude) of the southern area of the Dominican Republic from June to August, 2010, using various standard collecting gears. Multivariate methods revealed community patterns corresponding primarily to water salinity and watershed. Tributaries of Enriquillo Lake were more similar to the lake than to other fluvial sites in the Yaque del Sur River basin. Rivers and freshwater lagoons had relatively high diversity and evenness, while Enriquillo Lake had intermediate values, and an upland reservoir had lowest diversity. The Yaque del Sur River mainstream had highest species richness, while Enriquillo Lake had more characteristic species. This study provides critical data that can be applied to establish conservation priorities and to enhance public outreach and educational programs. It is also a baseline for evaluating possible future changes in fish assemblages as human populations and habitat effects increase.

Key Words: endorheic lake, biodiversity, conservation, habitat gradients, Neotropical.

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INTRODUCTION

The Caribbean is a biodiversity hotspot, high in endemism with many fragile ecosystems. In the Caribbean, the islands of Hispaniola and Cuba, in particular, are well-known for their high levels of endemism (Abell et al., 2008). Hispaniola has a considerable variety of different landforms and diverse habitats ranging from tropical rainforests, mountains, valleys, coastal plains, lakes, wetlands and arid areas, all of which contribute to a high biodiversity that includes fishes. The Dominican Republic occupies the eastern two-thirds of Hispaniola and harbors a total of 547 fish species of which 63 are inland fishes (Froese and Pauly, 2011; Llibre, Quírico, and Ramos, 2006). The inland fishes that inhabit Dominican Republic are secondary freshwater fishes with mainly Central and South American origins (Chakrabarty, 2006a; Hulsey and López-Fernández, 2011; Rauchenberger, 1988), but peripheral and amphidromous fishes also contribute importantly to inland assemblages. Seventeen of the 63 inland fishes are endemic to the island; many have narrow distributions, sometimes occurring only in a single river or lagoon (e.g., *Cyprinodon bondi* occurs only in Azuey Lake, *C*. n. sp. in Enriquillo Lake, and *Limia sulphurophila* in la Zurza of Duvergé). Past geological events may explain these distribution patterns and diversity (Briggs, 1987; Huggett, 2004; Woodring, 1954). The endemic fishes and, in particular, those with highly restricted distributions are vulnerable species and some presently may be threatened.

The human history of Dominican Republic has contributed to impacts on inland aquatic systems. The increasing human population has demanded construction of dams, irrigation canals, and hydroelectric generators, as well as land modifications for agricultural production. Additionally, at least 28 exotic fish species have been introduced in the country for aquaculture (e.g., *Dorosoma petenense*, *Oreochromis aureus, O. niloticus, and Tilapia rendalli*), sport fishing (e.g., *Lepomis auritus*, *Micropterus salmoides*, *Cichlaocellaris*, and *Oncorhynchus mykiss*), and aquarium purposes (e.g., *Betta splendens*, *Trichogaster trichopterus*, *Poecilia reticulata*, and *Xiphophorus maculatus*) (Llibre, Quírico, and Ramos, 2006). The ecology and conservation impact of these exotic species is largely unknown. We know very little about their present and potential distribution and abundance or if they are compromising conservation status of native fishes. For proper management and conservation of inland aquatic ecosystems and associated inland fishes, it is imperative to have a good knowledge about the ichthyofaunal diversity, species distributions, basic ecology, and status of the invasive species. Quantifying the abundance and distribution of inland fishes is urgently needed to facilitate their conservation. Quantitative knowledge of stream fishes can be used to assess the well-being of those fish communities and requisite habitats (Kwak, Cooney, and Brown, 2007).

Despite the high diversity with considerable endemism, the inland fishes of the Dominican Republic remain poorly studied. The few studies that have been done so far focused mainly on species descriptions (Beebe and Tee-Van, 1935; Evermann and Clark, 1906; Rivas, 1980), taxonomic revisions of some groups (Regan, 1913; Rodríguez, 1997; Rosen and Bailey, 1963), and more recently, phylogeography or behavior of a few particular species (Applebaum and Cruz, 2000; Echelle et al., 2006; Haney and Walsh, 2003). However, there are no comprehensive studies on the distributional ecology or diversity patterns of the inland fishes in Dominican Republic. Knowledge of community organization and dynamics is essential for sustainable management and conservation.

Describing and understanding the patterns of fish communities in streams has been a fundamental topic in aquatic ecology (Lowe-McConnell, 1987). The findings from such ecological analyses can be used for the ecosystem management of streams and lakes. In spite of their importance, the fish community patterns of tropical ecosystems are not very well understood, and we know even less about aquatic systems on tropical islands (Smith et al., 2003). Island fishes of Caribbean islands have been largely ignored; most ichthyologists have focused their studies on the marine fishes because of their importance for food and tourism.

The aim of this study was to evaluate the community assemblage patterns of the fishes of southern Dominican Republic. I test the null hypothesis that fish communities of Yaque del Sur River and Enriquillo Lake drainages are identical. I provide data from the fish survey about diversity, abundance and distribution patterns of inland fishes in southern Dominican Republic, including samples representing the full diversity of aquatic habitats. Here I evaluate the ichthyofaunal relationships between drainages as well as among habitats within basins, using data on species occurrences among localities. For example, this study explores the relationship among community assemblages along a river gradient from lowlands to uplands. Results will enhance our understanding of present distributions of inland fishes, including potentially harmful exotic fishes, and that can be relevant and useful to set priorities and goals for future monitoring, management, development planning and conservation programs.

STUDY AREA

The island of Hispaniola is located between 17°36' and 19°58' N Latitude and 68°18' and 71°45' W Longitude. It is the second largest island in the Greater Antilles and is shared by two countries -- the Republic of Haiti, with 27,686 km^2, and Dominican Republic, with 48,730 km^2 and occupying the eastern two-thirds of the island. Dominican Republic has 350 km^2 of inland waters (Ministerio de Medio Ambiente y Recursos Naturales, 2008; Perdomo et al., 2010). Hispaniola is situated within the Caribbean, which is considered a biodiversity hotspot by Conservation International and is one of the main ecoregions of the world (Abell et al., 2008; Myers et al., 2000).

My study area is within the southern region of the Dominican Republic (Figure1) and covers parts of the southern and northern paleo-archipelago remains. It is south of the central mountain system (Cordillera Central), crosses the Valle de Neiba Plain, and includes two drainage basins: Yaque del Sur River and Enriquillo Lake (Abreu, 2001). Within the area, in the Hoya de Enriquillo, there is a depression that goes to 42 m below sea level, creating gradients of depression and including an endorheic, hypersaline lake (Figure 2). This region includes three mountain systems with rivers, lakes, and underground rivers, with one Biosphere Reserve, a wetland of international importance protected under the Ramsar Convention, and other protected areas. It has proportionately more protected areas than any other region of the country. In addition, it has high number of endemic species, many of which differ taxonomically from their northern relatives (Guerrero, A. 2005; personalcommunication, UASD).

The area selected for the study corresponds to the least populated region of the country as well as the poorest and least developed; it has moderate to poor sanitary disposal systems and critically low amounts of potable water (Abreu, 2001). Land use for agricultural purposes is moderate in the Enriquillo basin and much higher in the Yaque del Sur basin (Abreu, 2001). Overall, the Enriquillo Lake basin has relatively low levels of disturbance compared to Yaque del Sur River basin, which is seriously affected by many modifications.

For this study, 74 sites were sampled and, based on geographic proximity and habitat characteristics, data for those sites were variously aggregated to comprise seven localities. The sites that corresponded to a whole water body were aggregated; for example, all the sites from the Enriquillo Lake were combined into one site named Enriquillo Lake. Analyses herein focus on aggregated fish abundances and associated average environmental characteristics for those seven localities (Tables 1 and 2), which are briefly described in the following paragraphs.

1. Cabral Lagoon: The Cabral Lagoon Wildlife Reserve is the biggest natural freshwater wetland of the country. The lagoon is about 30 km^2 in surface area and an average of 4 m depth (Carbonell et al., 2007). The size and depth of the lagoon change through the year in response to seasonal rains. Its hydrology has being highly modified for the development of agricultural projects. The lagoon is fed by waters coming from surrounding mountains and from overflows of the Yaque del Sur River through the Mena Channel. During periods of unusually high waters, for example after a big hurricane, the lagoon may drain to Enriquillo Lake through the Cristobal Channel (Carbonell et al.,

2007). The lagoon is surrounded of subtropical dry forest, composed of medium-sized trees, mangroves and high grasses.

2. Enriquillo Lake: This is the largest lake in the Caribbean (265 km^2 of average area, ~21.7m maximum depth, 8 m mean depth; Buck et al., 2005; Ministerio de Medio Ambiente y Recursos Naturales, 2008; Santana et al., 2001). At the time of my sampling in 2010, its surface was at 29.8 m below sea level and its lowest point was at ~51.5 m below sea level. It was formed by isolation of an ancient channel of the sea that separated the island into two paleo-archipelagos during the Miocene (Santana et al., 2001). The lake is located in a tectonic basin from the recent Quaternary, and the formations originated from volcanic and sedimentary rocks (Santana et al., 2001). It is an endorheic lake with sulphuric and hypersaline water (35-100‰) and is fed by seasonal streams and underground springs (Santana et al., 2001). The water level fluctuates cyclically and enormously, sometimes flooding riparian habitats and at other times drying down to form two bodies of water separated by a land bridge (Buck et al., 2005; Santana et al., 2001). The región is characterized by high temperaturse varying daily from 20-40°C (Santana et al., 2001). The lake is a national park and resides within a UNESCO Biosphere Reserve. The lake basin has the three largest-bodied endangered species of Hispaniola (i.e., a crocodile and two endemic iguanas) and at least 65 species of native and migratory birds, five of which are endangered species (Santana et al., 2001). Along the shores there are floodplains, wet grass lands, swamps, marshes, mudflats, and irrigated crops (Santana et al., 2001).

3. Enriquillo Lake tributaries: La Acequia Pool, Las Damas River, Boca de Cachón, Las Barías, Azuey Lake, En Medio Lagoon, and La Zurza Pool are some of the tributaries of Enriquillo Lake. Some of these tributaries are seasonal streams, others are underground springs, and some include lagoons formed similar to Enriquillo Lake. The majority of the springs are very short, and some have sulphuric waters (e.g., La Zurza). Azuey Lake is the biggest lake of Haiti, but at present because of very high water levels, part of it extends across the border into Dominican Republic; its outflow drains to Enriquillo Lake.
4. Sabana Yegua Dam (Presa de Sabana Yegua): This is one of the main and bigger artificial water reservoirs of the southern region, existing since 1980. This dam is located in the Yaque del Sur River basin and it is fed by that same river and the surrounding creeks and springs. Its main purposes are agricultural irrigation, energy generation and flood control.
5. San Juan River: This is one of the main rivers of the area; it is a tributary of the Yaque del Sur River. Its water is used for agricultural purposes and potable water. This is one of the longest rivers in the area (121 km), with 463 km^2 of basin and one artificial reservoir, Sabaneta Dam (Marcano, 2009; Ubgarte Lozano, 1981).
6. Yaque del Sur River: This is one of the most important rivers of the country and one of the biggest watersheds (4,972 km^2). It is ~ 141km long from headwaters to the sea and includes an artificial reservoir, Sabana Yegua. Its water is used for agricultural purposes, potable water, and electrical

generation (Marcano, 2009; Ministerio de Medio Ambiente y Recursos Naturales, 2008; Ubgarte Lozano, 1981). This watershed is one of the most exposed to extensive flooding influenced by tropical hurricanes in the Dominican Republic ("Información Hidrológica").

7. Yaque del Sur River tributaries: Arroyo Grande, El Salado, and a small channel. Narrow, small and shallow creeks with fast moving water that contribute to theYaque del Sur River. In general, the tributaries are characterized by their small size and the abundance of small waterfalls.

