Drift Composition and Gut Analyses of Rainbow Trout in the Guadalupe River below Canyon Dam, Texas

Research Update Submitted By: B. Thorpe Halloran &
Dr. Tom Arsuffi

For

Guadalupe River Chapter of Trout Unlimited

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Trout Unlimited
Guadalupe River Chapter
207 Finn Street
Austin, Texas 78734-4414

Ladies and Gentlemen:

Enclosed is an overview of the current research being funded by GRTU. The goal of this research is to describe the benthic macroinvertebrate population (insects) located in the Guadalupe River and to determine the foraging dynamics of trout stocked in the river. By establishing both the dietary preferences and distribution of prey items consumed by salmonids, it is possible to improve existing stocking procedures and examine the ecological relationships that arise as a consequence of the introduction of rainbow trout.

In the upcoming months, I will have the opportunity to present the results of this study at a number of scientific meetings and seminars. These include the Texas Academy of Sciences, Southwestern Association of Naturalists, and the North American Benthological Society. I believe these opportunities will increase interest in our fishery and allow me to focus on many of the achievements of the chapter. Most importantly, I feel that by advertising our fishery to others that might not know of it, will increase the number of visitors and prestige of GRTU chapter, particularly from a state, regional, and national perspective.

Sincerely,

Thorpe

This is the abstract I have submitted to the Texas Academy of Sciences and the Southwestern Association of Naturalists for presentations this semester:

FEEDING ECOLOGY OF RAINBOW TROUT IN THE GUADALUPE RIVER, TX.

B. Thorpe Halloran and Thomas L. Arsuffi. Aquatic Station, Department of Biology, Southwest Texas State University, San Marcos, TX.

The structure of benthic macroinvertebrates were determined through substrate sampling and diel benthic drift collections for a rainbow trout (*Oncorhynchus mykiss*) tailrace fishery in the Guadalupe River below Canyon Reservoir. Results were compared with gut analyses of rainbow trout stocked in the river. A selectivity index based on stomach contents and benthic macroinvertebrate composition was used to determine trout feeding preferences. Results indicate that stocked rainbow trout are using the epibenthos and not the drift as the primary source of food. The numerical abundance of drifting prey observed in the diet was not significantly correlated with the abundance of drifting prey available for consumption. These results show that introduced rainbow trout have developed a feeding strategy which relies primarily on the benthos and not the drifting aquatic fauna available in the river.

With the completion of Canyon Reservoir in 1969 there was the potential of creating a rainbow and brown trout fishery on the Guadalupe River. Since then, both Trout Unlimited (TU) and Texas Parks and Wildlife Department (TPWD) have initiated stocking programs in the hopes of creating and managing a carry-over trout fishery.

One tool available to those seeking to develop a salmonid fishery is to conduct a survey of the preferred food utilized by trout living in a river. Benthic drift serves as the principal food source in almost all rivers where the foraging strategies of salmonids have been investigated. Consequently, the optimal trout habitat is one which affords the greatest access to drifting benthic organisms. Benthic drift is comprised of aquatic organisms, which release from the bottom and subsequently drift downstream.

The foraging dynamics of salmonids stocked in the Guadalupe River have not been thoroughly investigated. Presently, the trout fishery on the river is considered to be a put-grow-and-take fishery. To determine the potential of the Guadalupe River as a possible carry-over fishery, a quantitative survey of the benthic macroinvertebrate population is necessary. Benthic macroinvertebrates make up the bulk of the salmonid diet and are subject to predation by trout as they migrate to the surface of the water for emergence or are carried downstream. By examining the structure and function of drift present in the river, it is possible to determine the relative amounts of food potentially available at various times of the year. Comparing observed prey densities with the gut contents of trout stocked in the river might provide insight into the dynamics of salmonid foraging preferences.

It has been found that trout actively forage for specific prey regardless of their availability in the drift. However, literature investigating the mechanisms governing salmonid foraging is equivocal. Variations in salmonid diets have been observed and attributed to: different size classes, light intensities, temporal conditions and interactions with other species of trout. Although diet of many species of wild trout has been determined for variety of lotic systems, little attention has been given to the feeding ecology of hatchery raised salmonids following their introduction into streams and rivers.

