DOCUMENT RESUME

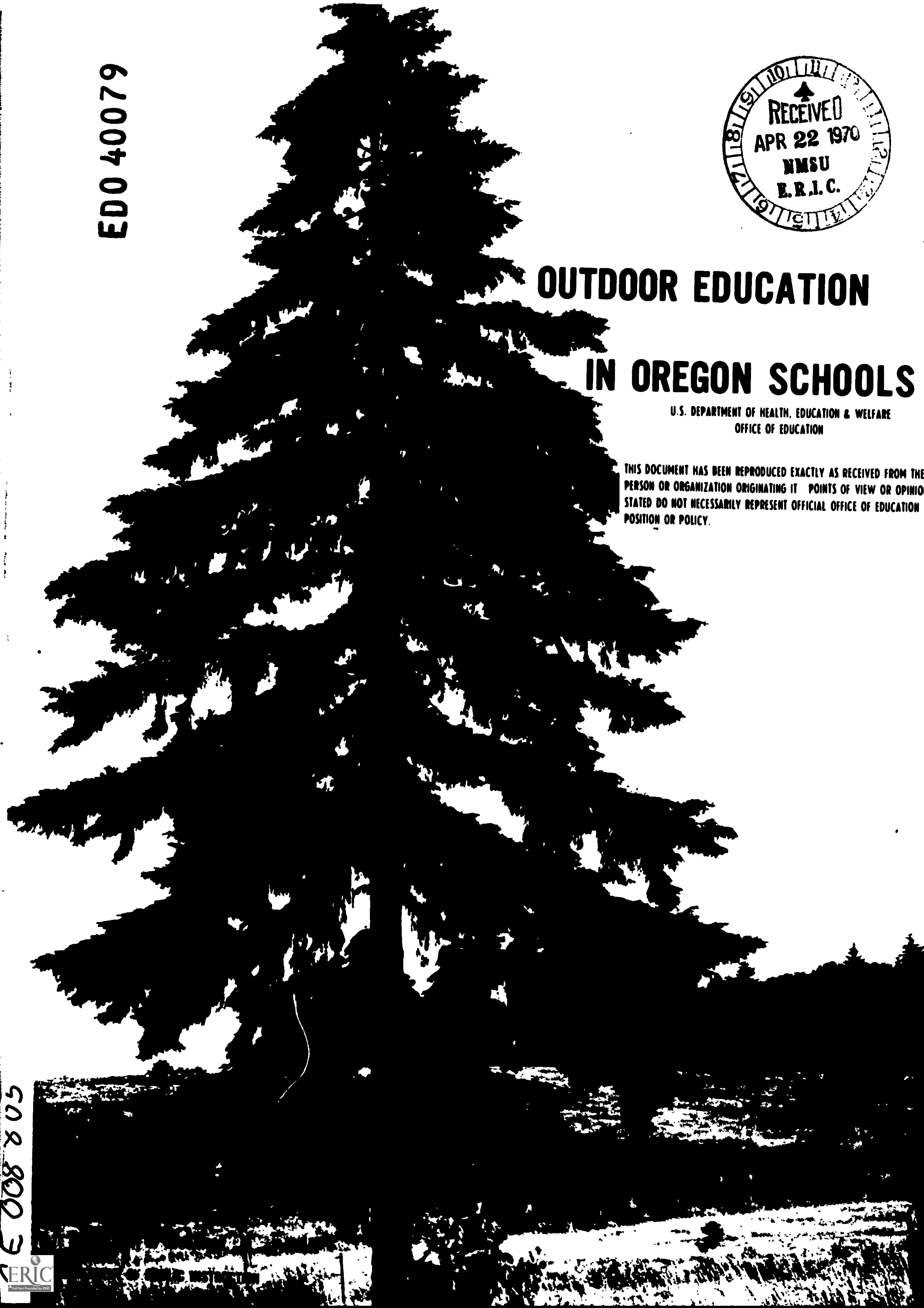
ED 040 079 SE 008 805

TITLE	Outdoor Education in Oregon Schools.
INSTITUTION	Oregon State Dept. of Education, Salem.
PUB DATE	68
NOTE	126p.
EDRS PRICE	EDRS Price MF-$0.50 HC-$6.40
DESCRIPTORS	Biology, *Conservation Education, Earth Science, Elementary School Science, *Environmental Education, Natural Resources, *Outdoor Education, *Science Activities, *Teaching Guides
IDENTIFIERS	Oregon

ABSTRACT

This handbook is designed to help classroom teachers to develop outdoor education programs. Discussed are the place of outdoor education in the curriculum, and the provision and use of outdoor areas. The section "What to Do and What to Look For" gives many suggestions for student activities uder the headings "Land or Terrestrial Communities," "Aquatic Communities," "Costal Communities," "Projects of Longer Duration," and "Measurement Experiences." Illustrated instructions are given for constructing simple equipment. Appended are guidelines for thr establishment of outdoor programs, and a statement of philosophy of education for Oregon schools. (EB)

OUTDOOR EDUCATION IN OREGON SCHOOLS



OUTDOOR EDUCATION IN OREGON SCHOOLS

ISSUED BY THE STATE DEPARTMENT OF EDUCATION • LEON P. MINEAR, SUPERINTENDENT OF PUBLIC INSTRUCTION, SALEM, OREGON 1968

Foreword

The primary responsibility, the most deep and abiding obligation of any people, is to preserve, to the best of their ability, the land which they have inherited and on which they live so that their heirs may in turn have the resources for a wholesome and abundant life.

This responsibility, this basic social obligation, has not always been met. We can excuse, to some degree, those peoples of the past who exploited the land and destroyed its natural resources in ignorance of the consequences and in the absence of techniques and knowledges which would permit them to use it wisely and constructively for their own benefit while fostering its continuing renewal.

Oregonians have been a favored people—the inheritors of a richly endowed homeland, studded with magnificent resources which the providence of nature has wrapped in an envelope of beauty that only nature's God could bestow.

The theme of this handbook is twofold, but simple: one, to teach the children of Oregon to love and appreciate the resources and beauty of our state by having direct and understanding contact with these elements; and, two, to develop a passion for their wise use and conservation based upon a true understanding of these resources and how they may best be utilized and preserved.

The argument of this handbook is also simple. Take the children to the outdoors and teach them there what they can best learn in the outdoors. No state has a greater stake in the development of sound conservation principles and attitudes by its citizenry than Oregon. No state is more dependent upon such bountiful and varied resources for its livelihood and the development of its economy.

Let us teach our young citizens through Outdoor Education to use this rich endowment wisely in order to create and preserve a more beautiful life in Oregon.

Leon P. Minear
Superintendent of Public Instruction

Acknowledgments

The development of this handbook was the responsibility of an Outdoor Education Handbook Committee, appointed by the Superintendent of Public Instruction, which worked several years on the compilation of materials. Members of the Committee, and their positions at the time the Committee work was being done, are listed here in appreciation of their sincere efforts. Others who contributed to the handbook and to whom appreciation is extended are also listed.

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Rationale For This Handbook

Recognition of the importance of Oregon's natural resources is almost universal. The task for education is to develop an informed citizenry--one which will make the best use of disappearing resources and manage renewable resources wisely. Related to these problems are major conservation issues which will still need to be solved by those who are now in school. Among the major areas of concern are the issues of air and water pollution, the use of insecticides, and the harnessing and distribution of water.

This handbook is designed to help classroom teachers develop programs through which young people will come to understand and appreciate the beauty and full potential of Oregon's natural resources. Perhaps its primary purpose is to help educators provide students with a first-hand acquaintance with their environment. The rationale for this may be illustrated with reflections about a chipmunk. The chipmunk is sometimes moved from his natural habitat into the science laboratory and often used in various kinds of investigations. One of the classic experiments is to study chipmunk behavior in a maze where his intelligence, compared to that of humans, appears quite low. However, if the animal is observed in its natural surroundings, its adaptations to its natural environment and its "native" intelligence appears better than that of man.

Just as it is with the chipmunk, students often find the four walls of a classroom an artificial place within which to study many things. It is a truism that some things in the school curriculum can best be learned in the out-of-doors. By using this Outdoor Education Handbook, it is hoped that teachers and administrators will be assisted in extending beyond the classroom those learning experiences which can best be presented out of the classroom.

The kinds of outdoor education programs organized by local schools vary from grade to grade and from school to school. In general, they fall into one of the following patterns:

- Observations and studies on the school ground
- Studies along designated nature trails
- Living at an outdoor school for a period of time
- Traveling to different locations to study the ecology of contrasting environments and to observe and study different geologic formations

The variety of programs which exists makes it impractical for a single publication to include a fixed or structured format for all schools to follow. Instead, this handbook contains guidelines for several kinds of programs and a variety of suggestions which can be adapted to many patterns of organization. Creative teachers can use these suggestions to develop imaginative programs custom-built to their local environments and to the interests and abilities of their students.

The Big Picture

Close examination of a tree stump gives the big picture about the forest. Which years had abundant rainfall? Which years were dry years? When did forest fires occur? At what stage of plant succession is the present forest? How has the tree competed with surrounding trees for survival? How old is the tree? Thus it is possible to learn about the past.

THERE WAS A CHILD WENT FORTH

There was a child went forth every day;
And the first object he looked upon, that object he became;
And that object became part of him for the day, or a certain part of the day, or for many years, or stretching cycles of years.

The early lilacs became part of this child,
And the grass, and white and red morning glories, and white and red clover, and the song of the phoebe bird,
And the Third-month lambs, and the sow's pink-faint litter, and the mare's foal, and the cow's calf,
And the noisy brood of the barnyard, or by the mire of the pondside,
And the fish suspending themselves so curiously below there—and the beautiful curious liquid,
And the water plants with their graceful flat heads—all became part of him.

The field sprouts of Fourth-month and Fifth-month became part of him;
Winter grain sprouts, and those of the light yellow corn, and the esculent roots of the garden,
And the apple trees covered with blossoms, and the fruit afterward, and wood berries, and the commonest weeds by the road. . . .

The doubts of day-time and the doubts of night-time—the curious whether and how,
Whether that which appears so is so, or is it all flashes and specks? . . .

The hurrying tumbling waves, quick-broken crests, slapping,
The strata of color'd clouds, the long bar of maroon tint, away solitary by itself—the spread of purity it lies motionless in,
The horizon's edge, the flying sea crow, the fragrance of salt marsh and shore mud;
These became part of that child who went forth every day, and who now goes, and will always go forth every day.

—*Walt Whitman*

Heceta Head typifies the beauty along the Oregon coast. Appreciation of such a view is enhanced when one notices the effects of wave action on the sandy beach and on the rocky cliffs. The dynamic forces in the environment take on new meaning when one realizes that the offshore rocks were once part of the promontory.

THERE WAS ANOTHER CHILD WENT FORTH
(A Parody)

There was another child went forth every day;
And the first object he look'd upon, that object he became,
And that object became part of him for the day or a certain part of the day,
Or for many years or stretching cycles of years.

The screaming sirens became part of this child,
The unceasing traffic noise on the city streets, and the shriek of brakes and curses and the fuzz,
The banging of garbage cans in the morning and the all-day clatter of rattling delivery trucks,
The neighbor's crying child, heard through thin walls, and the raucous voices of scolding women,
The tense silence before and after a street fight, when men with knives close quickly and there is blood on the dirty sidewalk, spreading red, crusting brown;
The broken bottles and rusty cans and rotten refuse in an alley; ragged cats, rampant rats, and a littering wind tearing old newspapers, all became part of him.

The fading billboards, the jungle jumble of signs became part of him.
The smell of wet pavement and the acrid stench of poisons from exhausts,
And the daily tons of industrial wastes which polluted the air he breathed, and the floating sewage in the river where he went to swim.

The doubts of day-time and the doubts of night-time, the curious whether and how,
Whether that which appears so is so, or is it all flashes and specks?

The hurrying crowds, faceless people, brushing past;
A wistful walk in a narrow city park, where a few dusty trees, a broken flower, and some dried-up grass, evoked a dream of a clean land
Where a child could run through green fields and find in the sun a promise—
These became part of that child who went forth every day, and who now goes, and will always go forth every day.

—Marguerite Wright

When man uses his inheritance of soil and grass carelessly, nature takes back her own.

Why Outdoor Education

From Plato to Pestalozzi to Mark Hopkins sitting on the end of a log, outdoor education has been part of the great tradition of successful teaching. That it is primarily education *about* the outdoors, about nature, about conservation of natural resources is too narrow an interpretation, for it is education *in* the outdoors, and the subject matter can include the wide scope of the entire school curriculum.

For Education is, Making Men;

So is it now, so was it when Mark Hopkins sat on one end of a log and James Garfield sat on the other.

—Arthur Guiterman, *Education*

From conducting a class under a spreading chestnut tree on the schoolgrounds to spending a week with students on a pack trip in the wilderness areas of the high Cascades, teachers in Oregon have some of the richest, most diversified, and most accessible outdoor classrooms and field laboratories in all the United States. These laboratories include magnificent Douglas fir forests, prehistoric fossil beds, perpetual glaciers, flower-covered slopes on the foothills, ponds and marshes, tide pools of the Pacific, sand and surf, and the vast juniper and sagebrush plateau of Central and Eastern Oregon.

But how well are we exploiting this educational resource? How can we get more children—whether they come from country lanes or city streets—into the outdoors to see, feel, smell, probe, discover, identify, and think for themselves about some of our society's most pressing problems, and to learn the intricate interrelationships of their environment?

There is an urgent need for much intensive work and study in the area of conservation. In one life span, we are trying to reforest denuded slopes where it took forests hundreds of years to grow. Naturalists are working to safeguard and improve the environment of fish, game birds, and large and small wild animals. Through careful management, natural resource experts are attempting to insure a lasting, adequate, and pure water supply for present and future generations.

What would the world be, once bereft

Of wet and of wildness? Let them be left,

O let them be left, wildness and wet;

Long live the weeds and the wilderness yet.

—Gerard Manley Hopkins, *Inversnaid*

Soil conservationists are studying the relationships between climate and soil types and productivity, as well as the kinds of animal and plant life the soil will support. How much of the wilderness area of the public domain should be preserved for the use and enjoyment of posterity must be determined immediately. If Oregon's, and the nation's, natural resources are to be saved for the use and enjoyment of present and future generations, we must produce a citizenry appreciative of these resources.

To impress students with man's dependence upon nature and his consequent responsibility for the welfare of nature insofar as he is able to affect that welfare, teachers will find the outdoor laboratory the most conducive setting for the necessary learnings. Here the first-hand on-the-spot study of life and its interrelationships—a vital step in the study of the earth and natural sciences commonly omitted by teachers—is possible.

In the study of science, we aim to teach students to be analytical, to search for explanations, to test generalizations. Students learn that, through development of scientific methods, man has acquired systematic ways to find workable solutions to his problems. In outdoor education, students may encounter directly some components of problems, e.g., erosion, overpopulation, water pollution, with which responsible members of the adult community also are wrestling. And, in the outdoor laboratory, the problems found in natural situations are met with meaningful and logical procedures which can be applied to all experiences in life.

Some learning takes place best in the out-of-doors. Concepts about ecological relationships are most effectively formed through observations in their natural setting. In field studies, students actually see interrelatedness: fish struggling to survive in polluted streams, deer adjusting to shrinking ranges, logging and reforestation activities and their effects upon animal life and upon local climate with its adverse or beneficial effects on agriculture. The recognition of this interrelatedness and interdependence of all life with the scientific and philosophical conclusions which logically follow is an inescapable and highly desirable outcome of an intelligently-guided study of science in the field.

Lest, in this introduction and for the most part throughout this handbook, it seems that the study of science overwhelms the humanities, teachers are invited to pause for a moment and consider what outdoor education could mean to a child of limited experiences and restricted environment. A great deal of the literature which Oregon students are required to study derives its inspiration from natural phenomena, for example. To someone who never before had walked on a windswept beach, the poetry of John Masefield will forever be more meaningful after a field trip to the coast. For the study of language, literature, history, social sciences, and the fine arts, outdoor education at its best can open windows to the whole wide world.

You do not educate a man by telling him what he knew not, but by making him what he was not.

—John Ruskin

Any teacher can use outdoor classrooms to enrich the learning opportunities of students. It is not necessary that he be a skilled naturalist, scientist, or outdoorsman. A love of the outdoors and an appreciation of the aesthetics of nature will be helpful, but the desire of the teacher to use the most effective place, tools, and methods for the education of children is essential. The natural curiosity of students, together with the teacher's professional motivation, will join to make a class venture into the field an *adventure*—exciting, stimulating, and a purposeful educational experience for both students and teacher.

An increasing number of schools are integrating field studies into their instructional program. These studies vary in length from a few hours to several weeks. Nature trails are being developed for exploration by students and the public. Many of these trails are posted by markers which emphasize important features of the trail and which often explain significant ecological phenomena. Outdoor schools which accommodate one or more classrooms of students for a one-week period are also increasing in number. In addition to academic and field studies these schools provide lasting experiences in human relations.

During the summer months other supplementary programs have developed. In some instances students move from one area to another to study contrasting ecological environments. In other instances special programs devote one or two weeks to in-depth studies in paleontology and marine biology. Particularly noteworthy are the programs developed by the Oregon Museum of Science and Industry.

It is gratifying to see the number of agencies which are contributing personnel and resources to the development of outdoor programs. The realization of these opportunities for young people is being made possible through the cooperation of representatives from the Oregon Department of Education, State System of Higher Education, Oregon State Game Commission, the U. S. Forest Service, the U. S. Bureau of Land Management, the U. S. Soil Conservation Service, and many private industries.

The suggestions in this handbook for outdoor experiences and projects relate, in the main, to group field study and therefore are especially useful within the class-size pattern of school

Some things are best studied beyond the four walls of the classroom. Are meaningful experiences related to leaves, twigs, buds, or plant growth possible without close observations of accessible specimens?

organization. However, their application to small groups or to individuals should not be overlooked. A resourceful teacher can lead students in a study of science when out on a ski trip, or fishing or hunting; small knapsack parties can be taken into areas far off the beaten track. Such explorations can extend into the crater or heavily glaciated areas of Mt. Hood, or to the varied scenic and natural history treasures to be found in the roadless, wilderness areas of Southwestern Oregon. The back country of the Wallowa, Siskiyou, and Cascade Mountains has many botanical and geological features which can be studied only by "going light on foot." Possible field studies are endless and offer many opportunities for open-ended scientific experimentation in the natural environment.

Finally, the very concrete education visualized in this handbook epitomizes the quality of comprehensive and intensive learning which responsible citizens in this world of growing complexity must have, and it fosters the physical and mental zest upon which democracy thrives. The committee which collaborated on this handbook hopes that the suggestions included herein, as adapted by teacher ingenuity, will stimulate much more in-the-field teaching—whether the teacher sits on the end of a log in an Oregon forest or, perhaps some day, on a chunk of meteorite in the craters of the moon.

The Tie-in /

OUTDOOR EXPERIENCES AND THE INSTRUCTIONAL PROGRAM

For teachers facing increased concern about the "regular curriculum," the question of the advisability of undertaking experiences in an outdoor classroom inevitably arises. The answer is: *This is the curriculum.* Subject by subject, the suggestions in this handbook meet the objectives of the Oregon curriculum at some grade level. In addition, the experiments and experiences outlined herein will make all learning more meaningful for students by bringing about a more complete understanding and by cultivating an inquisitiveness that creates readiness for further study.

Beginning a new learning experience by using the outdoors as a laboratory creates a situation wherein each student finds a place for himself and for others. Each individual is allowed to pursue and create interests and satisfy his curiosities. Values are developed. The atmosphere is noncompetitive, for everyone has the satisfaction of accomplishment in finding out something he did not know before. ". . . in our highly competitive society some youngsters rarely experience the feeling of success and achievement, and the maintenance of a sense of self-worth is difficult if not impossible."*

Children are all different, but in an outdoor setting teachers can meet each child's needs more simply just because there are so many materials and areas from which to choose and each child can use all of his senses to inquire. Teachers can dare to let the student explore and discover for himself. Each teacher can consider himself a resource person who is searching *with* the child; one who is looking for ways in which each individual student can find pleasure in taking advantage of the resources available so that he may continue to draw upon them as he matures.

The Oregon curriculum is built on an understanding of the growth and development pattern of children. The scope and sequence of course content is based on human needs for living in the contemporary world. By using the outdoors as a classroom, teachers will find not only leaves and rocks and snakes and bugs brought into the classroom but, as an intangible and important bonus, will find also that the children, in addition to having acquired a useful body of knowledge, have developed habits of orderly procedure, respect for the natural environment and for individual differences, and independence and self-confidence in learning about their world.

The understandings, value patterns, and skills which Oregon schools are expected to foster in students and specific instances showing how outdoor experiences can contribute toward fulfillment of these objectives of instruction in major curriculum areas are presented in the following paragraphs. (See the Appendix, page 113, for "Guidelines for the Establishment of Conservation and Outdoor Education Programs in Schools.")

Social Studies

Social studies teaching should lead to development of the following understandings:

Social responsibility is derived from the cultural environment.

Communication is learned within a culture and, in the American corporate society, participation is necessary by all.

The effect of an individual's health holds consequences for the health of a society.

The family is a functioning unit related to the larger social structure.

Social and economic backgrounds or any other single deterministic theory need not limit the economic expectancies of an individual within the American way of life.

Some forms of transcendant values prevail within most societies.

Beauty and its expressions are determined within the cultural setting.**

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* Millie Almy, *Child Development*. Holt, Rinehart and Winston, Inc., New York, 1955, p. 380.

** *Guide to Elementary Education in Oregon*, State Department of Education, Salem, 1966, p. 64.

Social Studies teaching should lead to the development of the following skills for the study of geography, history, psychology, philosophy, economics, political science, anthropology, and sociology.

In our society the effective citizen must possess skills for participation in orderly and constitutional processes.

Skills of critical and creative thinking are needed to assess propaganda and to contribute to clarification.

Skills in analysis of personal and social actions are necessary to determine health and safety precautions.

Each member of the family requires complex social and economic skills in order to fulfill his obligations to the family unit.

Effective skills of production and consumption are necessary to the welfare of our society.

Ability to inquire into different value systems and their sources and to assess their implications improves and facilitates social and political harmony and well being.

Each person needs to acquire aesthetic skills in order to raise the aesthetic and cultural level of society by developing and contributing his artistic talents.†

Outdoor experiences can contribute the following to social studies learnings:

- Map making and map interpretation
- Studying various types of maps and globes and purposes of each
- Making charts and graphs from data obtained outdoors
- Studying man's relation to various phases of his outdoor environment
- Studying the distribution of natural resources in the local area
- Learning new uses of materials, e.g., those utilized in a local industrial plant visited during a field trip
- Learning about contemporary problems, e.g., management of local natural resources
- Studying government agencies concerned with natural resources by visits to offices of U. S. Forest Service, a soil conservationist, etc.
- Learning local history by field trips to places of interest

Language Arts

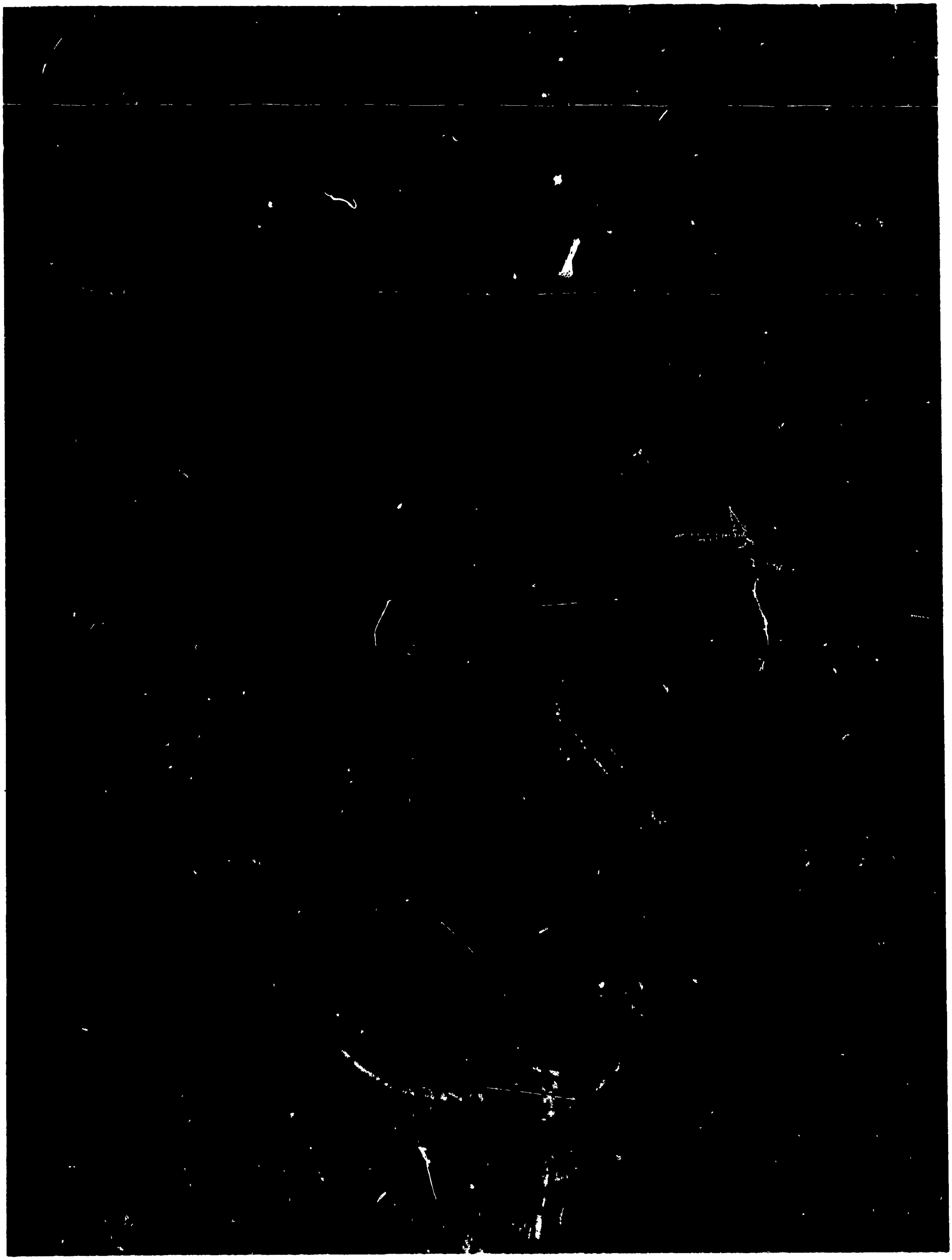
Language Arts is more than a series of skills—more than reading, writing, listening, speaking; more than spelling, grammar, handwriting. It is the ability to communicate our innermost thoughts to others. It is the essence of our 'humanness'—it is what sets us apart from all other animal life. It is not only communication with those around us but with those of the historical past and with those yet to be born.*

Outdoor experiences can contribute as follows to language arts skills:

- **Reading**
  Stories pertaining to nature
  Stories of famous naturalists
  Incentive to read for specific information
  Incentive to read for instructions for experiments, construction of equipment, etc.
  Nature poems for appreciation
  Myths and legends referring to nature
- **Writing**
  Letters of request, appreciation, invitations, letters home
  Notes of talks, results of experiments, field trips
  Record of experiences and questions in log of field trips
  Poetry
  Use of new vocabulary: scientific terms, descriptive words
- **Listening**
  Sounds in the natural environment, e.g., sounds of fall, sounds of winter, etc.
  Directions
  Reports and talks by others
  Radio and television programs about natural resources

† *Ibid.*
**Ibid.*, p. 25.

A thing of beauty is a joy forever—even when it is only a humble piece of driftwood.



- **Speaking**

  Individual sharing activities
  Reports on experiments, readings, field trips
  Discussion of coming experiences, plans, procedures
  Prepared talks on assigned topics related to outdoor experiences
  Radio and television presentations of material from data collected in the outdoor classroom
  Dramatizations

Science

The role of the teacher is one of guiding and encouraging children to explore, question, and formulate conclusions based on their experiences. This technique is quite different from telling children about an experience and then asking them to repeat or verify the concept already given to them. Although the latter technique is concise, easy, and fast, it is not as meaningful or conducive to real understandings as the first technique.

Students should develop and use self-learning skills. To remain scientifically literate for life depends on the ability of an individual to learn for himself. Skills for learning about the environment are best acquired when children are allowed to observe, inquire, and explore for themselves. There is no one scientific method which is universally used, but there are many logical approaches by which accurate insights may be gained. Children should be encouraged to try different ways to learn and to develop many self-learning skills.*

Outdoor experiences can contribute as follows to science learnings:

- **Observation**

  Plant and animal life in the home yard and on the school grounds
  Land formations: road cuts, shoreline, skyline
  Animal habits in parks, woodlands, at the shore
  Weather changes
- **Proper keeping of data**
- **Collection and mounting specimens** when these do not contribute toward waste and destruction
- **Construction**

  Weather instruments and other measuring devices
  Feeding stations and nesting boxes
  Dip nets and other collecting devices
- **Experimentation**

  Soil testing, erosion control
  Weather forecasting
  Interpretation of results of experiments
- **Interest in biographies of famous scientists**

Fine Arts

The omnipresence of the fine arts (art, music, drama) in our society—and, in fact, in most societies since the dawn of history—argues that the fine arts satisfy fundamental human needs. With society's continued emphasis upon technology and depreciation of human values, the value of the fine arts tends to be overlooked because they pertain largely to the senses.

Outdoor education can contribute to fine arts experiences as follows:

- **Development of skills**

  Listening to music
  Listening to sounds in nature—bird calls, animal sounds
  Singing, including folk songs
  Expressing one's self on a musical instrument
  Being able to interpret musical notation
  Using native materials such as grasses, clays, weathered wood, bark, pumice, or dried materials in weaving, carving, arrangements, plaques, mobiles
  Mounting materials
  Preparing displays and bulletin boards
  Adapting designs from nature
  Recording data by photography

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* *Ibid.*, p. 74, column 2, paragraphs 2 and 3.

- **Measuring**
  Pace (each child should know the length of his own pace)
  Height of tree
  Circumference of tree
  Board feet
  In construction of bird houses, feeding stations, etc.
  For formulas
  Shadows and time
- **Using formulas**
  For experiments, verifications
  For interpreting charts, graphs
- **Using data** obtained outdoors in story problems

Home and Family Life Education

Homemaking education is based on an understanding of the developmental stages and needs of all individuals and correlates family life experiences throughout the entire educational program. General and practical education are considered to be essential. Learning to plan and work, as well as live and share together through practical and realistic home and school experiences, promotes an appreciation of individuals and provides opportunities for increased skill in human relationships. The practical application of fundamental concepts learned in other subjects enriches the child's learning.*

The following outdoor experiences can contribute to home and family life education:

- Outdoor fun for the family
- Outdoor cookery
- Preparation of game and fish
- Preservation of wild fruits and berries
- Decorations for the home
- Home crafts, e.g., making mats, baskets, plaques
- Gift ideas developed from natural materials
- Mealtime responsibilities
- Housekeeping responsibilities
- Personal cleanliness
- Sharing chores

* *Ibid.*, p. 89, paragraph 3, column 1.

In the outdoor school students develop social responsibilities through participation.

Other Essential Outcomes—

VITAL VALUES FOR TOMORROW'S CITIZENS

A driving determination—inspired by a vision of an abundant and beautiful land—to use well all the natural resources of the nation for the benefit of its people is the goodly heritage conservationists and teachers of conservation pass on to the children of Oregon.

A righteous indignation, as well as "recklessness and sacrilege in the treatment of natural resources"* can lead students to realize the importance of the overall utility and the spirit that motivates action in the wise management of those resources—whether it is called conservation, multiple use, balanced use, harmonious use, or single use.

That the outdoor classroom provides a climate for conservation education which cannot be duplicated indoors is self-evident, but no claim is made that learning experiences outdoors can accomplish miracles.

Educators have long recognized the difficulties involved in attempting to measure the amount of learning absorbed by students. Measurement of progress in physical skills is difficult enough; of mental achievement and attitudes even more so. When it comes to determining the degree of accomplishment under one set of conditions as compared to another, many variables make accurate evaluation almost impossible.

Recognizing such difficulties, this handbook nevertheless asserts that in an outdoor laboratory the methods, tools, and skills of the scientist, naturalist, and outdoorsman can be most effective in helping the student to acquire knowledge of natural resources. It is here that the foundations for real understanding of man's dependence upon soil, water, plants, and animals are developed. With understanding comes appreciation of the economic, recreational and aesthetic values of these resources.

The teacher who can say confidently that he has achieved these objectives has done a masterful job of teaching, and has very probably given his students enriching learning experiences in the outdoors. But the ultimate measure of effective education is the degree to which the student participates in democratic action to improve conditions for himself, his contemporaries, and for those who will follow. If education has fulfilled its responsibilities, it will have prepared each citizen to seek factual information, analyze and interpret, and apply common sense and sound reasoning to the solution of problems.

These are the desirable outcomes of education in the outdoors:

- **To instill knowledge** of soil and water, forests and other plant life, and wildlife.
- **To promote understanding** of the interrelationships of these renewable natural resources, and of man's relationship to them.

To waste, to destroy, our natural resources, to skin and exhaust the land instead of using it so as to increase its usefulness, will result in undermining in the days of our children the very prosperity which we ought by right to hand down to them amplified and developed.

—Theodore Roosevelt,
Message to Congress, 1907

Human history becomes more and more a race between education and catastrophe.

—H. G. Wells,
The Outline of History

* The existing industrial order tends to recklessness and sacrilege in the treatment of natural resources . . . it is largely responsible for the problem of the "mass man" who easily develops the herd psychology. —William Temple, Archbishop of Canterbury, "*The Malvern Manifesto*," 1941.

- **To develop intelligent attitudes** toward conservation, the wise use and management of these resources, and an appreciation of recreational, economic, and aesthetic values.
- **To encourage positive action** to bring about recognition and solution of resource use and management problems.

Each of these outcomes, examined more closely, relates to each of the major areas of study.

Southeastern Oregon was not always the land of sagebrush. Writers of a century ago recall riding their horses belly-deep in grass in vast areas where little remains today but the sagebrush and the juniper.

It is now estimated that Oregon has some 20,000,000 acres of these sagebrush lands, mostly as a sorry heritage of over-grazing by cattle, sheep and horses when the state was young, and many of its pioneers ignorant of the value of conservation.

—*From Sagebrush vs. Grass*, 1961-63 Oregon Legislative Interim Committee on Natural Resources.

To Instill Knowledge

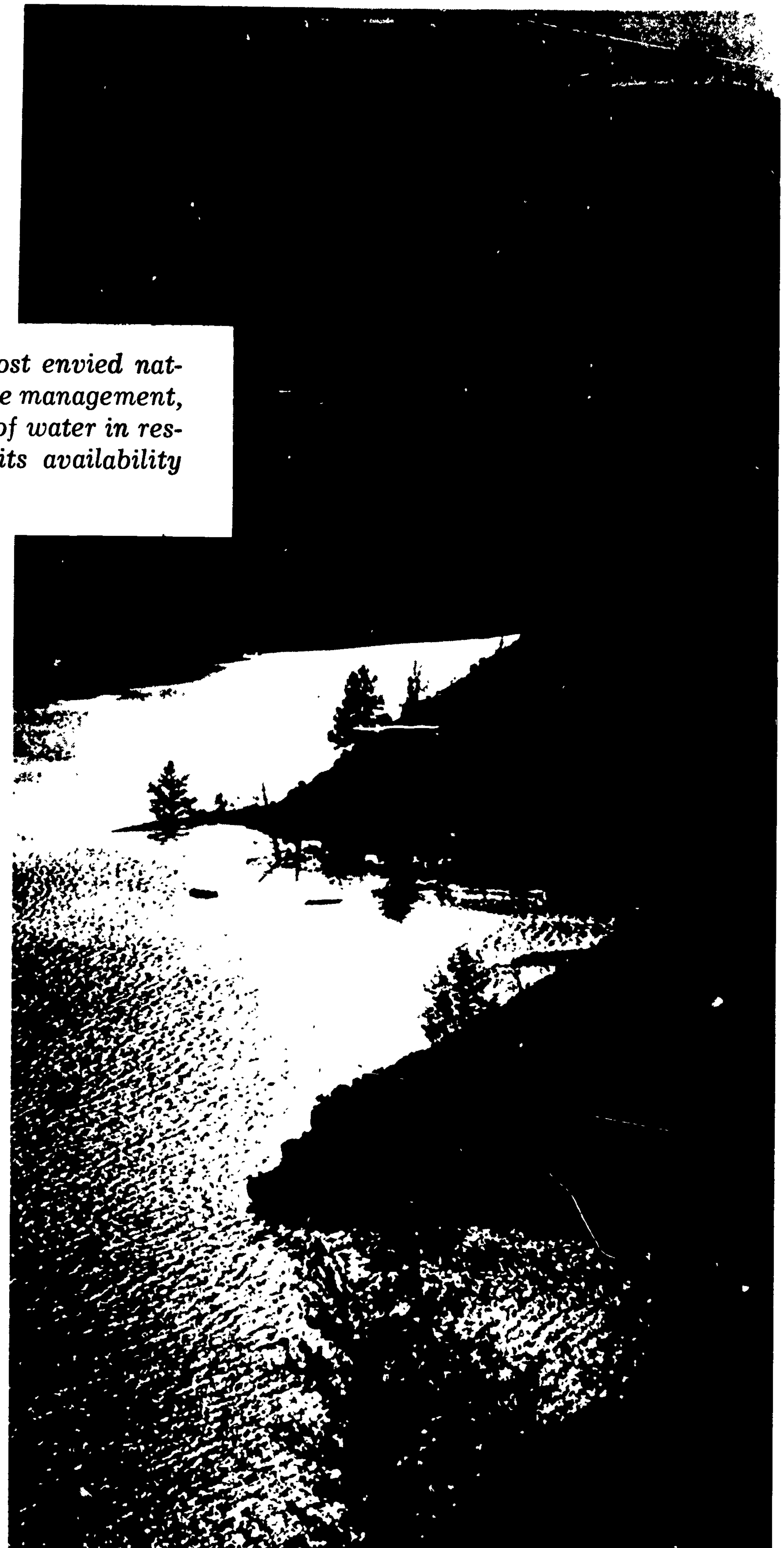
About Land—One of the aims of outdoor education is to have students gain a factual knowledge of the natural resources which represent the wealth and strength of the nation. With more than 90 percent of the population living in cities and towns, it is doubtful that the average youngster can grow up with an in-born love of the land. For the youth of this century, the outdoors is no longer the familiar part of everyday life that it once was. Now, children have to learn about the land, and there is increasing awareness that it is important they do so. The young person of today may find it difficult to locate a place where he can see the land as his father and grandfather saw it. His learning about the land and its resources may be almost entirely through vicarious experiences unless teachers avail themselves of every opportunity to use the outdoor classroom in all its variety.

Students must be indelibly impressed with the fact that civilization after civilization has risen to power on the strength of abundant resources, only to crumble and fall as the land became exhausted and unable to support the people. Wind and water scour the fertility from more than 400,000 acres of food-growing land each year in the United States, and the accumulated loss of this topsoil amounts to three whole inches of the original average depth of nine inches of topsoil across the nation. This thin layer of irreplaceable soil is the source of our food and shelter, and the major support of life. Our survival depends upon it, and this the students must know.

About Soil—The study of soil begins with its formation from solid rock. As the forces of nature cause the rock to disintegrate, particles of soil are formed. Soils vary in texture, structure, color, pH value, and depth. Because of these differences and because of such factors as climate and topography, different soils have different capabilities. In general, some land is capable of producing crops, some land is best suited for producing grass and forage, and some land is best suited for the production of forests. Once students understand the soil's capabilities and limitations, they are ready to understand the interrelationships of soil with other natural resources and with man. With this understanding students can make intelligent soil management decisions which will produce the highest benefits for mankind.

About Water—The old saying, "You never miss the water 'til the well goes dry," is just as true today as it was three hundred years ago. But the facts about water—its physical properties, its sources, its distribution, its importance for domestic use, agriculture, industry, wildlife and recreation—must be realized. The problems confronting this nation with respect to water use and abuse must be identified and studied carefully.

The slightest shortage of water in the community is immediately felt, and students can realize how serious a water famine would be. Americans can no longer take for granted a limitless supply of fresh water. Tremendous increases in population and greater use of water have placed an awesome drain on our national water resources. Many communities are faced with water problems today, and as more and more demands are placed upon the water supply, more communities will be faced with water shortages or poor water quality. The U. S. Public Health Service reports that the average requirement for water is 137 gallons per person per day. In smaller communities it may be less than that, but in cities of 10,000 or more it is about 180 gallons.



Water is Oregon's most envied natural resource, and wise management, such as conservation of water in reservoirs, will assure its availability when needed.

