

The Effects of Agriculture and Cattle Ranching;
Using Macro-Invertebrates to Evaluate the River
Quality

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RESUMEN:

Los ganaderos y la agricultura tienen influencias en la calidad del agua de los ríos. Las insectecidas y la basura de las vacas entran el río y lo sucian. Los macro-invertebridos pueden actuar a los indicios de la calidad y se puede identificar el nivel de la contaminación entre los ríos. En la region de las Abangares Costa Rica, los ganaderos y los granjeros comprenden la influencia de su trabajo en la contaminación de los ríos. Ellos han modificado y han creado otras maneras donde se puede practicar su trabajo sin tener un efecto negativo en los ríos. Cuando, investigué los ríos, encontré que los no tenían mucha contaminación. En vez de, los ríos reflectaban una calidad pura de la contaminación de productos organicos.

BACKGROUND INFORMATION:

Cattle ranching and agriculture are two of the main sources of income in the Abangares region of Costa Rica. The land of the Abangares is very hilly and mountainous, which could lead to the potential run-off of pesticides, fertilizers, and dirt into the rivers. The United States has similar problems with its farmers and ranchers.

Cattle ranching effects the quality of rivers in two ways. First, in the provision of drinking water for the livestock; and secondly, for the irrigation of the fields used to feed the cattle¹. The area surrounding a river on a cattle ranch can be classified as either grazed or un-grazed. Grazed streamside areas pollute the water directly with livestock wastes, as well as indirectly by the trampling of the stream bank². Grazed streamside areas also can remove vegetation that shades streams and filters sediments, which only

¹ Freilich

² Grazing Endangers Southwest

leads to further degradation of the aquatic habitat. On the other hand, un-grazed streamside areas help to stabilize the stream banks by helping to reduce flood damage. Un-grazed streamside areas also filter sediments providing a renewable source of clean water².

Don Modesto, a cattle rancher in the Abangares area, recognizes the effect of un-grazed streamside areas. His ranch is composed of twenty hectars, three of which are dedicated to protecting the river. The cattle have no interaction with the river at all. The water from the river is routed to the cattle, this way they do not contaminate the river with diseases or their waste. Since the cattle of Don Modesto's farm only eat what is grown for them on their plot of land (meaning no hormones or introduced food), Don Modesto devised a rotation system to protect his ranching land. His land is broken up into different plots. Every three days the cattle are relocated to a different plot of land, and in twenty-seven days the cattle are permitted to return to the original plot of land. This system of cattle ranching exhibited by Don Modesto is typical of most Costa Rican ranchers and helps to minimize the contamination of the rivers³.

Farming also provides a stress to the quality of a river. Farming leads to an "increased discharge of sediments and plant nutrients from watersheds contributing to pollution of lakes, estuaries, and costal ecosystems"⁴. The largest problem with farming is the use of herbicides and insecticides. Similar with cattle ranching, Costa Rican farmers seem very knowledgeable of these problems. On his farm, Miguel Salazar Nuñez uses a minimal amount of herbicides. He explained how there are restrictions on which chemicals can be used, the contents of the restricted chemicals is constantly

³ Don Modesto

⁴ Smithsonian Environmental Research Center

⁵ Miguel Salazar Nuñez

changing. Also, herbicides are applied to his plants only once every eight days. This leads to a minimal contamination of the nearby rivers⁵.

PROCEDURE:

Two Muhlenberg College students (Melissa Koberle and Stephanie Zettel) had previously tested the quality of the rivers of Las Juntas Abangares using macro-invertebrates as biological indicators. The presence, condition, and diversity of fish, insects, plants and algae help to provide information about the health of the water. Most species have certain requirements for life, such as oxygen concentration or pollutants, and can only live if these conditions are met⁶. Macro-invertebrates serve as good biological indicators of water quality because they live in water all, or most, of their life with limited mobility. Benthic macro-invertebrates can indicate whether water is clean, or unpolluted by organic wastes. Organic wastes tend to cause a decrease in oxygen available for the benthos.⁷

Both Melissa and Stephanie had found the overall quality of the rivers to be unpolluted. The same locations that had been tested in the past were once again studied to identify if there had been a change in river quality. The seven locations examined were: the high school bridge, Aguas Calientes – by the bridge, Gloria – downstream from the waterfall, El bueno – near the entrance to the Ecomuseo, the second crossing of the Ecomuseo, Aguas Claras – after the toma, and el Río Boston – before it joins with Aguas Claras. A small kick net was placed in the water to collect the samples. The rocky bottom was kicked in front of the net, stirring up the benthos, so that with the flow of the river would capture the macro-invertebrates that had been disrupted. The sample

⁶ Hellowell

⁷ EPA Online

was then put in a container with water, and later identified using the Environmental Protection Agency's handouts for macro-invertebrates intolerant, moderate, and tolerant to organic pollutants. Two samples were taken from each site; one where the current was fairly strong, and one where the current was weaker.

The most important thing to recognize about the results from this experiment is that the data is qualitative, not quantitative. So basically, what was found is of much greater relevance than how much was found. This is mainly because some macro-invertebrates can be found more often than others, or in larger amounts⁷. Also, a macro-invertebrate who is moderately tolerant to organic pollutants does not mean that it was found in a moderately polluted area. But rather, that the particular creature would be *capable* of surviving in a location that was moderately polluted.

