STREAM MONITORING TOOLS FOR CITIZEN SCIENCE

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THE IMPORTANCE OF CITIZEN SCIENCE

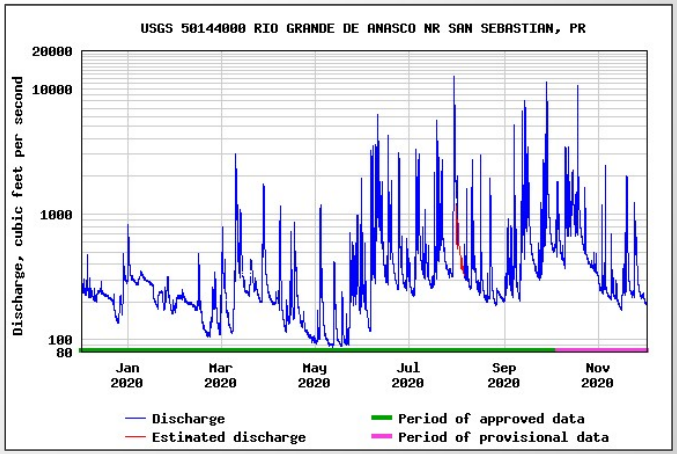
- Provides outreach and education opportunities
  - For a better understanding of natural systems
  - For fostering environmental stewardship
  - For showcasing career opportunities in science
- Expand capacity spatially and temporally
  - For data collection within a research project
  - For monitoring within a management project

https://sites.rutgers.edu/books-we-read/citizen-science-participatory-science-a-primer/

CITIZEN SCIENCE FOR STREAM ASSESSMENTS

- Citizen Science allows us to expand stream research and monitoring capacity:
  - Large scales: to address the same question on multiple sites
  - Across gradients: to determine non-point source pollution problems
  - Across time: to capture temporal variability

Source: Schubart et al 2011. Shallow phylogeographic structure of Puerto Rico freshwater crabs: an evolutionary explanation for low species diversity compared to Jamaica



CONSIDERATIONS FOR CITIZEN SCIENCE

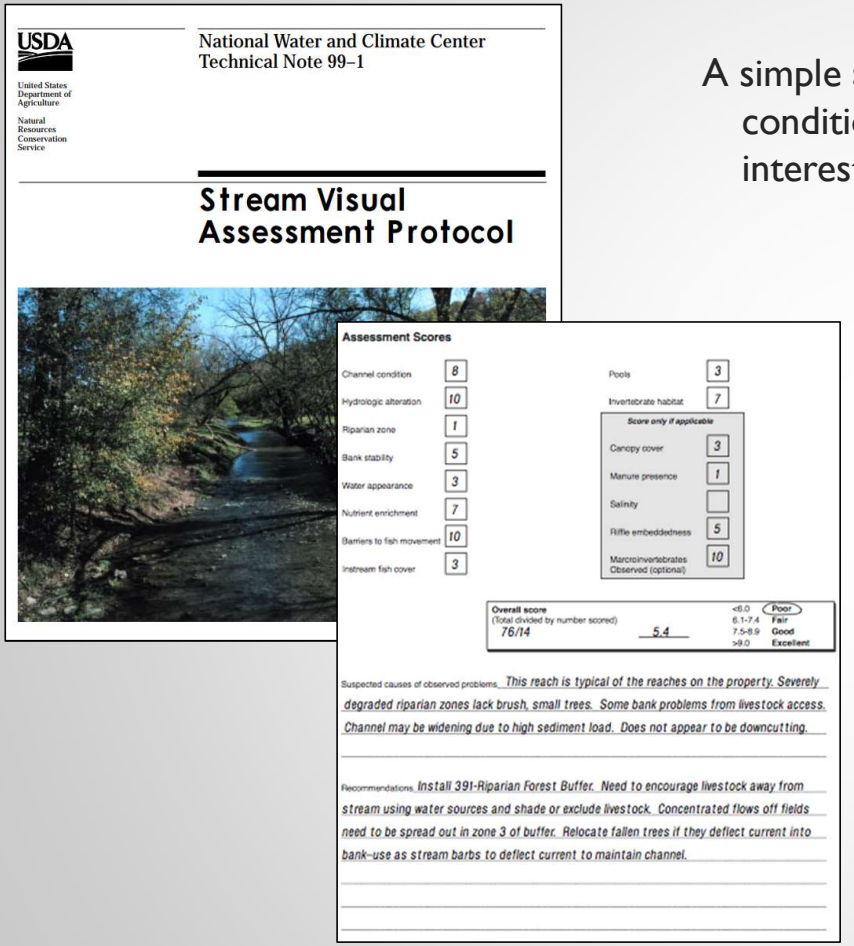
- **Cost Effectiveness**: Are the tools required affordable?
- **Expertise requirement**: Can the methods be replicated by non-experts?
- **Time commitment**: Are the methods time intensive?
- **Effectiveness:** Is the information useful?