The Willamette River below Oregon City is so polluted that it is a menace to human health and a barrier to passage of . . . salmon and steelhead trout. . . . There is not an industry on the river and not a single city or community that cannot afford to install proper systems to remove or treat human and industrial wastes. The polluters are in flagrant violation of state laws. . . . Pollution is Oregon's most disgraceful failure. It is destroying our priceless asset, clean water, at a time of economic prosperity when this degradation is shamefully unnecessary.

—*The Oregonian*, Editorial, August 11, 1965

There is a limit to the amount of water available to us. Fresh water supplies depend upon a circulation system called a water cycle. This is an unceasing operation in which water is evaporated from the land and water surfaces, held in the atmosphere as vapor before being transferred into clouds which later drop moisture in the form of rain, sleet, or snow. The amount of water which this cycle will produce is quite constant, and the only undeveloped source is the ocean itself. Efforts to desalt ocean water in commercial quantities are being made.

The major problem relating to water is that of inadequate distribution. Some areas have too much water and are plagued with seasonal floods. Other areas have a scarcity of water, and some are faced with the problem of pollution. An awareness of such problems is essential for all citizens in order that they may give enlightened consideration to various solutions which are proposed. Former President Eisenhower has said, "The conservation and use which we make of the water resources of our nation may in large measure determine the future progress and the future standards of living of our citizens."

Most of the water resource management problems can best be handled on regional or community levels, but state and federal governments are expected to provide technical assistance, research, and leadership. Experts believe that water shortages arise not because of lack of water, but from failure to plan for the optimum use of that water which is available. Grave as our water resource problems are, they are not insurmountable. They can be solved through the organized efforts of the nation, with every citizen accepting a share of the responsibility.

About Forests—Timber is Oregon's glory and the mainstay of its economy. Nearly half of Oregon's land area is covered with forests—30.7 million acres or about one-half the land area of the state. The Douglas fir region west of the Cascade mountains in Oregon produces more than seven billion board feet of logs annually. The harvest in the western pine region east of the mountains in Oregon is about one and one-half billion board feet.

Forest industries in this state employ more people than any other industry; they account for over one-half of Oregon's industrial jobs. More than 85,361 workers—54 percent of the state's industrial employees—have full-time jobs in forest-based plants that produce goods worth $1,461,570,000 a year. Their annual payroll amounts to $551.5 million. Dollars brought into the state by forest industries and paid out in wages and for raw material flow into every part of Oregon's economic life.

The remaining magnificent stands of timber in Oregon and the fact that one-fourth of the land area of the United States is covered with forests of commercial value do not mean that there will always be an abundance of timber, however. The practice of sound forest management will be increasingly necessary as the population grows and the demand for forest products becomes greater.

Students should be taught what kinds of trees grow in Oregon, and which ones are commercially valuable. They should learn about sylvicultural practices, such as thinning, pruning, clear-cutting, selective cutting, fertilizing, insect control, and fire prevention and control. They should study forest products industries to learn what manufactured goods come from trees. It is important that they learn how trees grow in order to understand the need for adequate reforestation programs and sustained yield logging practices.

About Wildlife—Animals are entrancing to people of all ages. They attract attention because of their shapes or colors and, frequently, because of their interesting behaviors. Some of the first toys a child receives are replicas of animals, and many of the first stories he is told are about animals. Some of these stories may be about hunting expeditions or fishing trips.

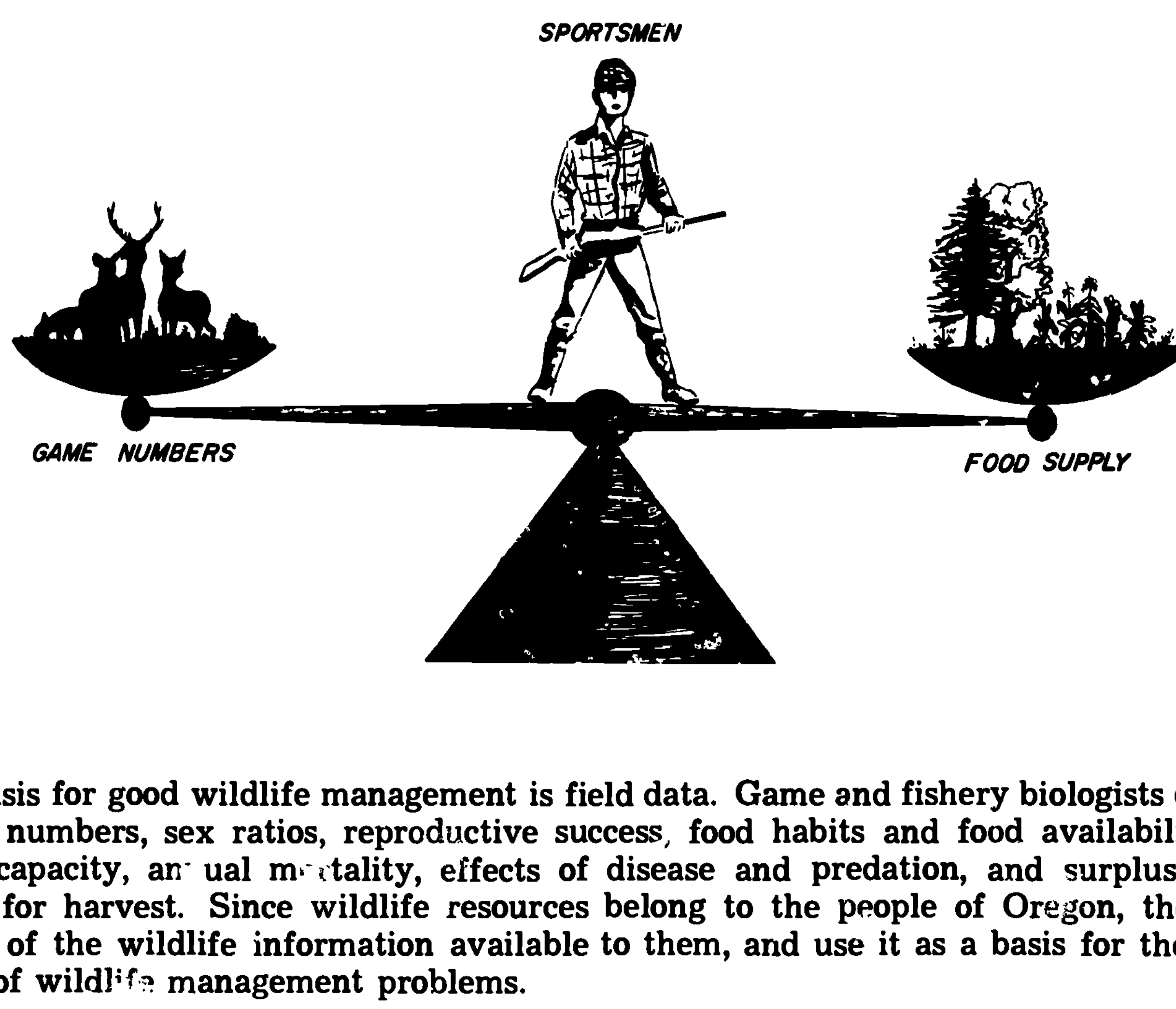
The fact that many Oregon children begin to participate in hunting and fishing, or camping trips for recreation, before they are old enough to attend school gives them a head start on learning about wildlife in the outdoors. Those who live in rural communities are often familiar with the small animals which inhabit the brushy fence rows or the cutover lands in

Oregon's timber is the state's most valuable natural resource and will continue to provide jobs and security for the people if logging operations are balanced with sustained yield practices.

the foothills. Suburban and city children may have had trips into the countryside to see wildlife in its natural habitat. Upon such casual acquaintanceships, the teacher can help students build a more useful fund of knowledge. Certainly a cursory knowledge of animal life histories or just the ability to name the important native species as recognized in pictures is inadequate. The teacher should have a more far-reaching objective.

Since primitive times wild animals have provided man with food, clothing, and shelter. Domesticated animals are important in agriculture, industry, and recreation. Once necessary for life itself, hunting and fishing has become a leisure-time pursuit of modern man. Young citizens should know just how valuable Oregon's wildlife resources are to the state's recreation and tourist industry. Every year more than 670,000 hunting and fishing licenses are issued for the privilege of pursuing game and fish. It is anticipated that by 1970 there will be at least a million hunters and fishermen in Oregon.

To meet this increasing demand for hunting and fishing recreation, more consideration must be given to the wise use of the land. Wildlife habitat shrinks with the advent of each new housing development, industrial area, freeway, airport, educational facility, and intensified agricultural development. This places a greater burden upon wildlife management agencies to also intensify their efforts to make each acre of available habitat produce a maximum number of animals without incompatibility with other land uses. A knowledge of the balance between animals and their habitats is essential. This balance can best be expressed with a diagram, as shown below:



The basis for good wildlife management is field data. Game and fishery biologists determine trends in numbers, sex ratios, reproductive success, food habits and food availability, range carrying capacity, annual mortality, effects of disease and predation, and surplus numbers available for harvest. Since wildlife resources belong to the people of Oregon, they should be aware of the wildlife information available to them, and use it as a basis for their understanding of wildlife management problems.

Every student should know about the "food chain" which affects each form of life. How does it work? What are some of the breaks which may occur in a food chain, and how would these breaks affect man? When the teacher has helped students answer such questions, he has helped them to add to their store of wildlife knowledge.

To Promote Understanding

A factual knowledge of natural resources is necessary before understanding can take place, but this does not imply that understanding automatically will follow the possession of information. The teacher can serve as a catalyst to make the data understandable in terms of interrelationships between resources. He can point out the probable causes of some of the more pressing resource management problems, tracing them back in history. He should be familiar with some of the available literature to which students can be referred for information on what has happened, and why specific actions were taken. This is all part of developing an understanding of data as it relates to management principles and practices.

Future citizens need to understand the economic importance of natural resources; their own jobs some day may depend upon dollars and cents values in relation to resource management. Resources are managed for the benefit of people, but too often the economic return on the investment is the yardstick used to determine what course management will pursue. An understanding of the recreational and aesthetic values of all natural resources is equally important.

Management of natural resources is a complex business. Agencies and organizations—both public and private—are becoming aware of the need for close cooperation. They frequently work together to collect information, and give serious consideration to the effect of management practices on each affected resource. The power of public opinion is an important consideration in management. An informed public, with a good understanding of resource management principles and practices, can be a decisive influence in bringing about progressive conservation for the benefit of present and future generations; the schools of Oregon have a major responsibility for the development of an informed public.

To Develop Intelligent Attitudes

When an average citizen can drive through the countryside and see evidences of soil erosion as a result of poor land use practices; when he can look at deserted farmhouses surrounded by worn-out land; when he can smell the stench of polluted air and rivers and ocean beaches, and see dead fish floating at the edge of his favorite fishing lake; when he can choke in the smoke of a rampaging forest fire which is consuming millions of board feet of standing timber while despoiling his favorite hunting grounds and not be vitally and personally concerned over the waste and misuse of his natural resources, his attitude toward conservation is not what it should be. Somewhere his education has been tragically neglected. He may have been given the facts, and teachers may have tried to help him understand interrelationships and values, but unless he has also developed *appreciation,* a crucial ingredient in the creation of desirable attitudes is lacking.

The citizen who does appreciate the beauty and necessity of his natural resources cannot allow himself to stand idly by and see them abused, misused, wasted, and destroyed. He considers himself responsible for the stewardship of the earth and its resources through the application of democratic action. If democracy is going to continue to work for Americans, its first task is safeguarding the resources which gave this nation its initial strength. It follows that, in a democracy, conservation education must reach all the people. The breakthrough in establishing and implementing good conservation policies will depend upon leadership and the attitudes of those leaders toward natural resource use and management.

To Encourage Positive Action

This is the final test of conservation education: Have students enough information about natural resources, a solid basis for understanding their complex interrelationships, and a concern for sound conservation practices so that when they confront a resource management problem they will recognize it and take effective action to solve it? If so, then the goals in conservation and outdoor education will be met. Oregon's hope for the future lies in an educational system which produces citizens who have the courage and foresight to solve resource management problems while they are still susceptible of solution.

A tree is like an orphan. It can stand alone or in a group. It has individuality and its own characteristics. Is it possible to adopt a tree and care for it?

The Outdoor Setting

BEQUEST*

Somewhere there is a child who does not know
The touch of fieldstone sun-warm in his hand,
Who has not felt a million summers flow
From sand to rock and halfway back to sand.

Somewhere there is a child who has not seen
The great green thrust of maypops by a wall,
Or watched a fish fan thoughtfully between
Sunlight and shade, or heard a killdeer call.

Look, child, I will to you this pebbled path,
This treetop full of sky, this meadowed place,
Praying that if the world's hard aftermath
Will leave some kind of love across your face,
Then you will come and find it good and new,
As it was when I wanted it for you.

—Edsel Ford

* *McCalls'*, May 1963, p. 185.

The good earth must be worked wisely if it is to continue to provide the food and fibers upon which mankind depends.

Outdoor Education—Where

Never before in history have teachers and students been equipped for learning with as great a variety of excellent books, but educators today know the value of returning to original sources and first-hand experiences.

The 17th Century English poet, John Dryden, said of Shakespeare: "He was naturally learn'd; he needed not the spectacles of books to read Nature." And Dryden added his own comment when he wrote: "By viewing nature, nature's handmade art/ Makes mighty things from small beginnings grow." Other writers have acknowledged that "the volume of nature was their book of knowledge" (Oliver Goldsmith).

The return to original sources, as exemplified by the learn-by-doing trend in modern education, has brought about a renewed appreciation for the educational value of outdoor experiences when students are learning about their own natural environment. But the use of outdoor laboratories and outdoor classrooms as a systematic, planned part of the curriculum is so recent a development, that many schools have no designated areas for such use. Their libraries may be well stocked with books about nature but there are no natural outdoor settings readily available which students may use to find "tongues in trees, books in running brooks."

To remedy this lack in past school planning, this section of *Outdoor Education in Oregon Schools* discusses three different but equally practical ways in which educationally-useful outdoor areas may be provided: (1) on the school grounds proper, (2) in a natural area away from the school grounds, and (3) in a resident outdoor school away from the school grounds. (See the Appendix, page 114, for "Suggested Guidelines for Outdoor Schools.") School boards, administrators, and teachers who find it possible to work together to provide such outdoor settings for their students will indeed find that "mighty things from small beginnings grow."

And this our life, exempt from public haunt
Finds tongues in trees, books in the running brooks
Sermons in stones, and good in everything.

As You Like It—Shakespeare

NATURAL AREAS ON SCHOOL PROPERTY*

School boards, architects, landscape architects, superintendents, principals, teachers, and laymen are giving increased attention to diversity of environments on school grounds for better education. New schools should make greater efforts to save sample habitats. Existing schools can often create diversified environments through careful land-use planning or can make better use of existing environments.

Setting aside a portion of the school site as a natural laboratory is a growing practice in many school districts. It is best if this can be done before building planning and construction starts; however, the denuded topsoil surrounding a newly-built school can serve as a location for a remarkable reclamation project. With the help of resource people (see page 31), students can plan experiments to study soil erosion, establish native grasses and trees, and fence off an "undisturbed area" as a refuge for birds, small animals, and reptiles.

* Adapted from checklist prepared by Nature Conservancy's National Committee for Natural Areas for Schools; Chairman: Dr. John Brainerd, Department of Biology, Springfield College, Springfield, Massachusetts. Permission to use granted.

Following is a checklist and description of desirable environments which the school already may have but is not using for outdoor education purposes, or which may be added by planning and working with the students.

1. **Barelands**

( ) *Paving,* as in parking lot or paved play area is useful in studies of microclimates and water run-off, correlated with physical sciences and geography.

( ) *Planting soil,* as in flower beds and vegetable gardens, can be used mostly for annuals.

( ) *Eroding soil,* as on eroding bank or field corner provides a laboratory where children can perennially experiment with digging, grading, mulching, and stabilizing with plants, then laying it bare again.

2. **Grasslands**

( ) *Lawn* is used for beauty and soil stabilization, of course, but some should be designated as experimental lawn for students to study. Many schools have a disproportionately large decorative lawn, to the detriment of other possible environments.

( ) *Turf for playfields* should have grass species best adapted to heavy wear.

( ) *Rough grass areas* contain perennial species (usually native) inexpensively maintained by only occasional mowing with sicklebar or scythe, by controlled burning, or by grazing, or which, in certain climates, may be stable without such maintenance.

3. **Forblands**—Forbs are herbaceous (non-woody) plants other than grasses, e.g., goldenrod. A school should try to include at least demonstration natural patches of the following:

( ) *Pioneer annual herbs,* revegetating bare land (to be laid bare again at intervals).

( ) *Perennial herbs,* representing later stages of plant succession on bare land. To the layman, these are often "unsightly weed patches," but to the scientist and artist, these are treasure troves.

4. **Shrublands**

( ) *Foundation plantings,* corner or facing plantings are useful educationally although they may go in and out of style architecturally. They should not be omitted from school grounds although some compromise with the architect may be necessary.

( ) *Hedges and screen plantings* are useful for beauty, life science study, and as boundaries to delimit areas of different land use. They serve as important windbreaks and dust filters for control of microclimates. (Caution: these should not be planted close to roads where they could hide pedestrians or running children from automobile drivers' view.)

( ) *Special plantings* might include a collection of flowering shrubs, small-fruit garden, shrubs used in crafts, wildlife food patch, or shrubs for experimental pruning. Shrubs suitable for home gardens might be planted in a demonstration barbecue area for homemaking classes outside the homemaking rooms. This area could also include a wild bird feeding station, designed by biology, art, and industrial crafts students.

( ) *Brushlands* are much misunderstood by laymen, and therefore as much needed on school grounds as an eroding area and a "weed patch." Native shrubs may appear above perennial grasses in plant succession, or flourish after cutting of trees, or sprout after fire. Valuable tree seedlings or sprouts may be nurtured by the "messy" brush. Many native shrubs are themselves valuable, so brushlands should not be needlessly destroyed when school grounds are laid out. If they are considered a fire hazard, a firebreak can be made. If they attract undesirables, they can be fenced off.

5. **Treelands**

( ) *Shade trees,* either planted or native, are of obvious use for beauty, nature study, and effect on microclimates, but are often destroyed in site preparation because of the economic adventage to the contractor who may genuinely think he is saving the taxpayers money by wholesale bulldozing. Native trees should be saved whenever possible, and other trees planted—generally, evergreens on the north side of the buildings, deciduous trees on the south.

An abandoned farm, overrun with weeds and shrubs, provides a challenging natural area for an outdoor laboratory.

( ) *Plantations* might include a grove of planted trees, under cultivation, such as orchards, Christmas trees, trees for other special purposes such as posts or lumber and the by-products from thinning and pruning (Christmas boughs, firewood, specialty wood for woodworking shop), an arboretum, an experimental forest.

( ) *Native woods* might include samples of various forest types of the region, both managed and preserved as natural areas. These have been widely recognized as educationally important, many schools in certain states having their own school forests for many types of correlation with classroom work. Most school grounds probably are too small to accommodate either extensive plantations or native woods, in which case these treelands could be incorporated into a larger natural outdoor area located away from the school itself.

6. Wetlands

( ) *Marsh* contains herbaceous plants such as cattails, grasses and rushes emerging from either fresh or salt water, gently flowing, or wet soil.

( ) *Shrub swamp* contains low, woody growth in wet soil or water, with some flow of water.

( ) *Swamp* is forested wetland or shallow-water area, with some flow of water.

( ) *Bog* has stagnant water and contains herbs, shrubs, and/or trees.

7. Water

( ) *Lake, pond or puddle*—any body of water is useful for teaching physics, biology, chemistry, social sciences, and arts. Both natural bodies and artificial impoundments are highly desirable on school grounds, with natural ponds especially valuable.

( ) *Streams* of any size, even temporary rills, are valuable teaching aids. At least one downspout from the school roof should run on the exterior to be used for study, instead of all downspouts being enclosed inside the walls as is now common. If a playfield must be located near a brook, the brook should not be buried in a culvert but diverted around the field. Natural brooks can be panned for educational gold.

8. Elevations

( ) *Slopes* have educational uses related to aesthetics, soil studies, microclimates, distribution of plants and animals, watershed studies, and measuring. Not all play areas need to be level as are those for the popular team sports involving a ball; hillside areas can be use for kiteflying, skiing, croquet.

( ) *Hilltops* give students an improved perspective on their environment, whether they are studying astronomy, weather, or patterns of human culture. An eminence, even a low one, adds character to school grounds by providing a view. When a hill is bulldozed level to destroy a wetland, for instance, the school suffers a double loss.

NATURAL AREAS AWAY FROM SCHOOL PROPERTY

Since nature's munificence has bestowed upon every section of Oregon a lavish abundance of locales to kindle curiosity in every child about the natural environment, the school district which fails to take advantage of the outdoor laboratory possibilities in its own environs on grounds of lack of funds is demonstrating not economic deprivation but a poverty of spirit and imagination.

Nearly every school in Oregon has access to a natural area suitable for use as an outdoor laboratory. This area is a place particularly rich in opportunities for observing, exploring, and discovering many things of scientific interest. It is often called an outdoor teaching station or outdoor classroom.

Administrators and teachers who can conceive the benefits to the educational development of their students of an outdoor laboratory, need only to investigate their own school grounds and neighborhoods. Once a site has been selected on the school grounds or in a nearby natural area, and permission for its restricted use obtained, the site should be set aside for an unlimited length of time, and made available to classes of all ages and in all subject areas.

Ideally, the outdoor laboratory is situated near enough to the school to permit its use during a single hour of class time, though some useful areas are more distant and require a time allocation of a half-day or more. Some natural areas are owned by the school district; more often they are private or public lands loaned to the school for an indeterminate time and administered by the school as any indoor laboratory might be.

Parks as Natural Areas

Of the publicly-owned areas in use by schools today, the city, county, state, and national parks provide some of the best places for learning experiences. Damsites, fish hatcheries, and bird refuges are equally suitable for extending classroom activities into the outdoors. Many of these sites are kept in a relatively natural state, and different types of activities can be developed by the teacher which will help children "watch living things live," interpret their environment, and learn the proper use of natural areas.

Natural Areas Along the Coast

Sand dunes, tide flats, rocky tide pools, and windswept beaches provide unique opportunities for exploration by students from coastal schools. Wind direction and velocity may be studied in the dunes and on the beaches. The relation of plants to their environment is dramatically illustrated by the dune vegetation and by the algae in the tidal pools. Adaptations of organisms to unusual environments may be investigated also in these pools. The study of land formations, ocean currents, tides erosion by actually observing them at the coast is an interest-arousing experience. A variety of rocks and minerals abound where the headlands meet the sea, and fossils may be found in many strata along the cliffs.

On some of the bluffs near the ocean the kitchen middens of Indians are conspicuous. By digging into these piles of broken mussel shells students may find fascinating artifacts left by Oregon's early natives, and history as well as science will become more real and meaningful when taught in such outdoor settings.

Forests as Outdoor Classrooms

In many Oregon counties, the Extension Service arranges annual school forestry tours to demonstration tracts loaned by land owners on a long-term basis. These areas have been developed as outdoor classrooms where representatives of the State Forestry Department, Industrial Forest Association, U. S. Forest Service, Soil Conservation Service, U. S. Bureau of Land Management, and the Extension Service may provide visual instruction in many aspects of conservation and forest management. In one such county demonstration forest, students make 15-minute stops at stations demonstrating seed production and tree planting, tree identification, Christmas tree culture, precommercial thinning, pruning forest trees, soil-root relationships, and fire control.

Some schools own and operate their own forests as outdoor classrooms. Others find areas in national forests which are excellent places to study wildlife, geology, conservation, or ecology. Within each of the forest areas selected, a wide variety of smaller habitats may be found. Springs, marshes, rocky hillsides, piles of lava, decaying logs, wet and dry meadows, and ferny glens in the forest primeval all offer exciting challenges to investigating children.

Natural settings provide substance for all areas of the curriculum. As in natural areas on the coast, in parks, in the high country of Central and Eastern Oregon, even in vacant lots and abandoned farmlands, the forest provides stimulating subjects for reports, stories, poems, and other types of writing for language classes. Art and photography classes may discover inspiration for creative composition, and music students may detect in the song of a bird, the ryhthm of a stream, or the soughing of wind in the pines an echo of a symphonic theme.

Privately-owned Lands as Outdoor Laboratories

Many teachers find that farm lands or roadsides near the school are more convenient to visit and as rich in educational opportunities as forests or agency properties. In the grassland of the vacant lot across the street in a city or in a farmer's pasture across the road in rural districts, students can learn about competition, study food chains, or compare the effects of water on bare soil and soil with cover. Fence rows which provide shelter for birds, reptiles, and mammals also constitute an outdoor laboratory for ornithology and biology students.

Pasture ponds give students a chance to see aquatic life, seasonal changes, food chains, plant succession, and the life cycles of animals. Ponds in gravel pits show a different type of environment for organisms. A school is indeed fortunate to have a number of different aquatic communities available for study purposes.

Gravel pits and river bars, as well as coastal bluffs, are rich displays of effects of erosion and weathering. Often, these areas are happy hunting grounds for fossils and rocks. Road and railway cuts showing distinct sedimentary strata may yield fossils, too, and provide natural exhibits for the study of geology and geography.

Schools near the glaciers and snowfields of the Cascade Range or the Blue Mountains and the Wallowas have splendid opportunities for outdoor study of weather and climate, topography, and the relation of soil, plant and animal life to these phenomena. Alpine meadows offer fascinating opportunities for ecological studies which are not readily available to most students.

RESIDENT OUTDOOR SCHOOLS

Resident outdoor schools offer a relatively new and effective type of educational experience which, like an extended field trip, gives students an opportunity to live and learn together in an outdoor setting.

Resident outdoor schools were begun by teachers who wanted to move outside the four walls of the traditional classroom for those areas of the school curriculum which could be taught most effectively in a natural environment. Just as other teaching aids have been used to make instruction more realistic, so the outdoor classroom has been accepted as a valuable supplement to the more formal aspects of classroom teaching.

The natural outdoor setting of these schools offers many educational experiences difficult to duplicate elsewhere. In a five-day period with resource people and a teacher outdoors, students can hear, see, feel, smell, and taste natural realities all around them. The extended period of time allocated to outdoor schools makes it possible to design a curriculum which includes study and action—working, exploring, investigating, and sharing the asethetic, economic, and conservation values of the natural environment.

In these outdoor schools, children study the earth and sky, soil, water, plants, and animals —their interdependence and man's relationship to them. They learn to use the simple tools of the outdoorsman. Their equipment is that of the discoverer: maps, compass, binoculars, hand lenses, and the microscope. Their methods are those of the scientist: observing, discovering, collecting, and evaluating. The skills they must use include reading, recording, measuring, and idea sharing.

The fields, forests, deserts, beaches, and other areas of the outdoor school provide endless varieties of natural phenomena to be examined. The simple, healthful outdoor school life itself, set at a natural tempo, gives students an opportunity to develop some of the skills and attitudes that are important elements of successful living.

Perhaps more important are the intangibles that grow out of the experiences in group living such as closer student-teacher and student-counselor relationships, and better student understanding of themselves and each other as well as of academic subject matter. For most students it will be the first experience where they have major responsibilities on a twenty-four hour basis. The changed frame of reference from which they view human relationships tends to develop objective and less selfish perceptions. Working with teachers on a damp log or eating together develops a new and healthful image of teachers as human beings. The constant concern of counselors for student welfare inevitably develops positive feelings about the worth and effectiveness of human compassion and interdependence. When conceived as a part of an overall approach to the learning process, the outdoor school becomes a meaningful life experience.

Some of the learning acquired in outdoor schools comes from the school curriculum but other learning is unique to the outdoor classroom because it cannot be experienced in the regular classroom. After a week at a resident outdoor school, students and teachers return to the classroom to find they have learned much that can be applied to all subject areas, and that their outdoor experiences enforce and enrich regular instruction. This makes the outdoor school one of the most promising frontiers of modern curriculum improvement.

Planning Guide

It is not within the scope of this handbook on outdoor education to give complete, step-by-step instructions for the development of a resident outdoor school; employment of personnel; advance preparation of teachers, counselors, and students; day-by-day outlines for the curriculum and recreation program; or lists of recommended equipment and clothing. Obviously, a week's outdoor residence with a class of students requires thoughtful preparation by everyone involved.

To establish an outdoor school is a major undertaking. It requires the joint efforts of all personnel concerned. In forming an effective outdoor education program, it is usually necessary to consider the following items:

Organization
- Responsibilities of
  - School Board
  - Administrators
  - Teachers
  - Program Director
  - Steering Committee
  - Curriculum Committee

Sources of Financing
- School Board
- Student Tuitions
- Service Organizations
- Federal Programs

Suggested Sites
- Church Camps
- Boy Scout Camps
- YMCA Camps
- Lodges (belonging to private organizations)
- Others

Expenditures
- Site Leasing
- Salaries
- Transportation
- Food Services
- Publications
- Supplies
- In-service Workshops
- Administration
- Maintenance
- Capital Outlay

Personnel
- Outdoor School Director
- Field Study Director
- Teachers
- Counselors
- Resource Consultants
- Cooks and Aides
- Nurse
- Maintenance Service
- Health Services

Integrated Program of Studies
- Pre-Outdoor School Classroom Preparation
- Outdoor School Program of Studies
- Follow-up

Evaluation of Outdoor Education Program
- Students
- School Personnel
- Parents
- Counselors

SOURCES OF INFORMATION

Agency Personnel

Any school district considering establishment of an outdoor education program will find much assistance from personnel and printed information available from the following agencies:

Conservation Education Coordinator
Bureau of Sport Fisheries and Wildlife
U. S. Department of Interior
730 N.E. Pacific Street
Portland, Oregon 97208

Conservation Education Officer
Forest Service
U. S. Department of Agriculture
P. O. Box 3623
Portland, Oregon 97208

Conservation Education Officer
Soil Conservation Service
507 Federal Building
701 N.W. Glisan Street
Portland, Oregon 97209

Consultant on Conservation and Outdoor Education
State Department of Education
312 Public Service Building
Salem, Oregon 97310

Education Agent
Information and Education Division
Oregon State Game Commission
P. O. Box 3503
Portland, Oregon 97208

Resource Utilization Specialist
Bureau of Land Management
U. S. Department of Interior
P. O. Box 2965
Portland, Oregon 97208

State Forester
State Forestry Department
2600 State Street
Salem, Oregon 97310

Other excellent sources for information may be obtained from existing outdoor school programs and authorities on conservation, outdoor education, and recreation at colleges and universities.

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What to Do and What to Look For

An exploration can take place anywhere or everywhere in the outdoors. Sometimes it is messy. It is enjoyed by the very young and the not so young. Most of the time, it makes one think and wonder.

THE STUDENT'S OUTDOOR CREED*

I believe that my outdoor manners reflect what I am at home.

I believe in keeping waters, highways, and camp grounds clean.

I believe that public property is for all of us and we should play fair in its use.

I believe in securing permission before using or entering another's property and will leave it without damage.

I believe that carelessness with fire is a crime against humanity.

I believe in taking only legal fish and game and will do my part in their propagation.

I believe in absolute safety with firearms and will observe all precautions in their use.

I will do something constructive with our natural resources each day I spend in the outdoors.

I believe we should do all in our power to keep America beautiful and productive.

*** Ward P. Beard, *Teaching Conservation*, The American Forestry Association, 919 Seventeenth Street, Northwest, Washington, D. C.**

Planning Outdoor Experiences

Good advance preparation provides not only the outdoor setting which stimulates the natural curiosity that leads to discovery but also the sound planning of field trips which makes discoveries meaningful in the larger context of the student's whole educational progress.

Field trips do not need to be long or distant to provide significant experiences for an individual or a class. Some of the most successful are those of a few minutes' duration just outside the classroom door, where children can find answers to simple questions and observe natural phenomena. But, whether the excursion is a walk around the school grounds or a daylong exploration of coastal tide pools, the success of any outdoor experience depends upon the thought, preplanning, and organization the teacher employs before the students leave the school.

Many suggestions for learning experiences are outlined in this chapter under these topics:

- **Land or Terrestrial Communities**—the school grounds, vacant lots or range lands, woodlands, soil and water experiences
- **Aquatic Communities**—ponds, streams
- **Coastal Communities**—tides, tidal pools, intertidal zones, sand dunes
- **Projects of Longer Duration**—studies pertaining to weather, natural areas, birds, conservation, animal tracking, trees, nature crafts, and maps
- **Measurement Experiences**

Most of these field studies have so many ramifications that they could be placed equally well in several other sections. This suggests the desirability of looking for interrelationships that may be studied during each outdoor education experience.

Notations of interrelationships perceived and of the discoveries made in the course of each outdoor experience should be made in field notebooks or logs as permanent records. This is not only good science training, but the log can also serve as a source book for many classroom activities later in the year. If a section of the notebook is reserved for student questions asked in the field, it may also serve as a springboard for further experimentation in the classroom or for library research.

On a field trip, after they have had time to explore the area, students should be assembled to discuss their observations and helped to develop the understandings to which the field study will contribute. Before returning to the classroom, it should be explained that any organisms picked up in the outdoor laboratory belong there and should be left there unless adequate provision for their transportation and treatment has been made beforehand. Too often animals are taken back to the classroom to languish and die from improper food and care. This may be an opportune time to review *The Students Outdoor Creed* which introduced this chapter.

The advance preparation necessary if both students and teacher are to have a pleasant and fruitful learning experience in the field should include many of the details listed in the following guidelines for planning.

GUIDELINES FOR PLANNING A FIELD TRIP

Explore—

- Educational possibilities located on the school grounds and adjacent area before considering trips involving more time and travel.
- Community resource persons, such as naturalists, agricultural extension agents, youth leaders, meteorologists, astronomers, bird watchers, foresters, gardeners, and others who can work with children outdoors. (Many senior citizens have the time, interest, and ability to contribute much to enrich educational opportunities for children, and would be willing to assist the teacher if asked to do so.)

- Conservation agencies, such as the U. S. Forest Service, State Forestry Department, U. S. Bureau of Land Management, U. S. Soil Conservation Service, State Game Commission, Fish Commission of the State of Oregon, etc.

Plan—

- With administrators and parents for adequate supervision on extended trips.
- With the administration about policies and procedures necessary to take excursions outside the school building.
- With other teachers if children are going to other rooms for instruction in other areas of the curriculum.
- With resource people well ahead of time so that arrangements can be made for guides and specific activities to be observed on a trip to private or agency property.
- With the students concerning purposes of the experience and their responsibilities.
- With the students about the proper way to handle live specimens, insects, reptiles, small animals, and plants.

Secure—

- Permission from the administration for all trips regardless of the time involved or distance from the classroom.
- Permission of all persons involved when using private or agency property.
- Written permission from parents, allowing children to go on the outdoor excursion.

Provide—

- Necessary equipment and supplies for the specific field trip, e.g., insect nets, plastic sacks, notebooks, labels, digging tools, pencils, and collecting bottles.
- Necessary reference material to stimulate and satisfy student curiosity and encourage additional inquiry after the class has returned from the trip.

Avoid—

- Doing too much in a limited time.
- Unnecessary hazards (busy streets, highways, loose rocks, quarries, swift streams, and deep water).

Caution—

- Students regarding proper clothing, safety rules, behavior in public, and responsibilities.
- Students about noxious plants, poisonous insects, and wild animals.

Travel—

- In a sensible and orderly fashion. (Being in the public eye has certain responsibilities.)
- By chartered bus or authorized school bus because traveling by private car might place the teacher in a liable situation, due to inadequate insurance coverage of the private vehicles.
- In small groups, never alone, using the buddy system while in the field.

Organize—

- The trip to the extent that it is flexible but directed to receive the most in the educational objectives anticipated.
- The class into small groups each under the supervision of an adult who has been properly briefed about the trip.

Capitalize—

- On any unique learning experiences encountered in the area visited.
- On the material found in the area and not on materials that will be found in other areas. (Save these for other trips.)

Suggestions for Learning Experiences

What can children learn out of doors? Beyond the four walls of the conventional classroom, the world can become the child's learning laboratory for life. The extent to which a child takes advantage of this laboratory is dependent on his curiosity, his ability to observe, and the resources available. In the organized outdoor school, the program of studies should attempt to provide those experiences which help the individual see the unifying schemes which operate in his environment. These include an understanding of—

- The dynamic nature of both living things and elements in the physical environment
- The interdependence of living things with each other and with their environment
- The systematic order found in all aspects of the universe

These broad understandings are not taught per se but develop as students observe and investigate more and more of the world about them. With numerous experiences, they will better understand the outdoors as a familiar and comfortable environment affording opportunities to recreate and offering a challenging learning laboratory for life.

Of the many suggestions which might be included in a program of studies. the following are a sampling of the kinds of activities which children can experience. These may be supplemented with the suggestions found in many textbooks, resource books, and guides from public and private conservation agencies. However, in the final analysis, effective learning takes place when the activities coincide with the intrinsic questions of the students.

LAND OR TERRESTRIAL COMMUNITIES

THE SCHOOL GROUND LABORATORY

WHAT TO DO AND WHAT TO LOOK FOR

In the Fall—The school grounds are as far as a class needs to go to begin an outdoor experience. In the early days of school, short excursions to observe the signs of fall should be planned.

- Let students be "detectives" looking for clues indicating the change of seasons. These might include: drying grass, seed pods, leaf color, falling leaves, cocoons and chrysalids, sounds (of insects, of dry leaves, etc.), and many other items.
- Finding the many methods of seed dispersal can be very interesting and rewarding. Have the students find out *how* this is done, not just "how many seeds can you find." Note the nature of the hooks and barbs on the seeds, the ways they are made light enough to float in the air, how they plant themselves, and so on.
- Look for evidences of insects and other animals.
- Note indications of temperature change, such as condensation of the breath or the sounds of crickets. (See the Measurement section for information on how to tell the temperature from cricket chirps.)
- Note the lengths of shadows at different times of the day. Eventually, graph these and compare them with records taken at another time of the year.

In the Winter—Experiences with snowbanks or drifts and bare ground, plants, frost and ice provide students with challenging opportunities to learn more about their wintertime environment.

Snowbanks and Bare Ground

- Dig a hole through a deep snowbank to the ground, drop a thermometer on a string to the bottom of the hole and cover the hole with snow. After a few minutes, draw the ther-

Snowbanks reveal many of nature's mysteries if the effects of sun, wind, temperature, and water upon them are knowledgeably observed.

mometer out and note what the temperature was at the bottom of the drift. Then note the temperature of the air at the top of the drift. What is the temperature of the air on bare ground near the drift? Which of the three places is warmest? Make these readings on a relatively warm day, on a severely cold day, on a day when there is a strong wind from the south, and on a day when there is a strong wind from the north. Keep records. Other things being equal, where would an animal be warmest on these different days? Try this experiment with loose, light drifts, and with those which have been compacted.

- Dig a series of holes into the sides of a big drift, at depths of one foot, two feet, and three feet from the surface. Insert sheets of blueprint paper into four photographic-printing frames. Put one of these, facing upward, into the one-foot-deep hole in the snow, one into each of the other holes, and leave one on the surface. Cover the side of the drift with a blanket. When the paper on the surface has printed so as to make a deep blueprint, remove all the papers and wash them in water. The one that received the most light will, of course, be the darkest. How deep in the drift does the light seem to penetrate? How does this vary in loose and compacted drifts?
- Watch what happens when the sun shines on weed-shaded snowbanks. Do they melt more rapidly in the shade or in the open? Of what other use may these weeds be in winter? Are they of any use in summer?
- Stand in a road which runs east and west, and which is bordered on each side by high snowbanks. Do the banks facing the north and those facing the south melt in the same manner? What differences can be explained? How does this situation apply to roads running north and south? Look at some strange road where the direction is not known and try to determine the compass directions from the manner in which the snow is melting on the face of the drifts.
- On a sunny day, put some pieces of dark cloth or paper and some pieces of white cloth or paper on a snow surface. Do they have any effect on the melting snow underneath them?
- In an open field erect a structure which will cause a snowdrift to form. The snowdrift need not be a big one; one a few inches high should be sufficient for demonstration and observation purposes.
- Keep a record to show in what places snowbanks remain the longest and where they melt most rapidly, and give reasons for their doing so.
- Other questions about snowbanks:
    1. Do they melt more rapidly in the sun or in the shade?
    2. Does the shade of weeds sticking up through the snow delay the melting?
    3. Do they melt more rapidly on a slope or on the level?
    4. Does the direction of the slope make any difference?
    5. Do dirty, dust-covered spots melt more rapidly than clean white areas?
    6. Are drifts formed to the windward or to the lee of an elevated area?
    7. Does a snow fence actually stop the snow or merely slow the wind so that the snow settles to the ground?
    8. What temperature and other changes accompany the forming of a crust?
    9. How do highway engineers save themselves work by making drifts form elsewhere than in roadbeds?

Plants

Plants are important in open fields as well as other places. They provide food and shelter for animals and birds, anchorage for soil, and penetration of the subsoil for water.

