DOCUMENT RESUME

ED 083 004 SE 016 827

AUTHOR	Hershey, John T., Ed.; And Others
TITLE	A Curriculum Activities Guide to In-Depth Environmental Studies.
INSTITUTION	Project KARE, Blue Bell, Pa.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Office of Environmental Education.
PUB DATE	73
GRANT	OEG-0-72-5105
NOTE	167p.
AVAILABLE FROM	Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	*Curriculum Guides; Elementary Grades; *Environmental Education; Instructional Materials; *Investigations; *Natural Resources; *Problem Solving; Secondary Grades; Student Research

ABSTRACT

This guide is the fourth in a series of four books emphasizing student-oriented problem solving related to environmental matters. It utilizes a three-level activity approach: awareness, transitional, and operational. The intent is to provide investigations that will motivate students to pursue in-depth studies, thus encouraging them to generate ideas, design and carry through plans of action, make decisions regarding data collection, processing, evaluation, and utilization, and determine what potential impact these findings might have on community action. In proposing or recommending action they must consider the action and alternatives to this action as they relate to a variety of political, economic, legal, social, scientific, and technological factors. Topics considered for the investigations include birds, weather, ferns, air quality and vegetation, and weeds. Each chapter is devoted to one topic and provides a series of investigations on that topic. An introduction and background information give initial orientation followed by an enumeration of materials and methods, and, where appropriate, data, interpretations, and conclusions. A bibliography supplements each chapter. Related documents are SE 016 524, SE 015 525, and SE 016 614. (BL)

A CURRICULUM ACTIVITIES GUIDE

To IN-DEPTH ENVIRONMENTAL STUDIES

BUCKS · MONTGOMERY · CHESTER · PHILADELPHIA · DELAWARE

Produced by

Project KARE BLUE BELL, PENNSYLVANIA Matthew M. Hickey Director

NOTICE

This book is the last in a series of four books produced by Project KARE with a grant from the Office of Environmental Education under Public Law 91-516. The other titles are:

- Curriculum Activities Guide to Solid Waste and Environmental Studies
- Curriculum Activities Guide to Population and Environmental Studies
- Curriculum Activities Guide to Water Quality Equipment and Environmental Studies

The books produced by Project KARE are being disseminated in slightly different format by:

The Institute for Environmental Education (IEE)
8911 Euclid Avenue
Cleveland, Ohio 44106
(Telephone: 1-216-231-5010)

Project KARE Books are Curriculum Activities Guides to...	IEE Books are Curriculum Activities Guides to...
Water Quality Equipment & Environmental Studies	Water Pollution Equipment
Solid Waste & Environmental Studies	Solid Waste
Population & Environmental Studies and two Chapters of In-Depth and Environmental Studies (birds, and weather)	Birds, Bugs, Dogs, & Weather
In-Depth and Environmental Studies	Three Chapters (ferns, vegetation and air quality, and weeds) produced at later date.

Questions regarding the use of the books may be directed to Project KARE, Colony Office Building, Route 73 & Butler Pike, Blue Bell, Pennsylvania 19422, Telephone: 215-643-7600.

A CURRICULUM ACTIVITIES GUIDE

TO

IN - DEPTH

ENVIRONMENTAL STUDIES

Alan D. Sexton
Environmental Specialist
PROJECT KARE
Colony Office Building
Route 73 & Butler Pike
Blue Bell, Pennsylvania 19422

Patricia M. Sparks
Temple University
Philadelphia, Pennsylvania 19122

John T. Hershey
Environmental Specialist
PROJECT KARE
Colony Office Building
Route 73 & Butler Pike
Blue Bell, Pennsylvania 19422

DOCUMENTATION TASK FORCE
PROJECT KARE
Blue Bell, Pennsylvania

The project presented or reported herein was performed pursuant to a Grant from the U. S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

The materials in this book were written in the summer of 1972 under grant No. OEG-0-72-5105 from the Department of Health, Education, and Welfare, Office of Education, Environmental Education, Washington, D. C. 20202.

Information concerning this publication may be obtained from:

Documentation Task Force
Project KARE
Colony Office Building
Route 73 & Butler Pike
Blue Bell, Pennsylvania 19422

FIRST PRINTING 1973

This document is printed on 100% recycled paper.

Acknowledgements Draft

There were many people who contributed to the completion of this document. It is a sequel to A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vols. I and II and as such, it leans heavily on the work of others who went through the ordeal of beginning something. Special thanks go to Donald L. Wright, Director of Project KARE, who encouraged the effort to formulate the Documentation Task Force (DTF) idea and to Allen C. Harman, Executive Director of Montgomery County Intermediate Unit #23, who facilitated the DTF effort in a myriad of ways from board approval to accounting procedures. The cooperation of the Intermediate Units of Bucks, Chester, Delaware, and Philadelphia Counties and the Roman Catholic Archdiocese of Philadelphia is likewise appreciated.

We are grateful to George Lowe, Assistant Director of the Office of Environmental Education, U. S. Office of Education who encouraged us to continue this work. We appreciate the efforts of Joseph H. Chadbourne, President of the Institute for Environmental Education (IEE) who encouraged his program staff and participants to contribute material related to their needs. Many of the activity ideas and past studies come from participants of IEE programs, past and present. In particular, contributions were received from participants of the Cuyahoga River Watershed Project, Quincy Public Schools, and 1972 Summer Training Programs. The coordinating effort was carried out by summer program director, Alan McGowan, Scientific Administrator, Center for the Biology of Natural Systems and Peter Gail, Adjunct Professor, Cleveland State University.

This guide was organized and edited by the team of John Hershey, Alan D. Sexton, and Patricia Sparks. They compiled the contributions of conference participants and the DTF staff writers. The staff writers were: Peter Goldie, Jonathan Gormley, David Kriebel, Robert Lippincott, Jerry Ruddle, Ronald Spencer, Tim Tanaka, and Melissa Weiksnar. The initial writing of Chapter 3 was done by Peter M. Renner and that of Chapters 4 and 5 by Robert W. Pultorak.

The efforts of Pat Abrams, Bette Connelly, Diana Geist, and Claire Pilzer made the writers' imperfections tolerable to the DTF.

Since the DTF began, there have been several personnel changes. Matthew M. Hickey has succeded Donald L. Wright as Director of Project KARE. Alan D. Sexton has succeded Mr. Hickey as the Assistant Director of Project KARE. John T. Hershey is no longer associated with Project KARE and is now the Manager of Environmental Programs for the University City Science Center, Philadelphia, Pa. Mr. Hickey and Mr. Sexton are currently administering the DTF. Mr. Sexton did the final editing of all four volumes in this series.

This book is one of four which are being produced by the DTF. The other three deal with solid waste, homemade water testing equipment, and population.

A CURRICULUM ACTIVITIES GUIDE

TO

IN DEPTH

ENVIRONMENTAL STUDIES

Environmental education is a learning process in which the learner investigates real problems of the real world. The major goal of this process, which deals with interactions within and between the natural and man-made environments, is to develop an informed citizenry that will be able and willing to take the actions necessary to solve problems dealing with environmental quality. The curriculum of environmental education is contemporary and projective, that is; it deals with issues of the present and requires projects for the future.

The emphasis in this guidebook is on student-oriented problem investigation. Students who are involved in problem investigation are active learners. By being actively involved in this process they will develop the capabilities of using resources to find information and of using this information to make decisions. As students become involved in the teaching-learning processes, they begin to experience success which tends to encourage further learning and involvement.

Relevancy is seen as a major key to involvement. Learning is most meaningful when it is relevant to the students' needs, abilities, interests, and personal as well as social purposes. In order for teachers to deal with transition from more traditional teaching approaches they must begin with the learner and not the subject matter. The teachers must relate to the students through experiences that will meet the personal and social needs of the students.

The intent of this guidebook is to provide student-oriented investigations that will motivate students to pursue in-depth studies. In moving from the more teacher-dominated to the more student-dominated classroom the learner must, in the words of Morris,

> "...be encouraged to identify with his subject matter, to identify with it emotionally so that he can announce a personal reaction to it. The teacher's function is to arouse the learner intellectually, spiritually and emotionally. Arousal in the learner will quicken his inner senses to perceive what his learning materials are saying to him; the affective center of a 'sensation' will then be in a better condition to react to the materials themselves. For it is in the reaction, and not in the materials, that knowing and learning really takes place.
>
> Therefore, in every subject matter a real effort must be made to involve the learner directly. He must get personally tangled up in the subject matter." (1)

In addition the students must be encouraged to generate ideas, to make decisions, to design and carry through plans of action and to evaluate those actions. The expected role of the teacher is that of a guide and participator rather than the ultimate authority.

The students function individually or in groups to investigate in-depth specific environmental concerns. The students may initiate their own study and design. They gain direct experience in carrying through investigations in which they are responsible for decision-making regarding data collection, data processing, data evaluation and data

---

(1) Morris, Van Cleve, Philosophy and the American School, Boston, Houghton Mifflin Co., 1961, p.392.

utilization.

Once the students have completed their investigations they are required to examine their findings and to determine what potential impact these findings might have on community action. The students then interpret their results and determine how they can be utilized. In proposing or recommending action they must consider the action and the alternatives to this action as they relate to a variety of political, economic, legal, social, scientific, and technological factors. The students realize through these investigations that they have definite roles as community members. They become aware of the complexity of both natural and man-made systems, and they realize that they have a responsibility that extends beyond their own interests and needs. Outgrowths of the investigation include a greater concern for social responsibility, a consideration for environmental ethics and a greater awareness of potential career opportunities.

CHAPTER 1

I. Introduction

Man has long been fascinated by living creatures that fly. Observing, photographing, drawing, banding, recording, hunting, and listening to birds have been favorite activities of man for centuries. His attempts to imitate, desire to eat and lack of knowledge about birds have caused him to study, to hunt, and unfortuantely to endanger the survival of birds wherever his influence is felt.

There are many who view birds as a unique and irreplaceable part of the delicately interwoven systems of nature. These people are the amateurs and researchers who seek birds for their beauty and work to preserve their existence and wildness. There are many institutions and thousands of individuals participating daily in an active appreciation of birds.

The activities, studies, projects and programs avialable to the bird lover are vast and at every level of interest, and intensity. The studies mentioned here are those performed each summer at Cooper's Cove, West Virginia (near Capon Bridge) at the Burgundy Wildlife Camp. Here the staff and campers daily investigate birds: recording sightings and nests, banding birds and completing individually designed projects realting to them. All these activities are aimed at achieving a greater awareness of the world of birds, specifically those found locally, but more generally an appreciation of the whole bird population. The rest of the bird world (outside Cooper's Cove) is revealed through numerous books, occasional nestings of migrating birds, staff and camper experiences, bird photographs, movies and guest specialists. The importance and achievement of the goal of a better knowledge of the appearances, habits and songs of birds is seen most clearly in the campers' desire and resulting ability to identify birds in the area. This is evident from a questionnaire given to experienced campers during the summer of 1972. Typical comments contained references to the wonderful feeling of interaction with and appreciation of nature deriving from the ability to walk through an area and know the birds around by song, flight pattern, sight and nesting evidences.

The Burgundy campers acquire a knowledge of the birds found in Cooper's Cove and a sympathetic understanding of the place that birds occupy in the total ecological tapestry that forms their surroundings. The attitudes generated by this knowledge and its use are necessary to ensure the preservation and in some cases restoration of bird populations. These attitudes and their ramifications are the implicit result of any comprehensive study of birds. A complete study consists of a sincere attempt to observe, identify and learn about birds. These studies take many forms and each has a valuable use.

Reports of nest finds, lists of species sighted, and numbers of birds banded if recorded and compiled can be useful in a multiplicity of ways. There are many national studies of birds banded and nests found, of population densities, migratory behavior, etc., and how each of these relates to the local an national environments. These relationships are established in terms of other environmental influences (food, nesting area availability and predator population, etc.). All banding data, of course, are first reported to the Fish and Wildlife Service (that department that issues the necessarily prerequisite banding permits). The other sorts of data are used when speculating on trends and fluctuations, establishing patterns, and explaining accidents. All of these represent only beginnings of uses for figures collected. The projects and ideas evolving from the records are interesting to the individual bird lover, useful to the institutions studying larger areas, and perhaps most important, symbolic of the true interest in ornithology. Projects will lead to initial impetus for local, regional, national or international action to promote wildlife management and conservation in direct relation to birds and indirectly to all animals and their natural environments. The most important element of wildlife management is the education of people and the management of their activities. Thus the watcher, bander and all the researchers are potentially those responsible for the actual preservation of birds.

II. Materials and Methods

A. For General Bird Studies; Field Observation

1. A pair of binoculars is a must especially for beginners.

These should be used by sighting a bird that you wish to examine. Then without losing sight of the bird, raise the binoculars to your eyes, magnifying the already spotted bird for observation and identification.

2. A good field guide to birds is essential. This book should contain at least the most common local species, pictures of both sexes and varying notes. The notes include information like dimensions, verbal description of bird song, nesting and breeding habits, map of distribution, description or picture of bird during flight, etc. (See Bibliography for several famous guides.) Many books have birds classified in phylogenetic order and are necessary for field identification when exceptional birds are sighted.

3. A list to record the birds observed facilitates the recording of data. These are often found in the field guides, but marking these limits their use when they are copied.

4. For extended study of a nest or particularly fruitful birding spot, a blind is an excellent device. It is of utmost use for photography of nesting birds. This can be a natural cover or a shield constructed out of nearby branches, etc. A portable and effective blind can be made from a wooden frame covered with burlap. A small stool inside and an appropriate observation hole will provide the observer (if properly placed) with a

comfortable, convenient viewpoint.

5. A chart, notebook or file of lists to store results of bird trips. The photographer who attempts to capture birds on film will, of course, need film, camera, and other equipment depending on desired sophistication of photographs, experience, and funds. The most valuable aids available to the camera operator are the many photographic books and journals, experienced advice, and persistence.

6. A viewing staff is of utmost use in nest identification. This is a piece of equipment, often handmade, that consists of a long pole (6-8 feet) with a mirror (at least 2" x 2") attached to the top at an obtuse angle. This will enable a ground observer to peer into a nest without damaging or disturbing it or removing it from its position in a tree.

7. Exceptionally useful in all bird studies are the Audubon Land Bird Guide Rapid Recognition Sheets, Doubleday, Inc., 1963. They are available for local birds and complement the book of the same name.

B. Equipment Necessary for Bird Banding

1. A bird banding license, dispensed by the U.S. Fish and Wildlife Service, IS NECESSARY FOR ANY BIRD BANDING OPERATION.

2. Bird bands (supplied free with license).

3. Nets or traps that may be purchased from a number of bird banding associations. These, of course, are used to trap the birds for banding, or to recapture previously banded birds.

4. Pliers and tools available from bird banding associations. These are used to put bands on birds.

5. Carrying cases for birds from nets or traps to banding station. These too can be purchased from bird banding associations.

6. Notebooks or other recording and filing system (easily made if standard charts are drawn up and lettered).

7. Scale to weigh birds. A net can be used to hold the bird. The scale is adjusted to compensate for the weight of the net.

8. A thermometer to record temperatures at time of banding and linear measuring devices to collect desired statistics for study.

9. A station or headquarters for banding and processing the birds. A tent provides protection for instruments, data files, etc. and serves as a soft walled cage for birds that might escape.

In a bird banding operation the most difficult problem presented is finding a way to safely and economically capture birds without harming them. The use of mist nets has proven to be the best method. The mist nets, which are made of fine nylon manage to capture birds that fly into them with a minimum of casualties. The majority of casualties result from improper removal from the nets or overexposure to the elements, while within the nets. The nets used at Burgundy Wildlife Camp were placed across expected flying paths of the birds. These paths included the area around the creek where the birds would come in to bathe and drink.

The bander will open his nets during the day and check them at 15 to 60 minute intervals, depending upon the severity of the weather. If a bird has been netted, the bander carefully removes it from the net and places it in a carrying case. After retrieving all captured birds the bander returns to the banding tent where the vital statistics are recorded. The bird will be identified; measured; weighed; aged by means of skull ossification or plumage; and sexed by plumage, evidence of brood spot, mouth color or wing measurement. After this the bird is banded and released. The total amount of time the bird was captured should never be more than an hour.

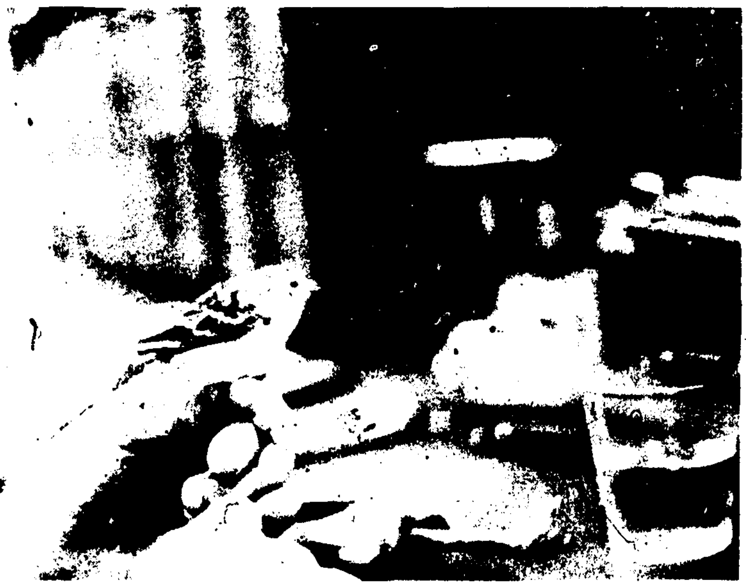
This brief summary of a banding operation should help to show the extend of training and preparation a bander must have in order to run a banding station.

Once the bird is inside the banding tent its wing is measured ...

It is wrapped in plastic netting and weighed ...

Its age is determined by skull ossification ...

And finally it is banded.



This bird is ready to be released with its new band.

III. Data

A. Bird Observation Studies

The least expensive and often most productive form of doing a bird study is through simple observation. Meaningful and reliable data are collected with few materials needed. The most valuable piece of equipment needed is an acute awareness of the surroundings.

The observation studies at Burgundy Wildlife Camp take the forms of a bird population study by sightings and a nest finding study. These studies provide the camp with a list of species predominate to the area and also species that are comparatively rare. The nest study, which takes the form of a contest at the camp, provides information that was forwarded to the Cornell Laboratory of Ornithology for analysis.

In order to have the bird population study on a scale that the Wildlife Camp does it is necessary to have forty observant and ornithologically oriented campers and staff who spend most of the day out-of-doors. Each day a camper is selected to keep the bird list. He is then given a simple two-page checklist of birds in the area. The list used was created by the Audubon Naturalist Society of the Central Atlantic States, Inc. (See Figure 1). The campers then go through their normal daily

Keen observation is the key to any study, especially bird watching. Here several campers attempt to locate the source of a call they just heard.

Loon, Common				Goldeneye, Common			
Red-throated				Bufflehead			
Grebe, Red-necked				Oldsquaw			
Horned				Eider, Common			
Pied-billed				King			
Shearwater, Cory's				Scoter, White-winged			
Greater				Surf			
Sooty				Common			
Petrel, Wilson's				Duck, Ruddy			
Gannet				Merganser, Hooded			
Cormorant, Great				Common			
Double-crested				Red breasted			
Heron, Great Blue				Vulture, Turkey			
Green				Black			
Little Blue				Goshawk			
Egret, Cattle				Hawk, Sharp-shinned			
Common				Cooper's			
Snowy				Red-tailed			
Heron, Louisiana				Red-shouldered			
Black-crowned Night				Broad-winged			
Yellow-crowned Night				Rough-legged			
Bittern, Least				Eagle, Golden			
American				Bald			
Ibis, Glossy				Hawk, Marsh			
Swan, Mute				Osprey			
Whistling				Falcon, Peregrine			
Goose, Canada				Hawk, Pigeon			
Brant				Sparrow			
Goose, Snow				Grouse, Ruffed			
Blue				Bobwhite			
Duck, Fulvous Tree				Pheasant, Ring necked			
Mallard				Turkey, Wild			
Duck, Black				Rail, King			
Gadwall				Clapper			
Pintail				Virginia			
Teal, Green-winged				Sora			
Blue-winged				Rail, Yellow			
Widgeon, European				Black			
American				Gallinule, Common			
Shoveler				Coot, American			
Duck, Wood				Oystercatcher, American			
Redhead				Plover, Semipalmated			
Duck, Ring-necked				Piping			
Canvasback				Wilson's			
Scaup, Greater				Killdeer			
Lesser				Plover, American Golden			

Figure 1
Bird Sighting Checklist

Plover, Black bellied				Great Horned			
Turnstone, Ruddy				Snowy			
Woodcock, American				Barred			
Snipe, Common				Long-eared			
Whimbrel				Short-eared			
Plover, Upland				Saw-whet			
Sandpiper, Spotted				Chuck-Will's Widow			
Solitary				Whip-Poor-Will			
Willet				Nighthawk, Common			
Yellowlegs, Greater				Swift, Chimney			
Lesser				Hummingbird, Ruby-throated			
Knot				Kingfisher, Belted			
Sandpiper, Purple				Flicker, Yellow-shafted			
Pectoral				Woodpecker, Pileated			
White-rumped				Red-bellied			
Baird's				Red-headed			
Least				Sapsucker, Yellow-bellied			
Dunlin				Woodpecker, Hairy			
Dowitcher, Short-billed				Downy			
Sandpiper, Stilt				Red-cockaded			
Semipalmated				Kingbird, Eastern			
Western				Western			
Godwit, Marbled				Flycatcher, Great Crested			
Hudsonian				Phoebe, Eastern			
Ruff				Flycatcher, Yellow-bellied			
Sanderling				Acadian			
Avocet, American				Traill's			
Stilt, Black-necked				Least			
Phalarope, Red				Pewee, Eastern Wood			
Wilson's				Flycatcher, Olive-sided			
Northern				Lark, Horned			
Jaeger, Pomarine				Swallow, Tree			
Parasitic				Bank			
Gull, Glaucous				Rough-winged			
Iceland				Barn			
Great Black-backed				Cliff			
Herring				Martin, Purple			
Ring-billed				Jay, Blue			
Laughing				Raven, Common			
Bonaparte's				Crow, Common			
Tern, Gull-billed				Fish			
Forster's				Chickadee, Black-capped			
Common				Carolina			
Roseate				Titmouse, Tufted			
Least				Nuthatch, White-breasted			
Royal				Red breasted			
Caspian				Brown-headed			
Black				Creeper, Brown			
Skimmer, Black				Wren, House			
Dovekie				Winter			
Dove, Mourning				Bewick's			
Cuckoo, Yellow-billed				Carolina			
Black-billed				Long-billed Marsh			
Owl, Barn				Short-billed Marsh			
Screech				Mockingbird			

Figure 1 (Continued)
Bird Sighting Checklist

Catbird				Mourning			
Thrasher, Brown				Yellowthroat			
Robin				Chat, Yellow-breasted			
Thrush, Wood				Warbler, Hooded			
Hermit				Wilson's			
Swainson's				Canada			
Gray-cheeked				Redstart, American			
Veery				Sparrow, House			
Bluebird, Eastern				Bobolink			
Gnatcatcher, Blue gray				Meadowlark, Eastern			
Kinglet, Golden-crowned				Blackbird, Red-winged			
Ruby-crowned				Oriole, Orchard			
Pipit, Water				Baltimore			
Waxwing, Cedar				Blackbird, Rusty			
Shrike, Northern				Grackle, Boat-tailed			
Loggerhead				Common			
Starling				Cowbird, Brown-headed			
Vireo, White-eyed				Tanager, Scarlet			
Yellow-throated				Summer			
Solitary				Cardinal			
Red eyed				Grosbeak, Rose-breasted			
Philadelphia				Blue			
Warbling				Bunting, Indigo			
Warbler, Black-and-White				Dickcissel			
Prothonotary				Grosbeak, Evening			
Swainson's				Finch, Purple			
Worm-eating				House			
Golden-winged				Redpoll, Common			
Blue-winged				Siskin, Pine			
Brewster's (hybrid)				Goldfinch, American			
Lawrence's (hybrid)				Crossbill, Red			
Tennessee				White-winged			
Orange-crowned				Towhee, Rufous-sided			
Nashville				Sparrow, Ipswich			
Parula				Savannah			
Yellow				Grasshopper			
Magnolia				Henslow's			
Cape May				Sharp-tailed			
Black-throated Blue				Seaside			
Myrtle				Vesper			
Black-throated Green				Lark			
Cerulean				Bachman's			
Blackburnian				Junco, Slate-colored			
Yellow-throated				Sparrow, Tree			
Chestnut-sided				Chipping			
Bay-breasted				Field			
Blackpoll				White-crowned			
Pine				White-throated			
Prairie				Fox			
Palm				Lincoln's			
Ovenbird				Swamp			
Waterthrush, Northern				Song			
Louisiana				Longspur, Lapland			
Warbler, Kentucky				Bunting, Snow			
Connecticut							

REV:A:1

Figure 1 (Continued)
Bird Sighting Checklist

routine and make careful mental notes of the location and species of birds they observe. Sometime in the afternoon the campers meet with the person who has the bird list and tell the species and location of the birds that were sighted that day. That evening the list is compiled and transferred to a chart in the dining room at the camp. The chart includes the species, location sighted, date sighted and a number sighted.

In 1970 the record of bird populations was kept by recording the number of days a species was sighted over the forty-day period the camp was in session. (See Figure 2.)

The data collected were then used by several campers in creating a checklist of birds of the immediate area. The project printed here was done by Fred Hirschman, then a camper at the Wildlife Camp. (See Figure 3.) The checklist includes the birds that nest in the area, the possibility of a sighting and a description of previous sightings of each species known to the area.

Keen observation is necessary for participation in the nest study. The study involves the location of active nests, that is, nests in use, and the collection of certain data about the nests. At the camp the study is in the form of a contest. Each nest sighted constitutes a certain number of points, depending upon the rarity of the nest in the area and the number of eggs

BIRDS SIGHTED AT COOPER'S COVE 1970

SPECIES	NUMBER OF DAYS SIGHTED				
	6/22 TO 7/1	7/2 TO 7/11	7/12 TO 7/21	7/22 TO 7/31	TOTAL
Green Heron	0	0	1	0	1
Wood Duck	0	0	1	0	1
Turkey Vulture	10	10	10	10	40
Black Vulture	7	8	7	1	23
Cooper's Hawk	2	0	1	1	4
Red-tailed Hawk	5	9	9	10	33
Broad-winged Hawk	1	5	7	7	20
Peregrine Falcon	0	0	2	0	2
Sparrow Hawk	0	0	4	3	7
Ruffed Grouse	7	7	2	7	23
Bobwhite	10	10	10	0	39
Killdeer	6	2	9	7	24
American Woodcock	1	2	0	0	3
Spotted Sandpiper	6	10	0	0	16
Solitary Sandpiper	0	0	0	1	1
Greater Yellowlegs	0	0	0	1	1
Mourning Dove	10	7	8	8	33
Yellow-billed Cuckoo	10	10	7	0	27
Black-billed Cuckoo	9	2	0	0	11
Screech Owl	-	-	4	8	12
Barred Owl	0	1	0	1	2
Whip-poor-will	10	10	10	5	35
Chimney Swift	8	10	10	10	38
Ruby-throated Humingbird	7	9	7	9	32
Belted Kingfisher	3	8	7	6	24
Yellow-shafter Flicker	10	10	9	10	39
Pileated Woodpecker	10	9	10	9	38
Red-bellied Woodpecker	3	10	4	8	25
Hairy Woodpecker	9	8	10	6	33
Downy Woodpecker	10	10	10	10	40
Eastern Kingbird	10	10	10	10	40
Great-crested Flycatcher	10	9	0	1	20
Eastern Phoebe	10	10	10	10	40
Acadian Flycatcher	10	10	10	7	37
Trail's Flycatcher	0	0	0	1	1
Eastern Wood Pewee	10	10	10	10	40
Horned Lark	0	0	0	1	1
Tree Swallow	1	0	1	1	3

Figure 2

BIRDS SIGHTED AT COOPER'S COVE 1970

SPECIES	NUMBER OF DAYS SIGHTED 6/22 TO 7/1	7/2 TO 7/11	7/12 TO 7/21	7/22 TO 7/31	TOTAL
Rough-winged Swallow	0	0	4	4	8
Barn Swallow	7	6	10	10	33
Blue Jay	9	6	10	10	35
Common Raven	0	0	1	2	3
Common Crow	10	10	10	10	40
Black-capped Chickadee	7	9	3	7	26
Carolina Chickadee	8	0	2	6	16
Tufted Titmouse	10	10	10	10	40
White-breasted Nuthatch	9	9	5	8	31
House Wren	2	1	0	0	3
Mockingbird	5	8	6	5	24
Catbird	7	10	10	9	36
Brown Thrasher	10	10	10	10	40
Robin	10	10	10	10	40
Wood Thrush	10	10	10	10	40
Eastern Bluebird	10	10	10	10	40
Blue-grey Gnatcatcher	8	6	4	5	23
Cedar Waxwing	2	2	0	5	9
Loggerhead Shrike	5	0	5	8	18
Starling	5	1	2	0	8
Yellow-thraoted Vireo	6	2	2	0	10
Red-eyed Vireo	10	10	9	10	39
Black-and-White Warbler	2	0	0	2	4
Worm-eating Warbler	9	6	1	4	20
Golden-winged Warbler	6	6	3	7	22
Yellow Warbler	1	0	1	0	2
Black-throated Green Warbler	0	1	0	0	1
Cerulean Warbler	10	9	8	8	35
Pine Warbler	2	0	0	0	2
Prairie Warbler	0	0	1	0	1
Ovenbird	5	3	1	0	9
Louisiana Waterthrush	6	9	8	10	33
Kentucky Warbler	9	2	1	0	12
Yellowthroat	10	10	10	10	40
Yellow-breasted Chat	10	10	9	6	35
Hooded Warbler	6	5	0	2	13
American Redstart	3	3	1	4	11
Eastern Meadowlark	10	10	10	10	40

Figure 2 (Continued)

BIRDS SIGHTED AT COOPER'S COVE 1970

SPECIES	NUMBER OF DAYS SIGHTED 6/22 TO 7/1	7/2 TO 7/11	7/12 TO 7/21	7/22 TO 7/31	TOTAL
Red-winged Blackbird	0	0	5	4	9
Orchard Oriole	9	9	2	0	20
Baltimore Oriole	10	10	7	10	37
Common Grackle	7	9	0	5	21
Brown-headed Cowbird	10	10	9	10	39
Scarlet Tanager	10	10	10	6	36
Cardinal	10	10	9	10	39
Indigo Bunting	10	10	10	10	40
American Goldfinch	10	10	10	10	40
Rufous-sided Tohee	10	10	10	10	40
Grasshopper Sparrow	0	0	0	1	1
Chipping Sparrow	10	10	10	10	40
Field Sparrow	10	10	10	10	40
Song Sparrow	0	5	6	4	15

TOTAL SPECIES 91

Figure 2 (Continued)

CHECKLIST OF SUMMER BIRD POPULATIONS AT COOPER'S COVE

Compiled by Fred Hirschmann
July 1970

GREEN HERON:	Irregular. Individual birds have been sighted at the pond and loo-goon. Usually these birds remain in the area for a few days and then depart.
WOOD DUCK:	Irregular. Individuals and pairs have been sighted at the pond during the beginning and end of the camping season.
TURKEY VULTURE:	Very common. Daily seen in small numbers soaring along all three ridges of the Cove.
BLACK VULTURE:	Uncommon. Seen soaring along the ridge of the Cove a few times each session. The Turkey Vulture is often mistaken for this rarer bird, so great care must be taken in identification
COOPER'S HAWK:	Uncommon. A few seen each year flying overhead at Oak Forest and on the Bald. Care should be taken not to confuse the Cooper's Hawk with the Sharp-Shinned Hawk which is a hypothetical bird for the Cove.
RED-TAILED HAWK:	Common. Most often seen soaring above the ridges of the Cove or perched upon the tall pines on the left ridge. A pair has nested and raised young near the Sanctuary's northeast boundary.
RED-SHOULDERED HAWK:	Only one record of this bird in the Cove, which was the banding of a second year, immature bird caught in a mist net by Jim Shiflett on July 7, 1970.
BROAD-WINGED HAWK:	Uncommon to common. Usually seen soaring over the right and left ridges but is unpredictable.
PERFGRINE FALCON:	There are two probable sightings of this bird by Trott and Wagner up on the Bald; also many unconfirmed sightings. Many birds identified as Peregrines later turned out to be the smaller Kestrel, so utmost care should be taken in identification.

