TECHNIQUES FOR TEACHING HIGH SCHOOL CONSERVATION EDUCATION

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By

Robert Edward Brown

A THESIS

Submitted to the School of Graduate Studies
of Michigan State University of Agriculture
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ABSTRACT

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By Robert Edward Brown

While teaching in secondary schools, the author found a decided lack of conservation education. In many standard biology courses offered in high school, conservation is the last subject to be considered during the year and then only superficially. Teachers feel inadequate to teach in the out-of-doors and many have had no background in either conservation or field techniques that might be useful in attempting to teach conservation concepts.

For these reasons, the author has undertaken this study. This thesis is designed as a guide to those teachers who have limited field experience and limited conservation training.

I have compiled a list of what appear to be important conservation principles covering the various natural resources. This is followed by a series of field trips indicating teaching techniques which may be applied.

The next section of the thesis is devoted to methods of demonstrating conservation principles as previously set forth. This is best done through active field participation on the students' part.

No part of the thesis is intended to stand alone. Rather each part is an integral unit of the total field experience. Careful study and use of this paper should produce useful and meaningful learning experiences in conservation education.

ACKNOWLEDGMENTS

The author wishes to express his sincere thanks to Dr. Gilbert M. Mouser, under whose able supervision and guidance this study was undertaken and to whom the results are herewith dedicated.

He is also indebted to Harry Stevens, a college teacher, for his suggestions and help with diagrams.

Finally, especial thanks are due my wife, Elizabeth, who has done much of the editing, proof reading and menial tasks connected with a thesis.

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Introduction

It became apparent to the author, during his several years of high school teaching, that there is a definite lack of interest and ability on the part of secondary school teachers to teach conservation principles and techniques. This problem was discussed at district science meetings, at teacher conventions, and other faculty gatherings and usually the comment arose - 'why should we teach and talk about a dry subject such as conservation when we have more than we can handle just teaching regular biology?' Later, it became apparent that these same teachers did not know much about conservation or even where to obtain information relevant to their teaching.

It is hoped that this paper will be an initial source of reference for science teachers. It is not intended to be exhaustive in subject matter but rather a start in the right direction. It is anticipated that the teacher could carry on further by inventing, improvising and otherwise continuing conservation activities after receiving basic ideas and methods from this paper.

In the series of chapters that follow (other than those concerning general techniques) the author summarizes the conservation principles and applications relevant to that particular study. These same principles, which should be kept in mind throughout, are listed in the next section.

One last point should be stressed here. It is further anticipated that many science teachers reading this will have had meager science training in some of the areas mentioned in these articles. Therefore, all vocabulary is kept as simple as possible and any technicle terms will be adequately defined.

Conservation Principles Useful as Teaching Guides

Throughout this study, various techniques are proposed and these are then described in enough detail so that a teacher could carry them out. It is wise to keep the proper perspective concerning conservation practices and problems. To this end, this set of principles has been devised.

Each field study unit will terminate with a short summation of the most applicable principles which should be stressed. These principles, which seem most appropriate for high school conservationists are as follows.

Soil Conservation: General comments - the soil factor of land has varying capabilities or capacities therefore it is up to us to analyze the sum total of the characteristics of any given soil to determine how it should be used.

If we strike at the full meaning of conservation, the essential use of any given piece of land must be appraised in the light of numerous factors such as (a) the immediate owner of the land (b) his neighbor (c) the community at large.

Principles:

A. If man is to know how to use soil wisely, he must first understand the important characteristics of the soil.

1. Geologic erosion is a natural constructive force essential and fundamental to soil building.

2. Soil is formed from rocks by physical, chemical, and biological processes.

3. Soils are a combination of minerals, living or-

ganisms, organic matter, water and air.

4. As most soils age and mature, the layers of topsoil and subsoil become more distinct from the parent material. Soils differ because of the parent material from which they are derived.

5. Some soils are made almost entirely from decomposed plant material with varying amounts of soil particles. Difference in soil texture is dependent upon size of soil particles. The water holding capacity of soil is dependent upon size of soil particles and amount of humus in the soil.

6. Soils differ in color, depending on chemistry, mineral compounds, amount of humus and drainage.

7. There is variation in availability of water and nutrients for plant growth in different soils.

8. Soils vary in ability to support different kinds of plants and animals. Land is classified according to its capability.

9. Soil materials are usually eroded by wind, water and gravity. Soil erosion is influenced by soil type, amount of water and wind, degree of slope of land, kind of cover and the season.

B. Certain other important understandings must be a part of man's knowledge if he is to use soil wisely.

1. Soil is a basic resource, a fundamental heritage of man.

2. The welfare of the people is affected by the way the land is used.

3. The erosion and misuse of productive topsoil has helped to cause the disappearance of some nations. A change in the fertility of surface soil can cause a shift in human populations.

4. Fertile soil was partly responsible for the patterns of development and the speed of advancement of civilization.

C. Man must recognize and understand problems and techniques of management.

1. In the use of any piece of land, all possible uses of that land must be considered and the selected use should not eliminate any other future desirable uses. The characteristics of each acre of land may be different and should be studied to determine what use should be made of it.

2. Soil, water, wildlife, and vegetation are interdependent.

D. Certain policies relative to soil conservation should be established and administered. The reasons for these policies should be made evident.

1. Wise use of land requires cooperative planning and administration.

2. Zoning and planning are important methods man uses to define and adjust himself to proper and varied land uses.

3. A high level of soil productivity is essential through economic application of energy and effort to provide food, clothing, and shelter for tremendous increases in populations.