- In an open field, observe whether the snow remains on the ground bare of plants longer than on plant-covered ground. The plants provide some anchorage for driving snow, just as they serve to hold loose soil from being blown by the wind.
- In both bare and grass-covered fields, notice which are bordered by clean snowbanks. Earth blown by the wind shows on the snowbanks whereas it would be less noticeable on plant-covered ground. The plants also hold the water which melts from the snow. In this way they help raise the underground water supply which fills wells, keeps springs running, and generally helps an area avoid drought during the dry months.

Frost

- Visit a nearby garden in early fall before frost. Note the colors and appearance of plants. Visit the same garden after the first heavy frost. Note the changes. Which plants are not affected? Which have changed?
- Take a walk around the school grounds or in adjacent areas one morning when the frost remains white. See if the frost shows everywhere. Is it visible high on trees, on sidewalks, on automobiles, on fences, on bare ground, on plants in the shade, on plants in the open, where the ground is usually wet or marshy, where the ground is usually high and dry? Look at some plants on which there is frost to see if all parts are covered with it or if it is heavier in some places and on some plants than others.
- Pick some frost-covered plants and hold them between the palms of the hands. When the frost has melted, do the plants remain stiff or are they badly wilted?
- Put a small stick into the ground at the edge of a frosted area. This will mark the place where the temperature is just at the melting or freezing point of water. On a weather map issued by the weather bureau, notice the lines drawn along points with similar temperatures. Such a line, marking points on the earth's surface having the same temperature at a given time, is called an isotherm. A row of sticks placed along the edge of a frosted area on the school ground marks a local isotherm.
- With a thermometer, measure the temperature where frost is present and where it is absent. Does it differ on the ground, high in trees, a few inches above the ground?
- When the frost is disappearing, notice whether it remains longest on any particular exposure, at any particular elevation, or near or far from any body of water.
- Keep records on the relationship between killing frost and clouds, wind, and rain. A large calendar may be used for this purpose and daily records kept thereon in the form of brief notes or by the use of symbols such as arrows indicating wind direction, black lines to show rain, and others to show clouds or clear sky.
- Attempt to control the effects of frost by using newspapers or other coverings to protect plants. The usefulness of such control measures can be demonstrated by choosing two plants of the same kind, of similar size and hardiness, growing in similar locations, preferably close together. On a night when frost is expected, cover one with newspapers and leave the other unprotected. How would the climatic condition under the paper differ from that outside?
- Keep records of the dates of killing frosts as they appear at different parts of the school grounds and the school district.

Waterways

- Measure the temperature of all available bodies of water when a film of ice begins to form. Observe whether the ice begins to form at the edge of the waterway or further out into the water; where it is deep or where it is shallow; where water is moving or where it is relatively still; in the shade or in the sun. Notice the shape of the crystals and their size at the edge of a freezing area. Are these crystals larger or smaller where they are forming relatively quickly? Check the temperature at each point.
- Fill some tin cans to the brim with water and leave them where they will freeze. Note whether the water flows over the tops of the cans before freezing, whether the cans become swollen, whether the water freezes from the outside to the inside of the can.
- Find an insect frozen in ice. Does the insect regain its activity when the ice melts? Does ice kill all living things in the water from which it is formed?

In the Spring—A spring field trip to observe the responses of plants to the new season and to stimulate further observation of twig and leaf development is worthwhile.

- A walk around the school grounds will disclose buds on some of the bushes. Some of the buds will be larger than others—examples of the opposite and alternate modes of growth, and of the old leaves protecting the new. Periodic observations help students to witness the systematic and changing conditions of their environment.
- Examples of thorns, fur, gum, and other means of protecting the buds, of the color of young twigs, and of catkins blooming on some of the trees may also be found.

A dazzling new world of beauty is revealed when the sun shines on the artistry of ice and twigs.

- Exhibits which might be arranged as a result of the trip include:
  1. Where buds grow
  2. How buds are protected
  3. Which buds make such structures as blossoms, leaves, and stems
  4. The colors of young twigs
- Ensuing activities might include a diary of the growth and development of twigs kept indoors compared to those outdoors, an exhibit of twig and leaf growth, and an exhibit of catkins.

VACANT LOTS AND RANGE LANDS

A vacant lot often proves to be a most interesting area for exploration. Wild shrubs, possibly a tree, grasses, weeds, blooming flowers, lizards, snakes, earthworms, snails, spiders, and other insects may be found. Questions will help the students to learn much from an excursion to a vacant lot.

WHAT TO DO AND WHAT TO LOOK FOR

- Try to identify any shrub found on the lot. What type of leaves does it have (simple, compound, or needle leaf)? Look at the leaf edges. Are they entire, toothed, or lobed? Do the twigs grow on the branches in an alternate, opposite, or whorled pattern?
- Observe the bark on a tree. Does it grow in ridges, or plates, or is it smooth? Examine the leaves and twigs of the tree in the same way as the shrub.
- Try to identify any flowers found on the lot. How many petals has each blossom? Look at the stamens and anthers with a magnifying glass and count them. Shake them gently to try to get a few grains of pollen for examination under a magnifying glass.
- Examine an insect from the vacant lot under a magnifying glass. Look for the three parts of its body: head, thorax, and abdomen. What kind of home does this insect have? Look for other animals. Can you find a vertebrate? Invertebrate? Mammal? Rodent? Amphibian?
- Look for many kinds of each species in a given area. How many of each can be found? Where does each living thing live? What evidence can we find of interdependence? Does the environment contain all the things necessary for life for the organisms involved? Where are these things located? What characteristics do some plants and animals have that help them to survive better? Can we account for the population distribution of the living things in the lot?

Plant Habitats

Flower in the crannied wall,
I pluck you out of the crannies,
I hold you here, root and all, in my hand,
Little flower—but if I could understand
What you are, root and all, and all in all,
I should know what God and man is.

—Alfred, Lord Tennyson,
Flower in the Crannied Wall

Vacant lots provide a place to observe several varieties of plants in different locations such as under a tree, near a road or sidewalk, or in the open sunlight.

- In the early autumn, visit a weed-filled vacant lot. Try to determine why weeds have been able to invade the lot in such numbers. Pull up some of the plants and look for underground stems that enable the plant to spread. Try to estimate the number of seeds produced by single plants of various species. Find plants that have large seeds and count the total number. If names for weeds are not known, have the class invent a descriptive name.
- Observe a shaded area. Are the plants usually smaller, darker green, or softer in texture than plants growing in sunny places? Will all these plants in the shaded area reach the seed-bearing stage? Why? Look also for fungi, molds, and mildews. Give descriptive names to unknown organisms.
- Examine plants that live in open sunny places and notice the leaf arrangements. How does the plant stem support the leaves

When I see, feel, hear, smell, taste, I KNOW.

so that each leaf receives the maximum amount of sunlight? Do some plants have rosettes or whorls of leaves; others have opposite leaves, or leaves alternately arranged along the stem? Do you find dandelion, burdock, or chicory plants? Pull up some of these plants and compare their roots with the roots of grasses. Do the roots differ? Do you find plants with tap-roots? What is their purpose?

Pesticides and Weed Poisons

Two simple experiments will show the effects of pesticides and weed poisons on plant and animal life. **Caution!** *These chemicals are poisonous and should not be handled directly or taken internally either as a liquid or vapor.*

- On a vacant lot, mark off two similar areas and observe or count the ants, beetles, spiders, aphids, etc., found in each. Then apply a pesticide to one plot according to the instructions given by the manufacturer, using proper caution. After one day, again observe or count the insects. After a week check again and note any changes.
- Repeat the foregoing experiment using a weed poison. Be sure to have a similar untreated plot of ground or area of the vacant lot to observe as a control. How does the poison affect the plants? Recheck after a month to see if the weeds have regrown. Make a population study. How did the weed poison affect the organisms such as ants, beetles, worms, etc., found in the plot?

Ants

According to some authorities, ants are the dominant insects of the earth, probably being more numerous than any other kind. It is thought that this dominance is largely due to the high degree of social life and to the specialization of the ants within the colony.

The ant, a prodigy of strength,
Lifts objects twice his weight and length
And never stops or sighs or glowers
Because it's after working hours.

—Richard Armour, *The Ant**

- Take the students on a field trip to locate an ant colony, which usually can be found on the school grounds or on a vacant lot. Open the colony with a stick. Observe the activities of the ants, some bringing food, others perhaps removing waste materials. See how they accelerate their activities as they become aware of human beings near the colony.
- Dig into the ant hill with a trowel or shovel. If the nest is under a stone, lift the stone. Look for eggs (very difficult to see), larvae and pupae. Do you see oblong, egg-shaped, white objects being carried about by worker-ants? These are not the eggs, but cocoons of ants in the pupal state. Wait long enough, or come back later, to see how the ants repair the damage done to their nests.
- The social life of the ant rests on a caste system. Note the physical differences. The winged males and females reproduce the species; the workers and slaves provide the food; the soldiers act as guards.

Spittle Bugs

The life cycle and habits of spittle bugs or frog hoppers present an interesting study in the vacant lot or school grounds laboratory.

- Take a field trip to a place where the grass has not been cut and look for white foamy masses attached to grass or weeds. The foamy masses are the homes of spittle bugs or frog hoppers.

* From *Light Armour* by Richard Armour. Copyright 1954 by Richard Armour. Used by permission of McGraw-Hill Book Company.

- Break into the foamy mass and remove one of the small, pale green insects. Place it on another stalk of grass and watch it produce another foam house. It will begin this about two minutes after it is put on a new piece of grass; five minutes or more are required to complete the new house. Are these spittle bugs always on the same kind of plant or are they found on many plants? Perhaps some students would like to keep a record of where they find them.
- The spittle bug or frog hopper is an insect with an incomplete metamorphosis, which means that the newly-hatched young resemble the adult form and there is no pupal stage in the life cycle. The immature insects found in the "spittle" are nymphs. With the last molt they develop wings and leave the foamy house. Can students detect the different stages of development in the insects they find?

Spiders

Spiders often construct homes which are of interest to children. Different spiders spin different kinds of webs in which they live.

- Look for spider webs showing a wide diversity of structure. Notice in which part of the web the spider is found. Try to find a spider making his home. Look for the spinnerets which are usually located near the tip of the abdomen. While it is within the body, the silk is in a fluid state; but it dries rapidly upon coming into contact with air. Compare to manufacture of rayon and nylon. Are some of the threads sticky and elastic? Where are spider webs frequently located?
- Spider webs are often a means of trapping insects which the spider then devours. Do you see flies, grasshoppers, and other insects alight on the web? Do they try to escape? Does the spider attack the prey immediately?
- Spiders are unlike some other insects in that they cannot sting, but some species are able to bite. In species like the black-widow spider, poison is secreted by glands, so that the bite is poisonous. **Caution!**—*Do not handle the black-widow spider.* It is a shiny black spider and may be identified by a reddish "hourglass" on its abdomen. Warn students to use caution in observing many kinds of insects.

Earthworms

Earthworms live in the soil and help make good soil structure.

- Investigate the countless small holes found in the ground. Mark out a foot-square area and dig down to the depth of a foot. How many earthworms are found in this cubic foot of soil? Estimate how many there might be in the top twelve inches of an acre of land.
- Look carefully at the soil forming the sides of the hole you have dug. Can you tell that earth has been transported from one level to another? Can you tell that organic material near the surface has been mixed with underlying soil particles? Compare your findings with another area in the same location.
- Try bringing earthworms to the surface by driving a stake into the ground and then rubbing a board over the top of the stake to make it vibrate. Compare the number of earthworms found on top of the soil after a heavy rain with those found in dry weather. Suggest reasons for this difference.
- How does the number of earthworms found in poor, neglected soil compare with those found in more fertile soil?
- How do earthworms help make good soil structure? What is the value of their tunnels? How does the work of the earthworm help in aeration, drainage, and root growth?

Moth Cocoons

After the leaves have dropped in the fall, cocoons may be found in thickets, bushy fence rows, and pasture shrubbery. Some of these water- and wind-proof baglets hang by a stem; others are held more tightly, closely attached to stem or branch by hundreds of fine threads; still others (some of the largest) which have been spun and sealed into green tree leaves, have fallen to the ground below and look like smooth owl pellets, plump, oval, and gray or brown in color.

- Try to distinguish varieties or differences in cocoons that are found. Are the same types of cocoons always found on one kind of plant? On what part of a plant are most cocoons found?

Using printed resources, attempt to predict the types of moths that will emerge from the cocoons collected.

- Larvae that are moving across walks or roads are usually ready to spin cocoons. Place these in containers with some soil, in case they like to bury themselves to form chrysalises, and a stick to hang on, if they prefer. For successful development duplicate the natural environment as closely as possible (temperature, moisture, vegetation, etc.).
- Carefully store the cocoons collected on a screened-in porch or window (never in heated rooms), to await the emergence in the spring of the moths—some of which may be quite beautiful to the wonder and surprise of the children!

Animal Tracks

These tracks found in vacant lots tell something about the lives of the inhabitants of the area and provide an interesting beginning for a study of wildlife.

- See how many signs of animal life can be found in a large vacant lot. Look for tracks. How large are they? Try to identify the animal that made them. Look for holes and paths made by burrowing animals. The tracks near the hole may give a clue to the animal using the hole. Are there any mounds that could have been made by moles or mice?
- Are there signs of browsing and left-overs such as chewed cones or nut shells and seed husks? Are food-bearing shrubs found near these?
- Are there any feathers on the ground? Are there any nests of birds? Identify the kinds of birds which made the nests. If an abandoned bird's nest is kept moist, what will happen to it?
- Why is this area a natural habitat for wildlife? Lift up some stones or other objects that have lain on the ground for some time and look for ants and other insects. Is there brush or shrubbery in the area? Do these places help to protect wildlife?
- After the students have observed all the signs of wildlife in the area, encourage them to piece together the stories that these signs tell. What needs and habits of particular animals are reflected in these signs?

Range Land Vegetation

Range land vegetation is important because it provides food for millions of domestic and game animals. A study of this vegetation shows the need for conservation of natural resources.

- Make a field trip to range land. Look along the fence rows. Are native grasses growing here? Does this vegetation provide a natural wildlife habitat? Can it be expected that pheasant, quail, chukar partridge, and rabbits will be found here?
- Try to identify bitterbrush. Break off some of the leaves; do they seem to be tender? Which animals depend on this plant for food? Try to find rabbit brush. Notice how the spreading roots hold dry soil. Does this provide food for jackrabbits? For deer and antelope?
- Study an ungrazed area to observe reproduction taking place in the form of small seedlings, small saplings, large saplings, and young thrifty trees.

Range Land Damage From Overgrazing

Range lands reveal damage resulting from violation of good land-use principles.

- Students may participate in a field trip survey conducted by a local county agent to observe damage to range lands in the area. Look for indications of soil erosion. Is there a decrease in the erosion-resisting cover (vegetation)? Are the grass roots gone that once helped to hold the soil?
- Notice the number of animals grazing. Look for different types of forage found on the land. Are the animals eating the most palatable forage species of the virgin cover literally to the ground? Are too many animals allowed on too few acres for too long a time?
- Is there other evidence of land damage resulting from overgrazing?

Western Juniper Forests

Three kinds of junipers are found in Oregon, although the ratio of Western Juniper to the other two varieties is about 1,000 to one. Western Juniper grows in dry "treeless" areas of Central and Eastern Oregon. Rocky Mountain Juniper is found mostly in the Wallowa Mountains district, while the Dwarf Juniper, growing like a matted vine, lives in the high Cascade Moun-

Once barren, overgrazed range lands, taken over by sagebrush and juniper, are being reclaimed and made productive by planting of forage grass in Central and Eastern Oregon.

tains. Different types of trees often live together in communities somewhat as people do. More often than not sagebrush is found growing among the juniper trees.

- Look at several juniper trees. What is the shape of the Western Juniper? Are there Rocky Mountain Junipers among the Western Junipers?
- Explain that the "berries" are the seed-bearing cones. Try to find some of the pollen-bearing cones which are about the size of a grain of wheat. Find some cone-like growths on a juniper which are about the size of the end of a thumb. Break some of them open. What is inside? What caused these growths? Are they cones? Bark?
- In what kind of soil do the junipers and sagebrush grow? Find the names of at least five kinds of wild animals that live in juniper forests.
- What are juniper trees used for?

Magpies

Many birds are found in the dry areas of Central and Eastern Oregon. The birds need food, water, shady trees, and bushy shrubs for protection from sun, storms, and enemies. Many of the birds help to maintain the balance in nature.

- The magpie is a characteristic bird of this region. Identify him by his striking black and white coloring. Notice the long bill. Look for the long, sweeping tail. Watch the bird in flight. Note the irridescent tail, and the large white patches flashing in the wing.
- Try to find a magpie's nest. The nest will be over-large and bulky. It will be made of mud, grass and sticks covered, with a side entrance hole.
- Why do magpies like to live near the junipers? Listen for the language of the magpie. Does this bird migrate? Do magpies travel alone or are they seen in groups?
- Why are magpies found only in the central and eastern parts of the state? What are their habits? How do they help to maintain the balance in nature?

WOODLAND LABORATORIES

A woodland laboratory is a splendid place to help young people find the answers to many questions about living things. A field trip to a nearby forest or woodland laboratory should include a hike along a road or trail where the students may look down and investigate the forest floor.

WHAT TO DO AND WHAT TO LOOK FOR

Forest Layers

- Do the students know a forest is made up of layers? Have them see for themselves.

  Canopy Layer—This layer is made up of the tallest trees whose interlocking branches sometimes form an umbrella over the plants below. What seems to be the most common tree? How tall is it? What other trees are a part of the canopy in this area? How do conditions of light, heat, and wind on top of the canopy differ from those on the ground below?

  Understory Layer—Trees of this layer never grow as tall as the canopy trees. What broad-leaved understory trees are seen? Are there any needle-bearing trees?

  Shrub Layer—This layer is made up of shrubs and young trees. (A tree has only one trunk, a shrub has several.) What shrubs are common in this woods?

  Forest Floor—This consists of several parts:

  a. *Ground Cover*—low growing plants, moss, grass, fungi, ferns, seedlings
  b. *Trash Layer*—rotting leaves, logs
  c. *Duff* or *Humus Layer*—rotted plant material
  d. *Soil*

- Now have students walk into the forest and study each of these layers separately.

  Canopy Layer—Look up at the branches of the trees in the woods. Do they come together? What shelter would they provide if it rained? How high is the first branch? Why? Would these trees provide much food for deer? Grouse? Squirrels? Search for the "witch's broom" growths in a dead tree. Look for other results of damage by plants or animals.

Understory Layer—How much light do these trees get? Why do they need such large, broad leaves? What birds and animals are in the trees? Why is this a good home for screech owls and other nocturnal animals? What insects are present? Are they very numerous? What plants are to be found growing on the trunks of trees? What evidence is there that humans damage both the canopy and understory trees? (Look for roots exposed in places where people have made short cuts off the trail.)

Shrub Layer—Find evidence that this layer serves to supply new trees to the canopy and understory layers. How close together are the plants of this layer? What is the approximate height of this layer? Would it provide good food for deer? Good protection? Is it a good place for birds? Look for food for birds.

Forest Floor—Have the students examine each forest layer as suggested in the following paragraphs.

a. *Ground Cover*—What are the common plants in this layer? Look for three different kinds of moss. Find two kinds of liverworts along a stream. Look for the following ferns: bracken, maidenhair, lady, sword, licorice. Why do the flowers in this forest bloom early in the spring? Dig under some of the plants to find their underground stems, bulbs, roots. Why are some of them so thick? Find the underground parts of the licorice fern or wild ginger, taste them. Are they well-named? Try to find mushrooms or other fungi. (**Caution!**—*Many species of mushrooms are very poisonous. Do not taste them.*) What seeds are on the ground?

b. *Trash Layer*—Find a rotting log or stump. Where is the rotting taking place most rapidly? Why? Dig into the log and look for snails, sowbugs, ants, beetles, even mice. Which animal is most numerous? Of what importance are these animals to the woods? To the other animals in the woods? Why are fires likely to start in this trash? Why is the trash layer an important part of the scheme of things?

c. *Duff or Humus Layer*—Find a place to dig into this layer. Identify the leaves on top of the layer. On the bottom. What leaves seem to decay faster than others? What parts of the leaves last the longest? How deep is this layer? What are the animals in this layer? Give reasons why this is the most important layer of the forest.

d. *Soil*—Find a cut in the bank of a stream, road, or trail, and determine the actual depth of the soil. How far is it to solid rock? What is the "parent material" of this soil: granite, lava, shale? Why is it important to build campfires on this layer when possible, instead of on other layers? Has there been any recent erosion here? What may have started this erosion?

Undisturbed Areas

When a small unused area is set aside for an outdoor forest laboratory, any number of science experiences can be developed. After it is fenced and posted as a natural area, students may be permitted to make special studies.

- The area can be explored for all types of plants and animals within its boundaries, and a count made to determine the dominant ones. Continue this count year after year to find what plants invade, gain supremacy, or fail in a given area.
- The rate of growth of native seedlings may be recorded, or a tree map of the community may be worked out.
- By trapping live rodents and then releasing them, students can learn something of the distribution and behavior of certain species of mammals.
- Careful observation of the birds that come to the area will provide much information concerning their population, food habits, migration, courtship and nesting behavior.

Plant-Animal Interrelationships

The nearest rough-barked tree may afford excellent lessons on the interrelationships between plant and animal life. On it one may find many types of plant life; algae, fungi, lichens, mosses, ferns, and seed plants (mistletoe).

- Study the various sides of the tree, noting the sides exposed to and protected from the weather. Are any areas moist? Examine cracks in the bark for water, for soil, for animal life. Look for insect galls on the leaves and stems; open them to find the larvae of insects. Look for puff balls (fruiting stages of certain fungi) on the branches.

- Where are plants found with respect to light? To moisture? Are moss plants found on the north side? On the side where there is greatest shade? Is there any soil where these plants are growing? Find different stages in the life cycle of insects. What is the food choice of the insects? Are there any evidences that birds might be feeding on the insects? What other animals might be found in or near the tree, or its roots?
- To follow up this outdoor study, make a sketch of a tree showing where the different animals and plants are living and how they depend upon each other for food, shelter, water supply, or shade.
- How would a natural community change if one element, for example, the trees or rocks, were removed? Which animals or plants would be affected? What changes would occur if a deer were brought into the area.
- What would happen if picnic tables were placed in the area?
- Would any change occur if the predominant tree or trees were replaced by another variety?
- What plants and animals in the natural environment are edible for survival purposes? **Warning!** *Unknown plants should not be eaten without counsel of an authority.*
- Make a study of life on a rotting tree. How does it provide an environment of its own? Does it have a place in nature's scheme?

Vertebrate Census

A census of the birds, mammals, amphibians, or reptiles provides an interesting project that may require several trips to the woodland laboratory area.

- As animals are sighted, record where they are found and the type of activity each was pursuing. What is the food of the animal? Are tracks visible? Does some other animal in this woods depend upon it for food? What chance does it have of escaping its enemies? In this particular woods?
- When observing birds, notice what kind of tree each species seems to prefer. Is the bird feeding at the top, middle, or lower level of the tree? Is it on the outermost branches of that level, or in toward the trunk? Make a map of the feeding habits of each species of bird observed. By careful watching it should also be possible to map the territory of each bird.
- Another study relating to birds could center around bill structure and feeding habits. Science students should be able to obtain evidence which shows relationships of these characteristics of birds.

SOIL AND WATER EXPERIENCES

Field trips to the school grounds, vacant lot, or woodlands may stimulate an interest in the soil, its importance in the environment, its characteristics, and the effects of water upon it.

WHAT TO DO AND WHAT TO LOOK FOR

Soil Formation

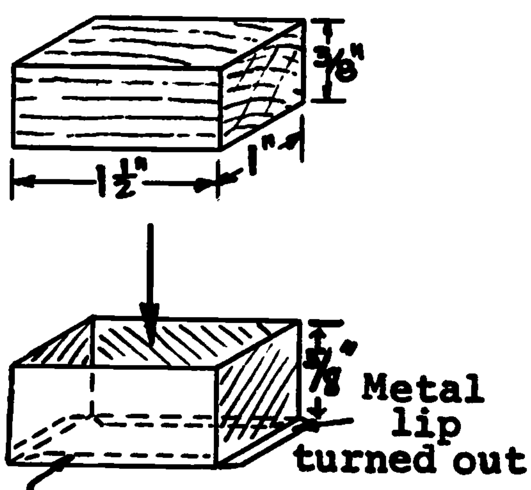
- Visit a limestone, sandstone, or shale ledge to see that soil is formed from rock. Look at the bottom of the ledge, in crevices, and between the layers of rock. What kind of material can be observed?
- Take some samples of these materials back to the classroom. Rub two pieces of limestone, sandstone, or shale together above a sheet of white paper. Notice the fine material which begins to collect on the paper. Note how long it takes to rub off a teaspoonful of the fine particles.
- What story can be pieced together from the shape of rocks found in the area?
- Does the composition of the loose rocks coincide with that of the bedrock in the area? If not, how did the loose rocks accumulate?
- Does the water on both sides of the stream flow at the same rate? If leaves could be dropped along a line across a stream, would they flow downstream at the same rate? Around a curve in a stream? What does the size and distribution of sand, gravel, and boulders on the bottom of a stream tell us about the water flow?
- How does a stream affect the ecology along its banks?

Soil Profile

- Visit an exposed vertical area, such as a road cut or building excavation, where layers of soil can be seen. If there is no such area available, dig a five-foot-deep hole in the ground.
- What sorts of layers (horizons) do the students find? What is the depth of each layer? Do they differ in color? How does the soil from each layer feel? Is it gritty, floury, or sticky when wet? Observe the soil structure of each layer. Is it platy (flaky), blocky, granular or otherwise?
- Soil samples from different localities can be examined by means of a soil augur. How do the samples differ? Enumerate as many factors as possible that change bedrock to subsoil. How is topsoil formed? (Later the teacher may want to indicate the role of topsoil in holding water.)
- To follow up the field trip in the classroom, make a micromonolith (a permanent record of the layers present) for each soil profile examined in the field.

Samples of soils at various depths can be obtained with the illustrated apparatus. (Any apparatus which will produce similar results may be substituted.)

SOIL SAMPLER

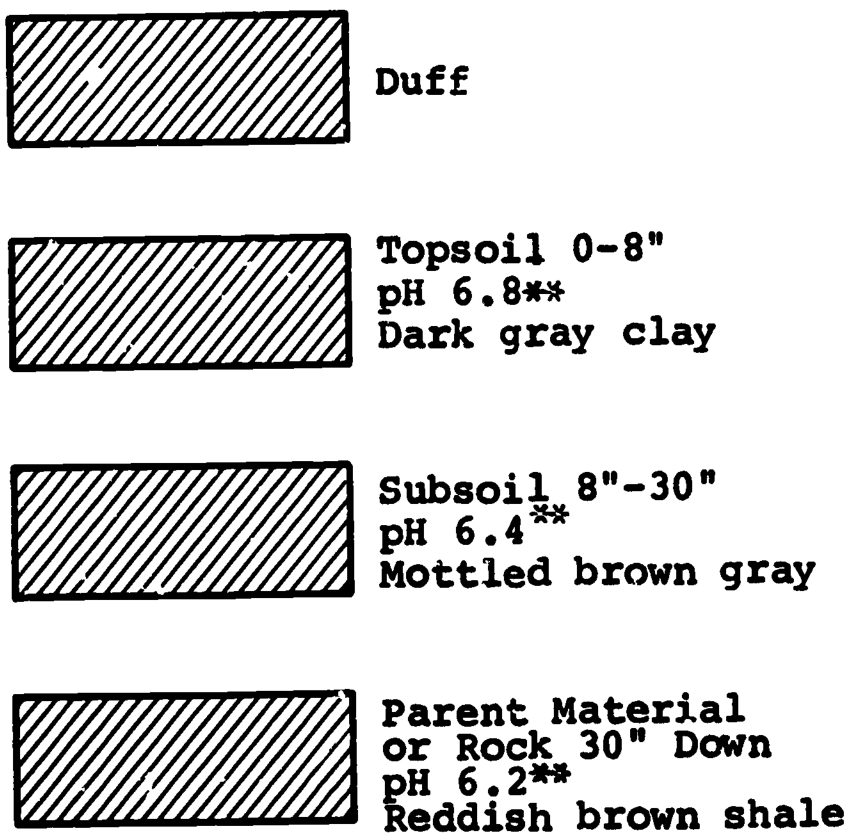


Procedure*

1. Place wood block in cutter.
2. Cut blotting paper the size of the wooden block so it will fit inside cutter.
3. Place blotting paper cut in Step 2 on the wooden block.
4. Cover entire blotting paper liberally with waterproof cement.
5. Push cutter into soil.
6. Push knife into soil behind cutter and pry out. This keeps soil attached to blotter.
7. Trim down the small soil sample to approximately one-quarter inch thickness.
8. Push the block, blotter, and soil upward through the cutter until blotter and soil are above the edge of the cutter.
9. Remove by placing knife blade between block and blotter. Place the sample on a card or paper with description of sample.
10. Repeat the procedure until all soil layers have been sampled. Generally, there are at least 4 samples taken—the duff or A; the topsoil or B; the subsoil or C; and the parent material or chip of bedrock or D.
11. The samples may now be cemented down the left side of a stiff cardboard in the same order they came from the soil profile.
12. The thickness, pH, color, texture of the surface, subsoil, parent material, and other layers can be then written on the right side of the cardboard.
13. The completed card should be sprayed with a thin film of plastic from any pressurized plastic spray can. This will help protect the soil samples.

* *Field Study Notebook for the Outdoor School*, pp. 33-34. (Compiled by Warren C. Gilfillan and Robert A. Burgess for Regional Outdoor Education program, from original *Field Study Notebook for the Outdoor School* by Margaret Milliken, Associate Professor, Oregon State University, Corvallis.)

MICROMONOLITH*
Name of Outdoor School (Date)
Name of Soil and Location
Name of Student



** This is a chemical test that will help tell you how easy it is for plants to get their plant food elements—nitrogen, phosphorus, potash, sulfur, etc.—from the soil. The measured pH is a number that will fit on the pH scale. This scale is numbered from zero to fourteen. Numbers below seven indicate how acid the soil is, with the numbers closest to zero the most acid. Seven is neutral. Numbers higher than 7 are alkali, and numbers close to 14 are the most alkaline. Some examples are: soap—pH 9, sea water—pH 8, pure water—pH 7, sour milk—pH 5, orange juice—pH 4, lemon juice—pH 3, etc. Only a few plants can get enough of their nutrients from the soil when the pH is more acid than 4.5 or more alkaline than 8.5. Most plants prefer a pH of 6.5 (slightly acid). It is at this pH that plants seem to best take plantfood elements from the soil into their roots and use.

pH Value of Soil

- To observe the relationship between the chemical reaction of the soil and life present, visit several locations with dissimilar types of vegetative cover.
- Collect surface and substratum samples from each vegetative location. Observe and record the kinds of plants and animals found in the soil at each location. Using a pH test kit, determine the degree of acidity and alkalinity for each soil sample. Compare the soils tested from the different locations. What types of plants grow best in each soil? Does the chemical reaction of soils determine what plants and animals will thrive in an area? (For the pH scale, see footnote to illustration on this page.)

Soil Organic Matter

- Visit a cultivated field and a natural sodded area such as a fence corner or a park. Using a trowel, collect lumps of soil from each area.
- Lower each sample gently into containers of water and notice what happens. Which soil holds its shape best? Why? How does organic matter improve soil structure? Compare the water-holding capacity of each soil. How does this prevent erosion?

* *Ibid.*, p. 34.

Soil samples make a permanent record of an outdoor experience.

Soil Life*

- Stake off a square foot of soil. Using a trowel, carefully remove the top one-inch layer of soil from the area, placing the soil in a paper bag. Then remove the next one-inch layer, placing this sample in a second bag. Repeat this for the third, fourth, and fifth-inch layers. Label each paper bag for the depth of soil layer it contains.
- Divide students into five groups. Each group should have a newspaper on which to spread the soil, tweezers or a large needle, and a magnifying glass. Have each group inspect a sample of the soil layers to find as many kinds of plants and animals as possible, and keep a record of the number of each in each layer. The various kinds of plant roots may be placed in separate piles. Put each kind of animal in a separate jar according to the following groups:

  Worms—earthworms or night crawlers, having no legs

  Insects—ants, beetles, bugs, all having three pairs of legs

  Insect larvae—wormlike organisms with three pairs of legs

  Snails—those without shells called slugs

  Spiders—small animals having four pairs of legs

  Others—small animals having more than four pairs of legs, e.g., centipedes, millipedes, pillbugs

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* Adapted from Ashbaugh and Beuschlein (U. S. Soil Conservation Service) *Things To Do in Science and Conservation,* Interstate Printers and Publishers, Inc., Danville, Illinois, 1960.

- After the soil has dried sufficiently, it may be sifted through one-half, one-fourth, and one-sixteenth inch mesh sieves and divided into separate screened piles to determine the animal and plant fragments left in it. How do the materials found in the various blocks or layers of soil differ? What is the total number of plants and animals found in that one square-foot of soil? Estimate the total number of plants and animals per acre of land (an acre equals 43,560 square feet).

Water Intake of Soil*

To discover that the rate of water intake determines the amount of water that runs off an area, take a field trip to several dissimilar vegetation-covered locations, such as a woodland, a grazed woodland, fence row, heavily-grazed pasture land, and an eroded cultivated area. Take along several large-size juice cans with the bottoms cut out, a small board, hammer, ruler, watch with a second hand, pencils and paper, a quart measure, and some water.

- In each different area visited, set a can in the ground two inches deep. Do this by placing the board over bottom of can and pounding with the hammer. Add a quart of water and then record for each location the following information:
    1. Place
    2. Condition of soil
    3. Presence of leaves or sticks
    4. Time when quart of water was added
    5. Measure the amount of water that moved downward (into the ground) at the end of each minute for the first ten minutes. Thereafter, note the lowered water level in the can every ten minutes, half-hour, or hour, depending on the rate of water movement.

- Upon returning to the classroom, compare the rates of water intake by the soil in each area tested. Was there a difference in the time it took the water to disappear into the ground? Try to explain why there was a difference in time. Which soils had the greatest water intake? Did these soils contain organic matter? How can farmers and gardeners improve the water intake of their soils?

Forest Floor and Water Retention**

- Visit an ungrazed wood lot and note how easy the forest floor is to walk on and the spring it gives to the step. Examine the forest floor to find the reason for this.
- Of what is the top layer of the forest floor composed? What happens to the material if a handful is squeezed? If the humus is dampened, can water be squeezed out of it? From these findings, explain why it is recommended that trees be planted on the headwaters of streams, around reservoirs, and on high farm land.

Vegetation and Water Evaporation

- To see how vegetation affects water evaporation, place some flat pans around the school grounds on a day when rain is expected. In areas where it does not often rain, place a quart of water in each pan.
- Place one pan under a tree with no shrubs, another under shrubs growing under a tree, and one in an open area. Observe what happens after a rain. Which one has the most water? Explain why.
- Leave the pans and observe them for a few days. Does the amount of water remain the same in each pan or has some of the water evaporated? Try to explain why the water evaporated from some of the pans more quickly than others. How does this affect the way plants might grow in each area?

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* Adapted from *Soil and Water Activities*, U. S. Department of Agriculture, Soil Conservation Service, Washington, D. C.

** Adapted from *Conservation*. Camp Fire Girls, Inc., 65 Worth Street, New York 10013 (a collection of activities).

Erosion by wind and water made these dramatic sculptures in volcanic rock of Central Oregon. Sometimes fossils are found in rock formations such as this.

Kinds of Erosion

- A field trip to areas where erosion has taken place will reveal different kinds of erosion, such as sheet, gully, wind, stream back, and splash erosion. How might these be controlled by man?
- Photographs or sketches made by students showing the different forms of erosion found might be mounted for a classroom display.
- To demonstrate the effects of splash erosion, splash boards can be made as follows: Take two boards about one inch thick, four inches wide, and three and a half feet long. Saw one end of each to make a pointed stake. Paint each with white enamel and calibrate each stake by marking lines across the board at one-foot intervals, beginning at the unpointed end. On the top of each board attach a wooden or tin shield to prevent rain from washing off the paint.*

  Drive the two stakes into the ground, one in loose bare soil, and the other in either sodded or mulched soil. After a heavy rainfall examine the stakes. How high did the soil splash on each stake? Compare the difference in amount of soil splashed and the height it splashed on each board.
- Another simple way to observe how soil is removed by splash erosion is to place some flat stones on bare soil. After a rain, observe what happened to the stones. Why do they seem to be standing on pedestals?
- Using the findings from these experiments, explain why farmers use cover-crops, crop residue, or mulch on the land?

Measuring Soil Loss

How valuable topsoil is being lost to erosion can be observed from one of the following experiments:

- In a cultivated field with a good slope, dig a small hole just deep enough to get below the topsoil. Cut off a slice of the soil and lay it on the ground. What is the depth of the topsoil? How are the particles held together? Are the particles in large lumps (clods) or is the soil crumbly?
- In a fence row at the edge of the field, at about the same level on the slope as the first hole was dug, dig another hole. Study the soil from the fence row as was done with the first sample. Compare the two soils. How do they differ?
- Locate a cultivated field that has a moderate to heavy slope and has been under heavy cultivation for a long time. Measure the thickness of the topsoil at the top of the slope and again at the bottom. This can be done by digging a straight-sided hole deep enough to reach the subsoil. The topsoil can be identified by its darker color and the presence of roots and plant remains. Is there any difference in the amount of topsoil at the top and the bottom of the slope? Is the soil moving downward?
- Find the beginning of a gully in a cultivated field. Try to locate one that is cutting deeper and farther into the field with each rain. Using three pegs, drive one 10 to 15 feet above the gully head and one 10 feet each side of its beginning. After each rainfall, measure the distance of the stakes to the edges and the beginning of the gully. Keep a record and compare the measurements. How fast and how much does the gully grow? Find how many cubic feet of soil has been lost by multiplying the average depth of the gully by the average width, and then by the length. Convert these measurements to feet; this figure gives the number of cubic feet lost.

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* Adapted from *Teaching Conservation—A Classroom and Field Guide*, U. S. Department of Agriculture, Soil Conservation Service, Washington, D. C., (Contact Local Conservation Agency for this publication).

AQUATIC COMMUNITIES

PONDS

It is glorious to behold this ribbon of water sparkling in the sun, the bare face of the pond full of glee and youth, as if it spoke the joy of the fishes within it, and of the sands on its shore,—a silvery sheen as from the scales of a leuciscus, as it were all one active fish. . . .

—Henry David Thoreau, *Walden*

Ponds provide excellent material for study in many areas of science—aquatic animals in all stages of development may be collected, the interrelationship of living things may be studied, and the behavior of birds, frogs, reptiles, and other vertebrates may be observed. Lily pads in fish ponds are floating nurseries for snails, aquatic insects, and rotifers. During the late winter and early spring fairy shrimp may be found suspended in the icy water of temporary ponds. Ponds in marshes or old river beds are often nearly filled with plants which harbor many kinds of organisms on their stems and leaves.

WHAT TO DO AND WHAT TO LOOK FOR

Physical Features

- Before studying the pond as an ecological community, encourage the students to obtain accurate data on the condition of the water, bed, banks, and drainage of the pond.
- *Water*—Find the temperature of the water at the surface, near the bottom, and just below the bottom. Is the temperature the same near the shore as it is near the middle of the pond? If there is a bridge or walk across the pond, or if it is possible to take a small boat out on the pond, try to learn something about the transparency of the water by lowering an object into the water and measuring the distance at which it can just be seen. What color is the water? How deep is it? Does the water level change in summer? Is there evidence of pollution?
- *Bed*—What kind of material is found on the bottom of the pond: mud, sand, gravel, boulders? What percent of each kind of substratum is present? What kind of parent material supplied the rocks found at the bottom? How deep is the mud?
- *Banks*—How high are the banks? Do they overhang the pond? Slope? What kind of material forms the bank: mud, sand, gravel, rock? Compare the material with other geological features in the area.
- *Drainage*—What is the source of water in the pond? Into what body of water does the pond drain? Is there a current in the pond?

Floating Nurseries

- Collect some of the lily pads or other floating leaves and examine the undersides to discover how the plants in a pond support animal life. Students should be able to find snail and beetle eggs, damsel flies, caddis flies, and other aquatic insects. (See "Aquatic Insects" chart, pages 58–61.) There may be larvae of a number of insects as well as rotifers, sponges, and water mites.
- Are all of the snail eggs in the same stage of development? Do some of the insects prefer one kind of plant over another? What kind of eggs are found most frequently on one kind of leaf?
- The lily pads may be taken to the classroom and placed in an aquarium for use during a study of reproduction.
- Examine the underside of floating leaves through a microscope.

Insect Life

- Most ponds are teeming with insects, and a systematic survey of a single pond will reveal many different species in many stages of development. Such a collection would fit in well

(Continued on page 62.)

