NATIONAL PARK SERVICE

Fourth Annual Scientific Research Meeting

SOUTHEAST REGION

JUNE 16-17, 1978

GREAT SMOKY MOUNTAINS NATIONAL PARK
GATLINBURG, TENNESSEE

FOURTH ANNUAL

SCIENTIFIC RESEARCH MEETING

NATIONAL PARK SERVICE - SOUTHEAST REGION

Great Smoky Mountains National Park
Gatlinburg, Tennessee
June 16-17, 1978

Editor: Jim Wood
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KEYNOTE ADDRESS

The Southeast Regional Science Program: National Park Service Mission Oriented Research

Raymond Herrmann
Chief Scientist, Southeast Region
National Park Service

The Southeast Regional Research Program has developed to a present level of more than 100 ongoing research projects, through the direct involvement of nineteen National Park Service scientists located in seven field units as well as contracts supervised by these scientists. These National Park Service-supported researchers are investigating high priority problems identified by park management.

The Uplands Field Research Laboratory was established at Great Smoky Mountains National Park. Establishment of the lab has permitted the development of Natural Science Research programs and projects which directly support the resources management programs of five upland parks: Great Smoky Mountains National Park, Kings Mountain National Military Park, Cumberland Gap National Historical Park, Mammoth Cave National Park, and the Blue Ridge Parkway.

The South Florida Research Center at Everglades National Park has developed over the past two years a diverse and complex program of research aimed at the solution of problems unique to southern Florida and four National Park Service areas: Everglades National Park, Biscayne National Monument, Big Cypress National Preserve, and Fort Jefferson National Monument.

The Coastal Field Research Laboratory has been established at National Space Technology Laboratories, Bay St. Louis, Mississippi, and provides direct research liaison with the five major coastal areas of the region: Cape Hatteras National Seashore, Cape Lookout National Seashore, Canaveral National Seashore, Gulf Islands National Seashore, and Cumberland Island National Seashore, as well as several additional coastal historic areas.

In addition, the establishment of two university located positions at the University of Georgia and Western Carolina University provides support to regionwide research activities.

Special projects of regionwide application that are being dealt with by these researchers are: (1) determining the impacts of visitors in natural and wilderness areas; (2) determining the role of fire in natural ecosystems;

(3) determining the feasibility of reintroducing extirpated species; (4) identifying disruptive non-native species and determining methods of control; (5) identifying the sources and nature of air and water pollution and means for correction; (6) conducting studies of barrier island dynamics and shoreline processes and conducting geologic surveys to identify vulnerable or hazardous conditions in seashores; (7) conducting cave and related radiation research; (8) implementing programs to support two international biosphere areas, Virgin Islands National Park and Great Smoky Mountains National Park; (9) evaluating the status of threatened and endangered native species; (10) developing remote monitoring and telemetry techniques; and (11) continuing studies of hydrological and geological conditions in areas having potential and existing threats to natural resources.

The goal of the Southeast Regional Research Program is to advance and test the principles of ecology and apply them to resources management problems; address specific park management problems; identify research areas and conservation areas for establishing baseline conditions and evaluating the impacts of man's activities; and establish controls and inventory data for comparison to exterior environmental modifications.

* * * AGENDA * * *

FOURTH ANNUAL
SCIENTIFIC RESEARCH MEETING
THE UPLANDS AREAS OF THE SOUTHEAST REGION
NATIONAL PARK SERVICE

June 16-17, 1978

Great Smoky Mountains National Park
Gatlinburg, Tennessee 37738

JUNE 16 PRESENTATIONS

8:00 - 8:10	Welcome	Boyd Evison, Superintendent, Great Smoky Mountains National Park
8:10 - 8:25	Keynote Address - *"The Southeast Regional Science Program: National Park Service Mission Oriented Research"*	Raymond Herrmann, Chief Scientist, Southeast Region, National Park Service

Caves and Rocks

8:25 - 8:40	*Gravity Methods for Detecting Caves*	Paul Lawrence and Paul J. Wolfe
8:40 - 8:50	*Bed Load Movements in LeConte Creek, Great Smoky Mountains National Park (GRSM)*	Karl S. Zimmerer

Water and Air Quality

8:50 - 9:05	*Chemical and Physical Characteristics of Streams in the GRSM*	David Silsbee, Gary Larson, and Raymond C. Mathews, Jr.
9:05 - 9:20	*Remote Sensing via Satellite of Water Quality and Weather in the GRSM*	Raymond C. Mathews, Jr., Raymond Herrmann, and Raymond Burge

9:20 - 9:30	*TVA Water Quality Monitoring Activities*	A. H. Smalley and D. L. Meinert
9:30 - 9:45	*TVA Air Quality Monitoring Program* *(Note that the TVA water quality vehicle will be at the meeting for a demonstration)*	H. C. Jones, III
9:45 - 10:00	*Air Quality Measurements in the Blue Ridge Mountains and Great Smoky Mountains National Park and Relationships to Vegetation Injury*	John Skelly, N. T. Stephens and L. W. Kress
10:00 - 10:15	*Cattle in the Cove: An Ecological Survey of Abrams Creek*	Raymond C. Mathews, Jr.
10:15 - 10:30	COFFEE BREAK	
Heavy Metals		
10:30 - 10:45	*Heavy Metals in the Sediments of Fontana Lake*	Ray Abernathy, Gary Larson and Raymond C. Mathews, Jr.
10:45 - 11:00	*Determination of Lead Levels Associated with Motor Vehicle Traffic within the GRSM*	Capt. Thomas J. McNeil
Salamanders		
11:00 - 11:15	*Interspecific Competition in Terrestrial Salamanders*	Nelson G. Hairston
11:15 - 11:30	*Geographic Variation and Evolutionary History of the Salamander Gyrinophilus porphyriticus in the Southern Blue Ridge*	Richard C. Bruce
11:30 - 11:45	*Ecological Aspects of Acid Precipitation (Rain and Snow) on the Salamanders in the GRSM, With Emphasis on the Shovel-Nose Salamander (Leurognathus marmoratus)*	Raymond C. Mathews, Jr. and Gary Larson

11:45 - 12:00	*Behavioral Aspects of Stream Dwelling Salamanders in the GRSM*	Jennifer Hedrick and Raymond C. Mathews, Jr.
12:00 - 1:00	LUNCH	

Brook Trout

1:15 - 1:30	*Population Dynamics of Brook Trout and Rainbow Trout in the GRSM*	Gary Larson, Jeff Sweeney and E. L. Morgan
1:30 - 1:45	*Taxonomic Status of the Brook Trout in the GRSM, Based on Electrophoretic Data*	Elizabeth Shipp, William F. Brandes and John W. Harris
1:45 - 2:00	*Comparison of Growth Rates and Longevity of Brook Trout (Salvelinus fontinalis) in GRSM and Adjacent States*	Richard C. Konopacky
2:00 - 2:15	*Effect of Removal of Rainbow Trout on Brook Trout Populations above Natural Barriers*	Steve Moore and B. L. Ridley

Turtles

2:15 - 2:30	*Satellite Tracking Loggerhead Sea Turtles (Caretta caretta) off Cumberland Island National Seashore: Strategies and Protocol for Research Activities*	D. L. Stoneburner, K. W. Eagleson and E. L. Morgan
2:30 - 3:00	COFFEE BREAK	

Insects and Pollinators

3:00 - 3:15	*Clonal Ecology of a Parthenogenetic Earthworm*	John Jaenike
3:15 - 3:30	*Are Pollinators Exerting Selection Pressure on the Azalea Hybrids on Gregory Bald?*	Clinton V. Kellner and Edward E. C. Clebsch
3:30 - 3:45	*Scale Insects of the GRSM*	Paris L. Lambdin and Keith Watson

Lake Ecosystems

3:45 - 4:00	*Limnology of Two Small Lakes at Carl Sandburg Home National Historic Site, Flat Rock, North Carolina*	J. P. Swigert, D. L. Stoneburner and E. L. Morgan
4:00 - 4:15	*Periphyton Communities of Two Small Lakes at Carl Sandburg Home National Historic Site, Flat Rock, North Carolina*	Jane Cameron, J. P. Swigert, Lou Martino and D. L. Stoneburner
4:15 - 4:30	*Water Quality Characteristics for Mathematical Model Considerations from Two Small Lakes at Carl Sandburg Home National Historic Site, Flat Rock, North Carolina*	Lou Martino, E. L. Morgan and D. L. Stoneburner

Wildlife-Mammals

4:30 - 4:45	*Panhandler Black Bears in the GRSM*	Jane T. Eagar

WORKSHOP

7:30 Evening workshop and open house at Uplands Lab -- Everyone is invited over to Uplands for a discussion on environmental monitoring, led by Dr. Gary Larson. Topics will include:

(a) What is monitoring?
(b) What is appropriate in a national park?
(c) How do you interpret it?
(d) What indicator species are important?