4. In some circles, incentive payments and technical assistance are wise.

Water Conservation: General comments - similarly to soil, water is considered an indispensable substance necessary

to life. It is important to stress the availability of water in some areas and the lack of it in others. The ravages wrought by water out of control is mentioned in the following principles.

A. Certain understandings of characteristics of water resources and their distribution and status are essential.

1. Water is a self replenishing and self depleting resource; it is intermittently replenished by precipitation and is steadily depleted by evaporation into the air and drainage away to the sea.

2. Water tends to cling to earth particles and to spread throughout the earth materials by capillary action.

3. Water is unevenly distributed geographically and the quantity of water in any locality varies from time to time.

4. Water is a very active and mobile resource. It is hard to capture and keep where it is wanted, or to keep it out of places where it is not wanted.

5. Water readily dissolves and carries away a wide range of substances.

6. All phases of the"water cycle" are closely related.

B. Understanding uses of water and its importance to man.

1. Water is indispensable for plant and animal life, and varies with climatic conditions.

2. Demands for water are increasing at a greater rate than the rate of population growth.

3. In any location, the ease of water's availability tends to influence the use made of it.

4. The usefulness of water at any location may depend importantly on how adjoining and upstream lands are used.

C. Various problems and techniques of management of water resources must be kept in mind.

1. Control of pollution is an essential aspect of water management.

2. Certain land management practices help to reduce the flood waters and silt that small streams empty into rivers and lakes.

3. Transporting and storing water to meet increasing needs require experience and management techniques.

D. Water resource conservation demands specific policy and administration of this policy.

1. Because water resources recognize no state, county, township or municipal boundaries in their occurence and travels, it is important that all units of government be given maximum opportunity for cooperating to solve mutual management problems.

2. Good public understanding of water resource problems, possible solutions, and management are extremely important.

Forest Conservation: General comments - keeping in mind that forests are actually communities of plants and animals in which trees are dominant members, it is then possible to understand why conservation of these resources is vital.

A. Characteristics, distribution, and status of forest resources which should be included in the overall understanding of modern-day conservation.

1. Trees depend upon water, soil nutrients, sunlight, and air for growth.

2. Climate, soil, and topography influence the natural range and distribution of the different types of forest communities.

3. Aggregations of living things influence the climate and soil they live in.

4. Forest litter, humus, and roots give forest soils an exceptional ability to absorb moisture and resist erosion.

5. Forests are constantly undergoing change, and as they mature and are harvested or die some species of plants and animals may be replaced by others.

6. The inter-relationships between plants and animals of forest communities determine the characteristics of a particular forest.

7. Fires, disease, insects, man, and animals may be harmful or beneficial to the forest.

8. Some lands are better adapted for the growing of forests than others.

B. Important principles concerning the uses of forest resources and their importance to man.

1. Forest yield many essential products for man's use.

2. Many communities are highly dependent upon local forests, forest industries, and forest recreation for economic stability.

3. Forests are important in helping to protect watersheds from drought and floods.

C. Understandings important to recognizing problems and techniques of management.

1. Forests can be managed to produce a continuous supply of wood and wood products, wildlife, water, and recreational opportunity.

2. Research is important for the development and improvement of forest management practices and the more efficient utilization of forest products and services.

D. Policies and administrative controls for forest resources.

1. Public use of forest land carries an obligation of good citizenship.

2. Forest owners have responsibilities as well as rights in the management and use of forests under democratic living.

3. Cooperation between public agencies, private owners, and the general public is necessary in protecting forests against fires, diseases, insects, and excessive animal populations.

Conservation of Wildlife: General comments - wildlife includes all animals used by man for pleasure or profit. It is intended here that some basic concepts concerning wildlife conservation will be brought out.

A. Principles governing characteristics, distribution, and status of wildlife.

1. Wildlife is a renewable resource because it is alive.

2. All wildlife have individual, specific living re-

quirements, yet are interdependent with their total environment.

3. The capacity of the environment to support a particular species of wildlife is limited.

4. All species of wildlife are directly or indirectly dependent on water and plant life.

5. Animals occupy and defend land for the same reasons people do.

6. Some wildlife species can, within limits, adapt themselves to a changing environment. Others cannot.

7. Certain species of wildlife may become extinct while others may become too abundant.

B. Understandings relative to the uses of wildlife and their importance to man.

1. Wildlife is valuable. It contributes to recreation and has economic importance.

2. Some natural checks on wildlife overpopulation have been disturbed by man.

3. Some species of wildlife may become harmful under certain circumstances.

C. Problems and techniques of wildlife management.

1. One phase of wildlife management is the proper control and manipulation of habitats by man through (a) fire, cutting, and spraying (b) flooding (c) food and cover planting (d) lakes and stream improvement (e) soil conservation practices.

2. Wildlife habitat is sometimes changed by man and also by natural forces.

3. Harvesting and annual surplus wildlife can be an important part of management.

4. Artificial feeding benefits the individual animal but may be poor resource management.

5. The understanding of food chains is basic to management of wildlife.

6. Wildlife populations are decreased by many natural and man-made factors including, (a) seasonal and environmental changes (b) predation (c) disease (d) automobiles and farm machinery (e) food and cover deficencies (f) chemicals used for plant and animal control.

7. Patterns of land use determine the type and quantity of wildlife.

D. Administration and policies used to control wildlife resources to suit man's needs.

1. Game and fish laws and their enforcement are essential to ensure equal opportunity for everyone in harvesting fish and game and in preventing over harvesting of some species and underharvesting of others.