Figure 3

KESTREL OR SPARROW HAWK:	Irregular from year to year but very common in 1969. Most often seen up on the Bald (possibily nesting) and flying overhead.
*RUFFED GROUSE:	Common. Usually seen on the ground in wooded areas of the Cove. Sometimes heard drumming in the early part of the season.
*BOBWHITE:	Common. Seen and heard calling in the fields of the Cove.
*WILD TURKEY:	More common than observations tend to show. Groups of 15 to 20 birds are seen in the latter half of the camping season running in wooded areas.
*KILLDEER:	Very common. Almost always seen at the pond or loo-goon where it feeds and nests. Its piping alarm call is often heard across the Cove.
*AMERICAN WOODCOCK:	Common but rarely seen. It usually inhabits moist woodlands in the Cove, such as along the stream.
*SPOTTED SANDPIPER:	Very common when nesting at the loo-goon. Usually seen feeding near its nest or at the pond.
SOLITARY SANDPIPER:	A few are spotted each year on migration at the beginning and end of the camping season. They are seen at the loo-goon in company with Greater Yellowlegs.
GREATER YELLOWLEGS:	A few are seen during migration along with Solitary Sandpipers at the loo-goon.
*MOURNING DOVE:	Uncommon. Seen occasionally flying over the fields and sparsely wooded areas of the Cove.
*YELLOW-BILLED CUCKOO:	Common. Usually seen in the wooded and sparsely wooded areas of the Cove. Often heard singing, even once at night!
*BLACK-BILLED CUCKOO:	Less common than Yellow-billed Cuckoo. Observed mainly in the wooded areas of the Cove. Often heard singing.
SCREECH OWL:	Uncommon. Heard calling usually in the middle of the night. It has never been seen in the Cove.

Figure 3 (Continued)

BARRED OWL:	Uncommon. Occasionally heard calling late at night and early in the morning. Only one sighting has occurred which was of an individual bird flying overhead at Fern Valley during 3rd session, 1969.
*WHIP-POOR-WILL:	Very common. Heard almost every dusk and dawn calling from the wooded areas of the Cove. This bird is occasionally seen when it is sitting on the road and after it has been flushed from the ground. Nocturnal.
*CHIMNEY-SWIFT:	Abundant. Regularly seen catching insects over the pond and loo-goon. Active nests of the species have been found in the old chimney near the pond.
*RUBY-THROATED HUMMINGBIRD:	Very common. This small bird is usually seen at or near flowers or perched on the electric wires. Its loud rattling call is often heard in the Cove.
BELTED KINGFISHER:	Common. Observed almost always at the pond where it perches on the dock or nearby electric wires. Its loud rattling call is often heard in the Cove.
*YELLOW-SHAFTED FLICKER:	Common. Most often seen in the open wooded areas of the Cove, such as the Bald and the area to the northeast of the pond. Often heard giving its call which is sometimes mistaken for a Pileated Woodpecker's call.
*PILEATED WOODPECKER:	Very common. Heard calling much more frequently than seen as this author can testify, since I have yet to see one. Usually heard or seen feeding on all three ridges of flying overhead.
RED-BELLIED WOODPECKER:	Common and increasing in numbers. Most often observed flying over the fields and in the three cherry trees above the loo-goon in grid # 18.
RED-HEADED WOODPECKER:	Seen only in May of 1966. Possibly nesting up on the Bald. To be looked for.
*HAIRY WOODPECKER:	Fairly common. Seen most often in wooded areas of the cove and up on the Bald. This bird is easily confused with the smaller Downy Woodpecker.
*DOWNY WOODPECKER:	More common than Hairy Woodpecker. Usually seen in small numbers in wooded areas and up on the Bald.

Figure 3 (Continued)

*EASTERN KINGBIRD:	Very common to abundant. Usually seen perching near the tops of trees and then darting out to grab insects in the air.
*GREAT CRESTED FLYCATCHER:	Common. Most often seen in open wooded areas of the Cove. Number of observations decrease near the end of the camping season, probably because the birds have stopped singing.
*EASTERN PHOEBE:	Abundant. Seen usually in open wooded areas in the Cove and near buildings where nests are placed.
*ACADIAN FLYCATCHER:	Very common. Seen and heard in the moist wooded areas of the Cove. Care should be taken in identifying this Flycatcher by call and habitat since it is possible for other members of the Empidonax group to be seen in the Cove.
*EASTERN WOOD PEWEE:	Very common. Seen throughout the woods of the Cove. Often heard calling.
HORNED LARK:	Rare. There have been three sightings of this bird in the Cove which are as follows: Individuals seen on the Bald in July, 1968 and 1969, and in the field near the pond on July 7, 1970.
TREE SWALLOW:	Rare, seen only once or twice each camping season up on the Bald. In 1970 an immature bird was seen on the electric wire near the chicken coop.
ROUGH-WINGED SWALLOW:	Uncommon. Regularly seen a few times each session flying over the pond and loo-goon.
*BARN SWALLOW:	Very common. Observed catching insects over the pond, loo-goon, and two barns daily.
CLIFF SWALLOW:	Seen only for about three days during the first session, 1970. About eight birds were seen flying over the loo-goon and toward the left ridge.
BLUE JAY:	Common and increasing in numbers. Usually encountered in the wooded areas of the Cove. Often heard calling their raspy scold.

Figure 3 (Continued)

COMMON RAVEN:	Uncommon. Observed in company with crows, mainly around the Bald. Also seen on the right and left ridges.
*COMMON CROW:	Very common. Heard calling from all three ridges more often than seen. Inhabits the wooded areas of the Cove.
*BLACK-CAPPED CHICKADEE:	Very common. Seen in all wooded areas of the Cove. Care should be taken to separate this species from the Carolina Chickadee by call notes.
*CAROLINA CHICKADEE:	Less common than Black-capped Chickadees. Encountered in wooded areas of the Cove in company with other Chickadees and titmice.
*TUFTED TITMOUSE:	Very common in coniferous woods of the Cove. Also seen in groups on the ridges.
*WHITE-BREASTED NUTHATCH:	Common. Observed climbing up and down trees in the wooded areas of the Cove. It sometimes flocks with Chickadees.
RED-BREASTED NUTHATCH:	Occasionally seen in a pine forest or high ridge outside the Cove. Only once observed in the Cove by Holly Wagner. This bird was seen on the left ridge on June 28, 1970.
*HOUSE WREN:	Now very common although not reported before 1970. Seen nearly everywhere in the Cove except in dense woods. Males heard singing near nesting boxes.
*BEWICK'S WREN:	Uncommon. Seen 4 or 5 times each summer usually on the road to the Bald. Occasionally caught in banding mist nets.
CAROLINA WREN:	One individual bird was seen on June 21, 1969 in a thicket near the Sheep Barn.
*MOCKINGBIRD:	Populations fluctuate from year to year. Very common in 1969 while uncommon in 1968 and 1970. Usually observed up on the Bald and in thickets.
*CATBIRD:	Very common. Most often observed in thickets and other scrub. Its mewing call is frequently heard.

Figure 3 (Continued)

*BROWN THRASHER:	Very common. Usually encountered in thickets where it nests.
*ROBIN:	Very common. Daily seen around active camp buildings and in the woods of the Cove.
*WOOD THRUSH:	Abundant. Constantly heard calling in the morning and evening from the moist wooded areas of the Cove where it is frequently encountered.
*EASTERN BLUEBIRD:	Abundant in sparsely wooded fields of the Cove. Found especially up on the Bald where they nest in Wood pecker cavities and on electric wires that go over the field near the pond.
*BLUE-GRAY GNATCATCHER:	Common in 1968 and 1969, uncommon in 1970. Often seen in wooded areas of the Cove, especially near the Bald and on the left and right ridges. Often seen with Titmice.
CEDAR WAXWING:	Entirely irregular. Wandering birds move in and out of the Cove. Most likely to be seen during the latter half of the camping season but still unpredictable. These birds are spotted perching in tall trees where they wait for and catch insects Flycatcher style. Also seen flying overhead and over the pond where they catch insects Swallow style. Their high, shrill, whistling call usually tells of their presence before they are sighted.
LOGGERHEAD SHRIKE:	Uncommon but regular. Seen across the fields of the Cove usually perching on electric wires or in dead trees.
STARLING:	Uncommon and irregular throughout the fields of the Cove. There is one exception. In late summer, 1969, a flock of about 50 was observed near the Sheep Barn.
*YELLOW-THROATED VIREO:	Uncommon. Seen in wooded areas on the right ridge and near the Bald.
*RED-EYED VIREO:	Very common throughout the deciduous woods of the area. Almost always heard singing on cool days. Less common in 1970.

Figure 3 (Continued)

BLACK-AND-WHITE WARBLER:	Rare. Seen occasionally each summer feeding Nuthatch style on trees. Also caught in mist nets about once every summer.
*WORM-EATING WARBLER:	Uncommon but regular. Observed most often along the stream in moist woods. Quite often seen from creek blind.
*GOLDEN-WINGED WARBLER:	Common in 1968 and 1969. Less numerous in 1970. Most likely to be seen in cleared, grassy areas in the middle of the woods. Also often observed from creek blind.
*YELLOW WARBLER:	Uncommon. Occasionally seen in willows near the pond.
*BLACK-THROATED GREEN WARBLER:	Rare. Heard three times in Oak Forest and seen twice in pines near Fern Valley. One caught in mist nets in 1967.
*CERULEAN WARBLER:	Common. Heard and seen eating insects in high deciduous woods. Also observed bathing at creek blind.
PINE WARBLER:	Irregular. Occasionally, but rarely, seen in Oak Forest. Also encountered in pines along the road coming into camp.
PRAIRIE WARBLER:	Uncommon just outside the Cove in pines along the camp entrance road. Seen only once in the Cove by J. Shiflett in the meadow below the pond.
*OVENBIRD:	Uncommon. Observed in Oak Forest. A pair nested on the right ridge in 1970. Occasionally heard calling.
*LOUISIANA WATERTHRUSH:	Very common. Daily seen and heard calling along Dry Run. Very often seen from creek blind.
*KENTUCKY WARBLER:	Uncommon near the spring and on the fire tower ridge. Often heard singing in 1967, 1968, and 1969, but fairly silent in 1970.
*YELLOWTHROAT:	Common in the willows near the pond, in the meadow below the pond and along Dry Run above the pond.
*YELLOW-BREASTED CHAT:	Very common in thickets throughout the Cove. Often heard chattering.

Figure 3 (Continued)

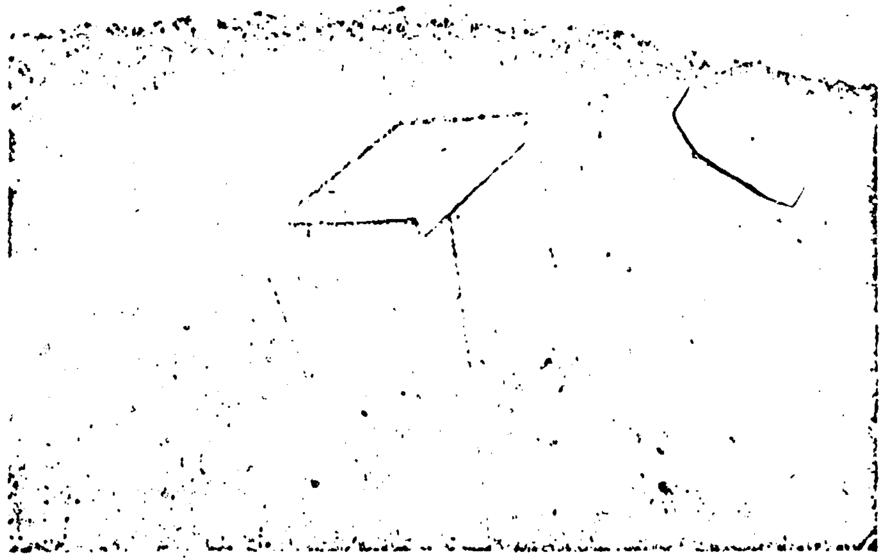
*HOODED WARBLER:	Irregular and uncommon in moist deciduous woods such as along Dry Run above the camp buildings.
*AMERICAN REDSTART:	Fairly common, but hard to see. Most often observed feeding in the understory trees of the Cove.
*EASTERN MEADOWLARK:	Very common and increasing slightly in numbers. Seen in the open fields and meadows of the Cove. Often observed perching on fence posts.
*RED-WINGED BLACKBIRD:	Irregular. Observed near the pond and loo-goon. Most numerous in early and late summer.
*ORCHARD ORIOLE:	Common. Populations fluctuate from year to year, possibly due to the increase and decrease of Baltimore Orioles. Seen along wood margins of the Cove.
*BALTIMORE ORIOLE:	Very common. Usually encountered in young, open deciduous woods. Often seen in the willows near the ponds.
COMMON GRACKLE:	Irregular. Wandering birds, moving through the Cove are seen flying overhead. Also occasional birds are observed bathing in the upper part of Dry Run.
BROWN-HEADED COWBIRD:	Very common throughout the Cove, especially in or near the fields. Young of this species are frequently observed in other birds' nests.
*SCARLET TANAGER:	Very common. Seen in the wooded areas of the Cove and feeding at the cherry trees above the loo-goon.
*CARDINAL:	Common, but small numbers. Usually seen in thickets and the wood margins of the Cove.
BLUE GROSBEAK:	Seen in 1969 just before the camping season began and in 1970 on the second and third days of camp. The latter sighting was of a male singing on the electric wire near the chicken coop.
*INDIGO BUNTING:	Very common. Encountered in the sparsely wooded fields and wood margins of the Cove. Also seen bathing at creek blind.

Figure 3 (Continued)

*AMERICAN GOLDFINCH:	Abundant. Seen in large numbers in fields with an abundance of thistle and mullein. Often seen and heard flying overhead.
*RUFOUS-SIDED TOWEE:	Abundant. Encountered in sparsely wooded areas and wooded areas and wood margins of the Cove. Constantly heard calling, "Drink your tea."
GRASSHOPPER SPARROW:	Rare. Individual birds seen a few times each camping season. Listen for this sparrow's grasshopper-like call. Seen in the fields and perching on the electric wires.
VESPER SPARROW:	Rare. Encountered in the fields of the Cove, especially in the roads that run through them. An individual was caught in a mist net below the pond on July 12, 1970.
*CHIPPING SPARROW:	Abundant. Seen throughout the fields of the Cove. Its chipping, chattering call is often heard.
*FIELD SPARROW:	Abundant in the fields of the Cove.
*SONG SPARROW:	Common and increasing in numbers in the meadow below the pond.

* = Birds known to have nested in the Cove.

Figure 3 (Continued)



Birdhouses like this one bring nests into the locality of the camp. Accurate observations of any tenants will be made.

or young inhabiting the nest. Other data collected on each nest include species, common name of plant supporting nest, height of nest, date found, and location by grid map. These data are placed on a simple data sheet and returned to the staff member in charge of this project. (See Figure 4.) The results of the findings are then recorded on record cards that are forwarded to the North American Nest Record Card Program at Cornell University. In correspondence with Edith Edgerton of the program, we obtained literatrue discussing the value and application of the nest record cards which are collected nationwide. Through the sightings the Laboratory of Ornithology at Cornell is able

NEST FINDING CONTEST

SPECIES ____________________

COMMON NAME OF PLANT SUPPORTING NEST ____________________

LOCATION ____________________

HEIGHT OF NEST ____________________

CONTENT ____________________

GRID IN WHICH NEST IS LOCATED
(ON MAP IN DINING ROOM) ____________________

FINDER (YOUR NAME) ____________________

Complete and place in Mike Sutton's Mailbox.

Figure 4

to tell peaks in breeding seasons, regional breeding distribution and variations of seasons, next sizes, etc. The program, started in 1965, now receives over 20,000 records from more than 900 contributors. Further information, including how to become a contributor, can be obtained by writing North American Nest Record Card Program, Cornell Laboratory of Ornithology, 159 Sapsucker Woods Road, Ithaca, New York 14850.

The staff member at Wildlife Camp also displays the data concerning the nest obtained by the campers. (See Figure 5.) At the end of a session at the camp the camper with the most points receives an award for his observations.

B. Banding Operations

There is a variety of possibilities for record keeping for a banding operation. Burgundy Wildlife Camp has used a system of data filing that has proved easy to compile and store for future analysis. This system involved the use of only three different mimeographed sheets for the recording of all records. From those sheets, which record the daily banding record, the birds banded that day, and the banded birds recovered that day, a multitude of analyses can be made. Among the analyses possible are a representative population survey of birds netted most often, the growth patterns of netted birds, and the net hours required to net a particular species of bird.

NEST FINDING CONTEST

Species	Nest Support	Location	Height	Content	Date	Grid	Finder	Points
Chipping Sparrow	Virginia Pine	Field below Sheep Barn	8 ft.	2 eggs	07-09-72	28	David Abbott	17
Cardinal	Blackberry Bush	Across Road Near Lodge	5 ft.	2 eggs	07-10-72	20	Joan Chaitern	22
Chipping Sparrow	Red Cedar	Far Field	4 ft.	4 young	07-13-72	-	John Gurn	27
Mocking Bird	Red Cedar	Far Field	5.5 ft.	3 eggs	07-15-72	-	John Gurn	23
Chipping Sparrow	Red Cedar	Near Pond	4 ft.	3 young	07-15-72	-	John Gurn	24
Eastern Bluebird	Nest Box	Near Chicken Coop	6 ft.	2 young	07-22-72	28	Peter Pyle	21
Rufous-sided Tohee	Redbud Tree	100 yds. past Green bus	5 ft.	2 young	07-24-72	-	Nate Erwin	26
Indigo Bunting	Common Thistle	Far Field	1.5 ft.	4 young	07-28-72	-	Peter Pyle	37
Indigo Bunting	White Ash	Road to Fire Tower	4 ft.	3 eggs	07-28-72	-	Steve Holt	28
Yellow-billed Cuckoo	Black Locust	Road to Bald	1.5 ft.	3 eggs	08-01-72	-	Peter Pyle	28

Figure 5

At the beginning or each banding day, a daily banding record sheet is started. The sheet is divided into three sections. The first includes date, minimum temperature, maximum temperature, a space for writing weather conditions and time of sunrise and sunset. The next section has spaces for figuring the net hours, found by multiplying the number of nets in operation by the number of hours that they were open. There is space for recording the location of the nets and the times of opening and closing. The third section of the record sheet is for recording total nets used, total net hours, total individuals banded, total species banded, recoveries and total birds netted on that day. (See Figure 6.)

When an unbanded bird has been caught, data on that bird are recorded in a notebook divided by band size. The bander will turn to the band size necessary for the bird and record on the banding sheet the band number, species, AOU (philogenetic) number, age, sex, wing length, weight, location of capture, time of capture, date, current temperature, number of location by the camp grid, and comments (such as molting or breed spot). (See Figure 7.)

If the bird netted has been banded before the bander will refer to a different notebook on recoveries of the current year. At this point the bird will be placed under one of three designations - repeat, return, or foreign retrap. A repeat designation

BURGUNDY WILDLIFE CAMP DAILY BANDING RECORD

Date ______________ Temperature Min. ________ Max. ________

Weather (Sky, Temp., Wind, Precip., Etc.):

____

____

____

Sunrise ______________ Sunset __________ NETS IN OPERATION

NETS	Location	Number
Set ________ at ____________		
Closed at ______ Net hrs. __________		
Set ________ at ____________		
Closed at ______ Net Hrs. __________		
Set ________ at ____________		
Closed at ______ Net Hrs. __________		

Total nets used __________

Total net hours __________

Total individuals banded __________

Total species banded __________

Recoveries: Repeats __________ Returns ______ Foreign ______ Total ______

Total birds netted __________

Comments ____

____

____

Figure 6

BAND SIZE ______ BAND PREFIX ______ PAGE ______

BAND NO.	SPECIES	AOU	STAT	AGE	SEX	WING	WEIGHT	LOC	TIME	DATE	TEMP	GRID	COMMENTS

Figure 7

means that the bird was banded during that banding season and has not migrated since then. This bird is often in its first year. A return bird is one that was banded in a previous season and has migrated and then returned to the area. This bird will always be older than one year. The majority of the birds recovered will be either repeats or returns. A rare occurrence will be the capturing of a bird banded at some other banding station. This is a foreign retrap. Very rarely will birds travel out of their migration paths and stop near a banding station. At Burgundy Wildlife Camp during a banding season in which about 200 birds are captured there might be one foreign retrap.

Also recorded on the recovery sheet are the species, band number, and original date banded. There are also about fifteen spaces on the sheet to record the date, time, location, age, sex, status, wing measurement, weight, temperature and weather conditions each time the bird is recovered. (See Figure 8.)

IV. Interpretations

After several years various comparisons can be made as a result of the records kept on the banding. An example of one of the many possible studies is a banded population comparison of various species over a period of several seasons of years. The banded population of a species is reached by adding the total number of birds of that species banded that year to the total returns of

RECOVERIES

REPEAT ______________ RETURN ______________ FOREIGN RETRAP ______________

SPECIES ______________ BAND NUMBER ______________

ORIGINAL DATE BANDED ______________

DATE	TIME	LOC	AGE	SEX	STAT	WING	WEIGHT	TEMP	WEATHER	COMMENTS

Figure 8

that species for the year. In this study, ten banded populations were compared over a period of five years. (See Figures 9 - 13.) According to John Trott, the director of Burgundy Wildlife Camp and operator of the banding station, the net hours and dates over the five years were very consistent; therefore, the banded populations would be a reliable indicator of the total populations of the species studied. There is distinct evidence from these graphs that the American goldfinch, indigo bunting, yellow-breasted chat, field sparrow and chipping sparrow exhibit similar population curves--predominantly decreasing. The wood thrush, rufous-sided tohee, and worm-eating warbler have predominantly increasing populations.* According to Mr. Trott, these relationships can be accounted for by the changing habitat of the camp. Over the five year period normal plant succession has been taking place in the meadow of the camp and the grassland habitat of the goldfinch, sparrows, chat, and indigo bunting is slowly being replaced by a succession forest. As a result of the increased foliage in these fields the forest dwellers, the wood thrush, tohee and warbler, have an increasing population in the area. The populations of these birds are directly dependent on the state of the environment.

In an effort to retain the habitat of the field dwellers, the field is now mowed in the fall on alternate years.

*The tufted titmouse population, despite a sharp increase in 1969, was essentially the same in 1968 and 1972.

BANDED POPULATION DATA SHEET

	1968			1969			1970			1971			1972		
	Banded	Total	Returned	Banded	Total	Returned	Banded	Total	Returned	Banded	Total	Returned	Banded	Total	Returned
American Goldfinch	123	155	32	90	101	11	177	233	56	114	154	40	16	24	8
Wood Thrush	13	13	–	28	32	4	21	30	9	33	46	13	35	47	12
Chipping Sparrow	21	29	8	22	22	–	46	62	16	13	16	3	8	12	4
Field Sparrow	33	37	4	26	29	3	21	24	3	19	25	6	11	19	8
Tufted Titmouse	7	10	3	17	18	1	7	7	–	5	9	4	8	9	1
Rufous-sided Towhee	6	6	–		8 10		2	9	9		– 13		11	13	2
Worm-eating Warbler	4	4	–	14	14	–	6	7	1	22	26	4	10	14	4
Yellow-Breasted Chat	12	16	4	10	16	6	13	18	5	8	10	2	5	8	3
Indigo Bunting	19	23	4	17	20	3	20	26	6	10	13	3	6	14	8

Figure 9

TOTAL BANDED POPULATION
WOOD THRUSH

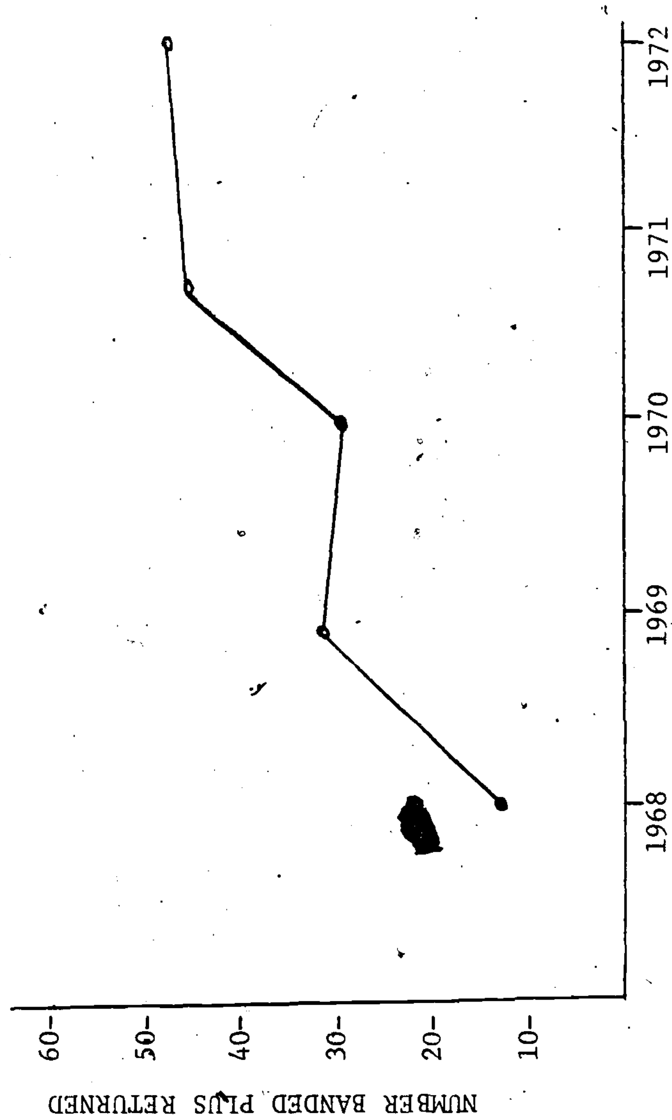


Figure 10

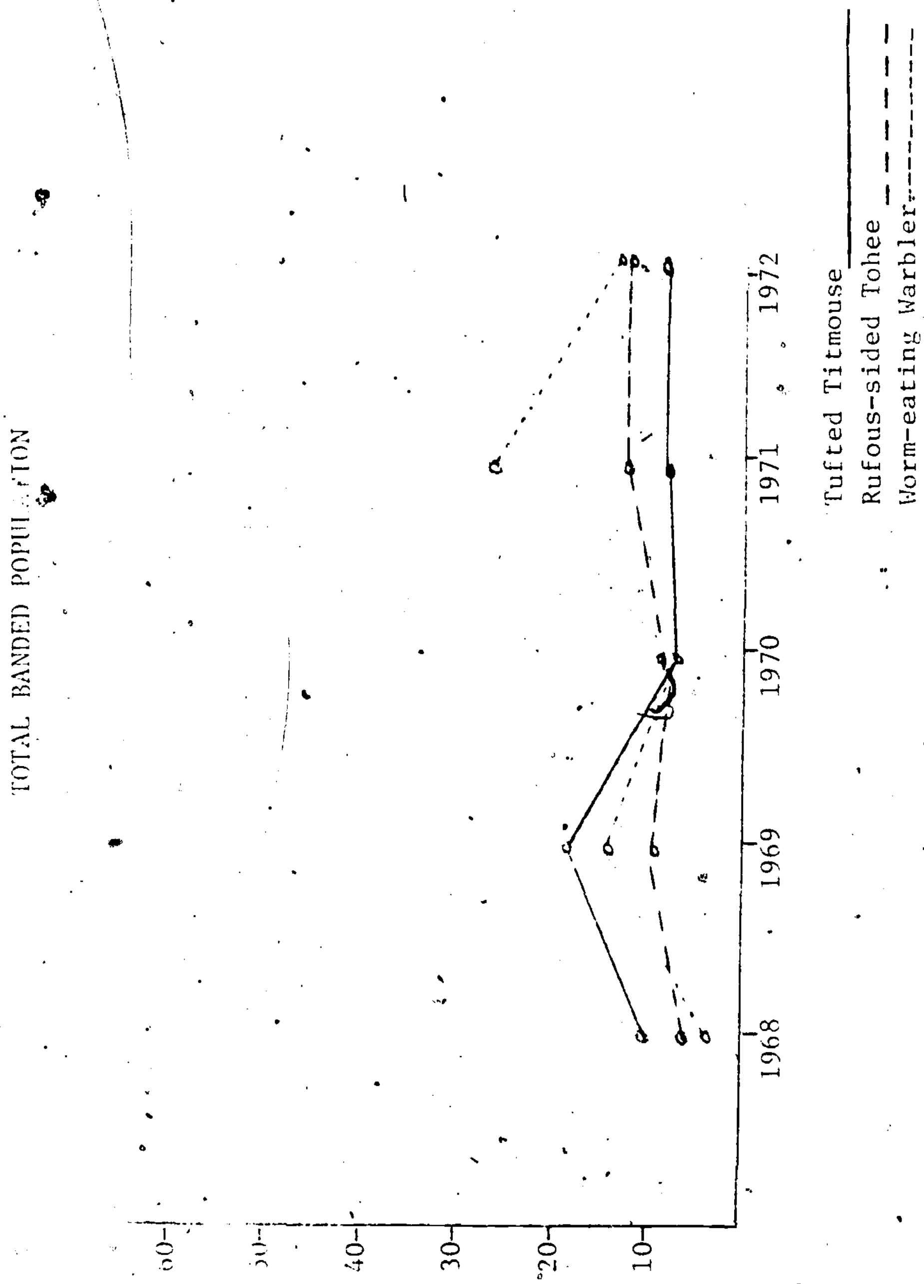

TOTAL BANDED POPULATION
10
20
30
40
1968
1969
1970
1971
1972
Tufted Titmouse
Rufous-sided Tohee
Worm-eating Warbler

