Two-year comparative study of water quality levels of two streams in San Juan, Puerto Rico

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INTRODUCTION

Rivers and streams serve many functions; however, they are one of the water bodies most vulnerable to pollution[4]. Some of the factors that tend to affect streams are climatic conditions, agriculture and contaminating effects of industrialization. The alteration of stream habitats by industrialization is widespread due that now people tend to destroy nature to construct new buildings and establish industries. These changes not only affect the stream's surroundings but also have a strong impact on the water quality.

Streams also serve as home for plants, and aquatic animals such as macroinvertebrates. Interactions with physical, chemical, and biological variables, as well as interactions with other landscapes, the climate, the stream channel, the hyporheic zone, and riparian floodplains, affect the macrohabitat structure of a stream, thus affecting the distribution and abundance of macroinvertebrates. Through this research several physical, chemical and biological parameters were used to determine water quality. To compare water quality changes in two streams, Total Suspended Solids (TSS), Total Phosphorus (TP), water temperature and macroinvertebrate abundance and richness, were measured in a rural and urban stream.

These samples were taken through a two-year period from 2010-2012, with 2010-2011 data retrieved from "The effect of temperature over macroinvertebrate abundance of two streams in San Juan, Puerto Rico" (Rivera & Rosario, 2011). This study will facilitate observing and understanding how contamination continues to rise on both streams. Water quality is an issue of growing concern as global demand for water increases and freshwater resources become increasingly scarce. [1]

HYPOTHESIS

Water quality on both streams will have declined, compared to 2010-2011 data, due to recent construction projects on their locations.

MATERIAL AND METHOD

This research is based on the comparison of two streams through two different years, December 2010 through February 2011 and October 2011 through January 2012. The streams are PN_RivStrm_154 for Rivera stream, a rural stream (Fig. 1); and PN_SenStrm_49 for the Señorial stream (Fig. 2), an urban stream. Both streams are located in San Juan, P.R.

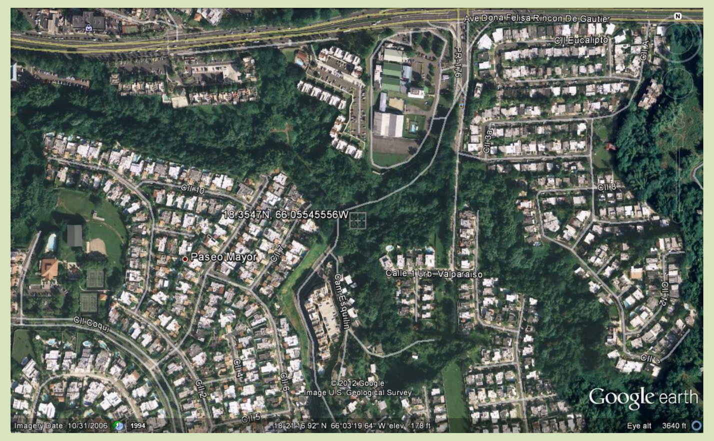

Fig. 1: PN_RivStrm_154 Stream

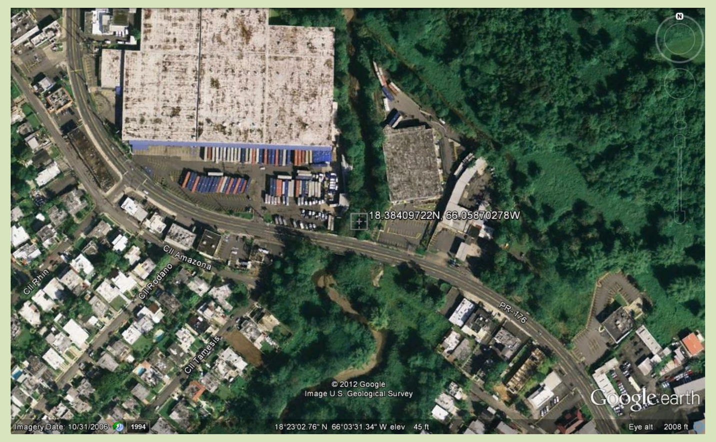

Fig. 2: PN_SenStrm_49 Stream

The first day of sampling a general description of the site, a physical characterization, water quality assessment, a visual assessment of the habitat and quantitative measurements of physical parameters were taken. In addition, samples of Total Suspended Solids (TSS), Total Phosphorus (TP), pH levels and air and water temperatures were taken. Water quality samples were done by filling three replicates of Total Phosphorus (TP), and three replicates of Total Suspended Solids (TSS). Additionally, air and water temperatures along with pH levels were measured with a Milwaukee® pH52 pH/ temperature meter.