AQUATIC INSECTS*

1. **May Flies** *(Ephemerotera)*

   May flies are abundant in streams and lakes and can be found in practically all fresh water throughout the state. The nymphs are found on the undersides of rocks or other underwater objects. They have two or three tails. The wings of the adult are held in an upright position while resting.

2 **Dragonfly** *(Odonata)*

   Dragonflies are found in all types of fresh-water areas; ponds, lakes, streams, and swampy areas. The nymphs can be found crawling about on the bottom, on aquatic plants, or on other underwater objects. They are one of the largest aquatic insects; most of them are dark brown to greenish as juveniles and change to brighter colors as adults. When resting, their four wings are held outstretched.

3. **Stone Fly** *(Plecoptera)*

   Stone flies seem to require running water in which to live. They are never found in lakes except in inlets and outlets. When the adult is resting its wings lie lengthwise upon the back. Nymphs are found in abundance only among the rocks in streams. Stone fly nymphs have two long and stiff tails.

4. **Water Boatman** *(Hemiptera)*

   Boatmen are found in nearly all waters. They swim in an erratic pattern underwater, and usually are found in slow-moving waters. Boatmen are normally brownish in color and equipped with leathery wings.

5. **Water Strider** *(Hemiptera)*

   Water striders are a familiar sight on the surface of slow moving waters, ponds, and lakes. They resemble long legged spiders. Although equipped with wings, they are rarely observed in flight. Their color is usually brown to gray. Many persons call them "water skippers".

6. **Caddis Fly** *(Trichoptera)*

   Caddis flies are found in nearly all lakes, streams, and ponds. During their underwater life, they live in cases made from sticks and small particles of rock. These can usually be seen moving about on the bottom. When the adults are at rest the wings are held roof-like over the body and sloping down at the sides. The adults are generally dull brown or black in color. Sometimes the larvae are called "penny winkles" by fishermen. "Periwinkle" is another common name.

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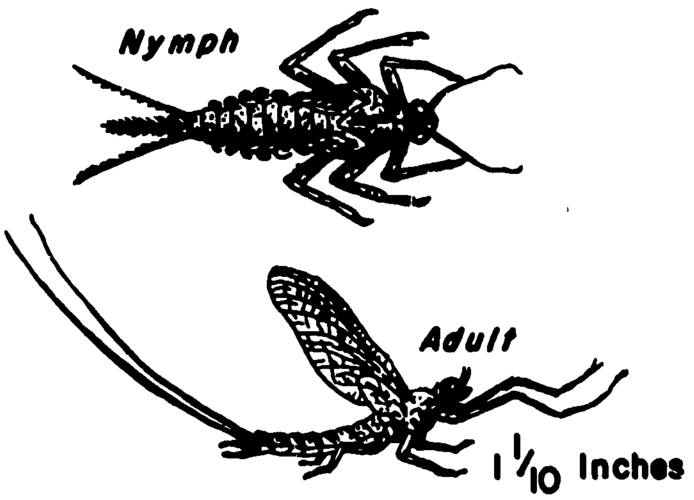
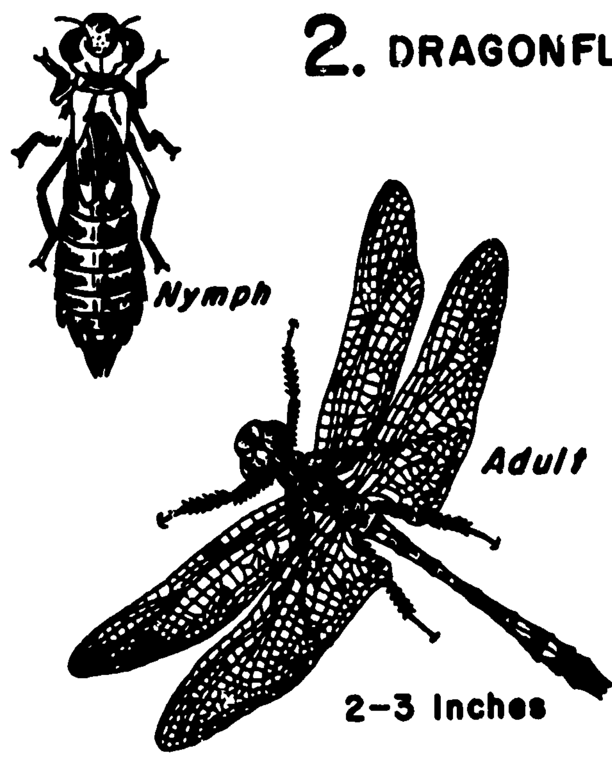
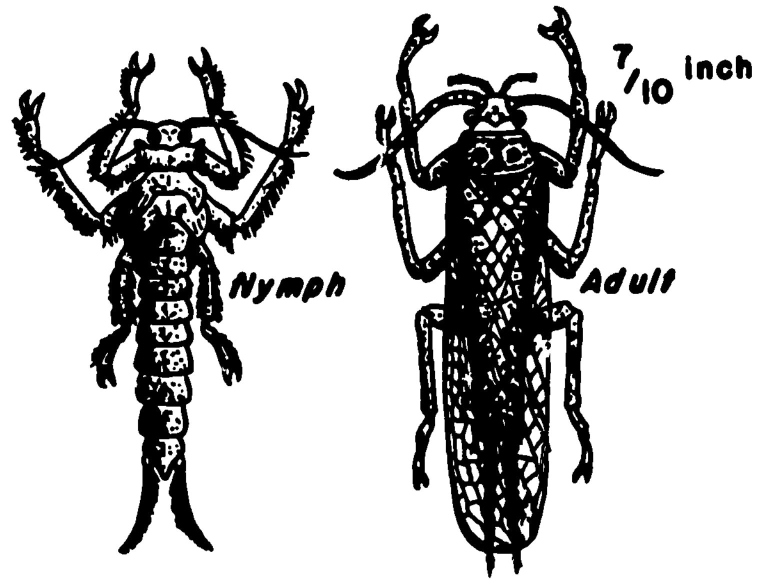
* *Field Study Notebook for the Outdoor School, op. cit.*, pp 46–49.



1. MAYFLY

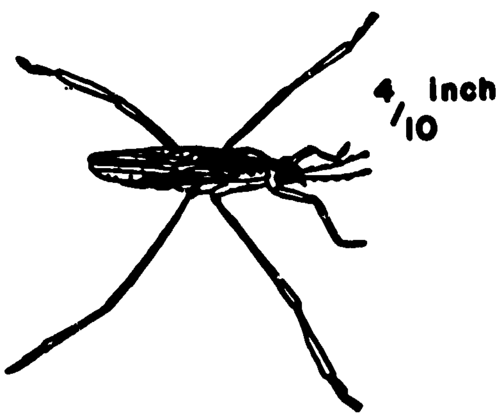


2. DRAGONFLY

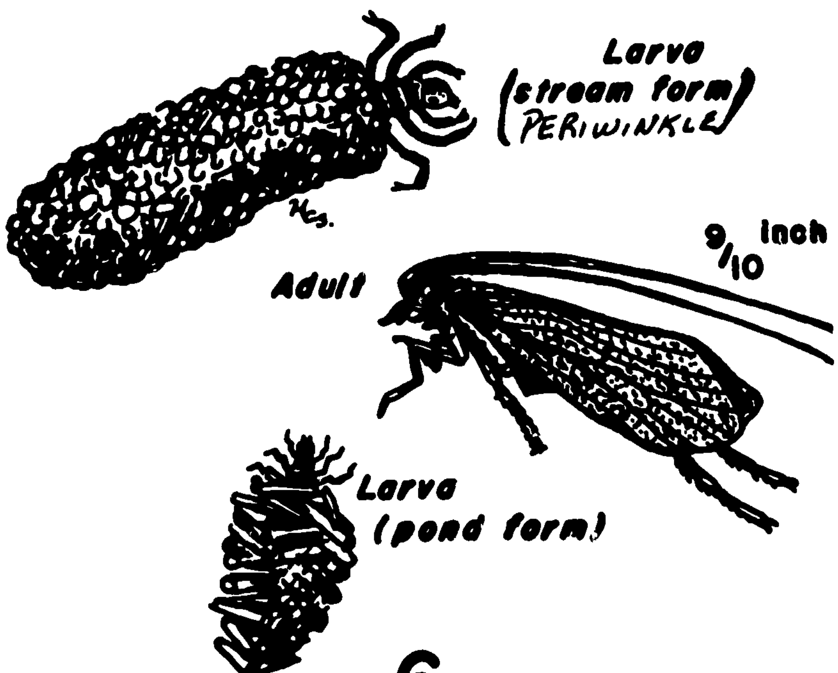


3. STONEFLY

4. WATER BOATMAN



5. WATER STRIDER



6. CADDISFLY

7. **Whirligig Beetle** *(Coleoptera)*

These beetles are found on the surface of slow-moving waters where they take advantage of the surface tension. The whirligig beetles, true to their name, whirl or swim on the water's surface. When disturbed, they dive frequently under the water. Their bodies are dark colored and robust, and the front legs are long and slender.

8. **Crane Fly** *(Diptera)*

The larvae of the crane fly are found in the scum of shallow waters, in the damp soil along streams or lake shores, and in marshy areas. The adults are never truly aquatic and may be found great distances from water. The adults look much like giant mosquitoes without a beak.

9. **Mosquitoes** *(Diptera)*

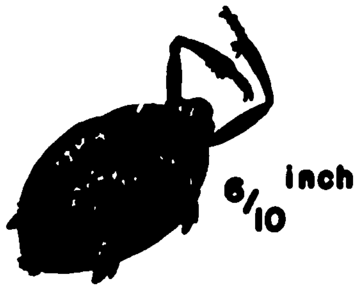
Mosquito larvae are usually found in stagnant slow-moving water. Most people are familiar with the appearance of adult mosquitoes and know that they are more abundant around marshy, damp areas. The young are often called "wigglers" and can usually be found wiggling about just under the water's surface. Contrary to popular belief, not all mosquitoes bite, the males just buzz and are not equipped for biting.

10. **Black Fly** *(Diptera)*

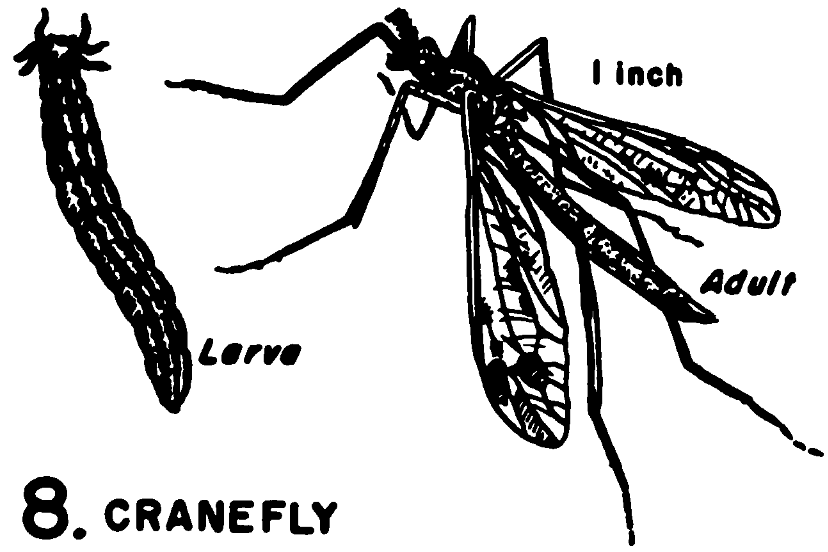
Black fly larvae are found only in flowing water on stones, vegetation, or other objects, usually in the swiftest part of the stream. In many cases, the larvae are so numerous they appear moss-like over the surface of the attached object. Later in life, they live in a cocoon which is customarily a boot-shaped structure. The black fly as the name implies, are usually dark, compactly built flies, with rounded back and short broad wings. The adults may be found great distances from water.

11. **Midges** *(Diptera)*

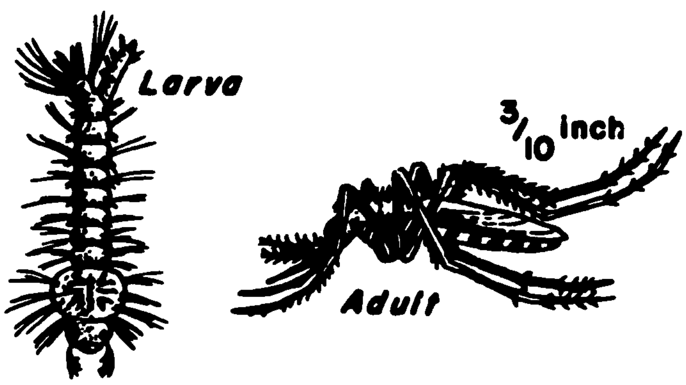
Midge larvae are most abundant in the shallow water areas of lakes, ponds, and streams favored by a heavy growth of aquatic plants. They prefer soft mucky bottoms, as they are a bottom-dwelling species, and need this type environment for constructing their tube-like homes. Larvae live in soft tubes; however, during later life, they are found living in silken cocoons or gelatinous cases. The adult midges look much the same as mosquitoes. Their antennas look like two feathers on the front of their heads and they don't have beaks.



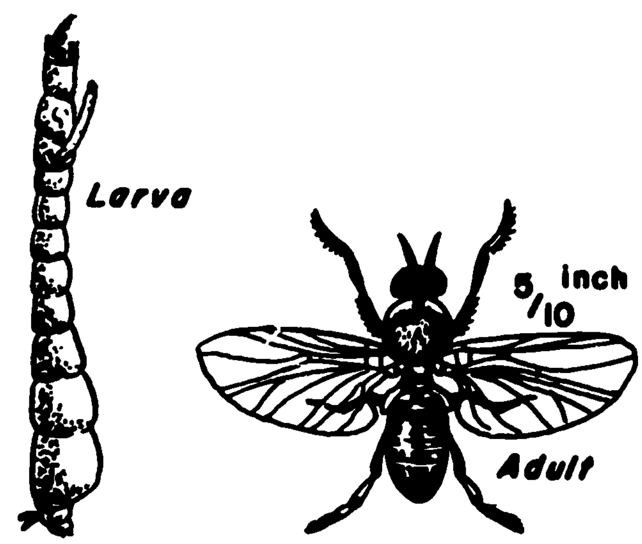
7. WHIRLIGIG BEETLE



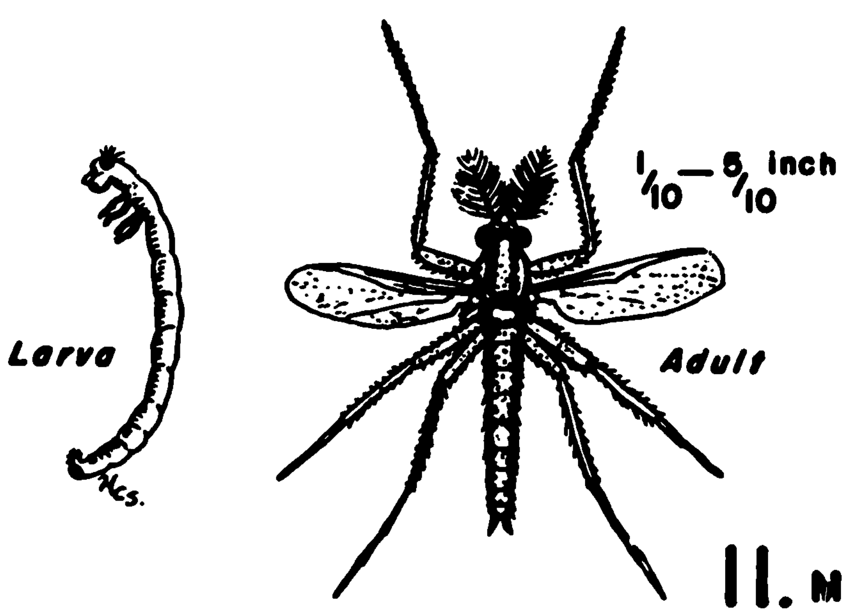
8. CRANEFLY



9. MOSQUITO



10. BLACK FLY



11. MIDGE

with a unit on reproduction. Other classes may want to study the adaptations for food getting, breathing, or movement of pond insects. (See "Aquatic Insects" chart, pages 58–61.)

- Let the students collect insects from the following places: on surface of the water, under rocks, in open water below the surface, on living plants, in the trash near the shore, and in or on the mud at the bottom of the pond. Keep those found in each place separate from the others and place in an appropriately labeled jar of pond water.
- Do those which live on top of the water have any characteristics in common? Are larvae found more abundantly in one place than another? Where are eggs apt to be found? How do the insects which live in the water get air?
- If there are a number of water striders on the pond surface, try feeding them by tossing ants or other small insects on the water surface. Watch the water striders pounce on their prey. Do they break through the water film? Can they run on the water? How? What kind of mouth parts do they have? Find the little red water mites which are parasites on the striders. (See "Aquatic Insects" chart, page 59.)
- Backswimmers, water boatmen, and whirligig beetles frequently can be found swimming in pond water. Watch these insects collecting air. What do these insects eat? What adaptations do they have for moving through the water? What other types of adaptations for motion can be observed among the pond insects? (See "Aquatic Insects" chart, pages 59, 61.)
- A search through the mud near the shore may reveal the larvae of the dragonfly with their peculiar food-getting structures. Dragonflies are harmless and useful because they feed on mosquitoes. Dragonfly nymphs eat the aquatic larvae of mosquitoes, too. (See "Aquatic Insects" chart, page 59.)
- Small groups of students might each select a particular insect to study, watching carefully for habits of food-getting, breathing, motion, escape, etc.

Ecological Community

- As in other ecological communities, every living thing in a pond provides food for some other living thing. Many fascinating days at the outdoor laboratory may be spent studying the balance of life in a pond. What happens to the billions of crustacea (cyclops, ostracoda, etc.) that feed upon the algae? How do these animals escape from being eaten? What feeds upon the animals that eat the crustacea?
- Since all the organisms in the pond are dependent upon their environment, the first part of the study should be concerned with the physical features of the pond. Later studies then consider the zonation of plants in the pond and the particular animals associated with each group of plants. Separate trips may be made to study each different association, to study communities in winter, fall, and spring, or to study associations at different times of the day.
- Near the shore, the emergent water plants may be found—those growing with roots in water but with their stems and leaves in air. The cattails, reeds, marsh grasses, and bulrushes are the most common. Examine the stems below the water line for algae, worms, crustacea, some egg masses, and the larvae and pupae of some insects. Above the water may be found empty pupa cases from which the adults have already emerged.
- The surface of some ponds is often entirely covered with floating duckweed, the smallest flowering plant, and with Azolla, the tiny water fern, as well as masses of algae. (See "Fresh Water Organisms," page 66.) Search this community for the myriads of water organisms living on or among these plants.
- Rooted to the bottom of many ponds are Nitella, Elodea, water lilies, and varieties of pondweeds. Attached to their leaves and stems are many tiny water animals (snails, hydra, insects) and swimming among the leaves may be fish, frogs, turtles, crayfish, and salamanders.
- In the decaying vegetation at the bottom of the pond is a still different community. Sieves and dip nets may be used to collect these organisms. If the catch is dumped into a white enamel pan, the search for organisms will be simplified.
- What are the characteristics of the plants that live along the shore? Plants that float? Plants that are rooted? How do plants along the bank contribute to the food of the pond animals?
- How do the animals on the bottom of the pond differ from those at the surface? How do their food-getting habits differ?

Plankton

- Plankton, the minute plant and animal life in water, form the first step in the complex food chain of aquatic animals. Students may collect floating surface plankton from a pond or lake by using a dip net or a long-handled net, or they may make a special net for which they will need a wire hoop (made from a coat hanger or heavy wire), a discarded nylon stocking, and some string. The hoop may have to be weighted in order to submerge the stocking.
- After the net is drawn through the water for a few minutes, it may be hauled in and the stocking turned inside out over a white enamel dish with a little water in it. Students may see the activity of such animals as crustacea (copepods, cladocerans, etc.).
- Samples of the water examined under a microscope should reveal a variety of protozoa, rotifers, and many eggs of animals. (See "Fresh Water Organisms," page 66.)
- Plants that are likely to be found in plankton include algae of various types, e.g., desmids and diatoms.
- Is the pond water clear or murky as samples are taken? Is any of the murkiness due to silt or clay, or is it due to millions of tiny plants and animals growing in the water? What observations can you make with a magnifying glass? With a microscope?

STREAMS

A stream, like a pond or lake, may provide many opportunities to study adaptations or habitats and to compare plant and animal life in differing bodies of water.

WHAT TO DO AND WHAT TO LOOK FOR

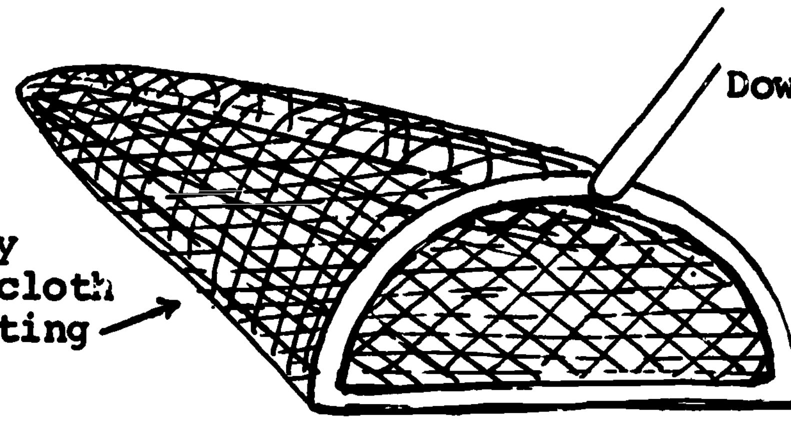
- Floating in quiet backwaters or pools, a tiny green plant with leaves about one-eighth inch in size is often found. Frequently this plant carpets large areas of the water's surface. These plants are called duckweed. They are among the smallest flowering plants and grow well in classroom aquaria. Also, in quiet pools will be found greenish slime or threadlike plants floating in the water. These are algae. A microscopic examination of these kinds of materials will introduce an entirely new dimension of living things to students. (See "Fresh Water Organisms," page 66.)

  A drop of water from the "scummy" part of these waters placed under a microscope will introduce hundreds of "invisible" organisms to children. The common ones will be paramecium, vorticella, stentor, rotifers, euglena, eudorina, and many other "oddities." (See "Fresh Water Organisms," page 66.)

  By placing rocks and plants in jars and viewing them through a hand lens children can observe larger creatures such as waterfleas (daphnia), hydra, planaria, roundworms, and leaches. Many parasites can also be seen attached to frogs, salamanders, and crayfish. (See "Fresh Water Organisms," page 67.)
- Many stages of the life cycles of insects are present in the mud or shallow waters of quiet streams. Spiders may be found on shore near the water's edge.
- Minnows, suckers, and sunfish are often seen in streams while frogs, turtles, and snakes are found near or on the shore. Are there trout or salmon in this stream?
- Look for birds that build nests near streams, and for such mammals as muskrat and beaver which make streams their home.
- Such physical factors as water temperature, hardness, turbidity, concentration of minerals, oxygen content, acidity or alkalinity, depth, velocity, type of stream bottom, type of shore, and presence of obstructions in the stream may be measured and the effects noted in terms of their influences on plant and animal life.
- Changes in stream population during flood, drought, and winter can be noted. Make observations regarding adaptations to aquatic conditions.
- In small streams an ecological succession may be started by constructing a small dam or submerging a log.
- Compare the kinds of living things in a slow-moving and a fast-moving stream. Are the organisms in a rapid stream more active than those in a quiet stream? Which organisms live in the stream's current and which abide on the banks or edges of the stream? How does the structure of the animals in the two habitats vary? Where are the animals most numerous?

A stream is more than a place to get wet. It provides the environment for many living organisms; it forms part of the environment for other organisms; and from man's point of view, it determines much of the economy and politics of the entire area through which it flows.

- A similar comparison of the plant and animal life from a shady and a sunny portion of the stream would be interesting. Are there differences in the number and kinds of living things in the two sections? How do the temperatures of these two areas compare? How does shade influence plant life? Advanced classes may want to determine the amount of oxygen present in the two areas.
- A study of food chains in the stream would include parasitism, predation, scavengers, and decay-producing organisms.
- One type of dip net, shown in the following diagram, can be made from cheesecloth or netting. Set the net in the water so the opening of the bag faces upstream. Stir up the stones, gravel, sand, or mud near the bottom so that material will be washed into the sack. Rinse



the sack into a white porcelain pan, then count and try to identify what has been found. Look for free-swimming and free-floating organisms, amphibians, aquatic vertebrates and invertebrates. Use the net or the hands to catch larger specimens also. Which live in fast-moving water? Which in slow-moving water?

COASTAL COMMUNITIES

Oregon's coastal shoreline provides many unique and stimulating learning experiences, but it is also a hazardous area and teachers undertaking field trips with students must make students aware of the dangers involved.

The buddy system should be used at all times and students cautioned to stay with their partners. They should walk, not run, over the rocks and driftwood. Seaweed covering the rocks has a gelatinous coating and is dangerous footing. They should watch for deep pools hidden by seaweed. It is also unsafe to stand or sit on logs near the water's edge because the force of an unexpected or unusually high wave may roll the log, injuring the person upon it.

Offshore currents are treacherous, tides change quickly, and children can be stranded on offshore rocks. Open knives and glass containers should not be carried by children as serious injury could result if a child slips and falls.

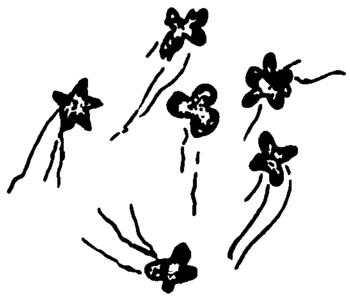
Many curious things that have washed ashore may be found on a sandy beach near the high tide line, including harmless treasures as well as interesting organisms that find shelter in the litter. Here, too, may be remains of jellyfish containing a substance that may sting or injure the skin. Children should be warned about picking up such jellylike materials.

In an effort to prevent the depletion and eventual extinction of some marine organisms, the Oregon Fish Commission has adopted administrative rules pertaining to the collection of or injury to tidal specimens. Under Section 10-670, "It is unlawful for any person to have in possession, take or molest animals living intertidally on the bottom or in the waters of this state, except as authorized by statute or Fish Commission regulation."

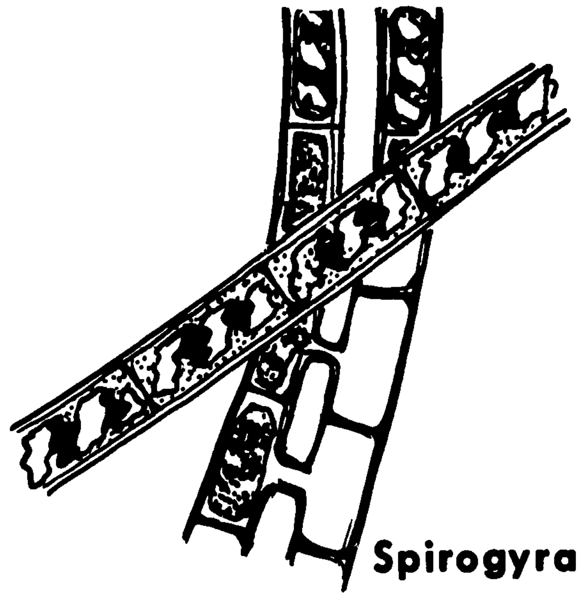
Collection permits may be obtained for the following areas: Boiler Bay, Depoe Bay, Yaquina Head, Sunset State Park, Cape Arago State Park, and Harris Beach State Park.

Collection permits and additional details may be obtained by submitting a written application in the form of a letter or on the appropriate Fish Commission form. Such application must include the following: (1) name and address of applicant, (2) species and number of each species to be collected, (3) dates of collection (include an explanation of the need for specific

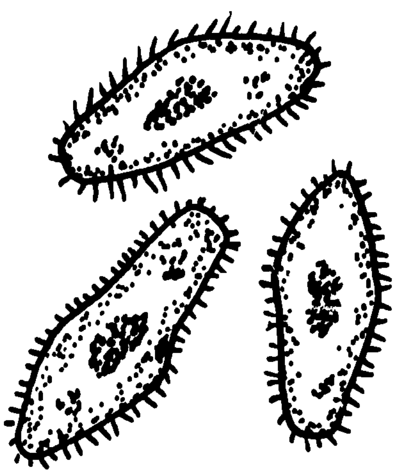
FRESH WATER ORGANISMS



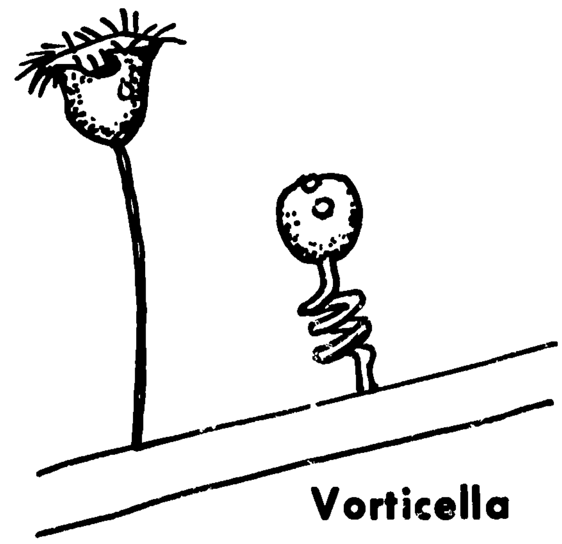
Duckweed (Lemna)



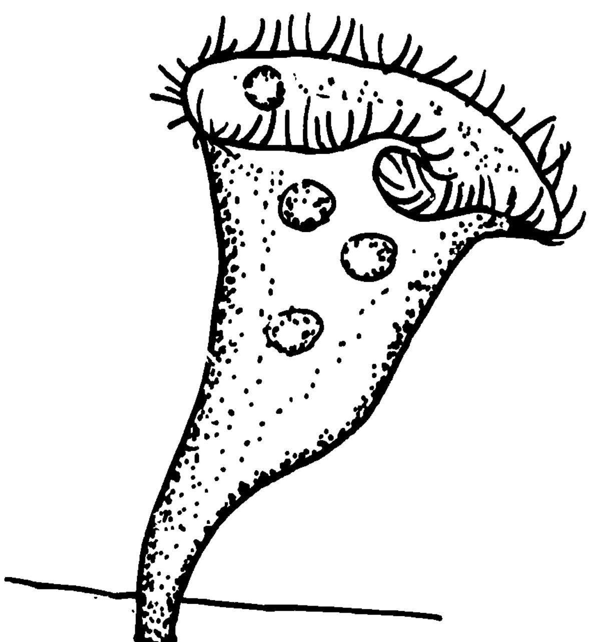
Spirogyra (Algae)



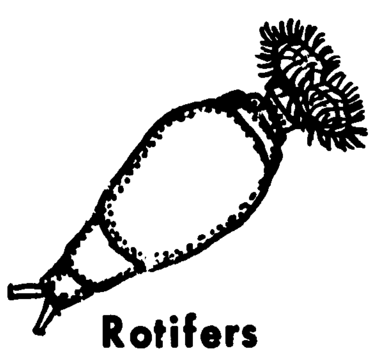
Paramecium ("slipper" animal)



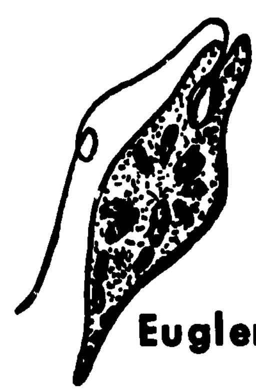
Vorticella



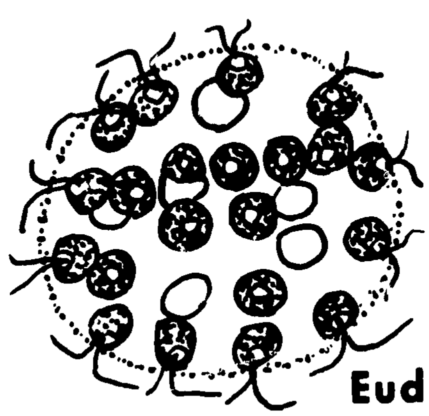
Stentor



Rotifers

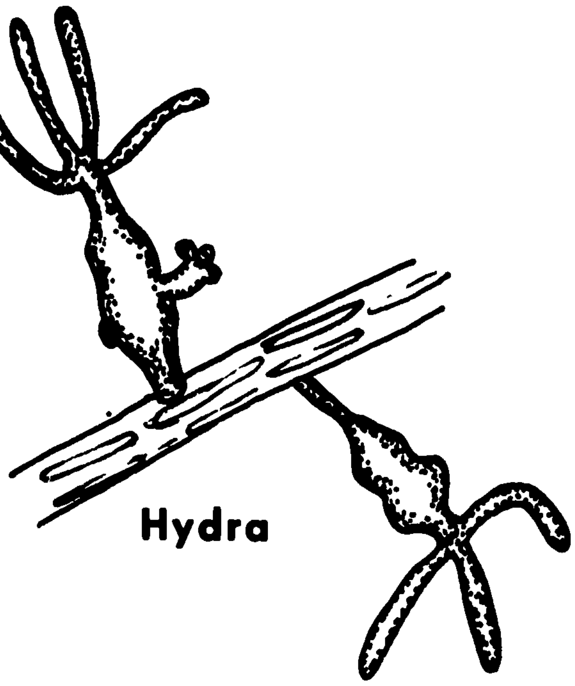


Euglena

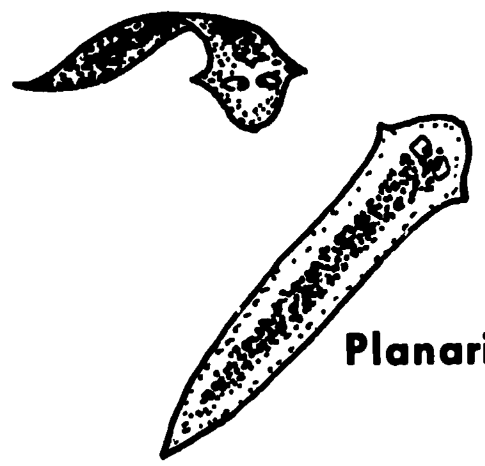


Eudorina

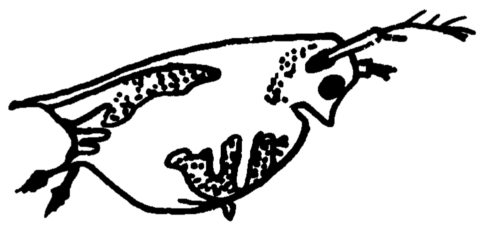
FRESH WATER ORGANISMS—Continued



Hydra

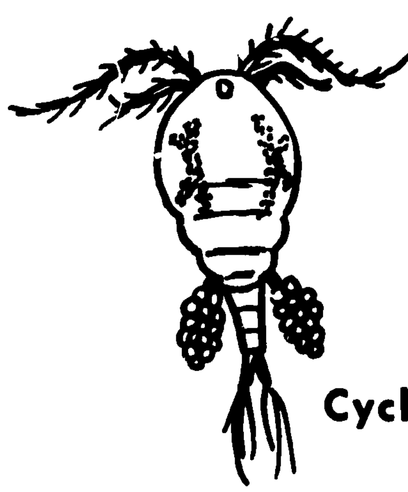


Planaria



Daphnia (water flea)

Leeches



Cyclops

dates), (4) area(s) of collection, and (5) purpose(s) of collection. Applications should be mailed to the Oregon Fish Commission, Shell Fish Investigations, Marine Science Center, P. O. Box 157, Newport, Oregon 97365.

Most visitors to the coast are tempted to collect starfish, sea urchins, and tiny crabs. Unless properly preserved in formaldehyde and later dried, these organisms will not become a very satisfactory part of the school specimen collection. Generally, the rule of leaving organisms in the outdoor laboratory, where they may be studied year after year as living creatures, should be followed. A good conservation practice is to replace every animal where it is found. If a rock is turned over in a search for living creatures, it should be put back in its original position because changing it changes the habitat and some animals might not survive the change. (An exception to this rule is when arrangements for transporting and properly caring for live specimens have been made in advance of the field trip.)

To satisfy the natural desire of children to collect specimens and "souvenirs" of their field trip, their attention may be directed to the empty shells of snails, clams and mussels, to agates and other unusual stones, to pieces of driftwood, and similar plentiful flotsam. Some of these can be used later in the classroom for learning situations of many kinds.

OREGON'S TIDES

A successful beach trip involves some knowledge of the characteristics of ocean tides. Even though Oregon's tides are usually quite moderate, the time and size of the tides will greatly influence the activities and value of the trip.

WHAT TO DO AND WHAT TO LOOK FOR

- Daily newspapers west of the Cascades generally carry current tidal information for the nearest coastal location. Sporting goods establishments often have tide books that can be checked or purchased.
- The size of tides varies from day to day. The largest tides occur approximately every 13 or 14 days. The best opportunity to observe the lower reaches of the beach, tidal pools, and a great variety of tidal action, is during the period of the spring tides.
- Have students answer the following questions about tides. Why is low tide probably the best time to begin beach exploration? How long is it from low tide to high tide? What evidences can you see of the highest reach of the ocean's waters? Can you tell how high the previous high tide came? How far up a creek or river has the tide come? What evidences can you note of wave or tide action on the various types of shoreline? How might the tide affect the lives of people who live along the coast?

Gather a shell from the strown beach
And listen at its lips: they sigh
The same desire and mystery,
The echo of the whole sea's speech.

—Dante, *The Sea Limits*

TIDE POOLS

A trip to a protected rocky area along the coast can provide one of the most exciting discovery days of the year. Check the tide tables for an afternoon with a good low tide. Plan to arrive at the tide pools *before* the time set for low tide. Using the buddy system, and following the safety precautions outlined above, allow the students to explore the tide pools in a systematic manner. The following activity guide has proved useful for some classes and can be modified to meet the conditions found in various places along the Oregon coast.

Low tide on the Oregon Coast develops a wonderment of nature by the inquiring mind. In a single tide pool, there is a highly populated community of diverse organisms . . . and there is always so much to see and do.

I must go down to the seas again, for the call of the running tide
Is a wild call and a clear call that may not be denied;
And all I ask is a windy day with the white clouds flying.
*And the flung spray and the blown spume and the sea gulls crying.**

—John Masefield, *Sea Fever*

First—At Lowest Tide

- Follow the tide out by going to the rocks at the very edge of the water. Here will be found mussels and barnacles fastened to the rocks.
- What holds the mussels and barnacles so tightly? Try to pull one off and then look for the worms living under the mussels. Are barnacles attached to anything besides rocks? Watch barnacles closely in a tide pool kicking food into their mouths with their feet. What is the temperature of the water? (See illustration No. 1, page 72.)
- Now look at the sides of these rocks and in the cracks to find several kinds of starfish; chitons (look for black, colorful lined, mossy, and giant red ones); plume worms; tube worms; sponges (look for a red sea slug on a red sponge); sea cucumbers; yellow or spotted sea slugs. (See illustrations No. 2, 3, 4 and 5, page 72.)
- Remove a starfish from a rock; put it on its back and watch it turn over. How long does it take? Try to find a starfish eating. What is it eating? Are all starfish eating the same things? Watch the tube feet. Look for starfish which are regenerating arms.
- Sea urchins are everywhere in little pockets in the rocks. Remove one from its hole, hold it for a moment and see what happens. How is it like a starfish? Try to remove a chiton from the rocks and look for its mouth and tenacles. To do this it is necessary to insert a dull knife blade under its shell before touching the top of the shell. Other animals just as hard to remove are the limpets. If a keyhole limpet can be found, look on the underside near the shell for a commensal scale worm. Another limpet, the dunce cap, is covered with a hard coral-like algae which makes it difficult to recognize. Do not injure the animals. (See illustrations No. 2, 6 and 7, pages 72–73.)
- Several kinds of snails live on these rocks. The largest is a carnivorous snail with leafy-like ridges on its shell. If any purple snails are found, try to find their eggs which look like, and are often called. "sea oats." Other snails to look for are turban snails, top snails, spire snails, olive snails, and drills. (See illustrations No. 8 and 9, page 73.)
- In cracks and crevices, and under the mussels, little animals called isopods (sea-going pill bugs) and amphipods (which hop around like fleas) will be found.
- Before leaving this low-tide area look toward the ocean and observe the seaweed floating on the water. How many kinds of kelp are found here? In the deepest pools some fragile red algae may be found. Do not get stranded on an island of rocks as the tide comes in.

Second—In the Tide Pools

- Now go shoreward and find a quiet tide pool. Here a large green sea anemone will probably be found. Put a finger in the anemone's mouth. Try feeding another. Look around for other sea anemones, such as a large red-beaded one or a tiny pink one with many little "baby" sea anemones around its base.