Figure 11

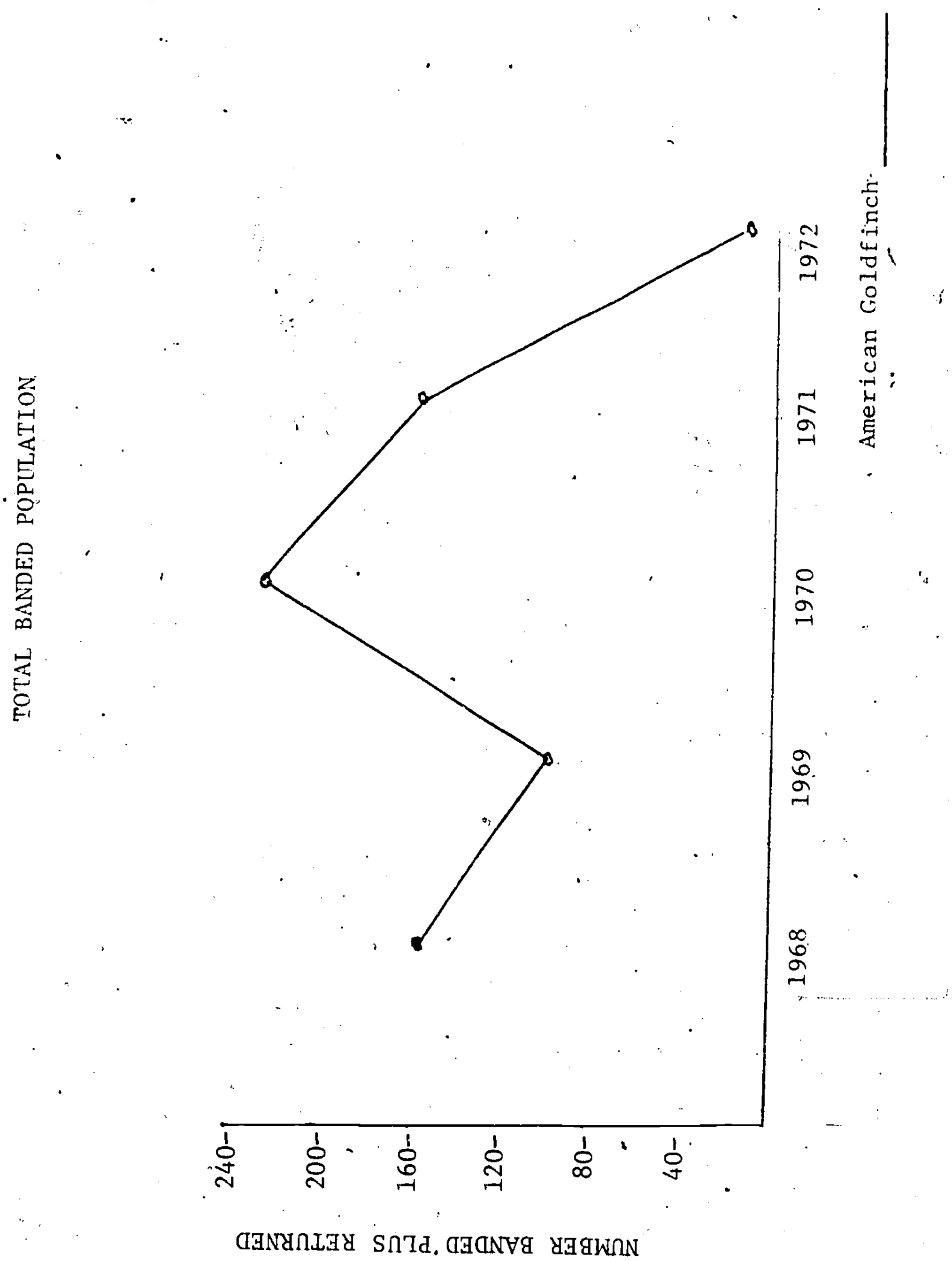

TOTAL BANDED POPULATION
American Goldfinch
NUMBER BANDED PLUS RETURNED
240
200
160
120
80
40
1968
1969
1970
1971
1972

Figure 12

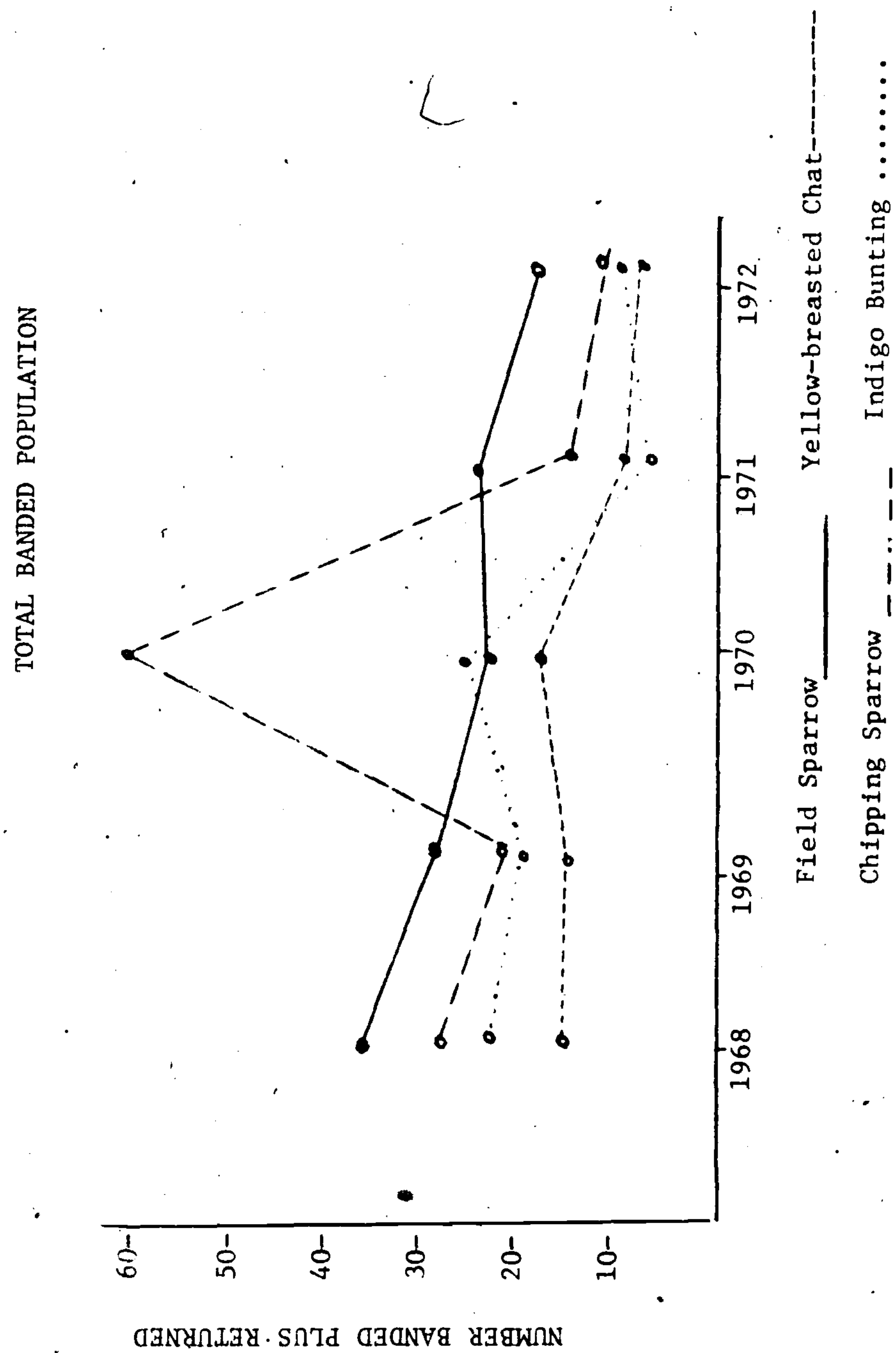

TOTAL BANDED POPULATION
NUMBER BANDED PLUS RETURNED
60
50
40
30
20
10
1968
1969
1970
1971
1972
Field Sparrow
Yellow-breasted Chat
Chipping Sparrow
Indigo Bunting

Figure 13

Another factor that affects bird population relationships is inter-species competition. This usually is found when several closely related birds, such as the mockingbird, catbird and brown thrasher come together in a similar habitat. These birds will be in direct competition and the result would be the domination of one species' population over the other two. The three wrens of the area, the house wren, Bewick's wren and Carolina wren, will also compete. Natural phenomena can also greatly affect the populations of birds. These events can range from destructive, i.e., drought, forest fire, famine, to beneficial, i.e., extremely good weather, abundant food. In 1970 the emergence of the seventeen-year chicada took place and had two effects on the bird populations. Upon the emergence an enormous food supply was created. This attracted insect feeders into the area in large groups.

The second effect of the locust was on the breeding of the birds. According to Mr. Trott, the din created by the locusts might have been confused with the territorial songs of some breeding birds. This would cause a decrease in mating of that year, but the full impact, less offspring, would not show until 1971.

V. Conclusions

The art of being a trained observer possibly becomes developed in bird watchers to a greater extend than in observers in other fields. The observation studies use practically no materials beyond the observer himself, and yet a multitude of in-depth, reliable data are obtained. Data from observation are placed on file in the camp for future use including comparison from year to year. The habits of the birds, when observed and recorded, can be used to spot environmental changes that might result from man's influence.

The important aspect about bird observation studies is that with some training everyone can participate. The study does not have to be made for a nationwide survey such as the Nest Record Card Program. A local project will increase total environmental awareness as more people study life outside the classroom.

In order to follow the results of the banding operations, we wrote to the U. S. Fish and Wildlife Service. From the Service we received information on the tabulation of nationwide banding operations and information on banding permits (Figure 14). More information can be obtained by writing U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland 20810.

There is much that can be done with bird data of the kinds one can collect. All banding data are reported and used by the U. S. Fish and Wildlife Service to formulate and verify national trends. The nest finding data are sent to a national study being conducted at the Ornithology Department of Cornell University on bird nesting. These sorts of national studies are invaluable in bird research and on a much larger scale with farther reaching ramifications than could be

UNITED STATES DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife WRes

Migratory Bird Populations Station
Laurel, Maryland 20810

Mr. Pete Goldie
Project KARE
County Office Building
Route 73 and Butler Pike
Bluebell, Pennsylvania 19422

August 15, 1972

In reply refer
to BLL-15

Dear Mr. Goldie:

I am writing in reply to your recent correspondence requesting information concerning the issuance of federal bird banding permits.

Most wild migratory birds throughout North America are protected by federal regulations. In order to capture these birds for the purpose of marking or banding, it is necessary to first obtain a Federal Bird Marking and Salvage Permit. Such permits are issued through this office.

The only purpose for banding such birds is the generation of complete, accurate, scientifically usable data. All such data accrued by professional and amateur banders throughout North America are forwarded to this office. This information is converted to magnetic computer tape and subsequently made available to scientists, wildlife technicians, students or banders who wish to make a detailed study of these birds.

For these reasons, persons who are issued permits are required to keep accurate detailed records pertaining to all birds they band. This requires not only many hours of paper work each year, but also a very sound background in ornithology and the ability to correctly identify the species, age, sex and various plumages of most of the birds they are likely to encounter.

At the present time, we are receiving many more requests from persons desiring permits than we are able to honor. We are, for this reason, only issuing permits to highly qualified individuals. We further request that these persons have a specific need for the banding technique.

In addition, all applicants must be at least 18 years old and be able to furnish the names of at least three licensed banders or recognized ornithologists who will vouch for the applicant's ability to correctly identify the birds he will likely be handling and his ability to maintain thorough, accurate, legible records.

Figure 14

Except in very rare instances, banding permits are not issued to persons holding propagating or taxidermy permits, and the banding of waterfowl is restricted to state and federal conservation agency employees or their assistants.

Special restrictions are placed on the banding of "endangered species" or Bald and Golden Eagles. We also place special restrictions on the use of mist nets, tranquilizing chemicals and color-marking techniques. If your research will require the use of any markers other than the standard, numbered leg bands, be sure to indicate this if you reply to this letter.

If you feel you can meet the qualifications outlined above, please notify me and I will forward the forms necessary to apply for a Federal Bird Marking and Salvage Permit.

In addition to your federal permit, most states require that you also obtain a state banding permit.

Sincerely yours,

George M. Jonkel, Chief
Bird Banding Laboratory

Figure 14 (Continued)

achieved by the individual or organization. The Burgundy Wildlife Camp, therefore, sends its yearly results of banding operations and nest finding contests to these respective studies. It is exactly this kind of contribution that supports these larger studies most effectively.

Other uses for those statistics are the multi-variate camper projects that are required of each camper. Many campers choose to work with birds and many use the extensive backlog of banding, sighting and nesting information. All sorts of possible correlations spring from such a wealth of data and each one suggests a further study. These projects are as different as the campers. Yet, invariably they interlock with the many other subjects investigated at the camp.

A few of these are listed below. They can be grouped into two general classifications: those that are related to studies already completed (i.e., continued on same lines, expanding individual areas), and those that are investigating inconsistent trends (i.e., accounting for population fluctuation by researching weather records). Another category might be those which initiate a new type of study (i.e., measuring light intensity when a spieces of bird is caught) that could be carried out in the future. These three categories are each expansive and are by no means complete.

In continuing further studies on these lines, campers have added criteria to banding records; attempted to capture and band an unusual bird unfit for mist nets used there; sitting in a blind observing bird behavior. Director John Trott has even been able to take serious campers outside of this nation to study bird habits and species. Mr. Trott has written an article on such a trip which appeared in National Geographic's School Bulletin (April 17, 1972, Vol. 50, #27). During this trip to Tobago in South America, Mr. Trott taught his students in the winter home of North American birds.

From the basic studies made at Burgundy Wildlife Camp many new directions can come forth. One investigation can be relating the bird songs of the area to seasons, weather conditions and locations around the camp. Investigations can be made into the significance and value of songs (calls) to bird life. Investigations of the weight differences between birds caught in the morning to those caught at night could be initiated.

The study of birds is by far the most important study made at Burgundy Wildlife Camp. Through such peaceful activities the campers gain insights toward our environment that far too few people ever realize. Perhaps the insights are received from love of the land or maybe they come from being in an environment where one is not taught, he learns.

VI. Bibliography

The following books and pamphlets were found useful in developing this study. Investigators should have on hand some of the more comprehensive sources for use in dealing with an in-depth bird study. This list is in no way complete and users are encouraged to make additions.

A.O.U. Checklist of North American Birds, 3rd Edition, A.O.U. Press of Edward W. Wheeler, Cambridge, Mass., 1895. A.O.U. Listings of over 770 classifications of birds according to philogenetic order. The checklist is used by banders to determine the evolutionary scale of birds for classification. Use from Grade 9 upward.

American Birds, 71st Christmas Bird Count (incorporating Audubon Field Notes), Vol. 25, No. 2, National Audubon Society and U. S. Fish and Wildlife Service, April, 1971. This book incorporates 903 bird counts made over Christmas 1970. Includes location, species, and individuals, compilers, etc. Good for population-oriented studies.

Audubon Aids, Audubon Nature Bulletin, Educational Services, National Audubon Society, 1130 Fifth Avenue, New York, New York 10028. A series of bulletins: NB2 14 Teaching Aids, NB 3 14 Bulletins on Arrivals, NB6 7 on Conservation, NB7 9 on Ecology. Excellent miscellaneous articles on the series of subjects by a spectrum of writers. Catalog available by writing to National Audubon Society.

Bird Banding, The Hows and Whys, U. S. Department of the Interior U. S. Fish and Wildlife Service, Washington, D. C. 20240, January 1960. This is very good introductory material for bird banding. It is easily understood from grade 6 upward. The pamphlet outlines the purposes and methods behind bird banding.

Collins, Henry H., Jr. The Bird Watchers Quit Book, Harper and Bros., New York, N. Y. A humorous way to learn bird identification. Challenging.

Robbins, Chandler S., Birds of North America, A guide to Field Identification, Golden Press, New York, N. Y., 1966. The best field guide to bird identification.

Altman, Philip L., and Dittmer, Dorothy S., Environmental Biology, Federation of American Societies for Experimental Biology, Bethesda, Maryland, 1966. A highly technical data collection on 10 acres of environmental biological concern. This is a book "in which the effects of the environment (are) quantified for reference purposes." An excellent and extensive text of tables and charts. Not recommended for below 10th grade.

Peterson, Roger T., A Field Guide to the Birds, Houghton Mifflin Co., Boston, Mass., 1947. A good field guide to the birds.

Bent, Arthur C., Life Histories of North American Birds. (In approximately 20 volumes), Dover Publications, New York, New York, 1960's.

These volumes cover every North American species in great detail, giving measurements, ranges, and other descriptions. Highly recommended research books.

Gray, Ralph, National Geographic School Bulletin, Vol. 50, Number 27, National Geographic Society, Dept. 162, 17th and M Streets, N.W., Washington, D. C. 20036, April 17, 1972. Excellent photographs and text of John Trott's trip to Tobago with some Burgundians.

Reed, Chester A., North American Birds Eggs (Revised), Dover Publications, Inc., 180 Varick Street, New York, New York 10014, 1965. Good guide to egg identification through description of eggs of each species. 560 life-sized photographs of eggs plus drawings. This can be used with 6th graders.

Trott, John and Wiggins, William, Summer Bird Population Studies in Catapon River Valley, (The Redstart), Vol. 35, No. 3, Brooks Bird Club, 707 Warwood Avenue, Wheeling, West Virginia, July 1968. This is John Trott's study of cold stream bird populations. This study was made in an area near Burgundy Wildlife Camp and it shows applications of bird banding and observation studies.

Montgomery, F. H., Trees of the Northern U.S. and Canada, Frederick Warne and Co., Inc., New York, N.Y., 1970. An excellent tree key for the specified area, good for most of the U.S. Includes key to both Tree Genera and Tree Species. Can be used effectively by grades 4-12. Useful if trying to relate bird sightings to kinds of trees.

CHAPTER 2

I. Introduction

Local forecasts and weather conditons can be obtained from a nearby U. S. Weather Station or heard nightly on radio and TV, but the investigation into the meanings of various readings, the actual recording of weather conditons, and the study of these multiple phenomena are exciting operations.

From a private weather station it is possible to observe the exact conditions (temperature, rainfall, etc.) in your area and how these affect and govern other natural phenomena. The mysteries of the ever changing environment become tangible, measurable entities. These incredible processes which affect each of us so greatly each day can be witnessed, charted, analyzed and discussed.

The individual weather station is also a continuous learning center for all involved. Those who constantly record the weather can gain a knowledge of meteorological phenomena and a backlog of weather observations. These data can then be used as standards for further observations and a basis for speculation and explanation of related phenomena: bird population and nesting behavior, other animal populations, plant growth, soil quality, and other environmental factors linked to weather.

Virtually all basic scientific concepts are needed to understand and properly operate a weather predicting station, and this understanding stems from the interest evoked by such a study and the related areas of study. Students using the equipment will want to know the why's and how's of barometric pressure, wind generation, temperature, humidity and cloud structure and formation, and how each instrument works. They will also be actively interested in how their station compares to the TV station and how the related phenomena are controlled or affected by weather. The kinds of things that you can measure at such a basic weather station, are: temperature, precipitation, wind direction and speed, barometric pressure, humidity and sky cover. Thus these data will allow you to learn about, observe and predict the weather in your local position and to understand the integral role weather plays in the whole of the surrounding environment.

Such a weather station was established in June, 1970, and has been in summer operation since then, at Burgundy Wildlife Camp at Capon Bridge, West Virginia. This summer camp has collected figures for maximum, minimum and various daytime temperatures, humidity, barometric pressure, wind direction and velocity, precipitation and sky cover. Participants learned to venture a short range prediction with consistent accuracy. Burgundy Wildlife Camp does not have TV, radio, telephone or regular delivery of newspapers, thus their weather station functions not only as a learning experience for the campers, but also as an actual service, actively supplying the residents with a quite reliable daily forecast. The forecast, however, is not the major focus or purpose of the weather center. It demonstrates the actively changing interacting sphere of weather and complements the other programs offered at the camp.

Another weather station is located at George School, in Newtown, Bucks County, Pennsylvania. It has been in continuous daily operation since January 1, 1907. Alan D. Sexton, the senior author-editor of this book, operated this station for 6 years. This station is one link in the flood warning system for the Neshaminy Creek Watershed.

George School benefits from this weather station in several ways. The superintendent of buildings uses the temperature data to compute degree days. By knowing the number of degree days in any given month, he can check on the efficiency of the heating system and can possibly identify problem areas in the underground steam lines. The students in the science classes use the data to construct climatograms, which they compare with those of other regions throughout the world. They also get to observe the results of long term data collection, a process vitally important in environmental studies and one which many students only read about.

One function is the daily recording of high and low temperatures, precipitation, and unusual occurrences (e.g., hail, thunder, etc). These data are sent monthly to the National Climatic Center, the Pennsylvania State Climatologist and the Neshaminy Valley Watershed

Association, providing data which are used at national, state and local levels. One of the most valuable contributions from the George School weather station is the 65 years of accurate records on file. These records provide a comprehensive data bank which is available to those who wish to use it.

II. Materials and Methods

Operation of a basic weather station might utilize the following instruments:

1. A maximum-minimum thermometer which not only indicates the present temperature but shows daily fluctuations. (High's and low's.)

2. A barometer, which shows the relative air pressure, indicating pressure areas and large scale weather fronts. (Make sure barometer is adjusted to your relative altitude in order to insure valid comparisons with official sources).

3. A psychrometer (wet and dry bulb thermometers) or Hygrometer which shows the humidity, the relative water content of the air.

4. A wind vane which indicates the direction of wind.

5. A wind speed indicator (anemometer), which gives wind speed.

6. A rain gauge to measure precipitation in its various forms.

7. A cloud chart with pictures and symbols representing these

clouds so that the clouds sighted can be identified and recorded.

8. A blackboard so that the day to day data may be recorded publicly and displayed. This information can then be transferred to a standard weather observation sheet that may be filed to compile a permanent record. (See Fig. 1)

The following pieces of equipment could be purchased but are of relatively little use and disproportionate cost:

1. Rain Pressure Gauge which records the intensity or actual speed of the rainfall, an interesting but not absolutely necessary measurement.

2. Weather balloons, theodolite, and cloud speed apparatus (a nephoscope). This involves not only difficult procedure but not very generally important results.

3. A solar radiation gauge, excellent for identifying sun spots but unnecessary for basic meteorology.

Two optional and expensive ($60.00 approximately) yet extremely helpful and accurate pieces of equipment are a motor driven, chart recording barometer (barograph) and a similar apparatus for temperature (thermograph). These continuously record pressure and temperature in the form of line graphs.

Another option that is less expensive and yet generally very valuable is available in the form of daily weather maps, compiled and published by the U. S. Government and obtainable approximately 2-3 days late, for a small ($6-$7) fee for each year.

Cost is an important consideration in outfitting a weather station because the usually desired accuracy rises only with the price. However, when the prime motive is not accuracy but acquaintance with meteorological concepts, general trends and general aquisition of actual weather know-how; the following homemade materials are always cheaper and often effective:

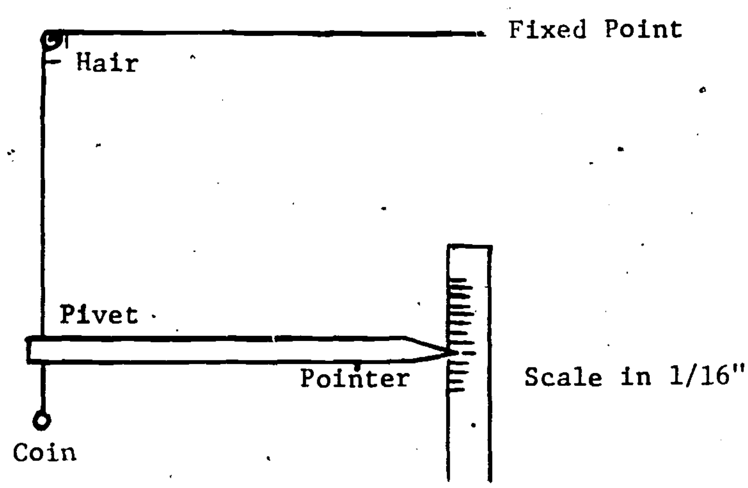
1. Wind vane. Any simple wind direction indicator, properly oriented, will serve easily.

2. Wind Speed indicator. There are many ways to make this, including one involving a ping pong ball, attached to a protractor by a short piece of nylon fishing line (described in depth in the October 1971 issue of Scientific American.).

3. A rain gauge can be made from a calibrated 1" diameter glass tube which collects the water falling into a 10" diameter funnel. This will collect water over a greater area, making the gauge much easier to read for small amounts of precipitation. The number of inches of rain measured in the tube will represent ten times the actual rainfall. (E.G., a reading of 1" in the gauge would indicate 1/10" of precipitation.)

4. A properly synchonized combination of wet and dry bulb thermometers can produce a psychrometer (humidity indicator). There are also some very temporary and makeshift materials which are not reccomended for accuracy or stamina, but highly useful for acquiring basic concepts.

5. A hygrometer, another humidity measuring device, can be devised from a peice of hair (blond human hair is best), attached to a coin with fingernail polish. Stretch the hair over 2 posts and attach to the end of a pointed indicator allowed to swing a calibrated scale (see figure).



6. A simple barometer can be constructed out of a milk bottle with a piece of rubber balloon stretched across the mouth and a paper straw glued to it to indicate changes in air pressure.

III. Data

The data collected for the weather station at Burgundy Wildlife Camp were measured daily and recorded on mimeographed record sheets. These sheets were then placed in a permanent file to be used later in analysis. The daily data sheet for 1970 and 1971 was divided into three sections, (1) morning, (2) afternoon, and (3) evening. The morning section includes appropriate titles and spaces for recording the time, minimum temperature (usually occurring the previous night), current temperature, humidity, barometric pressure, wind direction, and speed, sky cover, precipitation and a space for prediction of future conditions. The afternoon section contains all of the above spaces with the exception of minimum temperature. The evening section is also identical to the morning section except that the minimum temperature space is replaced by a maximum temperature space. In 1972, the afternoon recording section was eliminated due to lack of time to record. Variations can be easily made on any data collection sheet to accommodate any weather station.

Each year the data were collected during the three sessions the camp was open and not collected during the days between sessions. The weather station at the camp collected data immediately after breakfast at around 8:00 A.M., immediately after lunch, at about 1:00 P.M., and right after dinner at 7:30 P.M. The data were collected by campers at these times with the supervision of the counselor in charge of the weather station. They were then displayed on a blackboard and finally entered in the file.

Until July of 1972, no analysis of the data collected had been made. In this study, the first step in the analysis was arranging the data collected in a chart form that could be compared from year to year. The minimum and maximum temperature, precipitation and barometric pressures of the three years were graphed, using the summer term from about June 22 through July 31 as the horizontal base line and the variable as the vertical. The daily humidity was also graphed using three readings per day. In all, thirteen graphs were initially made. From this point, the data can be easily compared to any other records, local averages, or records established by the U. S. Weather Bureau Reports.

