







Aquatic food web studies at Bosque del Apache

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Introduction

This study examines the relative importance of different energy sources (algae and detritus) and their potential effect on ecosystem dynamics. The quality and quantity of available energy effects community structure and productivity of primary consumers, and subsequently the productivity of predators (including invertebrates and fish).

The Rio Grande is a highly dynamic system. Flows vary dramatically over time, from narrow channels and isolated pools to extensive overbank flooding (see Figure 1). This temporal variability in flows is potentially associated with differences in primary energy sources: the degree of connection with the floodplain influences contributions from riparian resources, and autochthonous production can be limited by increased turbidity levels associated with increased flow. During low flow events, the river channel contracts and the relative importance of food resource inputs from terrestrial sources (e.g. detritus from riparian vegetation) or from aquatic sources (e.g. algae) can be altered.

•How do differences in flow effect the availability of different energy sources in the Rio Grande?
•Do differences in energy sources cascade through the food web?

Methods

At regular sampling intervals during summer (2006-2008), we collected:
• water quality data (water temperature, dissolved oxygen, specific conductivity, salinity, turbidity);
• constituents of the food web from several trophic levels (primary producers, consumers and predators).
The food web constituents are processed, identified and counted. The most abundant constituents are used for stable isotope analysis.

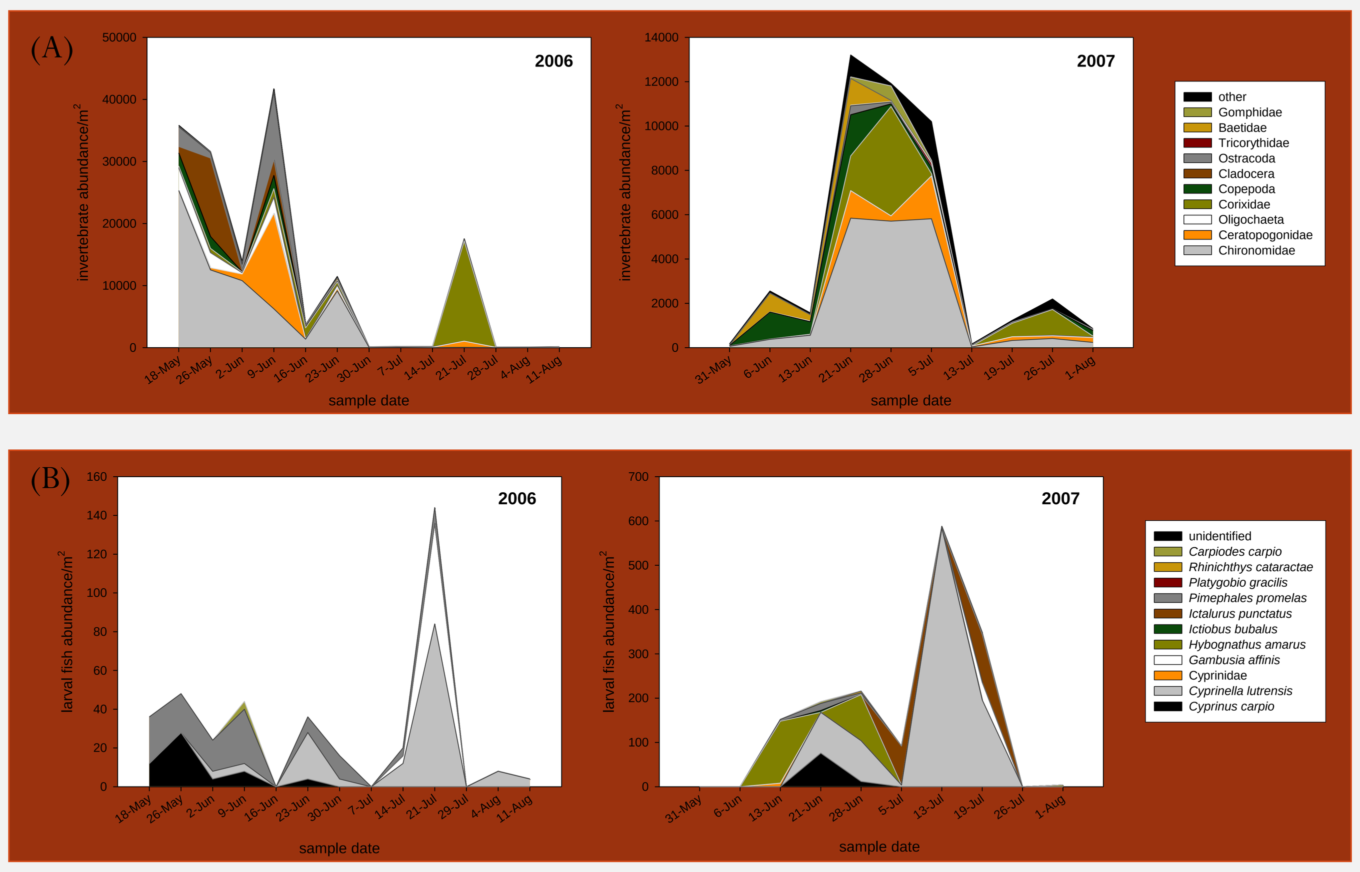

Figure 2. Community composition of (A) invertebrate fauna and (B) larval fish at Bosque del Apache in summer 2006 (left) and summer 2007 (right). Note differences in scale between years. Chironomids and *Cyprinella lutrensis* were common in both years, while other taxa had variable abundances

Stable isotope analysis

The relative abundance of stable isotopes of carbon (^{12}C, ^{13}C) and nitrogen (^{14}N, ^{15}N) can be used to examine food web relationships and the use of multiple basal food sources.
• $\delta^{13}C$ – describes the source of primary production
• $\delta^{15}N$ – describes the relative trophic level