These tiny ones live well in a salt water aquarium so if found on a rock that is easily removed the students may wish to take it back to the classroom. Try to find other kinds of anemones. (See illustration No. 10, page 73.)

- Look for shrimp darting around in the tide pools. Some will be green, some will have "bent backs." Probe around in the seaweed for kelp crabs. Several kinds of fish make these pools their home. It won't be hard to find a clingfish slithering around on the darker sides of rocks or the bleeny eel hiding under rocks. Sometimes beautiful iridescent sea slugs crawling on top of the water will be seen. If the students are lucky they may find an octopus.
- How many different kinds of empty snail shells can be found in the tide pools? These may be collected for taking back to the classroom. Shells of clams, limpets, or chitons (which look like white butterflies) may be collected for later study, too.
- Plants grow in profusion in tide pools. The brown seaweed, *Fucus* or rockweed, always forms two branches every time it divides. The green seaweed, *Ulva* or sea lettuce, is about the size of a lettuce leaf but a much lighter green. Many other kinds of brown seaweed may be found here and, if time permits, may be mounted on white herbarium paper for a permanent collection. This, however, must be done at the beach while the seaweed is still fresh. Put the plants to be mounted into a plastic jar containing sea water.
- The most interesting starfish in the tide pools has twenty rays (or more) when it is mature. Immature forms have fewer arms. Don't be surprised to find that it feels soft and limp when it is picked up.

Nothing that is can pause or stay;
The moon will wax, the moon will wane,
The mist and cloud will turn to rain,
The rain to mist and cloud again,
Tomorrow be today.

—Henry Wadsworth Longfellow *Keramos*

Third—Near the Shore

- When the tide begins to come in, study a little closer to shore. Walk up one of the rocky tide channels. Here some of the same animals found in the tide pools will be observed. Turn over rocks and look for several kinds of crabs, brittle starfish, six-ray starfish, tube worms, and peanut worms. There may even be some clams nestled in the rocks. Are there many of each? (See illustrations No. 11 and 12, page 73.)
- A little closer to shore look for the purple shore crab and a baby octopus. On the sand-covered rocks near the beach, you will find eel-grass and some forms of algae growing. Pull up these plants and look on their roots or holdfasts for brittle starfish and peanut worms.
- In a tide pool close to shore, hunt for hermit crabs. How many different kinds of shells do they carry around? Try to get hermit crabs to leave their shells. Why are they called the clowns of the tide pools?

INTERTIDAL ZONES

The area between ocean spray level and the low tidemark on the beaches and mud flats has been divided into zones corresponding to the types of plants and animals occupying the region.

WHAT TO DO AND WHAT TO LOOK FOR

- Arrange a field trip for arrival at the chosen location just prior to low tide. Locate the bands running parallel to the ocean's level which are visibly marked in stripes of color. These bands, or zones, are composed of living things or types of material that reflect the stages of the tide.
- The length of time that a particular level of shore is not covered by water determines, in large measure, what can live there. One authority lists these zones as: (1) black zone, (2) periwinkle zone, (3) barnacle zone, (4) rockweed zone, (5) Irish moss zone, and (6) laminarian zone.

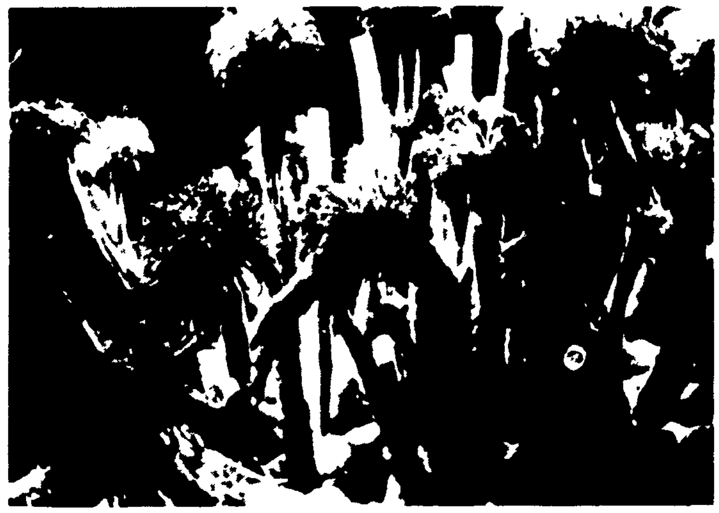
(Continued on page 74.)

TIDE POOL ANIMALS*

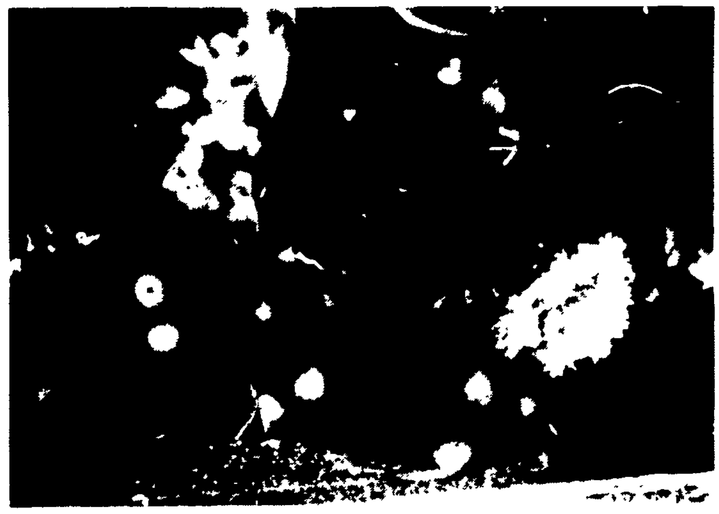
1. Edible Mussel

2. Brittle or Serpent Star

3. Black or Leather Chiton



4. Giant Tube Worms



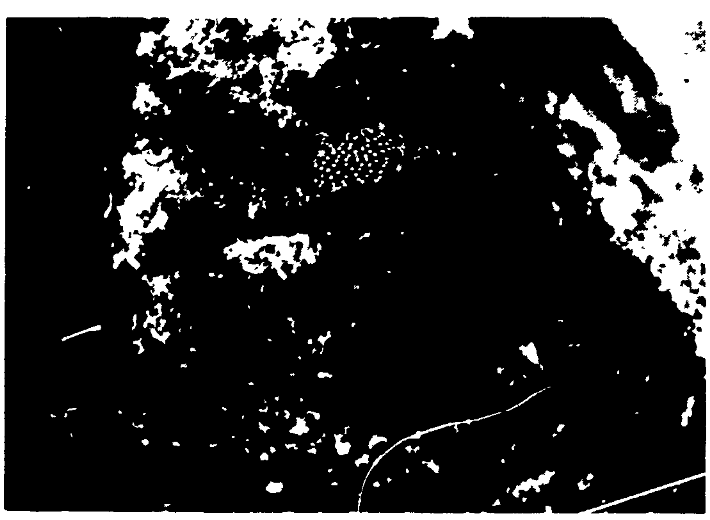
5. Large Red Sea Cucumber

6. Purple Urchin

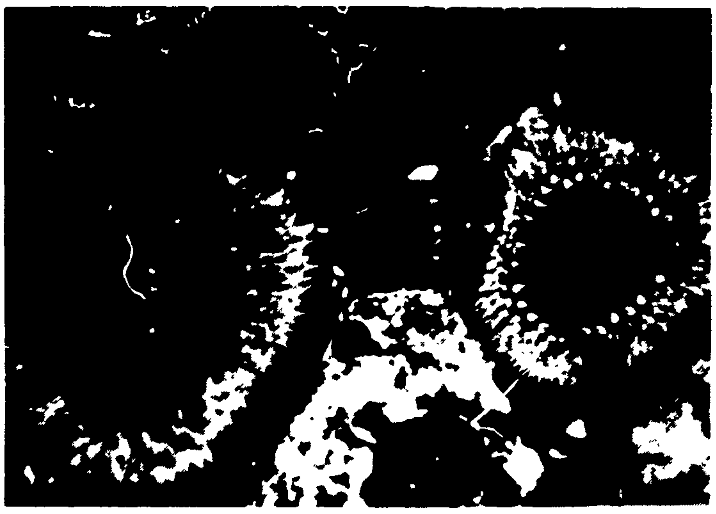
* Reproductions of selected slides from the "Seashore Life Series", Series L, Scientific Supply Company, 600 Spokane Street, Seattle, Washington 98134. Photographer J. W. Thompson, 5245 20th Avenue South, Seattle, Washington 98108.

7. Rough Keyhole Limpet

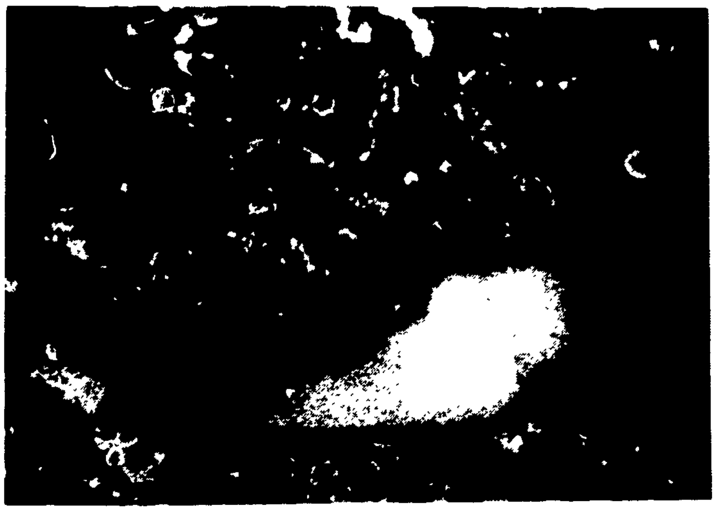
8. Periwinkle



9. Spotted Nudibranch



10. Aggregated Anemone



11. Peanut Worm

12. Hermit Crab in Empty Shell

- Locate tidal zones on the rocky bluffs. On sloping beaches. At what levels are seaweeds fastened to rocks? What are some of the things that cause the differences in the color of the bands or zones? What cautions seem to be necessary at the various levels?
- How do beach areas change from one tide to another?

SAND DUNES

Along some areas of the ocean beach sand dunes form a dramatic and colorful barrier between land and beach that presents unique features for student investigation. It is best to explore the dunes during September and October when the stiff coastal breezes and fog typical of midsummer die down and the coast has some of its balmiest days. Students should be encouraged to wear sun glasses and broad-brimmed hats for protection from sun and glare.

WHAT TO DO AND WHAT TO LOOK FOR

Wind and the Dunes

- Wind is both a builder and a destroyer of the dunes. Determine the direction of the prevailing winds. Observe the windward and leeward sides of the dunes and examine the sand closely, noting the size and shape of the grains. What general conditions seem to be necessary for the development of the dunes? (See following paragraphs on interrelationships of dunes and vegetation.)
- What evidence is there that the dunes are moving? In which direction are they moving? Which sides of the dunes are firmer? Why might residents resent disturbance of vegetation or even persons walking on the dunes on or adjacent to their property? Is there any evidence of efforts by people to control the dunes?
- How might wind velocity vary and what bearing does this have on dune development? (See following paragraphs on wind and dunes vegetation.) How can nearby trees help determine the direction of prevailing winds?

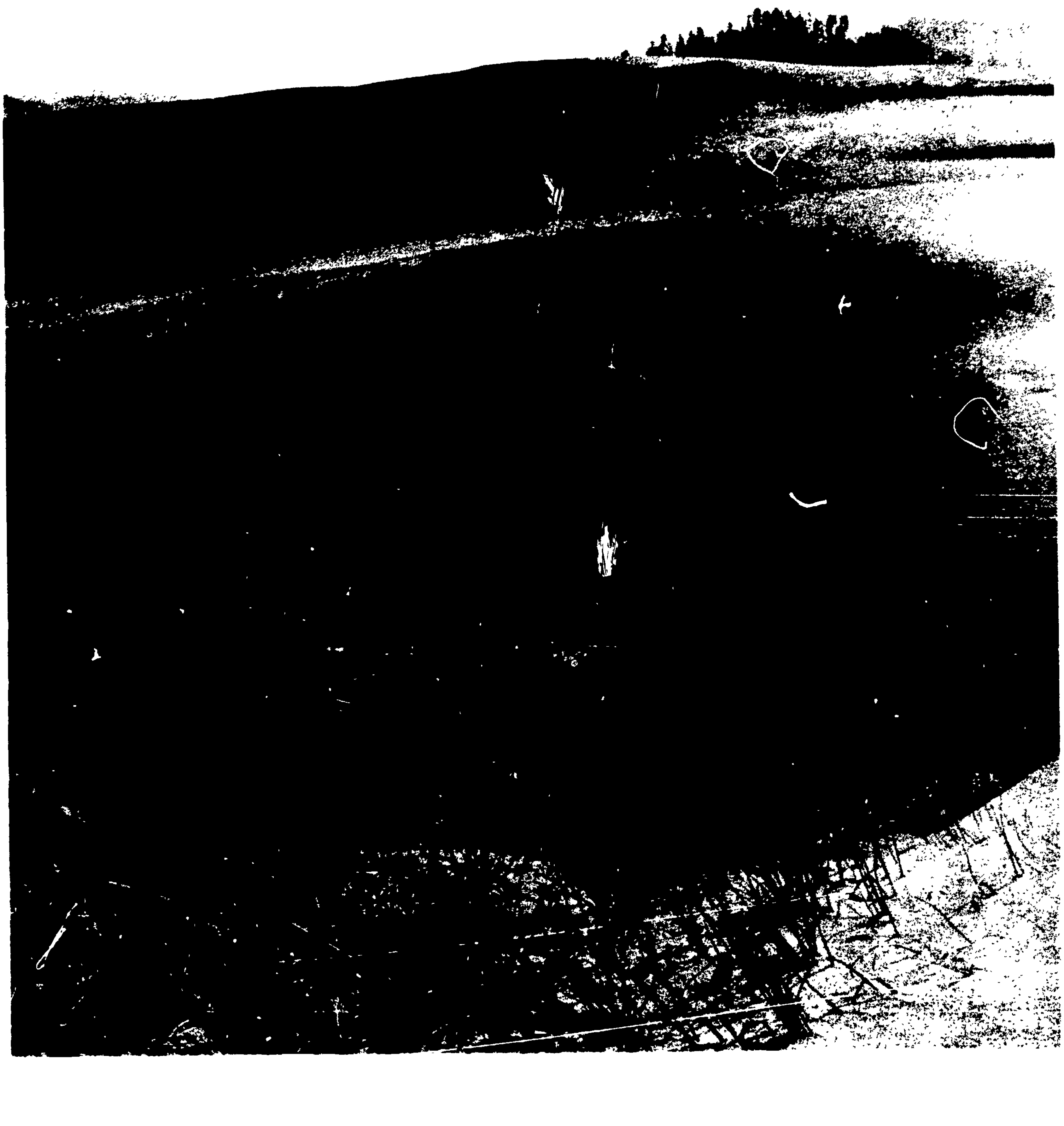
Dunes Plant Adaptation

- Dunes offer an unusual opportunity to note the adaptation of plants to a singular and harsh environment. Note how the dunes area resembles a desert and how the plants frequently show characteristics of those in arid regions. Find some plants with deep, penetrating roots and small, leathery, hairy, or waxy leaves. Some are succulents capable of storing water while most send their roots to a great depth.
- Some questions about dunes plants for which students may seek answers include: Which plants hug the ground? What adaptations do plants have that indicate there is a lack of moisture due to the rapid penetration of rain into the ground? What characteristics might some plants have that would slow down air movement on their stem or leaf surfaces and thus reduce evaporation? What characteristics might aid plants in their fight against the wind and its sandblast effect? How deep must one go to find moist sand? How far can the root of some small plant be followed?

Interrelationships of Dunes and Vegetation

- Dunes afford a classic example of the interrelationship of a special terrain and its plants for the continued existence of each other. The vegetation of the dunes tends to accelerate the fall-out of wind-borne grains of sand by creating eddies and slowing the wind velocity at ground levels.
- The great variation in wind velocity which can occur within an altitude range of some five feet demonstrates what ecologists call a "microclimate." The ground level climate is warmer, more humid, and more protected from the elements; but it is here the dune-building begins. As sand grains pile around the roots and stems of the plants, the plants themselves become choked and are eventually buried. Then new plants grow on the developing dune, only to become buried, too.
- How can the wind velocities at the various levels be compared? Might a small pinwheel help demonstrate this? Do nearby trees seem to be sheared off at a specific height. Find evidence of plant growth being asphyxiated by the sand.

Field trips to the sand dunes on the Oregon coast provide fascinating material for students, conservationists, artists, and photographers.



PROJECTS OF LONGER DURATION

Experiences that students continue for an extended period of time are classified as "projects" in this handbook. Good projects will keep students interested and involved, and they will be eager to find out more about their natural environment for themselves. Through projects, teachers can evaluate the extent to which students are developing effective self-learning skills.

The projects possible at any season of the year are endless. They may vary in difficulty from making a leaf collection to establishing a nature museum for the school. Some projects can be handled effectively by individual students or by a small group; others require the cooperative efforts of the entire class.

Perhaps the real value of a long-term project is that, out of necessity, a large part of the related activities must take place indoors. Projects started outdoors on a field trip can lead to a series of activities that can be continued in the school classroom, and therefore may more easily be integrated with other subject matter areas of the school curriculum. (See "The Tie-In: Outdoor Experiences and the Instructional Program," pages 9–14, for suggestions on indoor-outdoor related activities and studies.)

Suggestions for planning and developing projects, and information needed for carrying out these plans follow.

The hollow winds begin to blow;

The clouds look black, the glass is low

The soot falls down, the spaniels sleep,

And spiders from their cobwebs peep.

'Twill surely rain; I see with sorrow

Our jaunt must be put off tomorrow.

—Edward Jenner, *Forty Signs of Rain*

WEATHER PROJECTS

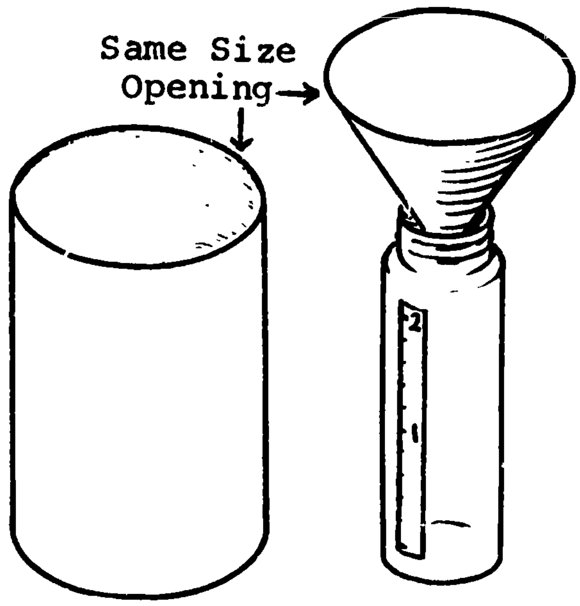
The weather: Everyone talks about it—now students can do something about it: learn to observe it with some degree of accuracy.

Students realize that what they wear, whether they walk or ride to school, whether they have a picnic in the woods or play baseball, and many other daily activities are influenced by the weather. Most of them have wished they could predict the weather so that they could plan better for tomorrow and the day after. This is what makes the study of weather a fascinating subject, and students will find much satisfaction in learning why the weather is what it is.

Simple observation—seeing, feeling—is one part of analyzing the weather. However, weather instruments must be used to determine exactly the temperature, wind speed and direction, humidity, air pressure, and amount of precipitation. This equipment can be made in simple form by the students in the classroom, and when they learn how to use the instruments and begin to understand some of the reasons for certain kinds of weather, they will be ready to try their own predicting. They may make a wrong prediction but they will have fun trying, and will learn much while doing so. Activities using this equipment offer opportunities to collect and analyze data over a period of time. Graphing could develop naturally from the data. Simple weather instruments may be made as follows.

WHAT TO DO AND WHAT TO LOOK FOR

Rain Gauge



- **Materials**

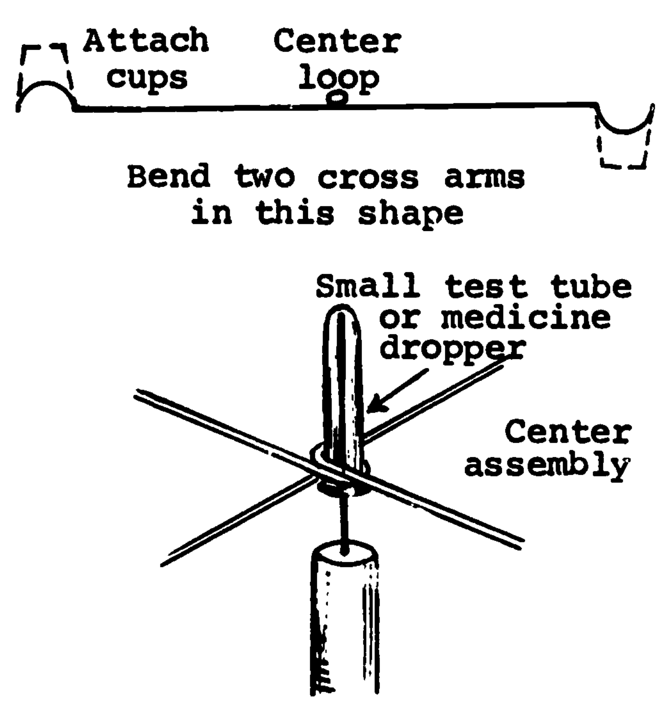
  No. 10 can or large can
  Small, straight-sided jar
  Funnel, size of No. 10 can
  Red pencil
  Scotch tape
  Scissors
  Sheet of white paper

- **Procedure**

  1. Place one inch of water in No. 10 can, then pour that water into the small jar.
  2. Cut a strip of paper a half-inch wide and as high as the small jar.
  3. Place this strip against the outside of the small jar, with the bottom of the strip exactly even with the bottom of the water in the jar.
  4. Make a pencil mark on the paper at the top of the water to show the depth of the water in the jar.
  5. Put the paper strip down on the table and make another mark, this one the same distance from the first mark as that first mark is from the bottom of the strip.
  6. Divide the space between each mark into ten even spaces and make a small pencil mark at each.
  7. Place the paper strip against the jar, with the marked side against the glass, and fasten it to the jar by winding several strips of scotch tape around the jar.
  8. Place the jar in the No. 10 can and place the funnel in the jar. The gauge is ready to use.

- **Explanation**—Rainfall is measured by the depth of water that would lie on the ground if none of the rain escaped. Whenever the amount of precipitation is reported, the amount of liquid in the moisture which fell to the ground is indicated. To measure the amount of rainfall, place the gauge outdoors, away from buildings and trees. The amount of rainfall may be measured at any time of day in tenths of inches as marked on the paper strip. Keep a daily record of the rainfall by measuring at the same time each day.

Anemometer



- **Materials**

  4 paper cups
  Eye dropper without bulb or small test tube
  2 coat hangers
  Nail and stick (or wood dowel)
  10 paper clips
  Masking tape

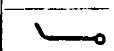
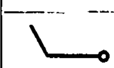
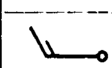
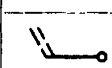
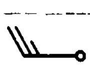
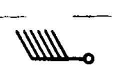
(See "Procedure" on next page.)

• Procedure

1. Straighten out a coat hanger and cut off the badly bent ends.
2. Bend a loop in the center of the hanger to fit the diameter of the eye dropper.
3. Bend the ends of the hanger into a U shape in opposite directions and parallel with the face of the loop. The U should be of a size to fit the inside of a paper cup.
4. Using paper clips or masking tape, fasten a paper cup over the U at each end of the hanger.
5. Repeat the above steps with the other hanger.
6. Color one of the cups with paint or a crayon to facilitate counting the number of turns the anemometer makes every 30 seconds.
7. Insert the eye dropper through the loops in the center of the hangers using masking tape to fasten the hangers in an + shape.
8. Drive nail into the end of the stick (or wood dowel); clip off and sharpen the end of the nail, making a spindle.
9. Place the eye dropper over the spindle and calibrate as described in item 10 below.
10. On a calm day ask someone to take you for a ride in a car on a quiet road. Sit next to the right front door with the window open. Hold the anemometer outside the window and have the driver drive a steady five miles per hour. As the car moves, count the number of turns of the anemometer in thirty seconds and write it down: "5 miles per hour—27 turns." Then increase the car speed to ten miles per hour and note the number of turns in thirty seconds; repeat the procedure at 15 and at 20 miles per hour.
11. Mount the anemometer where the wind can blow against it.

• **Explanation**—The anemometer is an instrument used to measure wind speed in miles per hour. It consists of four cups mounted on arms that are free to spin. To determine more accurately how fast the wind is blowing mount the anemometer atop a pole. Then, when the wind blows it can skim by the outside of each cup and be caught by the hollow inside, causing the entire assembly to turn. With anemometer mounted, wind speed can be determined in miles per hour by using a chart made when the anemometer was calibrated and by using the Beaufort Scale which follows: The information should be recorded each time a reading is taken.

BEAUFORT SCALE * OF WIND FORCE WITH VELOCITY EQUIVALENTS

Beaufort number	*Map symbol*	*Descriptive word*	*Velocity, miles per hour*	*Specifications for estimating velocities*
0	◎	Calm	Less than 1	Smoke rises vertically
1			1-3	Direction of wind shown by smoke drift but not by wind vanes
2		Light	4-7	Wind felt on face; leaves rustle; ordinary vane moved by wind
3		Gentle	8-12	Leaves and small twigs in constant motion; wind extends light flag
4		Moderate	13-18	Wind raises dust and loose paper; small branches are moved
5		Fresh	19-24	Small trees in leaf begin to sway; crested wavelets form on inland water
6			25-31	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty
7		Strong	32-38	Whole trees in motion; inconvenience felt in walking against the wind
8			39-46	Wind breaks twigs off trees; generally impedes progress
9		Gale	47-54	Slight structural damage occurs (chimney pots and slate removed)
10			55-63	Trees uprooted; considerable structural damage occurs
11		Whole gale	64-75	Rarely experienced; accompanied by widespread damage
12		Hurricane	Above 75	

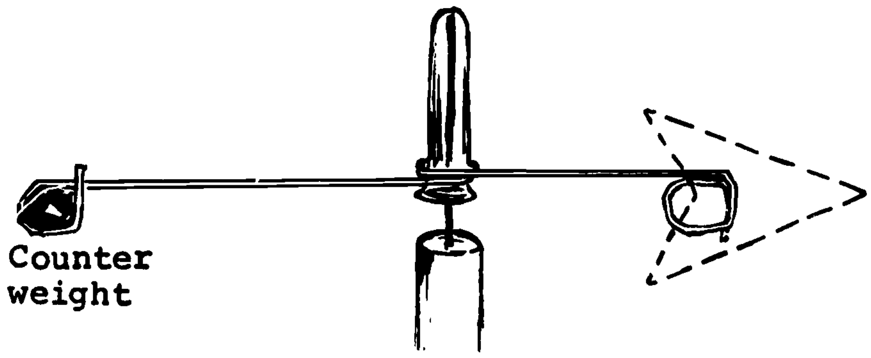
* This scale was conceived originally in 1805 by Admiral Beaufort of the British Navy.

Abstract patterns are formed in sand as the wind and water do their artistic work.

Wind Direction Finder

- **Materials**

  Coat hanger
  Tin can lid from No. 10 can
  Eye dropper without bulb or test tube
  Plastic cement
  Masking tape
  Nail and stick (or wood dowel)



- **Procedure**

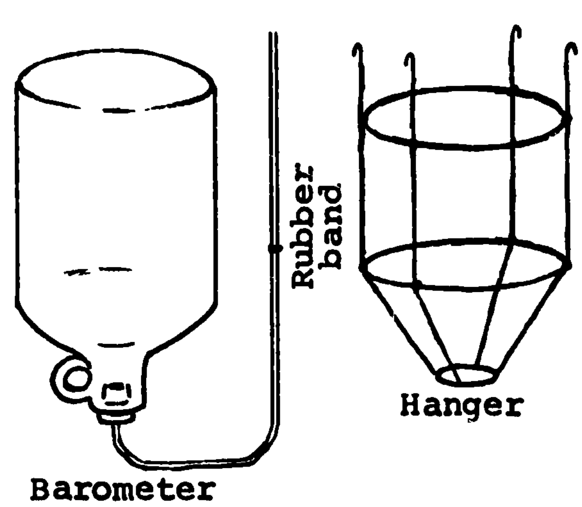
1. Cut an arrowhead and counterweight from tin can lid.
2. Bend coat hanger straight and cut off badly bent ends.
3. Bend oval loops in both ends, as shown in sketch, making sure loops are in line with each other.
4. Insert arrowhead in one end and counterweight in other.
5. Find balance point on the main body of the hanger and bend loop to fit diameter of an eye dropper.
6. Insert eye dropper and tape it in place with masking tape.
7. Drive nail into end of stick or dowel, clip off head of nail and sharpen end of nail to make a spindle.
8. Put eye dropper over spindle and wind direction finder is complete.
9. To locate the direction of the wind, a compass must be used to find the direction of true north. Once north has been found, place a peg into the ground, then turn around, walk two paces and place another peg in the ground to show which direction is south. To complete this ground compass, place two additional pegs at the east and west points. Erect the wind vane atop a pole placed in the center of the ground compass. By using the compass points on the ground, the observer can judge the direction in which the vane is pointing. Check the wind vane at the same time each day and record the direction of the wind.

- **Explanation**—This wind direction finder or wind vane is simple, but it will work very well. More complicated devices may be developed which indicate or record wind direction remotely. The wind vane's arrow will point to the direction from which the wind is blowing.

Water Barometer

- **Materials**

  1 gallon jug
  One-hole rubber stopper to fit jug
  24 inches of glass tubing
  Coat hanger
  Heavy string
  Rubber band



- **Procedure**

1. Bend glass tubing over gas flame into a U shape, making one leg of the U about four inches long and the distance between the legs about six inches. The legs should be parallel.
2. Insert the short leg about two inches into the rubber stopper. Wet the tubing to make insertion easier.

3. Fill the jug with water to within about two inches of the top, and insert stopper with tubing in it into the top of the jug.
4. Make a four-point hanger out of the coat hanger, and using the heavy string suspend the jug upside down from the hanger.
5. Put the rubber band at water level on the tube. The rubber band will act as a reference point as the water moves up or down due to air pressure.

- **Explanation**—This water barometer will indicate the pressure of the air. The liquid in the tube will rise or fall as the air pressure decreases or increases. In taking readings from the barometer, the important thing to look for is change in air pressure. Rising pressure usually means increasingly cold, heavy air; falling pressure means increasingly warm, light air.

  It is more important to know which way the pressure is changing than to know exactly what the pressure is. The barometer, therefore, should be checked more than once a day and the pressure noted. This way, it will be possible to determine whether the pressure is rising or falling.

Cloud Direction Indicator

- **Materials**

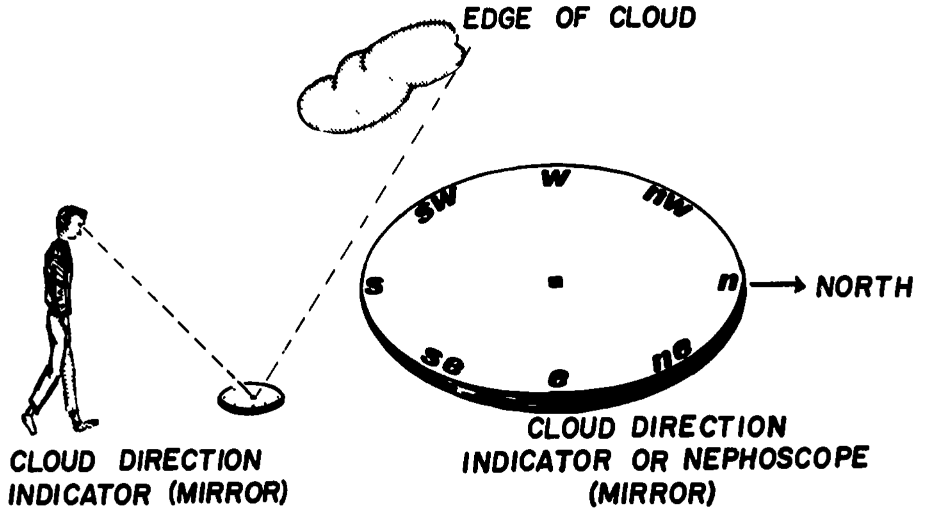
  Round mirror or a round piece of shiny aluminum foil

  Small piece of gummed paper or scotch tape

  Piece of cardboard slightly larger than the mirror

  Pencil and glue

  Compass



- **Procedure**

1. Place the mirror or round piece of foil on a piece of cardboard and trace its outline with a pencil.
2. Remove the mirror and then mark the outside of the circle on the cardboard with the compass directions as shown in sketch.
3. Cut a little circle of gummed paper about the size of a dime and paste it on the center of the mirror.
4. Put some glue on the back of the mirror and place it exactly on the circle on the cardboard. This completes the indicator.

- **Explanation**—The cloud direction indicator will show the direction of the wind high above. Winds in the upper air sometimes differ in their direction from ground-level winds, so both the wind vane and the cloud indicator are needed to determine which way the wind is blowing.

  The indicator should be set on a level place outdoors, with the N mark pointing to the north. Watch the mirror until a cloud appears in it. Follow the cloud until it reaches the other edge of the mirror. Note the direction the cloud has moved by checking the compass points on the cardboard. This will show the direction toward which the wind is blowing. If it is blowing toward the north, it is coming from the south and is called a south wind.

Weather Observations and Predictions

- Once the weather instruments are operational, students are ready to make some observations. On the basis of their data, they may predict what tomorrow's weather might be. Observations should be made twice a day and recorded on the following prediction chart. Of course, accurate forecasts require extensive data and analysis, which is not possible with limited information.

PREDICTION CHART

DATE	TIME	TEMP.	HUMIDITY	RAIN	BAROMETER READING	↓→↑	WIND DIRECTION	WIND SPEED	SKY	PREDICTION

NATURAL AREA PROJECTS

Once an unused, natural area has been set aside (on the school grounds, in a vacant lot, woodlot, or elsewhere) for use as an outdoor laboratory by students, a number of extended-time projects can be started and carried on whenever class schedules and interests permit.

School Sanctuary

An excellent example of the development of a wildlife sanctuary by a school class is now underway at Putney, Vermont. Approximately 12 students, working three afternoons a week, have been turning 50 acres of abandoned farm and forest land into a nature study area, a sanctuary for wild flowers and wildlife.

Long-term projects undertaken by these students include: cleaning old access roads, cutting new trails, controlling the silting of the streams and pond, thinning the forest, improving the field borders, rebuilding a dam.

A photographic project was initiated to record change of habitat and inhabitants at permanently marked sites throughout the area.

"It is expected," reports the biology teacher in charge, Herbert R. Drury, "that biological and ecological studies, identification and marking of local species and points of interest, and publishing of descriptive literature will be undertaken by the students to record changes over the years."

WHAT TO DO AND WHAT TO LOOK FOR

- The area should be fenced and posted as a natural area which is part of the school's learning environment.
- The area should be mapped accurately. Developing a coordinate system and grid would be an excellent experience.
- The area can be explored and a list made of all types of plants and animals within the boundaries. A count can be made to determine the dominant plants and animals.
- Students may keep logs in making special studies on:
  1. The rate of growth of native seedlings
  2. Population studies of small rodents or birds
  3. Plant succession
  4. Diet of birds using the area
- A project to improve the area as a wildlife habitat is worthwhile, if the area is suitable for such a project. Practical and permanent ways of providing for wildlife include:
  1. Building brushpiles to provide cover and protection from enemies.
  2. Improving existing springs, streams, and ponds or developing new watering places for wildlife.
  3. Planting shrubs, grasses, and trees that are needed, and which are available in the area, for establishing woody and shrubby fence rows.
  4. Planting the banks of drainage ditches or streams with plant food that wildlife enjoys. Such plantings also prevent soil erosion.
- Part of the outdoor laboratory which has not been set aside as an undisturbed area may be used for:
  1. Sowing bird food crops and planting shrubs for bird cover
  2. Experimenting with plant fertilizers
  3. Experimenting with weed killers
  4. Prevention of soil erosion

NATURE AND TESTING TRAILS

Nature trails may follow established paths in a park or they may be especially designed to wander through an area of the outdoor laboratory. Ideally, such trails should run through woods and open meadows, past swamps and ponds, and across streams. Their purpose is to give first-hand information in an informal and friendly manner, adding enjoyment to an outdoor walk. Their primary purpose should not be to test or to cram children with scientific names or data.

Testing trails are developed in the same way as nature trails but instead of giving information they ask for answers. A student who wants to test his knowledge about nature enters a testing trail with a piece of paper and a pencil. As he walks along, he jots down the answers to questions posted along the way. At the end of the trail he checks his answers with the correct answers posted there.

WHAT TO DO AND WHAT TO LOOK FOR

- By means of labels or trail guides, call attention to the geological features, plants, animals, and their interrelationships found along the nature trail.
- Labels may be made of tin or zinc, enameled, lettered in ink and given two coats of shellac or they may be made of Dennison linen tags and lettered in India ink before being shellacked.
- Try making the labels of different materials and of different sizes to add variety to the trail. Some labels should invite the reader to handle, taste, or smell an object. Some might be written in wooden books so that the reader must open the book to get the information which might include the origin of the name of the items, key identifying characteristics, or a listing of "fact or fiction" about the items along the trail.
- On the testing trail, questions about the items are lettered on the labels, instead of information about the items. Examples of the type of questions asked are: How many leaflets has poison oak? How old is this tree? Can you identify this shrub? What animal made this track?
- Imaginative students could make a testing trail as much fun as a "treasure hunt" by thinking up intriguing questions about interrelationships of plants and animals along the trail, e.g., "What animals might depend upon this tree for food and shelter?"
- A key to the questions, or a list of the answers, permanently affixed at the end of the trail is necessary to make a walk along the trail a satisfying and fruitful learning experience.

Sometimes goldfinches one by one will drop

From low hung branches; little space they stop;

But sip, and twitter, and their feathers sleek;

Then off at once, as in a wanton freak;

Or perhaps, to show their black, and golden wings,

Pausing upon their yellow flutterings.

—John Keats, *I Stood Tip-toe*

BIRD PROJECTS

WHAT TO DO AND WHAT TO LOOK FOR

Bird Lists and Surveys

Students will derive much enjoyment and knowledge about nature from keeping track of the birds they can identify. They can begin by listing the birds they see on their way to school and around the school grounds. As interest grows, they may make field trips to as many different bird habitats as possible such as brush- or wood-edged meadows, open fields, woodlots, forests, and marshlands. Some activities of this type follow.

- **Daily Lists**—Each day have each student jot down on a card the species of birds they see and the number of birds of each species.
- **Bird Count**—Organize the class into several teams before taking a bird walk. Compile the data and make a population map. Does the data change with the season?
- **Personal Lists**—Ask students to record each day, in a permanent record book, loose-leaf notebook, or on a separate file card for each species, the birds they identified that day. If this record is kept throughout the school year it will be a valuable means of determining the abundance of birds at certain times of the year. Make graphs.
- **Bird Calendars**—Keeping a bird calendar appeals to students as a classroom project. Make a chart with a space for the name of each bird, when first seen, where, and by whom.
- **Bird Census**—To make a census of the bird population of the school grounds or an area in the near vicinity, divide the area into squares so that the exact location of birds and nests actually seen can be recorded.

Bird Feeding

Feeding of birds in the winter is a worthwhile conservation project for school children who will realize that their assistance in saving bird life in cold, ice, and snowy weather is a useful effort. Once begun, however, the project should be continued for the duration of the inclement weather since the birds will soon come to depend upon the foods served.

The type of food placed in the bird feeders will depend on the birds that live in the area and the ones to be attracted. Types of foods to serve and kinds of birds that will be attracted follow.

- **Animal or vegetable fats** such as suet, fat trimmings from beef or other meats, bacon rinds, chopped meat and nutmeats, especially peanuts (chopped or in peanut butter), will attract woodpeckers, nuthatchers, and other insect eaters.
- **Seeds** such as hemp, millet, sunflower, squash, pumpkin, cantaloupe, watermelon, and **grains** such as corn, popcorn, whole or rolled oats, barley, wheat, buckwheat, and soybeans will attract juncos, sparrows, cardinals, and finches.
- **Fruits** such as dried fruits and berries, dried apples and peaches, (chopped) raisins, currants, and fresh apples, oranges, and bananas will attract robins, mockingbirds, cedar waxwings.
- **Miscellaneous foods** such as leftover bread, crackers, doughnuts, pastries, crumbs, dry meal, cooked spaghetti and macaroni, table scraps, chopped lettuce, and egg shells will be eaten by many kinds of birds.
- **A substitute nectar** for winter feeding of hummingbirds can be made by dissolving sugar in water—one tablespoon of sugar to two tablespoons of water.