OBJECTIVES

- **To evaluate tools that fit these three requirements: <u>Cost Effectiveness, Easy, and Rapid</u>.**

- **To describe how they relate to other more costly, time intensive tools, (which may also require specialized skills).**

STREAM VISUAL ASSESSMENT PROTOCOL (SVAP)



USDA

United States Department of Agriculture

Natural Resources Conservation Service

National Water and Climate Center
Technical Note 99–1

Stream Visual Assessment Protocol

Assessment Scores

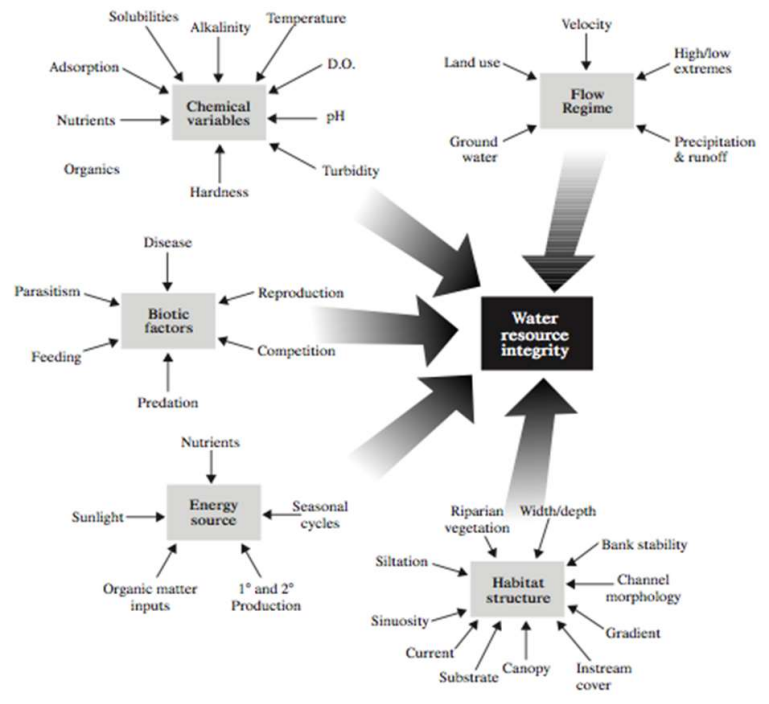
Channel condition	8	Pools	3
Hydrologic alteration	10	Invertebrate habitat	7
Riparian zone	1	*Score only if applicable*	
Bank stability	5	Canopy cover	3
Water appearance	3	Manure presence	1
Nutrient enrichment	7	Salinity	
Barriers to fish movement	10	Riffle embeddedness	5
Instream fish cover	3	Macroinvertebrates Observed (optional)	10

Overall score (Total divided by number scored)			
76/14	5.4	<6.0	Poor
		6.1-7.4	Fair
		7.5-8.9	Good
		>9.0	Excellent