JUNE 17 PRESENTATIONS

Wildlife-Mammals (cont'd)

8:00 - 8:15	*A Survey of the Cades Cove Deer Herd, GRSM*	Thomas L. Burst
8:15 - 8:25	*Characteristics of Black Bear Mark Trees in the GRSM*	Thomas L. Burst

8:25 - 8:40	*Ecological Factors Influencing Seasonal Range Shifts of Black Bears in the GRSM*	David Garshelis
8:40 - 9:00	*Population Biology of European Wild Boar*	Francis J. Singer
9:00 - 9:15	*Environmental Relationships and the Denning Period of Black Bears in GRSM*	Ken G. Johnson
9:15 - 9:35	*Prevalence of Selected Infectious Diseases of the European Wild Hog (Sus scrofa) and Black Bear (Ursus americanus) in the GRSM*	William J. Cook

Forest Types and Stand Maintenance

9:35 - 9:50	*A Comparative Vegetational Analysis of Cove Hardwood Forests*	Gary L. Walker and J. H. Horton
9:50 - 10:05	*The White Pine -- Hardwood Vegetation Types of the GRSM*	Hardy DeYoung and H. R. DeSelm
10:05 - 10:20	*The Maintenance and Origin of the High Elevation Beech Gaps in the GRSM*	Robert D. Fuller and Edward E. C. Clebsch
10:20 - 10:35	*The Role of Allelopathic Interference in the Maintenance of Southern Appalachian Heath Balds*	Robert E. Gant and Edward E. C. Clebsch
10:35 - 11:00	COFFEE BREAK	

Plant Habitats and Species Ecology

11:00 - 11:15	*Bridging the Gap between Managers and Scientists -- Important Plant Habitats of the Blue Ridge Parkway*	J. Dan Pittillo and Tom E. Govus
11:15 - 11:30	*An Undescribed Resupinate Fungus (Aphyllophorales) from the GRSM*	Brian S. Luther

11:30 - 11:45	*Pollination Ecology of Monarda didyma L. and M. clinopodia L. in the Southern Appalachians*	Mark Whitten
11:45 - 12:00	*Phenotypic and Genotypic Variation of Fraser Fir in Response to Altitudinal and Geographic Gradients (Progress Report)*	Joseph L. Weber
12:00 - 1:00	LUNCH	

Disturbance Ecology

1:00 - 1:30	*Comparison of Forest Cover prior to and following Disturbance in Two Areas of the GRSM*	Weaver McCracken and Edward Buckner
1:30 - 1:50	*Fraser Fir in the GRSM: Its Demise by the Balsam Woolly Aphid*	Ronald L. Hay and C. Christopher Eagar
1:50 - 2:00	*Natural Disturbance in Mature and Logged Forests in GRSM*	Peter White
2:00 - 2:15	*Effect of Disturbances on Red Spruce and Fraser Fir Age-Diameter Relationships*	Paul Richard Saunders

Fire

2:15 - 2:30	*Early Stages of Fire Succession in the Abrams Creek Area*	Mark Harmon
2:30 - 2:45	*Fire History of GRSM, 1931-1977*	Juliet Covell
2:45 - 3:15	COFFEE BREAK	

Fuels and Nutrient Cycles

3:15 - 3:30	*An Overview of Forest Fuels in GRSM*	Mark Harmon

3:30 - 3:45	*Assessing the Internal Variability in Forest Nutrient Cycles: Preparations for a New Look at Forest Process Comparisons*	David A. Weinstein

Human Impacts

3:45 - 4:00	*The Relative Impacts of Hikers and Horses on Different Trail Surfaces in GRSM*	Paul Whittaker
4:00 - 4:10	*Human Impacts on Backcountry Campsites: Canopy Opening, Tree Damage, and Wood Removal*	Linda Stromberg, CeCe Magistrale and Susan P. Bratton
4:10 - 4:20	*Rare and Endangered Plant Status Report*	Susan P. Bratton
4:20 - 4:30	*The Status of the Vegetation Survey*	Susan P. Bratton

TABLE OF CONTENTS

EDITOR'S NOTE

These abstracts are reports of ongoing studies. They are not a part of the scientific literature and should not be quoted without prior consultation with the investigators.

PROJECT: *Gravity Methods for Detecting Caves*

INVESTIGATORS: Paul Lawrence and Paul J. Wolfe
Wright State University, Dayton, Ohio

Gravity methods were used to locate caves near Mammoth Cave National Park. Initially, gravity profiles were taken over known caves to verify the reliability of the method. A substantial gravity anomaly (-.17 milligals) was observed over a long, dry cave which was known to have a diameter of about 45 feet and a depth of 85 feet to its top. Another long, dry cave at the same depth, but with a diameter of about 25 feet, was not clearly detectable.

Caves were sought along four profiles on a section of the Mammoth Cave Plateau. Four anomalies were found which indicate the likely presence of caves. By comparison with the theoretical gravity profiles produced by a horizontal cylinder model, the diameters of the caves producing the anomalies were estimated to be in the range from 25 feet to 35 feet.

On the Sinkhole Plain south of Mammoth Cave, the existence of a cave was known from earlier dye tracer studies. The position of this cave was located using gravity data. The cave was estimated to be 30 feet in diameter and at a depth of 65 feet.

The results of the study indicate that the gravity method using a conventional gravimeter is a practical method for locating caves whose diameters are 30 feet or greater and whose tops are less than 100 feet deep.

PROJECT: *Preliminary Studies on Bed Load Movement in LeConte Creek, Great Smoky Mountains National Park*

INVESTIGATOR: Karl S. Zimmerer, *Uplands Field Research Laboratory, National Park Service*

The preliminary studies on bed load movement in LeConte Creek, Great Smoky Mountains National Park, were conducted for a 30-day period beginning May 16 and ending June 15, 1978. During the study period the location of each of 45 marked rocks at three separate test areas was monitored on a five-day observation schedule. The sample loads of 45 were comprised of three distinct categories, each numbering 15 rocks that were defined on the basis of size and relative weight. The stream beds of the experiment stations were chosen to represent three distinct inclines. The limited data displays a defined trend toward greater movement among the smaller size classes, both in total movement within the group and individual rock displacement.

PROJECT: *Chemical and Physical Characteristics of Streams in the Great Smoky Mountains National Park*

INVESTIGATORS: David Silsbee, Gary Larson, and Raymond C. Mathews, Jr.
Uplands Field Research Laboratory, National Park Service

Water samples from streams throughout the Great Smoky Mountains National Park are being analyzed for pH, conductivity, turbidity, alkalinity, acidity, hardness, nitrate ion, and fecal coliform, fecal streptococcus, and total coliform bacteria. Temperature, dissolved oxygen, and discharge are being measured in the field.

Eight streams are being sampled seasonally (four times per year) along their entire lengths. Two streams are being sampled daily. Samples are also being taken from several streams every three hours over 24-hour periods, both during good weather and during storms. Work is still in progress, but preliminary results indicate variations in water quality are affected by elevation, geology, and successional status of the watershed. Heavy rain produced great changes in water chemistry, seemingly dependent on the nature of the stream prior to the storm as well as on intensity, duration, and chemistry of the precipitation. In addition, physical characteristics of the streams, such as bottom composition, bank composition, and organic debris accumulations, will be examined on many of the streams this summer.

PROJECT: *Remote Sensing via Satellite of Water Quality and Weather in the Great Smoky Mountains National Park*

INVESTIGATORS: Raymond C. Mathews, Jr., *Uplands Field Research Laboratory, National Park Service*

Raymond Herrmann and Raymond E. Burge
National Park Service

The collection of long term data records is under way in a multiphased program of field sampling and monitoring in the park. Four Convertible Data Collection Platforms (CDCP) are interfaced with water quality and weather sensors and relayed at regular intervals (3 hours) by the Geostationary Operational Environmental Satellite (GOES) system.

The CDCP instrumentation has much potential as a research tool in the park because it can be deployed in remote areas where inaccessibility and lack of personnel and time hinder frequent time interval data acquisition. At present, water quality data (temperature, dissolved oxygen, pH, conductivity, and oxidation-reduction potential) are being collected from two CDCP units in Abrams Creek in the park. These data, along with complementary data on other physical and chemical parameters, macroinvertebrates, and fish species compositions, are being used to determine the impact of cattle and other animals on the quality of the stream. Furthermore, weather data are being collected near one of the remote water quality sensing units and at the Uplands Field Research Laboratory in the park. The weather data (temperature, wind speed, wind direction, relative humidity, and rainfall) will be correlated to the water quality of Abrams Creek and a small stream near the Uplands Laboratory. Compilation and analysis of these data will provide a comprehensive method for evaluating environmental changes.

PROJECT: *TVA Water Quality Monitoring Activities*

INVESTIGATORS: Alan H. Smalley and Dennis L. Meinert
Tennessee Valley Authority

The responsibilities of the Tennessee Valley Authority (TVA), as set forth in Section 22 of the TVA Act of 1933, include studies, experiments, or demonstrations as necessary to ensure the proper use, conservation, and development of Valley Resources. Since 1936, when it began its investigations of water quality, TVA has conducted stream studies, identified sources of pollution, and encouraged and assisted the seven Valley states in developing programs for controlling stream pollution. TVA has continually collaborated in water quality management with state and Federal agencies, local government institutions, and organizations concerned with industrial, community and regional development.

Since the 1950's, temperature and dissolved oxygen have been measured weekly at over 30 dams throughout the Tennessee Valley. In 1972, this program was expanded to include monthly or quarterly sampling for over 30 physical, chemical, and biological characteristics, including nutrients and trace metals.

This information is used for various purposes both within and outside the agency. TVA's Water Quality and Ecology Branch (WQEB) answers more than 200 requests annually for information about water quality. The data are used for environmental baseline monitoring; management of TVA reservoirs to optimize their recreational, water supply, and ecological value; evaluation of long-term trends in water quality; facility siting and planning; development of water quality criteria; and various research studies on such problems as eutrophication, effects of strip-mining, nonpoint sources of pollution, and reservoir and stream modeling.

TVA's monitoring activities also include those required by various state and Federal laws to ensure that TVA facilities, power plants, and construction activities do not harm the aquatic environment. For example, before a typical TVA project begins operation, baseline monitoring for a wide spectrum of physical, chemical, and biological water quality characteristics is performed for years both upstream and downstream from the site. These data are used to establish a data base with which to evaluate any changes that the project might cause to occur in the aquatic environment. Monitoring is also performed during the construction phase to ensure that erosion control practices are effective in controlling siltation, erosion, and increases in nonpoint source characteristics, such as turbidity and total suspended solids.

At its nuclear power plants, TVA also commits itself to an operational monitoring program which usually includes quarterly sampling for almost

50 physical and chemical water quality characteristics at several locations upstream and downstream from the plant. Aquatic biological indicators, such as phytoplankton, chlorophyll a, productivity, zooplankton, and benthic organisms (for identification and enumeration) are also sampled quarterly at several locations upstream and downstream from nuclear power facilities.