Burgundy Wildlife Camp

1970 Master Data Sheet

Date	Temperature °F Minimum	Temperature °F Maximum	Pressure (In. of Hg) 8:00 A.M.	Precip. (in.)	Relative Humidity 8:00 A.M.	Relative Humidity 1:00 P.M.	Relative Humidity 7:30 P.M.
June 22	67	78	30.01		74	64	59
23	60	85	30.11		73	44	72
24	60	89	30.01		74	48	67
25	67	89	29.82	.75	76	58	77
26	71	84	29.79	1.25	80	78	80
27	69	72	29.63	.50	75	74	74
28	57	76	30.01		73	52	--
29	59	84	30.09		80	39	69
30	64	88	29.94		62	58	59
July 1	69	90	29.97		77	60	--
2	79	95	29.87	.35	85	67	80
3	68	89	---		--	--	--
8	68	89	29.84	.10	80	50	74
9	72	72	29.82	3.10	90	90	90
10	68	80	29.85	.35	80	70	78
11	66	79	29.86	.10	81	77	--
12	66	85	29.98		76	66	--
13	66	85	30.05		80	59	--
14	68	86	30.04	.10	80	75	79
15	73	90	29.92	.20	90	63	75
16	74	84	29.77		93	79	61
17	62	86	29.96		75	48	--
18	62	87	29.94		80	50	74
19	68	88	29.95		80	65	--
	68 Average	82 Average	30.01 Average	6.70 Amount	73.5 Average		

Figure 1

Burgundy Wildlife Camp

1971 Master Data Sheet

	Temperature °F		Pressure (in. of Hg)	
	Minimum	Maximum	8:00 A. M.	Precip. (in.)
June 22	68	82	29.72	.20
23	68	87	29.74	.10
24	68	86	29.83	.40
25	69	90	29.88	
26	73	90	29.73	
27	70	89	29.87	
28	72	96	29.91	.10
29	72	95	30.04	.10
30	72	92	30.02	.10
July 1	75	90	29.85	
6	68	90	29.84	
7	67	93	29.99	
8	69	83	30.08	
9	72	90	30.04	
10	68	78	29.99	
11	63	83	29.92	
12	63	88	30.05	.20
13	73	87	30.00	
14	69	86	29.72	
15	66	90	29.75	
16	67	90	29.77	
17	67	90	29.82	
	69	86	29.89	1.20
	Average	Average	Average	Amount

Figure 2

Burgundy Wildlife Camp

1972 Master Data Sheet

	Temperature °F		Pressure (in. of Hg.) 8:00 A. M.	Precip. (in.)
	Minimum	Maximum		
June 21	--	--	---	3.20*
22	60	64	29.33	3.50
23	52	65	29.21	2.40
24	53	73	29.51	
25	59	73	29.64	
26	59	73	29.69	
27	59	80	29.79	
28	64	82	29.80	
29	70	78	---	.60
30	64	79	29.65	.10
July 1	66	80	29.69	
2	69	92	29.87	
6	64	72	30.05	
7	57	75	30.11	
8	60	78	30.08	
9	60	80	30.08	
10	68	88	30.08	
11	70	90	30.14	
12	68	82	30.12	.10
13	72	86	29.95	.10
14	74	88	29.88	.10
15	71	88	29.89	
16	72	88	29.94	.50
17	73	88	20.02	
18	72	88	30.08	
	66	81	29.81	10.60
	Average	Average	Average	Amount

* = Hurricane Agnes

Figure 3

Burgundy Wildlife Camp

DAILY MAXIMUM AND MINIMUM TEMPERATURES 1970

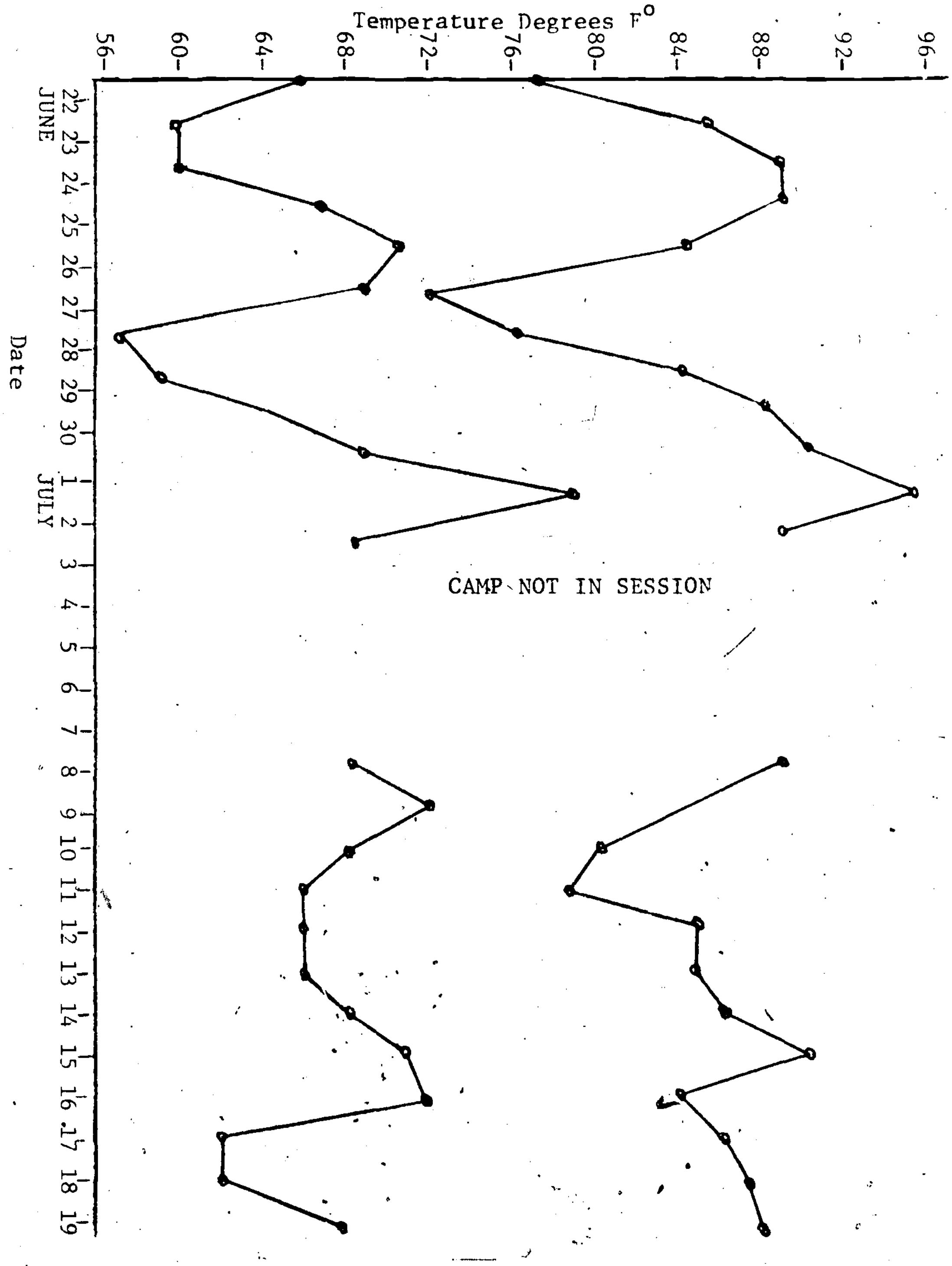


Figure 4

Burgundy Wildlife Camp

DAILY MAXIMUM AND MINIMUM TEMPERATURES 1971

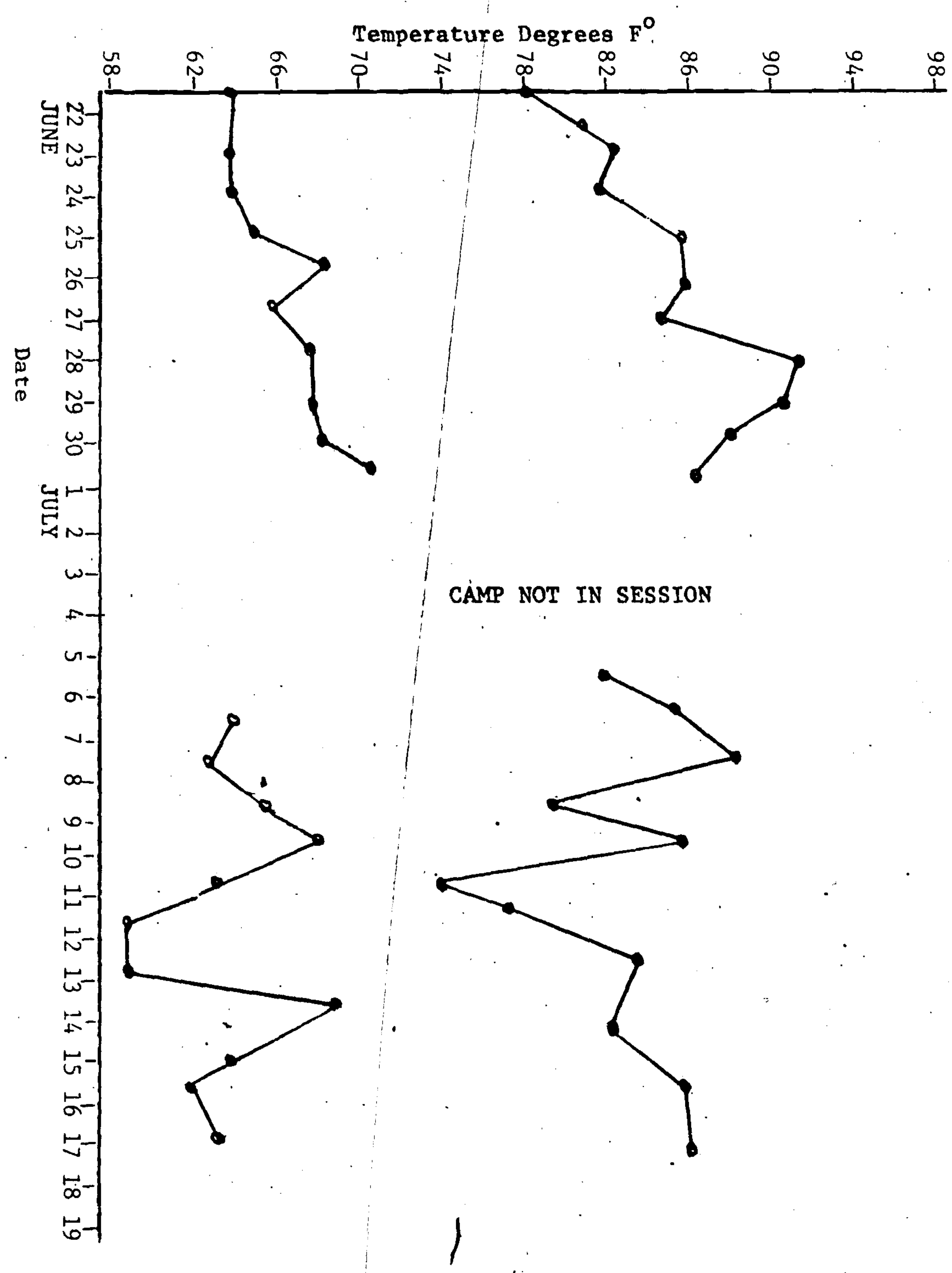


Figure 5

Burgundy Wildlife Camp

DAILY MAXIMUM AND MINIMUM TEMPERATURES, 1972

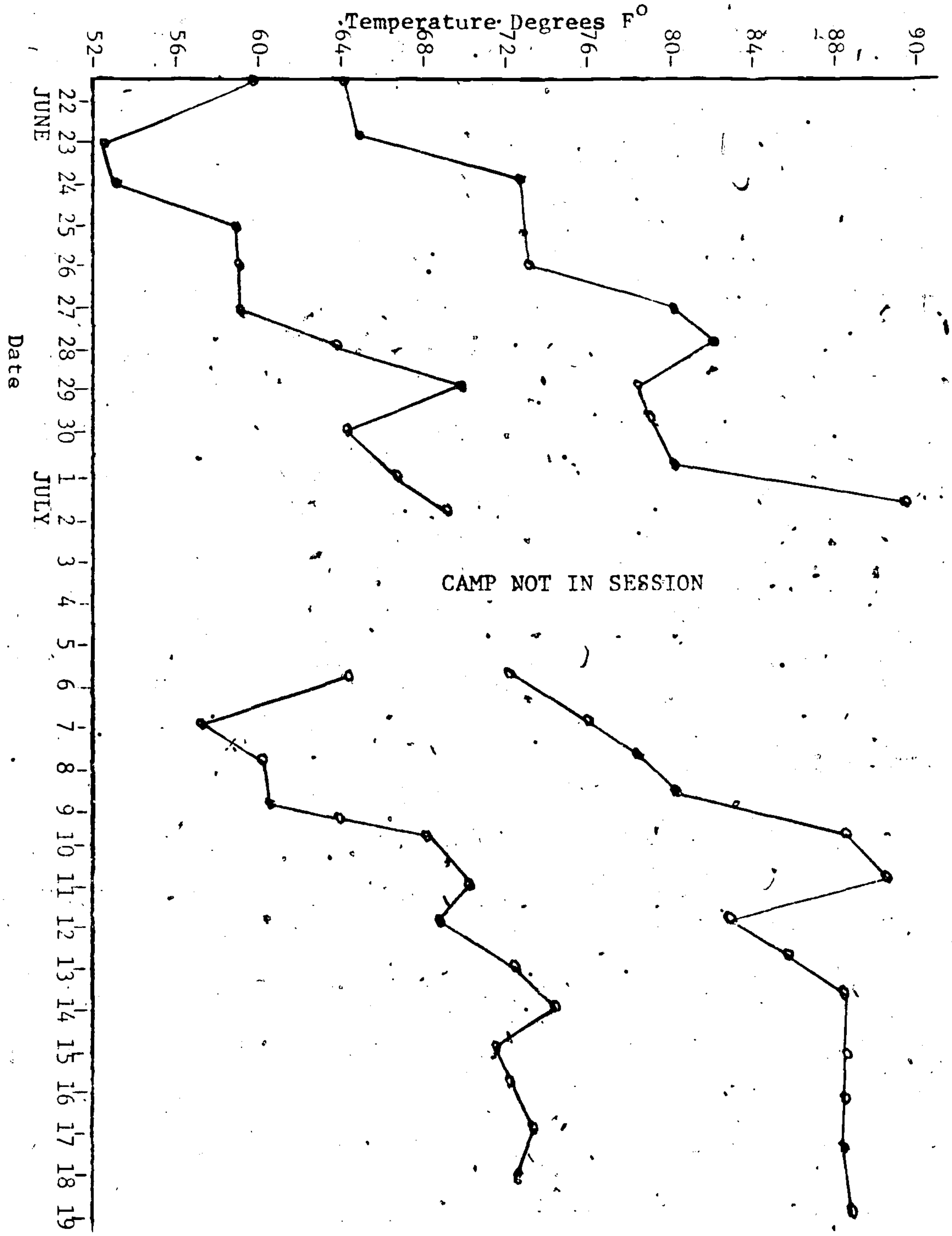


Figure 6

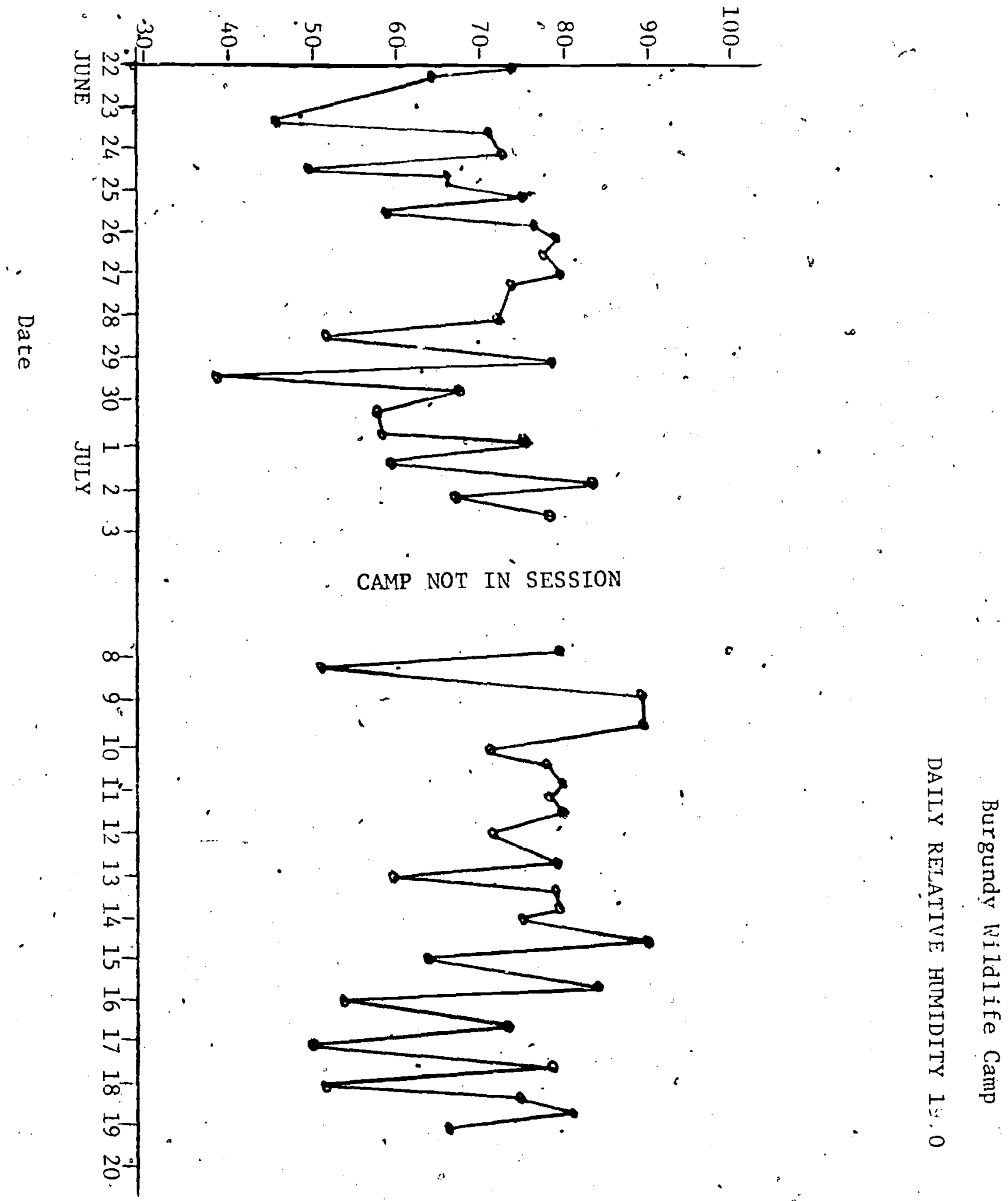
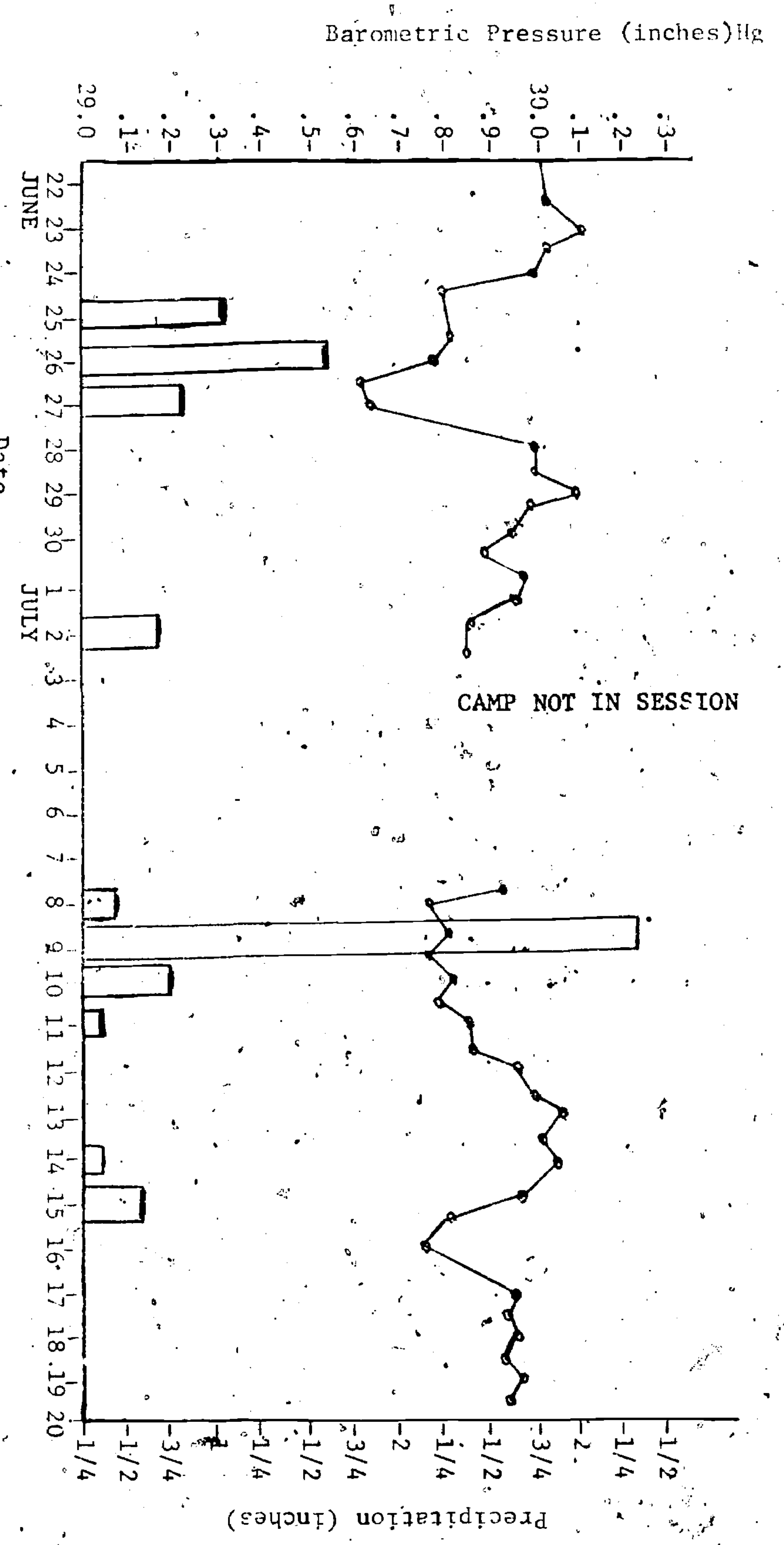
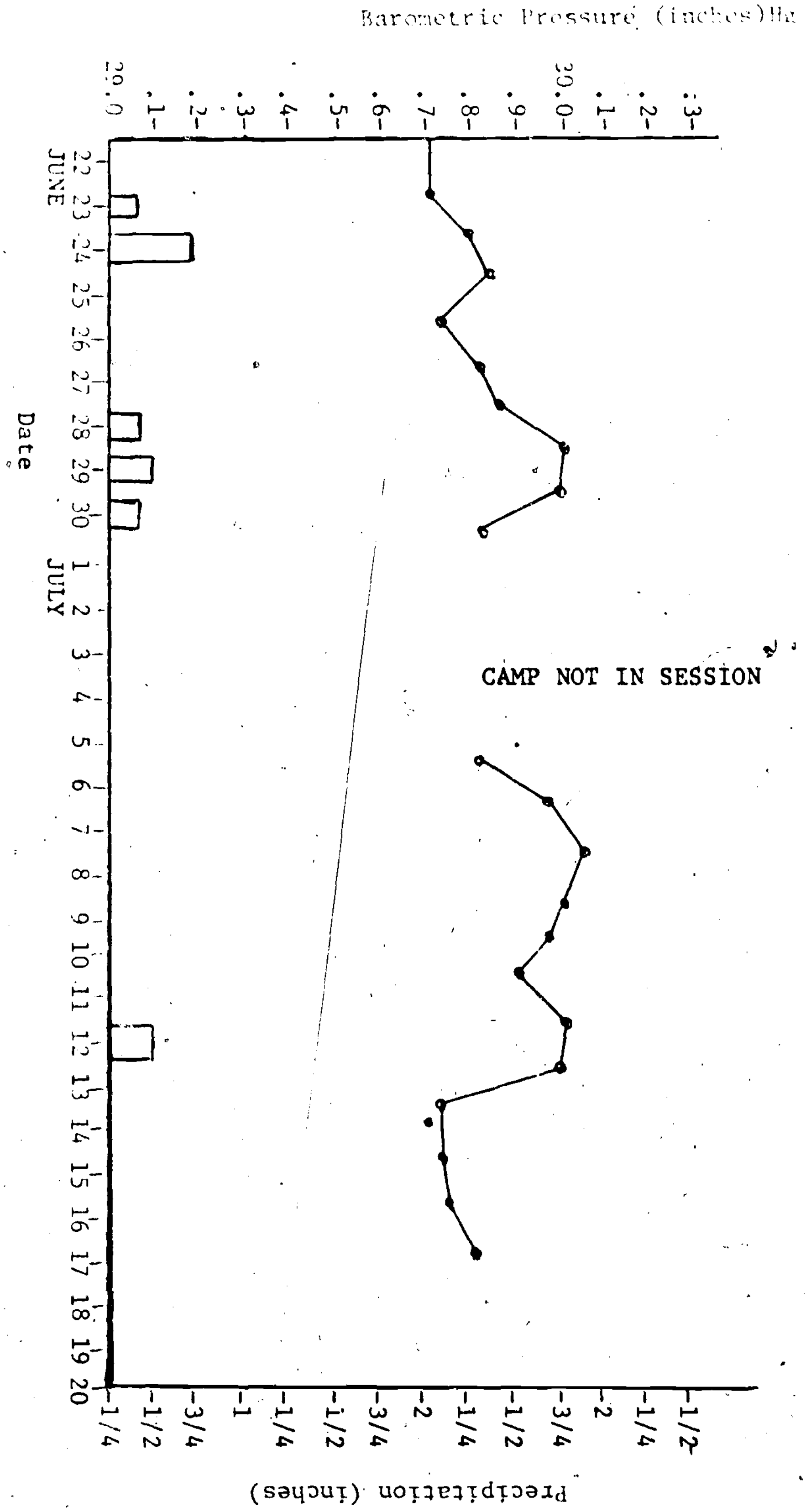

Burgundy Wildlife Camp
DAILY RELATIVE HUMIDITY
100
90
80
70
60
50
40
30
JUNE
22 23 24 25 26 27 28 29 30
JULY
1 2 3
CAMP NOT IN SESSION
8 9 10 11 12 13 14 15 16 17 18 19 20
Date

Figure 7



Burgundy Wildlife Camp
BAROMETRIC PRESSURE (Lines) AND DAILY PRECIPITATION (Bars) 1970

Figure 8



Burgundy Wildlife Camp
BAROMETRIC PRESSURE (Lines) AND DAILY PRECIPITATION (Bars) 1971

Figure 9

Burgundy Wildlife Camp
BAROMETRIC PRESSURE (Lines) AND DAILY PRECIPITATION (Bars) 1972

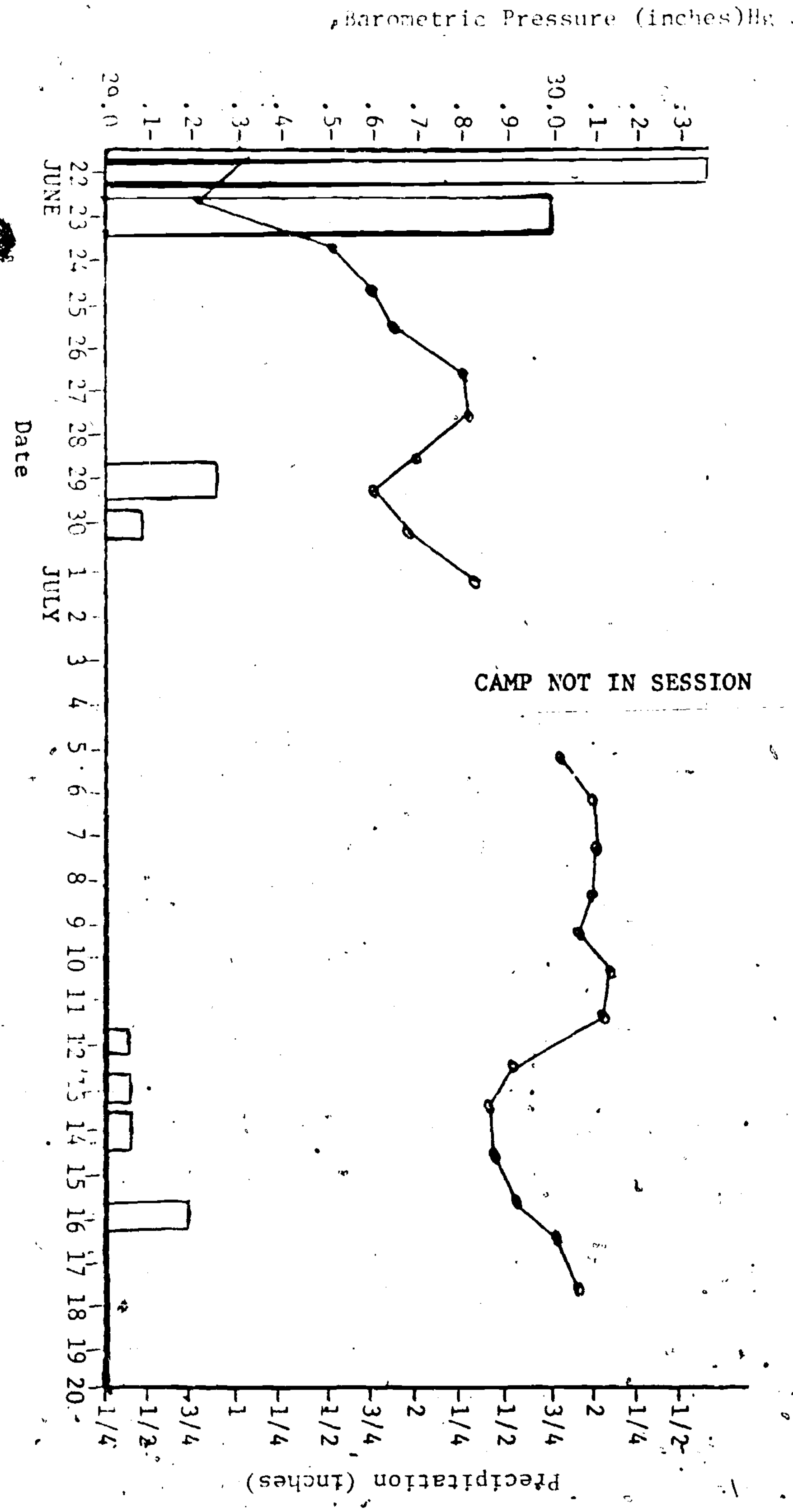


Figure 10

The weather station at George School is one of approximately 200 in Pennsylvania (see Figure 11). The monthly data (see Figure 12) are sent to the National Oceanic and Atmospheric Administration, where several kinds of analyses are made (see Figure 13). The Neshaminy Valley Watershed Association also uses George School's data in its reports (see Figures 14 and 15). Figure 16 shows one of the data sorts which has been made at George School.

We wish to re-emphasize the importance of the formation of long-term data banks. In far too many situations today, environmental impact assessments cannot be made because the necessary data are not available.