For the 74 collecting sites, eightwere in Cabral Lagoon, 33 in Enriquillo Lake, eight in Enriquillo tributaries, one in Sabana Yegua Dam, eight in San Juan River, 13 in Yaque del Sur River, and three in Yaque del Sur tributaries. For the different analyses, site data were aggregated to form locality data, as noted above (see Tables 1, 2, and 3); available raw data by sites are presented in Appendices 1 and 3. In this study, when I refer to 'Yaque del Sur River tributaries', I will be excluding the localities San Juan River and Cabral Lagoon, both of which are part of the Yaque del Sur basin, to allow consideration of distinct lowland lagoon and small stream habitats. In the same way for Enriquillo Lake, when I refer to 'Enriquillo tributaries' I will be excluding Cabral Lagoon, which at times drains into Enriquillo Lake.

MATERIALS AND METHODS

Field Sampling

During July and August, 2010, I sampled fishes and water quality in the southern regions of the Dominican Republic. The various primary habitat types in the study area were sampled to assess species habitat relationships, anticipating that fish assemblages would change along various habitat gradients (e.g., Schlosser, 1982). The 74 sampling sites were selected based on accessibility, habitat type, and position in the watershed; they varied in substrate, water quality, riparian habitat, and in altitude from 36 m below sea level (i.e., 6 m below surface of Enriquillo Lake) up to 735 m (Appendix 1). At each collecting site, longitude, latitude and altitude were determined with a hand-held Garmin GPS76, Marine Navigator. The area sampled at each collecting site varied, but generally it averaged 24 m^2 (see Appendix 1).

For comparisons among water bodies and to facilitate projections of potential future spread of invasive species, I collected water quality data, including pH (with a Glass Combination Electrode sensor, range 0 to 14 units, accuracy ±0.2 units), water temperature (with a Thermistor sensor, range -5 to 45°C, accuracy ±0.15°C), dissolved oxygen (with a Polarographic sensor, range 0 to 50 mg/L, accuracy 0 to 20 mg/L, ± 0.2 mg/L or ± 2% of reading, which ever is greater; 20 to 50 mg/L, ± 6% of the reading), and conductivity (with a Four electrode cell sensor, range 0 to 200 mS/cm (auto range), accuracy ±0.5% of reading or 0.001 mS/cm, whichever is greater (4-m cable) ±1% of reading or 0.001 mS/cm, whichever is greater (20-m cable), using a Yellow Spring

Instruments (YSI) multiprobe (Model556 MPS). To measure salinity (‰), I used a hand-held refractometer. Water depth (m) was measured using a cord that was marked in meters and centimeters and attached to a weight. A Secchi disk was used to measure water transparency. A stopwatch and a floating object attached to a meter-long cord were used to measure current velocity (m/s). Air temperature (°C) was measured with a thermometer (+/- 1°C). For distance from the shore, I used a range finder or a cord that was marked in meters. Substrate composition and riparian vegetation were described qualitatively.

The fishes were collected using various standard collecting gears, including beach seines (mesh sizes: screen, 3 and 5 mm), dip nets (mesh sizes: 3 and 5mm), experimental gill nets (5 mesh sizes), a cast net, and minnow traps (Appendix 1). The experimental gill nets and minnow traps were deployed overnight whenever feasible, but otherwise, for at least 4 hours. In some areas, nets were fished only during the day because they were vulnerable to being stolen during night. In addition, active gears such as seines and cast nets were used for ~1-2 hours of effort at most sites. In some sites, certain gears could not be used due to characteristics such as deep water (e.g., seines or cast net) or fast currents (e.g., gill nets).

Sample Processing

All fishes were fixed in 10% formalin in the field and maintained in formalin for at least one week. In addition, large-bodied fishes were injected with formalin to facilitate fixation of internal organs. In the lab, specimens were rinsed with repeated water changes to remove formalin residues and then transferred to 75% ethanol for longterm storage. For archival storage of voucher specimens, collections for species represented by more than a few specimens were divided, with about half being deposited in the Museo Nacional de Historia Natural of Santo Domingo, Dominican Republic, and the other half deposited in the Cornell University Museum of Vertebrates, Ithaca, New York, United States.

All fishes were sorted and identified to species level (with exception of some small juveniles and a few female poeciliids). Fishes were identified using regional field guides and the primary literature for the families, genera and species encountered. Important references for the various families were as follows – Clupeidae (Munroe and Nizinski, 2002), Engraulidae (Nizinski and Munroe, 2002), Poeciliidae (Boyer, 2006; Chambers, 1987; Evermann and Clark, 1906; Hubbs, 1926; Nichols and Myers, 1923; Rauchenberger, 1988; Regan, 1913; Rivas, 1963; Rivas, 1978; Rivas, 1980; Rodriguez, 1997; Rosen and Bailey, 1963), Cyprinodontidae (Smith, 1989; Smith et al., 1990), Syngnathidae (Kell and Carpenter, 2011), Centropomidae (Orrell, 2002), Cichlidae (Carpenter, 2002; Chakrabarty, 2006b; Chervinski, 1986; Tee-Van, 1935), Eleotridae (Pezold and Cage, 2002; Murdy, 2002a), Gobiidae (Murdy, 2002b), and Mugilidae (Bussing, 2002).

Data Analyses

Given that the ichthyofauna in inland waters of Dominican Republic is still poorly known, I compiled a checklist of the fishes encountered during the course of this study (Appendix 2). The list was organized by order and family following Eschmeyer and Fong (2011), with taxa in each family organized in alphabetic order. Each brief species account includes scientific name, author, year of description, common names in English (and Spanish, when available), status of origin (i.e., native, endemic or introduced), migratory classification, typical position in water column, and finally, localities where the species was collected. This compilation will facilitate future efforts to know the complete inland fish fauna of DR.

Estimation of Diversity Patterns

To estimate diversity patterns, I analyzed a site by species abundance matrix after combining the 'close forms' entries with their most likely entity species (Table 2). Raw data are presented in Appendix 3.

Simpson's index of diversity was used to measure alpha diversity (Hill, 1973), because that allows comparison between communities with different sample sizes (Rotenberry, 1978). The proportional abundance of each species relative to total diversity was calculated for the equitability index (Hill, 1973). Species richness is the total number of species caught at each site, including those represented by a single specimen in this context. Richness, however, generally has a positive correlation with sample size (N= number of individuals collected at a site). To correct for that bias and, thus, allow fair comparisons of species richness among sites, I applied rarefaction to normalize the species abundances to the smallest sample size of all the study sites using the computer software Paleontological Statistics (PAST) (Collins and Simberloff, 2007; Scluter and Ricklefs, 1993; Simberloff, 1972). The resulting estimate is termed 'expected richness' (see Table 2).

To provide another perspective on differences in faunal composition among sites, percent abundances for each family within each site were calculated by dividing abundance of each family by total abundance of all species at that site (times 100 = %). I similarly estimated percentage of all species at a site that belong to each family. Percentage composition values are reported for the three numerically most dominant families (Table 3).

Analysis of Community Patterns

Community patterns of inland fishes were described and compared applying standard indices and multivariate statistics for community analyses (McCune and Grace, 2002). A site-by-species abundance matrix was analyzed using PAST software to apply Detrended Correspondence Analysis (DCA), a multivariate technique of ordination. This is an indirect gradient ordination method in which environmental gradients are inferred from the species composition data (Galacatos et al., 1996; Ibarra and Stewart, 1989) and thus help to understand distribution patterns. Species that occurred with only one specimen at one location were removed for this analysis, because such records are not informative about relationships among sites. Species abundance were transformed by $\log_{10}(n+1)$ to better emphasize the less abundant taxa and to reduce the influence of extremely abundant taxa, facilitating among-location comparisons (Galacatos et al., 1996; Magurran, 1988). A complementary cluster analysis (Bray-Curtis analysis) was applied to that same transformed, site-by-species abundance matrix to provide additional perspective on associations of fish assemblages among sites. Bray-Curtis cluster analyses were run with and without exotic species being included in the matrix.

RESULTS

Estimation of Diversity Patterns

My field surveys revealed 24 species in the study area (11,147 specimens from 74 collection sites), representing 18 genera and 10 families (Table 2, Appendix 2). The most specious and abundant (numerically) group was the family Poeciliidae (9,539 specimens, 7 species, 4 genera); two of the poeciliids were introduced species. The next most abundant groups were Eleotridae (457 specimens, 3 species, 3 genera) and Cichlidae (440 specimens, 5 species, 3 genera); four of the cichlid species were introduced. Of the 24 species, Yaque del Sur River combined with its tributaries had the highest richness with 16 species; richness values at other localities were Enriquillo Lake and tributaries 11, San Juan River 10, Cabral Lagoon eight, and Sabana Yegua Dam five.

To correct for the positive correlation of species richness with the sample size, we applied rarefaction to standardize samples to 42 specimens and computed corresponding expected number of species. Thus, we would expect 10 species in Yaque del Sur and tributaries (nine in main river alone), six in San Juan River, five species in Cabral Lagoon, five in Sabana Yegua, and five in Enriquillo Lake and tributaries (four in the lake alone) (Table 2).

The mean Simpson's diversity for all the localities was 0.61 and evenness 0.18. This diversity index shows moderate to high values for the majority of the locations, and the evenness values were relatively moderate to low. The highest Simpson's diversity index was for Yaque del Sur River (0.81), then Cabral Lagoon (0.71); values for other localities were Yaque del Sur tributaries (0.61), San Juan River (0.68), Yaque del Sur tributaries (0.57), Enriquillo Lake (0.50), and Sabana Yegua Dam (0.40). The evenness values from highest to lowest were Cabral Lagoon (0.55), Yaque del Sur River (0.48), Yaque del Sur River tributaries (0.47), Enriquillo Lake tributaries and San Juan River (0.41), and Enriquillo Lake (0.39).

From the total species found, one of them is potentially a new species, corresponding to the genus *Poecilia* (Poeciliidae). Additionally, I found an undescribed species of the genus *Cyprinodon* (Cyprinodontidae) that was previously known from the area.

Of the species collected, eight were endemic to Hispaniola (*Cyprinodon bondi*, *C.* n. sp., *Poecilia hispaniolana*, *P.* n. sp., *Gambusia hispaniolae, Limia perugiae, L. sulphurophila*, and *Nandopsis haitiensis*). Nine species were native but more widely distributed in the Caribbean (*Dormitator maculatus, Eleotris pisonis, Gobiomorus dormitor*, *Awaous banana*, *Ctenogobius fasciatus*, *Anchovia clupeoides*, *Centropomus ensiferus*, *Microphis brachyurus*, and *Agonostomus monticola*). Finally, seven introduced species were encountered (*Dorosoma petenense, Xiphophorus* sp., *Gambusia affinis*, *Oreochromis mossambicus*, *O. niloticus*, *O. aureus*, and *Tilapia rendalli*). I also observed local fishermen with introduced largemouth bass (*Micropterus salmoides*) and common carp (*Cyprinus carpio*) near the Yaque del Sur River, but I was not able to collect those species.

The four numerically most abundant fish species are all endemic to the island. The most abundant species was *Limia perugiae* with 6,479 individuals; that species was one of only two ubiquitous species, occurring in 40 out of 74 sites and at all seven of the localities (Table 2). The second most common fish was *Gambusia hispaniolae* with 2,402 individuals; it was found in 30 sites corresponding to five localities. The third most common was *Poecilia hispaniolana* with 505 individuals, with occurrences in 11 sites and four localities. *Nandopsis haitiensis* was represented in the collections by 108 individuals, but it also had an ubiquitous distribution, occurring at 26 sites and all seven localities. Among other uncommon species encountered in this study were *Eleotris pisonis* (N=1) and *Centropomus ensiferus* (N=2).

None of the species collected during this sampling is formally listed as threatened under the IUCN guidelines. Some of them may be eligible for being on the list due to their narrow distribution and or due to the size of the aquatic system where they occur in addition to other criteria.

Introduced fishes were found in all localities sampled, representing about 29% of the diversity and 5% in abundance of all fishes caught (578 specimens, 7 species, 5 genera). Of this group, *Dorosoma petenense* was the most abundant (203 specimens, all juveniles), but it occurred at only one locality, Cabral Lagoon. The mosquito fish, *Gambusia affinis* (N=43), also had a relatively restricted distribution in Yaque del Sur River and *Xiphophorus* sp. (N=1) was only found in San Juan River. In contrast, *Tilapia rendalli* (N=174), *Oreochromis aureus* (N=114), and *O. niloticus* (N=41) were more widely distributed, occurring at four, six, and six localities, respectively.

