Tinker Foundation Proposal

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Linking terrestrial and aquatic ecosystems: stream ecosystem variation effects on riparian-aquatic exchange prey subsidies.

Introduction

Stream ecosystems are strongly linked to their adjacent riparian zone via fluxes and movement of resources between them (Baxter et al., 2005). Reciprocal invertebrate prey subsidies between these two environments have shown to have important indirect effects on both streams and riparian food webs (Baxter et al., 2005). Inputs of terrestrial arthropods represent an important energetic subsidy for fish during periods of low aquatic macroinvertebrate availability (Cloe and Graman, 1996). Terrestrial arthropods fall from the canopy into the stream where they are subject to fish consumption and downstream drift. When Nakano et. al. (1999) experimentally reduced terrestrial arthropod input from outside the stream, fish predation changed from terrestrial to aquatic arthropods which resulted in a trophic cascade. Aquatic invertebrates emerging from the streams and terrestrial insects falling into the stream represent a high quality food source of high concentration of nutrient and energy relative to biomass (Baxter et al., 2005). Nakano and Murakami (2001) observed seasonal variation in these fluxes showing that aquatic prey provided significant subsidies to forest birds during the defoliation period, while similarly allochthonous (from the outside) fluxes of terrestrial insect prey subsidized stream fishes during the leafing period. It has been suggested that terrestrial input play a important role in nutrient subsidies for forest lakes showing higher perimeter-to-area ratio between the donor and the recipient (Mehner et. al. 2005). While the role of terrestrial invertebrates input as a nutrient subsidy has not been measured, we expect streams should maximize this input due to a smaller area and high canopy cover. Our study is directed to know how phosphorus background levels influence this terrestrial-aquatic exchange. It will be the first one to look at these fluxes in two ways:1) across a nutrient gradient, 2) in tropical streams.

Streams at La Selva Biological station on the Caribbean slope of Costa Rica differ in their chemical composition due to varying inputs of geothermally altered groundwater (Pringle et al., 1990). Much of this trend is reflected in the concentration of soluble reactive phosphorus (SRP), which shows high variations among streams (Pringle, 1991). These fluctuations in SRP concentrations have altered the function of local aquatic ecosystems. Pringle and Triska (1991) showed that for periphyton growth in Salto River (SRP 50-200µg/L), nutrients levels were growth-saturated, while in Pantano River (SRP<10µg/L), algal growth was limited by phosphorus. Also Rosemond et. al. (2002) found that phosphorus concentration influenced the decay rates of organic matter and biomass of consumers.

We expect inputs of terrestrial invertebrates to be constant (on a per-area basis) or at least independent of stream phosphorus level among all sites. In contrast, Ramírez and Pringle (2006) found that biomass turnover rates increased with stream SRP for Chironomidae, the dominant invertebrate consumer in streams in term of biomass and abundance. A high turnover means that insects are living short life spans and perhaps more insects are emerging under high P conditions than under low P. Even if the biomass of emerging insects is constant, if emerging insects from high-P streams are enriched in P (Cross et al.,2003), this will result in a greater flux of phosphorus from the stream to the terrestrial ecosystem (Figure 1).

Methods

A total of eight sites with various SPR concentrations, as defined and monitored by the STREAMS project, will be studied. We will measure the exchange of terrestrial and aquatic arthropods over a 1.5 month period in these streams. Those are: Saltito-100, Carapa, Arboleda, Piper, Surá-30, Saltito-60, Salto-60, Surá-60. Nutrient composition for these sites are presented in Table 2.

Terrestrial arthropod input

Canopy cover will be estimated at each site with a densiometer to relate the percentage of canopy with the arthropod input. We will use soapy water traps with 2 types of plastic trays (80 cm x 40 cm x 15cm and 24cm x 33cm x 14cm) filled to a uniform water depth (4cm) placing one of each type on every site for a total area of capture of .4m^2/day. We will then add about 3g of commercially available surfactant to the trays. These traps will be placed at a different location along the river bank every three days during a period of 6 weeks. Every 3 days, samples will be collected, dried and weighed to obtain the biomass input rate in $gm^{-2}day^{-1}$. In addition, composite samples will be analyzed for nutrient contents to estimate the flux of C, N and P represented by these arthropods.

Table 2. Nutrient composition of STREAMS project sites at La Selva Biological Station (Ramirez and Pringle, 2006).

Stream	SRP (µg/L)	NO_3-N (µg/L)
Piper	4.8	204.6
Surá-60	4.8	212.8
Carapa	6.2	176
Saltito-100	9.8	154
Salto-60	22.6	272.8
Saltito-60	99.4	169.4
Surá-30	194.8	219
Arboleda	267.3	199.2

Aquatic insect export

Emergence traps will be deployed over similar habitats (similarities in: depth,water velocity and substrate) at every site. Its location will be changed temporaly to a different type of habitat in the same reach. Samples of emerging aquatic insects will be collected and sorted into dominant taxonomic groups and weighed to obtain the biomass export rate in $\mu gm^{-2}day^{-1}$. Tentatively, some of the samples will be analyzed for nutrient contents to estimate the flux of C, N and P represented by these insects.

Funding Benefits

I will be conducting research at La Selva Biological Station in Costa Rica during the summer 2007 term (June – July). This project will be used as a preliminary source to design my planned Ph.D dissertation research proposal which involves how variation and disturbances caused by both: natural and anthropogenic sources affects stream ecosystem composition and function. For this we will use streams at La Selva Biological Station in Costa Rica as the natural variation site viewing how differences in water nutrient content affects stream ecosystem processes and resource production focused on resource exchange with adjacent (riparian) systems. The counterpart of this study will use dam construction and land-use patterns as a source for anthropogenic disturbance causing the loss of stream network connectivity and function. We will use the same study sites as Greathouse et al. 2006 in Puerto Rico where they found that major consumer (shrimps) extirpation by dams caused a very significant difference in ecosystem composition in above-dam sites. Further research at both sites will use the same parameters in both locations with the purpose of doing a comparative analysis between them.

Funds obtained will help cover the travel and transportation expenses during my trip to Costa Rica. I should get the maximum benefit from this opportunity form both the academic/research part and personally since I'm a native Spanish speaker and fluent in English, so I can get involved better with Costaricans and their culture.

Budget : Funds requested from CLACS

Item	Cost
Airfare	$ 650
Domestic Travel	$ 550
Transportation	$ 300
Subtotal	$ 1,500

* Funding for housing, meals, research supplies and others will be provided by STREAMS Project.