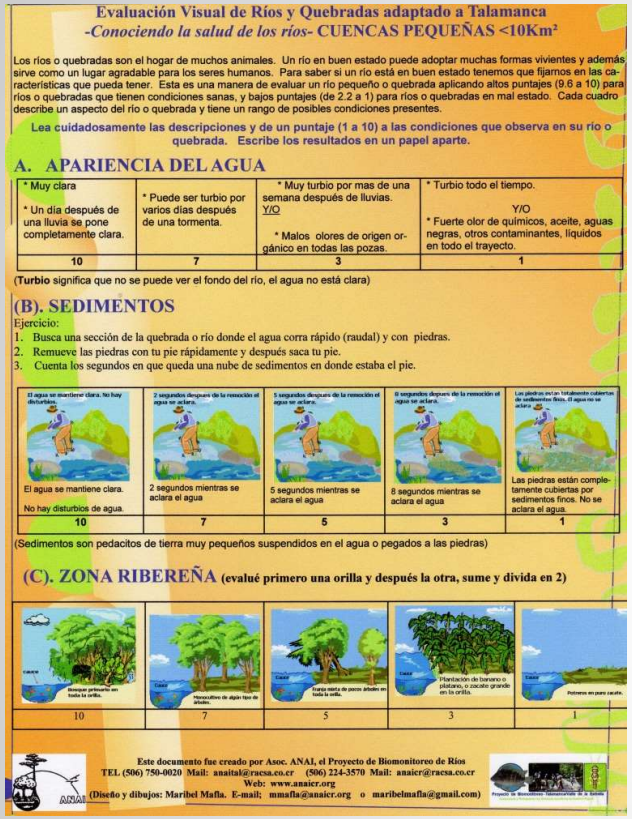
Suspected causes of observed problems. *This reach is typical of the reaches on the property. Severely degraded riparian zones lack brush, small trees. Some bank problems from livestock access. Channel may be widening due to high sediment load. Does not appear to be downcutting.*

Recommendations. *Install 39'-Riparian Forest Buffer. Need to encourage livestock away from stream using water sources and shade or exclude livestock. Concentrated flows off fields need to be spread out in zone 3 of buffer. Relocate fallen trees if they deflect current into bank–use as stream barbs to deflect current to maintain channel.*

A simple assessment methodology intended to evaluate the physical condition of a stream and provide this information to landowners interested in managing streams within their property.



STREAM VISUAL ASSESSMENT PROTOCOL (SVAP)



Evaluación Visual de Ríos y Quebradas adaptado a Talamanca
***-Conociendo la salud de los ríos-* CUENCAS PEQUEÑAS <10Km²**

Los ríos o quebradas son el hogar de muchos animales. Un río en buen estado puede adoptar muchas formas vivientes y además sirve como un lugar agradable para los seres humanos. Para saber si un río está en buen estado tenemos que fijarnos en las características que pueda tener. Esta es una manera de evaluar un río pequeño o quebrada aplicando altos puntajes (9.6 a 10) para ríos o quebradas que tienen condiciones sanas, y bajos puntajes (de 2.2 a 1) para ríos o quebradas en mal estado. Cada cuadro describe un aspecto del río o quebrada y tiene un rango de posibles condiciones presentes.

Lea cuidadosamente las descripciones y de un puntaje (1 a 10) a las condiciones que observa en su río o quebrada. Escribe los resultados en un papel aparte.

A. APARIENCIA DEL AGUA

* Muy clara * Un día después de una lluvia se pone completamente clara.	* Puede ser turbio por varios días después de una tormenta.	* Muy turbio por mas de una semana después de lluvias. Y/O * Malos olores de origen orgánico en todas las pozas.	* Turbio todo el tiempo. Y/O * Fuerte olor de químicos, aceite, aguas negras, otros contaminantes, líquidos en todo el trayecto.
10	7	3	1

(**Turbio** significa que no se puede ver el fondo del río, el agua no está clara)

(B). SEDIMENTOS

Ejercicio:
1. Busca una sección de la quebrada o río donde el agua corra rápido (raudal) y con piedras.
2. Remueve las piedras con tu pie rápidamente y después saca tu pie.
3. Cuenta los segundos en que queda una nube de sedimentos en donde estaba el pie.

