Report as of FY2007 for 2006VI73B: "Diversity of freshwater fish and invertebrates of St. Thomas watersheds and its relationship to water quality as affected by residential and commercial development"

Publications

- unclassified:
  - None as yet.

Report Follows

Problem and Research Objectives

Despite extensive current work surveying, characterizing, and mapping the watersheds and riparian vegetation of the Virgin Islands (IRF, CDC, and DPNR 2004), the *aquatic* portion of that freshwater and brackish habitat remains poorly surveyed. Even with the detailed GIS maps produced in the IRF et al. Final Report (2004), the principal investigators acknowledge that they are unable to resolve on the maps which watersheds contain permanent pools or continually flowing streams (B. Devine, pers. comm.). St. Thomas has limited freshwater resources, represented by a small number of guts that drain the island's 13 watersheds (identified by IRF et al. 2004). The majority of these guts carry water only seasonally, and flows vary dramatically with changing rainfall. Despite the often temporary nature of the freshwater habitat, several species of fishes and shrimps persist in these guts. In addition, the introduction of *Tilapia* to the Virgin Islands for aquaculture has resulted in the release of these African fishes into local freshwater habitats. The effect of this introduction on Virgin Islands wildlife remains unexplored.

From a management perspective, these freshwater habitats form a vital connection between terrestrial activities and the marine habitat downstream. The discharge of fresh water into the sea also creates a brackish habitat (e.g. mangrove swamps and salt ponds) used by many commercially and recreationally important marine fish species as a nursery. The current research emphasis in the Virgin Islands on the problems of non-point source pollution and the sedimentation from terrestrial erosion affecting the coral reef and other marine organisms has largely ignored the watershed habitat through which these pollutants are transported. With no record of faunal diversity of this fragile and ephemeral aquatic habitat, there exists no baseline for evaluating the potential effects of current and future land-use practices. The brackish environment created where the guts enter the sea also provides an important nursery habitat for juvenile mullet, snook and tarpon.

In addition, while territorial conferences on non-point source pollution as well as numerous marine outreach programs on the fragility of the marine environment have sought to educate schoolchildren and the voting populous, the more cryptic freshwater gut environments are largely unappreciated for their ecological value and their sensitivity to anthropogenic factors.
There is a great need for public education, including lawmakers, to ensure that development and zoning can proceed in an environmentally-agreeable manner.

The freshwater guts represent an important cultural and ecological resource in the Virgin Islands.
Interviews conducted by Toni Thomas from UVI's Cooperative Extension Service elucidate the recreational value of the guts in the form of hiking, a peaceful retreat, and a place for families to gather. Historically, islanders report gathering at deep gut pools with their families for an afternoon of bathing and collecting eels (*Anguilla rostrata*),

'langoustas' (*Macrobrachium sp.*), and 'cocouey' (small penaeaid shrimps) to cook right on the shores of the stream. These organisms may also mitigate the effects of high nutrient input and sedimentation associated with human development. Filter-feeding omnivorous shrimps (*Atya sp*.) found in the St. Thomas guts have been shown to play an important role in processing and reducing the fine benthic particulate organic matter in stream environments as well as the suspended organic material and sediments (Pringle et al., 1999). Tadpoles, also abundant in St. Thomas watersheds (*Leptodactylus albilabris* and *Osteopilus*; pers. obs.), have the potential to influence total sediments and organic components of tropical streams (Ranvestel, et al. 2004).

Despite an annual rainfall average of 96 cm (Southeast Regional Climate Center), St. Thomas has very limited freshwater resources. Steep island slopes have resulted in the formation of guts, or waterways that carry storm runoff to the coastline. The nature of this project is to document the biodiversity of aquatic fish and crustaceans utilizing freshwater gut habitats and compare this biodiversity between highly developed and less developed watersheds of St. Thomas. These data will be interpreted in terms of differences in watershed development, water quality, and presence of water flow during the driest months of the year.

Objectives for this project include:

- Documentation of fish and crustaceans utilizing St. Thomas's freshwater gut habitats, and comparison of aquatic faunal diversity between highly developed and undeveloped watersheds.
- Training of UVI undergraduates in research methods
- Creation of a display at a local facility to share information on importance of local habitats with the community.

Methodology and Principal Findings

Methodology

Selection of guts and locations to survey

Six watersheds that were mapped and characterized by IRF et al. (2004) as undisturbed (Botany
Bay and Perseverance Bay), moderately disturbed (Magen's Bay and Dorothea Bay), and highly disturbed (Benner Bay/Turpentine Run and Red Hook Bay) are provisionally selected for the most intensive survey of aquatic wildlife and water quality testing. Sites may be substituted depending on accessibility, water flow and presence of permanent pools, and personal safety. GPS will be used to mark the sampling sites so they may be plotted on geo-referenced maps created by UVI's Conservation Data Center (IRF et al. 2004).