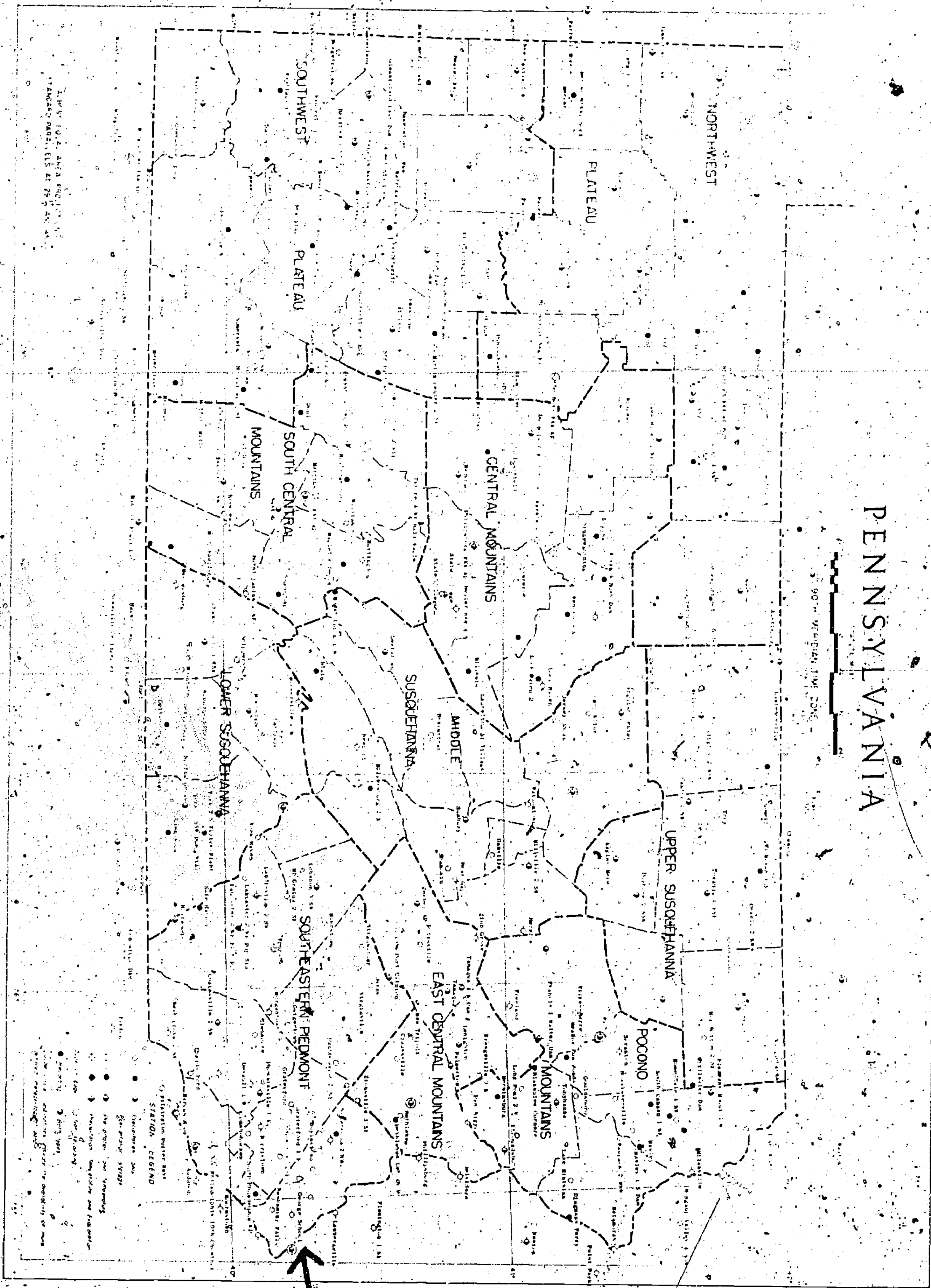

PENNSYLVANIA
NORTHWEST
PLATEAU
SOUTHWEST
PLATEAU
CENTRAL MOUNTAINS
SOUTH CENTRAL
MOUNTAINS
MIDDLE
SUSQUEHANNA
LOWER SUSQUEHANNA
UPPER SUSQUEHANNA
SOUTHEASTERN PIEDMONT
EAST CENTRAL MOUNTAINS
POCONO
MOUNTAINS

Figure 11

W.B. FORM 612-16 — U.S. DEPARTMENT OF COMMERCE—ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION — WEATHER BUREAU (REVISED 6-64)

RECORD OF CLIMATOLOGICAL OBSERVATIONS

Station: George School
County: Bucks
State: Pa

Time of observation (local time) if once daily: 7:30 A.M.
If at different times, temperature ______, precipitation ______
Month: June 1972
Standard time in use: EDT

Date	Temperature °F: 24 hrs ending at observation, Max	Min	At obsn	Precipitation: 24-hr amounts, Rain, melted snow, etc. (ins & hundredths)	Snow, Sleet, Hail (ins & tenths)	At obsn Snow, Sleet, Hail, Ice on ground (inches)	Weather (calendar day): Fog	Sleet	Glaze	Thunder	Hail	Damaging wind	Time of obsn if different from the above	Important weather conditions not included in "Weather" block; remarks, etc.
1	78	59	59	.02										
2	72	46	53							X				
3	77	53	71	.38									10:00AM	
4	85	53	79							X			6:00AM	
5	86	57	57	.02			X							
6	80	57	60	T										
7	75	57	57	.04										
8	76	47	47											
9	83	47	62											
10	85	58	58	.07										
11	63	39	57										11:00AM	
12	69	41	42											
13	77	42	52											
14	72	52	65	.11										
15	75	65	68	T										
16	85	66	66							X				
17	83	64	67	1.41									9:00AM	
18	75	64	65	.40						X				
19	68	63	63	.62										
20	71	63	66	.06										
21	81	65	72	.15									10:00AM	
22	76	66	66	.25						X				
23	68	50	51	2.47										
24	59	51	59	.12										
25	65	52	54	.75										
26	68	54	58	.25										
27	73	52	52											
28	81	52	57											
29	83	57	64							X				
30	69	64	66	1.01										
31														
Sum				8.13										
Avg														
Greatest				2.47										

Observer: Alan D. Sexton
Post Office: Newtown

Check ☐ when additional sheet is used for remarks
List forms or supplies needed ______
Station: George School Month: June 1972

PLEASE! Be sure the station name is on this form. An unidentified record is easily lost.

CLIMATOLOGICAL DATA

UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE

In Cooperation with Commonwealth of Pennsylvania, Department of Forests and Waters

PENNSYLVANIA
JUNE 1972
Volume 77 No. 6

MONTHLY SUMMARIZED STATION AND DIVISIONAL DATA

Station	Temperature: Average Maximum	Average Minimum	Average	Departure From Normal	Highest	Date	Lowest	Date	Degree Days	No. of Days: Max. 90° or Above	Max. 32° or Below	Min. 32° or Below	Min. 0° or Below	Precipitation: Total	Departure From Normal	Greatest Day	Date	Snow, Sleet: Total	Max. Depth on Ground	Date			
POCONO MOUNTAINS 01																							
FRANCIS E WALTER DAM	69.2	51.0	60.1		79	5	27	11	162	0	0	1	0	8.35		2.89	23	.0	0		11	4	-
FREELAND	69.2	51.2	60.2	+ 3.7	78	5	33	12	155	0	0	0	0	9.37	5.17	3.15	23	.0	0		10	5	3
HAWLEY	69.2	52.6	60.9		79	16+	34	11	137	0	0	0	0	10.37	6.90	2.75	1	.0	0		14	7	-
HUNLOCK CREEK 4 N	72.3M	52.4M	62.4M				31	11	129	0	0	1	0	10.13		3.50	22	.0	0		11	7	2
MATAMORAS	75.1	54.8	65.0		84	28+	37	11	63	0	0	0	0	9.83	5.92	2.01	1	.0	0		13	6	4
MILANVILLE	71.7	51.1	61.4		82	16+	32	11	129	0	0	1	0	8.66		1.43	22	.0	0		11	6	4
PLEASANT MOUNT 1 W	67.1	50.6	58.9		78	16	31	11	191	0	0	1	0	9.92	5.86	2.25	1	.0	0		12	6	4
SCRANTON	72.6	54.8	63.7	- 4.6	81	28+	31	10	91	0	0	1	0	5.16	1.43	1.73	22	.0	0		12	3	2
STROUDSBURG	75.3	55.6	65.5	- 2.5	84	9	35	11	60	0	1	0	0	8.85	4.64	1.36	19	.0	0		16	6	4
TOBYHANNA	69.0	51.3	60.2		78	4	29	11	153	0	0	1	0	10.14	5.81	2.73	23	.0	0		19	5	4
WIL-BARRE-SRAN WSO AP	70.8	55.0	62.9	- 5.3	82	15	34	11	109	0	0	0	0	7.04	3.13	2.01	22	.0	0		11	4	2
DIVISION			61.9	- 3.7										8.89	4.92			.0					
EAST CENTRAL MOUNTAINS 02																							
ALLENTOWN WSO AP //R	75.2	52.9	66.6	- 2.8	87	15	39	11	54	0	0	0	0	8.58	4.51	3.23	22	.0	0		10	6	3
BELTZVILLE DAM	71.6	53.5	62.6		82	5	34	11	112	0	0	0	0	9.22		2.87	23	.0	0		13	4	2
PALMERTON	75.1	55.9	65.5	- 2.8	85	15+	37	11	67	0	0	0	0	8.73	4.85	2.76	23	.0	0		11	7	1
PORT CLINTON	74.4	53.0	63.7	- 4.5	84	9+	32	11	92	0	0	1	0			1.67	19	.0	0		12	4	1
ZERBEY AIRPORT	67.1	52.9	60.0		82	29	36	11	171	0	0	0	0	18.70		6.53	22	.0	0		14	7	3
ZION GROVE	70.6	51.8	61.2		80	29+	34	11	133	0	0	0	0	11.49		4.59	23	.0	0		10	3	3
DIVISION			63.3	+ 5.2										11.34	7.46			.0					
SOUTHEASTERN PIEDMONT 03																							
COATESVILLE 1 SW	74.6	55.5	65.1	- 5.3	83	16+	37	11	75	0	0	0	0	10.36	5.94	3.75	23	.0	0		14	6	2
DEVAULT 1 W	73.7	56.7	65.2		84	4	38	11	66	0	0	0	0	10.98		4.77	22	.0	0		13	6	2
EPHRATA	74.0M	57.0M	65.5M	- 5.9	83	4+	42	11	55	0	0	0	0	12.11	7.91	5.79	22	.0	0		13	7	2
GEORGE SCHOOL	75.3	55.2	65.3	- 4.8	86	5	39	11	66	0	0	0	0	8.13	4.38	2.47	23	.0	0		12	5	3
GRATERFORD 1 E	75.6M	55.1M	65.4M		85	16+	36	11	67	0	0	0	0	8.63		2.10	23	.0	0		12	8	3
HOLTWOOD	73.4	57.9	65.7	- 6.8	83	4	45	11	55	0	0	0	0	11.44	7.94	4.05	22	.0	0		13	5	3
LANCASTER 2 NE PMP STA																							
LANDISVILLE 2 NW	76.4	56.3	66.4		83	16+	39	11	53	0	0	0	0	14.[illegible]		7.74	22	.0	0		15	6	2
LEBANON 3 SW	74.8	57.6	66.2		87	4	41	11	61	0	0	0	0	17.10		8.85	22	.0	0		14	4	2
MARCUS HOOK	78.3	62.3	70.3	- 4.3	90	9	46	11	20	1	0	0	0	8.02	4.48	3.73	22	.0	0		9	5	2
MORGANTOWN	72.9	55.1	64.0		82	5	39	11	86	0	0	0	0	14.31		5.63	23	.0	0		13	7	3
MT GRETNA 2 SE																							
NORRISTOWN	80.7M	58.9M	69.8M		90	4	41	11	21	1	0	0	0			1.25	17	.0	0		9	4	1
PERKASIE	76.8	53.4	65.1	- 3.6	87	9+	35	11	61	0	0	0	0	9.71	5.52	3.26	23	.0	0		14	5	2
PHILADELPHIA DREXEL U.																							
PHILADELPHIA WSO AP R	76.9	60.4	68.7	- 2.3	86	15+	44	11	26	0	0	0	0	5.79	1.74	2.35	22	.0	0		8	3	1
PHILA. 10TH CHESTNUT	77.9	62.8	70.4		89	9+	48	11	17	0	0	0	0										
PHOENIXVILLE 1 E	78.6M	56.2M	67.4M	- 4.3	86	15+	34	12	39	0	0	0	0			3.23	22	.0	0		7	5	2
READING 3 N R	74.9	56.9	65.9	- 6.3	84	16	36	11	64	0	0	0	0	15.73	12.01	6.49	23	.0	0		14	7	4
WEST CHESTER 1 W	74.7M	55.0M	64.9M	- 6.1	85	16+	35	11	68	0	0	0	0	9.58	5.73	4.56	23	.0	0		14	4	1
WEST GROVE 1 SE	74.5	57.2	65.9		84	5	38	12	53	0	0	0	0	11.50	7.81	5.75	23	.0	0		14	4	2
DIVISION			66.5	- 4.6										11.20	7.30			.0					
LOWER SUSQUEHANNA 04																							
BIGLERVILLE	73.1	56.0	64.6		83	5	40	11	84	0	0	0	0	11.84		4.88	22	.0	0		13	5	2
BLOSERVILLE 1 N	72.9	55.3	64.1		84	20+	37	11	90	0	0	0	0	13.46	9.38	4.58	23	.0	0		14	7	3
CARLISLE	71.7	55.4	63.6	- 8.1	80	9+	39	11	79	0	0	0	0	18.51	14.64	5.40	22	.0	0		15	8	4
CHAMBERSBURG 1 ESE																							
GETTYSBURG	75.2	56.4	65.8	- 5.7	86	5	39	11	67	0	0	0	0	13.50	9.98	5.75	22	.0	0		13	5	3
HANOVER	76.0	56.9	66.5	- 5.0	86	20+	40	11	59	0	0	0	0	12.92	9.16	6.10	22	.0	0		12	4	3
HARRISBURG FAA AP R	75.4	60.0	67.7	- 3.6	87	15	44	11	44	0	0	0	0	18.55	15.13	9.13	22	.0	0		10	5	2
MERCERSBURG	76.3	55.9	66.1		88	5	39	11	68	0	0	0	0	10.20	6.20	3.67	22	.0	0		10	5	3
SHIPPENSBURG	75.1	57.3	66.2		87	15	41	11	66	0	0	0	0	12.41		4.90	23	.0	0		11	5	2
YORK 3 SSW PUMP STA	77.6	55.8	66.7	- 4.8	85	16+	36	11	53	0	0	0	0	20.45	16.64	13.50	22	.0	0		11	7	4
DIVISION			65.7	- 5.3										14.65	10.87			.0					
MIDDLE SUSQUEHANNA 05																							
BERWICK																							
ENGLISH CENTER	71.7	49.8	60.8		87	16	29	11	155	0	0	2	0	12.43		4.62	23	.0	0		12	5	3
LAURELTON ST VILLAGE	77.1	54.1	65.6		87	16	32	11	65	0	0	1	0	16.22		4.86	22	.0	0		15	8	5
LEWISTOWN																							
MILLVILLE 2 SW	71.8	52.2	62.0		85	16	36	11	128	0	0	0	0	16.62		6.00	22	.0	0		13	6	3
NEWPORT	74.7M	55.5M	65.1M		87	16	38	11	70	0	0	0	0			4.52	22	.0	0		11	5	3
SUNBURY	73.0M	55.3M	64.2M		84	16	40	11	78	0	0	0	0	18.10	14.65	7.45	22	.0	0				
WILLIAMSPORT WSO AP	71.7	56.3	64.0	- 5.2	84	15	41	11	90	0	0	0	0	16.80	13.57	8.66	22	.0	0		13	5	3
DIVISION			63.6	- 5.6										16.03	12.55			.0					

See Reference Notes Following Station Index

SPECIAL WEATHER SUMMARY ON PAGE 82

Figure 13

Figure 14

SUMMARY OF PRECIPITATION - NESHAMINY CREEK WATERSHED

Month DECEMBER Year 1969

Date	Station # 1	2	3	4	5	6	7	8	9	10	Ave.	Doylestown API	A	B	C	D
1				T	T	T		0.03	T	T		.44	0.03			0.03
2										T		.40	0.02			0.02
3				T								.36				
4												.32				
5												.29				
6												.26				
7												.23				
8	1.00		1.00	1.14		1.00	0.89	0.92		0.65	0.94	1.21	0.92		0.92	1.10
9	0.03			0.05		0.01	0.03	0.02		T	0.02	1.09				0.04
10												.99				
11	2.10		2.25	2.07		1.61	1.98	1.95		1.50	1.92	3.13	2.00		1.76	2.25
12								0.02				2.82				
13												2.54				0.08
14	0.10		0.10	0.10				0.03			0.05	2.39	0.05			0.20
15	0.20		0.20	0.05		0.23	0.24	0.16		0.20	0.19	2.35	0.22		0.24	
16												2.11				
17												1.40				
18												1.71				
19												1.54				
20												1.39				
21												1.25	0.01			
22	0.80		0.50	0.52		0.87	0.31	0.72		0.40	0.59	1.62	0.35		0.22	0.60
23	0.90		0.80	0.61		0.56	0.98			1.10	0.71	2.26	1.02		1.05	0.20
24			T	0.01		T.						2.93				
25												1.93				
26	0.80		1.15	1.53		1.45	0.99	0.95		1.10	1.14	1.65	0.95		0.75	1.75
27						T		0.16			0.02	2.63	0.15			
28												2.67				
29												2.13				
30			T			0.09	0.55			0.15	0.11	1.92	0.05		0.32	0.85
31	0.50		0.50			0.82	0.31	0.70		0.65	0.50	3.23	0.85		0.50	
Total	6.43		6.50	6.08		6.64	6.28	5.65		5.75	6.19		6.62		15.76	7.72

Station Key

#	Name	#	Name	#	Name
1	Chalfont	6	Lansdale	A	Buckingham
2	Pipersville	7	Maple Glen	B	New Britain
3	Doylestown	8	Rushland	C	Wycombe
4	George School	9	Southampton	D	Hartsville
5	Holicong	10	Warrington		

	Amount	Station
Highest Monthly Total	7.72"	
Lowest Monthly Total	5.65"	
Greatest in 24 Hours (11th) 2.25"		Doylestown & Hartsville
Normal for month in Doylestown	3.43"	
Departure from normal in Doylestown	+3.07"	
Norm. for month at George School	3.33"	
Departure from norm. at George School	+2.75"	

NESHAMINY VALLEY WATERSHED ASSOCIATION
Doylestown, Penna.

Figure 15

NESHAMINY VALLEY WATERSHED ASSOCIATION
8 West Oakland Avenue
Doylestown, Pennsylvania
Phone 348 2530

GEORGE SCHOOL - AVERAGE PRECIPITATION

MONTH

PERIOD	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
1907-1930	3.16	3.05	3.17	3.63	3.51	3.37	4.34	4.60	3.27	3.14	2.64	3.37	41.40
1931-1952	3.51	2.53	3.93	3.45	4.19	4.08	5.19	4.56	3.76	2.99	3.90	3.32	45.41
1953	5.85	1.87	6.40	6.21	6.33	1.79	5.46	3.08	1.41	4.62	1.81	5.04	49.87
54	2.11	1.56	4.51	4.04	4.30	1.28	2.12	7.32	5.84	2.51	5.29	2.82	43.70
55	0.42	3.20	5.19	2.01	2.86	4.47	1.90	11.71	1.96	7.58	1.66	0.29	43.25
56	2.32	4.45	6.00	2.62	3.26	3.42	4.27	2.92	2.50	3.48	4.20	3.57	43.01
57	1.67	2.95	2.41	5.36	1.26	1.90	1.11	2.00	2.72	2.02	4.23	6.68	34.31
58	4.76	4.60	5.22	6.27	3.62	2.24	5.94	5.58	3.19	4.14	3.03	1.30	49.90
59	2.21	1.87	4.11	2.92	1.52	5.00	5.59	6.54	0.78	2.90	4.18	4.39	42.01
60	3.71	4.84	1.79	3.93	3.05	2.61	7.83	2.62	8.54	2.37	2.66	3.54	47.49
61	2.97	3.20	4.89	5.33	4.45	3.31	8.49	5.50	2.92	1.98	2.30	3.88	49.22
62	2.74	4.42	3.28	4.53	1.97	5.62	1.27	6.59	3.88	1.63	4.72	2.62	43.27
63	2.18	2.31	4.03	0.58	1.84	1.67	4.10	2.57	3.82	0.04	6.55	1.84	31.53
1907-1963 (57 years)	3.23	2.88	3.69	3.63	3.70	3.58	4.67	4.69	3.49	3.06	3.33	3.33	43.34

Monthly totals for the years 1907-1952 are available in the office of The Neshaminy Valley Watershed Association

Figure 16

Dates on which air temperatures, recorded at George School, Bucks County, Pa., were 100°F or above, and below zero, from January 1, 1907 to February 8, 1968. Table compiled by William M. Craighead.

100°F or Higher

July 3, 1911	103	July 22, 1926	100	Sept. 2, 1953	100
July 10, 1911	100	July 21, 1930	102	July 22, 1955	100
Aug. 6, 1918	100	July 9, 1936	106*	Aug. 2, 1955	100
Aug. 7, 1918	105	July 10, 1936	105	Aug. 6, 1955	100
June 5, 1925	100	July 11, 1936	100	July 21, 1957	103
June 6, 1925	100	July 18, 1936	100	July 22, 1957	102
				July 4, 1966	102

Temperatures Below Zero

Feb. 7, 1907	-6	Jan. 29, 1925	-6	Jan. 18, 1954	-11
Feb. 12, 1907	-3	Dec. 7, 1926	-1	Feb. 3, 1955	-6
Feb. 13, 1907	-4	Jan. 30, 1928	-6	Jan. 17, 1957	-2
Jan. 1, 1910	-2	Dec. 19, 1932	-2	Jan. 18, 1957	-8
Dec. 10, 1910	-3	Feb. 13, 1933	-5	Jan. 19, 1957	-6
Dec. 12, 1910	-2	Dec. 28, 1933	-5	Dec. 19, 1960	-1
Dec. 17, 1910	-1	Dec. 29, 1933	-5	Dec. 20, 1960	-3
Jan. 13, 1912	-8	Dec. 30, 1933	-3	Dec. 21, 1960	-1
Jan. 14, 1912	-18*	Feb. 4, 1934	-6	Dec. 23, 1960	-4
Feb. 10, 1912	-1	Feb. 7, 1934	-6	Dec. 24, 1960	-2
Jan. 14, 1914	-5	Feb. 9, 1934	-16	Jan. 21, 1961	-10
Feb. 13, 1914	-2	Feb. 10, 1934	-4	Jan. 22, 1961	-11
Feb. 22, 1914	-2	Feb. 14, 1934	-1	Jan. 23, 1961	-9
Feb. 25, 1914	-7	Feb. 28, 1934	-8	Jan. 24, 1961	-4
Feb. 26, 1914	-6	Jan. 25, 1935	-7	Jan. 25, 1961	-1
Dec. 27, 1914	-4	Jan. 28, 1935	-14	Jan. 26, 1961	-4
Feb. 14, 1916	-1	Jan. 31, 1935	-2	Jan. 28, 1961	-13
Feb. 15, 1916	-1	Feb. 1, 1935	-7	Jan. 29, 1961	-7
Feb. 13, 1917	-2	Feb. 7, 1935	-7	Jan. 30, 1961	-4
Dec. 30, 1917	-9	Jan. 23, 1936	-5	Jan. 31, 1961	-3
Dec. 31, 1917	-8	Feb. 10, 1936	-3	Feb. 2, 1961	-8
Jan. 1, 1918	-5	Feb. 19, 1936	-1	Feb. 3, 1961	-7
Jan. 2, 1918	-3	Feb. 20, 1936	-4	Feb. 11, 1962	-5
Jan. 4, 1918	-3	Jan. 20, 1939	-2	Feb. 12, 1962	-1
Jan. 20, 1918	-9	Jan. 20, 1940	-1	Jan. 29, 1963	-4
Jan. 21, 1918	-8	Jan. 11, 1942	-8	Feb. 8, 1963	-1
Jan. 24, 1918	-2	Dec. 21, 1942	-2	Dec. 31, 1963	-5
Feb. 2, 1918	-14	Feb. 15, 1943	-1	Jan. 1, 1964	-3
Feb. 5, 1918	-9	Jan. 25, 1945	-2	Jan. 15, 1965	-6
Feb. 6, 1918	-8	Dec. 18, 1945	-2	Jan. 16, 1965	-4
Feb. 23, 1918	-1	Jan. 29, 1948	-5	Feb. 8, 1967	-1
Dec. 18, 1919	-3	Jan. 31, 1948	-5	Feb. 9, 1967	-8
Jan. 19, 1920	-2	Feb. 7, 1948	-4	Feb. 10, 1967	-6
Feb. 1, 1920	-4	Feb. 9, 1948	-1	Feb. 13, 1967	-9
Feb. 17, 1922	-2	Dec. 27, 1948	-7	Feb. 14, 1967	-7
Feb. 8, 1923	-3	Dec. 28, 1950	-3	Jan. 2, 1968	-3
Feb. 14, 1924	-3	Dec. 17, 1951	-11	Jan. 3, 1968	-3
Jan. 28, 1925	-8	Jan. 14, 1954	-9	Jan. 12, 1968	-6

* Extremes: July 9, 1936 106°
Jan. 14, 1912 -18°

IV. Interpretations

As soon as all information from the three year weather station was graphed, overlays were made with clear vinyl plastic and felt-tip pens. By placing single overlays on each different graph, variable trends can easily be discussed. Although the Burgundy Wildlife Camp collected data for only 35 days each year, and only for three years, the relationships between barometric pressure, precipitation, temperature, and humidity are easily seen (see sample graphs that represent many of graphs made).

Other trends that are clearly displayed are:

1. A drastic drop in daily maximum temperature during periods of heavy rain (Figures 1, 4, 8).
2. The tendency of an increase in daily minimum temperature during periods of rain (Figures 1, 4, 8).
3. A general positive correlation between the <u>maximum</u> and <u>minimum</u> temperature each day. (Figure 6).
4. A midday low average humidity (Figure 7).

One other phenomenon discovered by analysis of the weather graphs is the inverse relationship between barometric pressure and temperature. One can see that all three years of study show that as the temperature reaches a high point, the barometer will register a low point and also visa versa (similar to the relationship of barometric pressure and humidity). The same holds true for the relationship between pressure and humidity.

Evidently accurate and meaningful data can be obtained from a comparitively simple weather station. The usefullness of the station is immeasurable for the acquisition of basic meteorological skills and prediction of local conditions.

The analysis of these data can always be extended to include comparisons with U. S. Weather Bureau records and averages and to further studies of the particular averages of the area. Campers at Burgundy are also encouraged to build weather stations at their own homes.

V. Conclusions

The data collected seem to indicate that with an analysis of meteorologica trends and conditions, the weather can be predicted locally with a fairly high degree of accuracy. Once a basic knowledge of meteorology is acquired and conditions are regularly recorded over a period of time, predictions become noticeably more accurate, records more complete and interest aroused.

We can now, from the data displayed (recorded at Burgundy Wildlife Camp), speculate on future summer weather, compare and correlate rain data with other related studies and make day to day predictions with a mesurable credibility.

In order to expand the uses of these data, they are used in a large variety of ways specific to the area where they were recorded. The Burgundy Wildlife Camp has been engaged in a number of other continuous studies over the same period of time, thus creating potential fields of comparison. These other studies are of birds, trees, shrubs and flowering plants, reptiles and insects. In each case, various weather factors can be seen as possible causes of fluctuations of population sizes and growth. This also can be accomplished in a variety of ways, using charts, graphs and tables to see general trends, and superimposing, overlapping, and comparing figures for present and selected past years. Some of these motives are evident in the methods of display of this study (see graphs, etc.). If comparable units (e.g., time) are used, this trend analysis is made more easily with graphs.

Records of weather such as those of Burgundy Wildlife Camp and George School clearly reveal unusual occasions (flood, draught, excessive cloud cover, etc.) and can be correlated to erosion patterns, stream bed alterations, water table shifts, and pond and sewage disposal levels.

Individual plant and tree growth can often be measured yearly by examining branches or tree rings. These will reflect recorded wet and dry seasons, temperatures, and resultant growth or even forest fire conditions. Bird populations (measured by banding or sighting) can be affected by weather. They will often be dependent on availability of food, nesting sights, predators, etc., all indirectly reflecting weather trends as well. As conditions change, often species of birds sighted will shift accordingly. All of these changes can usually be explained or substantiated by weather records if they are complete and extensive enough.

Suggestions for Further Study

The weather station can not only provide verification and speculation data but also the impetus for the instigation of further and related studies. The weather station may be expanded or re-out-fitted to increase precision. This, of course, is dependent on the direction and force of the interest aroused. Campers, students, club members, or families might be intrigued by the possible effects of weather on other ecological systems already cited as possible comparable areas of study.

Results of individual occurrences (stors, doughts, etc.) can be studied in terms of surrounding physical, geographical and dendrological conditions. Local occasions and characteristics can become the subject of an individual study. Specific idiosyncrasies may be studied in depth, developing a backlog of data to help observe, explain and understand them. Repeatedly similar readings or unusually divergent results are prime subjects for more precise and extensive investigations (e.g., an annual June flood or perhaps a repeated

August fire and so forth can be at least partially explained by weather records and conditons). Locating the individual weather station on a national or international weather map can help elucidate peculiar trends or consistent readings. This kind of investigation also incorporates many concepts involved with geography, geology and history, thus expanding the range of related studies. After a period of time, procedures or recordings may be adjusted to new desires. The Burgudny Wildlife Camp staff eliminated their midday readings because the results were realtively insignificant. The desire may be to focus weather analysis in connection with any specific study being simultaneously conducted, e.g., one might desire to record the effects of solar radiation on any of the previously mentioned phenomena or on other measurements taken with the weather study.

At Burgundy Wildlife Camp an element recorded in the bird banding records is the temperature at the time of capture in order to help study the habits of the birds and increase birds netted.

Branching points are numerous and self-instigating. They evolve out of the interest generated from the weather study, revealing new factors and possibilities for data collection and use.

VI. Bibliography

Climatological Data (Periodical), U.S. Dept. of Commerce, Asheville, North Carolina 28801. A weather data abstract published monthly for each state, compiling reports of statewide weather station reports including temperature, precipitation, and special data displayed in various tables. Available on subscription. Very important data use.

Edinger, Watching for the Wind, Doubleday, Garden City, New York, 1967. An enjoyable, very readable book about weather.

Fisher, Robert M., How to Know and Predict the Weather, New American Library, New York, New York, 1953. A good but very general prediction guide.

Forsdyke, A. G., Weather and Weather Forecasting, Bantam Books, New York, New York, 1970. This is an excellent, recent source on the weather.

Jameson, P. R., Weather and Weather Instruments, Taylor Instruments Co., Rochester, New York, 1923. Tells how weather instruments work and gives rudiments of forecasting.

Kimble, G., and Bush, R., The Weather, Penguin Books, New York, New York, 1946. This is a very good, technical book on weather study that is slightly out-dated.

Laird, Charles and Ruth, Weathercasting, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1955, 1961. This is a good guide to weather forecasting and tells how to make many of the necessary instruments.

Lehr, Paul E., Burnett, R. W., Zim, H., Weather, Simon and Schuster, New York, New York, 1957. This is a book from the "Golden Guide" series giving a good introduction to the study of weather. It gives comprehensive general information.

Ludlum, David M., Weatherwise (periodical), American Meteorologist Society, Princeton, New Jersey, 08540. An excellent publication with varied reports and articles about weather. A wonderful self instigating teaching mechanism. Includes also Daily National Weather Maps. Readable by all 6-12 grades.

Petterssen, Svetre, Introduction to Meteorology, McGraw-Hill Book Co., New York, New York, 1969. This is an excellent and very comprehensive text on weather, written and designed for college use.

Sloane, Eric, How You Can Forecast the Weather, Fawcett Publications, Greenwich, Connecticut, 1957. This is a very readable, interesting and comprehensive guide to forecasting.

