A Water Budget and Water Quality Study of the Dismal Swamp

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East Carolina University
Thesis Proposal

INTRODUCTION

The Dismal Swamp, one of the largest wetlands in the eastern United States, covers approximately 210,000 acres of southeastern Virginia and northeastern North Carolina. It is located between the Suffolk Scarp to the west and the Deep Creek Swale to the east.

Topography

The Suffolk Scarp, with a north-south axis, is a relict shoreline feature from the Pleistocene resulting from a sea level 45 feet above the present sea level. The Scarp is approximately 60 to 70 feet above sea level. The Deep Creek Swale is also trending north-south and is topographically lower than the Dismal Swamp. The Swamp slopes gently from 25 feet above sea level at the edge of the scarp to 10 feet above sea level on the eastern side.

Vegetation

The vegetation of the Dismal Swamp is represented by 5 main forest types. The pond pine forest and woodland, the red maple forest, the mixed wetland hardwood forest, the Atlantic white cedar forest, and the cypress-gum forest are the most abundant types. (Ingram and Otte, 1981)

Geology

The Dismal Swamp is dominated on the surface by various thicknesses of organic soils. The Precambrian to Paleozoic crystalline basement is overlain by approximately 2800 feet of late Jurassic and Cretaceous to Holocene poorly consolidated to unconsolidated sedimentary rocks. The

Holocene basal inorganic layer consists of a white, angular, fine to medium grained sand up to 1 foot thick, which is overlain by a light-blue clay with some organic fragments and freshwater microfossils (Lichtler and Walker, 1979). This entire sequence is underlying the organic peat which are up to 12 feet thick in some areas.

Hydrology

The water found in the Dismal Swamp is derived mainly from surface runoff from the scarp and rainfall. The swamp is cut by north-south and east-west trending ditches which result in a lowering of the water table. The groundwater, which seeps upward from the Norfolk Aquifer (sand units), is only a small percentage of the total water within the swamp. The formation of the swamp may have been initiated by the seepage of water from the Norfolk Aquifer. Wells on the Suffolk Scarp draw water from the Norfolk Aquifer and cause a reversal in the direction of the groundwater movement. This implies that there is a close relationship between the groundwater and the surface water of the Dismal Swamp.

The natural surface drainage in the swamp is restricted by the east and west physiographic boundaries. The surface inflow enters the swamp from off the Suffolk Scarp as streamflow from the Cypress Swamp and the Hamburg Ditch and as sheet flow. The Dismal Swamp Canal, the Jericho Ditch and the Portsmouth Ditch are the 3 major areas of surface outflow from the swamp.

A preliminary water quality study involving a total of 9 water samples of the surface, canal and groundwater was done in the Dismal Swamp by Lichtler, W. F. and Walker, P. N., 1979.

OBJECTIVES

The main objective of this project is to determine the change in water quality throughout a section of the Dismal Swamp and to calculate the water budget for the entire swamp. The objectives of this are as follows:

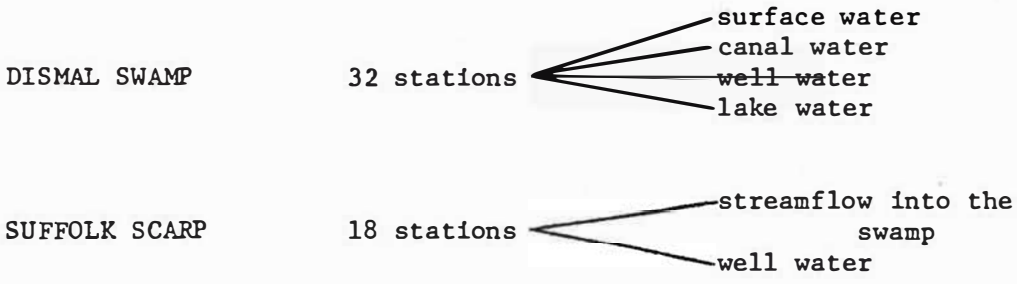
1. to analyze and monitor the chemical quality of the surface and ground water of the Dismal Swamp and the Suffolk Scarp, using the designated field area. A biannual study will invlove the sampling of 50 sites and the analysis of the major cations and anions of the well, canal, lake, surface and stream water;

2. to see if there are distinct water regimes determined by water chemistry and sample location. An attempt will be made to determine the change in water chemistry as the water flows eastward off the Suffolk Scarp into Lake Drummond and to determine any mixing which occurs from the groundwater seepage; and

3. to construct a general water budget for the entire Dismal Swamp using available hydrological, meteorological and biological data. This will include a determination of the total quantity of water moving into and out of the system.

PROCEDURES

A set of 50 water samples will be collected from well, surface water, stream and canal sites found in the Dismal Swamp-Suffolk Scarp field area. Due to the increase of inflow during the winter, 2 sampling sets will be collected, each at the high or low water level. The field equipment and a field assistant, Brenda J. Smith, are being supplied by the United States Geological Survey office at the Dismal Swamp Wildlife Refuge, Suffolk, Virginia. The 50 water samples will be divided as follows:



Set 1	Nov. 17/Dec. 2, 1982	low water
Set 2	April 1983	high water

1.750 liters of water will be collected at each site and used according to ~~the~~ flow chart.