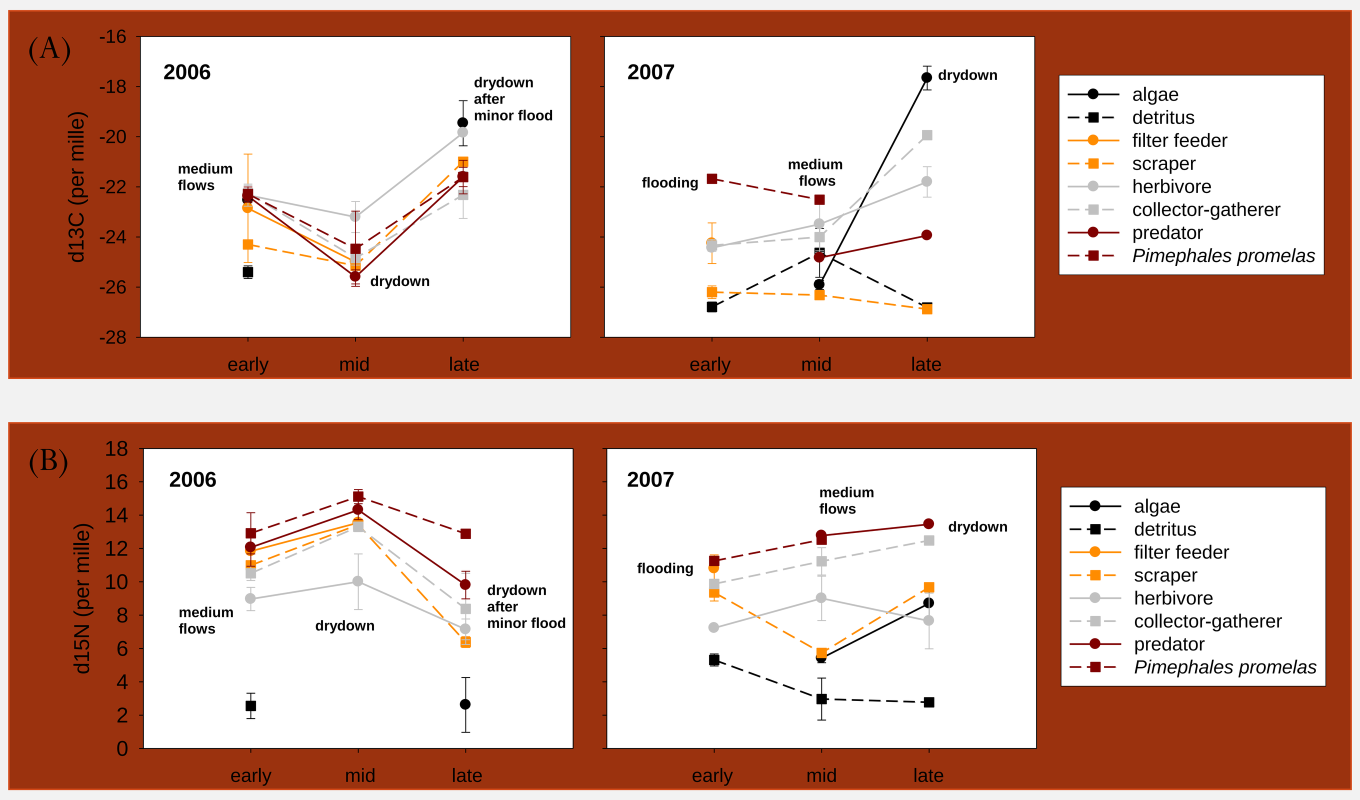

Figure 3. Key food web constituents used for (A) carbon and (B) nitrogen isotope analysis. Samples were collected in early, mid and late summer 2006 and 2007. These sample times represent different river conditions as flow varied through the sampling season. During higher flows, organisms were able to move among microhabitats. During drydown, organisms were confined to backwaters and isolated pools where biotic interactions can become more intense and abiotic environmental conditions can become limiting.