Hatchery fish initially lack any high degree of feeding sophistication and prey recognition ability. As a result, the opportunity exists to observe whether the development of some type of elective foraging behavior occurs after hatchery raised trout are introduced into natural conditions. Studies have concluded that rainbow trout, which are visual predators, could begin to identify and subsequently feed on unfamiliar food items in just four days. Further laboratory experiments involving trout have shown that the reactive distance, (distance from which a predator initiates its approach towards a perceived prey item) doubles in less than a week. Thus, it is possible that hatchery reared trout could begin to recognize and respond to food available in the drift shortly after their release into a river. In 1996, Karen Quinonez (an Aquatic student at SWT) found that 91% of stocked rainbow trout taken from the Guadalupe River had full stomachs. Clearly salmonids introduced to the Guadalupe River have been able to use food resources present. However, at present it is uncertain if these "naive" fish selectively foraged or were indiscriminate in their food selection. If the trout population on the Guadalupe River is to become a consistent carry-over fishery it will be important to determine if introduced fish can adapt to the invertebrate drift as a food source

Examination of the stomach contents of trout residing in the Guadalupe River indicates that bottom dwelling macroinvertebrates comprises a substantial portion of the diet. However, a review of the literature regarding the foraging dynamics of trout indicates that epibenthic fauna, defined as aquatic organisms that live directly in, or slightly above the river bottom, constitute a minor portion of the trout diet in most streams. However, a few studies have found a high degree epibenthic feeding in trout but attributed it to the turbidity of the river.

Because of insight gained from the Quinonez study, a more comprehensive survey of both the benthic macroinvertebrate population and food preferences of trout found in the river are warranted. It is possible that stocked trout in the Guadalupe River may be dependent on bottom dwelling organisms rather than on drifting macroinvertebrates. This study seeks to provide a quantitative analysis of the benthic macroinvertebrate population with respect to spatial variation associated with existing stocking sites and assess the potential of these sites to serve as carry-over areas for a trout fishery. In addition, a drift study will characterize fauna found in the water column. Further, gut analyses of trout taken from the river will provide data regarding food preferences. The results obtained from this study may allow the creation of a stocking strategy based, in part, on food availability. The objectives of this thesis will be to: (1) determine spatial variation the diet of introduced rainbow trout; (2) describe the benthic macroinvertebrate population and drift composition of the Guadalupe River over a eight month period; (3) compare the diet of rainbow trout with the drift present in the river based upon percent occurrence and frequency; and (4) test for foraging selectivity (through the use of the Linear Selection Index).

Methodology

Four sites--Kanz, Upper Rio Raft, Upper and Lower Beans, and Riverbank--were sampled in order to determine the benthic macroinvertebrate populations of the Guadalupe River. Sites were chosen because they included the sections of the river most heavily stocked by public and private agencies and lie within the designated trophy trout section of the river. Although trout are stocked at areas above the sampling sites, no drift studies will be conducted in these sections due to heavy use of the area by anglers (severe angling pressure at these public access sites results in a rapid reduction of hatchery raised trout). The selection of sites was based upon both accessibility and representiveness of the river. The geological composition of the river, flow conditions, lease agreements and safety precluded random sampling at the study sites. However, the placement of drift nets, where possible reflected the predominant flow pattern of the river of each sampling area. Drift net and benthic Hess sampling have been done monthly since April of 1998. Electrofishing to obtain trout, was done in April and July of 1998. I will continue drift sampling and electrofishing through the winter and into the early spring of 1999.

Benthic Sampling

A Hess sampler was used to quantitatively determine the benthic macroinvertebrate densities. Benthic samples were taken prior to each 24-hr drift sampling regime. All benthic sample sites were upstream of drift net placements. All Hess samples were obtained by thoroughly brushing all debris from rocks within the circumference of the sampler.

Drift Sampling

Drift nets were placed so that at least 2 cm of the net was above the water line if flow conditions allowed (this was not a problem except for the January 1999 sample). This insured the capture of any emerging aquatic insects and any terrestrial insects present in the neuston (defined as surface layer of the river). After removing the drift nets from the river, the entire net was examined and all specimens were removed. Nets were sampled every three hours. This was done over a 24-hr period (with the help of massive amounts of caffeine!). Most drift literature has found this procedure adequately described drift composition without the need for replicate nets (hence one drift net per location). Flow rates were taken at the beginning of the 24-hr sampling period. Any debris-sticks, pinecones, algal masses-found in the net were carefully examined for biota and discarded as circumstances warranted. Samples were subsequently placed in 70% alcohol and refrigerated until they could be examined.