PROJECT: *TVA Air Quality Monitoring Program*

INVESTIGATOR: Herbert C. Jones III, *Tennessee Valley Authority*

The Tennessee Valley Authority (TVA) air quality monitoring network, consisting of over 300 stations measuring about 65 air quality and meteorological parameters, is one of the largest in the world. Various air quality parameters--SO_2, NO_x and ozone at some locations, suspended particulates, and precipitation chemistry--are measured continuously. The monitoring stations, most of which are sited near coal-fired power plants, serve primarily to document compliance with ambient air quality standards and to provide data for operation of interim systems for intermittent control of SO_2. TVA also operates five trend stations, located in areas remote from large sources of industrial pollution, for determining baseline air quality and identifying long-term trends. Monitoring at these stations is restricted to continuous measurement of SO_2, sixth-day sampling of suspended particulates and sulfates, and biweekly monitoring of precipitation chemistry. Plans are being made to upgrade the trend stations to measure all criteria pollutants. The feasibility of establishing a TVA-Department of Interior cooperative trend station in the Smoky Mountains is being examined.

The monitoring network also provides important supporting data for TVA's routine surveillance of effects on vegetation near its coal-fired power plants and for various research projects: (1) the long-range transport and transformation of power plant pollutants; (2) yield studies of the effects of exposure to power plant emissions on crop productivity; (3) experimental watershed studies of the removal, fate, and effects of SO_x and NO_x in forest ecosystems; and (4) microcosm studies of the effects of simulated acidic precipitation on forest soils and vegetation.

PROJECT: *Air Quality Measurements in the Blue Ridge Mountains and Great Smoky Mountains National Park and Relationships to Vegetation Injury*

INVESTIGATORS: J.M. Skelly, N.T. Stephens and L.W. Kress
Virginia Polytechnic Institute and State University, Blacksburg, Virginia

At the present time very limited information regarding the air quality in National Parks exists. This has been particularly so in the Blue Ridge Parkway (BLRI), Great Smoky Mountains (GRSM) and Shenandoah National Parks (SHEN). Our study has monitored photochemical oxidant air pollution since 1975 in the Blue Ridge Mountains and more recently we have established sites in the SHEN (1976) and in the GRSM (1977). Near National Ambient Air Quality Standards (NAAQS) of 8 pphm ozone for 1 hour/year have been monitored for most months and near this level has been consistently monitored during the oxidant period of June-September of each year. Episodal conditions have existed each year with oxidant peaks being 13.2, 15.4 and 16.8 for 1975, 1976 and 1977, respectively. The length of each episode likewise increased each year as well. Recently, aircraft monitoring of O_3 and SO_2 has been initiated in the southern portion of the BLRI and over the GRSM. Although data has yet to be completely analyzed, the flight over the GRSM on 3/29/78 monitored an ozone level of 9.4 pphm. This correlated with a ground measurement of approximately 7.5 pphm. Future flights will map the air over the park in terms of ozone, sulfur dioxide, visibility, temperature and humidity.

Vegetation injury has been noted as extensive in the BLRI and SHEN with most severe injury following the episodal conditions. White pine and several other species are being examined closely for oxidant induced symptoms on a periodic basis. The study will be continued under the support of a new USEPA grant to be initiated October 1, 1978.

PROJECT: *Cattle in the Cove: An Ecological Survey of Abrams Creek*

INVESTIGATOR: Raymond C. Mathews, Jr., *Uplands Field Research Laboratory, National Park Service*

In response to high siltation levels in Abrams Creek in the Cades Cove area of Great Smoky Mountains National Park, a general water quality survey of the creek was conducted. Data collected included stream size, flow and bottom composition, turbidity, conductivity, pH alkalinity, hardness, acidity, phosphate, nitrate, benthic macroinvertebrates, and enteric bacteria (total coliforms, fecal coliform, and fecal streptococcus bacteria) at each of 37 sample stations. The stations were located in the cove and upstream and downstream from the cove. Distributions and species compositions of fish and periphytic algae were determined at specific locations along the creek.

PROJECT: *Heavy Metals in the Sediment of Fontana Lake*

INVESTIGATORS: A.R. Abernathy, *Clemson University, Clemson, S.C.*

Gary Larson and Raymond C. Mathews, Jr.
Uplands Field Research Laboratory, National Park Service

Several Great Smoky Mountains National Park streams which empty into Fontana Lake may be contaminated with heavy metals leached from Anakeesta formation. The objective of this study is to determine if heavy metals are deposited in the sediment of the lake from these streams. Heavy metal analyses of the sediment will include: iron, copper, zinc, magnesium, manganese, aluminum, and silicon. Sediment samples have been collected in the shallows near the mouth of each main stream entering the reservoir as well as in the deepest portions of the reservoir.

PROJECT: *Determination of Lead Levels Associated with Motor Vehicle Traffic within the Great Smoky Mountains National Park*

INVESTIGATOR: Capt. Thomas J. McNeil, *U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Maryland*

Motor vehicles which combust fuels containing leaded antiknock compounds have been identified as the major source of lead released to the environment. Previous researchers have primarily concentrated their efforts to studying the effects of this source of lead emissions to areas adjacent to major urban and interstate highways.

During 1976, almost nine million people visited the Great Smoky Mountains National Park. The majority of these visitors traveled within the Park by motor vehicles. This study focused on evaluating the potential buildup of lead in the environment. Samples of grasses, soils, and earthworms were collected, at specified distances from two roadways, within the Park. Sampling sites were selected so as to be representative of the varying topography along these roadways. Samples were collected using lead free tools, and then stored in lead free plastic bags prior to analysis.

Analysis consisted of drying each sample, then removing a representative portion of the sample for analysis. After weighing, each sample was digested in a heated, concentrated solution of nitric and hydrochloric acid for several hours. Following digestion, each sample was filtered through a size 42 Whatman ashless filter. Lead levels in each sample filtrate were then determined by atomic absorption spectrophotometry, at the 2170 angstrom wavelength. Sample blanks and control samples were also run in order to validate the analysis procedure.

The results of this research showed large variations in the soil and grass lead levels along the Park roadways. The lead levels determined from the soil sample were higher than those previously reported for areas adjacent to nonmajor highways. Samples were collected during the spring, before the peak traffic months, within the Park. If the soil lead levels vary with seasonal traffic flow patterns, then the results obtained may be close to the lowest levels which occur annually along these roadways.

Lead levels in the grass samples were below previously reported toxic levels. Earthworm samples were limited. Lead levels in the earthworms were from twenty-eight to thirty-seven per cent of the lead levels in the soils from which the earthworms were collected. Soil and grass lead levels from the control site were also high. This site, a hiking trail, originated at one of the sampling sites.

More extensive research is required to determine if the source of lead, from the areas sampled, was from the emisssion of lead from motor

vehicles. Also, further studies should be conducted to determine background levels in the Park ecosystems.

PROJECT: *Interspecific Competition in Terrestrial Salamanders*

INVESTIGATOR: Nelson G. Hairston, *University of North Carolina, Chapel Hill, North Carolina*

Plethodon glutinosus and Plethodon jordani show different altitudinal distributions in different mountain ranges in the Southern Appalachians. In the Great Smoky Mountains and the Black Mountains, the two species are found together in a narrow zone of about 200-400 vertical feet. This has been interpreted as indicating strong interspecific competition. In the Balsam Mountains the vertical overlap between the two species is 3000-4000 feet, indicating less competition. Experimental removal of each species from marked plots in the Great Smoky Mountains resulted in a favorable response by the remaining species. The same experiment in the Balsam Mountains resulted in either no response or a much reduced one. The experiment demonstrates the validity of the original interpretation.

PROJECT: *Geographic Variation and Evolutionary History of the Salamander Gyrinophilus porphyriticus in the Southern Blue Ridge*

INVESTIGATOR: Richard C. Bruce, *Western Carolina University, Cullowhee, North Carolina; Highlands Biological Station, Highlands, North Carolina*

Southern Blue Ridge populations of the salamander Gyrinophilus porphyriticus show marked geographic variation in adult body size and pigmentation. A small "flecked" morph occurs in the Blue Ridge escarpment and the southeastern Cowee Mountains; a large "dusky" morph inhabits the Nantahala, Snowbird, and northwestern Cowee Mountains. The two morphs approach one another closely in the upper Little Tennessee Valley and on Cowee Ridge, but apparently neither overlap nor intergrade. To the west, where the Snowbirds join the Unicoi Mountains, a change occurs in pigmentation. Unicoi specimens approach the distinctive "danielsi" morph of G. porphyriticus found just to the north across the Little Tennessee River in the Great Smoky Mountains. The intermediate nature of the pigmentation in Unicoi individuals suggests intergradation between the large "spotted" morph of the Smokies and the large "dusky" morph of the Nantahalas. The danielsi morph may also intergrade with the small Blue Ridge-southeastern Cowee morph via populations in the Balsam Mountains and Tennessee Ridge. The picture which is emerging is of a loop of intergrading populations of G. porphyriticus in the high mountains around the Little Tennessee-Tuckasegee basins, with the terminal populations of the loop essentially differentiated as full species. It is of interest that three recognizeable forms of G. porphyriticus inhabit the three most mesic ranges of the southern Blue Ridge (Blue Ridge escarpment, southern Nantahalas, Great Smokies). Perhaps these ranges served as refugia during a warmer, drier episode (post-Wisconsin Xerothermic) when the distribution of the species otherwise shifted northward. Thus the distinctive characteristics now evident among the three morphs may have evolved under conditions of isolation in mesic refugia in the recent past. Apparently separation of the Blue Ridge and Nantahala populations was more complete than that of either and the Great Smoky form.

PROJECT: *Ecological Aspects of Acid Precipitation (Rain and Snow) on the Salamanders in the Great Smoky Mountains National Park, with Emphasis on the Shovel-Nose Salamander (Leurognathus marmoratus)*

INVESTIGATORS: Raymond C. Mathews, Jr. and Gary Larson, *Uplands Field Research Laboratory, National Park Service*

It is suspected that the streams in the park may have declined in pH due to the decline in pH of atmospheric deposition during the last 10 to 20 years in the Southeast region. Based upon recent literature, it has been shown that decreased pH of ponds from acid precipitation can be very detrimental to the success of salamander populations. Therefore, a decrease in the pH of park streams could be expected to adversely affect the success of the salamanders (23 species). Since the shovel-nose salamander is entirely aquatic, it was selected for study in the present program. In order to obtain an understanding of the role of pH to the success of the species in the park, laboratory experiments will be conducted in which the species will be exposed to several acid pH solutions. Tests will include acidic toxicity and growth. In addition, the present distribution of the shovel-nose salamander in the park will be compared to its distribution in the past. These data will be correlated with changes in the water quality of the park streams during the period for which distribution data are available.