Analysis of Community Patterns

Results of the multivariate Detrended Correspondence Analysis (DCA) revealed a strong gradient of community composition along Axis 1 that largely reflects a shift from lowland lakes (left) to more upland fluvial systems and an associated reservoir (right). So Enriquillo Lake, its tributaries and Cabral Lagoon contrast with fluvial sites in the Yaque del Sur drainage basin (i.e., Yaque del Sur River, San Juan River, Yaque del Sur Tributaries, and Sabaneta Yegua Dam) (Figure 3-A). Along Axis 2 in that same ordination, the primary trend appears to be a contrast between hypersaline Enriquillo Lake (lower left) and all freshwater sites (upper end of Axis 2). When introduced species were removed from the matrix, DCA results were similar with the exception that Cabral Lagoon shifted to the right along Axis 1 (Figure 3-B). That modest change appears to reflect removal of *Oreochromis aureus*, which was relatively abundant in both of the lowland lakes (Table 2).

The Bray-Curtis cluster analysis reveals community patterns similar to those seen for the DCA, with two main groups as follows: 1) Enriquillo Lake, its tributaries and Cabral Lagoon, and 2) all remaining sites from Yaque del Sur drainage (Figure 4-A). In that latter grouping, the two sites in larger rivers contrast with samples from the reservoir and smaller tributaries. Results of clustering with the data matrix excluding introduced species (Figure 4-B) also reveals two main groups, but in this case, the two sites for the larger rivers cluster more closely with the lowland lagoon group. The upland Yaque del Sur Tributaries and Sabana Yegua Dam appear to be most distinct from the remaining localities. That shift in community pattern seems to be driven by high abundances of *Limia perugiae* and *Nandopsis haitiensis* occurring in Yaque del Sur and San Juan River localities, and both species are also relatively abundant in the lowland lagoons (Table 2).

DISCUSSION

Diversity Patterns

The highest Simpson's diversity indices were for Yaque del Sur River (0.81) and Cabral Lagoon (0.73); Enriquillo Lake had an intermediate diversity index (0.67), and Sabana Yegua Dam had the lowest (0.40). Many reasons could explain this pattern. High diversity in Yaque del Sur River could result from it being the longest and largest river in the study area, and it also is broadly open to the sea, so peripheral and amphidromous fishes can readily access the system. This locality also combines sites extending over a gradient of elevation, so it incorporates both lowland and some upland fishes. The Cabral Lagoon also has a connection to the sea via lower reaches of Yaque del Sur River, and small creeks around that lake may contribute to its diversity. Diversity of Enriquillo Lake is influenced by species adapted to the harsh conditions of that ecosystem and water fluctuations (i.e., salinities 35-100‰). In contrast, Sabana Yegua Dam, with the lowest diversity value, is an artificial lagoon formed on an upland tributary, and thus, it may be considered perturbed.

The total abundance of fishes shows a different pattern than does Simpson's diversity. In lacustrine environments, we caught more individual fishes than in the rivers (Table 2). That may be related to the relative ease of collecting in lakes versus the rivers, and that in the rivers, the fishes were more dispersed. Species richness shows a pattern similar to that for Simpson's diversity. Yaque del Sur River had the highest species richness, and Sabana Yegua Dam had the lowest; when richness was corrected for sample size by rarefaction, Yaque del Sur still showed highest diversity, but Enriquillo Lake's diversity was slightly lower than that of Sabana Yegua Dam (Table 2). The evenness values were uniformly relatively low across all sites. That may reflect differences in abundance among various groups of fishes. Fishes of the family Poeciliidae were, in general, very abundant compared to other taxa, so uneven abundances may be an artifact of the faunal composition. This may be because poeciliids typically can reproduce often and, hence, abundantly.

The ichthyofaunal composition of the study area is 33.33 % endemic species, 37.50 % wide-spread natives, and 29.17 % introduced. This general pattern is not necessarily unique. Hispaniola in general and the endorheic Enriquillo Lake basin, in particular, represent nested systems with long histories of isolation. The Enriquillo Lake basin is characterized by harsh conditions such as high salinity, sulphur springs, and lower elevations with drastic fluctuations in temperature and rainfall. Therefore, it is not surprising that some species inhabiting that ecosystem have evolved specialized climatization (e.g., *Limia sulphurophila*).

Community Patterns

Results for the multivariate DCA showed a gradient along Axis 1 reflecting community patterns associated with the two main watersheds and with lowland lacustrine versus more upland fluvial habitats (Figure 3). This broad pattern was consistent regardless of whether or not the introduced species were included. The Bray-Curtis cluster analysis reveals similar associations as the DCA.

When introduced species are present, the cluster analysis shows two main groups that correspond to two main drainages – Yaque del Sur and Enriquillo Lake (Figure 4-A). The Enriquillo basin cluster joins Enriquillo Lake, its tributaries and Cabral Lagoon. Enriquillo Lake and its tributaries are logically associated due to their direct connections. Cabral Lagoon clustering in this group can be explained by two factors: 1) both Cabral Lagoon and Enriquillo Lake are lacustrine environments, and 2) during extreme floods such as might happen with a hurricane, water may flow from Cabral Lagoon into Enriquillo Lake. So Cabral Lagoon sits on the drainage divide and represents a biogeographic portal with linkages via canals to both Enriquillo Lake and Yaque del Sur River. The fishes that were more abundant and shared between Enriquillo Lake and its tributaries were *Limia perugiae*, *Gambusia hispaniolae*, *Gobiomorus dormitor, and L. sulphurophila* (Figure 5). Dominant species shared between Enriquillo basin and Cabral Lagoon were *Gambusia hispaniolae, L. perugiae, Oreochromis aureus, and Nandopsis haitiensis* (Figure 6). These latter four species were very wide spread in the area, but they also have more broad tolerances to the harsh conditions of Enriquillo Lake.

The Yaque del Sur basin cluster includes Sabana Yegua Dam, San Juan River, Yaque del Sur River, and its tributaries. These sites are linked together because of direct connections and all but the reservoir are fluvial habitats. The reservoir, however, was constructed in a fluvial system. The fishes that were more abundant and shared between Yaque del Sur River and San Juan River were *L. perugiae* and *Poecilia hispaniolana*. Species shared between tributaries of Yaque del Sur River and SabanaYegua Dam include *Tilapia rendalli* and *L. perugiae*. The dominant or most characteristic fishes of the Yaque del Sur basin were *L. perugiae*, *O. niloticus*, and *P. hispaniolana* and

N. haitiensis (Figure 7). These three species were widely-distributed, except for *P. hispaniolana,* which was only found in the upper reaches of the drainage.

When introduced fishes were removed, the Bray-Curtis cluster analysis shows two main groups that partially correspond to two different drainages – Yaque del Sur and Enriquillo basin (Figure 4-B). This pattern is generally similar to that with introduced fishes included, except that two sites from Yaque del Sur basin now cluster more closely with Cabral Lagoon plus the Enriquillo basin. With *Oreochromis aureus* removed from the analysis, *Nandopsis haitiensis* remains as a shared species that helps make linkages between Enriquillo basin and Cabral basin, but at the same time, it is relatively abundant in Yaque del Sur and San Juan Rivers. In the Yaque del Sur basin cluster, linkages between Yaque del Sur River and San Juan River were influenced by abundant *N. haitiensis* and *Limia perugia*. The tributaries of Yaque del Sur and Sabana Yegua Dam were joined in part by sharing *Poecilia hispaniolana* and *L. perugiae*. So in this case, instead of a dichotomy between lowland lagoons and fluvial systems, associations of localities form a chain or gradient of relationships. Perhaps that more closely represents the natural system before humans disturbed it with introduced tilapias.

Conservation of Ichthyofaunal Diversity

Human alterations of the watersheds appear to be reflected in fish communities of the systems studied here. The abundance of the tilapias in all the sites should be a source of concern; all of them attain relatively large body sizes, so their contributions to fish biomass in the study area would be proportionality greater than their contributions in numbers of individuals. Without natural predators, they could displace the endemic

Nandopsis, or threaten many of the other native and endemic fishes. That, in turn, could lead to changes in a wide range of trophic levels (Coblentz, 1990; Zaret and Paine, 1973). The Nile tilapia (*Oreochromis niloticus*) is well-known for its tolerance of a broad range of environmental conditions and for its fastgrowth; it can acclimate quickly to changes in salinity and oxygen, and it is able to feed at various trophic levels (Mckaye et al., 2010). Today it is difficult to know if these exotic fishes are impacting native fishes, because there are no previous studies of fish community patterns. This study provides a baseline against which future changes can be assessed.

Rare fishes or those with restricted distributions are of special concern because, under IUCN guidelines (IUCN, 2010), some of them may be eligible for listing as threatened or endangered. At present, no species that I collected has been formally listed as threatened. Nonetheless, some species are known, to date, exclusively from one locality. That is the case with *Cyprinodon bondi* occurring only in Azuey Lake, and the undescribed species of *Cyprinodon* from Enriquillo Lake. Other uncommon species in the study area included *Eleotris pisonis* and *Centropomus ensiferus*; both of the latter two have wide distributions in the Caribbean, so they would not be considered threatened. Another species in my samples that might be eligible for some level of threatened status under IUCN guidelines is *L. sulphurophila*, because it is endemic to the Enriquillo Lake basin. To be elevated to some level of threatened status under IUCN guidelines, we need to know much more than just area of occupancy. For that process, it is imperative to analyze and quantify trends in population abundances, habitat degradation and other factors for which data are presently lacking.

I provide critical data to determine conservation status of the native fish fauna of the study area. These data now become part of our knowledge base, serving as a foundation for further studies, so urgently needed applications to conservation and management can proceed immediately. My results will allow comparative studies, for example, of possible future changes in fish assemblages that might occur as human populations and related habitat disturbances increase. More generally, my results can be used by various researchers as well as governmental and non-governmental agencies with interest in documenting and conserving biodiversity and for establishing conservation priorities. Results herein point to certain habitats and species that may need enhanced protected status to ensure survival of threatened fishes. A more comprehensive perspective on the Hispaniola ichthyofauna also opens the way to basic research on biogeography, ecology and evolution of the fishes and their roles in ecosystems of the island. Public outreach and educational programs also benefit; results can be used to enhance public appreciation of our inland fish diversity. I hope this work can be extended to other poorly studied areas of the island, and that this baseline can be extended into a long and valued time-series of observations that facilitates sustaining these unique and fragile ecosystems.

Perspectives for Future Studies on Fishes

Collection effort among the various sites was not uniform; as a result, some localities yielded more specimens because they were sampled more intensively. The accessibility to some sites was more difficult than others, and some collections were done following heavy rains when the river flows were relatively highand currents were fast.

Additionally, during the most intense rains, some places were impossible to reach, even with a four wheel drive vehicle. So for future studies, it would be valuable to focus most sampling in the driest part of the year when access is best and fishes are relatively concentrated by low water levels.

The methods used to collect fishes varied in effectiveness. Beach seines, dip nets, and cast nets were the most effective ones that I had available. The beach seines were light weight, easy to carry and not affected by turbidity of the water (Onorato et al., 1998). The dip net allowed me to access narrow habitats, but was relatively less effective for large-bodied fishes. The cast net was very useful in some relatively open habitats, but it requires training to attain its potential. Based on observations of catches by local fisherman, some fishes were not caught by the methods that I had available. The fisherman used some different gears that I didn't deploy, such as bigger traps and hook and line. For future sampling, it would be important to apply additional techniques and gears, such as electro-fishing, small trawls, bigger traps, and hook and line.