Bird Feeders

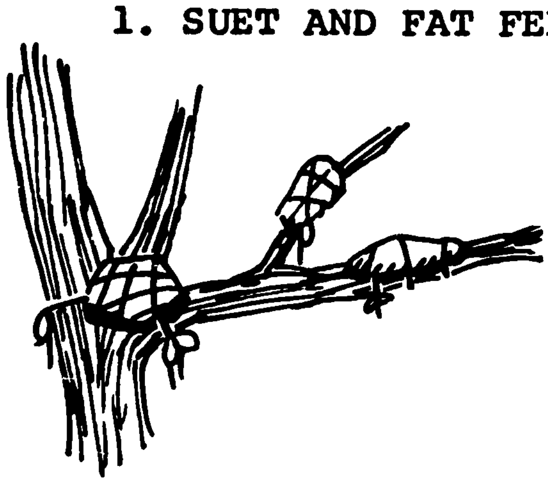
Bird feeders may be simple or elaborate in design but the most important concern is to have the correct kind for the varieties of foods to be served, and to keep them as open as possible. Obviously, they should be placed so as to minimize danger to the birds from predators or other natural hazards. Directions for making simple bird feeders follow.

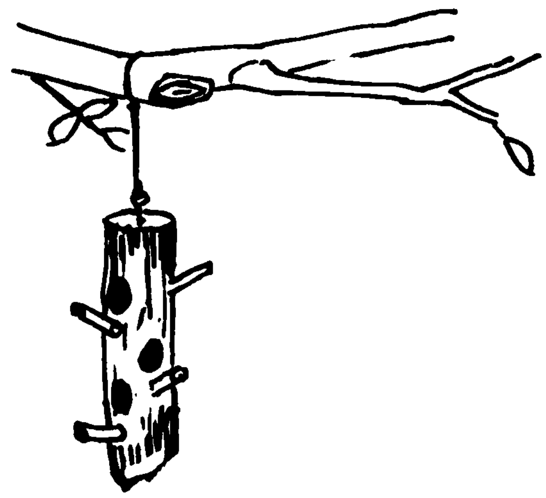
- **Suet and Fat Feeders**—Pieces of suet can be tied directly to tree branches with cords, or served in a mesh bag with tie-string to prevent one bird from taking the whole supply. Another popular and easy-to-make device is a suet stick which can be made by drilling holes, one inch in diameter and one and one-half inches deep, in a small bark covered log. Suet can be pressed into the holes and, when suspended from a tree or attached to a post, the log makes an ideal feeder. (See feeders, No. 1, page 85.)
- **Feeding Trays**—A foot-square shelf with a rim around the edge is an easy-to-make seed or fruit feeder. The shelf can be attached to a pole, a sheltered branch in a tree, or in front of a window. (See feeder No. 2, page 85.) A roof made of wood or glass over the shelf or tray will protect the food from rain and snow. (See feeder No. 3, page 85.)

(Continued on page 86)

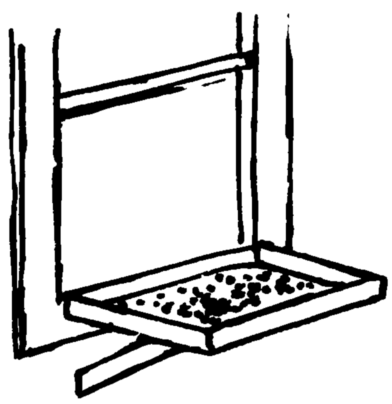
BIRD FEEDERS

1. SUET AND FAT FEEDERS

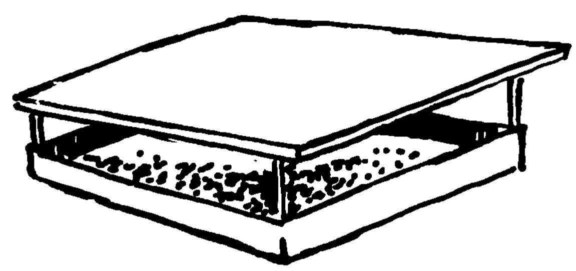




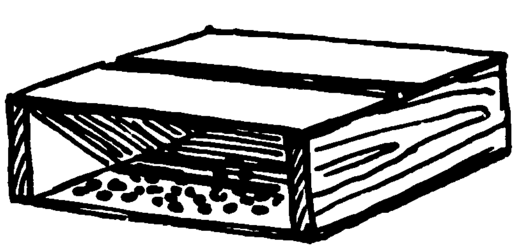
2. WINDOW TRAY



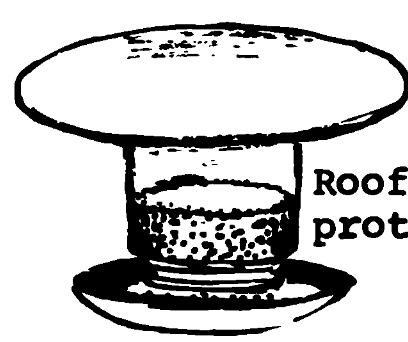
3. FEEDING TRAY (Hang or Mount)



4. BOX FEEDER (Hang or Mount)

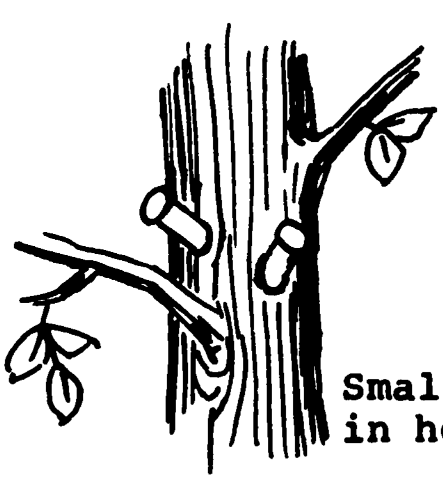


5. FEED HOPPER

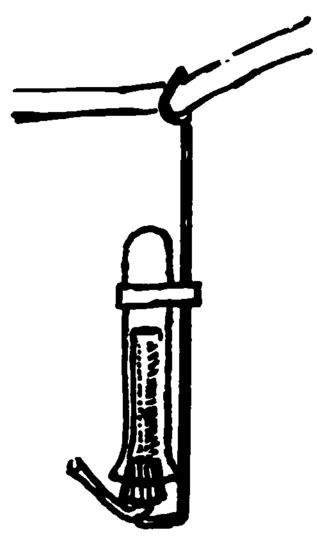


Roof, if not protected

6. NECTAR FEEDERS



Small test tubes in holes



- **Box Feeder**—In some winter weather conditions, a box feeder is preferable to a tray. A small topless wooden box, placed on one side so that the opposite side forms a protecting roof over the food, can be mounted on a pole and food placed inside. The open front should be turned away from the prevailing wind, rain, and snow. (See feeder No. 4, page 85.)
- **Feed Hoppers**—A hopper simplifies feeding of birds because it replenishes the food automatically, by gravity, from a main supply. A hopper can be made from wood, a glass jar, or a lamp chimney. (See feeder, No. 5, page 85.)
- **Nectr · Feeders**—Since hummingbirds use liquid food, substitute nectar (sugar syrup) can be served in tiny vials or small test tubes hung by wire among branches of a shrub or on flower stalks the birds visit regularly. (See feeder No. 6, page 85.)

Birdbaths

Birds are often attracted more by water than by food, especially during freezing periods. All birds need water for drinking and bathing and some need it to make mud for nest-building. Students will find making birdbaths an interesting craft project. Important features of birdbaths and directions for some simple ones follow.

- The most important features of a useful birdbath are:
    1. Correct water depth—one-half inch to three inches
    2. A rough edge and bottom to provide secure footing
    3. Water changed regularly

- Three simple-to-make birdbaths are:

  Bird Saucer—Any shallow dish, pan, pie tin or flower pot saucer makes a suitable birthbath for some species of birds.

  Birdbath—The lid of a garbage can makes a simple bath when the edge and bottoms are roughened by painting them with a gravelly cement mixture of one cup cement, one cup fine gravel, three cups of sand, and sufficient water to make the mixture stick to the metal. The bath is mounted on three sticks sunk into the ground.

  Bird Pool—Some birds prefer a water supply on the ground level. This can be provided by scooping out a depression in the ground, lining it with a piece of chicken wire and covering the wire with a two-inch layer of cement. This pool should be located in partial shade and near shrubs or trees so that the birds can perch to dry and preen themselves after bathing.

CONSERVATION PROJECTS

The habit of keen observation and awareness of the continuing or changing conditions of the natural environment from the viewpoint of a conservationist is one of the valuable outcomes of student participation in long-term projects directed at improving or preserving wildlife habitats and other natural resources. Some general and specific suggestions for such projects follow.

WHAT TO DO AND WHAT TO LOOK FOR

- Observe the fields, woods, streams, and lakes in nearby areas where events are taking place which will materially affect the kind and quantity of animal life there in that particular neighborhood. Notice that some hedgerows are being torn out while others are growing more and more lush, some streams are clear and clean while others are thick with soil or becoming clogged with the debris of logging or polluted with the effluent of industry. Swamps are being created and swamps are being drained. Some of the hills are logged off or grazed clean and erosion is setting in; on others the cover of grass and trees, saved by properly-conducted selective logging, holds water and soil to reduce erosion to a minimum, and gives aesthetic satisfaction to the eye.
- Exploration will show that the small brush patches and hedgerows are especially suited for quail and song birds which feed in the surrounding open area or the brush, and use the brush for shelter and nesting. Game birds find hospitable habitats in uncultivated grass-covered rock outcroppings and draws.

- Watch the streams in the area all year long, take measurements when possible, and keep records. How much variability is there in stream flow? How much silt is being washed into the streams? How do these factors affect fish life? How do logging and farming in the area affect animal life? What is being done by industry and farmers to encourage wildlife?
- On some abandoned farm land or woodland students can gain sound conservation understandings by working on the control of silting of stream or pond, thinning the forest, improving field borders, or rebuilding a dam. They might provide food and protection for birds by sowing food crops and planting shrubs for bird cover. Some areas might be cultivated, planted, and used for experiments with fertilizers or weed killers.

Improving Wildlife Habitats

Natural environments for wildlife are becoming rarer as the nation's population increases. Woodlands, wetlands, and open fields which offer the best habitats for wildlife are being used for highways, building sites, or new housing developments. Much land that was once suitable for wildlife has been converted to agricultural land on which little if any native plant or animal life remains. Projects to improve wildlife habitats in the local area might involve some of the following practical and permanent undertakings.

- **Woody and Shrubby Fence Rows**—Obtain from a local conservationist a list of shrubs, grasses, and trees that are needed and available in the local area for wildlife plantings. Find out when and where they can be planted to form woody or shrubby fence rows for wildlife food and shelter, and then organize a shrub-planting field trip.
- **Brush Piles**—Build brush piles where possible to increase wildlife by providing more cover and protection from their enemies. Brush piles are piles of cut sticks and limbs with branches and twigs intact, piled to a height of five or six feet and approximately 15-20 feet in diameter. Locate the piles so that small game need not cross open spaces to get to them.
- **Streambank Plantings**—Plant willow tree shoots along a stream bank to provide cover for some kinds of wildlife. Such plantings will also increase the number of fish by altering the temperature of the water and lessening the amount of harmful sediment in the water. Streams can be further improved for fish by building small dams, log and rock shelters, and deflectors which will either increase or decrease the force of the water flow, whichever is more conducive to development of fishlife.
- **Waterholes**—Existing springs, streams, or ponds can be improved in various ways, e.g., cleaning out debris, or developing new watering places for wildlife where this necessary component of a suitable habitat appears inadequate.
- **Drainage Ditches**—Drainage ditches are usually good places for wildlife because they contain water, and food is on the nearby land. Planting brush and food plants on the banks provides cover for wildlife as well as food, prevents the banks from eroding, protects the ditch from sediment, and prevents bank cutting.
- **Wildlife Borders**—Borders of grasses and legumes or shrubs and conifers around woodlands, next to tall shelterbelts or windbreaks, and along streams, waterways, gullies, and roads will help provide for wildlife.
- **Forestry Practices**—Homes for squirrels and birds may be provided if dead and hollow "den" trees are left standing. Nut-producing trees, such as hickories, beech, oak, and hazelnut, provide food for chipmunks and squirrels, deer, raccoons, bears, ducks and other animals. Brush piles offer shelter for songbirds, and woodchucks use them for their dens.

Conservation on a Farm

"Clean farming," the elimination of hedgerows and uncultivated areas, discourages wildlife which must have suitable cover to survive. Some activities stressing the importance of practicing conservation on a farm are as follows.

- When visiting a farm, notice what the farmer has done to protect wildlife. Perhaps he has increased the "edge" of his fields to provide places where rabbits, quail, and songbirds can live and raise their young.
- Excellent information for improvement of a farm for wildlife will be found in the booklets *The Farmer and Wildlife* (Wildlife Management Institute, Washington, D. C.) or *Making Land Produce Useful Wildlife* (U. S. Department of Agriculture, Farmers' Bul-

letin No. 2035). Students may find inspiration in these booklets for conservation projects in their neighborhoods.

- If the school's outdoor education program includes a school farm, students will find valuable information from the following U. S. Department of Agriculture pamphlets: *Shrub Planting for Soil Conservation and Wildlife Cover* (Circular No. 887) and *Multiflora Roses for Living Fences and Wildlife Cover* (Leaflet No. 256).
- Students who are summer campers or who are participating in camping experiences as part of the outdoor classroom program should know that proper cutting operations will assure that camp areas will be kept in many stages of vegetative growth and thus continue to provide habitats for the maximum numbers and kinds of wildlife. "Interspersion," or mixing of cover types, is important in making a farm area favorable to wildlife.

Duck Nesting Boxes

Unlike other waterfowl nesting in Oregon, wood ducks almost always seek a tree cavity in which to deposit their eggs. The nesting tree will usually border a stream or lake, but "woodies" may nest a mile or more from water. The lack of suitable natural nesting sites has led to construction of artificial boxes which may be placed in areas used by wood ducks. Of hundreds already placed in Western Oregon, wood ducks have used a high percentage. Others are used by owls, squirrels and bees. Directions for making and placing a nesting box follow.

- Make a nesting box out of rough or weathered lumber, using the following specifications and drawings:

  Inside measurements: 24" by 10" by 10"

  Hole: Four-inch diameter located four inches from top.

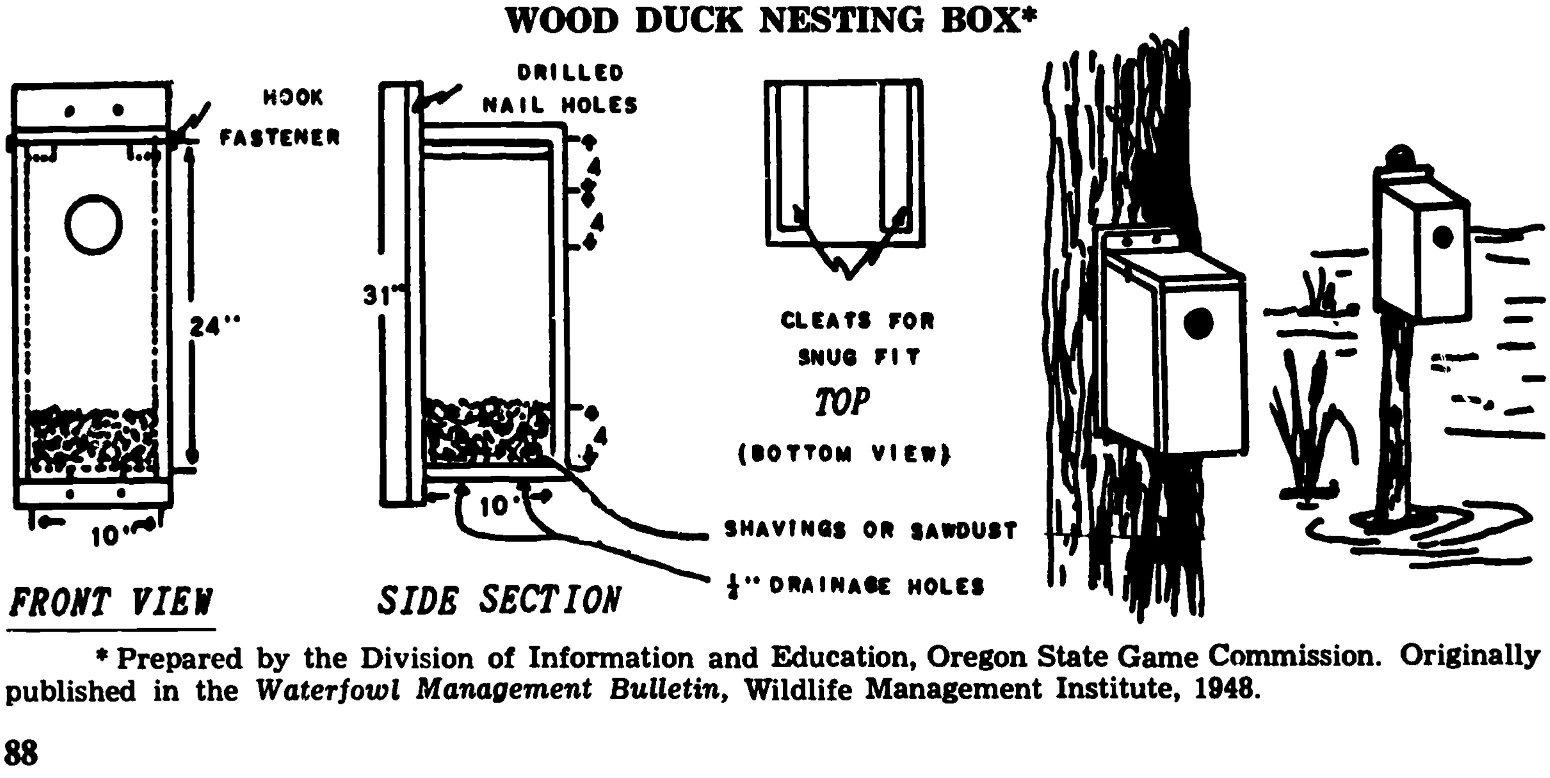
  Top: Nail two strips of furring in the inside to make a snug fit. Wire or hook the top down on two sides.

  Bottom: Drill two or three one-quarter inch holes for drainage.

  Back Board: May be extended several inches above and below the box to facilitate fastening to tree or pole.

  Do not paint the box. For nesting success, a four-inch layer of sawdust or wood shavings must be put on the floor of the box.
- The nesting box may be placed in a tree. It should be at least 15 feet above the ground, and faced toward the water but away from prevailing winds, if possible.
- Look for a living tree to which to nail the box since dead trees are more likely to be blown down. The nesting box should be turned so that its entrance hole is not obstructed by branches.
- If the box is placed on a post in the water, it should be above the high water danger line. This location is desirable because it eliminates the danger from ground predators.

WOOD DUCK NESTING BOX*



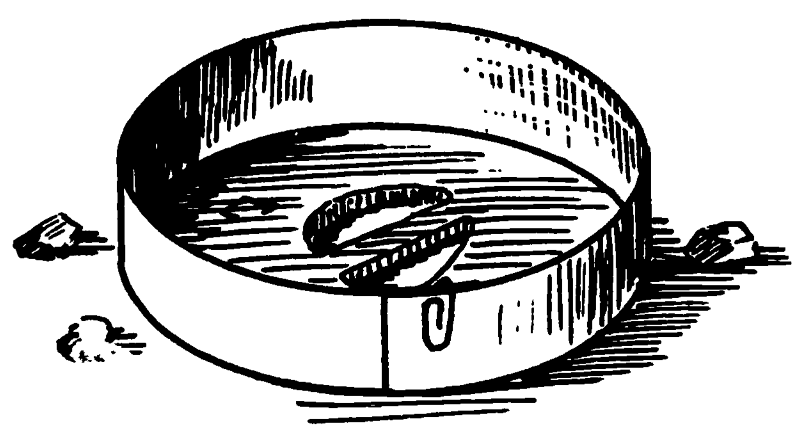
* Prepared by the Division of Information and Education, Oregon State Game Commission. Originally published in the *Waterfowl Management Bulletin*, Wildlife Management Institute, 1948.

ANIMAL TRACKING

Much can be learned about wildlife habits by carefully examining animal tracks, which makes an interesting outdoor hobby. To the expert woodsman and naturalist, tracks and other signs left by animals are like an open storybook telling what has been happening in the lives of these wild creatures. An animal tracking area might be prepared in the outdoor laboratory or other natural habitat, and plaster casts made of good tracks.

WHAT TO DO AND WHAT TO LOOK FOR

- Select an area which shows some evidence of animal life. This may be a well-used trail, a favorite watering hole or feeding area.
- How many different signs of wildlife, such as tracks, feathers, nut husks, chewed cones, pellets, droppings, nests, bedding spots, bits of hair, bones, holes in the ground, runways, and signs of browsing, can be found? Try to piece together the interesting stories that these signs tell.
- Clear the ground of sticks, leaves, or other litter. An area at least three feet square will be adequate, but it may be larger or smaller.
- Loosen the topsoil to a depth of one-half to one inch with a sharp stick or rake. All dirt clods or lumps should be broken up.
- Smooth the area with a flat stick or the back of the rake. Test it by placing the hand firmly on the soft ground. If a good "print" shows, the tracking area is ready. If the ground is too dry, it should be moistened slightly.
- Place bait in the tracking area or near it, taking into consideration the types of animals likely to range in the vicinity.
- The next day, or some time later, check the area for tracks. Try to determine what animals made the tracks and what the animals were doing.
- To make plaster casts of the tracks, first clean a track of loose particles of soil, twigs, leaves, or other litter.
- Spray track with shellac or plastic from a pressurized can, if available.
- Form a two-inch wide strip of cardboard or metal into a ring surrounding the track. Press it firmly into the ground to give support, but allow at least one inch to form the edge of the mold.
- Mix about two cups of plaster of Paris in a tin can or plastic bowl, adding water slowly to make it about as thick as heavy cream. Pour this carefully into the track and mold until plaster is about to the top of the rim. Allow plaster to harden at least 15 minutes before lifting it out of the track. If soil is damp, hardening may take longer.
- When the cast is hardened, lift it out, remove ring, and clean the cast by scraping with a knife blade and washing.
- Apply a thin coating of vaseline to track and surface of cast. Place on flat surface and surround casting with a two-inch strip of cardboard or metal as before.



Animal Track Ready for Casting

- Mix plaster of Paris as before and pour into mold, making certain that the top surface of the casting is smooth and level with the mold. If the casting is to be used as a wall plaque, place a loop of wire in back of the casting while the plaster is still soft. Allow two hours for plaster to harden.
- Carefully remove mold when plaster is dry. Separate the two layers and wipe excess vaseline from the face of cast and track. Scrape any rough places with knife blade, or use fine sandpaper to smooth. Wash in running water.
- When cast is thoroughly dry, paint inside of track with India ink or black poster paint. Label with name of the animal. A coat of clear shellac or clear plastic may be applied to protect and preserve the casting.

TREE PROJECTS

WHAT TO DO AND WHAT TO LOOK FOR

Adopt a Tree

Adopting a tree is a project that can last through most of the school year. This can be either a school-class or individual-project or a home project. A selected tree on the school grounds can be observed every day for any changes occurring. Before adopting a tree, the class will want to discuss what to look for in their observations which should include answers to the following questions.

- Determine what kind of tree it is. Does it lose its leaves in the winter? If so, when do the leaves begin to change color? When do the first leaves start to fall? When does the last leaf fall? When does the first leaf appear and how long does it take before the leaves are fully open? Do blossoms appear? When are the first fruits formed?
- Do any animals visit the tree? If so, what kinds and how long do they stay? Are they just temporary visitors or do some of them become tenants and live in the tree?
- Are there any insects in the tree? What kinds? Will they harm the tree?
- Are there any birds in the tree? If so, what kinds? Will they need additional materials to build their nests? Will they need to be fed during the winter months?
- Does anything live on the ground beneath the tree? Does anything else such as lichens, mosses, mold, fungi, or other plants grow on the tree?
- How big is the tree? How tall? What is the circumference? The diameter? How old is the tree?
- Has the tree ever received any injuries from man, storms, disease, or animals? Are the injuries healing or can something be done to help the tree?
- What are the uses of the tree to man or other animals? Can any uses be made of its wood?
- In addition to keeping a record of the things students observe about the tree, the class may wish to take photographs of the tree at various months of the year or make drawings of the tree.
- Making different kinds of leaf prints from the tree, collecting samples of twigs at different times of the year, and collecting tree fruits as they appear are activities which could result in an interesting display for mounting.
- Keep a "Guest Book" and register all new visitors to the tree as a record of how many "guests" the tree has during the year.

Plant a Tree

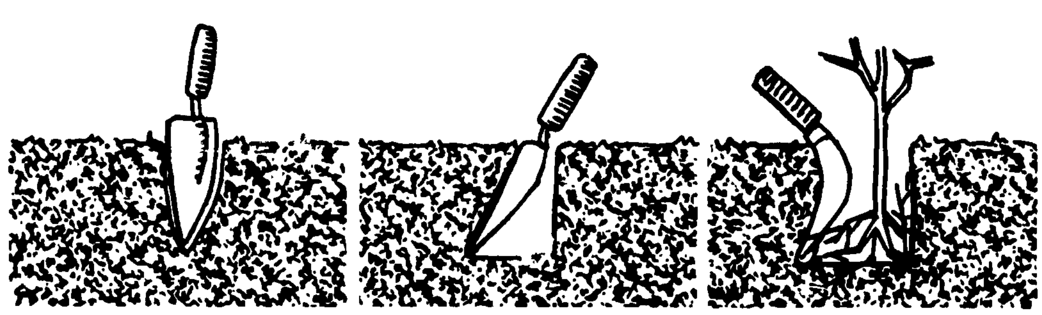
Trees can be planted as part of a soil erosion control project, for forestry improvement, wildlife encouragement, and for landscaping. An area near the school, or the outdoors laboratory, may need new interplanting or new planting to convert it into a woodland, or plantings in special places for shade, windbreak, or landscaping. Students enjoy participating in tree planting and learn something about conservation at the same time. It is wise to check with local experts about what kinds of trees to plant, when, and where. Planting stock is available from private nurseries and from the State and U. S. Forestry Departments. Observe the following instructions.

- Take proper care of the stock before planting it by digging a trench in the shade and out of the wind. Keep the roots moist at all times. When ready to plant, carry trees in container with roots covered with wet material such as moss, fine wood shavings, or in a pail of water.
- Prepare the planting site properly, clearing away debris and litter. Set the trees properly. Each tree should be at correct depth, about one-fourth inch deeper than when in the nursery. Main roots should be straight, not doubled. The soil should be firm around the roots, and the tree should be in an upright position as nearly perpendicular to the ground level as possible. (See the following diagrams.)
- Take care of the trees after planting. Young trees need protection from trampling and from weeds.
- Water if the ground is dry.

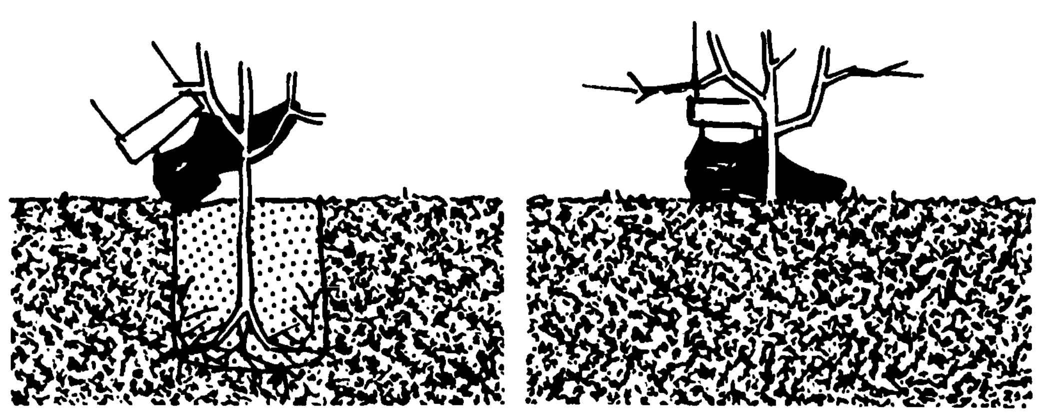
This is my tree.
I planted it.
I will watch it grow.
It will do many things for this area.
It will help hold the soil.
It will provide homes for birds.
It will add beauty to the countryside.
It may even add to the economy of the community.

It will be the prettiest tree in the world because I planted it.

HOW TO PLANT A TREE



1. Drive spade perpendicular into the ground.
2. Push handle ahead.
3. Scrape back soil to enlarge hole.



4. Fill in hole with soil and tamp tight with heel.
5. Close top of hole with heel.

Timber Cruising

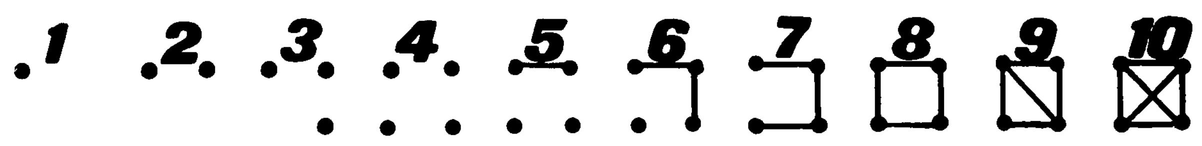
An interesting class project is taking an inventory of an acre or so of forest land to determine how many trees, what kinds, and what sizes of each species grow in the area. Instructions for a timber cruising project follow.

- Divide the class into five groups and have each group count all of the trees on a fifth of the area to be surveyed.
- Before going on the field trip, each student should make a chart, as shown below, for his notebook or clipboard so that he can record the trees he finds:

Diameter of Tree Breast-High (DBH)(4")	PINE				OAK				DOUGLAS FIR			
	HT in Feet				HT in Feet				HT in Feet			
	6	15	20	35	6	15	20	35	6	15	20	35
3"												
7"												
9"												
11"												• • • •
13"												

NOTE: The DBH (diameter at breast height) and HT of trees can be adjusted to fit the size of trees in the area. Also logs rather than HT can be used. This will help students learn to use the Biltmore Stick. For instance, instead of using the figures 6, 15, 20, 35, use 1 log, 2 log, 3 log, 4 log. As many different species of tree as indicated in the area can be added to the chart.

- The best way to take a tree census is to walk in straight parallel lines back and forth across the area, counting the trees within a distance four feet to the left and four feet to the right of the line being walked, and estimating the size of each tree counted, until the entire area has been covered.
- For each tree counted and estimated, mark the record sheet according to the "dot and dash" tallying method used by foresters. In this, one dot means one tree. When a maximum of four dots are used, dashes are used for each additional tree. Therefore, four dots and two dashes mean six trees, and so on, as shown below:



For example, a count of four Douglas fir trees 11 inches in diameter and 35 feet tall would be recorded on the chart as four dots opposite the DBH figure 11 and under the HT column 35. (See sample chart and note four dots in that column.)

- When the survey is completed, the five groups of students should meet and discuss their findings to determine which species are the most plentiful, which ones are the biggest, which ones have been living in this area the longest and which ones seem to be the youngest members of the community. Estimating the board-foot volume of the merchantable trees in the area would complete the "timber cruise."

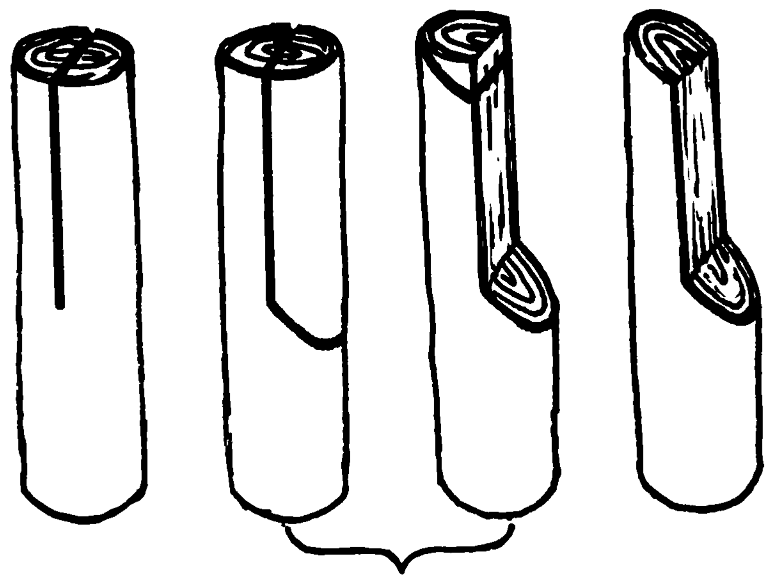
NATURE CRAFT PROJECTS

WHAT TO DO AND WHAT TO LOOK FOR

Collecting Wood Samples

Collecting and mounting wood samples is a good way to become acquainted with different kinds of trees, and a completed collection would make an excellent addition to the school's nature museum. Steps in conducting such activities follow.

- Assemble equipment needed for this project—a saw and vise, fine sandpaper, clear shellac, a small brush, paper, and cellophane or sheet plastic for labeling.
- Look for wood samples that show grain and color. Never cut down a living tree but take specimens from trees that have been felled or blown down. Look for branches that are at least two inches in diameter and, with the saw, cut off a straight piece about ten inches long. Try to cut where the bark is in good condition.
- Accurately identify each specimen by recording in a notebook some of the characteristics of the tree, e.g., shape, leaves, and fruit, if any.
- After returning to the classroom, place the specimens in a warm place to dry. When the wood has dried out, place a 10-inch piece horizontally in a vise, protecting the bark with a piece of cloth. Then proceed as follows:
  1. Saw off one end square, measure off seven inches and then saw off the other end.
  2. Saw down through the center of the wood three and one-half inches lengthwise.
  3. Saw across at a 45-degree angle to the point where the wood has been cut vertically. This will cut loose one side to show the cross-grain of the wood.
  4. At the top half of the piece, cut off another 45-degree slice.
  5. Remove piece from vise and sandpaper all cut areas, sanding with the grain until smooth.
  6. Draw light pencil line lengthwise through the center of the cut areas. Shellac only one lengthwise half of the sanded surface to show how the wood will take a finish and how it looks in both natural and finished state.



(2) (3) (4)

- Label each specimen by attaching (with two small tacks) a piece of white paper, one inch by three inches, with a protective covering of cellophane or clear plastic. Information on the label should give the correct variety name of the specimen.
- Display collections on an open shelf, in a display case with divided compartments, or by hanging the specimens from a wall shelf using a screw eye and hook.

  Keep additional information about each specimen and its uses in a separate notebook or card file.

Collecting Spider Webs

Collecting spider webs for study and identification can be a fascinating and unusual project. The amazing creations of design spun by the spider are worth all the time spent finding and preserving them. Instructions for this project follows.

- Assemble equipment needed—turpentine, piece of old cloth, newspapers, white enamel spray paint, dark sheets of construction paper, scissors.

- Look for webs on branches of small trees, shrubs, or fence rails. Since webs are traps for insects, they are usually spun across open spaces.
- When a suitable spider web has been located, spread newspapers behind it to catch waste paint. Spray paint on both sides of the web from a side angle, using short bursts of spray to prevent tearing.
- When all threads have been sprayed, place a piece of construction paper close to the underside or back of the web. Cut the web's guy lines carefully at the edge of the construction paper and set it aside to dry.
- Try to identify the spider which has made the web.
- Keep mounted webs in a scrapbook or frame and hang them as wall decorations. They are also attractive when placed under glass and hung as a picture or under glass on a serving tray or coffee table.

NATURE CENTERS

A school nature room can be built in a corner of the classroom, in the school science room, or in any vacant room. It should provide a place where children can come after a field trip to work at their collection projects, where they can get help in identifying specimens, and where they can look at various types of nature exhibits and collections. There should be wall space for displays, cabinets and drawers for storage, shelves, and work tables.

Exhibits in the center should be continually changing and reflect the dynamic aspects in nature rather than a static collection of isolated items. Collections made each year should replace those made in previous years. In this way children will feel that the center belongs to them. The center should not be a meaningless collection of items but each item should be identified by name and with one or two interesting comments about it.

WHAT TO DO AND WHAT TO LOOK FOR

- **Exhibits**—These can be made by making use of student artistic talents. They can create interesting frames for permanent exhibits, make original nature sketches and paintings, mount photographs and clippings from magazines, make nature models, develop nature maps of the school grounds showing location of important trees, animal homes, etc.
- **Nonlife Exhibits**—Bird nests, bird homes, mounted feathers, animal-track casts, snake skins, preserved snakes, mounted fish, shells, insect collections, pressed flowers, wood samples, twig and seed collections are examples of nonlife nature exhibit materials.
- **Models**—Miniatures of animal homes, wildlife communities, conservation practices, flower and tree parts, and insects can be made by students as craft projects and displayed.
- **Book Shelves**—Shelves should be provided for field identification books, reference works, nature magazines, and nature story books.
- **Mystery Shelf**—A "What Is It?" shelf may be provided for unidentified objects of nature found and brought in by students.
- **Bulletin Board**—An essential item in any nature center is a bulletin board where questions and answers, clippings, announcements, and instructions may be posted.

MAPPING AN AREA

Mapping an area is field work in the truest sense. To accomplish this, it is necessary to know how to use a compass, how to measure distances, and the fundamentals of map making. The following information will serve as a guide.

WHAT TO DO AND WHAT TO LOOK FOR

Measuring Distance by Pacing

There are several methods for measuring distance in the field. The woodsman measures the distance walked by pacing. A pace is a double-step, and is measured by counting each time the pacer puts down his right foot. The length of a pace will be from four to five feet. Everyone should determine accurately the length of his own pace and remember it.

- Mark off a 50-foot stretch of ground.

50′

←——————————————→

- Starting each time with toes on line, pace the distance ten times. Count and record the paces (double-steps) each time the distance is walked.
- Find the average number of paces (double-steps) by adding the total number and dividing by ten.

$$\frac{125 \text{ paces}}{10 \text{ times}} = 12.5 \text{ paces (average)}$$

- Divide 50 feet by average of paces. This is the length of your pace.

$$\frac{50}{12.5 \text{ Paces}} = 4 \text{ (pace)}$$

- Knowing the length of his own pace, a person can measure distance simply by counting the number of paces it takes him to reach a landmark or designated elevation. However, when hiking over slopes, the pace must be corrected because walking over uneven terrain shortens the pace. Therefore, paces must be dropped on slopes by skipping a count every few paces. The following chart will help determine pace corrections.

Percent Slope	Ascending		Descending	
	Step	Skip	Step	Skip
60	1	1	2	1
30	2	1	6	1
20	3	1	11	1
10	6	1	....	....

Direction-Finding with Sylva or Comparable Compass

The two basic skills in using a compass are: (1) finding direction from a given degree reading, and (2) finding a degree reading for a known landmark. Both skills are essential for mapping an area.