PROJECT: *Behavioral Aspects of Stream Dwelling Salamanders in the Great Smoky Mountains National Park*

INVESTIGATORS: Jennifer Hedrick and Raymond C. Mathews, Jr.
Uplands Field Research Laboratory, National Park Service

The behavioral aspects of the seven known species of stream dwelling salamanders are presently being studied in the Great Smoky Mountains National Park. Of the seven species, Leurognathus marmoratus and Desmognathus quadramaculatus are being studied with relationship to habitat segregation, distribution, and foraging strategies. These salamanders are observed during the routine field surveys and in simulated habitat circumstances in laboratory aquariums and terrariums. In addition, an observation tank which simulates stream conditions and contains salamanders, fish, and other stream dwelling organisms will be used for studying the behavioral strategies of salamanders.

PROJECT: *Population Dynamics of Brook Trout and Rainbow Trout in the Great Smoky Mountains National Park*

INVESTIGATORS: Jeff Sweeney and Gary Larson, *Uplands Field Research Laboratory, National Park Service*

E. L. Morgan, *Tennessee Technological University, Cookeville, Tennessee*

The distribution of brook trout in the park has declined markedly since about 1900. The distribution of rainbow trout, however, has increased. Preliminary field data suggest that the rainbow attain greater length and weight than do brook trout, especially in stream sections where the species are sympatric. The objective of this study is to determine if there are structural (weight and length) differences between the two species in selected streams. Fish data will include: length, weight, and habitat (riffle or pool). Other data will include stream width, depth, bottom composition, flow, gradient and water quality (pH, temperature), conductivity, and alkalinity.

PROJECT: *Taxonomic Status of the Brook Trout in the Great Smoky Mountains National Park, Based on Electrophoretic Data*

INVESTIGATORS: Elizabeth Shipp, William F. Brandes, and John W. Harris
Tennessee Technological University, Cookeville, Tennessee

A severe decline in both the number and range of the brook trout, Salvelinus fontinalis (Mitchill), in the Great Smoky Mountains National Park prompted this study designed to elucidate the taxonomic relationships which occur between various populations of this species. The genetic makeup of 35 allopatric populations of brook trout from nine states and the Park was assayed by means of starch gel electrophoresis. Examination of 14 enzymes representing an estimated 29 genetic loci revealed only slight differences between the gene frequencies of the populations sampled. Use of the Rogers coefficient, a statistical test which compares each population to every other one for all loci examined, indicated no specific or sub-specific differentiation. Values generated by this test fell between 0.91 and 1.00, where a value of 1.00 represents total genetic identity. Reduced genetic variation was observed in brook trout collected from the Park, suggesting the possible effects of inbreeding. It is concluded that no significant genetic differentiation exists between brook trout from the Great Smoky Mountains National Park and other brook trout populations examined.

PROJECT: *Comparison of Growth Rates and Longevity of Brook Trout (Salvelinus fontinalis) in the Great Smoky Mountains National Park and Adjacent States*

INVESTIGATOR: Richard C. Konopacky, *Tennessee Technological University, Cookeville, Tennessee*

Sectioned sagitta otoliths were validated as reliable indicators and then used to determine age and annual growth rates of 880 brook trout collected between June 1977 and March 1978 from the Great Smoky Mountains National Park and four adjacent states. Samples were compared for growth variability using weighted average lengths and annual increments at each annulus. Population growth characteristics were classified using a Duncan multiple range test and a Sneath-Sokal similarity cluster analysis, after analysis of variance revealed significant ($p > .05$) differences in growth when all streams were compared.

Of the 25 populations sampled, non-Park trout, except those from North Carolina, experienced better growth at all ages when considered as an area. Individual Park populations from Enloe, Eagle's Rock and Goshen Creeks showed significantly ($p > .05$) better growth than other Park streams, despite being located in the highest elevations of the Park. This suggested more favorable food or temperature conditions or a relative lack of interspecific stress at these altitudes. At least one sample from each adjacent state studied, except Georgia, and the six lower elevation Park populations were deemed slow growth when data from age I and age II fish from all streams were compared. Length attained at age I tended to predict eventual growth characteristics and potential of each population sampled.

Increased longevity could be due to the slow growth and absence of fishing mortality in the Park streams, whereas, outside the Park selective fishing practices and rapid metabolic growth were suspect in reducing the average lifespan of the trout.

PROJECT: *The Effects of Removal of Rainbow Trout Upon the Brook Trout Populations Above Natural Obstructions in the Great Smoky Mountains National Park*

INVESTIGATORS: Steve Moore and B.L. Ridley
Tennessee Technological University, Cookeville, Tennessee

Electrofishing has been used to remove rainbow trout from sympatric populations above natural obstructions in 1976 and 1977. Field data in 1977 showed a 74 percent to 98 percent reduction in the rainbow trout populations after sampling in 1976.

Brook trout populations in most streams showed small increases in number and larger increases in weight after the exotics were removed.

Fin-clipped brook trout exhibited upstream and downstream movements. One marked individual migrated upstream over a cascade to occupy an area with a greatly reduced rainbow population.

No marked exotics returned to the parent stream from which they were displaced. A small number of unmarked rainbow and brown trout moved upstream over two cascades to invade one study area. Rainbows moved upstream over a small waterfall to invade another study area.

Measurements of natural obstructions have also been taken. These give a close approximation of the height, length, and percent slope of each obstruction.

PROJECT: *Clonal Ecology of a Parthenogenetic Earthworm*

INVESTIGATOR: John Jaenike, *University of Rochester, Rochester, New York*

Octolasion tyrtaeum, a parthenogenetic earthworm, was collected in Tennessee, North Carolina, and New York in a variety of habitat types differing in soil pH, soil texture, and vegetation, which are important niche dimensions for earthworms. Eight genetically distinct clones were identified by starch-gel electrophoresis at ten structural gene loci. Six of these clones were present in only a few collections, and therefore information on their potential niches is limited. The other two clones, which were widespread and abundant, are broad niched and apparently very similar ecologically. Their microgeographic ranges in two areas where they coexist in New York were not found to correlate with environmental variations. Because soil and vegetation types form a mosaic pattern, only broad-niched clones can be widespread if dispersal occurs actively through the environment. If the two dominant clones of O. tyrtaeum are nearly identical ecologically as they appear to be, one might expect competitive exclusion or clonal "drift" where they occur together, whereas stable coexistence could result if they differ in their niches.

PROJECT: *Are Pollinators Exerting Selection Pressure on the Azalea Hybrids on Gregory Bald?*

INVESTIGATORS: Clinton V. Kellner and Edward E.C. Clebsch
University of Tennessee, Knoxville, Tennessee

Gregory Bald is renowned for an azalea hybrid swarm which contains a very diverse array of flower colors and forms. This report involves the study of the flower constancy of the pollinators to the different azalea flower types. The flower type classification is based on the floral morphology, color and presence of odor. The azalea species involved in the hybrid swarm are Rhododendron bakeri (Lemon and McKay) Hume, R. arborescens (Pursh) Torrey and R. viscosum (L.) Torrey. Pollinators' constancy to flower type and pollinators' preference for flower type were observed on square plots that contained two or more flower types.

The following aspects of the floral biology of the plants were examined to determine if there were any differences among the flower types: protandry, wind pollination, nectar amount, percent nectar sugar, the presence of nectar amino acids, nectar constituent sugars and the effects of temperature and time on pollen and nectar availability. Pollinator morphology and activity were examined to determine the relative contribution of each species group toward the azalea seed set. The factors examined were bumblebee tongue length, pollinator foraging preference (pollen or nectar) and the effect of time and temperature on pollinator activity.

The rare flower types attracted more pollinators than the common flower types. The large number of insect visits to the rare flower types is tenuously correlated with an increased amount of nectar sugar production of these plants. Since the rare flower types are too rare to promote flower constancy, the pollinators also visit the common flower types. Bumblebees are the most important flower visitors and cross-pollinators of the azaleas. Butterflies, small bees and vespid wasps are common flower visitors but not important cross-pollinators.

Tests for apomictic reproduction and self pollination indicate that these two forms of reproduction are not very important in this azalea population. This result combined with the observations of the flower constancy of the bumblebees indicates that outcrossing is probably the major form of reproduction of these hybrids.

PROJECT: *Limnology of Two Small Lakes at Carl Sandburg Home National Historic Site, Flat Rock, North Carolina*

INVESTIGATORS: James P. Swigert and Eric L. Morgan
Tennessee Technological University, Cookeville, Tennessee

Dan L. Stoneburner, *National Park Service*

A study of the limnology of two small lakes on the Carl Sandburg Home National Historic Site revealed that the small watershed system, draining approximately 198 hectares of shallow topsoil over igneous bedrock received soft, mildly acidic waters. The alkalinity ranged from 5.5 to 20.0 mg/l $CaCO_3$ equivalents. The hardness ranged from 12.0 to 20.0 mg/l $CaCO_3$ equivalents. The weak buffering capacity of this water caused pH shifts in the range from 5.7 to 7.0. The low detention time of each lake during periods of high rainfall maintained dissolved oxygen concentrations throughout most of the year. A summer low concentration of 2.0 mg/l dissolved oxygen was recorded near the bottom with the surface water being 2.8 mg/l. The temperature profiles indicate that a gradual temperature change occurs in the shallow lakes rather than the skewed curve typical of deeper lake water exhibiting a metalimnion.

