THE EFFECTS OF DAM OPERATIONS ON AQUATIC TROPHIC RELATIONS IN THE COLORADO RIVER BELOW GLEN CANYON DAM, ARIZONA

Dean Blinn et al. (NAU) and NPS (GRCA)

OBJECTIVES AND METHODS

1. Use existing collections and the present study to identify the species of aquatic macroinvertebrates that occupy the Colorado River corridor in Grand Canyon National Park, determine phenology, and provide the NPS with a reference collection.

Collections of macroinvertebrates (amphipods; gastropods; oligochaetes; and aquatic Diptera -- larval, pupal, pharate and adult Chironomidae and Simuliidae) are being collected using the techniques in Objective 2 (below) to determine species distribution and abundance throughout the Colorado River corridor in Grand Canyon below Glen Canyon Dam. Limited historical data have been obtained from previous studies, and phenologic data are being compiled. Specimens are prepared according to standard techniques and sent to taxonomists for identification. Temporal and spatial distribution will be documented for he December EIS report. This information and an illustrated key to these taxa will be produced for the NPS in the final report.

2. Examine sites in wide versus narrow reaches of the Colorado River to determine standing crop, dominance, phenology and habitat requirements of the dominant aquatic macroinvertebrates.

Three habitats (low and high velocity fluvial, and tributary) are under study at ten locations between Lees Ferry and Diamond Creek in Grand Canyon on a bimonthly basis. These sites include the USGS synoptic study sites. Sites in wide reaches include Colorado River miles 0 (Lees Ferry, the Paria River and Mile 2.0), 53 (Nankoweap), 61 (Little Colorado River and upstream USGS gauge), 68 (Tanner Canyon), 204 (Spring Canyon area). Sites in narrow reaches include sites at Colorado River miles 31 (South Canyon), 88 (the Grand Canyon gauge and Bright Angel Creek), 144 (Kanab Cr.), 157/166 Havasu Creek/ National Canyon gauge, and 220/Diamond Creek gauge.

Hess sampling efforts consist of at least three replicates for taxonomic analyses and three replicates for standing crop analyses per habitat type, while a minimum of six taxonomic and six standing crop samples are collected with the Peterson dredge in the low velocity environments. Six additional samples are collected in the upper (current high water line) and mid-littoral zones. Thus a total of at least 30 samples are collected per locality at each of 10 localities, six times in 1991. Water quality parameters (temperature, pH, DO and specific conductance) are evaluated at

each locality. Although 100 L of river water are sieved through a plankton net and preserved at each collection locality, this study will not contribute substantially to our understanding of drift in this system. In addition to benthic samples, mature forms of aquatic Diptera are collected by sweep netting, black and white lighting, 5-minute water surface sampling, and spot collections.

3. Determine the trophic significance of aquatic macroinvertebrates in this ecosystem.

The diets of the dominant aquatic macroinvertebrate taxa are under study. In addition to gut smears for dietary analyses, an experiment was conducted on the ability of chironomid midges to survive on free-floating phytoplankton, Cladophora, periphyton attached to Cladophora and Oscillatoria angustissima.

The role of aquatic macroinvertebrates in insectivore diets has been examined in limited collections of common herpetofauna (n = 40 samples to date). Avifaunal dietary analyses remain to be studied. Trout stomachs have been collected and are undergoing analysis. Although gut contents for native fish have been promised, none have materialized for analysis to date.

Energy invested in major trophic components is under study using microbomb calorimetry. Caloric values of Cladophora, periphyton, Oscillatoria, Gammarus, Chironomidae, and Simulium (not yet completed) are being determined and will be coupled with the standing crop data.

4. Determine the potential impacts of dam operations on aquatic macroinvertebrate taxa using survey and observational data, and experimental techniques.

Distribution of macroinvertebrates in benthic, sublittoral, littoral and upper littoral zones is under study (Objective 2). These data describe baseline conditions and can be used to monitor the effects of alternative flow regime. Thus far it has been apparent that the upper limit of Cladophora is dependent on patterns in minimum flow and little macroinvertebrate colonization of mid-littoral sand deposits has been observed during the past three years, except at Lees Ferry. Data gathered here can be used to evaluate the effects of an increase in minimum discharge or a reduction in the range of fluctuation on this potentially productive zone.