2. Wildlife regulations should be flexible enough to keep pace with changing times.

3. Conflicts between groups sometimes arise concerning use of land and water for wildlife purposes as opposed to other uses.

Preparing For The Field Trip

That which can best be learned in the out of doors through direct experience, dealing with native materials and life situations should there be learned.[1] The teacher who can take a group out of the confines of the classroom and conduct an orderly teaching experience in the field is a very valuable person. There are teachers who conduct field trips and make the whole experience seem extremely easy and stimulating. Conversely, there are teachers who would have general bedlam as soon as their students set foot out of doors. This is true of leaders of groups at varying age levels, from adult groups to kindergartners.

According to a new textbook written for science teachers, a good field trip, like a good classroom lesson, requires thoughtful preparation as well as enthusiasm.[2] Preparation, therefore, is a key word. Experience does give one considerable advantage yet if a teacher lacks experience, this does not mean he should deprive the students of field experiences. If adequate preparation is stressed, even beginners can achieve success.

Preparation need not cover days of class time, but, it should be thorough. The following check list contains the

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[1] Introduction by L. B. Sharp to Outdoor Education for American Youth, prepared by Julian W. Smith, American Association for Health, Physical Education, and Recreation, Washington, D. C., 1957.

[2] Teaching Science Through Conservation, by Martha Munzer, and Paul Brandwein, McGraw-Hill Book Co., Inc., New York, 1960, p. 413.

essential items to be covered in preparation previous to the actual field trip. This list should be issued to the students or at least explained point by point to them.

1. Purpose of field trip: Why is the class being taken out of doors? Examples: To discover the location of different animal habitats. The class is looking for local or migratory birds. The class is interested in the plants of a marsh or pond area as a community of living things - each competing and many helping one another. Any of these suggested purposes would be appropriate. Yet the statement of a definite purpose cannot be stressed too much. Without the students being made aware of an actual reason for going out, the venture could easily deteriorate into an unfortunate situation.

2. When the field trip will be. Students become easily upset when an unannounced trip is taken. Warn the classes in advance.

3. Where the trip will be. Students also like to know in advance in what locale they will be working. This takes the mystery out of field trip experiences and contributes the factor of anticipation.

4. Attire and equipment needed. If the teacher has explained points two and three clearly there should be not much doubt about attire. The girls should be warned to wear hiking shoes and slacks. If wet ground is anticipated, sneakers or boots should be required. Equipment varies with the trip planned but a pencil and pad should be considered standard equipment.

5. Map and area pre-trip study: If available a topographic map would supply information to the students about the area to be studied. Any slides the teacher has taken of the field area should be shown now.

6. Advance reconnoitering: Either the teacher or a committee of students should survey the area to be visited in advance. Find out what is where. There is nothing more embarassing to an inexperienced field trip conductor than to stumble through unfamiliar field, woods, or marsh without

knowing what to expect.

7. Advance research: If the class is to visit a limestone quarry in search of fossils, it would be wise to know in advance what the terms limestone quarry and fossil mean. It seems logical that one should also review fossil formation, methods of extraction of fossils, some fossils one is apt to discover and what they look like, etc.. In short, one is at a strong disadvantage if he goes into the field unprepared.

8. Use pictures the teacher can take to show some of the things that will be seen. Use other pictures, from books perhaps, to preview typical things to be seen. Opaque projection could be useful here.

9. Use actual specimens to show things to look for.

10. Plan a budget of time: Will there be enough time to travel to the area under study and back again without rushing? A good rule to keep in mind is this - actual time in the field should be equal to or greater than the time spent traveling to and from the area.

11. Plan for meals: This often presents a real problem. If you go to a public place, where can your group eat? How much does it cost? May they bring their lunch? Could you have a cook-out? Enthusiasm disappears extremely fast when the stomach is empty.

12. Anticipate weather problem: What happens when rain interrupts the field study? Find shelter first, then resume field study while under cover. Have an alternate teaching plan in mind such as a review of things learned, a team quiz, or further explanation of things to be seen later.

13. Records and summary: It is good policy to always have one or two people responsible for recording things seen and experiences encountered. Have another group use the data taken in the field for summarizing the entire field trip.

Some suggestions to the teacher follow:

1. Enthusiasm - If anything influences your students, especially youngsters, it is enthusiasm. One must often push himself to a certain degree to act as though he really wants to go on the field trip. One must not be artificial about this and if he just can not be enthusiastic, he should plan some activity in which he is really interested.
2. The trip must not be hurried. Even if the teacher is sure that he will not cover much of what he has so carefully planned, he should go slowly and help the students enjoy what they do.
3. Activity should not lag. Be quick to direct the students attention to something new if you feel their interest waning.
4. Be prepared for the unexpected. Take time to investigate a different plant or animal or unusual rock formation etc..

Transportation often presents a problem on field trips. Parents can be recruited to provide cars and drivers, and if a question of liability arises, their individual insurance will suffice - just be sure such exists. School buses are the most successful means of transportation if and when available. All of the worries of time schedules and safety are put in the hands of the bus drivers. Commercial companies may be used also and in most instances the companies usually will go out of their way to be accomodating. Many trips can be taken which are easily within walking distance of the school and thus transportation problems are eliminated. Never, under any circumstances should students be allowed to provide or locate their own means of transportation on an organized field trip. To clear the teacher of possible criticism one may issue (with the school's approval) a form which the students take home to their parents to read and sign. This form states that the parent is aware that the student is going on a school sponsored field trip and will be gone on a certain day, at a certain time,

with a certain teacher. The parent agrees to relieve the teacher and the school of any responsibility beyond that of normal care.