Identification keys for widely-distributed native and introduced species are available and adequate for fishes that occur in the Dominican Republic. However, no keys exist for many of the endemic species of fishes. Thus, I had to use the primary literature for proper identification. Another concern is that, in the case of the fishes of the family Poeciliidae, identification of females and juveniles was inferred based on the presence of mature males. That is because the majority of the diagnostic characteristics of each species are based only on the male, and in particular, on anatomical details of the gonopodium. It would be important and very helpful to develop an identification guide for this group of fishes that occurs so abundantly in Dominican Republic, including the characteristics of males, females and juveniles. Finally, my sampling led to the discovery of perhaps one new species, and I found a second undescribed species that previously was known to occur in the area. That highlights the need for continuing field studies because we cannot conserve species if we do not know they exist.

There are many things required to ensure persistence of the inland fishes of Dominican Republic. For most of the inland ichthyofauna, basic ecology, distributions, behavior, and evolutionary processes are poorly known, including the impacts of the exotic fishes on native fishes. In addition, it is critical to more precisely define conservation status of the inland fishes and to implement conservation efforts to protect threatened or sensitive habitats that may be critical for survival of various fishes. Finally, education and outreach programs are urgently needed to inform conservationists, resource managers and the general public about status of the fish fauna.

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TABLES AND FIGURES

Table 1. Average of environmental and ecological characteristics of collecting localities of the southern Dominican Republic in summer, 2010.

Site	Altitude (m)	Water	Habitat description	Sample area (m^2)	Sampling depth (m)	Sampling methods	Air temp. (°C)	Water temp. (°C)	Dissolved oxygen (mg/L)	Conductivity (ms/cm)	pH	Salinity (‰)	Secchi disk (m)	Current (m/sec)	Distance from shore/stream width (m)
Cabral Lagoon	10.8	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	13.8	1.4	beach seine, cast net, dip net, minnow trap	29.13	31.01	9.19	5.06	8.17	0.00	0.27 - 0.20	0.05	80.00
Enriquillo Lake	-27.7	hypersaline, green/gray	gravel, mud, sand, shells, rocks, swamp forest, open lake	25.7	4.5	beach seine, cast net, dip net, gill net, minnow trap	28.5	31.3	9.5	98.4	7.8	30.3	1.04 - 0.88	0.0	276.2
Enriquillo Lake Tributaires	-0.1	freshwater, green-gray-blue	gravel, mud, forest, swamp forest, riparian	16.9	1.2	beach seine, cast net, dip net	28.2	25.5	7.4	12.2	7.1	1.8	0.20 - 0.18	-	10.1
Yaque del Sur River	233.8	freshwater, turbid	grass, gravel, mud, sand, small rocks, riparian	27.7	0.8	beach seine, cast net, dip net, gill net	25.5	27.2	7.6	0.9	7.4	0.0	0.27 - 0.18	0.4	46.8
Yaque del Sur River Tributaires	167.5	freshwater, turbid	grass, gravel, rocks, riparian	30.0	0.5	beach seine, cast net, dip net, gill net	28.3	30.0	6.9	2.1	7.9	0.0	0.30 - 0.20	0.6	12.8
San Juan River	526.1	freshwater, turbid	grass, grave, sand, small rocks, riparian	17.5	0.6	beach seine, cast net, dip net	23.3	25.8	6.3	0.5	7.7	0.0	0.10 - 0.80	0.5	29.4
Sabana Yegua Dam	395.8	freshwater, turbid	gravel	20.0	-	beach seine, cast net	21.0	29.9	17.5	0.6	8.1	0.0	-	-	63.0

Table 2. Number of individuals of each species collected at seven localities (all gears combined) in southern Dominican Republic in summer, 2010.

Table 2. Number of individuals of each species collected at seven localities in southern Dominican Republic.

Species	Cabral Lagoon		Enriquillo Lake		Enriquillo Tributaires		Yaque del Sur River		Yaque del Sur Tributaires		San Juan River		Sabana Yegua Dam	
Dorosoma petenense	203		-		-		-		-		-		-	
Anchovia clupeoides	-		-		-		23		-		-		-	
Gambusia affinis	-		-		-		43		-		-		-	
Gambusia hispaniolae	386		1,779		203		6		-		28		-	
Limia perugiae	282		4,964		693		134		43		360		3	
Limia sulphurophila	-		53		16		-		-		0		-	
Poecilia hispaniolana	-		-		-		65		4		435		1	
Poecilia sp.	-		-		-		3		-		37		-	
Xiphophorus sp.	-		-		-		-		-		1		-	
Cyprinodon bondi	-		-		44		-		-		-		-	
Cyprinodon sp.	-		4		-		-		-		-		-	
Microphis brachyurus	-		-		-		3		-		-		-	
Centropomus ensiferus	-		-		-		2		-		-		-	
Nandopsis haitiensis	7		2		24		23		3		47		2	
Oreochromis aureus	67		37		2		2		2		4		-	
Oreochromis mossambicus	3		-		-		-		-		-		-	
Oreochromis niloticus	6		-		3		14		6		8		4	
Tilapia rendalli	62		-		-		-		5		75		32	
Dormitator maculatus	-		-		95		-		-		-		-	
Eleotris pisonis	-		-		-		1		-		-		-	
Gobiomorus dormitor	-		269		92		1		-		-		-	
Awaous banana	-		-		-		12		2		-		-	
Ctenogobius fasciatus	-		362		-		-		-		10		-	
Agonostomus monticola	-		-		-		44		2		-		-	
Richness | Abundance	8	1,016	8	7,470	9	1,172	15	376	8	67	10	1,005	5	42
Expected richness (N = 42)	5.48		4.45		5.95		9.21		7.52		6.18		5.00	
Simpson's Diversity | Eveness	0.73	0.55	0.61	0.39	0.61	0.41	0.81	0.48	0.57	0.47	0.67	0.41	0.40	0.47
Endemics (%) | Abundance (%)	3 (37.5)	675 (66.44)	5 (62.50)	6,802 (91.07)	5 (55.56)	980 (83.62)	5 (33.33)	231 (61.44)	3 (37.5)	50 (74.63)	5 (50.00)	907 (90.35)	3 (60)	6 (14.29)
Native (%) | Abundance (%)	0	0	2 (25.00)	630 (8.43)	2 (22.22)	187 (15.96)	7(46.67)	86 (22.87)	2 (25)	4 (5.97)	1 (10.00)	10 (1)	0	0
Introduced (%) | Abundance (%)	5(62.50)	341 (33.56)	1 (12.50)	37 (0.50)	2 (22.22)	5 (0.43)	3 (20.00)	59 (15.69)	3 (37.5)	13 (19.40)	4 (40.00)	88 (8.76)	2 (40)	36 (85.71)

Table 3.Percent abundance of the numerically dominant fish families at study localities in southern Dominican Republic in summer, 2010. Percent abundances were calculated using total individuals and total number of species collected at each locality.

	Poeciliidae		Eleotridae		Cichlidae	
Location	% indiv.	% species	% indiv.	% species	% indiv.	% species
Cabral Lagoon	65.75	25.00	0.00	0.00	14.27	62.50
Enriquillo Lake	90.99	37.50	3.59	12.50	0.52	25.00
Enriquillo Lake tributaries	77.82	33.33	15.96	22.22	2.47	33.33
Yaque del Sur River	66.76	33.33	0.53	13.33	10.37	20.00
Yaque del Sur Tributaries	70.15	25.00	0.00	0.00	23.88	50.00
San Juan River	85.67	50.00	0.00	0.00	13.33	40.00
Sabana Yegua Dam	9.52	40.00	0.00	0.00	90.48	60.00

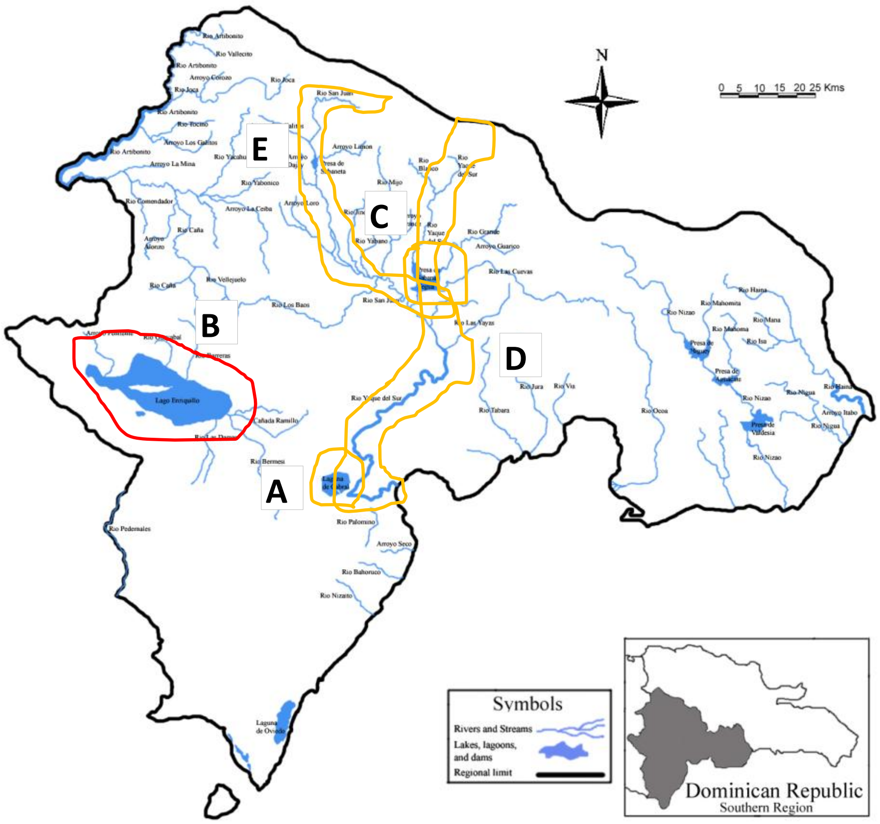

Figure 1. Map of the study area for the fish surveys in southern Dominican Republic in summer, 2010. Aggregated localities were as follows: A) Cabral Lagoon; B) Enriquillo Lake; C) Sabana Yegua Dam; D) Yaque del Sur River; and E) San Juan River.

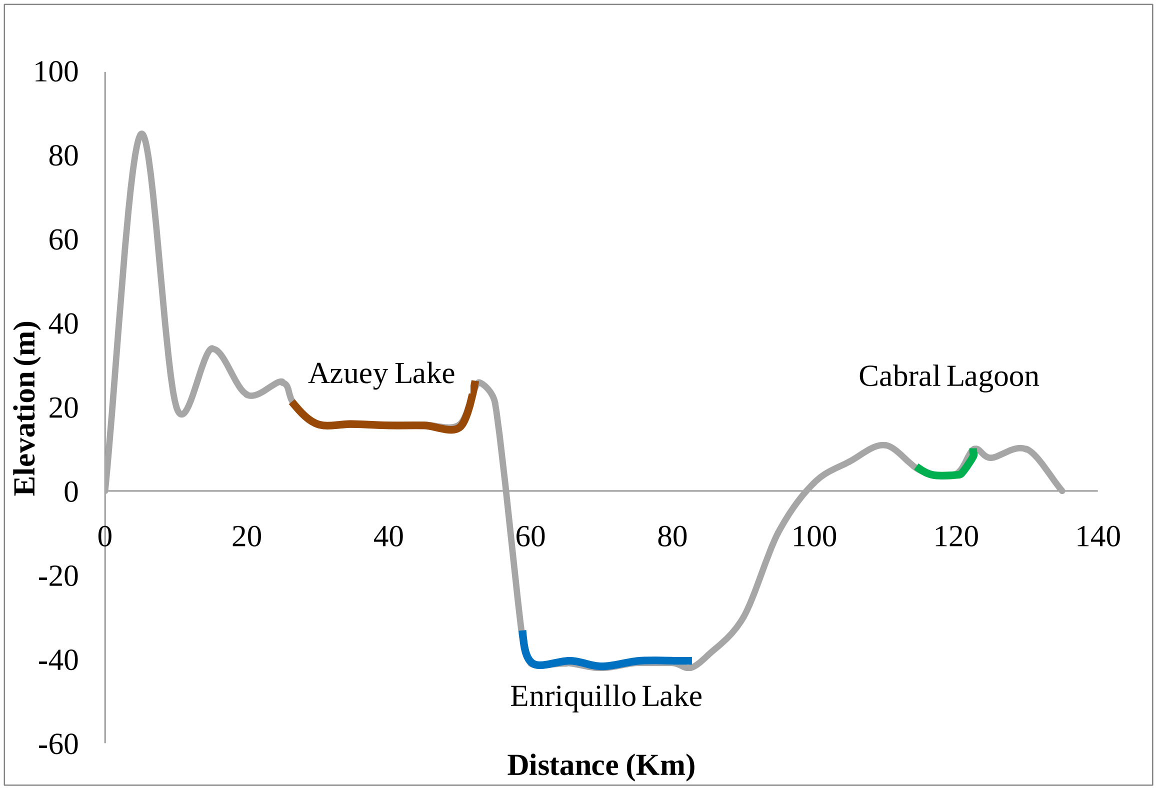

Figure 2. Hoya de Enriquillo Hypsograph. Elevation versus distance from the west shore in Haiti to the east shore of Dominican Republic along the Hoya de Enriquillo depression, showing approximate location of various lakes.