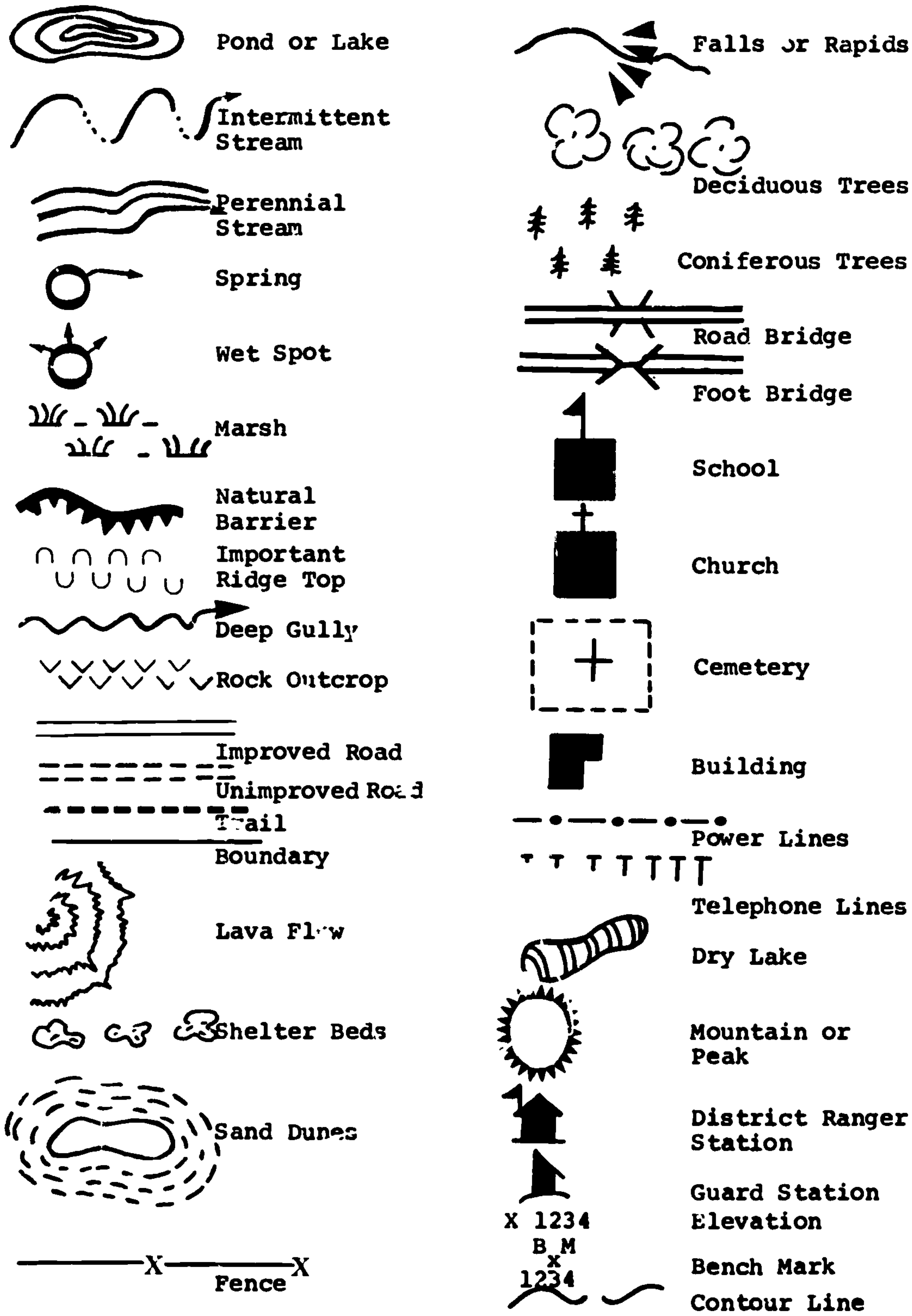
- To use a compass to travel to a given degree reading which locates a given fixture:
  1. First, turn the compass housing until the given degree reading is in line with the direction-of-travel arrow.
  2. Next, hold the compass level and waist high, with the direction-of-travel arrow pointing straight ahead.
  3. Now, turn around slowly until the magnetic needle points to N, directly over the orienting arrow. You are now facing in the direction you want to travel.
  4. Look up and sight an object straight ahead, such as a tree. Walk to the tree counting the number of paces and record this number upon arrival at that destination (tree).

5. Repeat the above procedure until destination is reached. Then convert paces into number of feet traveled and record in field notes.

- Sometimes in field work, it will be necessary to find the degree reading for a certain landmark, as follows:
  1. Hold the compass level and waist high, with direction-of-travel arrow pointing toward landmark.
  2. Orient the compass by turning the housing until the red end of the magnetic needle points to N, directly over the orientating arrow. The degree reading for the landmark is now in line with the direction-of-travel arrow.

Map Symbols

On a map, the important details of the countryside are shown with special signs or symbols to save space. The more common symbols have become standardized over the years. Consequently, almost everyone drawing maps uses the same set of symbols. Most map symbols look somewhat like the actual thing they represent. Therefore, they are easily recognized and are usually simple to draw. Some of the more common symbols which students may need in order to make sketches of the area follow.



Map Distances

Every map is a representation of an area of land, drawn to a specific scale so that the map reader will know how far it is from one place to another and, if the map includes such information, something about the terrain and landmarks.

- The scale of a map is the actual distance on land reduced in proportion to the size of the map. Map scales usually are given in measurements with which the reader already is familiar, such as the inches and fractions of inches on an ordinary ruler. For instance, one inch on a rule may represent 200 feet on e map or a centimeter may represent 50 or 100 feet.
- In mapping an area, students will need to select a scale in order to make a map sketch. They may want to look at maps in an atlas to compare various map scales. One sample scale, using one inch to show 200 feet, is shown as follows:

  Map Scale: | 0′ | 100′ | 200′ | 400′ |

- It is essential for accuracy that all distances indicated on a map be drawn in proportion to, or in scale with the actual land mapped. Students may wish to practice drawing to scale before making their map sketches.

Map Making

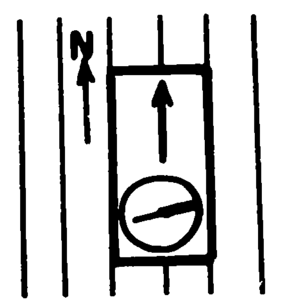
Making a map of a selected area should begin with an on-site survey. From the starting point note the landmarks found along each degree reading. (See page 95 for direction finding with the Silva compass.) The distance between the starting point and the first landmark or between successive landmarks is measured by pacing. These are recorded on the field survey chart. Sample notations are as follows:

RECORD OF FIELD SURVEY

DEGREE READING	FIELD NOTES	TOTAL DISTANCE	MAP INCHES
135°	WAGON ROAD 20 PACES; MAPLE GROVE 30 PACES; STREAM 20 PACES; FOOT BRIDGE 30 PACES; 20 PACES	120 PACES	——
270°	SPRING 20 PACES; FIR TREES 20 PACES; OUTCROP 30 PACES; LAKE 80 PACES	150 PACES	——
360°	FENCE 10 PCS; DEEP GULLY 120 PACES; MARSH 40 PACES; BARN 20 PACES	190 PACES	——

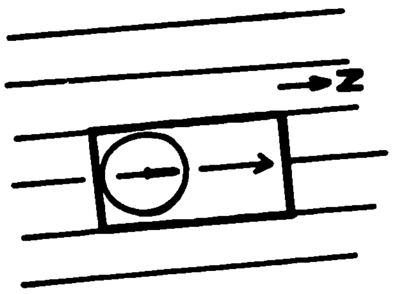
After all of the data are collected, the pacing measurements must be converted to map inches before the map is drawn. The procedures to convert paces into footage and footage into map inches are described in the preceding sections. Sketching the map will involve the following steps and should be studied carefully with a Silva compass at hand.

- **Step 1.** The vertical lines shown on the following sample mapping chart serve as meridian lines. Place the compass on the mapping chart alongside a meridian line with the direction-of-travel arrow pointing in the direction of N on the chart.



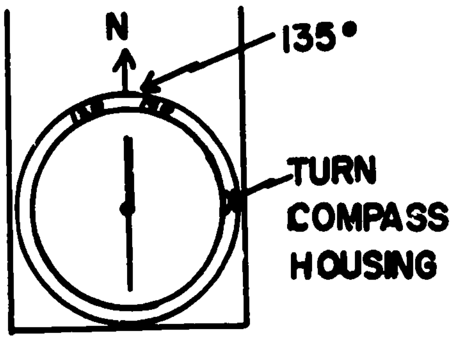
STEP I

- **Step 2.** Turn the map and compass until the red end of the magnetic needle is directly in line with the direction-of-travel arrow. Now the map is properly oriented. The mapping chart must remain in this position while the sketch is completed. (See p. 98.)



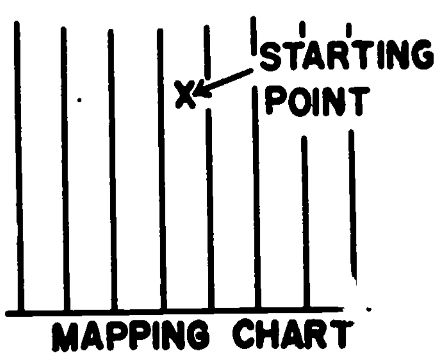
STEP 2

- **Step 3.** Next, turn the compass housing (the metal portion) until the first degree reading on the field notes is in line with the direction-of-travel arrow.
- **Step 4.** Select the starting point on the mapping chart. Care must be taken to be certain that the entire area to be mapped will fit onto the chart.
- **Step 5.** Rotate the entire compass so that the red portion of the needle is pointing to N on the compass housing. At the same time the edge of the compass base should be on the starting point.
- **Step 6.** Draw a line from the starting point which represents the total distance (in inches) measured along the first degree reading. The end of the line becomes the starting point for measurements along the second degree reading.
- **Step 7.** Label each landmark and the different areas with symbols or notations from the field survey.
- **Step 8.** Repeat the process for each successive degree reading using the procedures which are described starting with Step 3.
- **Step 9.** Continue in this manner until the map sketch is complete.

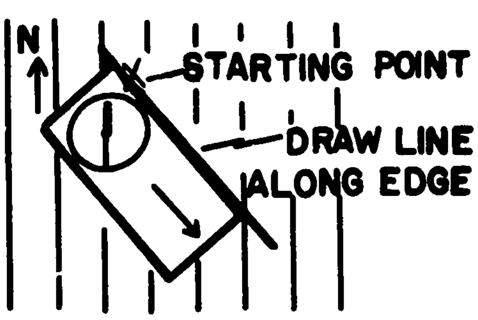


STEP 3

Several degree readings using the data on the sample field notes are drawn on the following sample mapping chart for clarification. The scale is based on 3 feet per pace and 50 feet per each map inch.

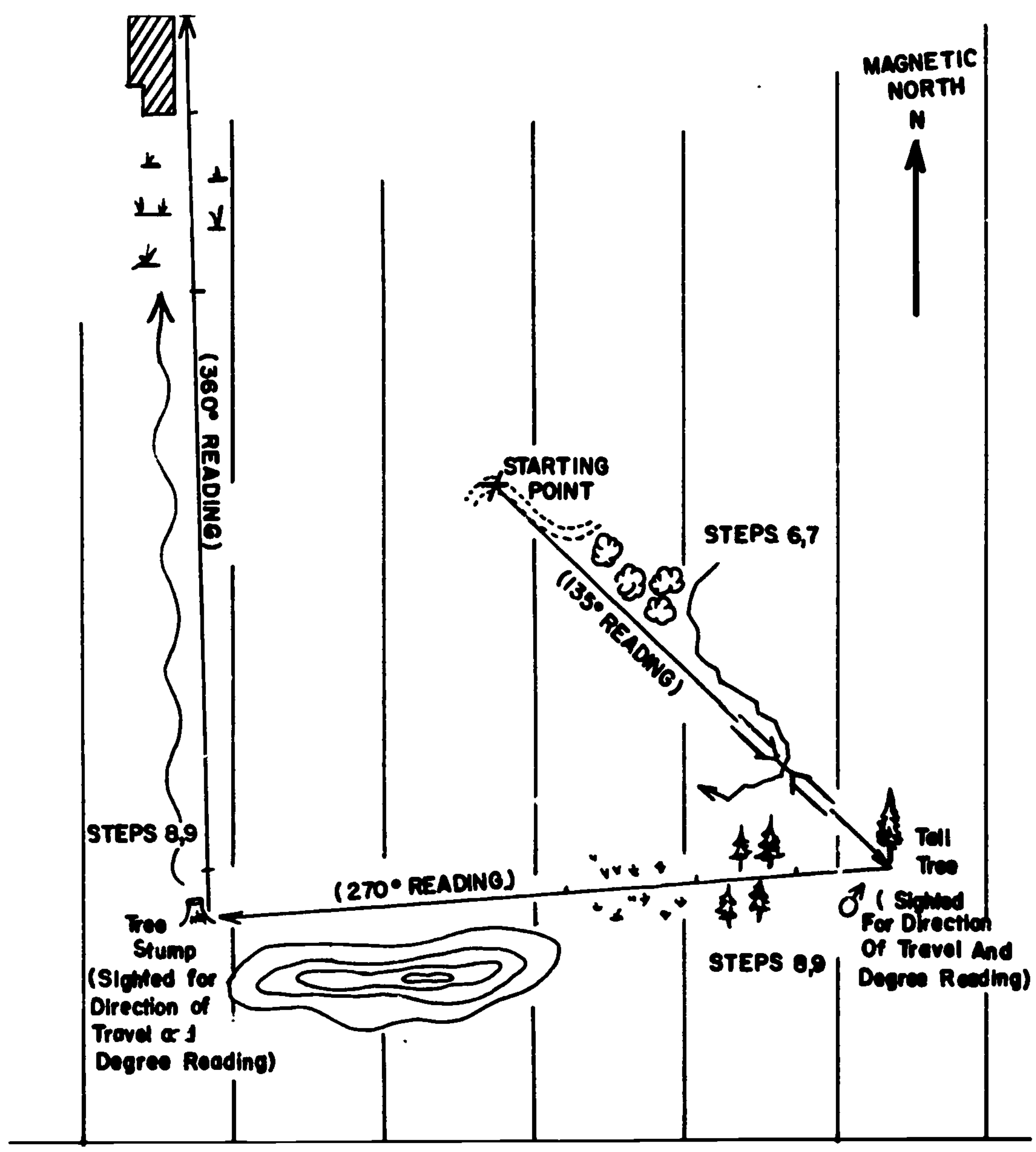


STEP 4



STEP 5

SAMPLE MAPPING CHART



MEASUREMENT EXPERIENCES

There are many occasions while exploring the outdoors when students will want to determine the length and width of some object or heights and distances. Often they will not have a ruler or measuring tape at hand, but will need to estimate measurements. The following pages give directions for using a number of devices and methods for measuring which students will find as engrossing and, quite likely, as useful in the future as any body of information they will acquire in the course of their outdoor education experiences.

PERSONAL MEASUREMENTS

There is a form of measuring device which every individual carries with him at all times: the dimensions of his own body. Some of these are easy to remember, such as the individual's height, but others are less familiar, though just as useful to know.

WHAT TO DO AND WHAT TO LOOK FOR

- Measure and record personal measurements as shown on the following form.
- Record them in a small notebook or on a card usually carried in pocket or billfold.
- Try to memorize them by using them as often as possible for measuring, checking with the record to determine the accuracy of the memory.
- Practice judging distances and heights to increase accuracy of such estimates, and check the estimates with the personal measurements to determine accuracy. This will enable individuals to increase their ability to make sound judgments.

MY PERSONAL MEASUREMENTS

Name ______________________________ Date ____________

Address ______________________________ Age ____________

My height is ________ feet, ________ inches.

My eyes are ________ feet, ________ inches above the ground.

My reach up, from ground to tip of upstretched hands is ________ ft. ________ in.

My reach across, from tip of one oustretched hand to the tip of the other, is ________ feet, ________ inches.

The length of my forearm, from tip of little finger to elbow, is ________ feet, ________ inches.

My hand span, from thumb to little finger, is ________ inches.

The breadth of my thumb is ________ inches.

The length of my index finger is ________ inches.

The length of my foot is ________ inches.

The length of my step is ________ feet, ________ inches.

The length of my pace is ________ feet.

Distance from my ____________ to ____________ is exactly one inch.*

Distance from my ____________ to ____________ is exactly one foot.

Distance from my ____________ to ____________ is exactly one yard.

---

* Example: end of thumb to first joint. Must be determined for individual.

MEASURING WIDTH

There are many possible methods of measuring width of an area. Some of the most common methods used by woodsmen follow.

WHAT TO DO AND WHAT TO LOOK FOR

Napoleon Method

- Stand on the edge of a stream or gorge. Place the edge of the hand, with palm turned downward toward the ground, on your forehead, just above the eyes.
- Tilt the outside edge of the palm downward until the outer edge of the hand seems to touch the opposite side of the stream or gorge. Now, make a 90-degree (quarter) turn, holding the hand in the same position. Note the spot on the ground where the edge of the hand now seems to touch the edge of the stream or gorge on the side upon which you are standing. If you have a companion, have him stand on that exact spot. If not, pick out a landmark (rock, bunch of grass, stick) which marks that exact spot on the ground or to which you can walk and find the exact location.
- Next, mark the place where you are now standing with a stick or rock and walk directly to the landmark you have spotted or where your companion stands. Place another marker (stick or rock) at this location.
- Pace off the distance from where you were standing originally to the sighted landmark or your companion. This distance should be approximately the same as the width of the stream or gorge.

Rope Method

- To measure the width of a stream or gorge, throw the weighted end of a marked rope across it.
- If possible, have someone on the other side of the stream or gorge hold one end of the rope while you hold the other. You can then measure the length of rope it took to cross the stream or gorge.
- If a second person is not available, you can sometimes pull the weight to the edge of the water or gorge, and measure the rope length as when someone holds the other end. This is a less accurate method because it is not always possible to draw the rope tight.

Pacing Method

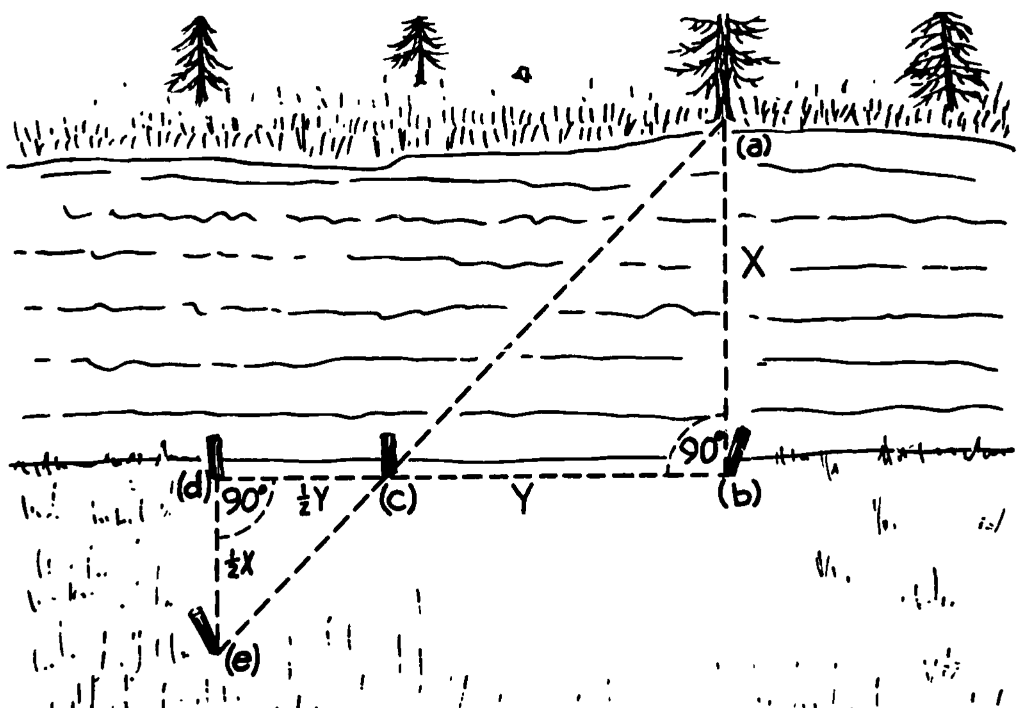
If the stream or gorge to be measured is wide, use the pacing method which applies a simple, geometrical fact about triangles, as follows:

- Note a landmark (a) on the other side of the stream or gorge and place a stick (b) on the side you are on, exactly opposite the landmark (a).
- Stand at stick (b) and walk along the edge of stream or gorge 100 feet at right angles to (a)(b). At this point, place another stick (c).
- Continue walking along the edge in the same line for half as much distance as before (in this case, 50 feet). Place another stick (d) here. At point (d) turn away from the river or gorge, and walk at a right angle to (d)(b), quarter turn to left. When you can sight stick (c) and landmark (a) in a straight line, stop. With another stick, mark this point (e).
- Now, (d)(e) is half the distance across the stream or gorge. Pace this line (d)(e). Multiply the paced distance by two; this figure is the distance across the stream or gorge. (See illustration on page 101.)

Compass Method

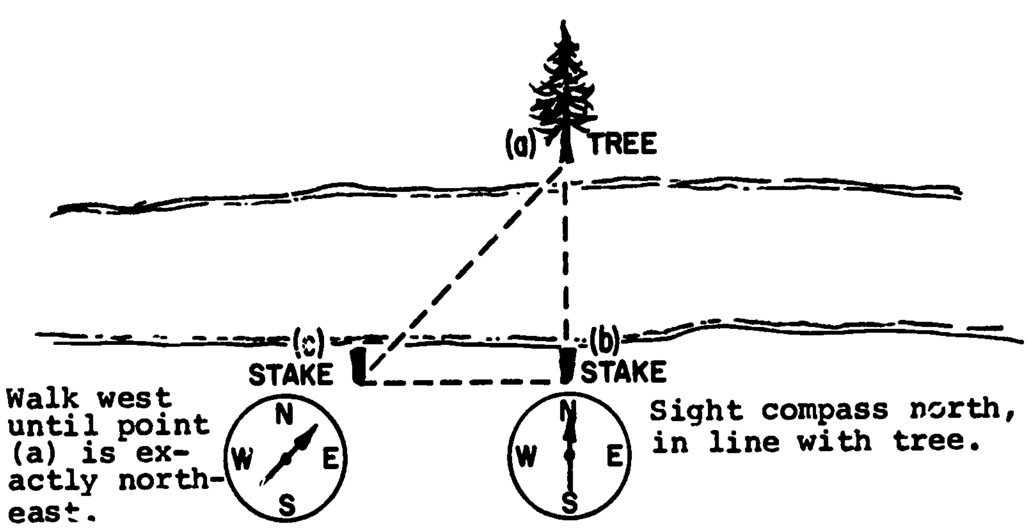
- If a stream or gorge runs east and west, sight compass directly north, in line with a tree or other landmark (a) across the stream or gorge. Place a stick (b) where you are standing, exactly opposite the landmark (a).
- Now, walk west until the compass points northeast at the landmark (a). Place another stick (c) at this point The distance between the two sticks, (b) to (c), will equal the distance from the first stick (b) to the landmark (a) across the stream or gorge, (a) (b).
- Pace off line (b) to (c); this measurement is the width of the stream or gorge. (See illustration on page 101.)

MEASUREMENT BY PACING METHOD



Formula: 2 x Distance from (d) to (e) = Width of stream or gorge, (a) to (b).

MEASUREMENT BY COMPASS METHOD



Distance between (b) and (c) equals distance across stream.

Formula: Distance from (c) to (b) = width of stream or gorge, (a) to (b).

MEASURING HEIGHT

When outdoors, a little knowledge often goes a long way and simple methods can provide answers to many questions, such as the height of a tree. Following are some of the common methods used by woodsmen to measure heights.

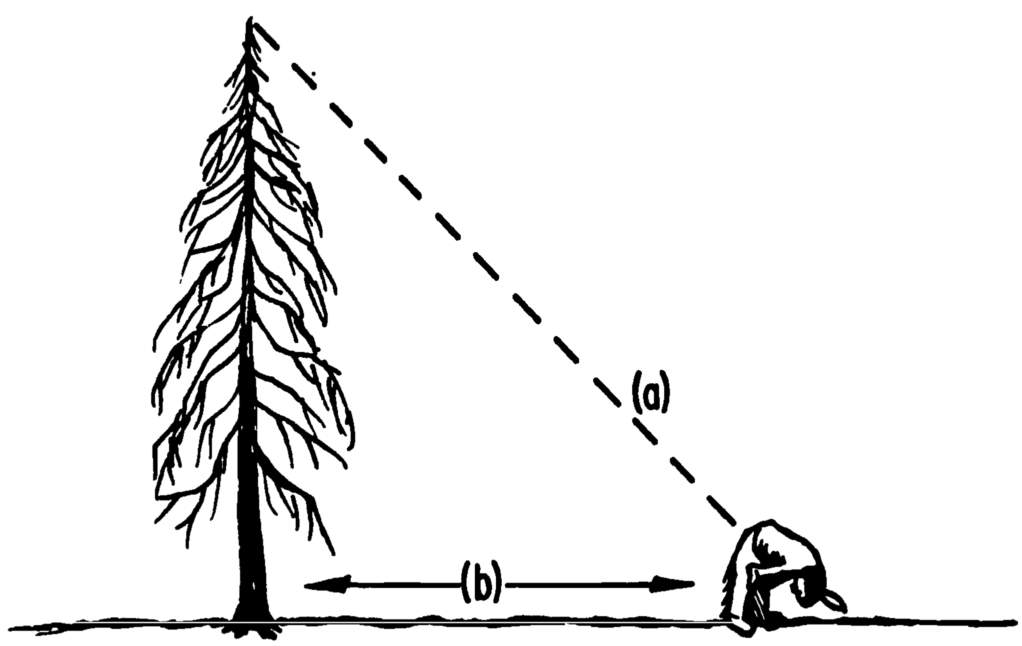
WHAT TO DO AND WHAT TO LOOK FOR

Indian Method

Perhaps the oldest and certainly the most simple method to make a rough measurement of the height of a tree is the one used by the Indians.

- Walk away from the tree (b) or other object being measured for height, in a straight line and bend over, sighting its top between your legs. When you can see the top while in this position, stop (a).
- The height of the tree will be equal to your distance from the tree (b). In bending over, you can rest your hands upon your knees, or grasp your ankles. (See illustration below.)

MEASUREMENT BY INDIAN METHOD



Pencil Method

This is a good method to use if you have a companion whose height you know, or if you know your own height.

- Have your companion stand against a tree, or mark your own height on the trunk. Step back several paces.
- Hold a stick or pencil up before you in an outstretched hand. Sight your companion or the height of your mark on the tree, and mark the apparent height of the companion (or mark) on the stick or pencil with your thumbnail.
- See how many times this height goes up in the height of the tree. If you multiply the number of times by the height of your companion (or your own height, whichever measurement was used), you will have the approximate height of the tree.

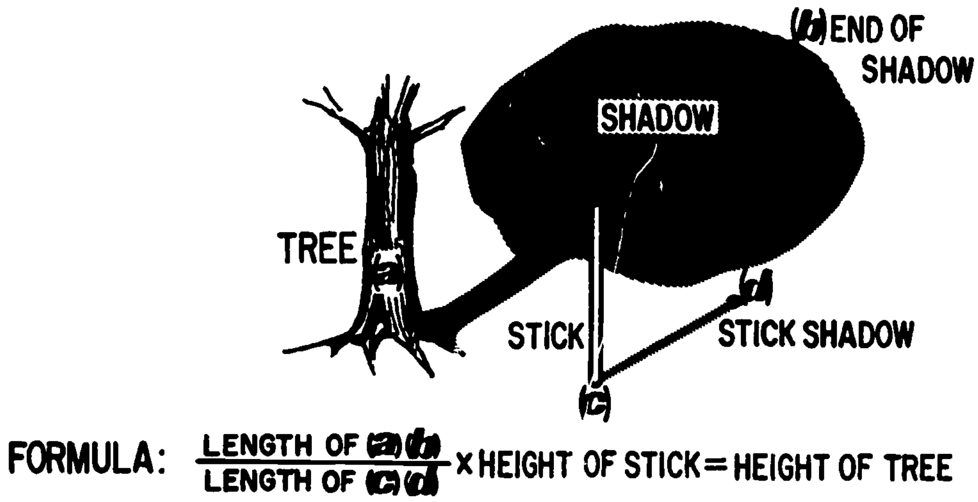
Tree-Telling Method

- Hold a stick upright in your outstretched hand.
- Step back from the tree until the tip of the stick covers the top of the tree, and your thumb covers the bottom of the tree.
- Twist your hand 90 degrees so that the stick is parallel to the ground. Note the spot on the ground at the tip of the stick and have a companion stand on that spot (or mark it with a rock).
- By pacing off the distance from this spot to the tree, you will know the approximate height of the tree.

Shadow Method

- *On a sunny day,* select a tree (a), standing in the open, that casts a shadow.
- Measure the length of the shadow by pacing. At the end of the shadow, place a stake (b).
- Place a stick (c), of known height, in the ground at a right angle to the shadow. Measure the shadow of the stick and mark it with a stake (d).
- Divide the length of the tree shadow (a) (b) by the length of the stick shadow (c) (d). By multiplying the height of the stick by the figure you found, you will know the height of the tree. (See illustration on page 103.)

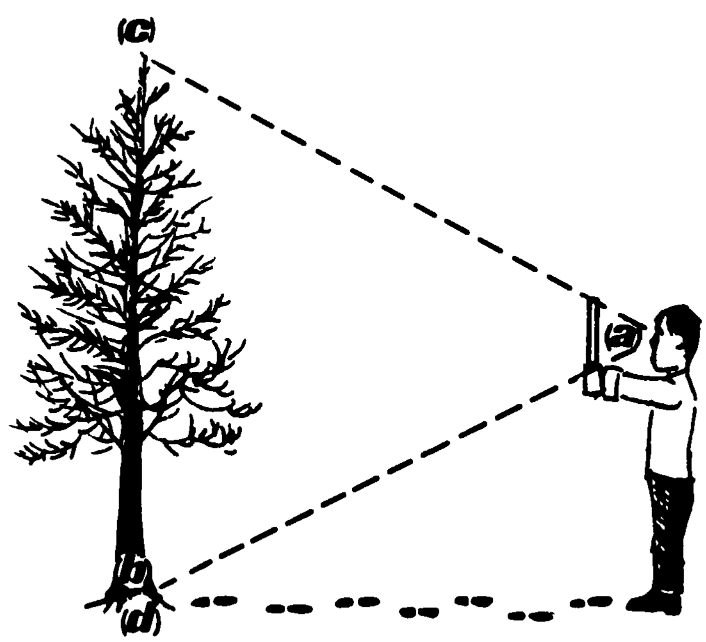
MEASUREMENT BY SHADOW METHOD



Ruler Method

- Select a tree or other object to be measured.
- Measure in inches the distance from your eye to a ruler held at arm's length (a).
- Calling each of the inches a foot, pace that number of feet from the tree (b).
- Hold the ruler upright so that the end of the ruler is in line of vision with the top (c) of the tree and your thumb is in line of vision with the bottom (d) of it.
- Each inch of the ruler above your hand corresponds to a foot in the height of the tree (b). Count the number of inches; and you will know the height of the tree in feet. (See illustration below.)

MEASUREMENT BY RULER METHOD



TREE MEASUREMENTS

The several dimensions of a tree provide opportunities for learning about measurement, as well as for learning about the devices and methods used by foresters as part of their professional equipment. Students will enjoy making and using their own devices, patterned after those needed by men who work in the woods.

WHAT TO DO AND WHAT TO LOOK FOR

Age of a Tree

The age and life story of a tree is revealed by its growth rings. Once they know how, students will find it fun to be able to tell how old their favorite trees are.

- Find a stump of a felled tree which shows the growth rings fairly clearly in cross sections.
- Each ring was formed during one season of growth, the outside ring being the growth of the last season before cutting. Generally, since a growing season coincides with one year, by counting the number of rings in the tree, from the center to the bark, you can tell the approximate age of the tree when it was cut.
- Starting with the center of the tree, notice the varying width of the growth rings. Whenever this line is wider, the tree had good growing weather that year. If the line is narrow, poor growing weather is indicated. Count how many years the tree grew well, and how many years it grew poorly.
- In a cross-section slice of a tree, or on top of a stump, pinpoint annual rings by placing pins in rings for years of interesting events, e.g., the year Oregon became a state, the year World War II ended, the years various members of the class were born, the year the United States sent its first astronaut into outer space. Small flags noting the events thus marked in the tree's growth rings will add interest to this class project or individual undertaking.

CROSS SECTION OF A TREE

Diameter of a Tree

A forester uses a cruiser or Biltmore stick to estimate the diameter of a tree. This is a stick with special markings graduated in such a way that when held against the tree it gives the tree's diameter. Such a stick is not difficult to make, and it is a useful piece of equipment to carry in the woods. To make a Biltmore stick proceed as follows.

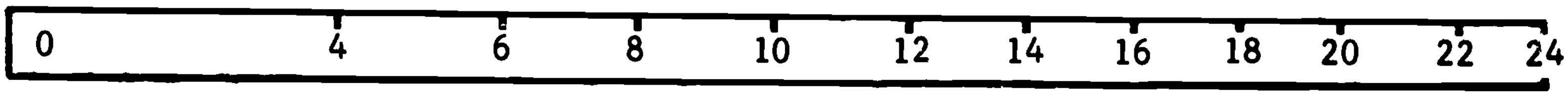
- Secure a piece of one-inch hardwood, three feet long. Enamel it white.
- On one end of this stick, mark the figure "0". Measure 3.72 inches from zero and make a second mark. Label this mark "4" in black enamel.
- At a distance of 5.39 inches from zero, make a third mark and label it "6".
- Continue marking the stick in this fashion, using the following diameter measurements:

Number on Cruiser Stick	*Inches From Zero ("0") Marking*
4	3.72
6	5.39
8	6.96
10	8.45
12	9.87
14	11.21
16	12.50
18	13.72
20	14.91
22	16.04
24	17.14

- See page 106 for directions for marking the reverse side of the stick to make a hypsometer for measuring heights.

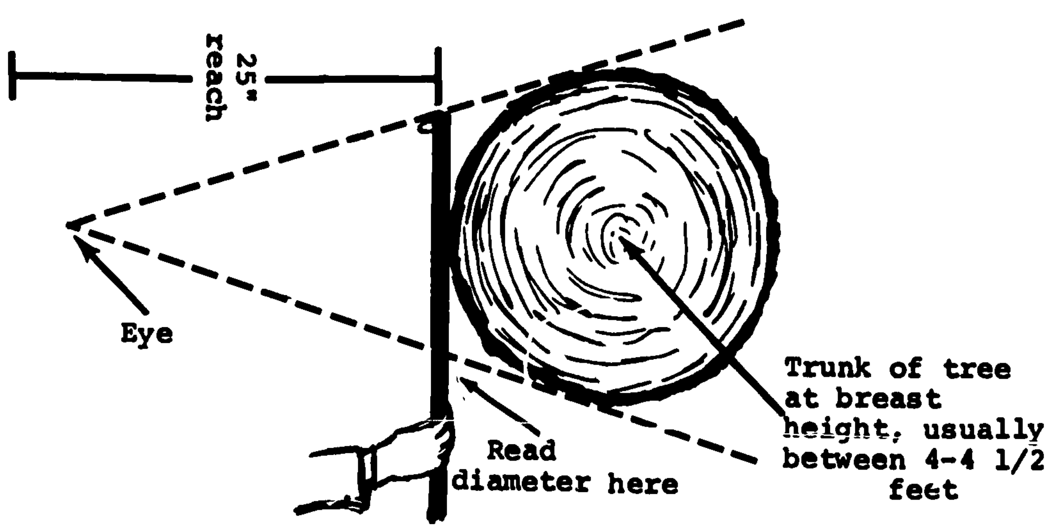
- If black enamel is used to paint the markings, and the stick covered with several coats of clear shellac, you will have a permanent cruiser or Biltmore stick that will look like the following diagram:

BILTMORE STICK FOR A 25" REACH



- The U. S. Forest Service has developed templates for making cruiser sticks for arm reaches of 23, 24, and 25 inches. Check with the local forester, or write to the U. S. Forest Service, Washington, D. C., and ask for a copy of the Biltmore stick template.
- To use the cruiser stick to measure a tree's diameter, hold the stick horizontally against the tree at breast height (4 to 4½ feet above ground), at a distance of 25 inches from your eyes, so that the "0" end of the stick and one side of the tree coincide. Read the diameter of the tree at the marking that coincides with the other side of the tree, as shown in the following diagram:

READING DIAMETER OF A TREE

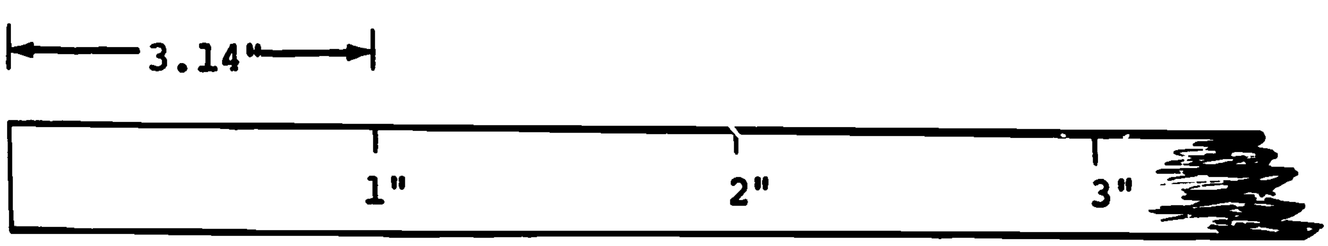


Volume of a Tree

For their timber cruising project (page 92), students will want to know how to estimate the volume of lumber a tree will produce. This is done by measuring a tree in special ways and with the special equipment that foresters use. Students can make these and learn to operate them as a measurement project.

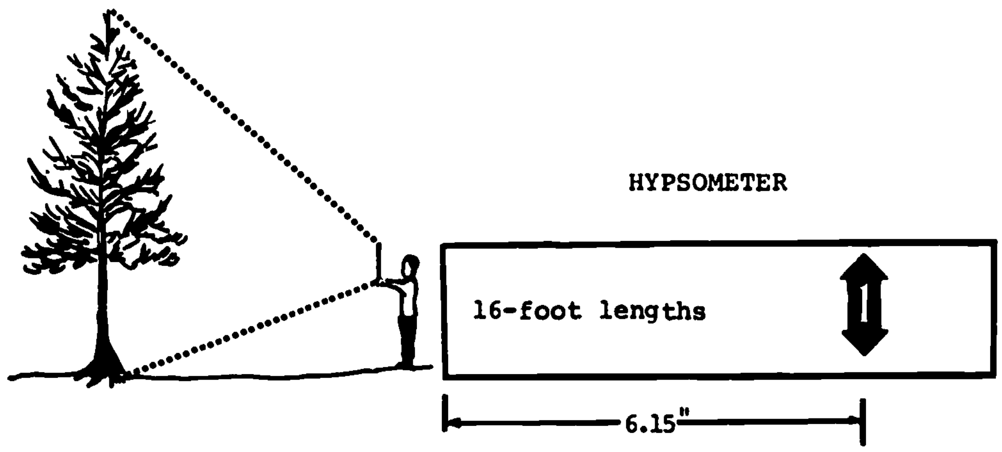
- First, measure the diameter of a tree at breast height above the ground. Foresters call this DBH. Use the cruiser or Biltmore stick you made (page 104) to measure the DBH, or use a special tape measure called a *diameter tape,* which can be made as follows:
  1. Cut a strip of cloth one-half inch wide and five or six feet long, or use the back of any ordinary tape measure.
  2. Beginning at one end of the tape, measure 3.14 inches (three and one-seventh inches) and mark a line across the tape at that point. This is mark "1". Measure off another 3.14 inches and mark this line "2", and so on to the end of the tape. Three and one-seventh actual inches (or, more accurately, 3.1416 actual inches) on the tape are equal to one inch in tree diameter.

TREE DIAMETER TAPE (½ scale)



3. To use tape, wrap it around the tree at breast height. The diameter of the tree in inches will be at the mark nearest where the tape overlaps the zero end.

- Next, measure the height of the tree, using the Biltmore stick, which is also called a hypsometer when used for measuring height, as follows:
  1. To make a hypsometer on the reverse side of a Biltmore or cruiser stick, start at one end and mark off the stick at intervals of 6.15 inches. Write "1" at the first mark, "2" at the second, and so on to the end of the stick. Each 6.15-inch section of the stick represents a 16-foot length of the tree to be measured.
  2. Standing at a distance 66 feet from the tree to be measured, hold the hypsometer stick vertically at arms reach—25 inches from your eyes. Move the stick up or down until the top of the stick is in line with the top of the tree.
  3. Without moving your head, sight to the bottom of the tree, being sure the stick is vertical, and note where the line of sight crosses it. The nearest figure on the stick gives the number of 16-foot lengths in the tree. For example, if the figure is 2, there are two 16-foot lengths and, therefore, the tree is 32 feet high ($2 \times 16' = 32'$).



- When you know the diameter and height of a tree, you can figure the board-foot volume, which is a term used for the amount of lumber that can be obtained from a tree. One board foot is a piece of lumber one inch thick, 12 inches wide, and 12 inches long.

The following volume table shows the number of board feet of lumber that can be obtained from trees of various sizes.

VOLUME TABLE

Diameter of Tree at Breast Height (Inches)	*Volume* (Board Feet) according to number of usable logs								
	1	1½	2	2½	3	3½	4	4½	5
10	39	51	63	72	80	....	....	....	....
11	49	64	80	92	104	....	....	....	....
12	59	78	98	112	127	136	146	....	....
13	71	96	120	138	156	168	181	....	....
14	83	112	141	164	186	201	216	....	....
15	98	132	166	194	221	240	260	....	....
16	112	151	190	223	256	280	305	....	....
17	128	174	219	258	296	325	354	....	....
18	144	196	248	292	336	369	402	....	....
19	162	222	281	332	382	420	457	....	....
20	181	248	314	370	427	470	512	546	580
21	201	276	350	414	478	526	575	616	656
22	221	304	387	458	528	583	638	685	732
23	244	336	428	507	586	646	706	761	816
24	266	368	469	556	644	708	773	836	899
25	290	402	514	610	706	779	852	922	992
26	315	436	558	662	767	849	931	1008	1086
27	341	474	606	721	836	925	1014	1100	1185
28	367	510	654	779	904	1000	1096	1190	1284
29	396	551	706	842	977	1080	1184	1289	1394
30	424	591	758	904	1050	1161	1272	1388	1503

Example—You have a tree 76 feet tall. You estimate that 10 feet down from the top of the trunk the diameter is eight inches. The usable height of the tree is 76 feet less 10 feet, or 66 feet. Since a log is 16 feet long, the tree has four usable logs. Assuming the DBH of the tree is 26 inches, find this diameter in the left-hand (DBH) column of the table, and move across to the column headed by the number of usable logs (4). The table shows that this tree contains 931 board feet.