When the group arrives at the area where the field trip is to start, the teacher should always remember to adjust the speed of walking and the distance to the group. The teacher should not be far in front of the group or far behind it. The middle of the group is convenient and it is also easy to observe the activities of everyone from this position.

The high school teacher who takes the time to plan successful trips outside the classroom is amply rewarded. One who takes his classes outside without much planning will probably have a frustrating experience which may tend to make him content to keep his teaching restricted to the classroom. As time goes on, pressure from students to be like their friends in other classes forces the teachers to spend more time and effort in planning activities. The result is often a better and more effective teacher.[3]

It is true that in spite of much preparation the first trip and certainly from time to time other trips may not be as successful as one might like them to be. Yet the teacher must attempt to be resourceful, unusual, versatile, and believe in his purpose. With reasonable effort it is quite possible that the teacher will come to find field trips rank highest among his teaching devices.

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[3] An Outdoor Laboratory as a Part of the Education Program by Robert McBurney, in Manual For Outdoor Laboratories, Richard L. Weaver, Editor, Interstate Printers and Publishers, Danville, Illinois, 1959. P. 39.

Techniques of Securing Student Participation

One of the most frequently voiced criticisms of science programs in our schools is the lack of what might be termed vital participation on the part of the students.[1] One finds administration and teachers alike wondering how to combat this problem. An analysis of the situation appears to yeild one or two underlying causes for this lack of student participation. Lack of interest is one factor which often affects students. Secondly there seems to be a fear of being ridiculed by others for taking part in the program.

There are ways of securing greater student participation. It is with little question a universally accepted fact that the more completely any individual enters into any given activity the more will be his enjoyment and subsequent knowledge gained from that activity. If the above is a logical and valid assumption, it would be true in any learning activity. Accordingly, any educational program should be so structured as to include a maximum of individual effort on the part of the student involving a wide variety of activities and a minimum of lecture on the part of the teacher. This applies to any age group and any type of class.

One will find younger students asserting their natural curiosity and eagerness much sooner and more frequently than older students. For example, seventh grade science

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[1] Julian W. Smith, Outdoor Education for American Youth, American Association for Health, Physical Education, and Recreation, Washington, D. C., 1957, p. 12.

students fairly quiver with enthusiasm while tenth grade Biology students can easily slip into an attitude of complacency. How are we to stimulate these complacent students? Usually a study which can be tied in directly to human relationships seems to interest students more than the isolated study of one plant or animal's physiology. The ameba may be interesting to some students when it is studied solely as an example of a common protozoan, but, a presentation of this same animal type (ameba) and its effects on humans in a disease such as dysentary gives real significance and a heightened interest in knowing the ameba and its workings.

Six approaches for encouraging more student participation follow. At the outset the writer in no way claims the list to be complete or unvariable. Doubtless there are numerous other techniques equally as valid and useable. Secondly he again is aware that the techniques are in no way new or original, rather it is the field teaching application to the varied approaches that presents the challenge to him. It is hoped that through this study others will find encouragment and assistance in accomplishing increasingly more and improved field teaching.

1. Field trips: These are especially good because of the excellent opportunity of setting up committees to work out details before recording and organizing a final report. Each student should have a responsibility even if it means only carrying a thermometer or an animal live trap.

2. Student projects: Projects are extremely useful in bringing about individual work on the part of all of the students. These projects should be required using one of moderate complexity or perhaps several in a semester. Pro-

jects may range from relatively simple leaf and animal collections to complex radiological studies. A science fair or some display of projects in the spring of the year brings about added incantive. There are several organizations such as Westinghouse and the National Science Foundation, which award scholorships for exceptional science projects.

3. Teaching Experiences: To some teachers this may seem to be a waste of time but actually students can do an excellent job of teaching. A student may take a unit, a topic, an animal, or plant and present the information gleaned as a teaching experience to the class. If enough preparation on the part of the student and some small ammount of teacher guidance goes into each, a high standard of work can be achieved. Often as a result of this the student feels important and a heretofore bashful, withdrawing student can learn to effectively express himself. For example, a biology student may elect to teach the reproductive cycle of a frog several months hence. The student can obtain several frogs and inject the female with pituitary extract. If carried out in the fall the frog will ovulate within several weeks and at such time the eggs can be squeezed out during the class lecture period and pricked with a pin to start cleavage. Obviously the student presenting the topic will need to do a considerable amount of research and work.

4. Student reports: This approach is similar to Student Teaching except that the students are asked to prepare a two or three minute talk on some scientific article.

Scientific American,[2] National Geographic, Science News, and Turtox News[3] all offer possibilities for reports. A Junior High School student did a report on an article in Scientific American called "Radiation and Human Mutation". This girl "digested" the article and presented it to the class complete with her own handmade charts and diagrams. Again the class received a learning experience most of them would never have gotten on their own. In fact probably few of the students would have bothered to read the article. The presentation was a success and there was much interest on the part of the class. After she finished there was a period of fifteen or twenty minutes when questions were directed to her. Such a technique proved to be a very good way to show students how they can do independent research and thinking.

5. Setting up teaching devices: Often a teacher is so busy that valuable displays, charts, bulletin boards and the like never materialize. Students often can and will do a creditable job at preparing such teaching aids.

6. Work Experiences: Work expreiences in the form of a shrub planting program, a pond development program, and the development of outdoor nature trails constitute good teaching.

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[2] Scientific American, 2 West 45th St., New York 36, New York.

[3] Turtox News, General Biological Supply House, Inc., 8200 South Hoyne Avenue, Chicago 20, Illinois.