Weather Science Study Kit, U. S. Department of Commerce, Washington, D. C., 20402. For one dollar you can get this excellent kit which gives readily teachable material on all basic concepts with procedural directions and sample weather maps.

CHAPTER 3

I. Introduction

Ferns are easy to study. They are conspicuous and easy to locate, they do not move away when approached by even the noisiest person. In addition, they have several other attributes which make them desirable for study. They are among the most highly evolved plants which do not reproduce with seeds and yet they are vascular, thus they have rather specific niches in an environment and therefore can be used to indicate environmental change. They are a large group of plants with a wide variety of species to study. They are easy to collect and make into herbarium specimens. They are fairly easy to draw, and finally they are relatively easy to propogate from spores in the laboratory/classroom with simple materials, where the alternation of sporophyte and gametophyte generations can readily be seen and appreciated.

Only rarely does one find that all aspects of a study will be equally fascinating to all of the participants making the study. Ferns provide a particularly felicitous choice of organisms to study in any given environment. They can be appreciated by the artistically inclined student, by the student primarily interested in collecting something tangible, by the manipulating person who desires to make things grow, and by the truly scientifically inclined person. We will consider each of these possibilities. Others may well occur to the reader during the study of ferns.

By studying a family of organisms in an environment, we can gain some measure, some index, of the quality of the environment. If we can relate or compare the family of ferns, for instance, in a natural or unaltered area with a comparable area that has had recent alterations, we should be able to provide some concrete measure of the degree of alteration. For instance, if along a given stream we find profuse quantities of Hartford fern and along a stretch of stream just downstream from a drain pipe there are few if any Hartford ferns, we can deduce that the environment has been latered, and it is now unfit for the growth of that fern. We can hypothesize that something entering the stream from the pipe has sufficiently altered the quality of the water to make the adjacent soil inhospitable to the fern. Can we compare the number of plants in a sample area in two places to give an index? Can we test the water for contaminants? Can we be certain that these are the only measurable indices? Should we test the soil also? Should we also look at the total plant association pattern?

No scientific study made has ever been truly exhaustive of uncontrolled variables. But, we can do a study of an environment using whatever tools and whatever indices are available to lead us toward an understanding of what makes an environment as it is. Since the study of environments is relatively new and many times the need for information acute, we must move along with reasonable haste and care in our attempt to understand and to raise our level of consciousness.

If our conclusions are tentative, at least our familiarity with a special ecology will be increased and perhaps as the time and tools become more available we can hope to re-study an area with more sophistication.

Ferns have not previously been used as indicators of environmental quality. Some early data on elevations at which various species of ferns grew was collected eighty years ago (see Small in the Bibliography), but nothing appears to have been done since. There is much to be done in the way of data gathering about the unaltered stations where fern species have been located before we can make definitive statements about the alteration of other stations. The possible contribution to scientific knowledge is most exciting. Even if we discovered that ferns make a poor index for environmental quality, those who participate in the study of them will have learned a great deal about other aspects of the various and diversified habitats in which ferns are present or in which they have been in the past. The ferns themselves are not without interest. They are one of the most conspicuous groups of plants in the landscape, and are of interest because they do not depend upon flowers for their conspicuousness.

If we should find that ferns [illegible] highly resistant to the effects of environmental alteration, we might then desire to know how this could be. We already know, for instance, that various flowering plants are very susceptible to specific air pollutants. One would then wonder what makes some plants more or less prone to damage by air pollution. There are obvious connections between this study and the interests of chemists, engineers, public health officials and city planners. If man is to continue to inhabit this planet, he must know what to do in order to maintain a quality of environment in which plants can live: for it is with plants that all food chains originate.

There will be a number of more immediate gains to the participants in this study, however. The students will see for themselves the inter-relatedness of life - something that is talked about a great deal but rarely grasped: a sense of taxonomy which can be thought of as the inter-relatedness of species, species to genera, and genera to families. In the process the whole matter of what determines a species and how species arise will naturally come up. It may occur through the finding of a natural hybrid (a thrill in itself) or through the obvious absence of hybrids among closely occuring species. In the same moment of insight, the obvious relationship between taxonomy and genetic inheritance might well make itself know. In the process of growing spores into gametophytes, and gametophytes into the mature plants we all recognize (the sporophytes), investigators will discover that there is a very subtle balance required for the success of the whole process. Finally, to conduct any part of the study of ferns without concluding that the rich variety of of species and the richness of all living things cannot be diminished without a major loss to the very quality of our lives would be nearly impossible. The richness of life engendered by the wide variety of living things may not have been invented for man's pleasure, but who can deny that it does benefit man greatly?

II. Materials and Methods

1. Tools and Supplies.

   a. Books, as repositories of the knowledge of others, are indispensible. The following, in particular, have served the author well. They are:

Cobb, Boughton. A Field Guide to the Ferns. Peterson 1963. Houghton Mifflin Company, Boston.

Grillos, Steve J. Ferns and Fern Allies of California. 1971. University of California Press, Berkeley.

Harlow, William M., Trees of the Eastern and Central United States. 1957. Dover Publications, Inc., New York.

Shaver, Jesse M. Ferns of the Eastern Central States, 1954. Dover Publications, Inc., New York.

Shuttleworth, Floyd S., and Herbert S. Zim. Non-Flowering Plants. Golden Nature Guide. 1967. Golden Press, New York.

In addition, a leaflet, Carolina Tips, Vol. XXXV, No. 4, published by the Carolina Biological Supply Company of Burlington, North Carolina 27215, has been very useful as a compact, thorough introduction to the subject of the fern life cycle.

b. Minimal equipment for any field work should include a hand lens, a compass, a pocket knife, insect repellent, a snake-bite kit, a few band-aids, contour maps showing elevations (U. S. Coast and Geodetic Survey maps are the best), and last, but most important, sturdy hiking shoes, long pants and long-sleeved shirt.

c. If you are simply going "collecting" for herbarium specimens, you won't need more than a simple plant press in addition to the items listed. A plant press is difficult to carry, but you can't get the more delicate specimens home before they wither, even on a very short hike. If they curl up, they are nearly impossible to work with, so take a simple press with you. One can be made from two pieces of paneling samples slightly bigger than one-half a newspaper page (slit horizontally), an Army surplus strap of 1/2" width, and 1-1/2" of newspaper slit open to give half pages. It could be fancier with holes in both covers, and it might have a quick release strap. After returning to the laboratory transfer the specimens and their surrounding paper to a professional plant press with the proper blotters and corrugated cardboard aerators.

It's double work, but it keeps one from lugging all the extra paper and cardboard over hill and dale. Also when handling the specimen for the second time, one might be reminded to take notes.

When you get to mounting the dried specimens, you will need a few other items. These include liabrarians white fabric book mending tape, a single-edge razor blade, a glass microscope slide, a pair of slant-ended tweezers, rag (or rag content) herbarium sheets, herbarium labels. Eventually you will want species and genus covers as your collection grows. The collection should be kept in a closed box or space where you can keep pests to a minimum with moth balls.

d. If you collect ferns another way, such as in drawings, you will want other equipment. A Rapidograph or Pelikan pen can be used to make excellent drawings on good quality sketch pad paper. (See the accompanying drawings --pages 108 - 121-- by Stella Paul. They were done this way.) If you want to do spatter prints, or blue prints, then you should bring the fern fronds back to the lab in a plant press. Shaver's book has clear instructions for doing this.

e. The growing of ferns from spores is usually easy and very instructive. Of course you need the spores and they should be mature. This you can tell by the fact that they are being released from the sori or that the sori are brown and drying and appear to be about ready to split open. Small, plastic sandwich bags make good containers for fern fronds collected for spores. You will also find compressed peat pellets useful; they are called Jiffy-7's and are carried by most garden centers now. They expand when soaked for a few minutes in water, and being peatmoss, they have an acid pH which retards the growth of molds. Glass beakers big enough to give a 1/2" space around the Jiffy-7"s, clear film (such as Saran) and rubber bands complete the equipment needed to raise fern gametophytes and juvenile sporophytes. When the sporophytes become too big for their beaker nursery, they should be transplanted to small flower pots. Hyper-humus, or other bagged soil and humus material can be modified if needed with additonal amounts of peatmoss (for a lower pH) or crushed dolomitic limestone or crushed oyster shells (for a higher pH). In order to keep a fairly high humidity level around the young sporophytes, you can use an aquarium covered with glass or clear food-wrapping film for a top.

f. For the more scientific study you will need a variety of fairly simple items. A foot candle-light meter, a soil test kit (for pH and ion/salt testing), a steel tape measure (although a heavy 5 meter long cord tied at 1 meter intervals could be used), 20 short wooden stakes, a ball of twine, a Centigrade thermometer, a soil thermometer, maps (mentioned in b. above) a folding carpenter's ruler marked in centimeters and millimeters, a bound compositon book and something to write with. Plastic sandwich bags with twist closures will make handy soil sample containers. A rucksack will hold all items nicely. If the tables for recording data have been previously inked into the data book, the work will go faster, and you won't be forgetting to record something essential.

2. Methods

a. A number of preliminary walks, hikes, or rambles may be taken before a likely spot to study is found. Once these have occurred, or if you already know of a good study site, make certain that you obtain the explicit permission of the owner of the land to study the ferns growing there. You should point out that you might desire to collect a few fern leaves to take back to the lab to study further. While you obtain permission, you can usually get a bit of information about any alterations in the environment that the owner knows have taken place. Friendly questions about when the woods were last logged, or when the limestone was last quarried, or when the highway department altered the course of the stream for the new highway, will yield useful tidbits of knowledge to your understanding of the plantlife found there.

When you have permission to study and collect small numbers of fern fronds and have left your car or bus where it won't block anyone's way, and the gear is all accounted for, you are ready to go.

However, before investigators can appreciate the quality of a given environment, they must first become "tuned-in" to the location. They must experience the particular environment through all of their available senses. This can only be done <u>in</u> that environment and while perfectly <u>still</u> and <u>silent</u>. That, unfortunately, is not easy for many people today, but it must be done.

A well-trained bird dog can teach us something. When he first enters a field, he stops. He looks around him carefully, he listens, he smells, he feels the ground through his foot pads. We can do the same. He also looks to the interface between field and thicket as a probable place for birds. Let's try it. Sit down.

1. How much light is there? Is it shady, filtered light or bright unshaded light?
2. How much water is in the soil beneath us? What kind of soil is it anyway? Loamy? Sandy? Boggy?
3. What can we hear? Running water? Waves on a shore? Oozing water coming from a rock outcropping? Birds? Traffic?

4. Is it foggy, or rainy, or is there water spray from a falls?
5. If there is a slope, or a cliff, does it face north?
6. What's the air temperature? Does it freeze here in the winter or get very hot in the summer? What season is it now?
7. Can you detect any influence of man in the environment? Are there stumps of trees that have been logged? Is there trash on the ground? What kind? Are there buildings or ruins of former buildings?
8. Do you smell anything?

After making a mental and a written inventory of all that your senses tell you, you can begin to look at the organisms that live in the environment you have chosen to study. Find the interfaces between field and woods, field and water, woods and water, etc. What do you see? If there is variation; is it orderly, that is, can it be explained? Develop some possible explanation for the variation you see. Can you relate what your senses have told you to the variation in the location of plants and particularly the ferns? Write in your bound data book, noting the date, time of day, etc.

b. Having located ferns, and having noted (in writing) the specifics of their locations as well as the general data of the location as well as you can, you can now turn to the specific task which you set out to accomplish.

1. If you are collecting fern fronds for your herbarium, there are a number of things to consider. First, it's a single plant, look around for others in the immediate vicinity. You should never disturb a plant that is unique in any way. If you should contribute to its destruction, you might have removed forever something that represents a frontier plant that has started to adapt to conditions other than the usual or normal conditions for that same species. If it happens to be the only fern plant of that species in that area of 25 square meters, then simply leave it alone, but note it in your notes. If there are others of the same species nearby, then collect fronds from them, taking two fronds for each herbarium sheet, one to be mounted showing the front, the other, the back (which is where the sori usually are). Pinch them off sharply between thumbnail and pad of forefinger: if they don't pinch off easily, use your pocketknife to cut them off. In no case should you disturb the roots.

Look for "typical" fronds to collect: ones without insect damage or other injury, and ones that are neither unusually large or small. Open you field press, leaving three or four pieces of newspaper above and below the specimen. Straighten out as naturally as possible all the leaflets and the stem before closing the press; once dried you cannot make changes in the appearance of the specimen. If the bare stem of the frond is much longer than the newspaper, bend it back sharply at an angle of about 45 degrees. (See the drawing of the mounted Christmas Fern which has fertile leaflets, page 109). Each fern will present a challenge; the safest thing to do is to visualize what the specimen will look like when it is mounted. The only point in collecting and mounting ferns is to demonstrate what a typical fern of that species looks like. If you destroy the normal relationships of leaflets to stem, or fail to show spore sori, or lop off most of the stem, you have destroyed any way of knowing what a fern of that species really looks like. Fortunately ferns do not lose their color as much as other plants, so that pressed ferns are most life-like in appearance. Finally, do not overcollect. For any given herbarium one doesn't need more than one specimen sheet. After you have become quite sophisticated in collecting, and you are certain you have found a most unusual group of plants, you might collect for two or three sheets in order to share with other botanists. If your collecting should lead to the destruction of a group of important variants in a species, you are indulging in a counter-productive venture.

All details of the habitat of any collected fern should be recorded in your data book: when, where, elevation, soil, water, other ferns, tree canopy, etc. As mentioned before, upon returning to the lab or your home, put the specimens, undisturbed, into a regulation plant press, between blotters and aerators. After a reasonable number of days (dependent upon the humidity at the time), you can check to see if the specimens are dry. If so, then you can prepare to mount them on herbarium sheets. This is exacting work and should not be undertaken lightly.

Using the glass microscope slide as a guide, cut narrow strips of the fabric book-mending tape approximately 2 or 3 mm in width, using the single edge razor blade. Even very new paper cutters will not give strips of uniform width in the narrow width you will need. After you have cut a number of strips, position the specimen on the herbarium sheet in such a fashion that you can show one front (leaf) face up and the other face down, side by side. Try to make the arrangement aesthetic, too, if possible, and leave a space for the label on one of the bottom corners. When you have determined the best arrangement, moisten one of the strips of tape and strap it over a stout part of the bare stem. Quickly, using the slant-ended tweezers just on either side of the stem, press the tape tightly to the paper so that the stem will be held firmly in place. Always try to keep the tape perpendicualr to the stem (this looks best). Going up the stem toward the tip of the frond, put tape straps at about equal distances, using only so many as you need to keep the specimen from falling away from the sheet when the mounted fern is held horizontally, upside down. With experience you will learn to work quickly, accurately and carefully enough to preserve your specimens.

After the fern is positively identified, make out a label with all of the pertinent information included. If you can't write neatly, type the labels. Herbarium sheets should be stored in closed boxes or other containers with enough moth balls (p-dichlorobenzene) to ward off insect damage. Most of the supplies required can be obtained from Carolina Biological Supply Company, Burlington, N. C. 27215, or Ward's Natural Science Establishment, P. O. Box 1712, Rochester, New York, 14063, or a local biological or scientific supply house. If students are long on time and short on cash, they can make their own plant presses from instructions attached (page 107). The quick release straps that cost one dollar each are very helpful.

2. If you are collecting with pen and ink, or a camera, or some other indirect means, then the procedure will be a bit different. You won't need the plant press, for instance, unless you intend to make spatter prints or blue-prints later. But you will need drawing supplies and something waterproof to sit on. Generally, most ferns live in damp places, and to sit on the ground for several minutes could prove to be uncomfortable. Some people take a simple folding camp stool.

If photography is your sport, then take along a tripod, extra film and something light-colored such as a piece of old sheet stretched on a cheap picture frame to reflect light. Ferns aren't found in the very brightest locations - hence the tripod for longer exposures. Also the available light often doesn't model the fronds very well, so anything that will reflect light at about a 90 degree angle to the sun will usually help. A very shiny reflector will distort and disrupt, while a fabric reflector will usually produce a softer, more natural second source of light. Try varying the angle until the fronds are best separated from the surroundings. You will be forgiven if you gently push aside or tie back any other plant material that gets in the way of the picture subject.

Many times while photographing ferns and very small wildflowers one will find use for an old slicker or a rubberized lab apron to keep his front dry while leaning against a wet rock face or lying on his stomach on the damp ground.

Finally, you'll find that most advanced photographers are at home for a siesta after lunch, for they know that the best light for showing texture and detail is light that comes at an angle. Light from directly overhead is pretty dead and lifeless in a photograph. So early mornings (when dew is often still on leaves) and later in the afternoon are generally good times for photographers. Very, very early or late light is very heavy with red wavelengths and not good for accurate color rendition.

3. Growing fern gametophytes and sporophytes is easy and fun. After soaking the Jiffy-7 in water for a few minutes, it will have expanded to its full size. Fern spores are minute and look like rust when dry, so watch closely and work over a piece of white paper. If they're dry, dust them onto the top and sides of the Jiffy-7; if they are still not released from the sori they can still be picked up on a dissecting needle or any pin and transferred to the surface of the wet Jiffy-7.

   After seeding (sporing?), the Jiffy-7 is put carefully into a glass beaker (250 ml is about right) and the beaker is covered with a clear plastic lunch bag or with clear plastic film made for food wrapping, which in turn is secured with a rubber band. The beaker is then marked with the fern species and date. The container is then placed in indirect light (a north window is good) but kept away from radiators and sources of heat and extreme cold. Close observation every few days will reveal when the amount of water needs to be replenished. You can open the top or inject additional water with a needle and syringe. Opening the incubator probably allows mold spores to enter and develop, although puncturing the plastic film may cause the contents to dry out more quickly.

Place the incubators in different intensities of light, carefully recording the maximum light intensity for each different postion. In this way you might determine what effect light intensity has upon spore germination.

You might try to produce hybrid ferns, although the technique is fairly difficult. Interestingly, this was first done many years ago in an effort to demonstrate that some of the rare ferns found naturally not only could be, but were, natural hybrids.
The mystery of the Walking Spleenwort Fern bothered a number of people. It looked like the Walking Fern, and produced tiny buds at the tip of the leaves, as though it might "walk" too; but its stem color and leaflet shape looked very much like the Ebony Spleenwort. Margaret Slosson, in 1902, managed to oppose the two gamete-producing structures of gametophytes of the two supposed parents, and after some time and a great deal of frustration, managed to produce hybrid plants that were like the Walking Spleenwort found in nature. (For a

discussion of her work and technique, see Shaver or Cobb; for the real mystery tour, do get Miss Slosson's original article in the Bulletin of the Torrey Botanical Club, 1902, Vol. 29, pp. 487-495.)

Binocular dissecting microscopes with 1x and 3x magnification are a great help in looking at the gametophytes as they develop. You may have to sacrifice a few to remove them from the Jiffy-7, although the water-absorbing root-like structures are usually fairly superficial.

After the familiar sporophytes begin to develop and have reached a few centimeters in length, they can be transplanted to small pots filled with a humus soil. Peatmoss added to the soil will help keep down mold growth. Several pots can be kept in an aquarium incubator to keep the humidity high. A glass or plastic film top can be secured with cellophane tape. In time the sporophytes will grow large enough to produce sori with spores and the cycle is then complete.

4. In our attempt to find the ranges of the various factors necessary for the growth and development of ferns, we will have to measure accurately and keep detailed records. The factors which we hypothesize exert control on ferns are: light intensity, soil compositon (pH, ions and organic matter), air temperature, soil temperature and water. We will attempt to use as indices of environmental acceptability: presence of ferns, number of ferns per 100 square meters, and the length, width and number of fronds per plant.

Light intensity should be measured with a light meter that reads directly in foot candles by the incident method. General Electric Company makes such a meter and it is carried by Ward's Natural Science Establishment. Readings should be made between the hours of 10:00 AM and 2:00 PM and be averaged for the brightest and the darkest locations within the colony. Both readings should be kept in case they are useful later. A reading taken in full sunlight should be made at the same time, and recorded, for comparison.

La Motte makes a kit that tests all of the soil properties mentioned above. Many such tests vary with the person handling the equipment, and if time permits two people should make each test any any site to check comparability.

The Centigrade thermometer can be placed in an average spot (not in full sun or deep shade) to check air temperature. The soil thermometer can be used according to directions supplied with it.

Simple hydrometers for determining the per cent of water in soil can be purchased from a greenhouse supplies firm and read directly from a dial. They should be accurate enough for our purposes.

In each case tests should be made in nearby sites where there are no ferns of the species under examination, to determine environmental differences. A comparison of the values will lead to hypotheses about the limits of toleration for that species.

Within the fern colony itself, we will want to determine a number of things. Using our cord of 5 meter length, and the twenty stakes, we should lay out a 5 meter by 5 meter square, with stakes at 1 meter intervals. String should then be laced between opposite stakes, giving 1 meter squares. Based upon random number tables, we shall concentrate on blocks # 3, 4, 16, 20 and 22. Within those blocks we shall count the number of fern plants, count the maximum number of fronds per plant, and measure the largest fronds for length and width.

In setting out the original 5 x 5 meter square, it is important not to bias the results by making the plot do anything but take in the greatest bulk of the colony.

The figures gathered can then be averaged and the population multiplied by 100 to give us averages for 100 square meters. These data can be plotted against the light, soil, temperature and water figures gathered previously. As mentioned in the introduction, the author wishes to gather his data from as many sources as possible to look for correlation that one team might not find by itself.

Correlations between frond size and light, or frond size and moisture content of the soil, or frond size and nutrient levels should start to show up for a given species if the research can be extended to several colonies of common ferns (such as the Christmas Fern).

After we discover what the acceptable limits for light intensity, or soil temperature, for the Christmas Fern are, we can predict what will happen if a woods is logged at the 10%, 20% or 30 % levels, or clear cut. This is not far-fetched. A number of years ago someone discovered that yellow birch, once a dominant tree in the northeast U. S. forests was rapidly dying out in areas where logging made it impossible for the yellow birch to survive. The yellow birch depended upon the sugar maple and beech trees to keep the soil shaded and cool.

Carrying forward Small's work, one might attempt to relate the altitude and the latitude of ferns, both minimum and maximum, and to compare recent findings with Small's much earlier data. Since one teacher or one group of students could not accomplish this alone it will depend upon the efforts of a number of study groups up and down the Appalachian Mountain range to cooperate.

DIRECTIONS for MAKING A PLANT PRESS

I. Materials

10 - 18" x 7/8" x 5/15" hardwood (oak or ash)

12 - 12" x 7/8" x 5/16" hardwood (oak or ash)

60 - rivets or staple gun to affix each intersection

2 - quick release straps

- corrugated cardboard

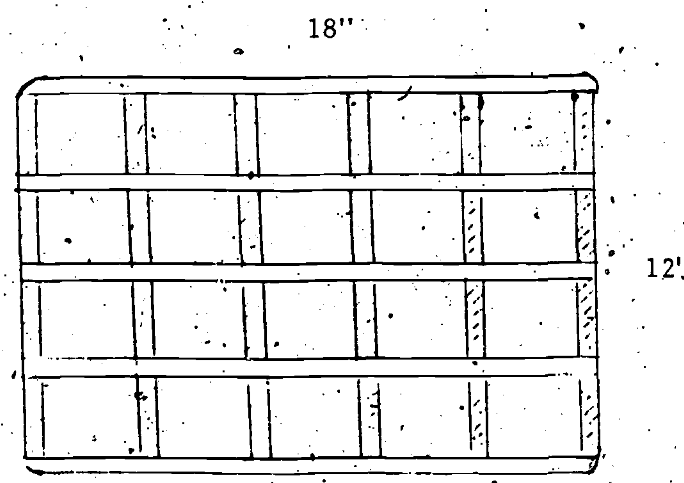
- Blotter sheets or newspaper sheets cut in 1/4 sheets

II. Finishing

Dimensions given for wood are actual or finished dimensions.

Quantities given will make both a top and a bottom to the press.

Corners of the finished top and bottom should be rounded as shown in the diagram below. Sanding the wood smooth is also advisable.



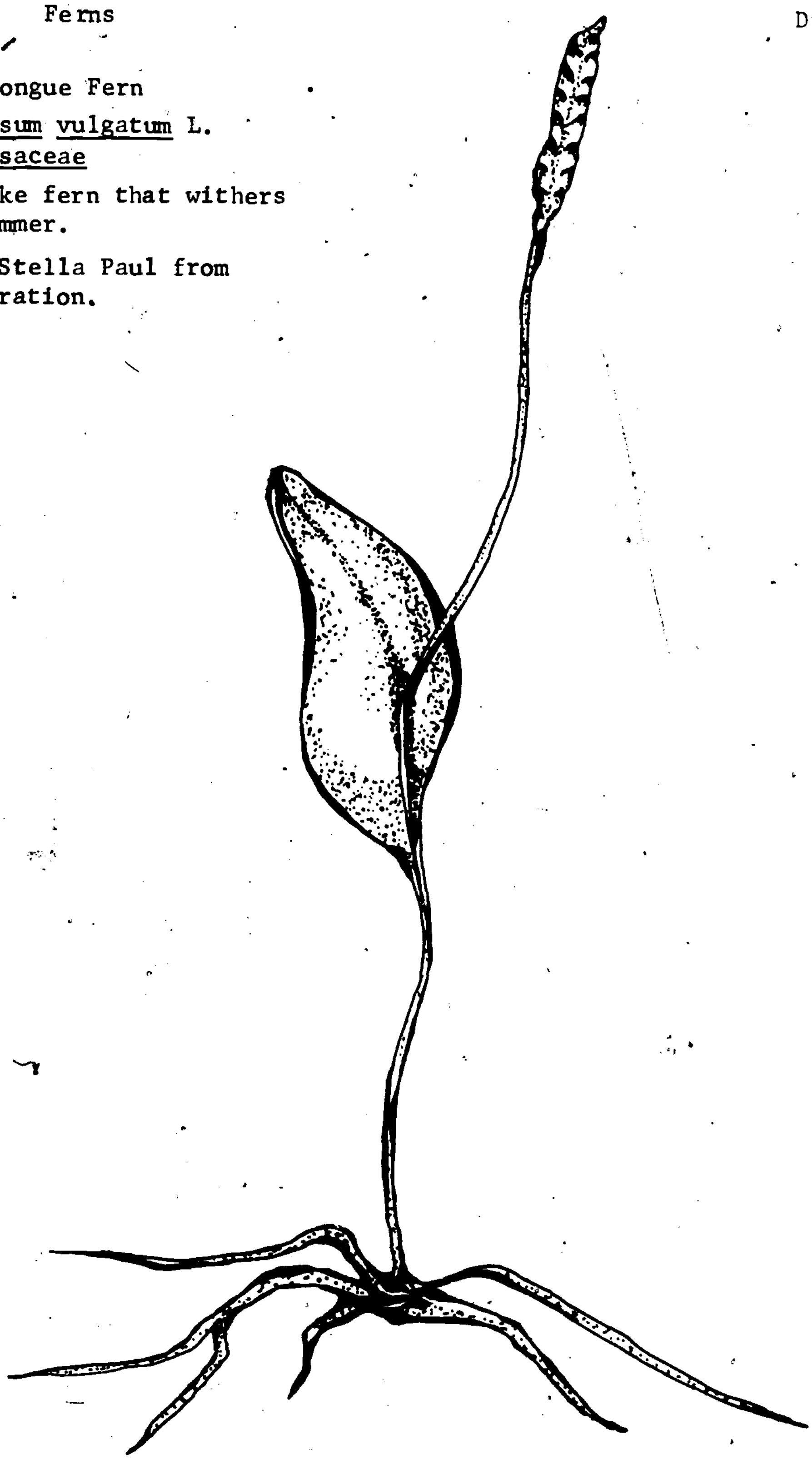
Adder's-Tongue Fern

Ophioglossum vulgatum L.

Ophioglossaceae

Unfern-like fern that withers by mid-summer.

Drawn by Stella Paul from an illustration.