El agua se mantiene clara. No hay disturbios.	2 segundos después de la remoción el agua se aclara.	5 segundos después de la remoción el agua se aclara.	8 segundos después de la remoción el agua se aclara.	Las piedras están totalmente cubiertas de sedimentos finos. El agua no se aclara.
El agua se mantiene clara. No hay disturbios de agua.	2 segundos mientras se aclara el agua	5 segundos mientras se aclara el agua	8 segundos mientras se aclara el agua	Las piedras están completamente cubiertas por sedimentos finos. No se aclara el agua.
10	7	5	3	1

(Sedimentos son pedacitos de tierra muy pequeños suspendidos en el agua o pegados a las piedras)

(C). ZONA RIBEREÑA (evalué primero una orilla y después la otra, sume y divida en 2)

Bosque primario en toda la orilla.	Monocultivo de algún tipo de árboles.	Trapiz más de pocos árboles en toda la orilla.	Plantación de banano o plátano, o zacate grande en la orilla.	Potreros en puro zacate.
10	7	5	3	1

Este documento fue creado por Asoc. ANAI, el Proyecto de Biomonitoreo de Ríos
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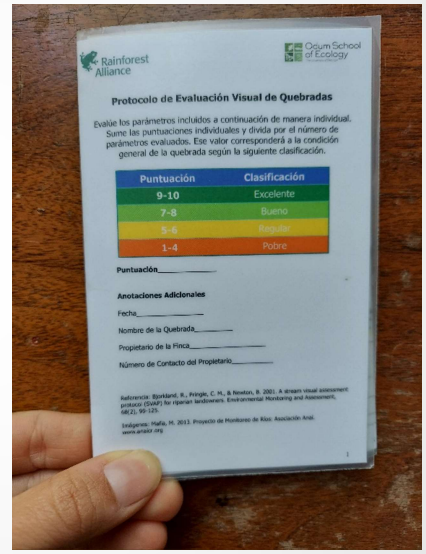
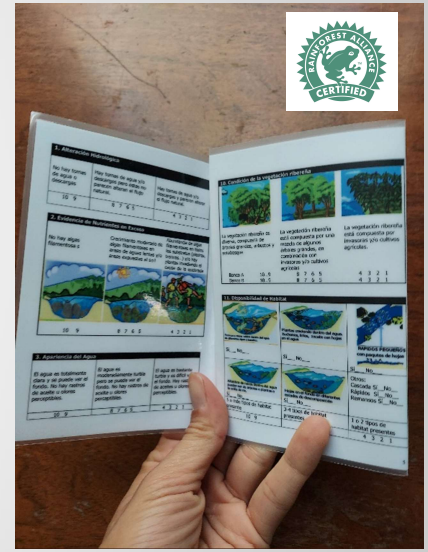
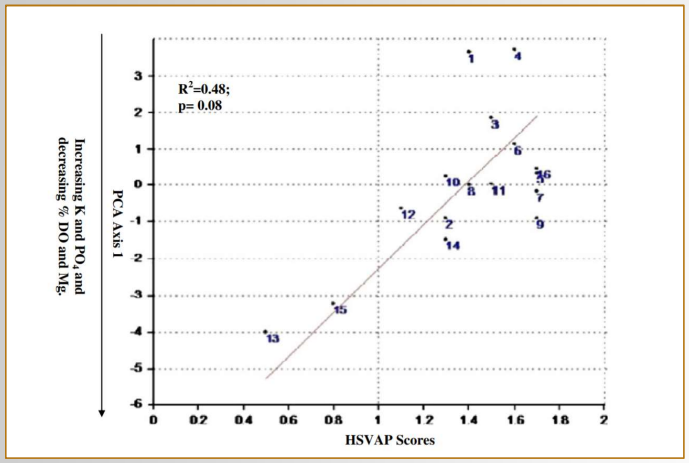