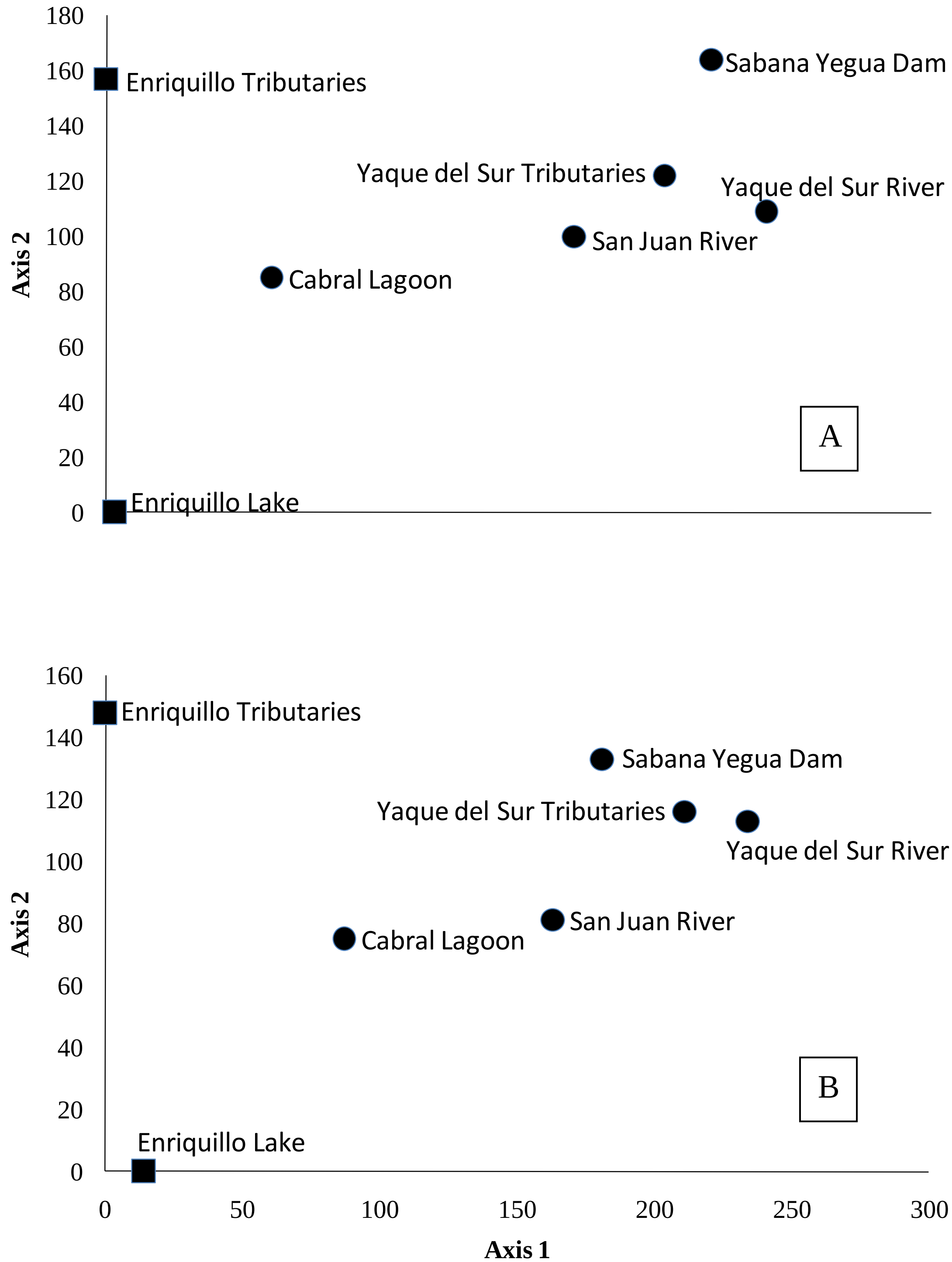

Figure 3.Detrended Correspondence Analysis results; circles represent Yaque del Sur River basin, and squares Enriquillo Lake watershed; A) including all the species, and B) excluding the exotic species.

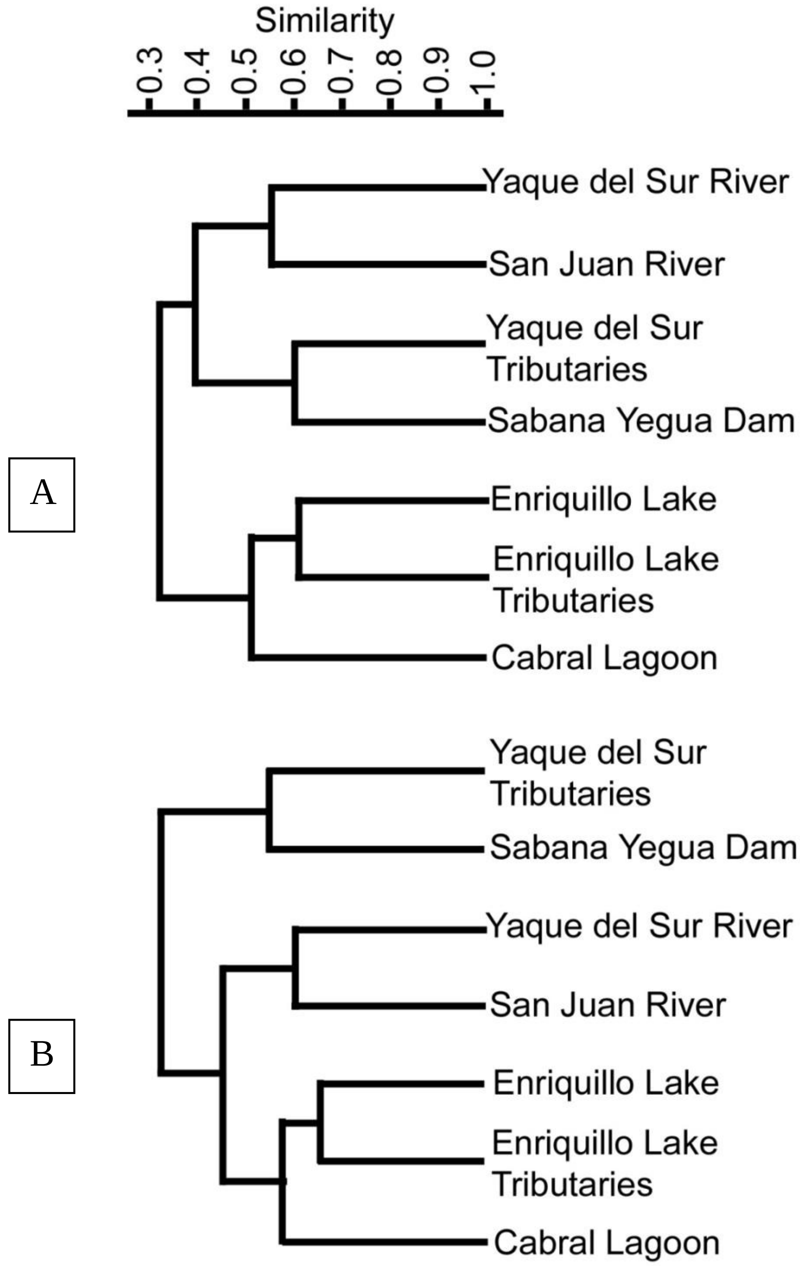

Figure 4. Bray Curtis cluster analysis results: A) including all species; and B) excluding exotic species. The X axis represents similarity 0-1, where, 1 = similar, and 0 = dissimilar.

Figure 5.The Enriquillo Lake environment and the fishes that make the association with Enriquillo Lake basin.

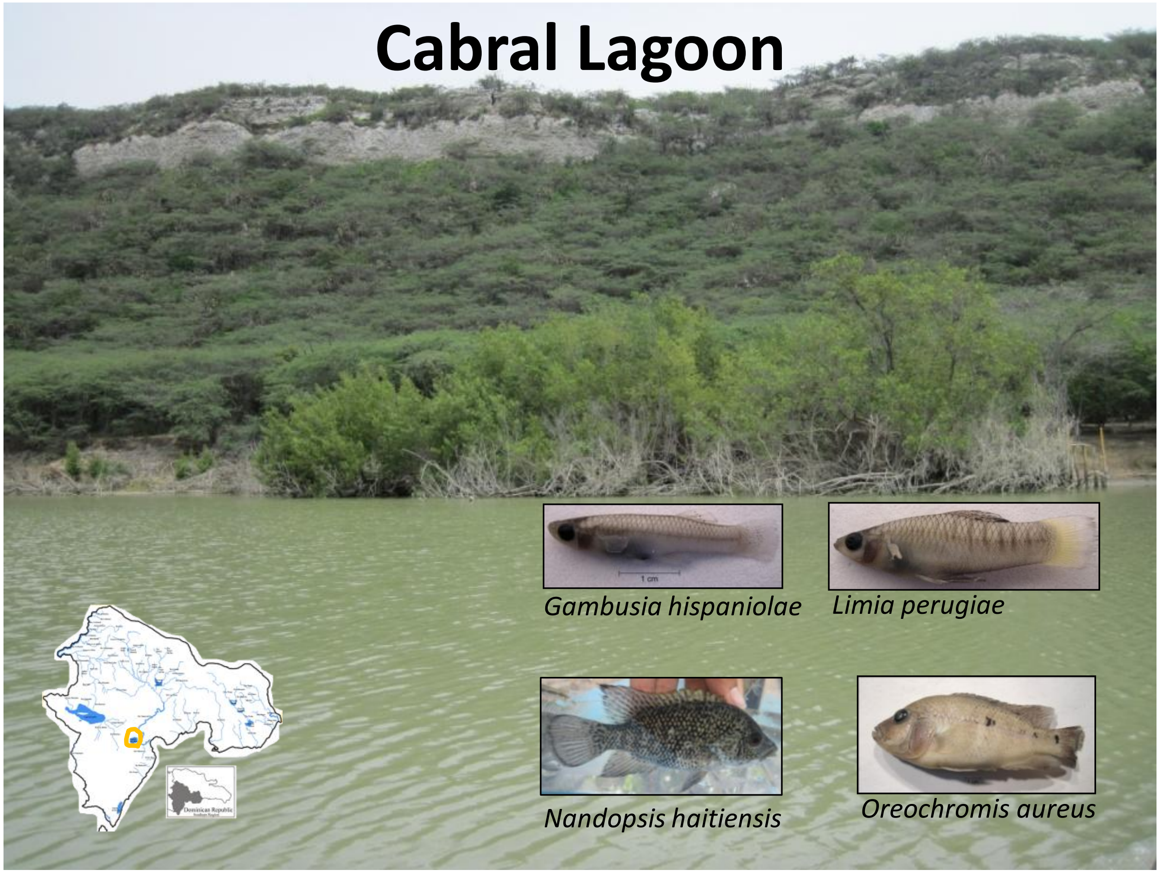

Figure 6.Cabral Lagoon environment and the fishes that make the association between this lagoon and Enriquillo Lake basin.