The water will be tested for $NH_4 \cdot N$, $NO_3 \cdot N$, total alkalinity, conductivity, SO_4^{-2}, Si, Cl^-, Ca, Mg, Fe, K, Na, and pH. The lab preparation and analysis of the water samples will be done at the Centralized Environmental Laboratory, Biology Department, East Carolina University, Greenville, North Carolina under the guidance of Research Assistant Martha Jones. The ammonia nitrogen ($NH_4 \cdot N$) content of the water will be determined by using a phenol hypochlorite method. A rapid cadmium

reduction method is used to analyze the water samples for nitrate nitrogen ($NO_3 \cdot N$). The total alkalinity of the samples are done by a standard titration method. A conductivity meter is used to measure the conductivity. Sulphate (SO_4^{-2}) is measured by a gravimetric method involving the formation of a $BaSO_4$ precipitate. The Soluable Reactive Silicon (Si) in the water is determined by use of a colorimetric titration. A chloridometer titration unit, which has been adapted for fresh water, will calculate the chloride (Cl^-) values of the samples. The Atomic Absorption Spectrometer will be used to analyze the major cations found in the water. This analysis will be done in the Geochemistry Laboratory, Geology Department, East Carolina University, Greenville, North Carolina.. Ca, Mg, and Fe will be measured using the Atomic Absorption Mode and K and Na will be analyzed in the Flame Emission Mode. The pH meter will be measured using a pH meter in the field and in the laboratory.

Standard equations and available data will be used for the general water budget. The total precipitation, water storage and stream discharge are available for the 3 weather stations bordering the Dismal Swamp. The 3 stations that will be used are:

1. Suffolk-Lake Kirby (Virginia),
2. Norfolk Airport (Virginia), and
3. Elizabeth City-Lake Drummond (North Carolina).

WORK DONE AT PRESENT

1. First set of 50 water samples collected Nov. 17 and Dec. 2, 1982.

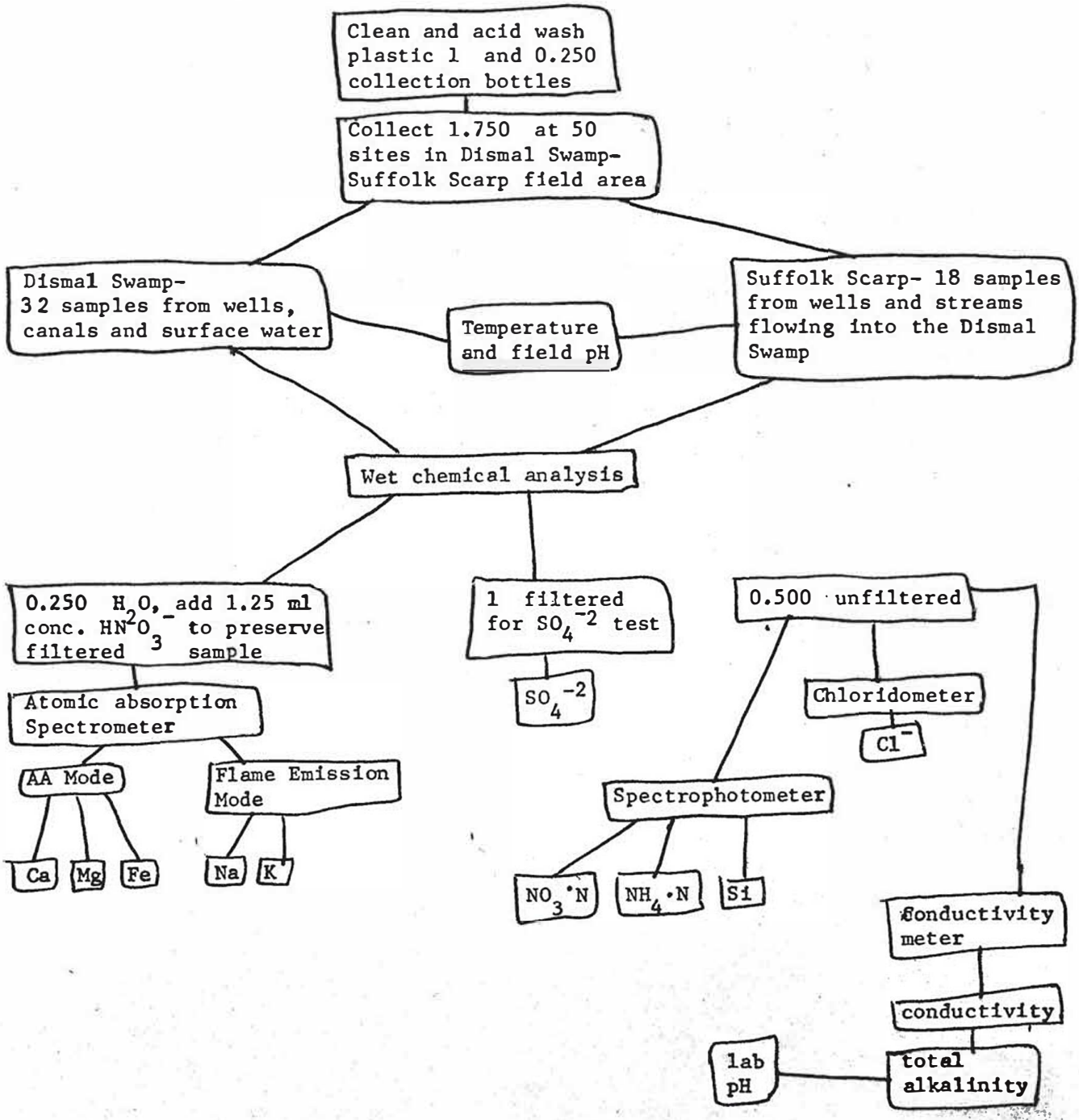
2. Analysis of $NO_3 \cdot N$, $NH_4 \cdot N$, Si, SO_4^{-2}, Cl^-, total alkalinity, conductivity and pH completed and data reduced. Preparation for AA analysis of major cations.