- The tool has been previously translated in Spanish and illustrated (*Asociacion ANAI*, Costa Rica).
- I developed a version of the Spanish SVAP into a pocket size guide for use by managers as part of my research projects with the Rainforest Alliance

SVAP IN THE RIO PIEDRAS WATERSHED, PUERTO RICO



- On the urban streams of the Rio Piedras watershed in Puerto Rico we found good correlations between the SVAP scores and:
  - Water quality parameters: Dissolved Oxygen, and Phosphates.
  - Benthic fauna: Family Biotic Index (FBI), Family Diversity, and Family Richness
- de Jesús-Crespo, R., & Ramirez, A. (2011). The use of a Stream Visual Assessment Protocol to determine ecosystem integrity in an urban watershed in Puerto Rico. Physics and Chemistry of the Earth, Parts A/B/C, 36(12), 560-566.

Regression coefficients of macroinvertebrate metrics and individual variables within the HSVAP: A. turbidity, B. eutrophication, C. channel condition, D. flow alteration, E. channel stability, F. canopy cover, G. riparian condition, H. available habitat and I. litter/trash.

	Total value	A	B	C	D	E	F	G	H	I
FBI	$r^2 = 0.32$ $p = 0.02$	$r^2 = 0.01$ $p = 0.65$	$r^2 = 0.20$ $p = 0.22$	$r^2 = 0.20$ $p = 0.08$	$r^2 = 0.018$ $p = 0.10$	$r^2 = 0.03$ $p = 0.49$	$r^2 = 0.06$ $p = 0.34$	$r^2 = 0.11$ $p = 0.19$	$r^2 = 0.49$ $p = 0.002$	$r^2 = 0.05$ $p = 0.38$
Diversity	$r^2 = 0.30$ $p = 0.03$	$r^2 = 0.01$ $p = 0.97$	$r^2 = 0.28$ $p = 0.03$	$r^2 = 0.42$ $p = 0.006$	$r^2 = 0.29$ $p = 0.03$	$r^2 = 0.10$ $p = 0.21$	$r^2 = 0.00$ $p = 0.93$	$r^2 = 0.28$ $p = 0.03$	$r^2 = 0.27$ $p = 0.04$	$r^2 = 0.00$ $p = 0.91$
# of Families	$r^2 = 0.24$ $p = 0.05$	$r^2 = 0.002$ $p = 0.99$	$r^2 = 0.09$ $p = 0.24$	$r^2 = 0.31$ $p = 0.02$	$r^2 = 0.25$ $p = 0.04$	$r^2 = 0.27$ $p = 0.04$	$r^2 = 0.00$ $p = 0.87$	$r^2 = 0.14$ $p = 0.15$	$r^2 = 0.32$ $p = 0.02$	$r^2 = 0.00$ $p = 0.79$

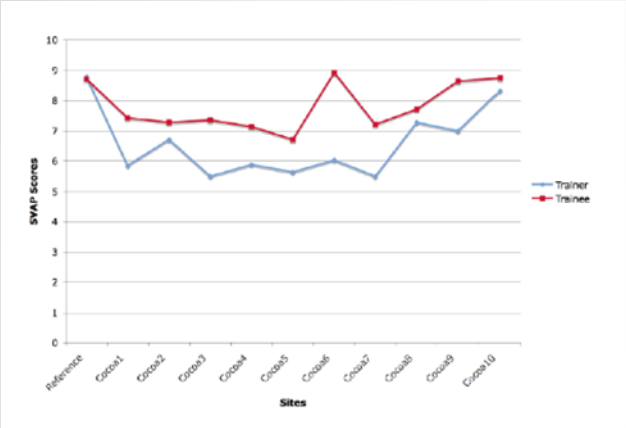
SVAP IN THE PIRRIS WATERSHED, COSTA RICA

- On the coffee agriculture streams of Pirris watershed in Costa Rica we did not find good correlations between the SVAP scores and measures of water quality, but we were more limited in the number of measurements we were able to undertake.
- We found correlations between the % of shredder taxa and the SVAP. Subsequent studies on these streams showed that in fact, shredders tend to respond to riparian canopy pruning practices, which can be detected by the SVAP.

