

BOYLE, TEAREN
Project proposal

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ECOLOGICAL CHARACTERIZATION/BIOLOGICAL ASSESSMENT
OF THE AQUATIC ECOSYSTEMS OF THE WATERPOCKET FOLD,
CAPITOL REEF NATIONAL PARK, UTAH

The Waterpocket Fold is so named because of the small lentic ecosystems, or tinajas, found in profusion the length of Capitol Reef National Park. Aerial reconnaissance in December 1985 indicates that the tinajas are primarily distributed in the Navajo Sandstone and are concentrated in the southern third of the Park with a secondary group in the northern third. The size of these tinajas varies from small ephemeral pools formed from shallow scours along bedrock watercourses, to large deep plunge pools formed at the base of intermittent waterfalls which are permanent bodies of water. There are several systems of springs rising in remote canyons at the base of Thousand Lakes Mountain in the northern part of the Park that are also of interest. Although there has been some work done on Hall's Creek and the Fremont River (Lindahl, 1977; Hoddenbach, 1975; Woodbury and Musser, 1963), the contribution of desert aquatic ecosystems to the general ecology, productivity, distribution and support of the associated terrestrial fauna and flora are poorly characterized in desert areas in general and Capitol Reef in particular. Moreover, the existing impact of cattle grazing, and present and future recreational use of these systems needs proper biological assessment to provide the Park with data to formulate management decisions.

Aquatic ecosystems in xeric areas behave differently than those in more mesic areas in several respects. The variation of the hydrological cycle, and the associated composition and concentration of chemical constituents in runoff waters is much more extreme and erratic in desert

watersheds than in those in more mesic areas with developed vegetation cover and mature soils (Fisher and Minckley, 1978). Aquatic ecosystems in deserts range from highly dependent on organic matter transported in runoff from the surrounding watershed for their ecological energy base (heterotrophic) (McConnell, 1968), to systems that are capable of generating most of their own energy through algal photosynthesis (autotrophic) (Fisher and Gray, 1983). Busch and Fisher (1981) provide some evidence that aquatic ecosystems in deserts are net exporters of energy to the local terrestrial environment, possibly supporting a faunal assemblage not present at some distance from water. Moreover, the community structure of desert aquatic ecosystems is highly vulnerable to catastrophic events such as flash floods, or high rates of evaporation and concentration of dissolved substances resulting in osmotic stress (Fisher et al., 1982), and may exhibit a pronounced difference in community succession patterns down the length of a watercourse due to washing of communities in tinajas upstream into those downstream.

The aquatic systems at Capitol Reef are not only subject to the variability of natural physical and chemical environment but may sustain significant impact due to cattle grazing which include increased sedimentation due to disturbance in the watershed, increased nutrient loading, and organic enrichment due to animals eliminating waste directly in the water resulting in partial deoxygenation and alteration of the natural community (Janzen et al., 1974, Willrich and Smith, 1970).

In order to properly characterize the role of these aquatic ecosystems in the overall ecology of Capitol Reef National Park and to

provide a basis for the assessment of the effects of grazing and other future impacts, a two-year study is proposed with the following objectives:

1. Classify the different types of aquatic ecosystems in the Waterpocket Fold exclusive of the lotic ecosystems found in the principle drainages.
2. Select four areas for sampling the tinaja type ecosystems and at least one spring system. Three of these sites will be in the southern third of the Park and two will be in the northern third.
3. Assess the effects of cattle on the aquatic communities in the various sample areas.
4. Estimate the role of the aquatic ecosystems in the overall ecology of the Waterpocket Fold.

The first year's effort will focus on describing the structure and dynamics of critical physical, chemical, and biological characteristics of the various aquatic ecosystems. Because of the nature of rainfall and runoff in desert areas the hydrology of the tinajas and their respective watershed will be considered as the "master variable" directly and indirectly controlling the other variables measured in this study. In addition to the hydrological regime, the inorganic nutrient nitrogen and phosphorus, and organic carbon input will largely determine the level of productivity achieved in these systems and role and relationship with the surrounding terrestrial ecosystem. The biological characterization will estimate the relative importance of the photosynthetic community by measuring production of the periphyton on appropriate substrates, and the density and community structure of both the

zooplanktons and benthic macroinvertebrates. The occurrence of other invertebrate forms will be made observationally on a systematic basis.