Macroinvertebrate samples were taken the first sampling day at four different riffles of each stream. These were done for a period of thirty seconds per riffle holding a kick net to capture all organisms while scrubbing the rocks under the water. The samples were preserved in Whirl-pak® bags with 95% ethanol. Macroinvertebrates samples were counted and classified using the "Guide to Aquatic Invertebrates of the Upper Midwest". On the other hand, water samples were sent on refrigerated containers to be analyzed on the University of Vermont Water Quality Laboratory.

All the obtained data was organized using averages to compare the results obtained through the two-year research period.

RESULTS

The data demonstrates that water quality samples during 2011-2012 appear to be more contaminated compared with samples from 2010-2011. The air and water temperature were similar in both years; however, the temperatures in 2011-2012 appeared higher than those in 2010-2011. In addition, pH levels were higher on 2010-2011 than in 2011-2012, particularly in PN_SenStrm_49. The Total Phosphorus (TP) data showed a decrease in 2011-2012, mostly in the PN_SenStrm_49. A significant change of TSS values was observed in 2011-2012 compared to 2010-2011.

Macroinvertebrate abundance was higher during the 2010-2011 period. Nevertheless, on PN_RivStrm_154 there was greater richness compared to the other samples on the past year. Although 2011-2012 appeared more contaminated on some aspects, and had fewer macroinvertebrates, 2010-2011 had a greater total of *Diptera chironomidae*, which indicates more contamination. However, this year this species was the most abundant of all, indicating that the waters are still contaminated.

Year	2010-2011				2011-2012			
Stream	PN_RivStrm_154[5]		PN_SenStrm_49[5]		PN_RivStrm_154		PN_SenStrm_49	
Month	Air Temperature	Water Temperature	Air Temperature	Water Temperature	Air Temperature	Water Temperature	Air Temperature	Water Temperature
October	*	*	*	*	27.65	25.85	28.10	26.35
November	*	*	*	*	27.10	27.00	27.70	26.80
December	25.70	23.80	25.45	25.50	26.50	24.60	27.20	26.40
January	26.44	23.86	25.66	26.86	25.20	25.20	25.20	25.20
February	26.30	23.60	26.13	26.50	*	*	*	*
Total	26.15	23.75	25.75	26.29	26.61	25.66	27.05	26.19

Table 1: Comparison of air temperature (°C) and water of both streams between 2010-2011 and 2011-2012. *Sample was not collected.