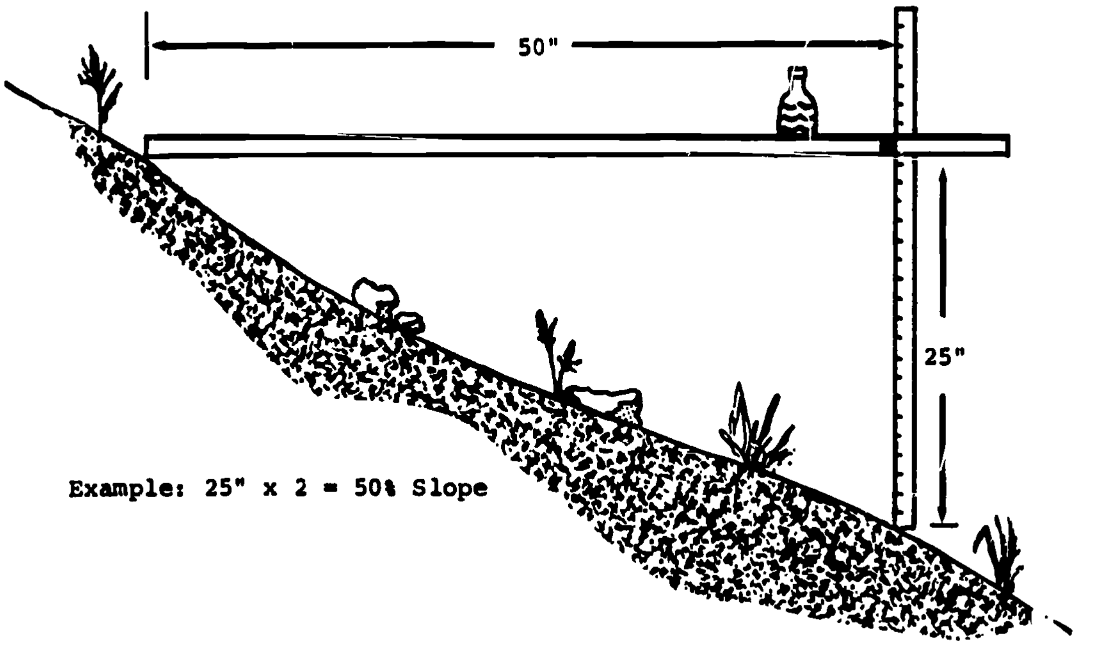
MEASURING SLOPE

One criterion for determining the best use of an area of land is the slope. Upon the slope's steepness or gentleness may depend the land's suitability for farming, for example. Knowing how to measure slope is an important skill in the outdoors.

WHAT TO DO AND WHAT TO LOOK FOR

- Select an outdoor site where you want to know the slope of the land and place a 50-inch board on the ground parallel with the slope.
- Place a flat-bottomed bottle half full of colored liquid on the 50-inch board and raise or lower the free end until the water shows that it is level.
- Using a yardstick, measure the distance of the raised end of the board above the ground. (See following diagram.)
- Read this distance in inches and multiply by two to determine the percent of slope. The percent of slope is the number of units the land falls or rises in 100 units of horizontal distance.
- Knowing the slope of this land, discuss what the best use of the land would be. Could it be farmed? Would the farmer use straight rows or follow curved lines? Why? Could anything be done with this piece of land to enable the owner to use it in a different way?

MEASUREMENT OF SLOPE



MEASURING WATER FLOW

An unusual outdoor measurement project is determining the water flow of a stream.

WHAT TO DO AND WHAT TO LOOK FOR

- Measure off a 50-foot distance along a straight section of stream bank and mark with stakes.
- Tie knots in a clothesline at 1-foot intervals and tie a sinker or weight at one end of the clothesline.

- To find the average width of the stream, measure the width of the stream at several places, using the knotted clothesline; add the figures and divide by the number of measurements taken. The result is the average width.
- To find the average depth of the stream, measure the depth at several places by wading across the stream in a straight line. This may be accomplished with a yardstick or knotted cord with a weighted end sunk to the bottom of the stream. Add up the different depths and divide the sum by the number of measurements taken. The result is the average depth.
- To find how fast the water is flowing, throw a piece of bark (two or three inches wide) or a piece of stick (two or three inches long) into the water upstream from the first marker stake. As the floating object passes the stake, start counting the seconds until it reaches the downstream marker stake. Record the time in seconds. To find how many feet per second the water flows, divide the number of feet by the total number of seconds.
- To find how much water flows in the part of the stream being measured, multiply the length (50 feet) times the average width in feet, times the average depth in feet. The answer is the volume of water in cubic feet in that stream area. This volume divided by the number of seconds (time) is the discharge in cubic feet per second.
- Keep a record of the stream measurements as follows:
  1. L (length) = ________ ft.
  2. W (average width) = ________ ft.
  3. D (average depth) = ________ ft.
  4. V (total volume) = L × W × D = ________ cu. ft.
  5. T (time for float to travel L) = ________ sec.
  6. Rate of flow = $\frac{L}{T}$ = ________ ft. per sec.
  7. Discharge = $\frac{V}{T}$ = ________ cu. ft. per sec.
- What will measurements at different times of the year tell us?

ANIMAL HEIGHT AND WEIGHT BY TRACKS

Finding tracks of animals along trails, in open places, or along a stream bank is part of the excitement of exploration outdoors. (Development of an animal tracking area for an outdoors laboratory is explained in the previous section on long-term projects, page 89.)

Sometimes it is difficult to identify an animal from its track, but students can learn how to determine the size and weight of the animal by measuring its track.

WHAT TO DO AND WHAT TO LOOK FOR

- To determine the approximate shoulder height of the animal, multiply the length of the foot track in inches by eight.
- To determine the animal's approximate weight, multiply the width of the forefoot track in inches by its length in inches. Then multiply this product by five to arrive at the approximate weight in pounds.
- Use a ruler or personal body measurements for the above animal-track measuring experience.
- Some students may want to verify the above experience by measuring the tracks, weight, and height of their own pet animals.

CRICKET THERMOMETER

One of the most intriguing outdoor experiments in measurement is to determine the temperature by listening to crickets chirping.

WHAT TO DO AND WHAT TO LOOK FOR

- In the spring and summer, when the days are warm and the crickets are chirping, listen carefully.

- Count the number of chirps a cricket makes in 15 seconds and add 40 to that number. The result is the approximate temperature.
- For instance, a cricket may chirp 37 times in 15 seconds: 37 + 40 = 77; the temperature will be close to 77 degrees Fahrenheit.

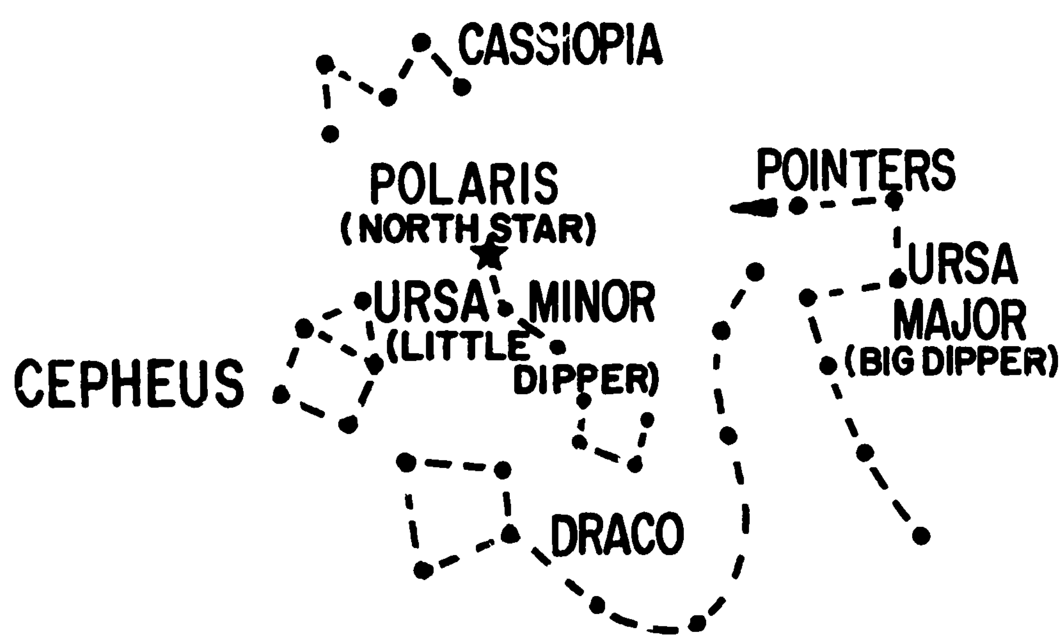
MEASUREMENTS BY STARS AND SUN

Explorers, mariners, and other outdoorsmen have, for many centuries, used the familiar celestial bodies, sun and stars, to help them tell time and find directions. Knowing how to measure time by the stars or find true north, day or night, is valuable information for anyone in the outdoors—hiking, camping, hunting, or using the outdoor laboratory.

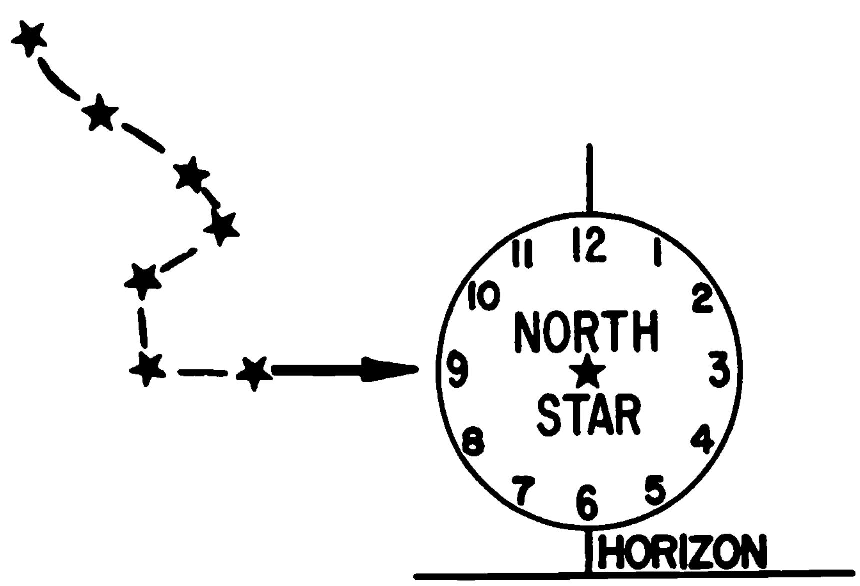
WHAT TO DO AND WHAT TO LOOK FOR

Measuring Time by the Stars

There is an amazingly accurate star clock in the heavens if one knows how to use it. It is composed of the North Star and the two pointer stars of the Big Dipper (Ursa Major), which moves around the North Star once every 24 hours. The following diagram shows the location of these stars in the sky.



- Stand facing the North Star and imagine that it is exactly in the center of a huge clock dial in which 12 o'clock is directly above the North Star. The hour hand of this clock will be exactly opposite the two pointers of the Big Dipper, as shown in the diagram below:



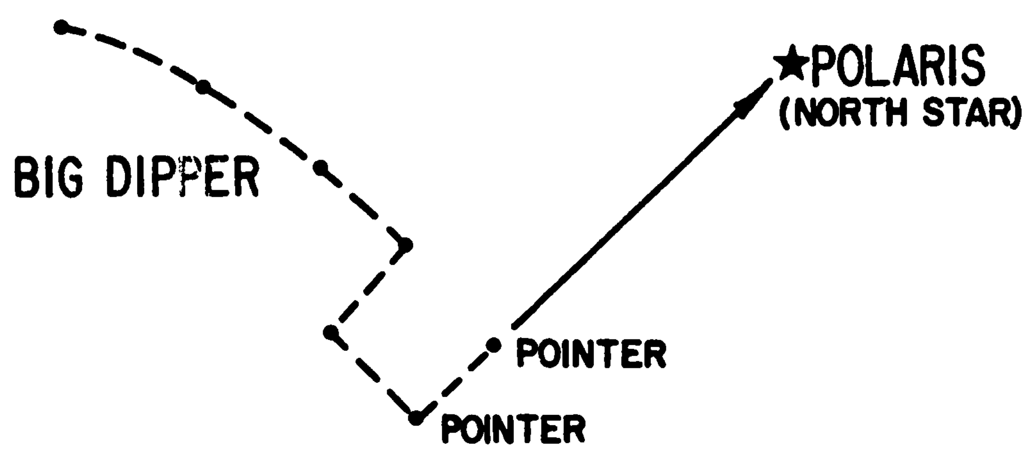
(Continued on page 110.)

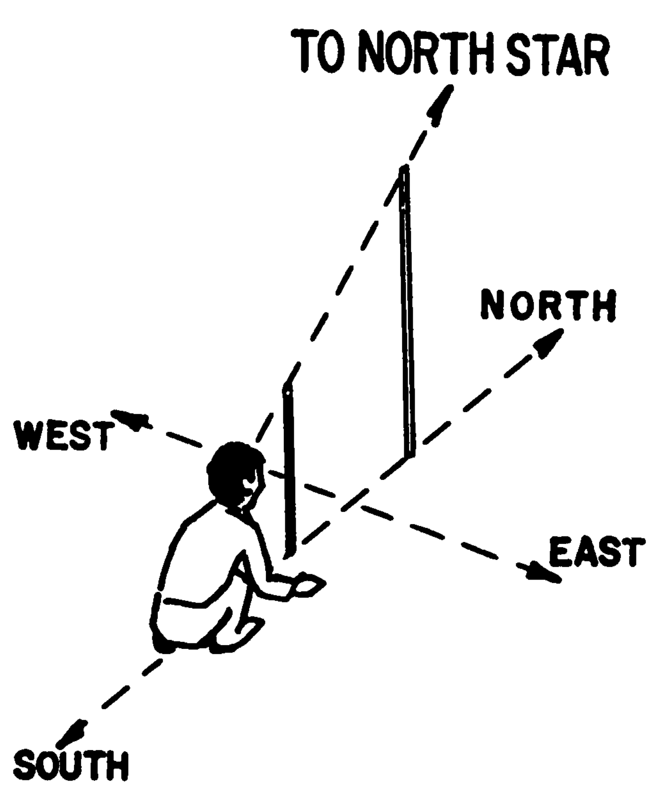
- To learn how to tell time by this star clock, follow these steps:
  1. First, read the apparent time on the star clock to the nearest quarter hour. The apparent time is the point where the "hand" extending from the pointer stars crosses the imaginary clock dial.
  2. To this number, add the number of months that have elapsed since January 1.
  3. Take this number and double it. Subtract the answer from 28¼. If the answer is larger than 28¼, substract it from 52½. That number should be the approximate local time.
- If the answer is more than 12, it would be in the p.m. (Post Meridian), or hours after 12 noon. If less than 12, it would be in the a.m. (Ante Meridian) or the first 12 hours between midnight and noon. For example, an answer of 22½ would mean that the local time was 10:30 p.m.
- **Example**—Imagine that the date is June 15. Read the star clock in the diagram above and figure the time of day. The apparent time on the star clock is 9:00 or simple 9. Add the number of months since January 1 ($5\frac{1}{2} + 9 = 14\frac{1}{2}$). Double the result ($2 \times 14\frac{1}{2} = 29$). Since 29 is more than 28¼, subtract it from 52½. This equals 23¼; 23¼ since the previous midnight gives a local standard time of 11:15 p.m.

The ability to read the imaginary star clock accurately requires some practice, but time accuracy depends on this ability. Students who become proficient at reading the stars to determine the time will amaze those who do not know how it is done.

Finding Directions by the Stars

Anyone who can learn to recognize the Big Dipper constellation of stars (properly called "Ursa Major" or "Great Bear"), can always find true north. This dipper-shaped grouping is always located in the north, revolving around Polaris, the North, or Pole Star.



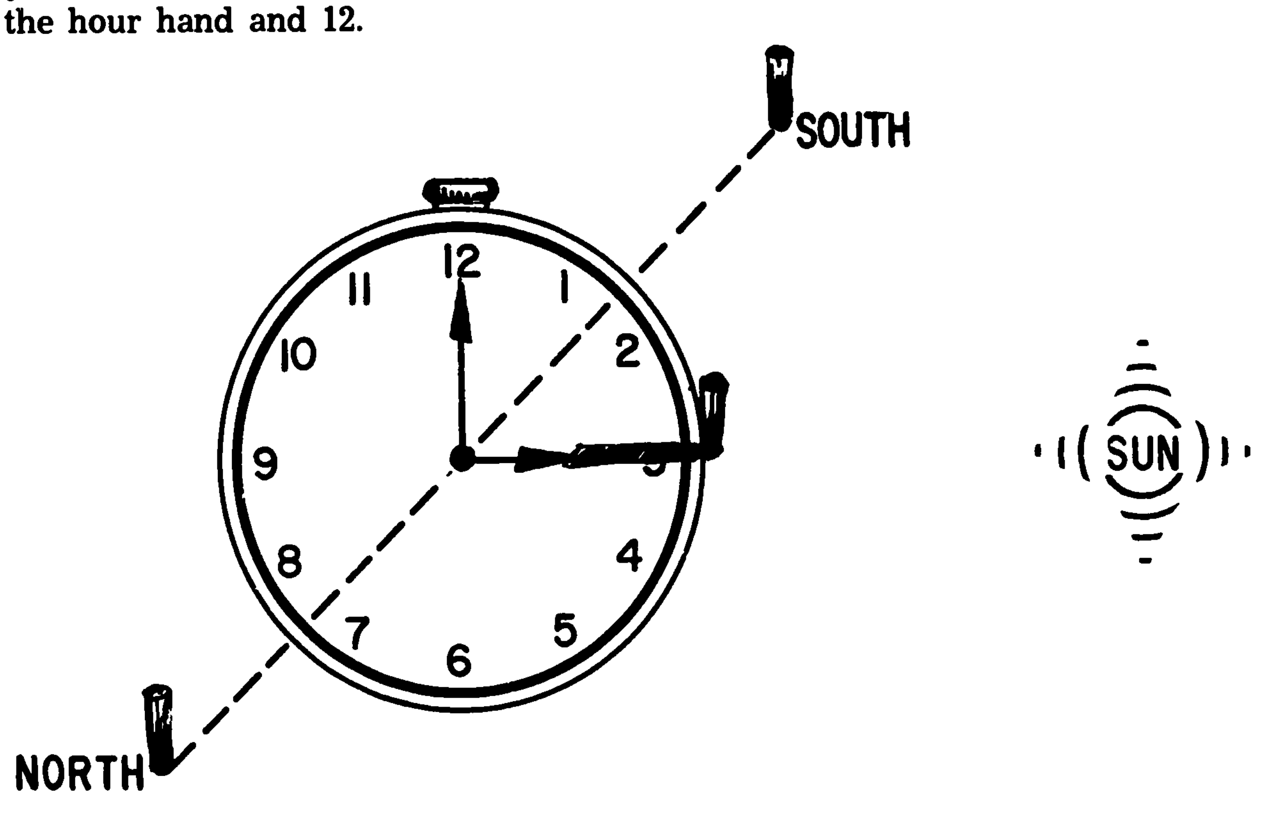


- Locate the two stars at the end of the Big Dipper known as the "pointers" and draw an imaginary line through them. This line will extend to the North Star. The point on the horizon directly beneath this star is true north.
- To get the exact direction, bring the North Star down to the horizon by sighting with two sticks, one taller than the other.
- Place the taller stick upright in the ground. Hold the shorter stick upright with the bottom end of it touching the ground.
- Move the shorter stick about until you can sight over the tops of both sticks to the North Star. When the sticks are in line, push the shorter stick into the ground. A line drawn between the two stick is a N-S (north-south) line. The other compass directions can then easily be found by making intersecting lines to complete the ground compass.

Finding Directions with the Sun

A ground compass can be made in the daytime, too, by using the sun and a watch.

- Lay a watch on the ground. Place a small straight twig or stick upright against the edge of the watch.
- Turn the watch until the shadow of the twig falls exactly along the hour hand. The hour hand of the watch is now pointing directly to the sun.
- Divide the angle between the hour hand and the figure 12 in half. Between 6 a.m. and 6 p.m., standard time, a line from the center of the watch through the halfway mark between the hour hand and the figure 12 will point due south. In the morning, use the point halfway between the hour hand and the coming figure 12 (noon). In the afternoon, use the point halfway between the hour hand and the previous figure 12 (noon). If local time is daylight saving time, use the figure 1 instead of 12 to find south. (See following diagram.)
- To delineate the north-south line more clearly, scratch a line on the ground from the halfway mark between the hour hand and figure 12. With north and south thus determined, the other directions can easily be completed on the ground compass.
- **Explanation**—This method for finding directions with the sun is understandable knowing that at 12 o'clock noon the sun is in the south. It requires 24 hours for the sun to return to this position, but in the meantime the hour hand of a watch has run around twice. If watches were divided into 24 hours instead of 12, it would only be necessary to point the hour hand at the sun and the figure 12 would indicate south. But, since there are only half as many divisions in a watch (12), it is necessary to go back only one-half the distance between the hour hand and 12.



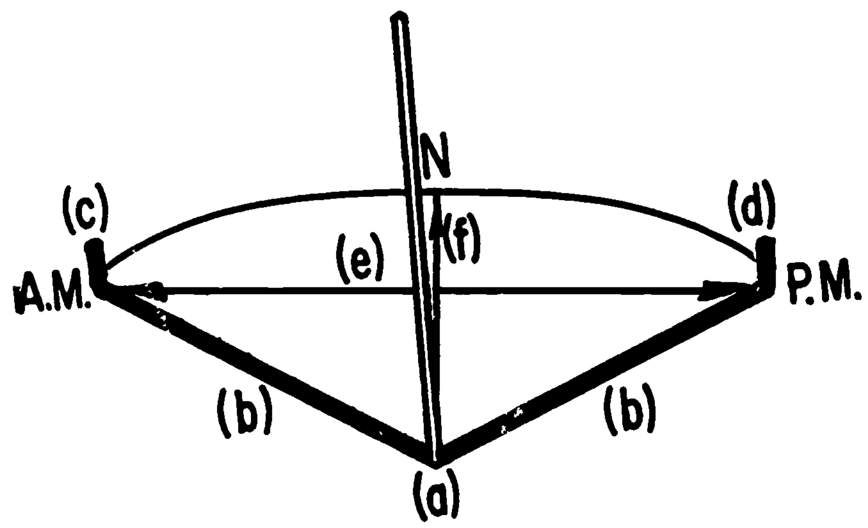
(Example for P.M. Reading)

Finding True North by the Sun

A close estimate of where true north lies is possible when the time of day is known and the sun is shining. This experience in measurement will require most of a sunny day to complete.

- In the morning of a sunny day, drive a five-foot stick (a) into the ground in a flat area where the shadow of the stick (b) can easily be seen.
- Next, drive a peg (c) into the ground at the end of the shadow of the stick. Using the distance from the bottom of the upright stick to the peg as a radius, draw an arc with the bottom of the upright stick as the center. (To draw this arc, tie a cord around the bottom of the stick (a) and tie a small stick to the cord where the cord touches the peg (c), then swing the cord in an arc, allowing the small stick to scratch the arc line in the ground.)

- As the sun rises in the sky, the shadow of the stick (a) becomes shorter and shorter, but as the sun goes down in the afternoon the shadow begins to grow longer again. When the shadow again touches the outline of the arc, mark the point of contact with another peg (d).
- Now draw a straight line (e) between pegs "c" and "d", and mark the point one-half the distance between the two pegs. A line (f) drawn from the bottom of the stick (a) through this halfway point, will be pointing to true north. (See following diagram.)



Appendix

GUIDELINES FOR ESTABLISHMENT OF CONSERVATION AND OUTDOOR EDUCATION PROGRAMS

Developed by the Conservation and Outdoor Education Advisory Committee, Department of Education

This material is presented to help individuals, organizations, and educators establish conservation and outdoor education programs in schools.

Purpose of conservation and outdoor education programs

Natural resources are basic to life. Their condition and abundance has a direct effect on the physical and mental well-being of the nation, and on the standard of living enjoyed by the people. Because of the basic resources—soil, water, minerals, and plant and animal life—are some of the most precious possessions with which the nation is endowed, each citizen has the responsibility to develop an appreciation, awareness and understanding of man's dependence upon the natural laws that govern us and these resources.

Conservation education is concerned with wise action, by people, towards the use and management of natural resources. The purpose then is to develop in students an awareness and appreciation of the natural resources, their uses and their effect upon society so that in adulthood they will be able to plan and participate in future actions necessary to protect and perpetuate these resources.

Conservation is not a separate subject but a field of knowledge that is given special emphasis in all the courses of study in school, making it stand out in importance.

Classroom study can be made more interesting and meaningful by integrating and stressing conservation beliefs in existing courses.

A teacher or student cannot study the social or natural sciences, for example, without discovering the effect of natural resources on our lives. A study of history, economics, geography or modern problems cannot be undertaken without talking about the part natural resources have had in shaping the destiny of civilization.

Conservation learnings about the natural resources take place in two areas:

1. Indoor classroom and laboratory to discover conservation concepts best learned in the classroom and to prepare the students for outdoor learning.
2. Outdoor classroom and laboratory to discover conservation concepts best learned out-of-doors and make indoor classroom learnings more meaningful.

Some values of the program include a better understanding of the following:

1. Our economy and standard of living are based on our supply of natural resources.
2. Recreational and social values are related to everyday living.
3. Spiritual values of our natural resources have an intangible but important place in our lives.
4. Cultural values are tied to our history and present natural resource use.
5. Scientific values are evident in activities which lead to the understanding of our natural resources.
6. Our children's heritage depends on the way in which we manage our natural resources now.

The Program

The conservation and outdoor education program need not start out with a complete committee. One or two people may be sufficient for the initial effort. Interest and leadership have often come from the school district Director of Curriculum. He can be instrumental in stimulating the program.

A beginning point might be some local resource problem which can be studied in the classroom, or a school beautification project. From this concern, conservation beliefs and learnings can spread to all grade levels.

The important thing is to plan toward a fully integrated program for all grades (K to 12). A district conservation scope and sequence chart can be the basic tool in this plan by providing a starting point and giving continuity of learning in the existing curriculum. Several successful projects will ensure backing and interest in further development and accomplishment of the overall plan and objectives.

Listed below are several types of programs now in operation in Oregon:

1. Outdoor School
   Usually one week of living and learning in the outdoor laboratory. (Usually for t n graders because it is last year of self-contained classroom.)
2. Forest Conservation Tour—One day show-me trip set up by numbered stations. (5th, 6th, 7th grades)
3. Outdoor laboratory. (Example, nature trail with tour booklet for teacher.) (all grade levels)
4. Specialized classes and field trips. (all grade levels)
5. Teaching of one resource at each grade level.

6. Fully integrated program based on a Conservation Scope and Sequence Chart combining indoor and outdoor learnings. (grades 1 to 12)
7. Some youth organization programs, such as the 4-H forestry program, adapted to fit into the school program.

Some contacts to help initiate and implement the program

All requests for assistance in setting up programs should be sent to the Consultant on Science, Conservation and Outdoor Education, State Department of Education, Salem, Oregon 97310.

1. Agencies and organizations that will provide assistance:
   School Districts and teachers already involved in programs
   Oregon Game Commission, 1634 S.W. Alder Street, Portland (P. O. Box 3503)
   Oregon State Forestry Department, P. O. 2289, Salem, Oregon
   U. S. Soil Conservation Service, 1218 S.W. Washington St., Portland 97205 (P. O. Box 3503)
   U. S. Forest Service, 729 N.E. Oregon Street, Portland (P. O. Box 3623)
   American Forest Products Industries, Inc., 847 Pittock Block, Portland
   Oregon State Extension Service, O. S. U., Corvallis
   Oregon State University, Director of Outdoor Education, Corvallis
   University of Oregon, Director of Outdoor Education, Eugene
   Southern Oregon College, Director of Outdoor Education, Ashland
2. In the community you may find help from the local offices of the:
   County Agent
   U. S. Soil Conservation Service
   U. S. Forest Service
   Bureau of Land Management, Department of Interior
   Oregon Game Commission Office
   State Forestry Department

Some local organizations which can help gain support for the program:

Parent Teacher Association
Local School Board
Junior Chamber of Commerce
Service Groups
Citizens Advisory Committee (established by school superintendent or Board of Education)
Local Soil and Water Conservation District
Sportsman Groups
Garden Clubs
Local timber, lumber, paper or other resource using companies

Teacher Training and Preparation

In implementing these programs it is advantageous to provide in-service or summer workshops in resource use education and methods of implementation of the basic conservation learning for your teachers. The following institutions offer summer and/or in-service conservation workshops:

1. Oregon State University, Corvallis, Oregon
2. Southern Oregon College, Ashland, Oregon
3. Division of Continuing Education, % Robert Gridley, 1632 Southwest Park Avenue, Portland, Oregon
4. University of Oregon, Eugene, Oregon

SUGGESTED GUIDELINES FOR OUTDOOR SCHOOLS

In order to assist interested school personnel in determining what is needed in an area to be used as an outdoor classroom, a subcommittee of the Department of Education's Conservation and Outdoor Education Advisory Committee has undertaken to suggest the following criteria to be used as a guide. It is believed that state and federal agencies, youth serving agencies, and private industries with land available for use as outdoor classrooms may also benefit by having these criteria to use as a guide.

SITE

1. The site is located within a 75-mile radius of a school center.
2. The site provides for maximum privacy. (Located away from densely populated areas or undesirable resorts.)
3. The site provides abundant natural resources and varied topography to enrich an outdoor living experience. (Mixed timber types, variety of plant and animal life native to the area, fields, hedgerows, ponds, streams, swamps, deserts, lakes, oceans, hills, mountains are examples of natural resources.)
4. The site including contiguous areas is of adequate size for the number of students using it at any one time. (One or more acres per student camper.)
5. The area is free from unnecessary hazards. (Unprotected cliffs, pits, treacherous waters, poisonous plants, poisonous snakes, dangerous snags, insect pests are examples of unnecessary hazards.)
6. The site has a good year-around access road leading into the property.
7. The site provides for an adequate parking area for at least 15 cars.

8. The site provides for effective drainage in the living and activity areas.
9. The site is located near a source for convenient delivery of supplies and for emergency medical services.
10. The site has an adequate supply of potable water.
11. The site must be adaptable to the development of sanitary facilities that comply with all local, county, and state sanitation laws.
12. The site provides for an open playfield area.

FACILITIES AND EQUIPMENT

1. The site has winterized separate living areas for boys and girls to accommodate 60 to 120 students plus supervisorial staff.

   Each separate living area must provide for the following minimal standards:

   a. Accommodates a minimum of 30 students with separate buildings or rooms to house 8 to 10.
   b. Provides living accommodations for counseling staff. (Ratio: 1 staff person for each group of 8 to 10.)
   c. Provides for indoor day rooms large enough to accommodate 30 students for meetings and leisure use.
   d. Provides hot water facilities for bathing purposes. (Ratio: 1 showerhead to every 10 persons.)
   e. Provides toilet facilities adequate in number. (Ratio: 1 seat per 10 persons. In boys areas with urinals, the ratio is 1 seat for every 15 persons with 1 urinal for every 30.)
   f. Provides for handwashing facilities in proximity to all toilets and urinals. (Within 20 feet of the toilet facilities. There should be a ratio of one wash sink to each 15 persons.)
2. The site provides separate living quarters for a minimum of fifteen supervisorial staff and guests.
3. The site provides for a modern dining and kitchen facility to accommodate a minimum of 150 persons.
4. The site provides for an administration building space that includes a gathering place for supervisorial staff to hold meetings and to use during their free time.
5. The site provides space for an infirmary with isolation quarters.
6. The site provides for a recreation building that will accommodate a minimum of 150 persons for indoor gatherings and space for a library, nature museum, trading post, storage of tools and other equipment.
7. The site provides space for a laundry and drying room.
8. All facilities should be constructed in accordance with school building codes.

PHILOSOPHY OF EDUCATION FOR OREGON SCHOOLS

All the major branches of learning include a body of underlying principles or general conceptions which denote their social significance. This is particularly true of the field of education. Teachers, to be effective, should hold an integrated view of these principles which will provide them a basis for the general determination, interpretation, and evaluation of educational objectives, practices and outcomes.

This statement of philosophy, developed by the staff of the State Department of Education, was officially adopted by the State Board of Education on April 7, 1959. It is presented to the teachers of the state for their guidance.

BELIEFS ABOUT MAN

The objectives of education should stem directly from the nature of man and his needs, from the nature of the school, and from our society's basic characteristics which distinguish its culture. Man has certain inherent characteristics:

1. He is a product of both his heredity and his environment.
2. He is a biological organism and his developmental processes and actions are to a large degree determined by this heritage.
3. He responds to his environment by making choices which are influenced by values he holds.
4. He has a capacity for self-direction which enables him to exercise degrees of control over his biological nature and over his physical environment.
5. He constantly develops new ways of satisfying his physical, social, and aesthetic needs; thus his culture is ever changing.
6. He is a social creature and the group culture stimulates and directs his development.
7. He learns by and through his own experiences and the experiences of his society which are meaningful to him.
8. He has personal worth and dignity.
9. He is self-centered, but has the capacity to subordinate personal desires when these conflict with the best interests of others.
10. He is neither inherently good nor bad but individually develops moral standards from his culture.
11. He is curious and this curiosity may be a stimulus to directed learning.
12. He can discover and seek to solve his problems through the processes of reasoning.
13. He is creative and the product of this creativity contributes to the culture.
14. He seeks an explanation of his relationship to the universe.
15. He passes through interrelated stages of physical, social, intellectual, emotional, spiritual, and aesthetic development; however, each individual differs both in his potential and rate of growth.

These characteristics result in all men having certain basic needs. The satisfaction of these needs, as long as man respects the rights of others, is essential to his sense of well-being as a person and as a worthy member of society. He strives for these satisfactions in the following ways:

1. He seeks satisfaction for his physical needs, such as food, clothing, and shelter.
2. He seeks satisfaction for his social needs, such as a sense of security and acceptance by his group.
3. He seeks satisfaction for his intellectual needs, such as freedom of thinking, learning, and expression.
4. He seeks satisfaction for his emotional needs, such as mutual affection, and enjoyment from contributing to the well-being of others.
5. He seeks satisfaction for his spiritual needs such as freedom of belief and religious expression.
6. He seeks satisfaction for his aesthetic needs, such as harmony in the arrangement of his environment and aesthetic fulfillment in his creative efforts.
7. He seeks satisfaction of his needs as a total personality, such as contentment gained from a complete and abundant life and self-respect developed as an individual.

BELIEFS ABOUT OUR NATION'S CULTURE

1. Our culture is based upon the importance of the individual within the group.
2. Our culture is dynamic and changing at an increasingly accelerated rate, but all changes do not necessarily contribute to human progress.
3. Our culture has developed in a democratic society with group processes becoming increasingly important as society becomes more complex.
4. Our culture is based upon the political equality of man and growing reliance upon the democratic spirit and process which more and more pervades all aspects of life.
5. Our culture is influenced by a variety of political, religious, social and economic ideologies which may create conflicts and stimulate or retard progress.
6. Our culture in the 20th Century is confronted with many unsolved problems, arising from conditions largely created by science and technological development, such as a rapidly growing population, increased leisure, earlier retirement, greater longevity, mobility of population, urbanization, specialization, increased complexity of living, changing patterns of family life, rapid mass communication, and a shrinking world.
7. Our culture is becoming steadily more humane and is making increasingly effective provisions for the well-being of the individual.
8. Our culture is increasingly affected by the interdependence of individuals, groups, and nations.
9. Our culture is permeated with the ideal of an increasingly good life for all.

ROLE OF THE SCHOOL

The school is a major institution through which our cultural heritage is transmitted and by means of which the members of society are prepared to evaluate social changes. The intellectual development of each member of society, to the degree that he is able to profit thereby, is the primary responsibility of the public school. The school shares with other institutions and agencies such as the home and the church the responsibility for the physical, social, emotional, aesthetic, moral, and spiritual growth of individuals.

The objectives of education grow out of and reflect society's understanding of and beliefs about the nature of man, the nature of society itself, and the concept of the role the school plays in the culture. New insights or understandings growing out of experience or research in any of these areas are reflected in the objectives of the school.

The following specific objectives of education in Oregon are derived from the beliefs about man and his culture delineated above and form the bases for the framework of public school education in Oregon. They should be examined, evaluated, and adapted by lay and professional groups in local school districts when formulating their statements of educational beliefs to serve as foundations for locally developed educational programs.

OBJECTIVES*

Citizenship—The good citizen knows his country—its people, its history, its geography, the structure and function of its government, and its internal and external problems. He understands the fundamental principles of American democracy—political, economic, social, moral, and spiritual.

He is loyal to American ideals, is proud of his heritage, respects constituted authority, has concern for the welfare of his country and of his fellow men at home and abroad, and seeks ways to increase world cooperation towards a just and lasting peace.

He participates in the life of his community and nation by exercising his rights and assuming his responsibilities as a member of a free and self-governing society, and he strives to improve it.

Basic Skills of Communication—The effective citizen has, to the extent of his ability, achieved proficiency in use of the basic tools of learning. He recognizes that communication is fundamental to intellectual development and has acquired skill in receiving ideas through reading, listening, and observing and in expressing them through writing and speaking. He understands the use of symbols from other fields such as mathematics, science, music, and the visual arts and may have extended his range of communication by mastering other languages.

He recognizes that learning is continuous throughout life.

He employs the basic skills efficiently to gather, organize, and disseminate information, to think critically, to solve problems, and to gain enjoyment. He uses the skills and understandings to acquire knowledge and to participate in individual and group activities.

Health—The educated person knows the structure and functions of his body, is aware of hazards to his own and his community's well-being, and knows desirable mental and physical health practices. His health practices are based upon factual information. He understands the role of health services in the welfare of the community and the importance of good health to himself and others. He understands the interrelationship of mental and physical health.

He finds satisfaction in developing and maintaining good health habits and attitudes. He regards physical and mental fitness as a personal obligation as a family member and as a citizen.

He practices safety and applies health knowledge in daily living, and supports efforts to safeguard and improve the health of the community.

Family Life—The effective family member has knowledge and skills which result in the wise use of money, time, and energy; the provision of adequate food, clothing, and shelter; the care, training, and guidance of children; and constructive interrelationships among members of the family and with the community.

He recognizes the family as the basic institution of our society, and also its changing role in our contemporary society. He has an appreciation, respect, loyalty, and a sense of responsibility for his own home.

He maintains affectionate home relationships. He provides an adequate and secure home within his means. He accepts his share of the duties and responsibilities for maintaining satisfactory personal and family relationships.

Economic Life—The educated person has a knowledge of our natural and human resources and of the necessity for their wise use and conservation. He understands the workings of the economic system in our society and he has some comprehension of other systems. He recognizes that the abundance of goods and services he enjoys as a consumer is largely a result of the high productivity of a free enterprise system.

He accepts the necessity for controls that will help insure a fair distribution of the products of the economy. He appreciates the value of labor and feels satisfaction in doing well any task he undertakes.

He acquires the skills and understandings that will provide a foundation for vocational success. He learns about occupational opportunities and requirements. He earns his way in the world; and he secures information that enables him to consume goods and services wisely.

Moral and Spiritual Values—The educated person has gained an insight into moral and spiritual values. He knows the main facts of the history of religions and he understands the contributions of the Judeo-Christian ethic to Western culture, and the role of our national ideals. He is familiar with the significant contributions of literature, art, music, science, and other fields of learning to moral and spiritual growth.

He seeks support in a faith that upholds the virtues of goodness and morality and which explains and reconciles his relationship to fellow men and the universe. He regards devotion to truth and services to fellow men as a high goal among the active outcomes in his life. He places human values above material things.

He is humane and considerate in actions and dealings, has sympathetic understanding of differences and deviations, and is respectful of the rights of others. He exhibits personal integrity measured by the acepted values of the culture. He defends religious liberty and other human freedoms vigorously and opposes all forms of tyranny over the human mind.

He responds with appreciation, reverence, and reasoned conduct to the worthy ideals of his country, his faith, and his culture.

Aesthetic Values—The educated person has developed sensitivity to aesthetic values. He can discriminate among expressions of artistic and creative achievement. He understands fundamental aesthetic principles having to do with expression, organization of environment, and our art heritage.

He observes, appreciates, and wants to preserve the things of beauty provided by nature or produced by man.

He incorporates aesthetic principles into his daily living. He supports the endeavors of his community to improve the aesthetic life and opportunities of the people.