Platform and shoreside desiccation experiments were conducted in the summer, 1991 to determine whether simulated and actual fluctuating discharges affected standing crop of aquatic primary producers and primary consumers. Twelve-hour cycles of alternating submersion and exposure were carried out for five-day periods on replicated rocks. Day exposure versus night exposure treatments were included in these experiments. The NAU crew conducted three experiments: two with 36 rocks in each of three treatments, sampled initially and at the conclusion of the five-day period to determine the magnitude of desiccation effects on Cladophora, periphyton, and

associated macroinvertebrate taxa; as well as a serial sampling effort designed to determine the loss rate through time of these components. A similar experiment is planned in the lower Grand Canyon in February/March to determine winter desiccation effects especially on Simulium arcticum and lower Grand Canyon chironomids.

5. Develop protocol to assist the NPS in monitoring aquatic Diptera in this system.

This effort will include an EIS report (due December, 1991) and a final report (due June, 1992) describing present standing crop and distribution, an identification guide for the NPS for future macroinvertebrate monitoring efforts, and a reference collection. The EIS and final reports will include a discussion emphasizing the potential impacts of each EIS alternative (where identifiable) on the aquatic food base, as well as the boundaries of existing data.

MAJOR FINDINGS TO DATE

1. A pronounced, stair-step decrease in benthic and attached algae and associated macroinvertebrate abundance and standing crop occurs downstream from Lees Ferry. Confluence of major tributaries are the "steps down" in this system.

2. Macroinvertebrate species composition changes with distance from the dam. The tailwaters run is characterized by a Cladophora/Diatoma/Gammarus/Cricotopus/Physa/lumbricid assemblage, while the lower Grand Canyon is characterized by an Oscillatoria/Simulium/ mixed chironomid assemblage.

3. Several patterns exist between habitats: (1) benthic macroinvertebrate diversity is low in the Colorado River as compared to tributaries; (2) benthic macroinvertebrates (chironomids and oligochaetes) exist in silty fine sand deposits throughout the corridor in wide reaches; however, these deposits and associated macroinvertebrates appear rare in narrow reaches; and (3) benthic macroinvertebrates appear rare in mid- and upper-littoral zones along the river, but are abundant in these settings in tributaries.

4. Simuliids appear to be an important source of food for trout, but are patchily distributed. Simulium arcticum, the dominant simuliid taxon is most commonly encountered on lodged driftwood branches in cobble bars.

5. Field experiments showed that cobbles exposed to fluctuating flows for five days lost more than 50% of the standing crop of Cladophora, more than 50% of the standing crop and caloric value of periphyton, and more than 70% of the chironomid standing crop and abundance.

ANTICIPATED PUBLICATIONS

1. Chironomid taxonomy in the Colorado River, Grand Canyon National Park, Arizona.

2. Distribution and abundance of aquatic primary producers and consumers in the Colorado River below Glen Canyon Dam.

3. Trophic relations in the aquatic food base of the Colorado River, Grand Canyon National Park, Arizona.

4. Ecological efficiency in lower trophic levels of the Colorado River, Grand Canyon National Park, Arizona.

5. Impacts of fluctuating flows on lower trophic levels in the Colorado River, Grand Canyon National Park, Arizona.

6. Responses of Simulium arcticum to fluctuating flows in the Colorado River, Grand Canyon National Park, Arizona.

AQUATIC MACROINVERTEBRATES

CHIRONOMIDAE

Cardiocladius platypus

Chironomus sp.

Cricotopus annulator

Cricotopus globistylus

Cricotopus trifascia

Cricotopus edurus

Cricotopus new sp. 6

Eukiefferiella claripennis

Eukiefferiella coerulescens

Eukiefferiella new sp. 7

Limnophyes sp.

Metrionemus new sp. 7

Microspectra sp.

Orthocladius rivicola

Parakiefferiella new sp. 2

Paraphaenocladius exagitans

Polypedilum apicatum

Polypedilum obelos

Pseudosmittia sp.

Tvetenia discoloripes

SIMULIIDAE

Simulium arcticum

Simulium argus

Simulium griseum

Simulium petersoni

Simulium vittatum

GASTROPODA

Physella sp.

Hawaiia miniscula

Zonitoides arboreus

Glyphyalinia indentata

Oreohelicidae strigosa

Succinea grosvenorii?

Fossaria obrussa

Cionella lubrica

Gastrocopta pellucida

Discus cronkhitei