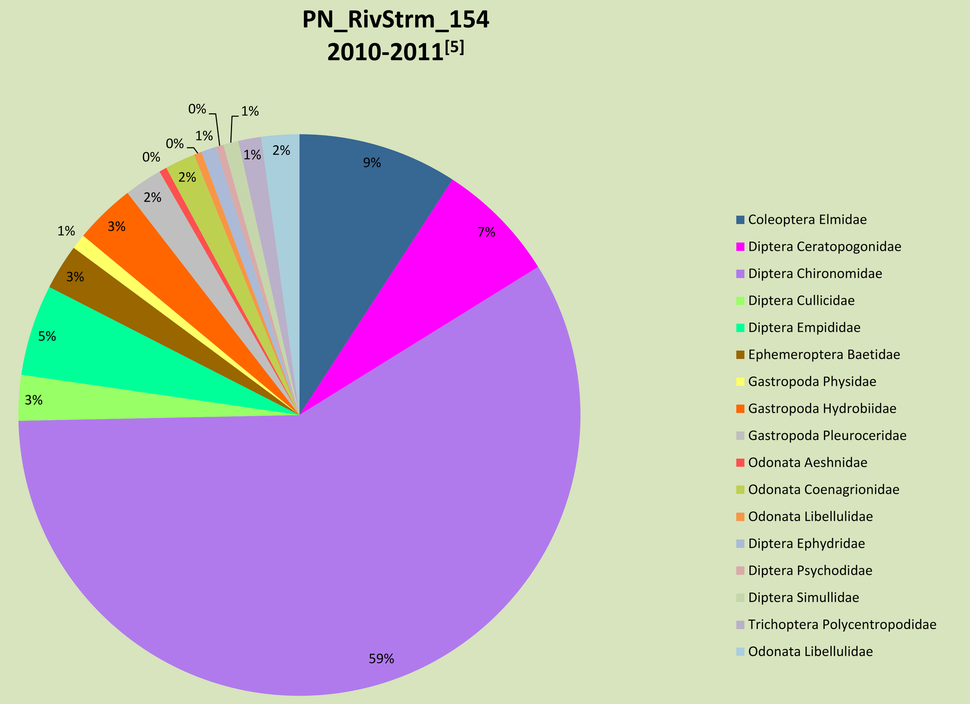

Fig. 3: Rivera Stream Macroinvertebrate Abundance

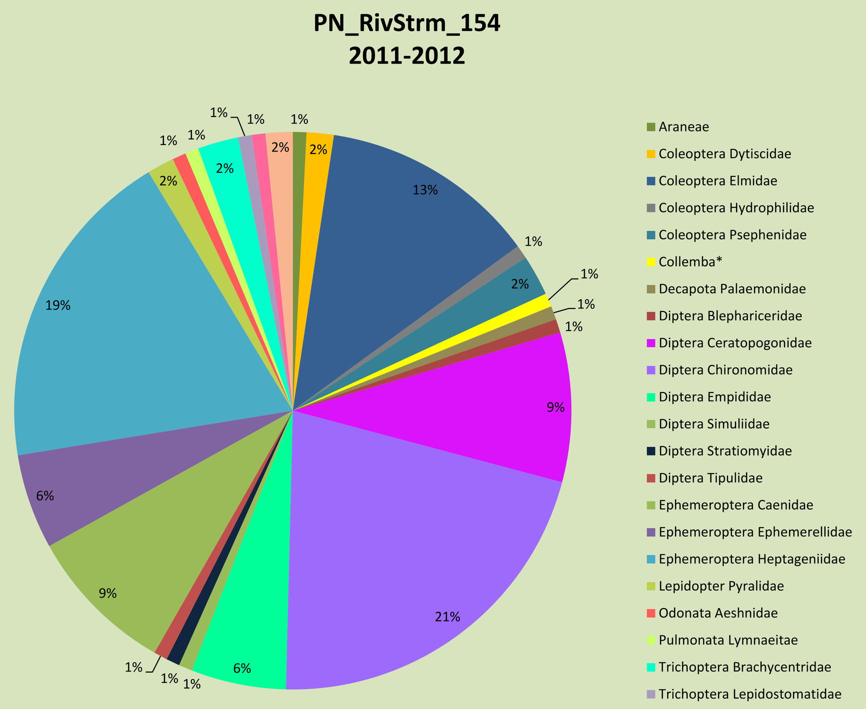

Fig. 4: Señorial Stream Macroinvertebrate Abundance

Months	2010-2011						2011-2012					
Stream	PN_RivStrm_154[5]			PN_SenStrm_49[5]			PN_RivStrm_154			PN_SenStrm_49		
Variable	pH	TSS	TP	pH	TSS	TP	pH	TSS	TP	pH	TSS	TP
October	*	*	*	*	*	*	7.6	40.97	117.88	7.85	41.87	91.67
November	*	*	*	*	*	*	7.50	41.27	103.94	8.00	42.74	122.10
December	8.4	2.60	110.44	8.7	3.37	266.10	7.20	38.23	84.38	7.90	45.67	102.05
January	7.34	0.99	118.97	7.72	4.25	330.79	7.70	39.20	78.98	7.70	50.40	95.21
February	7.98	0.87	125.56	8.35	20.74	167.28	*	*	*	*	*	*
Total	7.91	1.49	118.32	8.26	9.25	254.72	7.5	39.92	96.30	7.9	45.17	102.76

Table 2: Comparison of pH, TSS and TP of both streams between 2010- 2011 and 2011-2012. *Sample was not collected.