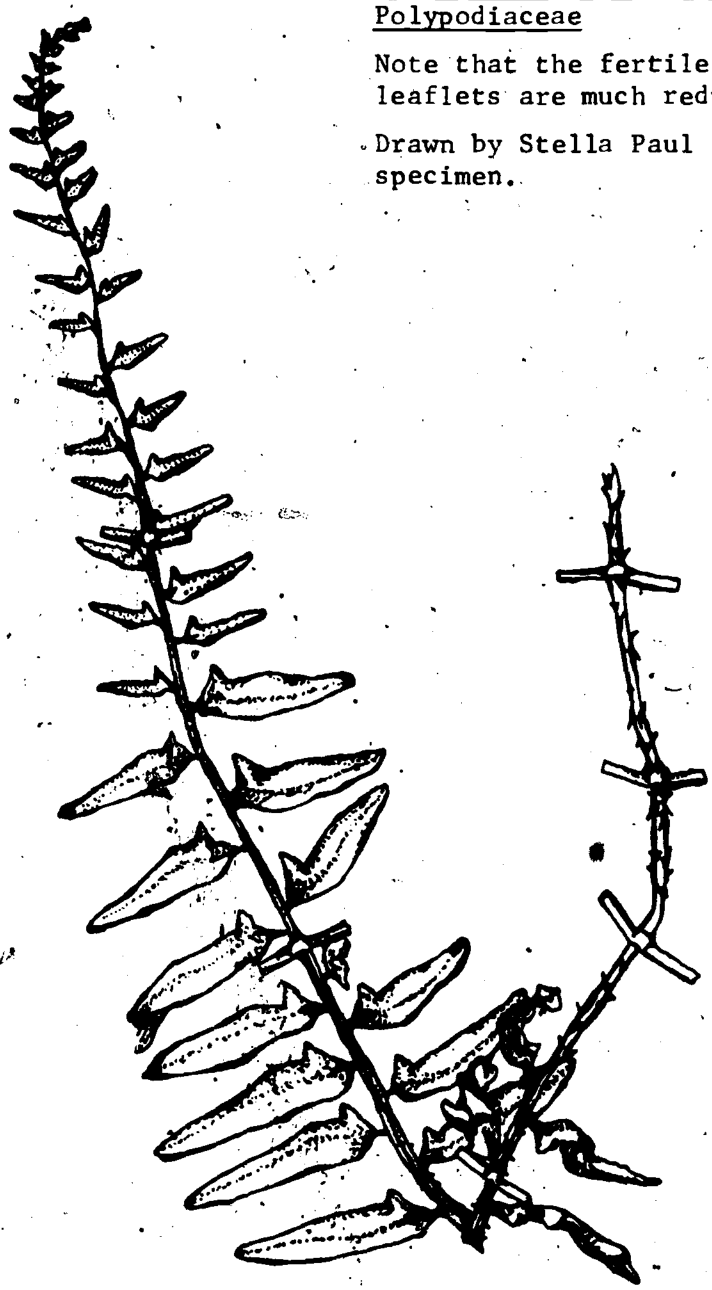


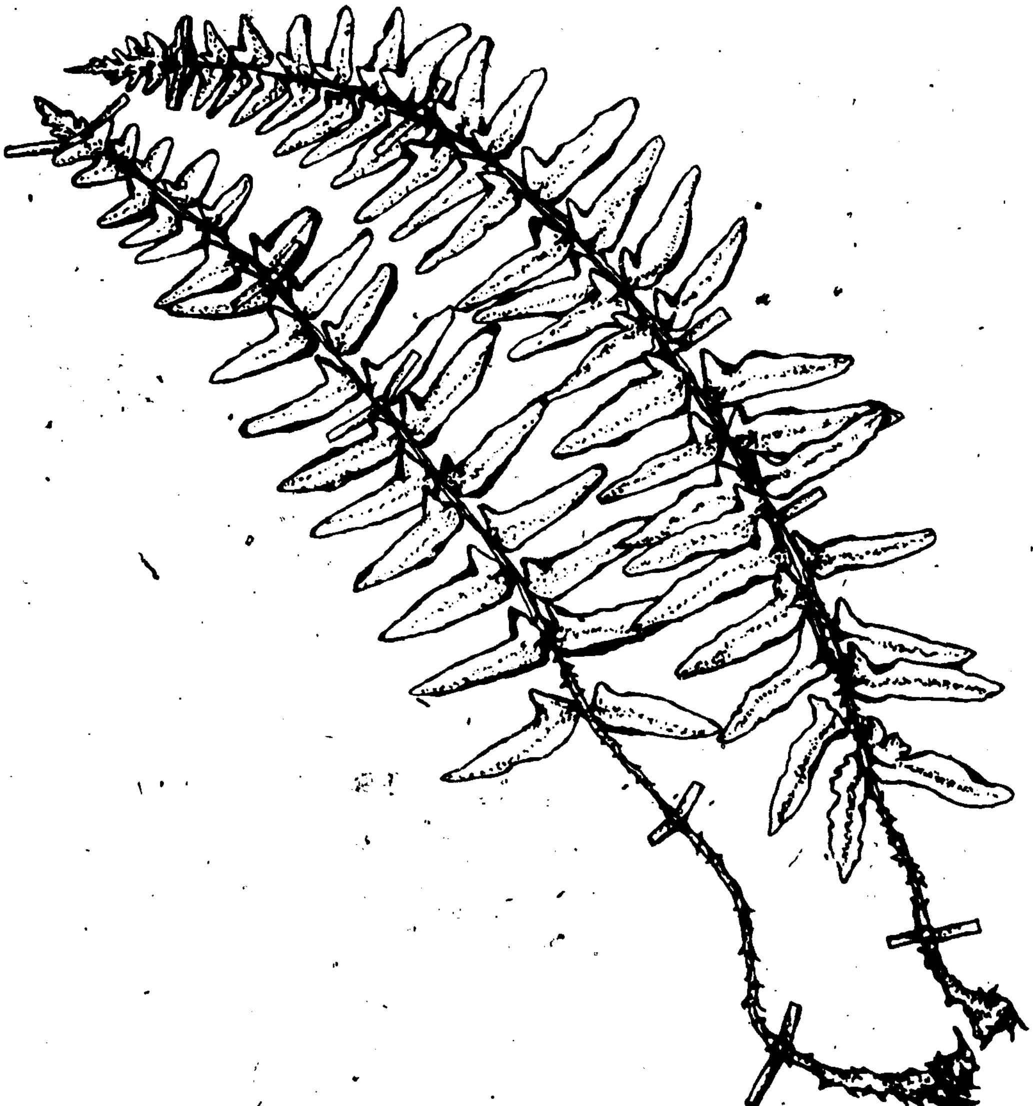
Christmas Fern

<u>Polystichum acrostichoides</u> (Michx.) Schott
<u>Polypodiaceae</u>

Note that the fertile (spore-bearing) leaflets are much reduced in size.

Drawn by Stella Paul from an herbarium specimen.





Christmas Fern

Polystichum acrostichoides (Michx.) Schott
Polypodiaceae

Note that both leaves have no fertile leaves.

Drawn by Stella Paul from an herbarium specimen.

Chapter 3 Ferns

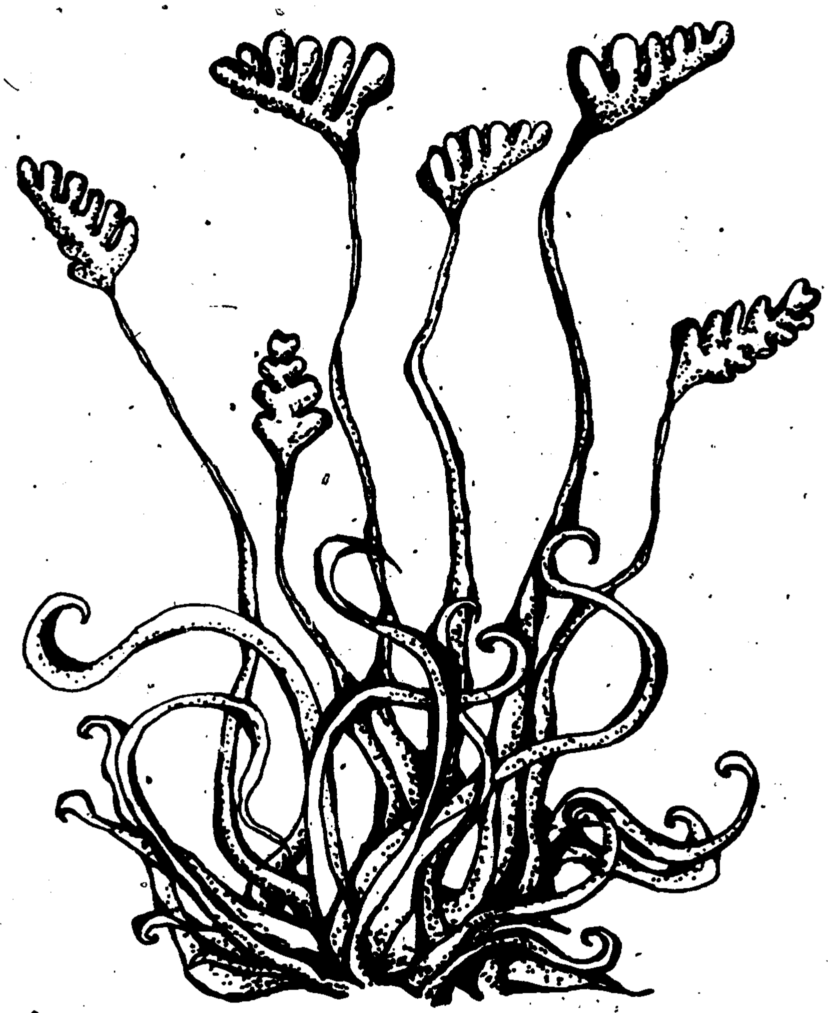
Draft

Curly Grass Fern

Schizaea pusilla Pursh
Schizaeaceae

A classic case of discontinuous distribution be ng found only in Nova Scotia and the Pine Barrens of Southern New Jersey

Drawn by Stella Paul from an illustration.



Hartford Fern (Climbing Fern)

Lygodium palmatum (Bernh.) Sw.
Schizaeaceae

A most un-fern-like fern, being a vine that grows up the stems of other plants. In this case growing upon maple and alder saplings.

Drawn by Stella Paul from an herbarium specimen.

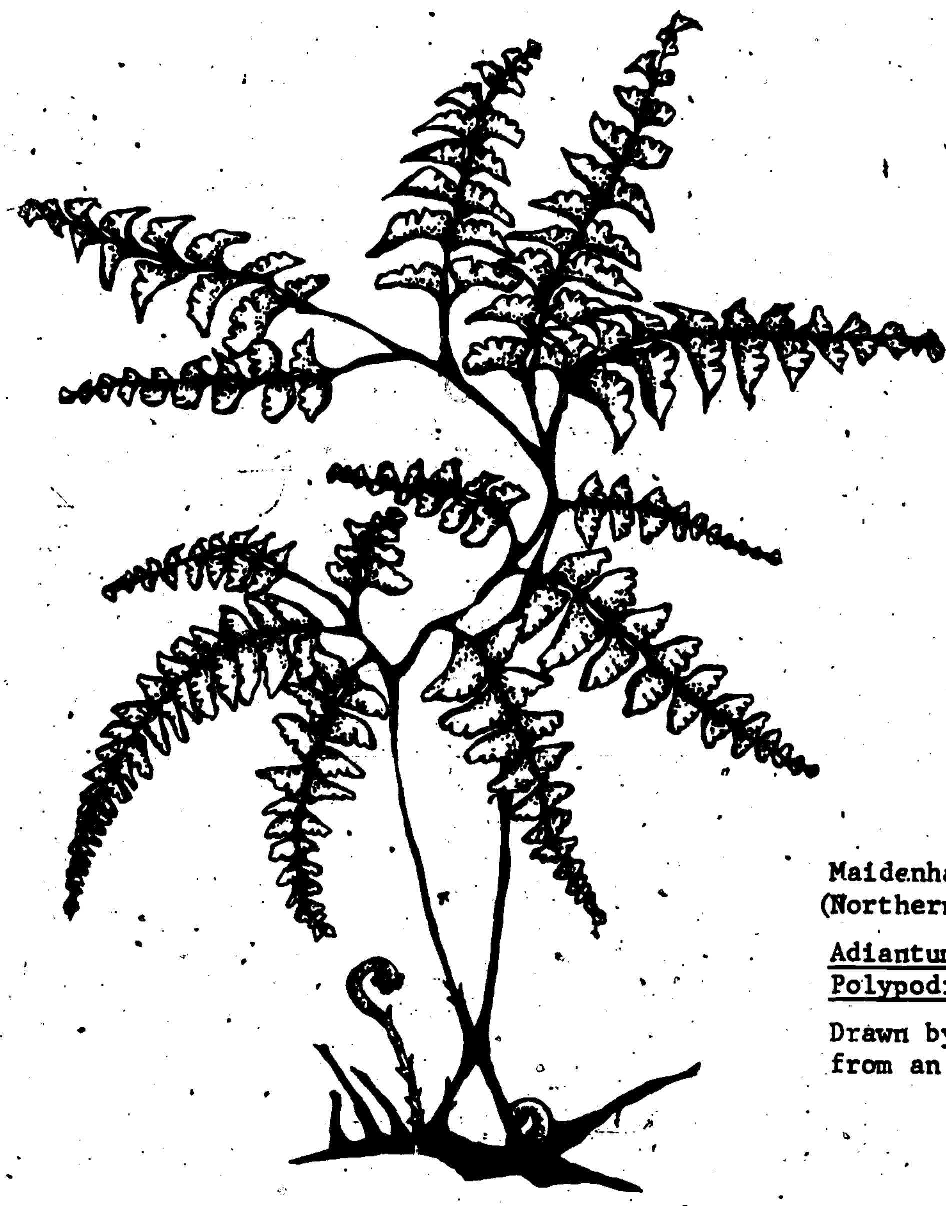
Chapter 3 Ferns

Draft

Long Beech Fern (also Narrow or Northern B.F.)

<u>Thelypteris</u> <u>Phegopteris</u> (L.) Slosson
<u>Polypodiaceae</u>

Drawn by Stella Paul from an illustration.



Maidenhair Fern
(Northern Maidenhair)

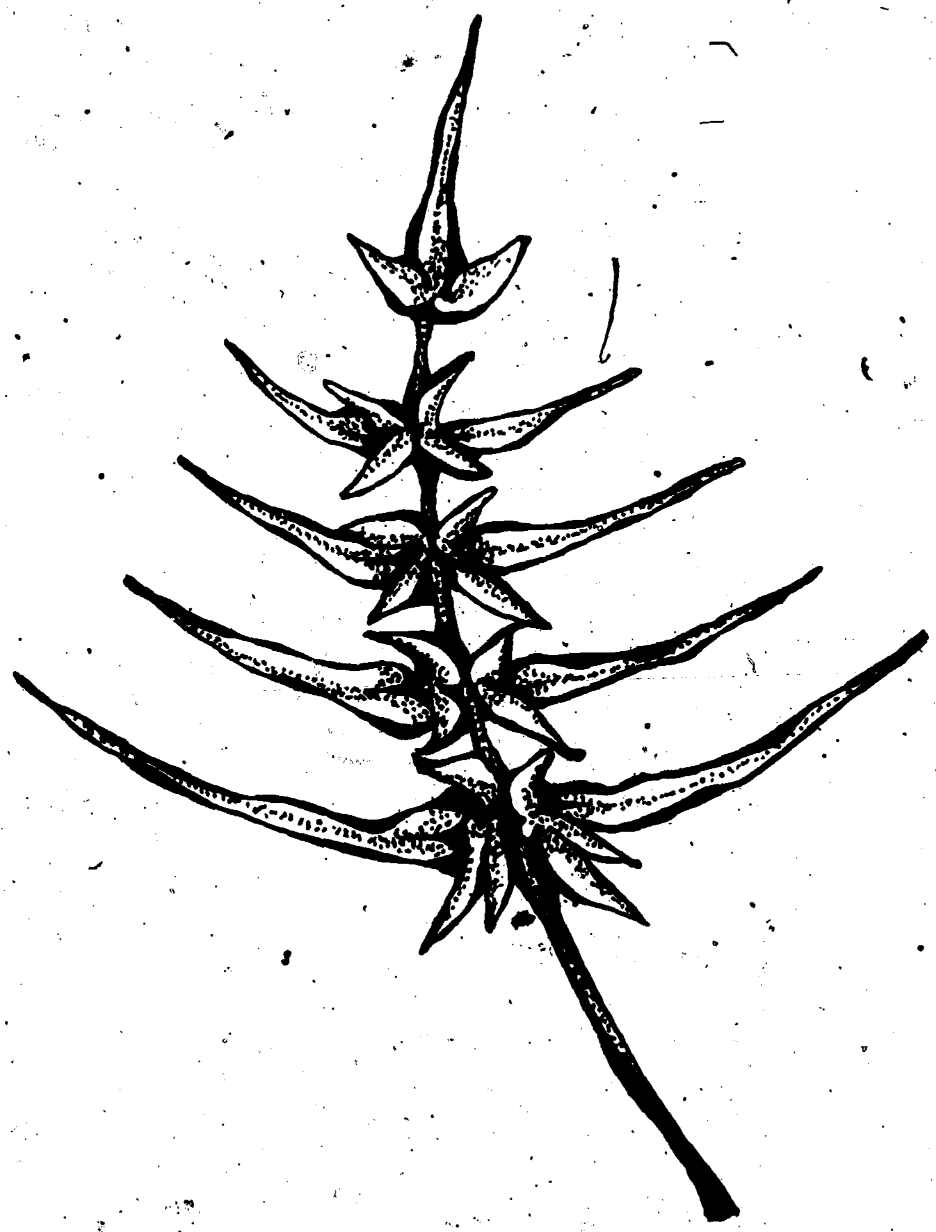
Adiantum pedatum L.
Polypodiaceae

Drawn by Stella Paul
from an illustration.

Pteris ensiformis cv. victoriae

An exotic species, now greenhouse cultivated.

Drawn by Stella Paul from life at Longwood Gardens, Kennett Square, Pa.

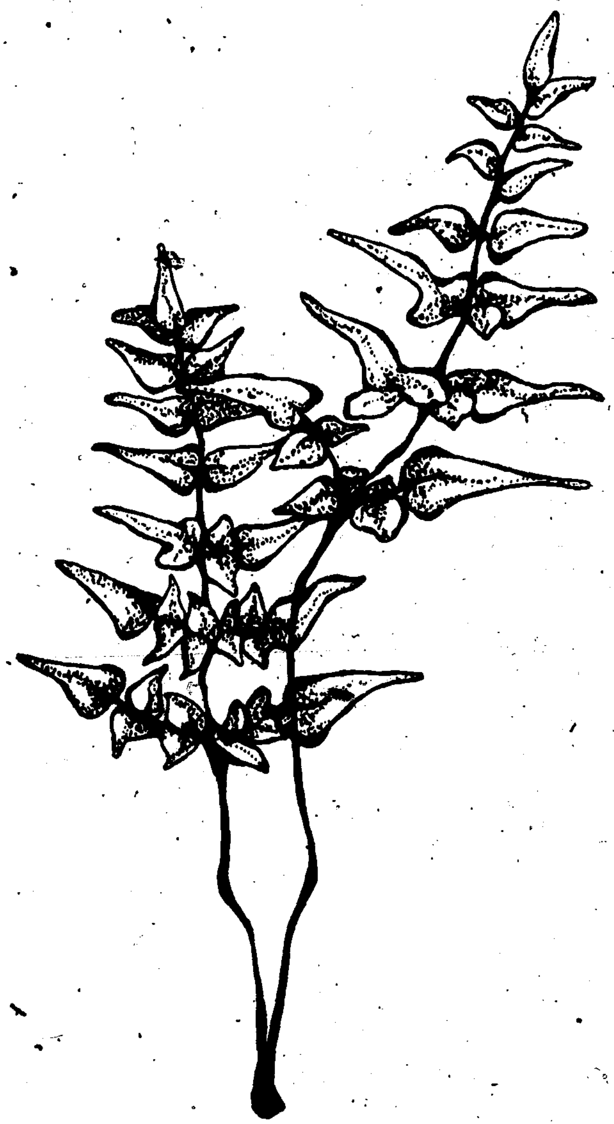


Purple-Stemmed Cliffbrake

Pellaea atropurpurea (L.) Ling
Polypodiaceae

Sometimes found on walls or old masonry. Distinctly lime-loving.

Drawn by Stella Paul from an illustration.



Slender Cliffbrake

Cryptogramma Stelleri (S.G. Gmel.) Prantl
Polypodiaceae

Very rare, even shy, fern.

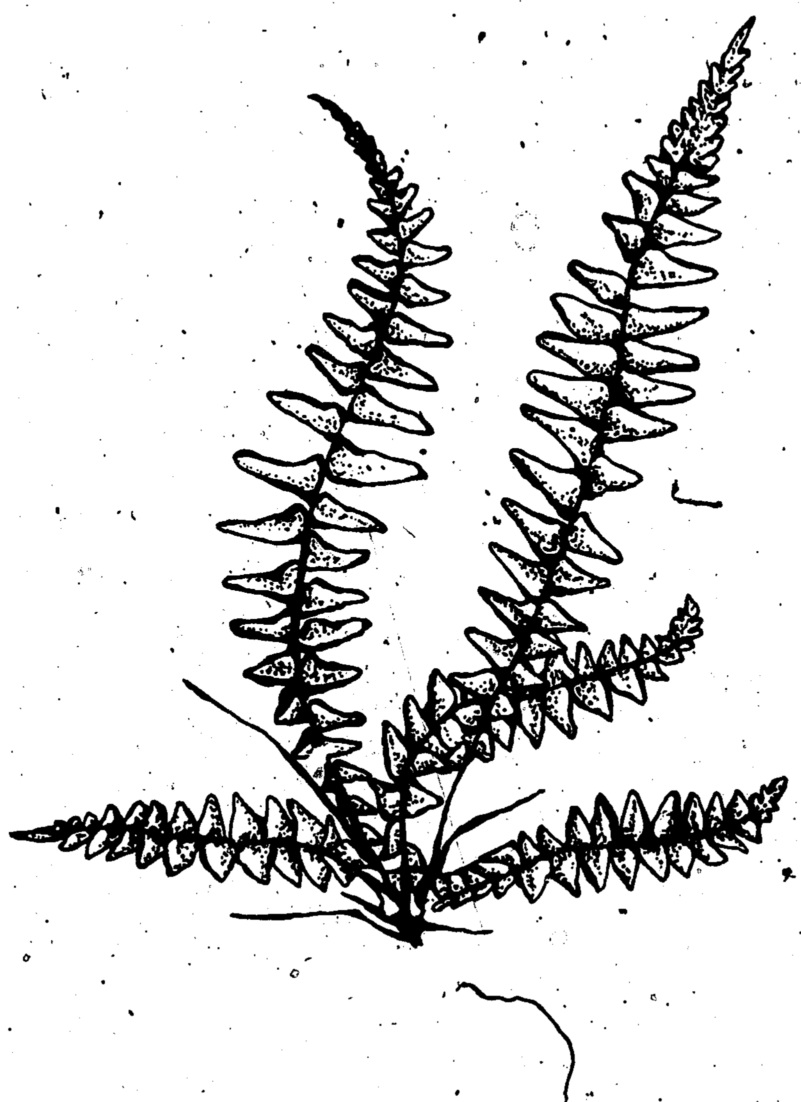
Drawn by Stella Paul from an illustration.

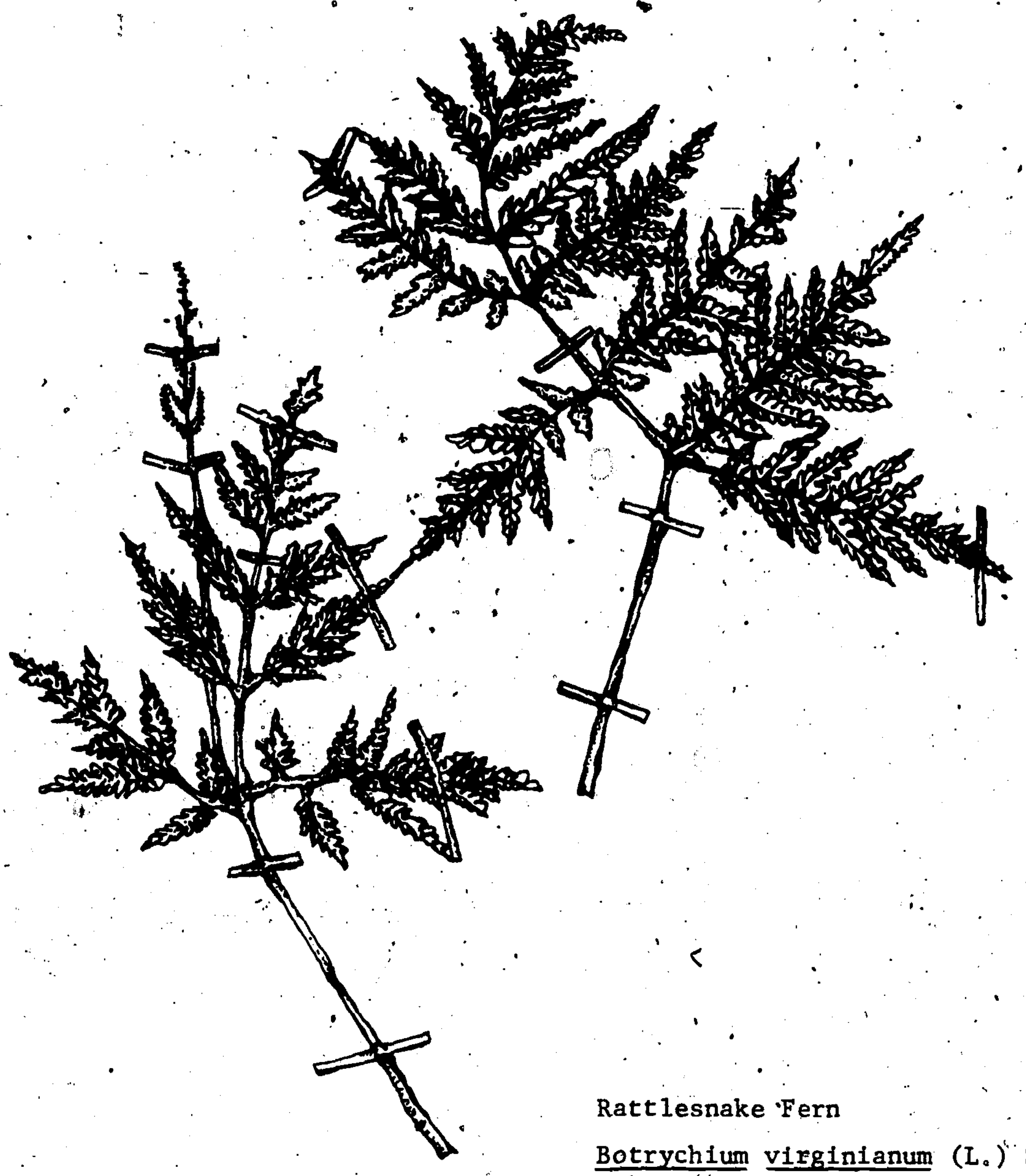
Chapter 3 Fern Draft

Ebony Spleenwort

Asplenium platyneuron (L.) Oakes
Polypodiaceae

Drawn by Stella Paul from an illustration.





Rattlesnake Fern

Botrychium virginianum (L.) Sw.
Ophioglossaceae

Drawn by Stella Paul from an herbarium specimen.

Scott's Spleenwort

Asplenosorus ebenoides (R.R.Scott) Wherry

A hybrid between Ebony Spleenwort and Walking fern.

Drawn by Stella Paul from an illustration.

Walking Fern

Camptosorus rhizophyllus (L.) Ling
Polypodiaceae

A curiosity as it propagates both sexually and asexually in a conspicuous fashion. New plants form on the tips of the leaves.

Drawn by Stella Paul from an illustration.

IV. Bibliography

A List of British Seed-Plants and Ferns, British Museum, London, England, 1907. Note the date and the order of the Trustees of the British Museum. This is how it was done in a well-ordered society in times when life moved at a much different pace. Descriptive: perhaps a bit smug, as if, "Look what we've got."

Anderson-Kotto, Irma, Genetics of Ferns, Bibliographica Genetica, Vol. 8, 1931, Note the date. One of the few references available dealing with fern genetics.

Beddome, Richard H., Handbook to the Ferns of British India, Ceylon, and the Malay Peninsula, Today and Tommorow's Publishers, New Delhi, India, 1969. If the British can do it so can we. Clearly modeled after British lists of a century earlier.

Bentham, George, Handbook of British Flora, L. Reeve, London, England, 1865. Mainly of historic value, although a source of stations where particular species have been found. It would be of interest to see how many stations still exist.

Blassdell, Robert F., A Monographic Study of the Fern Genus Cystopteris, Memoirs of the Torrey Botanical Club, Vol. 21, #4, It's worth noting that the Torrey Botanical Club ceased publishing its memoirs about 30 years ago.

Broun, Maurice, Index to North American Ferns, Orleans, Massachusetts, 1938. Ferns and so-called fern allies - including hybrids, forms and varieties. Again the date may be significant, just preceding a war.

Canan, Elsie D., Key to the Ferns of Pennsylvania, The Science Press Printing Co., Lancaster, Pa., 1946. Shows how to identify 59 species by the sterile leaf alone. Shows statewide distribution. Out of print and should be made available again.

Chen, Mei-Huei, Studies on the Development of Young Gametophytes of Onoclea Sensibilis, Master's Thesis, 1965. One of the very few theses dealing with ferns that is available in the Biology Library of the University of Pennsylvania. Ferns have not been used recently for research subjects for some reason.

Cobb, Boughton, Field Guide to the Ferns, Houghton, Mifflin, Boston, Mass., 1963. One of the handy-dandy volumes of the Peterson Field Guide series. A standard reference. Excellent drawings, descriptions, etc. Fairly easy to use, providing you study and use the introductory sections of the book. The author had difficulty deciding how complete to be without being too voluminous. Most authors do.

Correll, Donovan S., Ferns and Fern Allies of Texas, The real measure of affluence is culture and research supported by tax-exempt foundations. Or, the private sector models itself after the public sector of the New Deal. Nevertheless, useful and contribution to the sum total of knowledge of ferns.

Copeland, Edwin B., Genera Filicum, The Genera of Ferns, Chronica Botanica, Waltham, Massachusetts, 1947. Apparently the very last of the truly scholarly books published on ferns. Published by the same people who took the effort to see that N. I. Vavilov's classic work on plant genetics and plant distribution was made available to English-speaking people. It was too good to last and plants lost their glamour in the late 1940's and Chronica Botanica gave up the ghost. That says something about the influence of fad and fancy on scientific endeavors. Regardless, this book will have to be seen to be believed. It's a classic treatise on the taxonomy of ferns, and as the relationship between genetics and toxonomy sinks in, we will once again have books of this quality to refer to in our studies.

Copeland, Edwin B., Tropical American Ferns, University of California Press, Berkeley, California, 1941. If the development of a scientific mind fascinates you, compare this effort with his later work. Maturity does have some effect.

Delvoryas, Theodore, Origin and Evolution of Ferns, Memoirs of the Torrey Botanical Club, 1962. Technical papers dealing with the paleobotany of fossil ferns. Deals with evolution of leaf form and what ferns were first seen in fossils.

Druery, Charles Thomas, The Book of British Ferns, Country Life Magazine, London, England, 1903. Significant for the date and publisher only.

Eaton, D. C., Ferns of North America, Whidden, Boston, Mass., 1893. Colored drawings of the charming Victorian type.

Egler, Frank E., Checklist of the Ferns and Flowering Plants of the Seashore State Park, Cape Henry, Virginia, N. Y. State College of Forestry, Syracuse, New York, 1942. A tract-like title, reminiscent of religious works of the 17th Century, obscures a 20th Century scholarly work. Note the publisher and the fact that it is only a checklist. Useful today if one were to restudy the area to see what has disappeared and to try to determine why.

Handlist of Ferns and Fern Allies Cultivated in the Royal Gardens, The Royal Gardens, London, Kew, 1895. The merchant ships of the crown sailed home laden with plants from exotic places. The Royal Gardens at Kew were their destiantion. A symbol of great power, but also a way to educate those who stayed at home to man the ledgers and the hearths.

Hooker, Sir W. J., British Ferns, Reeve, London, England, 1861. What the gentlemen and ladies of another day did for intellectual calisthenics. Amusing and quaint but worth a peek at the illustrations which are glorious.

Hopkins, Lewis S., Ferns of Allegheny County, Pennsylvania, Their Haunts and Habits and Something of their Folklore, Botanical Society of Western Pennsylvania, Pittsburgh, Pa., 1914. The quaintness of the sub-title tells a lot. Good mostly to see what was around sixty years ago in order to judge what may have been happening environmentally in Allegheny County.

House, Homer D., Annotated List of the Ferns and Flowering Plants of New York, 1924. A useful checklist against which to compare what's there now.

Hull, Helen S., Handbook of Ferns, Brooklyn Botanic Garden, Brooklyn, New York, 1971. A dandy book filled with practical ideas, good diagrams, glossary, bibliography, etc. A very modern version of the Victorian efforts to promote an interest in ferns. Reasonable enough to ask students to purchase it. ($1.50).