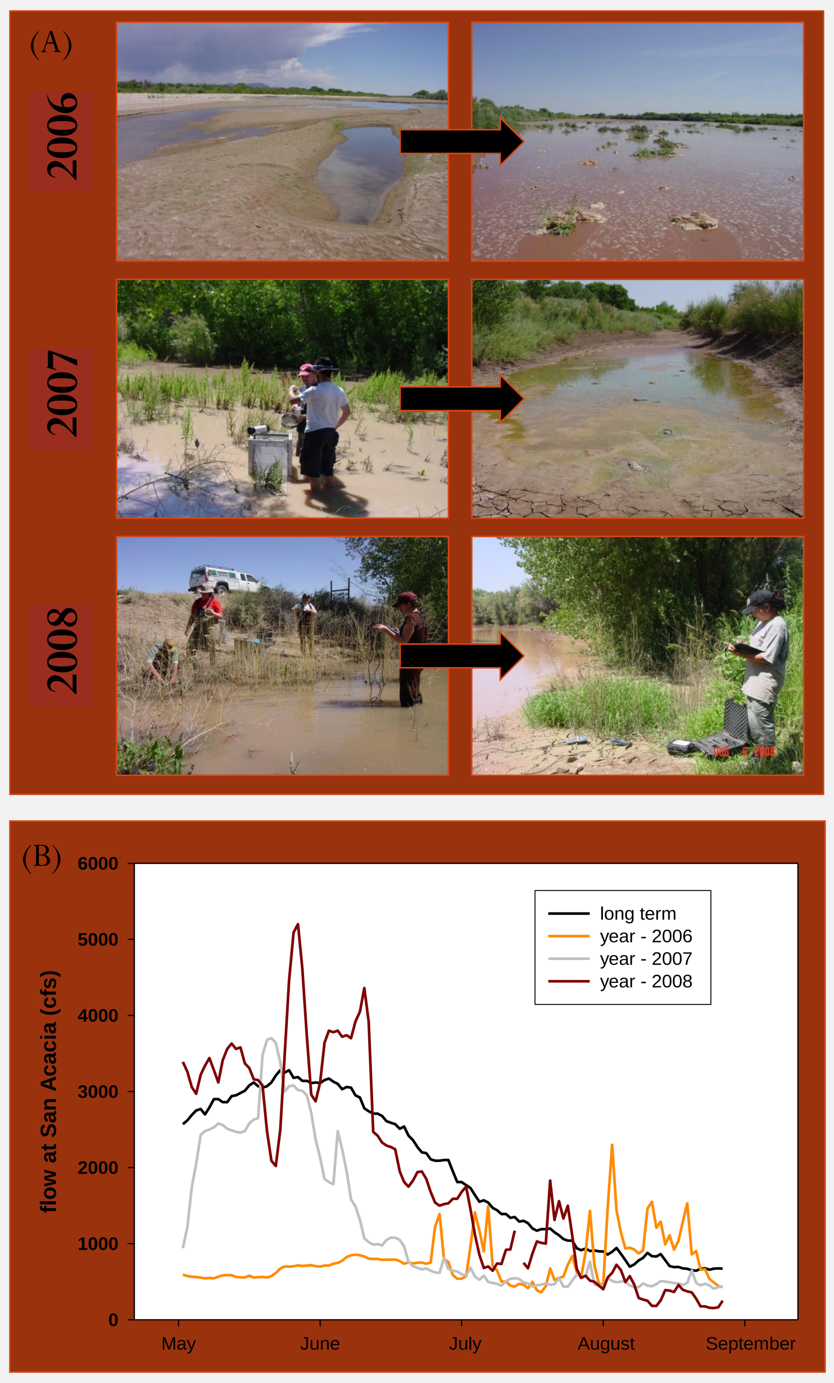

Figure 1. Flow variability in the Rio Grande at Bosque del Apache. (A) Photos from early and late summer for 2006, 2007 and 2008. (B) Flows measured at San Acacia (USGS gauge 08354900) through the summer sampling season in the three years of this study in addition to a long term average (1973-2007). In general, flow gradually decreases over the summer, but flow for summer 2006 and 2007 was much lower than average. In 2006, there were extremely low flows at the beginning of summer, followed by a wet monsoon, whereas in 2007, there were slightly low flows early in the season, followed by an extremely dry monsoon. In 2008, there were extremely high flows throughout the sampling season.

Results

Water quality

1. Water temperature was consistently high (>20°C), particularly in isolated pools.
2. Dissolved oxygen (DO) was generally low in backwaters and side channels compared to isolated pools (with algal growth) and in high flow areas (with more turbulent water).
3. Turbidity was relatively low in isolated pools and backwaters (<50NTU), whereas it was extremely high during high flows (>4000NTU).

Invertebrate fauna (Figure 2A)

We continue to sort and identify samples collected in 2008. Results from 2006 and 2007 will be presented.

1. High densities of invertebrate fauna associated with low flow ("density effect").
2. Some seasonal patterns are apparent in invertebrate populations - chironomids arrive early whereas corixids and odonates arrive later.

Larval fish (Figure 2B)

1. Larvae of *Pimephales promelas* were relatively more abundant in 2006 than 2007, whereas larvae of *Hybognathus amarus* were more common in 2007 .
2. In both years, *Cyprinus carpio* tended to spawn relatively earlier than *Cyprinella lutrensis*

Stable isotope analysis (Figure 3)

1. Both carbon and nitrogen signatures were affected by flow conditions: C signatures tend to be relatively more enriched during higher flows than during lower flows, whereas N signatures are generally higher during drydown.
2. Changes in carbon signature are transferred through the food web, particularly during dry conditions when organisms become concentrated in low-flowing microhabitats.
3. Relative trophic positions are generally constant, despite fluctuations in nitrogen signatures.

Discussion

Community structure and resource use differed both between years and within a summer sampling season. This emphasizes the value of long-term monitoring projects and the importance of intensive sampling over a short period of time.

Changes in flow conditions effect food web interactions in several ways. During low flow, abiotic conditions can become limiting (particularly water temperature and DO). At the same time, organisms become increasingly concentrated into smaller areas and the chance of migration or finding alternative food sources diminishes. Cascades through the food web become more evident in drydown conditions.

Shifts in carbon signature within a trophic level may indicate that either (a) resource use is altered or (b) the carbon signature of primary sources is altered as flows differ. A change in resource use, from algal to detrital resources, may be important during the developmental stages of invertebrates and fishes. To investigate this further, we are currently exploring the relationship between the DIC carbon signature and the algal carbon signature, and how this may be altered by differing conditions in the Rio Grande.

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