Tests, quizzes, and threats have intentionally been omitted as devices to encourage more student participation. The writer however is aware that testing when wisely used and completely divorced from any disciplinary or punitive role can be effective teaching devices and can be used to stimulate learning. Various of the approaches will be discussed more in detail in succeeding sections of the paper.

Directing Individual Studies

Individual study can be defined as work in which students are allowed a rather free hand in some aspect of scientific study and research.

Individual studies may consist of projects, reports, research, or any combination of these. One of the most common is the project study.[1] For the purposes of this study a project is defined as the type of study in which the student chooses an area or topic of special interest to him and developes this into a meaningful class report. These projects may include charts, demonstrations, talks, working models, written reports, etc.. Many teachers assign projects as required work. Others use projects only for those students who indicate an interest in them. In still other instances, projects are used as a means of meeting the needs of superior students. Another technique which is commonly used is the research and/or experiment type study. Research and experiment techniques include selecting a research type problem in which the information sought is not readily available to the student. The student must then devise techniques for experimentation which will lead to a possible solution of the problem originally selected. Rather than presenting a summarization of material, as a project might be, the research-experiment technique is original problem solving work. This is usually

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[1] Many suggestions from Turtox Leaflets, available to teachers from: General Biological Supply House
8200 South Hoyne Avenue
Chicago 20, Illinois

carried out by one person and involves a great deal of organization and scientific research. Still another method of encouraging individual study is that of setting up the entire class and its course of study so that each member is specifically assigned individual projects or research work. This is a newer trend and will be discussed more fully later. It differs from the above in that it is a class organization technique.

Students must be guided in the individual study program rather carefully. The student's innate eagerness is a boon to the teacher. But, very often, teachers are disappointed with the results of their students' long and often not so well planned work. Since each student must have a topic or project in mind he should not be held back. Let his wildest imagination go to work. It is much easier to pare down an overambitious project than it is to build up an under developed subject. After the student has selected a subject area, a written outline should be made. One example of the format of such an outline follows:

Title of Research Problem
Name of Student Researcher
Anticipated Completion Date
Complete list of Materials Needed
Materials Needed from School Supplies
Summary of Type of Project Work Planned
Teacher's Comments

This type of outline, which can be checked and commented on by the teacher helps the student fully visualize and subsequently keep in mind the object of the project.

Many schools set up an honors type program which could be adapted to a limited number of science students. In

this program, the student spends a specified amount of time each week on a special project or experiment. The time may be taken from study halls, lunch hours or before or after school. The student outlines the work he desires to do. This outline is then presented to his advisor in the science department. The student meets the advisor from time to time for conferences to discuss his work. Midway through his experiment and at the end, he presents his work to a faculty group at an open meeting. Later the project can be presented to the students' classmates. This experience allows the student to earn recognition and academic credit. Often a half semester's credit is awarded for successful work of this type. The writer has seen students discuss Differential Calculus in front of a group of science and mathmatics teachers and do a commendable job. The knowledge that the judging will be done, in part, by the faculty committee tends to keep the student on his toes.

The group project method as outlined by H. Z. Snyder is as follows.[2] In this type of study the students select a topic of interest to them from many offered by the teacher. There may be fifteen or more topic areas from which the students choose the one area of most interest to them. Two students work easily together on this type of problem. The object of the group type of study is the selection of a project which will enable the students to learn as much about their limited problem as possible. They should do

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[2] H. Z. Snyder and G. W. Mouser, The Value of Using Conservation As A Motivating Theme For High School Biology, Fisheries and Wildlife, Michigan State University, East Lansing, Michigan, pps. 2-3.

the project in such a way that the rest of the class can hear, feel, see, operate or in some way gain, in so far as is possible, the same concepts as did those who actually worked on the project.

In all of these students experiences, the teacher should be readily available to guide, to help, but not to push. Students seem to work well when there is a teacher available for possible assistance. The temptation on the part of the teacher is sometimes almost overwhelming to take over and do for the student engaged in project work. One must keep in mind the fact that the student, not the teacher needs the experience. Gentle guidance seems to be the key word here. The following outline lists the important items to be kept in mind when one is setting up a program of individual study.

I Students should choose their topics as soon as possible.

II Students should submit an outline and have it approved.

III Students should announce the completion date of their projects and be held to this date. This deadline adds a note of importance to the projects.

After the method of individual study has been established and the students are aware of their responsibilities, the teacher may then transfer this technique of learning to field situations. Projects, either group or individual, should be set up for work in the field. Pond studies, quadrat work, ecology and habitat studies, rainfall and erosion surveys, food studies, plant and animal censuses, and individual animal studies are just a few possibilities

for these field studies. Techniques and approach should be understood by all students before the actual undertaking of a field project. Weather conditions need not be a deterent factor since students may collect on fair days and work indoors analyzing their data on stormy days.

The teacher should attempt to confer with each student at regular intervals concerning the progress and problems connected with the project, experiment, or research. The class may be and should be kept up to date on each student's progress as often as possible. It is assumed that much of this work may be done in the classroom or school building where the other classes can see it.

Since the class as a whole should benefit from the individual's work nearly as much as the student, the individual students should complete their work by offering an enthusiastic report to the class. Usually "gimmicks" such as lighted displays, films, color slides, recordings, and other audio-visual aids are encouraged.[3]

Use of special audio-visual aids enables the student to present the report in an interesting fashion and is much superior to the standard, recited, typewritten report.