Kearney, Thomas H., Flowering Plants and Ferns of Arizona, U. S. Government Printing Office, Washington, D. C., 1942. Note the date and publisher; probably a federally sponsored research project to keep the money flowing during the 1930's depression. Many worthwhile projects were so sponsored. A good checklist.

Knowlton, Frank H., Descriptions of Fossil Plants from the Mesozoic and Cenozoic of North America, Smithsonian Institution, Washington, D. C. 1884. Notable for its early date and the publishing institution. Interesting if you're into fern fossils.

McVaugh, Rogers, Ferns of Georgia, University of Georgia Press, Athens, Georgia, 1951. Georgia has ferns, too, and the garden clubbers want to know which ones, so they sponsored a study. A useful checklist.

Moore, Thomas, Popular History of the British Ferns and Allied Plants, Reeve, London, England, 1855. Mother England did it first. All the rest are copy-cats.

Parsons, Mrs. F. L. Dana, How to Know the Ferns, Scribner, New York, New York, 1900. A folksy account of the study of ferns by a liberated lady of 1900. (If not liberated, how else could she have found herself slithering and slipping down wet slopes?)

Plumier, Charles, Traite des Fougeres de L'Amerique, Imprimatur Royale, Paris, France, 1705. Oh, fanch, fancy. Look at the date and the royal imprimatur. Well, the French got there first after all. The text is in both Latin and French in parallel columns. The Latin is always used to describe a new species, so this may well be one of the very earliest of published descriptions of species of ferns of North America. Let's face it, it *is* exciting to hold such a very old book and feel a part of a long line of students.

Rosendahl, Carl O., Guide to the Ferns and Fern Allies of Minnesota, University of Minnesota, Minneapolis, Minn., 1909. Note how early this is. Published long before the states to the south and the affluence to permit an interest in such esoteric matter.

Shaver, Jesse M., Ferns of Tennessee, George Peabody College for Teachers, Nashville, Tennessee, 1954. Recently re-printed by Dover Press under the title of "Ferns of the Eastern Central United States, with Special Reference to Tennessee." A very valuable book. Thorough and unstinting in scholarship. Maps included indicate stations in Tennessee only. Can be regarded as a model for scholars to follow in other states, or perhaps as a secret weapon in the hand of the Tennessee Tourists Bureau. It makes you want to pack and head there to see the broad range of ferns growing in Tennessee. It's a bargain at the ridiculously low price of $4.00. Buy it before they let it go out of print.

Slosson, Margaret, How Ferns Grow, H. Holt & Co., New York, New York, 1906. An early scholar in the fern patch. She's the lady who first made fern hybrids to prove her point. She didn't lack the lady-like virtues of her day, either, because she made 46 drawings to accompany her text in this book.

Small, John K., Altitudinal Distribution of the Ferns of the Appalachian Mountain System, Bulletin of the Torrey Botanical Club, Vol. 20, 1893. Later reprinted by Columbia University in Dept. of Botany Contributions, Vol. 2, # 41. A very interesting correlation made. Based upon a variety of correspondents' work which small correlated. Notable as a very early, scientific piece of work.

Small, John K., Ferns of Royal Palm Hammock, 1918. A book about one of the most studied spots in the world, the Royal Palm hammock. A tiny speck of a critical environment that anyone would enjoy visiting and studying, it is now part of the Everglades National Park.

Taylor, T.M.C., The Ferns and Fern Allies of British Columbia, D. McDiarmid, Victoria, B. C., Canada, 1956. A checklist of one of the last frontiers. Done perhaps as part of the anticipated centennial celebration of the province.

Waters, Campbell, E., Ferns, H. Holt & Co., New York, 1903. Taxonomic keys based upon stalk cross sections and fruitifacation. Somehow or other the stalk cross sections didn't work out; at least they are not used for identification purposes now. Over 200 illustrations.

Wherry, Edgar T., The Fern Guide, Doubleday, Garden City, New York, 1961. The more modern edition of his previous guide; it is just as solid and delightful as the author, who is now retired from the University of Pennsylvania. Highly recommended.

Wherry, Edgar T., Guide to Eastern Ferns, Science Press Printing Co., Lancaster, Pa., 1937 9revised 1942). Dr. Wherry's first guide to ferns. It was small and compact, but like many small and compact things was extremely useful.

Wherry, Edgar T., The Southern Fern Guide, Doubleday, Garden City, New York, 1964. Useful, handy and thorough for ferns in the Southeast and South midlands of the U.S.

CHAPTER 4

Chapter 4 Air Quality and Vegetation Draft

I. Introduction

Within our natural ecosystems changes have been going on for many centuries. Changes in vegetational forms have evolved with a complex system of interacting physical and biotic factors. With each change comes a concomitant change in the inhabitants of the ecosystem. Food webs become adapted to these new changes. Succession is a natural process in which these changes are brought into a dynamic equilibrium.

Through man's activities he has, until recently, unknowlingly affected the ecosystem with all its delicate balances of changes. In an attempt to control nature and provide a "good life", man has placed materials into the environment which have altered the delicate balance. Many of these additives to the atmosphere, lithosphere and hydrosphere are variously referred to as pollutants.

The objective of this chapter is to provide a background on the effect of various air pollutants on vegetation - in particular, trees. Interspersed with this discussion will be suggested activities which may be used to dramatize the effect of various air pollutants.

One may ask why we should worry about air pollution and trees. Sit for a moment and contemplate the answers to these questions. Have you ever been in a forest or wooded area and taken a deep breath of fresh air? Have you ever been refreshed by stopping on a hot summer day to sit under a tree for a few moments? Do you know that lumber and various fruits come from trees? Have you ever marveled at the scenic beauty of a forest-covered mountain? Have you ever seen young birds in a nest in a tree making loud chirps to attract their distant parents? If your answer to any of these or to similar questions is "yes", then you will probably want to save our trees and to know more about air quality as it relates to trees.

A scientist many times takes the findings of experts and agrees (usually) with many of their conclusions. However, an important part of the scientific process is to verify and extend the findings of scientists to other situations. In this segment of the text we will list the various air pollutants and their effect on trees. We hope that you will engage in many of the suggested activities and, further, that you will add variations of your own to the suggested schemes and exercises.

For the purposes of clarity, we can divide air pollutants into three groups: (1) inorganic, (2) organic and (3) combinations of both.

INORGANIC POLLUTANTS

Sulfur dioxide. This pollutant enters the atmosphere from the heating of coal or fuel oil with a high sulfur content. The result is sulfur dioxide. Man releases sulfur dioxide through residential and commercial heating of homes. Petroleum refineries, some chemical plants and power-generating stations are contributors to the addition of sulfur dioxide to our atmosphere.

Some elementary chemistry may help us show how this obnoxious pollutant is formed. Again, burning fuels with sulfur produces sulfur dioxide:

$$S + O_2 \longrightarrow SO_2$$

Under the influence of sunlight, sulfur trioxide may be produced from a reaction between sulfur dioxide and oxygen. A type of reaction which is promoted by the sunlight is referred to as a photochemical reaction:

$$2\ SO_2 + O_2 \longrightarrow 2\ SO_3$$

Moisture in the air rapidly reacts with sulfur trioxide to produce sulfuric acid:

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

Sulfuric acid, when it falls to earth as a component of precipitation, may affect the soil pH. It would lower the pH. What effect does dilute sulfuric acid and some of its related compounds have on the growth of seedlings?

Activity 1. What is the effect of sulfurous acid on the growth of tree seedlings?

Procedure: Plant the seeds, as suggested in this paragraph, at least two weeks before the lab. Obtain five maple tree samaras or five oak acorns. Place one of each in a separate 2" plastic pot. Plant the samara or acorn approximately 1" deep in rich forest soil. Do not over water. When the first pair of leaves (not cotyledons) is well-developed, begin watering with the dilute sulfurous solution.

Dilute sulfurous acid solutions may be produced by heating 3 grams of flowers of sulfur in a deflagrating spoon. Heat until a bluish flame appears. Thrust the spoon with the burning sulfur into a gas collecting bottle one-quarter filled with distilled water. Place a glass cover plate over the top of the bottle to prevent the loss of sulfur dioxide. After approximately one or two minutes, remove the deflagrating spoon and shake the gas collecting bottle with the glass cover plate, preventing the liquid from splashing out. The sulfur dioxide will dissolve in the water. The chemical reaction is:

$$SO_2 + H_2O \longrightarrow H_2SO_3$$

Water four of the five developing seedlings with 10 milliliters of the sulfurous acid daily. Then place the tree seedlings in the full sun. The remaining seedling acts as a control.

Decide on exactly what you are going to measure to determine the effect of the acid on the plant. This can be represented by a graph where the measurement is plotted against time. Suggested measurements may be leaf width, leaf length, height of seedling, etc. Can you now answer the question posed at at the beginning of this activity?

The type of industry which first called man's attention to the potential destruction of plants by sulfur dioxide was the smelting industry. Smelting companies produce metals from ores. One of the first processes in removing copper from ores is to heat or roast copper sulfide. Note how sulfur dioxide is produced from the reaction below:

$$2\ CuS + 3\ O_2 \longrightarrow 2\ CuO + 2\ SO_2$$

In a forested area near Sudbury, Ontario, the damage caused by sulfur emissions was dramatized. White pines (Pinus strobis) suffered severe damage in an area of 720 square miles. The yearly loss in white pine lumber was estimated to be $117,000.00.

Damage due to sulfuric acid mists first makes its appearance on leaves of trees. What one notices is distinct punctate spots on the leaves. This damage is aggrevated especially during foggy weather and with plants that have a limited cuticle on the upper epidermis. Further exposure to the sulfuric acid mist results in a progression from the punctate spots to rather large blotches. This change is brought about through a general cellular collapse that progressively moves downward from the upper epidermis through the palisade layer, the spongy layer and finally to the lower epidermis. The reason for the collapse in cellular structure is believed to be due to plasmolysis.

Activity 2. What is the effect of various air pollutants on tree seedlings?

Procedure: After obtaining ten maple or oak seedlings (see former activity), place large plastic bags around the pots containing these plants. Arrange three sticks in the pot to support the bag so that the plants are not crushed. All bags should be large enough so that they can be closed at the top with wire ties. Gas cylinders of sulfur dioxide, nitrogen dioxide, ethylene, etc., must be purchased next. With the help of a rubber hose from the gas cylinder, release the gas into the bags slowly and then close each bag with the wire tie. Place all plants in indirect sunlight at room temperature for two to three days. Examine the plants each day and record any changes.

Can you answer the question posed at the beginning of this activity?

Nitrogen oxide. One of the major contributors of nitrogen oxide pollutants in the air is the automobile. Nitrogen oxide (NO) is produced as a result of the high temperatures that are reached in an internal combustion engine permitting nitrogen and oxygen to combine in the following manner:

$$N_2 + O_2 \longrightarrow 2\ NO$$

Nitrogen dioxide may also be produced. It results from a chemical reaction between nitrogen oxide and oxygen:

$$2\ NO + O_2 \longrightarrow 2\ NO_2$$

Damage to leaves by nitrogen oxides is characterized by irregular white or brown collapsed areas between the veins and near the margins of the leaves. This usually results in leaf fall.

Ozone. The source of ozone is not completely understood. Some scientists believe that in the presence of notrogen dioxide, atmospheric oxygen molecules become activated from sunlight and form ozone (O_3). Further, investigators have found that there is usually no build-up of ozone unless other hydrocarbons are present. A combination of nitrogen oxides, ozone, and hydrocarbons results in a condition known as photochemical smog. Another ingredient of this photochemical smog is water vapor.

Ozone damage has mainly been identified with commercial crops. The injury is manifested in the leaves. It is characterized by a flecking or stippled effect on tobacco, spinach and grapes.

Wind carrying ozone and other oxidants has been shown to be responsible for the destruction of hundreds of thousands of Ponderosa Pines (Pinus ponderosa) in California. In the San Bernardino and San Jacinto Mountains, 60 miles from Los Angeles these beautiful trees are showing damage through needle loss. The more resistant stands are weakened also. Being so weakened they become intolerant to bark beetle invasion. Hence a secondary effect is also producing a loss of many Ponderosa Pines.

The primary site of injury from ozone damage in the internal structure of the leaf is the palisade layer. Cytological investigations reveal that the chloroplasts in the cells condense and accumulate in one area of the palisade cell. This is followed by a collapse of the cell. This is followed by a collapse of the cell wall. This area becomes reddish-brown on the leaf surface. When rather large and discrete areas of palisade tissue become deteriorated, punctate spots appear at the site.

Fluorine. Fluorine exists as an air pollutant in the form of hydrogen fluoride (HF). It enters the air through the following industrial processes: phosphate rock processing, the production of aluminum, iron smelting, brick and ceramic production and fiberglass manufacturing.

Unlike the other pollutants previously discussed, plants that are less sensitive to fluorides than highly sensitive plants, may in fact, concentrate it in their leaves. Livestock feeding on the contaminated foliage will concentrate it in their bones resulting in an aggrevated form of fluorine concentration is called fluorosis. It is characterized by an abnormal calcification of the bones. This is an excellent example of how man's activities can have a relatively unknown effect on other living things. If further emphasizes how interdependent living things are in an ecosystem.

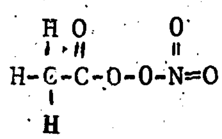
Fluoride in very low concentrations, as low as 0.1 part per billion is toxic to some plants. Examples of trees affected by fluoride damage include prune trees, maples and pines, especially young Ponderosa Pines. Fruit trees affected show smaller leaves, lower fruit yield, general dwarfing and early dropping of fruit.

Injured tissue begins at the tip of broad leaved trees and then works its way along the margin toward the petiole as time progresses. Upon internal examination, a cross section of the leaf shows a severe collapse and shrinking of all layers in the area of infection.

ORGANIC POLLUTANTS

This type of pollutant is of a hydrocarbon origin. Its source is principally from the exhausts of automobiles and trucks. Ethylene (C_2H_4) has been studied more than any other hycrocarbon, especially as it affects flowering plants. For example, ethylene damage has been noted in orchids, azaleas, carnations and commercially important crops such as tomatoes, peppers and cotton.

Another organic pollutant is referred to as PAN, peroxyacetyl nitrate. It's structural formula appears below.



PAN was the first phytotoxicant to be isolated from photochemical smog. Since it is considered to be one of the most active ingredients in smog, it's effects will be noted in category 3 with smog. It is placed in this category since smog is a mixture of both inorganic and organic components.

COMBINATIONS OF INORGANIC AND ORGANIC AIR POLLUTANTS

Smog is variously defined. Actually any noxious mixture placed into the atmosphere as a result of man's activities that is a combination of gaseous, solid and liquid components may be considered smog. One type, sulfur smog, results from a mixture of burned soot, sulfur dioxide and water. The primary contributor of this type of smog is from the burning of coal and fuel oil.

Photochemical smog made it's appearance with the increase in the number of automobiles on the road. The term photochemical smog is derived from the fact that the presence of sunlight is necessary to cause various components of the atmosphere to react to produce this type of smog. It's formation begins with the pumping into the atmosphere of large quantities of nitric oxides from automobiles. The nitrogen oxides react with oxygen to produce ozone and nitrogen dioxide. Other hycrocarbons from automobile exhausts react with nitrogen oxides to produce secondary pollutants with the help of sunlight. These include formaldehyde, arolein and peroxyacetyl nitrate (PAN).

In addition, carbon monoxide, water vapor, sulfur dioxide, hydrocarbon fragments from incompletely combusted fuel, volatile hydrocarbons evaporated from gasoline, lead, boron and bromine may be added to the components already placed in the air from automobiles.

Two of the components of smog have been extensively studied. These are ozone and PAN. Since ozone has been referred to earlier, PAN will now be considered.

PAN is extremely toxic to small plants with young leaves. The most noticeable effect produced is the bleaching and glazing of of the leaves. This is especially noticeable on commercial leafy plants such as spinach, lettuce and tobacco. Presently broad-leaved vegetables cannot be commercially grown in the smog of the Los Angeles basin.

A number of years ago a research project involving citrus fruit trees and smog was performed in the Los Angeles area. Two areas of lemon trees were grown on a test plot. One group was grown in the open air where smog appeared nearly every day. A similar number was grown in the same area in a plastic greenhouse supplied with filtered, fresh air. The lemon trees grown in the open produced 43 per cent less fruit than the filtered air group. The smog-affected lemon trees were also characterized by an early loss of leaves and smaller fruits.

Leaves are among the first to manifest the effect of smog injury. One notices a banding on the leaves. The banding has a silvering, galzing or bronzing appearance. On the younger leaves, the injury is near the leaf tip or banding may appear in the middle of the leaf. With increasing age, the injury moves toward the periole.

PAN injury affects the spongy cells in the area of the stomate. These spongy cells become plasmolyzed and the chloroplasts lose their integrity and collapse.

Secondary injury may follow with those trees that are only slightly damaged by photochemcial smog. A general weakening may make the trees more susceptible to insect attack.

Trees, along with other vegetation, are extremely important, not only because of their aesthetic beauty, production of oxygen, etc., but for another significant reason. Leaves are modified for the removal of gases in addition to other functions such as carbohydrate manufacture. Most of the atmospheric pollutants disappear after a period of time. We do not know how they are removed. One theory is that plants, especially the leaves of plants, may, by some mysterious process, cleanse the air. How this is accomplished is not known. Therefore, any destruction of trees and other forms of vegetation may be a serious move on the part of mankind. Maybe his demise!

As a final activity, we may ask what kind of simple exercise can we use to demonstrate and quantify air pollution?

<u>Activity 3</u>. How can we determine the quantity of particulate air pollution over a given period of time?

<u>Procedure</u>: Visit a wooded area or trees found on the school grounds and designate a few broad-leaved trees to be the test trees.

Leaves from these trees should be accessable to the students. Approximately three leaves from a given tree are selected for study. For identification, paper clips are attached so that they hang between the blade and the petiolar attachment to the stem. Wipe the blades of these three leaves clean with tissue paper. Be careful not to damage the leaf. The leaf should be wiped as clean as possible.

After one week, return to the same three leaves with three pre-weighed filter papers. With one filter paper for each leaf, wipe the leaf as clean as you can and place the soiled filter papers into separate plastic baggies. Upon returning to the classroom, reweigh the filter paper and record differences in weight. After four weeks a graph (See Figure 1) may be plotted which gives the student some idea about the extent of particulate pollution in the test area over a period of four weeks (or more).

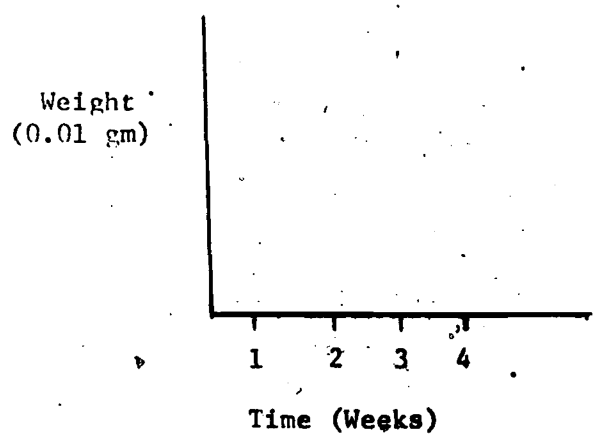


Figure 1

You may initiate some of the following questions which may arise from the data: Is the air quality different in different areas of the city (or country)? What industries nearby may be responsible for the collected particulate matter? What is the effect of particulate matter on trees? Does particulate matter air pollution vary during the day? during the season? How relaible are the collected data? Can you determine mathematically from your data how much particulate matter falls on a square foot in one year at the collection site?

We hope that you have become aware of the potnetial danger of various air pollutants as they affect trees, and that you partici-pate in many of the suggested activities and even take part in helping to identify and work toward reducing air pollution. Your concern may affect your future of mankind.

II. Bibliography

Abeles, Ann L., "The Effect of Smoke and Exhaust on Plant Growth," The Science Teacher, Vol. 39, (March, 1972), pp. 65-67.

Brodine, Virginia, Air Pollution, Harcourt Brace Jovanovich, Inc. New York, 1973.

Mason, William H. and Folkerts, George W., Environmental Problems, William C. Brown Co. Pub., Dubuque, Iowa, 1973.

Moran, Joseph M., Morgan, Michael D. and Wiersma, James H., An Introduction to Environmental Sciences, Little, Brown and Co., Boston, 1973.

Turk, Amos, Turk, Jonathan, and Wittes, Janet T., Ecology, Pollution, Environment, W. B. Saunders Co., Philadelphia, 1972.

United States Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service, National Air Pollution Control Administration, "Air Pollution Injury to Vegetation," Raleigh, N. C., 1970.

CHAPTER 5

I. Introduction

One may ask: "When is a plant a weed?" and, "Why investigate weeds as a topic in environmental studies?" The chapter will be devoted to answering these two questions. Let us begin by answering the second question first.

Something today is considered environmentally important if it: 1) is obnoxious and, 2) interfers with man's activities, and 3) results from man's activities. A weed, as it is generally understood, fits in these categories. If you have ever tried to maintain a beautiful lawn or attempted to grow a small garden, you can well understand the noxious and unsightly nature of a weed.

If one were to ask what is a weed, the most common definition given is, "A plant that grows in a place that you do not want it to grow." This definition implies a "will" on the part of the weed to grow in an area considered important. Consider a weed defined as a plant which has a wide range of adaptability. This portion of the chapter will demonstrate that this is a valid definition. In the exercise that follows, we will measure some of the environmental conditions in which weeds grow.

Weeds are encouraged to grow as a result of man's activities. Let us look at a small vegetable garden. To begin a garden, you must first turn up the soil. This results in light exposure to many weed seeds. They then begin to germinate. Some weeds in which germination is initiated by a light treatment include mullein (Verbascum), dock (Rumex) and primrose (Oenothera).

In the garden, the weeds compete with the vegetables for nutrients, water and space. This may lead to a lower yield from the vegetable.

With the lawn, weeds may be encouraged by: 1) not cutting the lawn at regular intervals, 2) by not removing thatch (which contains many weed seeds) during the spring and, 3) by not removing weeds from the lawn.

II. Materials & Methods

To begin, an old field with weeds in it, must be used as an area from which to collect data. This old field can take on many forms. It might be a vacant lot, a recently plowed weed-covered field or a well established old field with pioneer trees found in it.

On the first visit to the old field, the students should do a visual survey noting the variation in vegetational types, slope of the land and the orientation of the field with respect to possible influencing factors. The students should be encouraged to name any of the weeds that are familiar to them.

Garden shovels or some other digging implement, should be provided for each student or to the team captain if the class is large. Bags are needed for collecting soil.

Upon visiting the old field, a specific weed (goldenrod, dandelion, etc.) should be selected for the initial study. This weed should be common and found in different areas of the old field. Demonstrate to the students how soil samples should be removed from around the weeds. Instruct the students (or teams) to disperse throughout the old field in search of the same weed to collect soil samples from around this weed.

To collect the soil sample, you must first dig beneath or adjacent to the root system. Fill the "baggie" approximately one-third full of soil. The top of the "baggie" must be twiste and tied with a wire-reinforced paper "tie" to prevent loss of moisture. One of the weeds should also be taken back to the lab for identification.

Upon returning, and in the succeeding laboratory periods, the students should determine the pH and the moisture content of the soil. They will also wish to identify the weed. For the non-taxonomist, a preferred text is one which is very easy to use because of a large number of pictures. This is a tremendous aid to identification. The spiral bound manual, "How to Know the Weeds" by H. E. Jaques, is such a text. The key is published by the William C. Brown Company in Dubuque, Iowa.

To determine the pH of the soil in which the weed grows, the following procedure should be followed. Fill a 250 ml. beaker with 200 ml. of distilled water. Add approximately 25 grams of soil to the water and stir with a glass stirring rod. Stir for about one minute and allow about 5 minutes for the large particles of the suspension to settle. The upper portion of the suspension above the settled material should be relatively clear before continuing. Immerse either the probes of an electronic pH meter or a strip of pH paper into the relatively clear upper portion of the liquid. If an electronic pH meter is used, care should be taken not to immerse the probes into the settled material. The pH may be read directly on the scale of the pH meter. Paper strip determination is less accurate than the meter. This is because the pH paper involves a judgment on the part of the student when comparing colors.

Readings on pH should be placed on the blackboard. After all the pH readings are recorded, the pH range for the weed should be entered onto a master sheet. A suggested master sheet is shown on page 146.

To determine the moisture content of the soil, first weigh a 500 ml. beaker to the nearest 0.01 gram. Next fill the beaker with the remaining soil from the "baggie". Make sure all of the soil is removed from the "baggie". Determine the weight of the beaker and the soil. Then determine the weight of the soil alone. See relationship (1) below.

(1) Weight of soil and beaker - weight of beaker = weight of soil.

Place the beaker with the soil, in an oven set at 55°C. for 24 hours to dehydrate the soil sample. After 24 hours, remove the beaker and soil from the oven and re-weigh both. Determine the weight of the dehydrated soil from the relationship below.

(2) Weight of dehydrated soil and beaker - weight of beaker = weight of dehydrated soil.

Next determine the loss in weight (due to the evaporation of water) from the heating of the soil. See relationship (3) below.

(3) Weight of soil - weight of dehydrated soil = loss in weight.

To determine the percentage of water content in the soil sample, insert the data into the formula below.

(4) $$\text{Percent water content} = \frac{\text{loss in weight}}{\text{weight of soil}} \times 100$$

An example may illustrate how the soil moisture content can be determined. A soil sample was returned to the lab from the root system of <u>Polygonum pensylvanicum</u>. After

WEEDS

COMMON NAME	SCIENTIFIC NAME	FAMILY	ENVIRONMENTAL RANGES pH	ENVIRONMENTAL RANGES Water (%)
Dandelion	*Taraxicum officinale*	Asteraceae	6.1 - 7.2	5 - 20
Wild Carrot	*Daucus carota*	Apiaceae	5.9 - 7.0	10 - 22
Rush	*Juncus sp.*	Juncaceae	6.9 - 7.1	20 - 25
Others				

Date Collected ____________________

Location ____________________

the pH was determined, a 500 ml. beaker was weighed and it's weight was found to be 179.66 grams. When the soil was added to the beaker, the combined weight was 301.96 grams. Using relationship (1), the weight of the original soil sample collected was 122.30 grams.

301.96 grams - 179.66 grams = 122.30 grams

After drying in the oven for 24 hours, the weight of the dehydrated soil can be determined from relationship (2)

295.51 grams - 179.66 grams = 115.85 grams

The loss of weight due to the evaporation of water is therefore 6.45 grams. This was computed from relationship (3).

122.30 grams - 115.85 grams = 6.45 grams

Relationship (4) is used to determine the percentage of water content from the soil sample.

$$\frac{6.45 \text{ grams}}{122.30 \text{ grams}} \times 100 = 5.3\%$$

The students should be encouraged to make pH readings and soil collections from other weeds, entering the data they found into the master data sheet (See page 146).

Some students or teams might be directed to obtain data on pH and soil water content for those plants the students would not consider weeds in the old field. Enter these data also in the master data sheet.

After collecting data for 10 to 15 plants (the number depending on the diversity of weeds in the old field, time, etc.), several questions need to be considered:

(1) Is there a relationship between those plants with a relatively wide range in pH and soil moisture content and their distribution in the old field?

(2) What relationship, if any, is there between those plants with a narrow range in pH and soil moisture content and their distribution in the old field?

(3) The definition proposed in the early part of this chapter was that a weed is a plant which has a wide range of adaptability. Do the results obtained support this definition?

(4) What problems do you see with this definition?

(5) What other environmental factors could be investigated to support the proposed definition of a weed?

(6) Are there any characteristics about any of the weeds themselves which permit their populations to be extensive?

(7) Is there a plant family which contains a high degree

of weeds? What are the reasons for your answer?

(8) Are the weeds investigated temporary or permanent members of the old field?

(9) Of what value to the biotic community are weeds?

(10) Are there weeds which are considered beautiful? By whom? For what reasons?

In addition to being adapted to a wide range of environmental conditions, weeds have also evolved diverse reporductive techniques. Many weeds reproduce vegetatively. Grasses, such as crabgrass (Digitaria sanguinalis and D. ischaemum) spread by stolons. Field onion and/or wild garlic (Allium vineale) reproduce by forming terminal bulblets which fall to the ground and grow into new plants.

Sexual reproduction in weeds results in the production of high numbers of fruits and seeds. For example, seeds produced in one season have been counted for some weeds: black mustard (Brassica nigra) 58,363; fleabane (Erigeron canadensis) 243,375 and amaranth (Amaranthur graecizans) 180,220. Additionally, many seeds are capable of germinating after being buried for 20 years.

In addition to a large proliferation of seeds and fruits, many of the propogules possess structures for dispersal, especially the fruits. Modifications for wind dispersal are exemplified by the milkweeds (Asclepias sp.), dandelions (Taraxicum sp.) and thistle (Circium sp.). Hooks and spines on some fruits provide for the attachment of the fruit to man and other animals. These structures may be found in the fruits of cockleburs (Xanthium sp.), beggar-ticks (Bidens sp.), burdocks (Arctium sp.) and tick trefoils (Desmodium sp.)

Finally, man has carried seeds, fruits and whole plants (as ornamentals or inadventently) across natural barriers such as oceans. With no natural enemies they usually spread rapidly. Weed pests in this group include bindweed (Convolvulus sp.), sow-thistle (Sonchus sp.), peppergrass (Lepidium sp.), sheep sorrel (Rumex sp.), crabgrass (Digitaria sp.), plantain (Plantago sp.), wild carrot (Daucus sp.), dandelion (Taraxicum sp.), and poison ivy (Rhus sp.).

The preceding four paragraphs should suggest many interesting investigations for motivated learners. We close with a specific example of the use of a weed to study previous and extant environmental conditions.

Ragweed, Amvrosia sp., grows only in areas where the soil has recently been disturbed. Ragweed pollen is very stable and persists for years in soil and in sediments in bogs, marshes, ponds and lakes.

Previous land use can be directly correlated to the amount of ragweed pollen present in the various layers of core samples of soil or sediments. If a guide to the microscopic identification of pollen is not available, find a ragweed plant and collect some pollen in a small bottle. This will serve as your "natural reference guide" to the identification of ragweed pollen.

Extant conditions can be studied by conducting density studies of the ragweed plants and by determining airborne and soil surface pollen densities.

The results of these investigations can be compared to local history records to establish patterns of land use.

Although weeds are considered obnoxious by most individuals, we hope that a new appreciation be extended to the "weed". That is, that we recognize the ability of the plant to endure a variety of environmental situations and yet carry on it's life functions.