

**Biological and Chemical Characterization of Representative Tinajas
of Capitol Reef National Park, Utah**

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**A proposal to the National Park Service Water Resources Division
for Wetlands Inventory**

**Period of Research: 6/1/93-12/31/95
Amount Requested from NPS: \$26,000
Amount of Cost-Share: \$37,495**

Introduction

Tinajas and their surrounding wetlands represent a truly unique aquatic environment about which very little is known. In order to develop strong resource protection and management strategies for these waterpockets, it is necessary to increase our understanding of their biological, physical, and chemical characteristics. Intensive studies of their individual characteristics will tell us much about the sensitivity of tinajas to external threats (Dodson 1987). Extensive studies across the Colorado Plateau will tell us how ecologically important they are for Plateau wildlife (Brown and Johnson 1983), and how useful they may be as indicators of change from increased recreational use, altered wildlife use patterns, atmospheric deposition of nutrients and pollutants, and climatic change (Dodson 1991). Long-term goals for tinaja wetlands studies, perhaps achievable over the next 5-10 years, are:

1. To gain an understanding of the regional ecological importance of tinajas and other across the Colorado Plateau, and use this understanding in developing a comprehensive strategy for their preservation on the Plateau.
2. To determine whether temporal trends of metals, organic compounds, or nutrients from local or regional urban, agricultural and industrial air pollution emissions are recorded in sediments of tinaja wetlands. If so, interpret these trends historically, use to determine extent of atmospheric deposition influence on the Colorado Plateau, and use as aid in forecasting potential for future adverse ecological impacts from atmospheric deposition.

Goals for tinaja wetlands studies over the next two years, as part of the inventory of Capitol Reef National Park tinajas:

1. To gain an understanding of the range of biological and chemical characteristics of desert tinaja wetlands in CARE so as to develop informed resource management strategies for their protection. Part of this goal will be to develop a baseline of data for future reference.
2. To gain an introductory understanding of the sensitivity of tinaja wetlands within CARE to disturbance, especially that related to increased visitor use.

Objectives of biological characterization:

To survey biological communities of tinaja wetlands of CARE and obtain an understanding of community variation across the range of tinajas found within the park. We will compare and contrast biological communities in tinajas that differ in size, hydrologic regimes, surrounding vegetation, degree of shading, and chemical characteristics.

To characterize seasonal biological community dynamics in tinajas. We expect tinaja will must be very responsive to climatic variation on a seasonal and storm events scale. We will observe and classify the biological response to storms, seasonal temperature changes, and evaporation. Questions we will ask pertain to the life histories of the major organisms and how they are tied in to physical and chemical factors.

To observe whether disturbance from use of tinaja wetlands by hikers, horse users, or wildlife affects tinaja biological dynamics.

Objectives of chemical characterization

To survey range of chemical dynamics of tinaja wetlands. Tinajas are expected to exhibit chemical variability resulting from seasonal temperature changes, biological nutrient cycling, dilution from storm events, concentration from evaporation and riparian transpiration, biological oxygen consumption and respiration, and sediment processes. Increased hiking and mounted visitor use may add sediments and nutrients to systems that previously had not experienced such inputs. On-site measurements will include specific conductivity, dissolved oxygen profiles, and pH. We would like to obtain seasonal analyses of major ions, including Ca^{2+} , Mg^{2+} , Na^+ , K^+ , NH_4^+ , Cl^- , NO_3^- , SO_4^{2-} , PO_4^{3-} , SiO_2 , alkalinity, and organic carbon (dissolved and particulate), and metals such as Mn, Fe, and Al.

Methods

Biological Community characterization

Several tinajas drainages (3-7) will be selected for biological and chemical characterization from those inventoried by Capitol Reef staff during summer, 1993. The tinajas will be chosen to represent the full range of variability observed within the park. A master's level graduate student with aquatic biology experience will be recruited to conduct the biological studies. This student will begin in the fall, 1993, working under the supervision of Drs. Jill Baron and Boris Kondratieff at Colorado State University. Currently two, well-qualified, students have expressed an interest in this project. Reconnaissance trips to the tinajas will be made during Thanksgiving

and Christmas breaks of the fall semester. A full thesis research proposal will be written by the student and approved by his committee and park staff by February, 1994. Intensive field work will begin in May, 1994, when the student will spend 3-4 summer months in CARE collecting samples, observing summer dynamics, and classifying aquatic algae and invertebrate communities. Additional extended trips to collect and observe tinaja systems will be taken during other seasons in order to address full annual variability.