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[3]Morholt, Brandwein, and Joseph, Teaching High School Science: A Sourcebook for the Biological Sciences, Harcourt, Brace, New York, 1958.

Recording and Reporting

In any field trip situation, it seems apparent that some record keeping should be done.[1] Rather than have the entire class take notes as individuals, it is usually just as beneficial to all if a few students do the recording. If the class is divided into committees beforehand with definite jobs assigned, the secretary usually falls heir to the recording job. The secretary may want to have a helper to aid in record keeping. One should not get bogged down in the field note-taking but some method of record keeping should be utilized, either by individuals or by the group. Included in this outline are several forms which should be used in field trip reporting, both in the field and in follow up work.

Field work lends itself naturally to photographic record keeping. One or two photography minded students can provide an excellent series of photographs of the field trip activities. These photos may be processed in a school darkroom and enlarged for easy viewing or, they may be done as partial fulfillment of a project. Polaroid cameras are excellent. Perhaps one or more of the students can locate such cameras. Black and white film should be used if possible since color film is very expensive and difficult to process privately.

Committees with chairmen, recorders, workers, etc. work out very well in a field study. Usually it helps to make

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[1] Workbook for Field Biology and Ecology, Allen Benton and William Werner, Burgess Publishing Co., Minneapolis, Minn., 1957, pps. 49, 50.

clear that the entire committee will receive a grade on their work and therefore all should work equally hard. Most often this is successful. There are many ways of efficiently reporting back information. Photographs which are large enough to see readily are one way. I have seen movie films which students make of the field experiences. These are good, but, they are also expensive. Tape recordings of field sounds may be utilized by some groups. The reporting may be done only by the chairman as a summary of everyone's work, or each committee member may report separately. This latter method seems to be the most logical and fair.

Another effective method of reporting on field trip experiences is to have one committee held responsible for reviewing and later leading the rest of the class on a similar field trip. After the teacher has spent all the time possible in the field, a committee may lead the review by taking the class back to the particular area studied. Then the committee may take sections of the class and test them with field questions or just lead the class in a general review. The teacher simply observes and participates as little as possible. The selected review committee then receives a grade based on how well they carry out the review.

The teacher may decide that it is more advantageous to have students summarize the findings of the field trip right on the spot, in an informal gathering.[2] This is a

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[2] Teaching Science Through Conservation, Martha Munzer and Paul Brandwein, McGraw-Hill Book Co., New York, 1960, P. 74.

good way to tie together information and to indicate deficiencies in the information which should be gathered before the students leave the field.

If student leaders are to be used on the field trip, they must prepare for the trip in advance. It is good to allow the student to become a "minor authority" on some aspect of study which is to be covered during the trip. The entire class may benefit by reading and studying in advance of the trip. Some leaders allow their students to take reference cards, prepared in advance, into the field. An outline sheet consisting of simple, help questions or a guide or outline of things to look for may help in recording and reporting back information. Student recorders may be appointed prior to the trip. One of their functions should be that of writing down all unanswered questions along the way. These may later be used by the class for research.[3]

Any of these foregoing methods should be more interesting and effective than just having individuals report, in the classroom, what was heard and seen.

One should strive for the unusual in class reports. It is also important to remember that accurate and complete records must be taken for good reports to be made.

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[3] Field Trips, A Handbook for Leaders, Michigan Department of Conservation, Lansing, Mich., 1955, p. 17.

Field Trip Summary Sheet

Name:

Date:

Location:

Time spent:

Weather:

Temp.:

Summary of work done on field trip, things seen and/or collected, follow-up study.

Committee Chairman's Worksheet

Chairman's Name:_____ Date:_____

Members:

Recorder:_____ Equipment gatherers:_____

Equipment needed:

Work done today:

Final Field Report (to be handed in)

Name: Class: Date:

Location of Area Studied:

Concepts Learned or Observed:

Summary of Your Field Work:

Questions For Future Field Trips:

Teacher's Remarks:

Record Sheet

Name: **Date:**

Weather: **Temp.:**

Time: **Class:**

Species seen or collected	Number and place
Day Lily	abundant, roadside Maple street
Bullfrog	several, Miller's pond
Norway Maple Leaves	abundant, school lawn
Unknown Maple Leaves	scarce, school lawn
Mayfly larva	common, Brown's creek

Techniques of Collecting and Identifying

In any study of living things, a collection of the items to be studied is desirable. Many teachers will spend weeks describing the physiology of plants and assign many chapters of reading on the subject. Then when satiety has been reached, the teacher launches into a descriptive-lecture of animal physiology.

Presented here are several methods of identification and collection which can add considerable interest to any science course. Some general remarks on collecting:

Try to impress the students that they are making their collections to facilitate their learning. There are proper ways to collect; one does not rip leaves off trees willy-nilly nor does one pick all pretty wild flowers. Students should collect only what they need and no more.

Familiarize them with federal and state laws regarding collecting priviliges. As an example, at the end of this outline is included a partial list of protected wild flowers.

Now we shall consider keys. Many teachers think of taxonomic keys as entirely too difficult; This may be due to rememberences of detailed and complete keys used in college. The keys presented here as examples are designed to be used by any thinking student. They are simple in mechanics, phraseology, and as a result, are far from complete. If your students are ready and you want them to use detailed taxonomic keys, many are available. Try to impress upon the student that keys are used to unlock something, an unknown plant or animal in this case.

In the following pages techniques useful in collecting

a particular type of plant or animal are outlined. Your students will surprise you with their interest; their collecting and collections will improve and become more meaningful.