Water Testing

In-site: A portable multiparameter meter (YSI Model 85) will be used to measure salinity, conductivity, dissolved oxygen and temperature. This waterproof model automatically compensates all readings for temperature and may be used to measure DO in both fresh and salt water. Up to 50 data readings can be stored. Water will be collected for offsite testing of
Turbidity and Total Suspended Solids will be quantified using equipment owned by UVI's Center for Marine and Environmental Studies.

E. Coli, total nitrogen, and phosphates will be measured by Caribbean Safe Water, St. Thomas (or their subcontractors). Because of the high cost of these tests, this initial study will examine these factors on only a single date per gut, at a single location. Future funding opportunities, plus less expensive testing options, will be sought if this part of the study shows strong correlations that need to be explored further.

Biodiversity sampling:
Given the varying size of the pools and waterways to be sampled, and differences in vegetation and substrate, a variety of collection tools will be used to assess the diversity of species present, including funnel traps, kick nets, dip nets, and small seine nets. Because of the rarity of this habitat, all efforts will be made to sample non-destructively with the exception of voucher specimens and where identification needs to be confirmed. All fish, shrimps, and tadpoles will be identified. Aquatic insects will be collected for identification. Many of these species are cryptic and retreat into crevices, therefore, it is not expected that sampling will be exhaustive.
Where possible, species abundance will be recorded to calculate density.

Progress and Principal Findings to Date

1. Documentation of the freshwater fauna found in selected guts of St. Thomas:
Fish and shrimp have been collected and identified from 3 guts on St. Thomas, including Dorothea, Neltjeberg, and Turpentine Run. Five species of native shrimp, two species of native fish, and two species of introduced fish were identified in three gut streams. Breeding activity has been documented for several shrimp (bearing eggs), and Tilapia (nest building). A reference collection of specimens has been preserved at UVI. Several species have been documented for apparently the first time in St. Thomas, including the shrimps *Xiphocaris elongatus*, *Atya innocous*, and a gobiid fish.

2. Documentation of marine fish using the estuarine habitat as a nursery:
Incidental observations of fish in the estuarine habitat have been made but it is recognized that any list will not be exhaustive given the variation in reproductive seasonality of different species. Most of our sampling took place farther upstream due to easier access and where we found pools year-round.

3. Water quality assessment of the guts:
Water tests of pH, temperature, salinity, conductivity, and total dissolved solids have been performed for all three streams on three different dates. Total Kjeldahl Nitrogen, Total Phosphorous, and presence of coliform bacteria were evaluated from water samples

taken from all three streams on two different dates. A YSI data logger was deployed in one stream for 5 days, providing baseline data on daily cycles of some of the above parameters.

4. Evaluation of the effects of freshwater fauna on quality of water flowing into marine environment between developed and undeveloped watersheds:
Most water quality measures (pH, salinity, conductivity, total dissolved solids & temperature) were found to be highly variable and showed no clear pattern with respect to different guts or human impact.
The gut streams in the areas with mid and high human disturbance had, relative to the stream with low human disturbance:

- Fewer native shrimp and fish species
- Elevated total phosphorous concentration
- introduced fish species

In one gut, we identified a residential sewage discharge that provided a reference point for comparison of conditions upstream and downstream. Directly downstream of that input,

- Total Phosphorous concentration increased nearly 10-fold and TKN doubled.
- Pool substrate changed from gravel, to a thick layer of anoxic sludge.
- Native species of shrimp and fish were absent, with only introduced guppies and trumpet snails persisting.

5 and 6. Student training in biodiversity assessment and water testing:
Two undergraduate students (Duvané Hodge and Rifca Mathurin) worked during summer 2006 on this project, putting in approximately 30 hours a week for 6 weeks. They performed all of the water quality testing on their own and have learned to identify organisms encountered in the field as well as how to use identification keys with preserved specimens. They participated in a weekly meeting with other students doing research and shared their project proposal and results with two Power Point® presentations to fellow student researchers and faculty mentors.
Rifca continued working on the project as a Directed Independent Research Project in the spring of 2007.
The results of this project were presented by the students in the following local and national conferences:

- Poster, 2006UVI Fall Research Symposium, (D. Hodge and R. Mathurin)
- Oral Presentation, 2006 Annual Biomedical Research Conference for Minority Students, Anaheim, California (R. Mathurin)
- Poster**,** 2007 HBCU-UP National Research Conference, October 4-7**,** Washington, DC (D. Hodge)

7. Aquarium display at Coral World Ocean Park, St. Thomas that recreates and interprets freshwater guts and their aquatic life:
To meet this objective, we are designing two outdoor graphic panels that communicate the ecological role of freshwater habitats in the Virgin Islands, and how human activity can impact the organisms that inhabit them. The signs will be placed next to an outdoor waterfall and pond that represent those natural habitats that our study addressed.