PROJECT: *Periphyton Communities of Two Small Lakes at Carl Sandburg Home National Historic Site, Flat Rock, North Carolina*

INVESTIGATORS: Jane T. Cameron, James P. Swigert and Lou Martino
Tennessee Technological University, Cookeville, Tennessee

Dan L. Stoneburner, *National Park Service*

This study was implemented to describe periphyton communities in terms of productivity and species composition in relation to seasonal changes, nutrient levels, and physical-chemical data. Artificial substrates were used to permit quantitative analyses. Samples were collected every four weeks during the year beginning April 1, 1977 and ending April 1, 1978.

Productivity was measured indirectly by chlorophyll analyses. The West Lake was consistently more productive with greater individual and collective values of chlorophylls a, b and c. Peak productivity occurred in late April and July. The less productive East Lake showed peaks in April and August. In both lakes productivity decreased gradually after the summer peak and all chlorophyll values remained low until March. Values began to increase sharply in early April.

Species identifications are in progress.

PROJECT: *Water Quality Characteristics for Mathematical Model Considerations from Two Small Lakes at Carl Sandburg Home National Historic Site, Flat Rock, North Carolina*

INVESTIGATORS: Lou Martino and Eric L. Morgan
Tennessee Technological University, Cookeville, Tennessee

Dan L. Stoneburner, *National Park Service*

Water samples from two lakes at Carl Sandburg Home National Historic Site were evaluated for nitrogen and phosphorus during year-long monthly sampling survey. Water quality data was combined with hydrologic data to assess the nutrient loading for the two lakes. Nutrient loading will be evaluated by a nutrient budget model with mass balance considerations. The monthly nutrient data will be supplemented with further sampling to obtain a more complete nutrient loading data set to add insight to eutrophication management in the two lakes.

PROJECT: *Behavior of Panhandler Black Bears: A Broad Perspective*

INVESTIGATOR: Jane Tate Eagar, *University of Tennessee, Knoxville, Tennessee*

The black bear (Ursus americanus) is usually described as a shy, secretive animal rarely seen by man; yet there is one segment of the population which regularly interacts with people and may be considered an artifact of modern society. In national parks the panhandler bear can be frequently seen begging for cookies along the roadsides or raiding picnic tables. Being essentially an opportunistic omnivore, consuming any palatable food item it may encounter, the black bear could quite easily develop a penchant for panhandling. On the other hand, park visitors, generally naive and unaware of the problem they are perpetuating, reinforce the bear's behavior with food handouts. For the visitor the result may be property damage or personal injury; for the bear the price is usually higher -- it may be translocated within the park, given to state wildlife agencies, or destroyed.

The problem has no easy solution, but a logical beginning is to gain an understanding of the behavior of panhandler bears, especially in their interactions with park visitors. Such a study is being conducted in the Great Smoky Mountains National Park.

During 1977, 76 observations were recorded, primarily along the transmountain road (US 441 from Gatlinburg, TN, to Cherokee, NC) with supportive data being collected in picnic areas and campgrounds. Both written and photographic records were necessary to obtain as much information as possible. This paper focuses on the broader picture of human-bear interactions and the general parameters associated with these encounters.

Data analysis yielded the following conclusions:

1) Bears tend to utilize an individual "panhandling territory," though this may sometimes be temporal as well as spatial in the case of family groups.

2) The activity cycle of the panhandler bear is bimodal with peaks occurring at mid-morning (1000-1100) and mid-afternoon (1400-1500). This is atypical of the pattern exhibited by backcountry bears.

3) Of the six categories of aggressive actions used, the charge was the most frequently observed, accounting for 52 percent of those recorded.

4) Those bears panhandling often tend to have a greater mean latency to aggression than those which do so infrequently. Furthermore, as the length of a panhandling session increases, so does the likelihood of an aggressive act.

5) Aggressive acts are slightly more likely to occur in the afternoon than in the morning.

6) A multiple regression analysis of setting factors revealed that the number of feeding incidents is the best predictor of aggression in panhandler black bears.

The study is continuing now with more attention to the acquisition and maintenance of the panhandling habit, an evaluation of National Park Service management practices, and a detailed analysis of the behaviors exhibited by both visitors and bears in these interactions.

PROJECT: *A Survey of the Cades Cove Deer Herd, 1977*

INVESTIGATOR: Thomas L. Burst, *University of Tennessee, Knoxville, Tennessee*

An observational study of whitetailed deer (Odocoileus virginianus) in Cades Cove, Great Smoky Mountains National Park was conducted during the summer of 1977, to determine population density, herd behavior, habitat utilization, and condition of the herd. Thirty-seven counts were conducted and 2172 deer observed. The minimum summer population was estimated at 519 deer using the method of bounded counts; the sex ratio was 90.8 bucks per 100 does. Fawn-at-heel counts yielded a ratio of 49.5 fawns per 100 does. Deer utilized the hayfields and horse pastures but avoided the cow pastures. Feeding was the primary activity during all observation periods; bedding occurred primarily at night. Management recommended was removal of 125 deer with a 9 : 10 sex ratio. The large number of deer using the Cove, the apparent importance of food as an attractant, and the fair to good reproduction were the critical factors determining the recommendations.

PROJECT: *Characteristics of Black Bear Mark Trees in the Great Smoky Mountains National Park*

INVESTIGATOR: Thomas L. Burst, *University of Tennessee, Knoxville, Tennessee*

Within the Great Smoky Mountains National Park, 662 black bear (Ursus americanus) mark trees were located and identified. Trees along 135 km of preselected index routes were tagged, and their diameter at breast height, crown class, and distance from trail recorded. The size of the scar, its position with respect to the trail and slope, and the type of trail were also recorded. These trees were reobserved periodically from April to December to monitor fresh marking. Trees located off-trail were classified as to their position on the slope. Most trees were found adjacent to trails. The marks generally faced the trails and were centered at approximately 1.6 - 1.7 m above the ground. Scar size varied with tree species, size, and the age and intensity of the mark. The mean height to the lowest portion of the scar was 121 cm for conifers (s=31) and 143 cm for hardwood (s=20). The mean length (vertical measurement) was 84 cm for conifers (s=52) and 41 cm for hardwoods (s=28). The mean width (horizontal measurement) was 37 cm for conifers (s=23) and 19 cm for hardwoods (s=12). Eight coniferous and 26 hardwood species were marked. The choice of species apparently reflects availability of the species in the areas of high bear use. Most trees were located along abandoned trails and ridge tops. Most fresh marking occurred during May, June, and July, but some fresh marks were observed during all seasons.

PROJECT: *Ecological Factors Influencing Seasonal Range Shifts of Black Bears in the Great Smoky Mountains National Park*

INVESTIGATOR: David L. Garshelis, *University of Tennessee, Knoxville, Tennessee*

Black bears in the Great Smoky Mountains often have discrete seasonal ranges. Of 30 bears radio-tracked from July 1976 to December 1977, 27 percent had a distinct spring-summer range separation and 80 percent had a distinct summer-fall range separation. Most female fall range shifts occurred during October, while most males began moving to a fall range in late September. Return to the spring/summer range for denning usually occurred in December.

Trees were sampled along transects through the centers of various seasonal ranges to determine vegetational influences on range shifts. Measuring abundance by basal area, percentage composition, and percentage frequency, it was determined that fall ranges had significantly more oaks than did spring/summer ranges (t-test, $p<0.05$). Many male fall ranges tended to be clustered in an area which was exclusive of females. All oak species except chestnut oak (Quercus prinus) were more abundant in the male ranges (t-test, $p < 0.05$), and heavier males had a proportionately greater abundance of these species than did lighter males ($r=0.92$, $p < 0.05$). These factors may indicate a preference for and competition for fall ranges with abundant red oaks (Q. rubra, Q. coccinea, Q. velutina) and white oak (Q. alba). Female ranges were not clustered; a direct relationship existed between the abundance of red oaks in a female's fall range and the extent of her fall shift ($r=0.99$, $p < 0.05$).

Significant elevational changes (t-test, $p<0.05$), reflecting phenological development of food sources, corresponded with seasonal range shifts. Spring ranges averaged 1300 m, summer ranges averaged 980 m, and fall ranges averaged 700 m. Males were at a significantly lower elevation than females during the fall (t-test, $p<0.05$), while there was little elevational difference between the sexes during the spring and summer.

PROJECT: *Population Biology of European Wild Boar*

INVESTIGATOR: Francis J. Singer, *Uplands Field Research Laboratory, National Park Service*

Wild boar populations were studied in a high elevation area of hardwood forest. Population densities were estimated at about 7.5 to 8 per square kilometer. A greater proportion of the adult class were females at the high elevation (ratio 3:1) and less in the valleys. This observation supported the hypothesis that gestating and lactating females were occupying the area of most abundant food sources. Computer simulations of harvests were conducted. One harvest of 50 percent had a much greater influence in population reduction than two harvests of 25 percent each in a single year. This suggests that any control efforts would need to be very intensive.

PROJECT: *Environmental Relationships and the Denning Period of Black Bears in the Great Smoky Mountains National Park*

INVESTIGATOR: Ken G. Johnson, *University of Tennessee, Knoxville, Tennessee*

Den entrance dates for seventeen black bears (Ursus americanus) were obtained using radiotelemetry. Multiple regression analysis was used to correlate den entrance with total precipitation, number of days with precipitation, minimum and maximum daily temperature and the range for both, average daily wind and the maximum daily wind for the three days prior to den entrance. The eight factors were screened through an all possible regressions and stepwise procedure. The strongest linear relationship of den entrance was with total precipitation, number of days with precipitation, minimum and maximum temperature ($R = 0.8375$, $P < .00037$). Student's t-statistics showed all four independent variables to be significant ($P < .02$) in the relationship. When analyzed on an individual basis the weather factors showed much weaker correlation than in a cumulative effect. This combination of weather factors may function similar to a chill factor.

Short term and erratic weather factors probably function in a proximate manner to provide the final stimulus to den but ultimate readiness, reflected in the return to the denning areas and reduced movements and activities, is probably tied to a factor of a periodic or consistent nature such as photoperiod or an endogenous rhythm. Sex and age differences, the food supply, and weather factors interact to adjust the denning period to allow for flexibility in an environment that changes from year to year and with latitude.