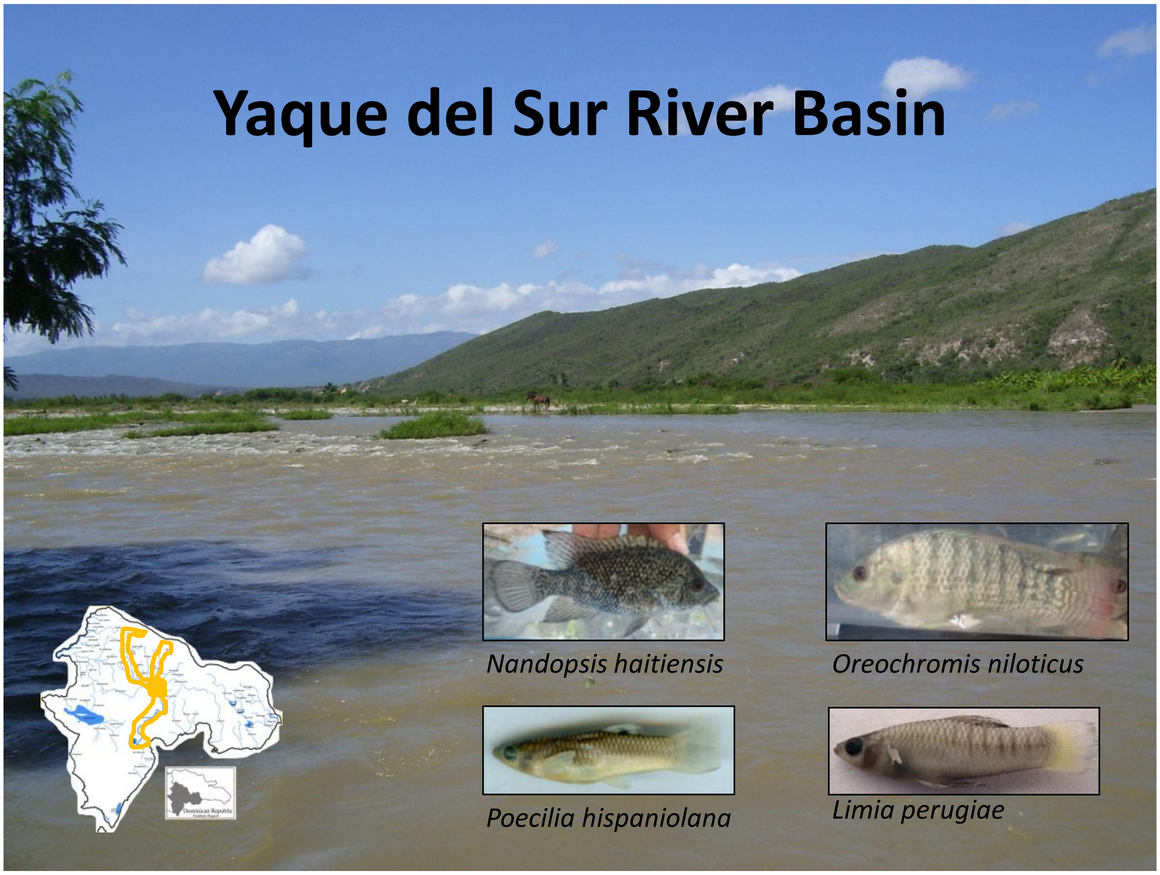

Figure 7.Yaque del Sur River environment and the fishes that make the association in this watershed.

APPENDICES

Appendix 1. Environmental and ecological characteristics of collection sites in southern Dominican Republic in summer, 2010.

Site	Latitude Longitude	Altitude (m)	Water	Site Description	Sample area (m^2)	Sampling Depth (m)	Sampling Method	Air Temp. (°C)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	Conductivity (ms/cm)	pH	Salinity (‰)	Secchi Disk (m)	Current (m/sec)	Distance from Shore/Stream Width (m)
Cabral Lagoon																
1	18° 16' 11.9" N, 71° 14' 14.2" W	12.0	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	20	1.52	cast net, minnow trap	28	31.13	9.30	9.330	7.95	0	0.26-0.16	-	100
2	18° 16' 21.5" N, 71° 14' 37.7" W	14.0	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	20	2.13	cast net, minnow trap	29	31.19	8.98	4.256	8.11	0	-	-	140
3	18° 16' 9.4" N, 71° 14' 34.3" W	9.0	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	10	1.22	beach seine, deep net, cast net	28	32.99	9.20	4.302	9.20	0	0.20-0.15	-	10
4	18° 15' 35.2" N, 71° 14' 48.2" W	10.5	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	10	0.91	beach seine, deep net, cast net	30	34.60	10.14	4.252	8.12	0	-	-	10
5	18° 17' 38.5" N, 71° 14' 45.0" W	10.0	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	20	2.10	cast net, minnow trap	27	30.82	9.24	4.935	8.04	0	0.35-0.30	0.063	350
6	18° 18' 17.9" N, 71° 14' 50.2' W	12.0	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	10	1.00	beach seine, deep net, cast net	31	21.20	8.14	4.269	8.20	0	0.20-0.15	0.033	10
7	18° 18' 9.3" N, 71° 15' 14.5" W	11.9	freshwater, turbid, green-gray	mud, short vegetation, swamp forest	10	1.20	beach seine, deep net, cast net	31	32.22	8.77	4.810	7.47	-	0.35-0.25	-	10
8	18° 18' 23.0" N, 71° 14' 13.1" W	7.3	freshwater, turbid, green-gray	gravel, short vegetation, swamp forest	10	1.00	beach seine, deep net, cast net	29	33.90	9.74	4.324	8.25	-	-	-	10
Enriquillo Lake																
12	18° 33' 43.3" N, 71° 41' 50.4" W	-25.6	Hypersalt, green/gray	gravel, rocks, sand, swamp forest	20	0.80	deep net, minnow trap	28	30.95	6.50	97.560	7.93	30	-	0.013	5
13	18° 32' 40.3" N, 71° 41' 49.8" W	-27.6	Hypersalt, green/gray	open lake	40	16.00	experimental gill net, minnow trap	26	30.98	5.66	105.300	7.99	35	1.50 - 1.00	0.033	2,000
14	18° 30' 6.7" N, 71° 43' 13.2" W	-27.5	Hypersalt, green/gray	open lake	40	16.00	experimental gill net, minnow trap	32	30.97	5.66	105.300	8.50	33	1.20 - 1.00	0.011	1,500
15	18° 29' 50.6" N, 71° 43' 21.4" W	-24.5	Hypersalt, green/gray	decomposing plants, mud, swamp forest	20	1.52	beach seine, deep net	38	32.21	6.58	108.700	7.92	35	-	-	10
16	18° 33' 35.1" N, 71° 43' 19.7" W	-	Hypersalt, green/gray	gravel, mud, sand, swamp forest	5	1.52	beach seine, cast net, deep net	28	31.88	7.49	83.520	7.84	-	-	-	5
18	18° 33' 40.0" N, 71° 41' 44.7" W	-28.7	Hypersalt, green/gray	swamp forest	3	6.50	minnow trap	26	38.85	5.10	105.000	7.99	-	1.35 - 1.05	-	100
19	18° 33' 36.4" N, 71° 41' 23.4" W	-28.1	Hypersalt, green/gray	swamp forest	3	5.80	minnow trap	25	30.84	5.12	105.100	8.06	-	1.43 - 1.35	-	135
20	18° 33' 32.5" N, 71° 41' 12.2" W	-27.6	Hypersalt, green/gray	swamp forest	40	5.60	gill net	25	30.74	4.63	104.900	8.08	34		-	195

Appendix 1. Continued. Environmental and ecological characteristics of collection sites in southern Dominican Republic in summer, 2010.

Site	Latitude Longitude	Altitude (m)	Water	Site Description	Sample area (m^2)	Sampling Depth (m)	Sampling Method	Air Temp. (°C)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	Conductivity (ms/cm)	pH	Salinity (‰)	Secchi Disk (m)	Current (m/sec)	Distance from Shore/Stream Width (m)
21	18° 33' 29.2" N, 71° 40' 57.8" W	-30.3	Hypersalt, green/gray	mud, swamp forest	3	5.72	minnow trap	27	30.73	5.43	104.800	8.14	34	1.38 - 1.15	-	244
22	18° 33' 24.1" N, 71° 40' 43.1" W	-24.5	Hypersalt, green/gray	swamp forest	3	5.58	minnow trap	27	30.73	5.58	104.900	8.14	-	1.40 - 1.10	-	260
23	18° 32' 57.1" N, 71° 40' 55.2" W	-29.8	Hypersalt, green/gray	swamp forest	40	21.66	gill net	29	30.79	5.45	105.200	8.17	-	1.64 - 1.21	-	1,026
24	18° 33' 55.9" N, 71° 42' 24.5" W	-30.0	Hypersalt, green/gray	concrete, gravel, swamp forest	10	1.10	beach seine, deep net	25	31.70	7.48	102.600	7.92	31	-	-	24
25	18° 33' 51.5" N, 71° 41' 58.0" W	-21.8	Hypersalt, green/gray	gravel, leaves, mud, swamp forest	10	0.50	deep net	24	33.85	10.97	103.500	8.27	34	-	-	5
26	18° 30' 7.0" N, 71° 44' 48.4" W	-28.9	Hypersalt, green/gray	swamp forest	40	7.24	gill net	28	30.68	7.22	103.400	7.50	35	1.13 - 0.92	-	986
27	18° 29' 45'.0' N, 71° 44' 24.5" W	-28.5	Hypersalt, green/gray	gravel, mud, sand, shells, swamp forest	40	1.82	gill net	29	30.96	7.57	105.600	7.20	32	0.5 - 0.40	-	20
28	18° 31' 56.6" N, 71° 43' 58.8" W	-29.0	Hypersalt, green/gray	gravel, mud, swamp forest	15	0.60	beach seine, deep net	22	29.51	4.96	85.360	7.75	25 - 30	-	-	5
29	18° 30' 2',0' N, 71° 35' 3.4" W	-29.6	Hypersalt, green/gray	open lake	40	7.05	gill net	29	30.42	6.45	103.700	7.86	-	1.15 - 0.95	-	744
30	18° 30' 26.0" N, 71° 35' 5.1" W	-29.0	Hypersalt, green/gray	gravel, mud, sand, swamp forest	40	1.12	beach seine, deep net, gill net, minnow trap	27	30.96	4.11	104.700	7.17	31	-	-	15
32	18° 31' 40.4" N, 71° 50' 16.5" W	-26.3	Hypersalt, green/gray	mud, swamp forest	10	0.50	beach seine	25	33.96	2.71	86.580	7.88	25	-	-	10
33	18° 26' 32.5" N, 71° 41' 0.8" W	-28.9	Hypersalt, green/gray	open lake	40	6.25	gill net	24	30.42	5.72	104.100	7.87	35	1.50 - 1.10	-	160
34	18° 26' 21.6" N, 71° 41' 9.0" W	-29.0	Hypersalt, green/gray	sand, shells, swamp forest	40	2.00	beach seine, gill net, minnow trap	24	30.46	5.11	104.200	7.84	35	-	-	20
35	18° 25' 13.7" N, 71° 38' 10.6" W	-31.4	Hypersalt, green/gray	sand, swamp forest	40	0.90	beach seine, cast net, deep net	25	30.49	4.41	105.800	7.83	31	0.30 - 0.25	-	30
36	18° 33' 32.0' N, 71° 43' 13.0" W	-19.7	Hypersalt, green/gray	mud, sand, swamp forest	40	5.00	gill net	38	31.07	6.89	104.400	7.70	33	1.13 - 1.00	-	216
37	18° 32' 3.6" N, 71° 43' 49.3" W	-	Hypersalt, green/gray	open lake	40	5.41	gill net	38	32.08	103.50	103.500	7.58	36	1.14 - 0.99	-	58
39	18° 29' 19.7" N, 71° 45' 51.7" W	-22.5	Hypersalt, green/gray	open lake	40	7.00	gill net	29	30.49	6.52	103.300	7.70	35	0.90 - 0.70	-	352
40	18° 29' 39.9" N, 71° 47' 47.4" W	-24.9	Hypersalt, green/gray	mud, sand, swamp forest	20	1.20	beach seine, cast net, deep net, minnow trap	30	30.23	10.39	97.280	7.75	34	0.33 - 0.25	-	20

Appendix 1. Continued. Environmental and ecological characteristics of collection sites in southern Dominican Republic in summer, 2010.