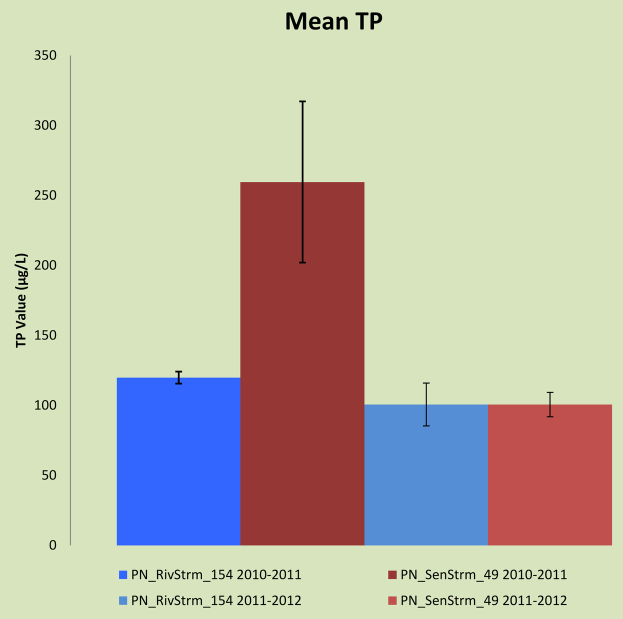

Fig. 4: Average TP with 95% confidence interval bars

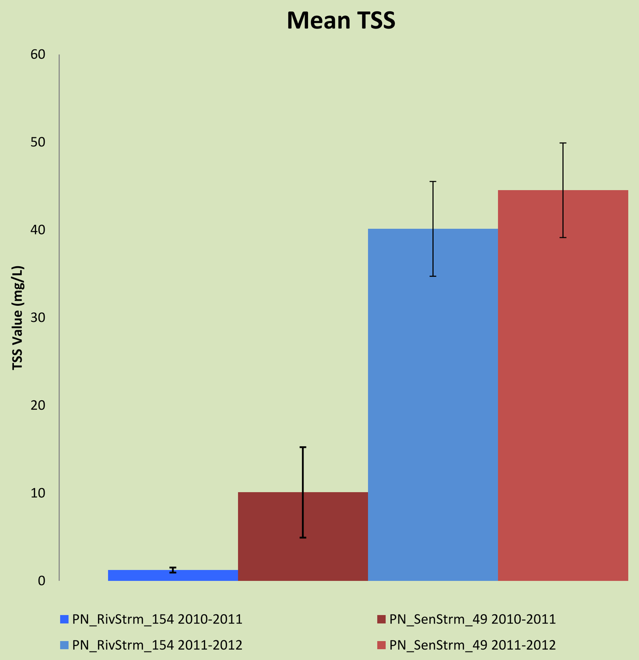

Fig. 5: Average TSS with 95% confidence interval bars

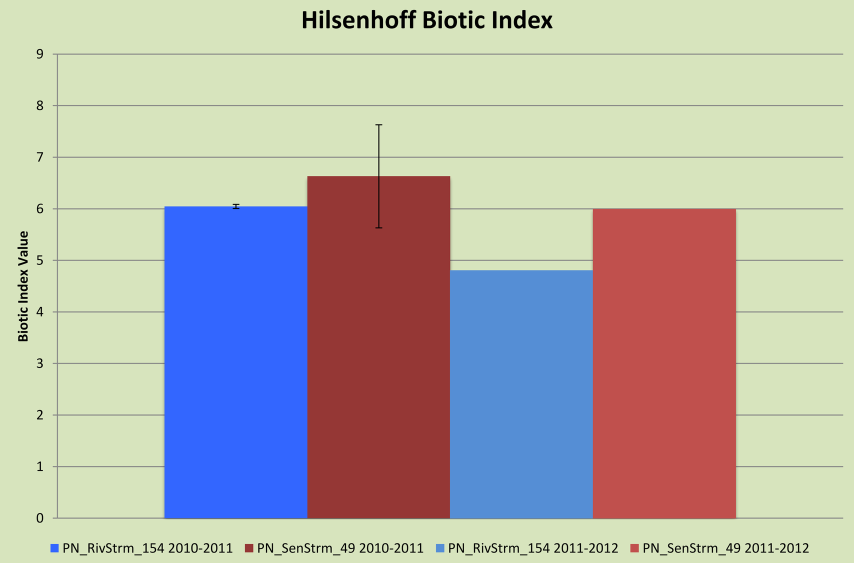

Fig. 6: Average Biotic Index Values with 95% interval bars

CONCLUSION

The results obtained through the analysis of the streams support the hypothesis that the 2011-2012 samples would be more contaminated than those of 2010-2011. The TSS difference between both years of sampling increased significantly, from an average of less than 10 to an average of more than 40. However, TP, pH levels, air temperature and water temperature remained almost the same. These results in TSS may be due to the fact that on both streams some constructions are being made. In addition to the constructions being made some deforestation took place on the right side of both streams. The damage made was so great that the stream dried up on the side of the deforestation, and where once there was deep water now people could easily walk. Nevertheless, there is not a precise explanation for the results of macroinvertebrates found on PN_SenStrm_49. It may have happened because of leakage of a toxic material on the days before the sampling, but the exact cause is not known. For this reason it is why more macroinvertebrates samples should be done, to have more samples to evaluate and determine the cause of the changes in abundance and richness of macroinvertebrates.

These results indicate the possible effect that industrialization and repair works on bridges may have on the streams quality and how it all affects the stream ecosystem. With this data we may devise a way of avoiding damage to stream ecosystems through promoting the decrease in human development around stream ecosystems.

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