PROJECT: *Prevalence of Selected Infectious and Parasitic Diseases of the European Wild Hog and Black Bear in the Great Smoky Mountains National Park*

INVESTIGATOR: William Joseph Cook, *University of Tennessee, Knoxville, Tennessee*

In 1977, studies were begun to determine the prevalence of selected infectious and parasitic diseases in the European wild hog (Sus scrofa) and black bear (Ursus americanus). One hundred and nine black bears were tested for antibodies to Brucella canis, 47 bears were tested for canine distemper, and 109 bears were serologically tested for leptospiral antibodies. No reactors (>1:50) were found for Brucella canis and canine distemper. Of the five serotypes of Leptospira tested, antibodies were detected in 23 percent of the bears included in the survey. Titers ranged from 1:50 to 1:3200 for L. canicola and icterohemorrhagiae serotypes. One bear was a slight reactor for L. pomona serotype. No reactors were indicated for L. grippotyphosa and hardjo.

Dirofiloria ursi, a nematode similar to the dog heartworm, was found in 54 of 60 whole blood samples examined. The parasitic infection rate was determined to be greater than 90 percent for the black bears.

Twenty-eight European wild hogs were tested for antibodies to pseudorabies and swine influenza, with no reactors indicated. Forty-six wild hogs were tested serologically for hog chlorea and Brucella sp.; no reactors were indicated. One small hog was checked for rabies; laboratory results were negative.

Thirty-six hogs were tested for five serotypes of Leptospira. Forty-one and six-tenths percent of the animals tested were serologic reactors. L. canicola and icterohemorrhagiae were the serotypes indicated by the agglutination procedure. The high serologic reactor rate is cause for epidemiological, ecological, and public health concern, particularly in reference to hog wallowing in drainages.

Twenty-nine hog diaphragm tissue specimens were examined for trichinella larvae. No infection was detected. Four large granular masses were excised from the lower legs of three different hogs. The masses were determined to be exocrine glands, whose function has not yet been documented.

Overlapping of preferred habitat by wild hogs and other free-ranging mammalian species, including the black bear, conceivably will contribute to the spread of leptospirosis in the Great Smoky Mountains National Park wildlife. The unique wallowing behavior of the wild hog will increasingly be detrimental to other species utilizing water contaminated by drainage of pathogens into nearby streams. Increases in the percentage of black bear and European wild hog serologic reactors and the distribution of all wildlife reactors will continue to be closely monitored.

PROJECT: *The Effect of the European Wild Boar (Sus scrofa) on the Woody Vegetation of Gray Beech Forest in the Great Smoky Mountains*

INVESTIGATOR: Mark H. Huff, *Duke University, Durham, North Carolina**

The European wild boar (Sus scrofa L.) was introduced into the mountains of North Carolina in 1912 and has since spread into the Great Smoky Mountains National Park. Omnivorous feeding and rooting disturbance by this exotic species is a management problem in the park. The Gray Beech Forest is intensively used by the wild boar. Beech (Fagus grandifolia) communities occupied by the wild boar displayed a reduction in total understory-reproductive plant cover. However, these disturbed areas have a slight increase in total woody plant cover. Vegetative sprouts of beech in disturbed areas were 4 to 45 times more numerous than sprouts in undisturbed areas. This increase in beech reproduction remained in the ground cover.

When comparing understory density to previous research, Double Springs Gap showed a decrease in beech understory density. Evidence indicates that hog rooting may be disturbing the natural size distribution of arborescent species in the lower strata.

Beech and blackberry (Rubus canadensis) disturbed by hog rooting had high populations in the reproductive stratum. The foliar height of blackberry was supressed by hog rooting. There was a significant decrease in the mature arching Rubus stems in the disturbed areas.

A negative or positive effect on rare woody species could not be detected in this study.

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PROJECT: *The White Pine-Hardwood Vegetation Types of the Great Smoky Mountains National Park*

INVESTIGATORS: Hardy DeYoung and H. R. DeSelm
University of Tennessee, Knoxville, Tennessee

The White Pine-Hardwood type was described by Miller in 1938; however, subsequent researchers of Park vegetation have not described this type. In the summer of 1977 a vegetation analysis was conducted utilizing Miller's type map.

Historically, white pine has been a prime timber resource which was probably logged on a small scale by the early inhabitants of the Park. Miller identified white pine as an invader into old fields. The majority of White Pine-Hardwood vegetation is located in the western end of the Park on the Tennessee side at low to mid-elevations generally centering around Cades Cove and extending down Abram's Creek to Chilowhee Lake. Slope position is highly variable with white pine occurring on dry ridges, mid-slope positions and along floodplains.

Field data were collected on 144 one-tenth acre (1/25 ha.) circular plots adjusted for slope angle. Canopy (over 10 cm), understory (2.5 to 10 cm), saplings (under 2.5 cm) and herbaceous data were tallied for each plot. Site and soil variables were collected to evaluate environmental relationships with the vegetation.

Seven White Pine-Hardwood types were derived from the 144 sample plots grouped by leading dominants using the Orloci (1967) cluster analysis. The types were: White Pine-Virginia Pine-Pitch Pine, White Pine-Virginia Pine-Northern Red Oak, White Pine-Hemlock, White Pine-Tulip Poplar, White Pine-Chestnut Oak, White Pine-White Oak, and White Pine-Northern Red Oak. Preliminary data manipulation used canonical analysis to array the centroids of the seven types. The two White Pine-Virginia Pine types were found to be similar in composition representing both old field succession types varying in time of release, and undisturbed ridge associations with Virginia Pine. The three oak types are probably variants of oak types that overlap and occur with white pine. The White Pine-Hemlock and Tulip Poplar types are low and protected in topographic position. From the canonical analysis the types can be inferred to occur along a complex scale utilizing slope position and protection which influences moisture availability.

PROJECT: *The Maintenance and Origin of the High Elevation Beech Gaps in the Great Smoky Mountains National Park*

INVESTIGATORS: Robert D. Fuller and Edward E.C. Clebsch
University of Tennessee, Knoxville, Tennessee

A combination of interference mechanisms which progressively increase red spruce (Picea rubens Sargent) seed and seedling mortality in beech (Fagus grandifolia Ehrhart) dominated forests maintain the structural integrity of these "beech gaps". Large diurnal soil temperature variation under the beech canopy in the spring delays and inhibits spruce germination. Seed mortality caused by animal foraging is enhanced in beech litter. Bioassays of spruce germination and growth revealed potential allelopathic toxins in fresh autumn litter, decomposed summer litter, and autumn soil in the beech gaps. Monophenols including p-hydroxybenzoic, vanillic, p-coumaric and ferulic acids, leaching out of overwintering beech litter, may inhibit spruce seed germination. The beech gaps may have originated during the hypsithermal period of the post-pleistocene when spruce was limited to higher elevations by increased temperatures. In the ensuing period, beech forests have been maintained on south-facing concave slopes by these interference mechanisms dependent on the integrity of the beech litter.

PROJECT: *The Role of Allelopathic Interference in the Maintenance of Southern Appalachian Heath Balds*

INVESTIGATORS: Robert E. Gant and Edward E.C. Clebsch
University of Tennessee, Knoxville, Tennessee

Allelopathic interference seems to be an important mechanism in the maintenance and persistence of southern Appalachian heath bald communities. Comparative analyses were conducted on two heath balds located in the Balsam Mountains of western North Carolina to distinguish phytotoxic characteristics that enhance persistence. Field studies revealed that one community was a mixed heath bald dominated by Rhododendron catawbiense and the second resembled an immature spruce-rhododendron forest heath dominated by Rhododendron maximum and Picea rubens.

Caffeic acid, gallic acid, gentisic acid, hydroquinone, p-hydroxybenzoic acid, 2-pinene, phloroglucinol, rhododendrol, and vanillic acid were isolated and identified from canopy drip, leaves, litter, roots, and soil of the two heath balds. Bioassays run with aqueous leachates of heath bald litter and soil produced varying degrees of radicle reduction in three test species. Long-term inhibition by heath bald soils was confirmed in greenhouse experiments. Field studies demonstrated that environmental forces increased the allelopathic effectiveness of heath bald soils on seedling growth and survival.

Influx of seed from the surrounding forests was sufficient to sustain invasion pressure against both heath balds.

Allelopathic interference delays successional replacement of Rhododendron maximum heath balds by partially suppressing the establishment and growth of forest competitors. Heath balds dominated by Rhododendron maximum cannot maintain themselves and represent truly successional communities.

Rhododendron catawbiense heath balds represent stable communities that employ allelopathic interference to arrest succession and maintain themselves. Communities of this type can be expected to persist in the southern Appalachian forests.

Investigations of southern Appalachian heath balds revealed that these communities are more diverse and more involved in the succession of the regional vegetation than has been previously recognized.

PROJECT: *Bridging the Gap Between Managers and Scientists: Important Plant Habitats of the Blue Ridge Parkway*

INVESTIGATORS: J. Dan Pittillo and Tom E. Govus
Western Carolina University, Cullowhee, North Carolina

A field, literature and information survey of the Blue Ridge Parkway between Roanoke, Virginia and the parkway terminus at the Great Smoky Mountains National Park resulted in designation of 155 sites as habitats of important plants. These habitats are defined as those containing (in order of priority): 1) nationally listed endangered and threatened species, 2) state listed endangered and threatened species and unique or exemplary plant communities, 3) showy populations, and 4) rare plants serving as food sources for animals, etc. About two-thirds of these contained plants listed nationally or by states as threatened or endangered. The 463 page "manual" developed during this study is an attempt not only to designate sites to be approached with care but also to offer suggestions for management. Often the methods of achieving desired goals of management are not clear and will require some experimental manipulation. It is in these areas that it is particularly important that a close interaction between managers and scientists occur.