Site	Latitude Longitude	Altitude (m)	Water	Site Description	Sample area (m^2)	Sampling Depth (m)	Sampling Method	Air Temp. (°C)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	Conductivity (ms/cm)	pH	Salinity (‰)	Secchi Disk (m)	Current (m/sec)	Distance from Shore/Stream Width (m)
41	18° 28' 14.4" N, 71° 28' 51.7" W	-26.6	Hypersalt, green/gray	mud, swamp forest	20	0.76	beach seine, cast net, deep net	28	35.01	10.57	108.900	7.61	-	-	-	50
42	18° 27' 59.0" N, 71° 29' 52.4" W	-28.9	Hypersalt, green/gray	swamp forest	40	4.00	gill net	29	30.14	5.90	102.300	7.72	33	1.00 - 1.85	-	-
43	18° 28' 5.9" N, 71° 30' 21.1" W	-29.1	Hypersalt, green/gray	swamp forest	40	5.00	gill net	38	30.61	7.21	103.500	7.53	33	1.22 - 0.93	-	-
44	18° 27' 28.2" N, 71° 28' 44.9" W	-26.0	Hypersalt, green/gray	mud, swamp forest	15	0.57	cast net, deep net, minnow trap	31	31.88	3.83	98.570	7.43	11	0.45 - 0.33	-	10
45	18° 30' 21.6" N, 71° 48' 48.7" W	-30.6	Hypersalt, green/gray	mud, swamp forest	10	0.70	beach seine	25	26.39	8.79	1.924	7.61	2	-	-	10
46	18° 29' 49.4" N, 71° 48' 25.7" W	-30.5	Hypersalt, green/gray	mud, sand, swamp forest	25	0.80	beach seine, deep net	28	30.23	8.96	98.250	7.54	23	0.21 - 0.14	-	30
48	18° 24' 19.1" N, 71° 36' 9.1" W	-31.7	Hypersalt, green/gray	mud, swamp forest	25	0.57	beach seine	30	33.86	6.96	101.100	7.48	30	-	-	10
Enriquillo Lake Tributaries: 9-Asequia Pool, 10-Las Damas River, 11 Boca de Cachón Pool, 38-Boca de Cachón channel, 17-Las Barías River, 31-Azuey Lake, 47-En Medio Lagoon, 49-La Zurza Pool																
9	18° 16' 47.6" N, 71° 24' 21.2" W	-	freshwater, blue	gravel, forest	15	0.6 m	beach seine, deep net	26	22.97	7.33	0.971	5.89	0	-	-	15
10	18° 16' 47.6" N, 71° 24' 20.9" W	84.6	freshwater, blue-green	mud, forest	10	1.52 m	beach seine, cast net, deep net	18.5	19.15	7.88	0.564	6.22	0	-	-	10
11	18° 33' 21.7" N, 71° 50' 3.6" W	-17.4	freshwater, blue	gravel, rocks, riparian	10	1.52 m	beach seine, deep net	36	25.32	4.47	3.188	6.86	0	-	-	10
38	18° 32' 48.4" N, 71° 50' 0.9" W	-28.0	brackish, green gray	mud, riparian	30	1.25	beach seine, cast net, deep net	30	30.36	7.13	51.580	7.49	4	0.20 - 0.18	-	6
17	18° 33' 35.2" N, 71° 43' 29.4" W	-	freshwater, gray	gravel, muds, forest	10	1.22 m	beach seine, deep net	26	20.26	10.72	0.532	7.04	0	-	-	10
31	18° 29' 35.0" N, 71° 52' 8.9" W	-33.2	brackish, green gray	mud, grass, sand, swamp forest	10	0.75 m	beach seine	27	32.92	7.72	29.590	8.16	7	-	-	10
47	18° 25' 43.5" N, 71° 41' 58" W	4.3	brackish, green gray	mud, sand, swamp forest	25	0.35	beach seine	31	30.79	10.31	8.256	8.13	3	-	-	10
49	18° 23' 52.3" N, 71° 34' 12.1" W	-11.1	sulphuric, blue	gravel, riparian	25	2.00	beach seine	31	21.94	3.97	2.548	7.16	0	-	-	10
Yaque del Sur River																
51	18° 36' 45.9" N, 71° 0' 25.2" W	239.0	freshwater	grass, gravel, mud, riparian	30	0.51	beach seine, deep net	24	28.37	7.99	1.022	-	0	0.27 - 0.13	0.541	77
52	18° 34' 14.5" N, 70° 58' 56" W	209.0	freshwater	grass, gravel, mud, riparian	40	0.50	beach seine, cast net, deep net	28	26.40	9.22	1.055	8.32	0	0.20 - 0.16	-	75
54	18° 33' 30.4" N, 70° 58' 51.8" W	198.0	freshwater	grass, gravel, mud, sand, riparian	20	0.73	beach seine, deep net	31	30.19	9.01	1.066	7.20	0	-	0.578	70

Appendix 1. Continued. Environmental and ecological characteristics of collection sites in southern Dominican Republic in summer, 2010.

Site	Latitude Longitude	Altitude (m)	Water	Site Description	Sample area (m^2)	Sampling Depth (m)	Sampling Method	Air Temp. (°C)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	Conductivity (ms/cm)	pH	Salinity (‰)	Secchi Disk (m)	Current (m/sec)	Distance from Shore/Stream Width (m)
55	18° 31' 6.7" N, 71° 1' 13.5" W	-	freshwater	grass, gravel, mud, riparian	20	0.50	beach seine	25	29.89	7.70	1.049	7.43	0	0.31 - 0.17	-	76
57	18° 24' 6.9" N, 71° 11' 1.1" W	38.5	freshwater	grass, gravel, mud, sand, small rocks, riparian	50	0.71	gill net	-	30.19	10.31	1.168	7.73	0	-	0.380	65
58	18° 17' 57.7" N, 71° 10' 21.6" W	15.5	freshwater	mud, riparian	20	2.50	beach seine	29	30.20	-	1.750	7.65	0	0.26 - 0.15	0.330	20
59	18° 15' 10.3" N, 71° 13' 10.1" W	14.8	freshwater	gravel, mud, riparian	20	0.50	beach seine	27	30.71	7.95	1.249	7.54	0	0.20 - 0.11	-	34
60	18° 15' 11.9" N, 71° 8' 47.4" W	13.2	freshwater	mud, riparian	20	1.40	beach seine	27	30.93	6.94	1.336	7.42	0	0.18 - 0.12	-	35
71	18° 47' 3.7" N, 71° 3' 44.0" W	439.0	freshwater	gravel, mud, small rocks, riparian	20	0.50	beach seine, cast net	21	22.47	7.27	0.230	5.50	0	-	0.250	12
72	18° 50' 54.2" N, 71° 2' 8.3" W	479.0	freshwater	gravel, sand, small rocks, riparian	20	0.60	beach seine, deep net	19	20.75	6.37	0.182	5.12	0	-	0.540	12
73	18° 54' 25.3" N, 71° 1' 2.5" W	735.0	freshwater	gravel, small rocks, riparian	20	-	cast net	18	18.34	7.18	0.136	8.14	0	0.26 - 0.23	-	34
74	18° 40' 55.8" N, 71° 3' 2.9" W	319.2	freshwater	gravel, mud, sand, riparian	40	0.80	beach seine, cast net, deep net, gill net	29	26.10	5.15	0.539	8.40	0	0.36 - 0.29	-	58
75	18° 28' 30.5" N, 71° 3' 27.4" W	105.2	freshwater	gravel, small rocks, riparian	40	0.70	cast net	28	28.80	6.59	1.033	7.97	0	0.36 - 0.30	-	41
Yaque del Sur Tributaries: 50-El Salado																
50	18° 38' 3.0" N, 71° 1' 6.7" W	257.6	freshwater	grass, gravel, riparian	30	0.25	beach seine, deep net	27	30.26	3.97	3.244	8.23	0	0.26 - 0.20	0.617	11
53	18° 33' 29.1" N, 70° 58' 48.9" W	192.0	freshwater	grass, gravel, riparian	40	0.70	beach seine, cast net, deep net, gill net	32	31.49	8.12	2.012	7.41	-	-	0.059	15
56	18° 24' 50.7" N, 71° 8' 33.3" W	53.0	freshwater	gravel, mud, rocks, riparian	20	0.53	gill net	26	28.19	8.57	1.126	7.91	0	0.34 - 0.20	1.240	-
San Juan River																
62	19° 2' 23.9" N, 71° 18' 22.0" W	677.0	freshwater	gravel, sand, small rocks, riparian	30	0.60	beach seine, deep net	26	21.46	9.96	0.518	7.54	0	-	0.370	31
63	19° 0' 15.3" N, 71° 17' 37.3" W	654.0	freshwater	grass	10	0.50	beach seine, deep net	24	28.46	6.55	0.317	8.84	0	-	-	-
64	18° 57' 20.4" N, 71° 17' 7.2" W	564.4	freshwater	gravel, small rocks, sand, riparian	20	0.60	beach seine, cast net, deep net	21	26.78	7.02	0.396	6.83	0	-	-	25
65	18° 55' 11.5" N, 71° 15' 49.1" W	526.0	freshwater	gravel, small rocks, riparian	20	-	beach seine, cast net, deep net	21	23.23	0.26	0.262	6.66	0	-	0.540	28
66	18° 48' 25.7" N, 71° 14' 7.8" W	403.5	freshwater	gravel, sand	20	0.60	beach seine, cast net, deep net	20	25.58	7.44	0.817	8.17	-	-	0.630	19

Appendix 1. Continued. Environmental and ecological characteristics of collection sites in southern Dominican Republic in summer, 2010.

Site	Latitude Longitude	Altitude (m)	Water	Site Description	Sample area (m^2)	Sampling Depth (m)	Sampling Method	Air Temp. (°C)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	Conductivity (ms/cm)	pH	Salinity (‰)	Secchi Disk (m)	Current (m/sec)	Distance from Shore/Stream Width (m)
66	18° 48' 25.7" N, 71° 14' 7.8" W	403.5	freshwater	gravel, sand	20	0.60	beach seine, cast net, deep net	20	25.58	7.44	0.817	8.17	-	-	0.630	19
67	18° 44' 58.7" N, 71° 11' 35.3" W	370.0	freshwater	grass	20	0.70	beach seine, cast net, deep net	29	28.06	7.57	1.198	8.20	-	0.10 - 0.08	0.500	20
68	18° 43' 51.6" N, 71° 6' 50.8" W	342.0	freshwater	gravel, sand	20	0.80	beach seine, cast net	28	28.58	7.91	0.915	7.36	0	-	0.220	88
69	18° 43' 18.3" N, 71° 6' 21.2" W	331.7	freshwater	grass	5	-	cast net	28	29.32	6.48	0.932	7.96	0	-	-	44
Sabana Yegua Dam																
70	18° 42' 41.4" N, 71° 3' 16.1" W	395.8	freshwater	gravel	20	-	beach seine, cast net	21	29.87	17.45	0.554	8.12	0	-	-	63

Appendix 2. List of fishes encountered in southern Dominican Republic, including common names, ecological characteristics, and collection locations.

CLUPEIFORMES

Clupeidae.Peripheral.

Dorosoma petenense (Günther, 1867). Threadfin shad, Sardina de agua dulce.

Introduced. Anadromous, pelagic-neritic.

Cabral Lagoon.

Engraulidae.Peripheral.

Anchovia clupeoides (Swainson, 1839). Poey's anchovy, anchoa.

Native. Anadromous, benthopelagic.

Yaque del Sur River.

CYPRINODONTIFORMES

Poeciliidae. Secondary.

Gambusia affinis (Baird y Girard, 1853). Mosquitofish.

Introduced. Potadromous, benthopelagic.

Yaque del Sur River.