How To Make A Leaf Collection

If one is going to make a collection, don't waste time and effort by just putting things together haphazardly. Do a good job by having a definite pattern and order. It will be worth keeping for this course and for future use.

Step 1 Collect leaves early, choosing only the perfect ones. Leaves which are turning color add interest to the book. Gather at least two whole leaves of most kinds.

It is wise to take a magazine or old book when collecting. By placing leaves in it immediately, any curling due to wilting, can be stopped. Some leaves curl as soon as they are picked.

Step 2 Processing Leaves. Leaves should be processed as soon after gathering as possible. The following steps will give a good leaf mount.

1. Place the leaf between two pieces of wax paper. (bread wrappers are very good for this)

2. Place a piece of newspaper over this.

3. Press the leaf with a slightly warm iron, NOT HOT, until the wax has melted off the paper onto the leaf. The newspaper should keep the wax off the iron.

4. Place the leaf on the mounting or scrapbook page and press again with the warm iron. The leaf should be next to the page and a piece of wax paper over the leaf with the iron protected with a piece of newspaper again. This melts the wax on the side of the leaf next to the page and when it cools the wax will hold the leaf in place.

5. Allow the leaf to cool thoroughly.

6. Waxed leaves will last a long time if the wax is not broken or cracked open. The wax preserves them. Therefore the pages should be handeled carefully from now on.

7. As an added protection one could give the leaves several coats of white shellac. (It should be noted however that any preparation applied to a leaf will alter the true texture characteristics.)

8. Large leaves may be folded to fit the page.

Step 3 Arranging the leaves on the page. Here are some rules to make the collection have eye appeal and less monotony.

1. Be sure the two leaves mounted are good and that one shows the under side or the back of the leaf and the other shows the front. This is important since some leaves are recognized by their under sides or dull side.

2. In the case of smaller leaves one may wish to show a group of leaves as they are on the tree, with the tip of the branch attached. This adds some interest to the collection.

3. Arrange the leaves differently on each page so there is no monotony. Place them as if they were falling from the tree on some pages, slanting on others, and so on. Use originality in getting eye appeal.

4. When mounting small leaves it may be better to have more than two of a kind on the page so that the page will be filled but not crowded. Each

page should appear to have the same amount on it.

Step 4 Labeling and describing leaves. It is a sign of good work when the collection is properly described.

1. Place labels in the lower right hand corner of the page having the mounted leaves.

2. Write a complete description of the leaves as they were when collected: include - color, size (in inches), place (town, state, backyard, etc.), number of leaflets, etc..

Step 5 Putting the leaves in order. Sort leaves according to the following diagram when assembling the mounted leaves. This will put the collection in a systematic order.

I Simple Leaves (Having only one blade)
  A Entire
    Oval shape
      smooth
      serrate
      double
    Ovate
      smooth
      serrate
      double
    Heart
      smooth
      serrate
      double
    Deltoid
      smooth
      serrate
      double
    Spatulate
      smooth
      serrate
      double
    Oblong
      smooth
      serrate
      double
  B Lobed

It is important to realize that it is not necessary to have a leaf like each of these listed.

This is merely the way or the order in which they should appear if all were present.

Those collected will have to be in this order.

Oval or Oblong	Ovate, Heart, or Deltoid
smooth	smooth
serrate	serrate
double	double

II Compound Leaves (Having more than one blade)

A Those having leaflets coming from a common joining to the stem of the leaf.

B Those having leaflets coming off the stem opposite one another like rungs on a ladder.

III Cone-Bearing (these are the Evergreens)

A Pines
B Spruce
C Fir
D Hemlock
E Tamarack
F Cedar
G Ornamental

How To Make A Twig Collection

Twigs are best collected in the winter time after they have shed their cumbersome leaves. One will need a pair of pruning shears or a sharp jackknife to cut the twigs. Do not collect from someone's prive ornamental shrub or attempt to take a six-foot length of branch. Ripping off branches from a tree or shrub does them considerable and sometimes deathly damage. Even along roadsides and in fairly open places, try to take a twig from some concealed place on the plant so the scar will not show. Care must be taken in selecting a twig so that a six inch cutting of a tip twig is chosen. This cutting should be selected as an average tip twig of the plant. Size will then offer some clue as to what the twig is.

After the twigs have been collected and identified, they should be mounted in a uniform and neat manner. Information should be given as to location, (town in which the twig is found and state), size of tree or shrub, and name of plant. The twigs may be mounted on cardboard, poster paper, or in cigar boxes. Twigs may be varnished or shellacked to preserve them. Again it should be noted that the shellac will alter the natural texture. Remember, if a collection is worth doing, one should take the time to do it neatly and accurately.

Collecting Frogs and Toads

There are few general statements that can be made concerning the collecting of frogs and toads. One should remember however, that some frogs are protected by law. Because of the great variety of habitats, one may come across frogs and toads practically anywhere. Many people think that these amphibians will always be found in or near water. On the contrary, many frogs and toads are found miles from aquatic habitats. One does not "sneak" up on a frog or toad as their eyes are perched on top of their heads and they see almost as well to the rear as they do forwards. Therefore, if a hand is put in front of the frog he will hop forward into it, since he has no reverse. Unlike other specimens which may be pressed or preserved in one fashion or another, we run into difficulty with frogs and toads. In the interest of conservation and humaneness, why collect these amphibians? Live specimens may be taken back to the class to be identified and perhaps drawn or photographed. This would be one good way of keeping a record. Perhaps the class may want to keep a terrarium with some frogs in it all winter, but be sure that there is an escape proof place for the collection. If one approximates their natural environment as much as possible, they should live and remain healthy. A very nice project for one or several students would be the following. Set up a vacant corner of the classroom or another room (perhaps a storage room) with a fenced in area, (use chicken wire about four feet by six feet.) Construct a metal or wooden pan which will serve as the floor and which will hold enough water to insure dampness at all times. This should be made to form a slope from

four inches down to the floor level. Fill this frog pen in with loamy soil on a pebble and charcoal base. Add a large pool or pan for the swimming area, and any living plants that will survive the activity of the inhabitants. Any frog or toad is a fussy eater and usually will not eat by himself unless the food is alive and moving. If such food is not possible, each animal will have to be fed individually using grubs or worms.