Every attempt will be made to sample non-destructively. Benthic samples will be collected with an Ekman dredge lowered from the side of a small rubber raft so as not to disturb the sediments. If the dredge appears inappropriately large, we will switch to a smaller Hongve sediment corer. Boats and coring devices can be borrowed from the Loch Vale Watershed project. Sediments will be sieved through a number 30 mesh screen and counted and identified on-site.

Enumeration and species identification of large zooplankton can be made without any sample removal at all from the smaller rock pools. Organisms can simply be counted. Smaller plankton will need to be identified in the Capitol reef laboratory; samples will be collected with bottles or small buckets and filtered on-site into vials containing Lugol's solution. Where rock pools are larger and deeper, a 10 liter bucket or van Dorn sampler and a plankton tow will be used to collect zooplankton. Sample water will be filtered on-site. Identification and density estimates of large species (based on volume of water and number of organisms) can be made at the rock pool, and the organisms returned unharmed to the water within one hour of collection. Smaller organisms will be filtered into vials with Lugol's solution and identified in the laboratory. Organisms will not be evenly distributed in the larger rock pools. They may be concentrated at one side of a pool due to wind action, stratified according to depth, or randomly located. Representative samples will be obtained by sampling at discrete depths, including above and below any temperature or oxygen gradient encountered, and at multiple (up to 5) locations within each pool.

Reference collections will be made. No attempt will be made, however, to collect common organisms from each rock pool, to avoid the possibility of seriously depleting pool populations. Zooplankton and benthic macroinvertebrates will be rinsed from the sieves and preserved in 70% alcohol. Zooplankton will be identified to species. Algal samples will be preserved with Lugol's solution and identified at least to family. Reference collections will be archived at CARE if facilities are adequate, or at Colorado State University. If new or unusual species are found or suspected, expert taxonomic opinions will be obtained.

Assessments of primary productivity will be made during all four seasons using standard light and dark bottle techniques (Lind 1979). Biomass will be estimated at least once each season by determining the dry mass per unit volume of filtrate that has been acidified to pH 5.0 to detach any metals that have chelated to organic

material. The abundance of individual species and their temporal population dynamics will be determined quantitatively using standard methods.

Chemical characterization

Water samples will be collected concurrent with biological collections and preserved for later analyses of major ions, silica, organic carbon and metals. Field chemical and physical analyses will include specific conductivity, dissolved oxygen profiles, pH, light attenuation (secchi disk), and temperature profiles. Field equipment is either available from Capitol Reef or can be borrowed from the Loch Vale Watershed project. Samples will be collected in acid-washed 250 ml LPE bottles that are copiously washed in deionized water at the Natural Resources Ecology Laboratory prior to transport to the field. Sample bottles will be stored full of deionized water until their use. Prior to sample collection, the specific conductivity of each bottle will be tested. Sample bottles with conductances greater than $2 \mu\text{eq L}^{-1}$ will not be used. Depending on the depth, size, and temperature profile of each tinaja, samples may be collected at two depths, surface and hypolimnion. In the larger tinajas samples will be collected from the rubber raft, using a van Dorn sampler loaned from the Loch Vale Watershed project. The specific preservation strategy will depend on the availability of freezer or refrigeration space. Samples may be filtered on site with a Nalgene hand pump and 0.45 μ filter. Preservation strategies being considered include acidification for cations and chloroform for all other solutes. We will collaborate with the USGS, Salt Lake City (Dr. Briant Kimball), for chemical analyses. Dr. Kimball will allow us access to his ion chromatograph (IC) for the analysis of anions. The IC is in Denver at the USGS Central Analytical Laboratory. The Loch Vale Watershed project will purchase the low-ionic strength column and guard column necessary for analyzing the Capitol Reef tinaja samples; these columns will be shared between the two projects. Cations will be analyzed by USGS technical staff with inductively-coupled plasmography (ICP) at the USGS laboratories. Dissolved organic carbon will be analyzed with a Dohrmann carbon analyzer at USGS laboratories in Boulder Colorado. Alkalinity will be analyzed at the CSU Natural Resource Ecology Laboratory with gran titration methods. All analyses except those for cations will be conducted either by Baron or the graduate student. Analytical methods used will follow those detailed in Fishman and Friedman (1985). An estimated 250 samples will be collected per year for water quality analyses.