Trout Sampling

Trout were obtained via electroshocking. Following capture all trout were immediately placed in ice to prevent post-capture digestion and lessen the possibility of regurgitation. Gut removal procedures followed practices outlined by the American Fisheries Society. The sex, total length, standard length, weight, and age were recorded for each fish. Age will be determined by examining otholiths and/or scales.

Analysis

Drift and benthic samples were measured in terms of frequency of occurrence and percent distribution (occurrence) per sample. When high density collections occur, sub-samples will be taken to determine benthic and drift numbers. Benthic macroinvertebrates were classified genus or the lowest taxonomic level possible. Comparisons of total drift versus time of day and total drift versus time of year will be examined. I will also characterize the pattern of drift for genera in order to determine relative abundance of organisms in terms of time of year and time of day.

Prey items obtained from gut examination are being recorded in terms of frequency, percent distribution, and frequency of genera (if the prey item could be taken to that taxonomic level). Once the percent occurrence in the diet is known, it will be compared to the percent occurrence in the drift. To determine preferences drift comparisons with observed gut contents using the Linear Food Selection Index (L), a measure of electivity or degree of selection, will be used. It is defined as:

$$L = r_i - p_i,$$

where r_i, is the percent occurrence in the diet and p_i, is percent occurrence in the drift (both represent relative abundance). This will allow estimation of food selection for individual fish as well as the sampled population.

Kanz 1200-1500

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	15	.33
Diptera		
Simuliidae		
Simulium	6	.13
Decapoda		
Procambarus	1	.02
Ephemeroptera		
Baetidae	2	.04
Gastropoda		
Viviparidae	1	.02
Hymenoptera	1	.02
Odonata		
Libellulidae		
Sympetrum	1	.02
Trichoptera		
Helicopsychidae		
Helicopsyche	11	.24
Hydroptilidae		
Neotrichia	3	.07
Leptoceridae	1	.02
Limnephilidae	1	.02
Polycentropodidae		
Crynellus	1	.02
Turbellaria		
Dugesia	2	.04
TOTAL	46	

Upper Rio 1200-1500

	Total Number Observed	% of Drift
Amphipoda		.33
Hyalella	2	
Diptera		
Simuliidae	1	.17
Ephemeroptera		
Baetidae	1	.17
Tricorythidae		
Tricorythodes	1	.17
Turbellaria		
Dugesia	1	.17
TOTAL	6	

Lower Beans 1200-1500

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	1	1
TOTAL	1	

Riverbank 1200-1500

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	2	.07
Diptera		
Simuliidae		
Simulium	15	.52
Coleoptera		
Elmidae	1	.03
Microcylloepus	1	.03
Hydrophilidae	1	.03
Ephemeroptera	1	.03
Baetidae		
Tricorythidae		
Tricorythodes	2	.07
Hemiptera		
Veliidae		
Rhagovelia	1	.03
Lepdioptera		
Pyralidae		
Petrophila	1	.03
Trichoptera		
Helicopsychidae		
Helicopsyche	1	.03
Hydropsychidae		
Hydropsyche	3	.10
Polycentropodidae		
Crynellus	1	.03
TOTAL	29	

Kanz 1500-1800

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	2	.12
Diptera		
Chironomidae	4	.24
Simuliidae		
Simulium	5	.29
Ephemeroptera		
Baetidae		
Tricorythidae		
Tricorythodes	1	.06
Hymenoptera	1	.06
Trichoptera		
Helicopsychidae		
Helicopsyche	2	.12
Leptoceridae		
Nectopsyche	1	.06
Turbellaria		
Dugesia	1	.06
TOTAL	17	

Upper Rio 1500-1800

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	3	.25
Diptera		
Chironomidae	2	.17
Simuliidae	1	.08
Ephemeroptera		
Baetidae		.25
Fallceon	3	
Hymenoptera	1	.08
Trichoptera		
Helicopsychidae		
Helicopsyche	2	.17
TOTAL	12	

Lower Beans 1500-1800

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	1	.17
Diptera		
Chironomidae	1	.17
Ephemeroptera		
Tricorythidae		
Tricorythodes	1	.17
Hymenoptera	1	.17
Trichoptera		
Helicopsychidae		
Helicopsyche	1	.17
Leptoceridae		
Nectopsyche	1	.17
TOTAL	6	