TABLE 2.6. Correlation coefficients (r_s) between physicochemical and biological response variables and the SVAP scores across coffee streams (N=15) and in a forested reference site in the Pirris watershed, Costa Rica. *P ≤0.05.

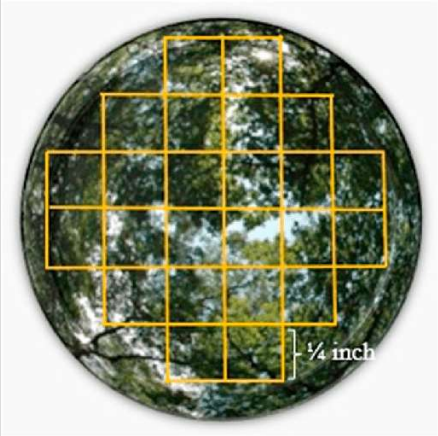
Response Variables	Correlation Coefficients	
PHYSICOCHEMICAL	r_s	p
Turbidity	-0.17	0.52
Conductivity	-0.12	0.66
pH	0.14	0.57
%Fine Substrates	-0.10	0.75
BIOLOGICAL		
Richness	-0.17	0.52
Diversity	0.05	0.86
% dominance	-0.04	0.86
% Predators	0.15	0.91
%Shredders	0.50	*0.05
%Simuliidae	0.05	0.86
Baetidae/Ephemeroptera	0.36	0.17
Hydropsychidae/Trichoptera	-0.16	0.56
%EPT	0.04	0.89
FBI	-0.29	0.27
BMWP	-0.25	0.35

SVAP INTER-RATER BIAS



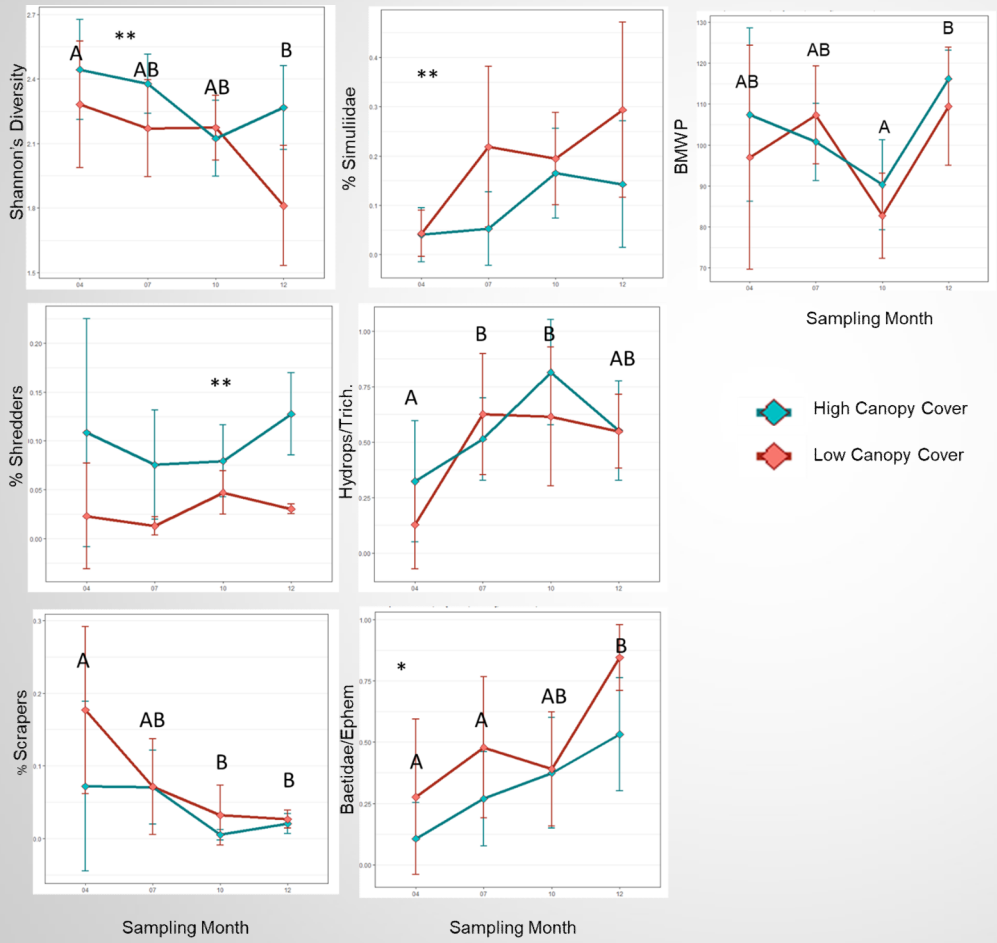
- We assessed inter-rater bias in conducting the SVAP in cocoa farms in Ghana.
- Inter rater bias: Different people may have different perceptions of condition.
- This issue can be solved by having multiple people conduct the evaluation on a given site.