DATA:

High School Bridge

Flow***	2
Dissolved Oxygen Level	Varied Average ~ 94.1% 7.29 mg/L
Macro-invertebrates Found	Significance
Dobsonfly	Sensitive
Rifle Beetle Larvae (3)	Sensitive
Dragonfly Nymph	Moderate
Adult Alderfly (3)	Sensitive
Alderfly Larvae	Sensitive
Rifle Beetle Adult	Sensitive
Stonefly Nymph (5)	Sensitive
Mayfly Nymph (3)	Sensitive
Snipefly	Sensitive

Aguas Calientes

Flow***	1.5
Dissolved Oxygen Level	86.4% 6.43 mg/L
Macro-invertebrates Found	Significance
Mayfly larvae	Sensitive
Dragonfly nymph	Moderate

Observation: Little striped fish were found here

Gloria

Flow***	2
Dissolved Oxygen Level	99.5% 7.98 mg/L
Macro-invertebrates Found	Significance
Water penny beetle	Sensitive
Rifle Beetle Larvae (6)	Sensitive
Snipefly	Sensitive
Stonefly Nymph (3)	Sensitive
Mayfly Nymph (4)	Sensitive

El Buente

Flow***	2
Dissolved Oxygen Level	85.0 % 3.03 mg/L
Macro-invertebrates found	Significance
Water penny beetle (3)	Sensitive
Dobsonfly	Sensitive
Cranefly	Moderate
Rifle Beetle Larvae	Sensitive
Stonefly Nymph	Sensitive
Mayfly Nymph	Sensitive

Observation: Little fish were found here

Second Crossing

Flow***	3
Dissolved Oxygen Level	97.8 % 8.22 mg/L
Macro-invertebrates Found	Significance
Mayfly	Sensitive
Rifle Beetle (3)	Sensitive
Rifle Beetle Larvae	Sensitive
Mayfly Nymph	Sensitive
Alderfly Larvae (2)	Sensitive

Aguas Claras (after Toma)

Flow***	3
Dissolved Oxygen Level	91.0 % 7.59 mg/L
Macro-invertebrates Found	Significance
Rifle Beetle Larvae	Sensitive
Stonefly (2)	Sensitive
Alderfly	Sensitive

Boston River

Flow***	3
Dissolved Oxygen Level	97.3% 8.19 mg/L
Macro-invertebrates Found	Significance
Rifle Beetle	Sensitive
Rifle Beetle Larvae (3)	Sensitive
Alderfly	Sensitive

NOTE:

When samples were taken from the second crossing, Aguas Claras, and the Boston River it was raining quite hard.

*** Flow based on a 1-5 scale

DISCUSSION AND CONCLUSION:

The stonefly is a macro-invertebrate that is sensitive to organic pollutants. The presence of stoneflies also indicates an ample supply of oxygen⁷. Stoneflies were found at the High School Bridge, Gloria, El Buente, and Aguas Claras. Except for El Buente, the data corresponds with locations with high dissolved oxygen levels. Stoneflies are also important because they act as food for fish⁷. Out of the locations where stoneflies were found, fish were also noted at El Buente and Aguas Claras.

The water penny beetle, a macro-invertebrate sensitive to organic pollutants, also indicates an ample supply of oxygen⁷. Water penny beetles were collected at Gloria, El Buente, Aguas Claras, and the Boston River. Once again, El Buente housed a macro-invertebrate that indicated higher levels of oxygen. Perhaps there was a contradiction due

to the fact that even though El Buente had the lowest level of oxygen from the seven sampling locations, it still contained what would be considered a high level of dissolved oxygen.

Mayflies can display a varied tolerance to pollution, but are normally found in cleaner water⁷. For that reason, they are also considered sensitive benthos. Mayflies were found at several of the sampling sites: High School Bridge, Aguas Calientes, Gloria, El Buente, and the Second Crossing.

Dobsonflies are sensitive benthos that are considered to be fairly intolerant to pollution⁷. They were found at the High School Bridge and El Buente. Dobsonflies generally feed upon other macro-invertebrates⁷. This is most likely why they were found at two locations where there were diverse findings of other macro-invertebrates.

Alderflies are also considered to be intolerant to pollution⁷. Alderflies were collected at the High School Bridge, the Second Crossing, Aguas Claras, and the Boston River. Like the dobsonfly, alderfly larvae are aggressive predators and feed upon smaller macro-invertebrates⁷.

Rifle beetles are unique in the fact that both larvae and adults are found readily in water. They are considered to be another sensitive benthos, and indicate an ample supply of oxygen. They are generally found in faster moving waters⁷. Rifle beetles, or their larvae were found at each sampling site, except for that of Aguas Calientes.

Only two benthos that indicate moderate levels of organic pollution were found in all of the sampling sites. Dragonfly nymphs are found in slower moving water and usually indicate lower levels of dissolved oxygen⁷. They were found at the High School Bridge and Aguas Calientes. The High School Bridge also housed macro-invertebrates who

indicated higher levels of oxygen. This contradiction most likely occurred because at the High School Bridge there were variations in the levels of dissolved oxygen, and the numbers that were presented (94.1%, 7.29 mg/L) represented an average. The other moderate indicator found was the crane fly. Crane flies, although indicating moderately clean water, are seldom found in polluted water⁷.

Overall, the water of Las Juntas Abangares was found to be very clean of organic pollutants. This also coincides with the results from the previous two testings. This means that in the past three years the levels of organic pollution has not accumulated. The cattle ranchers and farmers seem to be very aware of the problem with the contamination of the rivers. They recognize the fact that they are not the only ones who benefit from the rivers, that other farmers/ranchers, as well as village citizens use the river water³. There are other options to even further minimize the effects of farming on the river quality. For example, Mercedes Arias Gonzales had a small hydroponic farm. However, this is a very inefficient means of farming for those whose income relies solely on their produce. These types of farms not only require a tremendous amount of work, but also produce a smaller yield of crops⁸.

Even though cattle ranching and farming do their part in contaminating the river, the people of Las Juntas Abangares are knowledgeable and have made adaptations to keep their rivers clean of organic pollutants.

⁸ Mercedes Arias Gonzales

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