Precision of the measured values will be determined by collection and analysis of field duplicates. Field duplicates will add an additional 10% to the total samples to be collected and preserved. Another 5% of the total sample numbers will be field blanks. The purpose of field blanks is to detect sample contamination from field handling. Field blanks will be sample bottles carried to the field sites, and filled there with de-ionized water carried out for this purpose. The field blank samples will be analyzed as if they were regular samples, and used to determine estimates of bias.

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Plots of standard deviation against mean concentrations of duplicate pairs will be used to determine data precision. Charge balances of the major ions will be calculated, as ion percent difference, and calculation of theoretical conductance based on methods of Stensland and Bowersox (1984) will be used to interpret overall data quality. These are standard methods used by the Loch Vale watershed project, and are detailed in Denning (1987).

Disturbance assessment

Bulk precipitation collectors will be constructed adjacent to each study pool. Records will be kept of precipitation amount and dates, as well as pH and conductivity. Observations of visitor use, grazing, or other disturbance conditions will be recorded on standardized data sheets. This part of the project will be observational only, although, evidence of potential grazing or human-caused disturbances may be used to formulate additional research questions for further study.

Products

We expect to work closely with CARE staff and keep them informed as to progress made on this study. In addition, annual progress reports (due 6/1/94 and 6/1/95) will be submitted to the park, regional office, and WRD offices. A final report will be submitted to these same entities by 12/31/96. This report will detail biological community dynamics of the different tinajas, characterize seasonal variability of chemical parameters, biological productivity and biomass. To the extent possible, we will draw conclusions regarding the role of climate, hydrology, chemical dynamics, and disturbance on biological communities. We will work closely with park staff to draw up tinaja resource management recommendations based upon the results of this and previous tinaja studies. All data produced from this project will be made available in spreadsheet form on a 3 1/2" disk. Reference collections will be archived in CARE or at Colorado State University. Other products from this effort include a masters thesis, a manuscript for Park Science, and at least one jointly-authored manuscript for submission to Limnology and Oceanography.

References

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Budget Explanation

Dr. David M. Swift is co-principal investigator of this project. He will help with the interpretation of visitor, and wildlife use impacts on tinajas. Dr. Boris Kondratieff is cooperator, and will serve as co-advisor to the M.S. level student. The students who have expressed an interest in this project, Richard Rockwell and Toben LaFrancois, are both from out of state. Tuition (out-of-state in year 1, in-state thereafter) will be carried by the Entomology Department in return for teaching assistance of Cell Biology. Supplies include preservatives for chemical and biological samples (alcohol, Lugol's solution, chloroform, nitric acid), reagents for the ion chromatograph, filters for chemical filtration, field data books, and sample buckets. Most limnological equipment is available on long-term loan from the Loch Vale Watershed project. The Loch Vale Watershed project will purchase a low ionic strength anion column and accompanying guard column; these will be used to analyze anions from both the Loch Vale Watershed project and the Capitol Reef tinaja project. Student housing, access to laboratory and computer facilities will be contributed by Capitol Reef National Park. Use of the IC and analyses of cations on the ICP will be contributed by the USGS. CSU Indirect Costs, as part of the NPS/CPSU Cooperative Agreement are 0.15% of Total Direct Costs.

The two proposals attached comprise the two components of the Wetlands Inventory project funded by the Water Resources Division for \$40,000 for FY 1993-1994 at Capitol Reef National Park to inventory tinaja wetlands and to conduct biological and chemical characterization of representative tinajas. The inventory portion of the project will be conducted by the park for \$7000 per year (\$14,000 total) while the biological and chemical characterization portion of the study will be conducted by Colorado State University (CSU) for \$13,000 per year (\$26,000 total). Norm Henderson of Capitol Reef and Jill Baron of Colorado State University will be closely coordinating the park and CSU portions of the study.

The 2 proposals:

- ① CARLE ~~to~~ Tinaja Wetland Survey proposal
- ② Baron, Swift, + Kondratieff proposal