Beyond the basic management procedures, education of the public using the parkway is perceived as an important activity. Some plant species require disturbances or selective manipulation for their continued existence in a given ecosystem. Sometimes mowing is the most reasonable technique to achieve this goal. In other situations, plowing or perhaps controlled burning would be most desirable. Generally the layman will not understand such activities due to his unfamiliarity with the species requirements or the management technique. On the other hand, disturbances such as that of trampling and soil compaction, plant collection, etc., caused by humans operate against continuance of some plant populations. It is recommended that the Park Service develop programs which will explain some of these activities to the Blue Ridge Parkway visitor, thereby rectifying possible misconceptions of management procedures.

PROJECT: *An Undescribed Resupinate Fungus (Aphyllophorales) from the Great Smoky Mountains National Park, Tennessee*

INVESTIGATOR: Brian S. Luther, *University of Tennessee, Knoxville, Tennessee*

Collections and habitat of a unique poroid resupinate Basidiomycete found only on the bark of dead Betula twigs and branches in a restricted area of the Great Smoky Mountains National Park, Tennessee are discussed. Microscopic characters are indicative of a new genus, which is most closely related to the genus Lindtneria Pilat. A monographic study of Lindtneria and segregates is currently underway at the Department of Botany, University of Tennessee, Knoxville.

PROJECT: *Pollination Ecology of Monarda didyma L. and M. clinopodia L. in the Southern Appalachians*

INVESTIGATOR: Mark Whitten, *University of Tennessee, Knoxville, Tennessee*

The pollination and reproductive systems of two species of mint are being studied to evaluate the importance of pollinator specificity and differences in floral structure as isolating mechanisms.

Monarda didyma and M. clinopodia are sympatric throughout the southern Appalachians and sometimes occur in neighboring or mixed populations. The two species are highly interfertile, and purple-flowered hybrids (Monarda x media Willd.) are not uncommon in mixed populations. Artificial and natural hybrids have high pollen viability, suggesting that genetic barriers to hybridization are weak. Two introgressed populations have been located and sampled.

Observations of insect and bird visitors indicate that the large, scarlet-flowered M. didyma is pollinated almost exclusively by the ruby-throated hummingbird, while the smaller, white-flowered clinopodia is pollinated by several species of bumblebees (Bombus). The purple-flowered hybrid is visited and possibly pollinated by both hummingbirds and bumblebees. Halicted bees and syrphid flies are common visitors to clinopodia and x media, but their pollen-foraging behavior precludes them from acting as pollinators.

Breakdown in pollinator specificity of hummingbirds was observed only when the two species were separated by only one or two meters; the birds then forage indiscriminately on both.

Both species are protandrous, obligate outcrossers. The primary differences in floral characters are size, color and volume of nectar. Both species appear dark in long-wave UV. M. didyma produces ten to twenty times the volume of nectar of clinopodia.

Field work this summer will continue observation of pollinators and measurement of nectar production and seed set. Artificial mixed populations of the plants will be used to determine the effect of plant spacing upon pollinator constancy and pollen transfer.

PROJECT: *Phenotypic and Genotypic Variation of Fraser Fir (Abies fraseri (Pursh) Poir.) in Response to Altitudinal and Geographic Gradients*

INVESTIGATOR: Joseph L. Weber, *North Carolina State University, Raleigh, North Carolina*

Natural selection has resulted in most tree species being well adapted to their environments. If natural selection is to operate, variation within a species is required. The objectives of this study are to attempt to categorize the variation within Fraser Fir into three components: variation among mountains, variation among elevations within a mountain, and individual tree-to-tree variation within an elevation.

One hundred trees were sampled on five mountains throughout the range: Mount Mitchell, Roan Mountain, Mount Rogers, Richland Balsam, and Clingman's Dome. Trees on each mountain were classified according to elevation. Traits such as age, diameter, needle length, needle width, periodic annual increment, cone length, scale length, bract length, seed length, and seed width were assessed on each tree.

Seedling offspring of the one hundred trees are being grown in a study whereby environmental variation is controlled so that a reliable estimate of genetic variation can be obtained. In August of 1979, these seedlings will be assessed for needle length, needle width, number of total buds per plant, internode elongation, root collar diameter, and total height.

PROJECT: *Comparison of Forest Cover Prior to and Following Disturbance in Two Areas of the Great Smoky Mountains National Park*

INVESTIGATORS: Weaver McCracken and Edward Buckner
University of Tennessee, Knoxville, Tennessee

Pre-logging forest cover and the nature and intensity of logging disturbance for two areas in the Great Smoky Mountains National Park were characterized using written records, photographs, interviews and, where available, virgin stands on similar sites. Present seral position and stand character were determined from fixed-area plots established on sites for which previous forest cover and intensity of disturbance had been determined.

A low- to mid-elevation hardwood forest occupying a north-facing drainage on the Tennessee side of the Park was determined to have been mixed mesophytic in character prior to logging and was most intensively disturbed by skidder logging near drainage bottoms. Succession reverted to early pioneer stages where logging was followed by gardening and where skidder damage was intensive, generally the most productive sites. Upper slope and higher-elevation sites were generally less disturbed and appear to be returning more rapidly to stable mid- to late-seral stages.

Yellow-poplar was unusual among the species studied in being one of the largest dominants in the original forests while being the most aggressive "pioneer" on the best sites following intensive disturbance.

In spruce-fir forests at upper elevations, spruce, although less tolerant than fir, was the dominant species in mixed, old-growth stands. This was due to the large size and longevity of spruce compared to the smaller size and shorter life span of fir. Logging disturbance appeared to favor spruce except on exposed sites and at higher elevations where climatic extremes favored fir.

PROJECT: *Fraser Fir in the Great Smoky Mountains National Park: Its Demise by the Balsam Woolly Aphid*

INVESTIGATORS: Ronald L. Hay and C. Christopher Eagar
University of Tennessee, Knoxville, Tennessee

The Fraser fir range in the Park was categorized as heavily infested with balsam woolly aphid or moderately infested. Mt. Sterling, Big Cataloochee, Heintooga, Hyatt Ridge and Mt. Guyot are nearly void of fir in the upper canopy according to 1977 observations. In the western portion of the Park balsam woolly aphid infestations are smaller and more irregular, but is anticipated that they will meld together to remove Fraser fir from the canopy. Fraser fir in the western portion of the Park are not more resistant to aphid attack, rather the aphid has just recently moved into those areas.

There are still living Fraser fir in the moderately infested areas. Mt. LeConte provided an excellent opportunity for study; it's some distance from the State-Line Ridge and yet it is connected to the Ridge by the Boulevard. The base of the mountain on the north has been heavily infested by the aphid and the infestations are growing toward the summit. Already (1977) dead trees are common above 5800 feet and some infested fir have been found near 6400 feet elevation. Similar patterns of aphid infestation development along elevation gradients were witnessed on Clingmans Dome where the Noland Divide infestation was most well developed. Individual infestations spread uphill and quite rapidly for a while, but our study could not yet determine how long the rapid spread rates were maintained as higher elevations were approached. Repeated sampling will reveal infestation spread rates.

Various levels of balsam woolly aphid populations were recognized on the basis of selected environmental-community characteristics. Uninfested stands were characterized as having the following attributes: 1) high elevation, 2) greater than 60% fir composition, 3) high stand densities, 4) eastern aspects, 5) in the western portion of the Park, 6) less than 25% red spruce composition, 7) less than 35% slope, and 8) small diameter of all trees in the stand. Slightly infested stands were similar. Moderately infested stands didn't exist according to analyses. Heavily infested stands were characterized by the following: 1) eastern half of the Fraser fir range in the Park, 2) elevation less than 5400 feet, 3) west and north aspects, 4) some past disturbance in the community, 5) large diameter Fraser fir, 6) large diameter for all trees especially red spruce, 7) greater than 40% red spruce composition, and 8) greater than 50% slope.

In summary, elevation had one of the strongest correlations with balsam woolly aphid population levels. Stands at highest elevation were least likely to be infested by aphids, while stands at low elevations were almost assuredly aphid infested. Geographic area of the Park was also

correlated with aphid infestation, primarily because the aphid was first introduced into the eastern portion and that was where the greatest mortality had taken place. Stand structure was also correlated with balsam woolly aphid population levels. Stands composed of small stems at very dense stocking that were predominantly pure Fraser fir lacked aphids. However, stands comprised of large trees (both fir and spruce) at less dense stocking usually had high populations of balsam woolly aphids.

PROJECT: *The Ecology of Natural Disturbances in Logged and Unlogged Stands in the Cades Cove and Tremont Areas of Great Smoky Mountains National Park*

INVESTIGATOR: Peter S. White, *Uplands Field Research Laboratory, National Park Service*

Understanding natural disturbance is fundamental to the understanding of vegetation-landscape relations. Natural disturbances initiate compositional changes, either by the creation of open sites or by altering the environmental setting of the individuals that persist through the disturbance. Natural disturbances are also correlated with landscape positions and may be correlated with the nature of the vegetation; e.g. the "fire promoting" habit of pines.

In Great Smoky Mountains National Park, windcreated dynamics (defined to include gap phase reproduction) are probably the most widespread kind of disturbance. The purpose of this study is to investigate the effects of this type of natural disturbance in both logged and unlogged forests. Tenth hectare plots will be sampled in a variety of topographic positions. Additional plots will be established along a disturbance gradient from single tree falls and small canopy openings to larger disturbances. The qualities of individual woody species, such as wood density and seed weight, and the relationship of these to their response to disturbances will also be investigated.

The study should result in a description of the internal successional sequence in an unlogged forest community; a description of the differences in stand dynamics between logged and unlogged stands in similar topographic positions; and stand classifications for logged and unlogged mesic communities.

PROJECT: *Effect of Disturbances on Red Spruce and Fraser Fir Age-Diameter Relationships*

INVESTIGATOR: Paul R. Saunders, *Clemson University, Clemson, South Carolina*

Increment cores were collected from seventy-six spruce and the same number of fir trees in the sampling of virgin, aphid infested and second growth spruce-fir forest stands. Sixty-four fir and thirty-two spruce increment cores were collected in the recreation samples of trails, shelters, campsites and picnic areas. All cores were collected from Southern Appalachian spruce-fir forests from 1975 to 1978. A linear regression model ($Y = a + bX$) using age as the dependent variable and diameter as the independent variable was calculated for each tree species in the forested and recreation areas. A significance test of the regression coefficient (b) was used to determine if there was a significant difference between the age-diameter linear regression models with respect to the type of disturbance sampled. Significance was tested at the five percent level.