The magnitude of production and utilization of the invertebrate community provides the potential link back to the terrestrial community.

There are at least 12 species of amphibians found in the Waterpocket Fold, some of which have been noted in very dense numbers (Lindahl, 1977), and all of which are dependent on aquatic ecosystems for breeding, habitat and other life functions. It is this limnological-herpetology aspect of the study that will define the role of the aquatic ecosystem in the overall ecology of Capital Reef National Park. The utilization of the aquatic ecosystem in the Waterpocket Fold will be more fully addressed in the second year's study.

Procedures: Objectives 1 and 2 will be specifically addressed by the May 1 - September 30, 1986 sampling effort. Objective 3 will be addressed in both 1986 and 1987. Objective 4 will be the focus of the 1987 study and study plans will depend on evaluation of data collected in 1986.

Each of the five areas will be visited every two weeks from May 1 - September 30, 1986. Each area will have up to five separate sampling sites. Sample areas and sites within areas will be chosen to contrast several sets of characteristics, i.e., size of tinaja, watershed size, substrate type, position of tinaja in watershed, accessibility of tinaja or spring to cattle. Each sample site will be characterized physically in the first trip in May for volume, surface area, shoreline and substrate type. An appropriate type of artificial substrate for colonization of algae and benthic macroinvertebrates (Carins, 1982) will be introduced at this time and water samples taken and characterized on a

one-time basis for major cation and anions and analyzed at the Soils Testing Laboratory, Colorado State University. The sites will be sampled every two weeks until October for the following:

1. Rainfall collected over two weeks
2. Temperature/dissolved oxygen profile
3. Conductivity
4. pH/alkalinity
5. Turbidity
6. Total nitrogen
7. Total phosphorus
8. Organic carbon
9. Zooplankton
10. Discharge (for spring systems)

Every four weeks the benthic macroinvertebrates will be sampled and preserved. Water samples will be analyzed for Total Nitrogen and Total Phosphorus using persulfate digestion (Raveh and Avnimelech, 1979) and organic carbon by the dichromate oxidation procedure (Maciolek, 1962) at the Soils Testing Laboratory, Colorado State University.

Temperatures and dissolved oxygen will be measured in situ and pH, alkalinity, conductivity and turbidity will be measured by the Park technicians at Fruita. The zooplankton and benthic macroinvertebrates will be enumerated by personnel at the Water Resources Division at Colorado State University in fall/winter 1986/87. Rainfall data will be collected at each site and used in a simple hydrological model to estimate turnover and flushing rates for individual tinajas. A checklist of potential amphibians has been compiled and the Park technician will note when each species makes its appearance and what type of aquatic ecosystems are most utilized.

Timetable of Events

Work

March	Park purchases equipment
April	Boyle and Beeson visit Park and with Henderson visit and select site to be sampled and set up collection and analytical procedures at Park. Initial Chemical Characterization samples collected at this time.
May 1 - Sept. 30	Sample collection in Park, chemical analysis.
Oct.-Feb. 1987	Zooplankton and Benthic Macroinvertebrates counted and enumerated. Data entry and compute analysis of all data performed.

Products

1. Preliminary report 1986 work.
2. Article to peer review journals.
3. Final report to park 1986-87 work.
4. Interpretive brochure.

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Finances

Personnel

1/2 time GS-5, May 1-Sept. 30

\$6500/2

\$ 3,250

Duties: collection of samples from field and some
water quality analysis. Other half time
for grazing study.

Technician, CSU, 3 months winter 1986-87

4,000*

Duties: counting and enumeration of 200
zooplankton and 100 benthic invertebrate
samples and data entry on computer.

*Includes 25.8% overhead

Computer CPU Time

500

Chemical Analysis

Characterization of 10 major cation
and anions at 12.50 per sample for five
sample areas twice per year.

125

Total nitrogen and phosphorus ~200 sample
at \$8.00 per sample

1,600

Organic carbon ~200 samples at \$3.00 per sample

600

Equipment

YSI O₂ meter probe, cable calibration chamber

900

Plankton nets and substrate samples

200

Reagents and preservatives

100

Collecting bottles and vials and miscellaneous
glassware

200

\$11,475

3250

500

+
+ invertebrate
sampling