3. Collected data for water budget from weather stations around the Dismal Swamp.

    a. Total precipitation
    b. Stream discharge
    c. water storage

4. Background research and bibliography

FLOW CHART


Clean and acid wash plastic 1 and 0.250 collection bottles
Collect 1.750 at 50 sites in Dismal Swamp-Suffolk Scarp field area
Dismal Swamp- 32 samples from wells, canals and surface water
Temperature and field pH
Suffolk Scarp- 18 samples from wells and streams flowing into the Dismal Swamp
Wet chemical analysis
0.250 H_2O, add 1.25 ml conc. HNO_3^- to preserve filtered sample
1 filtered for SO_4^{-2} test
0.500 unfiltered
Atomic absorption Spectrometer
SO_4^{-2}
Chloridometer
Cl^-
AA Mode
Flame Emission Mode
Spectrophotometer
Ca
Mg
Fe
Na
K
NO_3·N
NH_4·N
Si
Conductivity meter
conductivity
lab pH
total alkalinity

DISMAL SWAMP NATIONAL WILDLIFE REFUGE
MANAGEMENT STUDY
TRANSMITTAL

Date: 7 April 1983

✓ Proposal
___ Amendment
___ Final Report
___ Progress Report - Time Period From _____ To _____

Permit # _____ (assigned by refuge)

Title of Study A WATER BUDGET AND WATER QUALITY STUDY OF THE DISMAL SWAMP

Project Supervisor DR. LEE J. OTTE (Name) PROFESSOR (Title)

EAST CAROLINA UNIV., GREENVILLE, NC 27834 (Mailing Address)

Person(s) Conducting Field Work On The Refuge:

Name	Title	Agency or Institution
Susan L. Oppenlander	Graduate Student	East Carolina Univ.

Cooperators (other agencies or individuals assisting in project)

Name	Title	Agency or Institution

Signatures

Susan L. Oppenlander — Submitted By — 7 April 1983 — Date

Project Supervisor — Date

Cooperator (other than Refuge) — Date

Approvals

James P. Oldham — Refuge Manager — 4/7/83 — Date

Submit all transmittals and reports in duplicate.

All management study proposals must conform to the outline provided by the refuge office.

(OVER)

FORM 3-1383
(REV. 11/75)

UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service

Great Dismal Swamp National Wildlife Refuge

SPECIAL USE PERMIT

Permit number	Sta. No. to be credited
83-83-8	51580

Contract number

Date: April 7, 1983

Permittee *(Name and address)*

Susan L. Oppenlander
c/o Lee J. Otte, Ph.D.

Period of use *(inclusive)*

From April 7, 19 83
TO February 1, 19 84

Purpose *(Specify in detail privilege requested, or units of products involved)*

To evaluate water quality, quantity in the Dismal Swamp NWR

Description *(Specify unit numbers; metes and bounds; or other recognizable designations)*

Travel throughout refuge in personal or state vehicle - collect water samples from wells and surface locations.

Amount of fee $ None If not a fixed fee payment, specify rate and unit of charge: _____

☐ Full payment

☐ Partial payment-Balance of payments to be made as follows:

Record of Payments

N/A

Special Conditions

1. Collection from the Refuge is restricted to those materials or specimens defined in this permit.
2. Vehicular access is prohibited on wet or saturated roads.
3. Access to the Refuge will be frequently altered. Contact the Refuge Office at 804-539-7479 for combination and report on road conditions.
4. Progress or final report is due upon expiration of permit or completion of study.

This permit is issued by the U.S. Fish and Wildlife Service, and accepted by the undersigned, subject to the terms, covenants, obligations, and reservations, expressed or implied therein, and to the conditions and requirements appearing on the reverse side.

Permittee *(Signature)*: Susan L Oppenlander

Issuing Officer *(Signature and title)*: James P Hand Ref. Mgr.