Gambusia hispaniolae Fink, 1971. Hispaniolan gambusia, baíta.

Endemic. Potadromous, benthopelagic.

Azuey Lake, Cabral Lagoon, Boca de Cachón, En Medio Lagoon, Enriquillo Lake, La Acequía , La Zurza, San Juan River, Yaque del Sur River.

Appendix 2. Continued. List of fishes.

Limia perugiae (Evermann& Clark, 1906). Perugia's limia,baíta.

Endemic. Potadromous, benthopelagic.

Azuey Lake, Boca de Cachón, Cabral Lagoon, En Medio Lagoon, Enriquillo Lake, La Acequía, Salado Creek, San Juan River, Yaque del Sur River.

Xiphophorus sp.

Endemic. Potadromous, benthopelagic.

San Juan River.

Limia sulphurophila Rivas, 1980. Sulfur limia, baíta.

Endemic. Potadromous, benthopelagic.

Enriquillo Lake, La Zurza.

Poecilia hispaniolana Rivas, 1978. Hispaniolan molly, baíta.

Endemic. Potadromous, benthopelagic.

Sabana Yegua Dam, Salado Creek, San Juan River, Yaque del Sur River.

Poecilia sp. new species,

Endemic. Potadromous, benthopelagic.

San Juan River, Yaque del Sur River.

Cyprinodontidae. Secondary.

Cyprinodon bondi Myers, 1935. Hispaniola pupfish, titicaco.

Endemic. Potadromous, benthopelagic.

Azuey Lake.

Appendix 2. Continued. List of fishes.

Cyprinodon sp.

Potadromous, benthopelagic.

Enriquillo Lake.

SYNGNATHIFORMES

Syngnathidae. Peripheral.

Microphis brachyurus (Kaup, 1856). Opossum pipefish.

Native. Canadromous, demersal.

Yaque del Sur River.

PERCIFORMES

Centropomidae. Peripheral.

Centropomus ensiferus Poey, 1860. Swordspine snook, róbalo.

Native. Amphidromous, bentopelagic.

Yaque del Sur River.

Cichlidae.Secondary.

Nandopsis haitiensis (Tee-Van, 1935). Haitian cichlid, biajaca.

Endemic. Potadromous, benthopelagic.

Azuey Lake, Boca de Cachón, Cabral Lagoon, En Medio Lagoon, Enriquillo Lake, La Acequía, Sabana Yegua Dam, Salado Creek, San Juan River, Yaque del Sur River.

Appendix 2. Continued. List of fishes.

Oreochromis aureus (Steindachner, 1864). Blue tilapia, tilapia.

Introduced. Potadromous, benthopelagic.

Boca de Cachón, Cabral Lagoon, En Medio Lagoon, Enriquillo Lake, Salado Creek, San Juan River, Yaque del Sur River.

Oreochromis mossambicus (Peters, 1852). Mozambique tilapia, tilapia.

Introduced. Potadromous, benthopelagic.

Cabral Lagoon.

*Oreochromis niloticus (*Linnaeus, 1758). Nile Tilapia, tilapia.

Introduced. Potadromous, benthopelagic.

Cabral Lagoon, Sabana Yegua, Salado Creek, San Juan, Yaque del Sur River

Tilapia rendalli (Boulenger, 1897). Redbreast tilapia, tilapia.

Introduced. Potadromous, benthopelagic.

Cabral Lagoon, Salado Creek, San Juan River, SabanaYegua Dam.

Eleotridae. Peripheral.

Dormitator maculatus (Bloch, 1792). Fat sleeper, mampeté.

Native. Amphidromous, demersal.

Azuey Lake.

Eleotris pisonis (Gmelin, 1789). Spinycheek sleeper, guavina negra.

Native. Amphidromous, demersal.

Yaque del Sur River.

Appendix 2. Continued. List of fishes.

Gobiomorus dormitor Lacépède, 1800. Bigmouth sleeper, guavina.

Native. Amphidromous, demersal.

Boca de Cachón, Enriquillo Lake, Yaque del Sur River.

Gobiidae.Peripheral.

Awaous banana (Valenciennes, 1837). River goby, sago.

Native. Amphidromous, demersal.

Salado Creek, Yaque del Sur River.

Ctengobius fasciatus Gill, 1858.Blotchcheek goby.

Native. Amphidromous, demersal.

Enriquillo Lake, San Juan River.

Mugilidae. Peripheral

Agonostomus monticola (Bancroft, 1834). Mountain mullet, dajao.

Native. Catadromous, rheophilic.

Arroyo Grande, Yaque del Sur River.

Appendix 3. Abundances of fish species collected (all gears combined) at study sites in southern Dominican Republic in summer, 2010.

	Enriquillo Lake																																	Yaque del Sur River Tributaires		
Specie	12	13	14	15	16	18	19	20	21	22	23	24	25	26	27	28	29	30	32	33	34	35	36	37	39	40	41	42	43	44	45	46	48	50	53	56
Dorosoma petenense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anchovia clupeoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gambusia affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gambusia hispaniolae	24	-	-	15	16	-	-	-	-	-	-	103	27	0	1247	-	-	104	42	-	43	44	-	-	-	47	-	-	-	2	3	-	41	-	-	-
Gambusia cf. *hispaniolae*	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-
Limia perugiae	115	-	-	226	15	-	-	-	-	-	2	318	11	-	2125	-	-	542	977	-	70	67	-	-	-	154	-	-	-	5	5	34	298	43	-	-
Limia sulphurophila	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poecilia hispaniolana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Poecilia cf. *hispaniolana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poecilia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xiphophorus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyprinodon bondi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyprinidon sp.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microphis brachyurus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Centropomus ensiferus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Centropomus cf. *ensiferus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nandopsis haitiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	3	-	-
Oreochromis mossambicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oreochromis niloticus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-
Oreochromis aureus	-	-	-	16	-	-	-	-	-	-	-	-	-	-	14	1	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	2	-	-
Tilapia rendalli	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Dormitator maculatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleotris pisonis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gobiomorus dormitor	-	-	-	-	1	-	-	-	-	-	-	1	4	-	21	-	-	-	-	-	33	-	-	-	-	13	-	-	-	1	33	157	4	-	-	-
Awaous banana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Ctenogobius fasciatus	-	-	-	-	1	-	-	-	-	-	-	-	-	-	4-	-	-	1	-	-	11	7	-	-	-	2	-	-	-	-	-	43	257	-	-	-
Agonostomus monticola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Appendix 3. Continued. Abundances of fish species collected(all gears combined) at study sites in southern Dominican Republic in summer, 2010.

	Cabrall Lagoon								Enriquillo Lake Tributaires								Yaque del Sur River													San Juan River								Sabana Yegua Dam
	1	2	3	4	5	6	7	8	9	10	11	17	31	38	47	49	51	52	54	55	57	58	59	6-	71	72	73	74	75	62	63	64	65	66	67	68	69	70
Dorosoma petenense	-	-	2	4	-	163	26	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anchovia clupeoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gambusia affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Gambusia hispaniolae	-	-	29	1	-	216	129	-	40	-	6	-	14	11	11	121	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	4	-	-	-	-	-
Gambusia cf. *hispaniolae*	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limia perugiae	-	-	52	133	-	72	25	-	123	-	21	-	257	148	144	-	-	38	56	1	3	19	-	-	1	-	-	16	-	-	311	1-	8	-	17	7	7	3
Limia sulphurophila	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poecilia hispaniolana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	-	-	-	-	-	18	-	-	2	-	92	-	36	283	-	2	16	4	1
Poecilia cf. *hispaniolana*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Poecilia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-	1	34	-	-	-	-	-
Xiphophorus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Cyprinodon bondi	-	-	-	-	-	-	-	-	-	-	-	-	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyprinidon sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microphis brachyurus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Centropomus ensiferus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Centropomus cf. *ensiferus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nandopsis haitiensis	1	1	2	2	-	1	-	-	3	-	15	-	1	4	1	-	2	12	3	1	-	-	-	-	1	-	-	3	1	-	7	9	1	-	5	8	17	2
Oreochromis mossambicus	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oreochromis niloticus	-	1	-	2	3	-	-	-	-	-	-	-	-	3	-	-	4	1	1	3	2	-	-	-	-	-	-	3	-	1	-	-	-	-	1	2	4	4
Oreochromis aureus	35	2	-	20	9	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Tilapia rendalli	5	1	7	47	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	-	-	-	32
Dormitator maculatus	-	-	-	-	-	-	-	-	-	-	-	-	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleotris pisonis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gobiomorus dormitor	-	-	-	-	-	-	-	-	-	-	7	10	-	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Awaous banana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	4	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Ctenogobius fasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-
Agonostomus monticola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	10	-	7	4	9	9	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-

Curriculum Vitae

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- Course in Marine Ecosystems: "Summer Ecosystem Experiences for Undergraduates" by the Center for Environmental Research and Conservation, Columbia, NY, USA, with the Center for Sustainability, in Punta Cana, DR. — May 24–Jul. 2, 2005

WORK EXPRERIENCE

- Assistant Professor. Universidad Autónoma de Santo Domingo, Biology Dept., Santo Domingo, DR. — Jun. 2005–Present
- Photographer and Database worker. http://insectdatabases.oeb.harvard.edu/caribbean/index.htm Harvard University, Museum of Comparative Zoology, Cambridge, MA. Project in DR. — Jan.2003-Jan.2009

PRESENTATIONS

- **Marmolejo, A***, Stewart, DJ. 2011. Community Assemblage Patterns of Inland Fishes in Southern Regions of the Dominican Republic. Oral presentation[1].
- **Marmolejo Hernández, A***, Ortíz Arias, RO, Rodríguez Peña, CM, Bastardo Landrau, RH. 2010. Feeding habits of *Poecilia elegans* in Masipedro River, Dominican Republic. Poster presentation[2].
- **Marmolejo Hernández, A***, Ortíz Arias, RO, Rodríguez Peña, CM, Bastardo Landrau, RH. 2008. Feeding habits of *Poecilia elegans* in Masipedro River, Dominican Republic. Oral presentation[3].
- **Marmolejo Hernández, A***, Karnauskas, M, Rodríguez Peña, CM. 2005. Ichthyology of Masipedro River. Oral presentation[4].

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*Presenter
[1]Joint Meeting of Ichthyologist and Herpetologist, Minneapolis, Minnesota, July 7, 2011.
[2]Spotlight Symposium Focuses on Student Research, Apr. 13, 2010. SUNY-ESF, Syracuse, NY, USA.
[3]VI Congreso de la Biodiversidad Caribeña. Jan. 31, 2008. Santo Domingo, DR.
[4] V Congreso de la Biodiversidad Caribeña. Jan. 27, 2005. Santo Domingo, DR.

- Karnauskas, M*, **Marmolejo Hernández, A**, Rodríguez Peña, CM. 2005. Trophic relationships of fishes of the genus *Poecilia* in the Dominican Republic. Oral presentation[4].
- Henríquez, DJ*, **Marmolejo Hernández, A**, Guerrero, KA, Veloz, D, Paulino, D, Wrobel, D, Naskrencki, P, Farrel, BD. 2005. Integrating science, education, conservation and ecotourism: student digitization of museum specimens from national parks in the Dominican Republic for an online database. Poster presentation[4].

HONORS AND AWARDS

- Apr.2010 Fulbright Research Grant. Award for summer research expenses (US$2,650).
- Aug.2009 Fulbright Program. Scholarship for a M.S. in Conservation Biology at SUNY-ESF.
- Feb.2005 Secretary of State of Higher Education, Science and Technology, RD Scholarship to study B.S. in Biology at Autonomous University of Santo Domingo (US $909.00 per year).
- 2002-2004 Autonomous University of Santo Domingo. Recognition of Academic Merit.

AFILIATIONS

American Society of Ichthyologists and Herpetologists
Dominican Association of Biologists
Biology Students Association.

SKILLS

Languages: Spanish-native, English-fluent, French-advanced.
Software: Microsoft Office, Photoshop, Minitab, ArcView, MANTIS, Auto-Montage.
Field Work: Camping, backpacking, snorkeling, collecting fishes and insects, banding birds.