DENSIOMETER TO MEASURE CANOPY COVER



- Canopy cover is an important component of the aquatic ecosystem, especially for small streams.
- It helps regulates temperature, and provides food sources and woody debris.
- In order to quantify canopy cover in urban and agricultural streams we used a concave densitometer.
- This device is easy to use, and relatively inexpensive.

DENSIOMETER TO MEASURE CANOPY COVER



- We used canopy cover as an indicator of riparian buffer management in coffee streams in Costa Rica.
- Richness, diversity, and % shredder-detritivores, were **positively related to Canopy Cover.**
- % dominance ,% Simuliidae , and Baetidae/ Ephemeroptera ratio, was **negatively related to canopy cover.**

SECHI TUBE TO MEASURE WATER CLARITY

- Sediment is one of the main pollutants found in both agricultural and urban streams. It affects light penetration, visibility, and degrades benthic habitat.
- A commonly used approach to determine sedimentation problems is to estimate water clarity.
- Water clarity can be measured using turbidity probes, but these can be expensive and difficult to maintain and operate.
- Sechi tubes are an inexpensive tool to measure water clarity that can be applied by anyone at any time.

SECHI TUBE

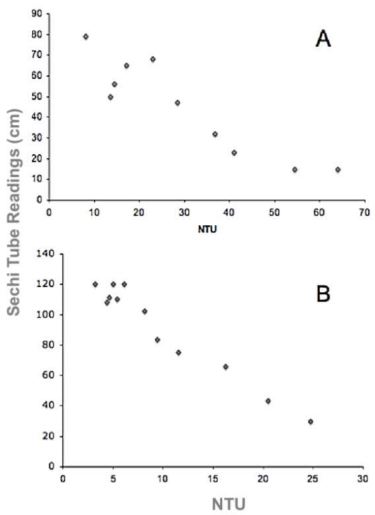


FIGURE 4.2. Correlations between NTU readings from a probe and water clarity readings from a Secchi tube in Ghana (A; R^2=0.49, p<0.009, N=11) and Costa Rica (B; R^2=0.95, p<0.001, N=12). Note lower Secchi tube readings and higher NTU values both indicate high turbidity.

- We used sechi tubes and turbidity probes in coffee streams of Costa Rica, and cocoa streams in Ghana, as part of our work with the Rainforest Alliance.
- We found strong correlations between the two methods, suggesting that the sechi tube is a good alternative at a fraction of the cost.

SUMMARY

- Tools used for citizen science should be cost effective, replicable and rapid.
- For streams, some tools we have used effectively that fit this criteria include the SVAP, the Sechi Tube and the Concave Densiomenter
- The SVAP provides a visual estimate of stream condition. It has been shown to correlate to some quantitative measures of water quality and biological condition It is a good tool to engage citizens and learn about stream condition as a whole.
- Sedimentation and riparian management are important elements of healthy stream ecosystems. The use of sechi tubes and densitometers allows collecting quantitative measures of these parameters inexpensively and with little experience.

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THANK YOU!

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