Riverbank 1500-1800

	Total Number Observed	% of Drift
Diptera		
Chironomidae	3	.33
Simuliidae		
Simulium	2	.22
Ephemeroptera		
Baetidae	1	.11
Hymenoptera	1	.11
Trichoptera		
Helicopsychidae		
Helicopsyche	1	.11
Polycentropodidae		
Crynellus	1	.11
TOTAL	9	

Kanz 1800-2100

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	4	.11
Coleoptera		
Elmidae	1	.03
Microcylloepus	1	.03
Diptera		
Simuliidae		
Simulium	13	.35
Chironomidae	11	.30
Ephemeroptera		
Baetidae		
Fallceon	1	.03
Caenidae		
Caenis	1	.03
Hymenoptera	2	.05
Trichoptera		
Helicopsychidae		
Helicopsyche	3	.08
TOTAL	37	

Upper Rio 1800-2100

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	8	.31
Diptera		
Chironomidae	2	.08
Simuliidae		
Simulium	3	.12
Ephemeroptera		
Tricorythidae		
Tricorythodes	8	.31
Trichoptera		
Helicopsychidae		
Helicopsyche	4	.15
Turbellaria		
Dugesia	1	.04
TOTAL	26	

Lower Beans 1800-2100

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	8	.36
Diptera		
Chironomidae	5	.23
Coleoptera		
Elmidae		
Microcylloepus	1	.05
Ephemeroptera		
Baetidae		
Fallceon	4	.18
Tricorythidae		
Tricorythodes	3	.14
Hydracarina	1	.05
TOTAL	22	

Riverbank 1800-2100

	Total Number Observed	% of Drift
Amphipoda		
Hyalella	4	.1
Diptera		
Chironomidae		
Simuliidae		
Simulium	20	.5
Ephemeroptera		
Baetidae		
Fallceon	4	.1
Procloeon	1	.03
Heptageniidae		
Stenonema	1	.03
Isonychiidae		
Isonychia	2	.05
Tricorythidae		
Tricorythodes	6	.15
Trichoptera		
Polycentropodidae	2	.05
TOTAL	40	

Linear Food Selection Values for April 1998

(L= ri – pi)

Where values range from –1 to 1, with <u>negative</u> values indicating avoidance or inaccessibility of the prey organism, <u>zero</u> indicating random selection from the environment, and <u>positive</u> values indicating active selection for various prey.

The(ri) values were obtained by examining the stomach contents of rainbow trout (6) captured from an area of the Guadalupe River around the fourth crossing on April 12, 1998. The drift data (pi) was from the sample sites at Kanz, Upper Rio, and Lower Beans for the period 1200-2100 on April 15, 1998. The time period chosen was considered to be reflective of pre-capture foraging time and thus would have comprised the items found in the gut of the trout.

Prey Item	L value for drift	L value for benthos
Amphipoda (scuds)	-0.3	0
Hyalella		
Arachnida (spiders)	0	0
Coleoptera (beetles)	0	0.1
Dytiscidae		
Psephnidae		
Diptera (flies & mosquitoes)		
Chironomidae	0	0.2
Simuliidae	0.1	0.1
Simulium		
Decapoda (crayfish)	0	0
Procambarus		
Ephemeroptera (mayflies)		
Baetidae	0.1	0.2
Fallceon		
Caenidae		
Caenis		
Tricorythidae	-0.1	
Tricorythodes		
Gastropoda (snails)		
Physidae	0	0
Viviparidae	0	0

Homoptera (locusts)	0	0
Hydracarina (water mites)	0	0
Hymenoptera (bees, ants, and wasps)	0	0
Lepidoptera (butterflies and moths)	0	0
Odonata (dragonflies)	0	0
Libellulidae		
Sympetrum		
Oligochaeta (earthworms)	0	0
Orthoptera (grasshoppers)	0	0
Ostracoda (seed shrimp)	0	0
Trichoptera (caddisflies)		
Helicopsychidae		
Helicopsyche	0.2	-0.2
Hydroptilidae		
Neotrichia	0	0
Leptoceridae	0	0
Limnephilidae	0	0
Polycentropodidae		
Crynellus	0	0
Turbellaria		
Dugesia	0	0