There was a significant difference between the linear models for spruce and fir in both the recreation samples and in the forest samples.

The fir linear models had no significant difference among the regression coefficients within the recreation samples, the forest samples, or between the total recreation and total forest samples. The spruce linear models had no significant difference within the recreation samples or between the total recreation and total forest samples. Within the forest stands there was a significant difference among four sets of spruce regression coefficients. The spruce in balsam woolly aphid infested stands were significantly different from the total spruce forest samples, the spruce in previously logged stands, the spruce at shelters, and the spruce from the total recreation samples.

A number of conclusions can be drawn from these tests of significance. Spruce and fir have different physical characteristics with respect to longevity, height and diameter growth. It was not unexpected that spruce and fir would differ significantly in both the recreation areas and the forest stands. One would have been surprised had these two rather different species shown linear regression models which were not significantly different.

The absence of significant differences among the fir linear regression models for the recreation sites, forest stands, and between the total recreation and total forest samples indicates that fir diameter growth was not significantly altered by either recreational or logging disturbances in these forests. Fir had a relatively similar mean age and diameter at the various sample locations. The important role fir plays in reforestation would favor rapid growth rates in all of the disturbed conditions which were sampled.

Stagnation of fir regeneration is relatively uncommon in most forest conditions.

The general absence of significant differences among the spruce linear regression models also indicated that these disturbances did not seriously alter its diameter growth. The one exception to this generalization was the balsam woolly aphid infested stands. The spruce in the aphid infested stands had a younger mean age and a larger mean diameter than the rest of the spruce sampled. In this limited sample the spruce were younger in the stands which had been attacked by the aphid. Spruce diameter and height growth responded favorably to the decreased midcanopy and canopy density which resulted from the death of the fir trees. Insect attacks rather than logging or recreational disturbances had the greatest influence on spruce diameter growth.

In summary, spruce and fir diameter growth was not significantly altered by the various recreational disturbances or by logging and subsequent regeneration in former virgin stands. Spruce diameter growth was significantly altered in spruce-fir stands that had been attacked by the balsam woolly aphid. Spruce growth in the aphid infested stands responded favorably to the decreased canopy competition. Spruce in the aphid infested stands had a lower mean age and diameter than the spruce in the recreation area or forested stands. Spruce in the second growth stands and aphid infested stands were of similar mean age and diameter, but the second growth stands presented considerably more competition for spruce growth.

PROJECT: *Early Stages of Fire Succession in the Abrams Creek Area*

INVESTIGATOR: Mark E. Harmon, *Uplands Field Research Laboratory, National Park Service*

The response of herbaceous and woody vegetation is being followed in recently burned forests in the western part of the Great Smoky Mountains. Longer term successional trends are also being examined by matching sites with similar topographic position, aspect, elevation, etc., and varying the age and degree of fire disturbance.

Typical "cool" ground fires removed 33 percent of the original canopy stems but left over 90 percent of the prefire basal area. In direct contrast, "hot" ground fires killed over 75 of the original stems and basal area. Fire severity was, however, extremely heterogeneous within a stand, leaving many unburned patches.

Total herb cover and species richness increased as fire severity increased. On the hottest burns, herb cover appeared to be inversely related to pine seedling reproduction. Three types of responses were noted in the ground layer after fire.

Bracken fern is present in all pine plots but increases in frequency only after hot fires. Panic grass, on the other hand, is only present in burned plots and exhibits the greatest frequency on hot burns. Pine seedling are also present on all pine stands, and hot burns do not always lead to increases in pine seedlings. A general model for the ground layer response is suggested which includes canopy opening, seed source, quality and quantity, and soil alteration as predictive variables.

PROJECT: *Fire History of Great Smoky Mountains National Park, 1931 - 1977*

INVESTIGATOR: Juliet Covell, *Uplands Field Research Laboratory, National Park Service*

Individual Forest Fire Reports from 1942 to 1953 and from 1960 to 1977 have been received, and pertinent data from these reports has been transcribed onto the General Fire Statistics form. Updating of fire history information on this form is intended to make a possible computational analysis of historic fire characteristics (i.e., frequency, yearly and seasonal distribution, cause, size, intensity, and severity) and their relations to vegetation type, fuel loads, and past land use.

1:25,000 scale maps for 1931 to 1977 compiled from the Forest Fire Reports and records in the Fire Atlas show the location, date, relative size class, and cause of each fire. Geographic and temporal clumping of various man-caused fires contrasts with the character of natural fires. The majority of smoker fires occur along Highways 73 and 441 and along the Park Boundary (particularly the perimeter along Highway 129 and the Bryson City and Cosby areas). The majority of fires were of incendiary origin; many debris-burning fires occur along the Tennessee Valley Authority powerline right-of-way or highway right-of-way. Along the Fontana Lake shore, many fires were started by careless campers. Lightning fires, on the other hand, occurred on ridgetops and most were in the interior regions of the park.

Man-caused as well as natural fires were probably more extensive and often more intense prior to the adoption of present fire-suppression techniques. Size and frequency of the forest fires within Great Smoky Mountains National Park has changed. After the park was established in the 1930's an effort was made to control all wildfires. Such efforts at complete suppression have been particularly effective over the past 20 years, resulting in fewer and smaller fires.

PROJECT: *An Overview of Forest Fuels in the Great Smoky Mountains National Park*

INVESTIGATOR: Mark E. Harmon, *Uplands Field Research Laboratory, National Park Service*

A knowledge of organic matter distribution upon the landscape is a vital component of fire and fuel management in the Great Smoky Mountains. The diversity of climate, topography, soil, geology, vegetation, and historical factors leads to a highly complex pattern of fuel distribution. Profound differences occurring throughout the park can be emphasized by reviewing the literature on past work concerning the Southern Appalachians.

Preliminary results from fuel sampling in the western portion of the Great Smoky Mountains also emphasizes the complexity of the problem. Both fresh leaf litter and small wood fractions were relatively constant between forest types. Partially decomposed leaf material and large wood fractions tend to peak in certain vegetation communities. Partially decomposed leaf matter tends to accumulate in xeric oak, pine-oak, pine, and rhododendron hardwood communities. Large wood fractions accumulate where stand histories indicate some type of heavy disturbance during the last 50 years.

PROJECT: *Assessing the Internal Variability in Forest Nutrient Cycles: Preparations for a New Look at Forest Process Comparisons*

INVESTIGATOR: David A. Weinstein, *University of Tennessee, Knoxville, Tennessee*

Nutrient cycling mechanisms have been investigated for potential monitoring purposes, since the cycles are intimately connected to the long term dynamics, productivity, and stability of forest systems. An experiment will be performed to evaluate the applicability of mineral cycling information generated for one forest type to other forests. Dominant tree species are hypothesized to be sensitive to and to have adapted to the statistical variability in the pattern of nutrient release from the litter decomposition process. Plots of mature and successional stands of Liriodendron tulipifera and Quercus prinus will be perturbed by removing all litter from the forest floor. Differences in the responses of components and flux rates within the forest floor to the perturbation (induced variability) will be used to indicate differences in the adaptive flexibility of these stands to variability in nutrient availability.

PROJECT: *Comparison of Surface Impact by Hiking and Horseback Riding in the Great Smoky Mountains National Park*

INVESTIGATOR: Paul L. Whittaker, *Uplands Field Research Laboratory, National Park Service*

This study attempted to quantify differences between horse and foot use on trails in Great Smoky Mountains National Park. Four types of surfaces -- pasture, foot trail, mesic foot and horse trail, and xeric foot and horse trail were investigated. Foot use included both lug and flat soles.

One hundred foot passes on the pasture surface increased compaction. Horse trampling initially increased compaction, but after twenty passes, compaction decreased and the surface became muddy. After one hundred passes the height of the vegetation had decreased by 85 percent under foot use and 96 percent under horse use.

All types of use on the foot path decreased compaction and the depth of litter. The effect of the horse was much greater than that of the foot users, causing the surface to become muddy. Horse use had a much greater effect on the mesic foot - horse trail section than on the xeric section.

Regressions were presented for change in trail surface condition by the number of passes.

PROJECT: *Human Impacts on Backcountry Campsites: Canopy Opening, Tree Damage, and Wood Removal*

INVESTIGATORS: Linda Stromberg, CeCe Magistrale, and Susan P. Bratton
Uplands Field Research Laboratory, National Park Service

This study follows up a general study (S. Bratton 1977) conducted last year, investigating vegetation disturbance, canopy opening, and wood removal in several campsites in the Great Smoky Mountains National Park. The relationship of canopy opening and understory damage to visitor use and site location will be examined after data collection.

Firewood versus stove use in the backcountry will be monitored by surveys conducted by backcountry rangers and Uplands Laboratory staff. Firewood availability will be determined by using the scheme developed for estimating fire fuel loadings for forest fire management. The remainder of the sampling will be consistent with the vegetation survey. Additional information will be gathered on injured trees.

PROJECT: *Rare and Endangered Plant Status Report and the Status of the Vegetation Survey*

INVESTIGATOR: Susan P. Bratton, *Uplands Field Research Laboratory, National Park Service*

A rare plant status report has recently been prepared for the Great Smoky Mountains National Park. It discusses unnatural disturbances thought to be affecting populations of rare plants. Copies will be made available. Other area botanists are requested to help update sighting and other population information, particularly in the case of species whose status is not well known.

The vegetation survey is well under way, with over 100 .1-hectare plots completed under four different projects. This year's sampling will continue in the Abrams Creek area and south of Cades Cove. The computerized vascular checklist and data books describing the sampling scheme are now available. Computer coding of Frank Miller's old data is currently underway. About 200 plots have been written into data sheets and will be keypunched.