Collecting Turtles

Turtles are often found at the edges of wet places such as bogs, ponds, rivers, and swamps. They like to sun themselves on offshore logs and rocks. One should look for land turtles in open woods, edges of fields, gardens, and abandoned pastures. Sea turtles are most often seen in the spring when they are moving around looking for a place to lay their eggs. They are also often to be seen after a rain. In the intense heat of summer, they usually will go into retirement (aestivation). In early fall, the turtles are on the move again and readily seen. Many types of turtles are kept as pets. Examples of such pets are the Map, Painted, Red-eared, Snapping (This animal will attack one), Wood, and Box turtles. Some states forbid the capturing and keeping of wild turtles. Check the state and federal laws before collecting. If one collects turtles and wants to keep them as pets, the following suggestions may be helpful. The diet of a young turtle should include finely chopped raw meat, fish, worms, and occasional greens. Add a drop of vitamins or a pinch of bone meal at least once a week. Provide some water in the container so that the turtle may swim or eat under water as some turtles have to do, but do not let the water get dirty. Keep the container warm, even at night (75 to 80 degrees). Do not paint a turtle's back as the scales will be deformed. If a turtle is bought which has been painted, scrape off the paint.

The Quadrat: An Approach To The Study Of Ecology

Ecology may be defined as the study of the relations of organisms or groups of organisms to their surroundings or environment. The quadrat, or self contained ecology study, has been found to be one good answer to the problem of how to study these relationships. A quadrat is a staked out, measured piece of land, its size depending on the plants and animals being studied in it. For high school students, a manageable quadrat size is 2 x 2 feet. This is most easily and thoroughly covered in the amount of time available to most high school classes. Once the boundaries of this quadrat are determined, the idea is to observe and record as many living organisms in it as possible. This record will then be compared with other, different quadrats and a comparison can be worked out. From these observations, various conservation principles can be taught. Some of these are the concepts; that specific kinds of land support specific kinds of life, that erosion can be started or thwarted by man's effect on these areas, that in any area other than those that man seldom or never frequents, man has a great influence on the nature and condition of the living forms, that cultivation or landscaping does dramatically effect living organisms, that soil is produced by minute organisms which are necessary for all life.

Many schools will be fortunate enough to be located near several contrasting plant successional stages. Successional stages are those areas which are undergoing changes in types and numbers of plants and animals. These successional stages continue until a point is reached where no further change is possible in that particular area, en-

vironment, soil type and climate. This is called the climax stage and will remain as such until altered by man or nature in the form of fire, erosion, floods, and the like.

The primary purpose of this study is to set up appropriately sized quadrats for the major stages of plant succession. Some of these are called, the pioneer weed stage - the first plants to grow on bare soil; the shrub stage - small clusters of woody plants with several stems to a cluster rather than one main trunk as in a tree; temporary tree stage - made up of small trees (saplings); climax forest stage - the ultimate growth in that area, usually made up of mature growth which was once the previously mentioned saplings.

The field work in these various stages may be carried out as follows: weed stage - list weed which might be found in the area under study. These might be grasses, sedges, many annual and perennial wild flowers such as Queen Anne's lace, Day Lily, Yarrow, Wild Phlox, Butterfly Weed, Thistle, Buttercup, etc. These are easiest found along a roadside. If soil of a roadside has been recently disturbed these plants will be among the first to pioneer. After this area is located and the quadrats are measured out, the students should collect any specimens they are unable to identify in the field and return these to the classroom for further study. A soil analysis may be made. This should consist of a soil profile, acidity test, temperature, and composition. These techniques will be discussed in detail in later chapters.

The shrub stage is characterized by low growing plants, intermediate in size between the weeds and the saplings. These might be found on a roadside or on the fringe of a

woodlot. Stag-horn sumac is a typical representative here along with pines, cedar, and other conifers. In this area, after the quadrats have been set up, students may collect samples for later analysis, analyze the soil as above, and map or record in some fashion the proximity of this area to a forest or weedy area.

The temporary tree stage is characterized by the saplings of what may become the climax forest stage of this area. Depending on the climate and the region of the country, these saplings may be species of maple, oaks, ash, hickories, or poplars plus others. This does not necessarily mean that all of these will remain into the climax stage. Competition among these will undoubtedly eliminate some altogether. After the students have established their quadrats in the temporary tree stage, they should count the number of species represented and record this number for future reference. They might estimate how much effect the shadow that each sapling casts has on the undergrowth. Again, a soil analysis should be made. A temperature is likely to vary from the top of the saplings down to their base and then to the region under the canopy. Therefore, all temperatures should be taken at the same level at each checking station.

The climax tree stage is characterized by mature stands of trees which have developed from some of the saplings present in the temporary tree stage. Since the organisms under study here are larger than the previous ones, it is advisable to enlarge the quadrat size to get a more representative sampling of organisms. A 10 x 10 foot size is usually adequate. Students should carry out a soil analysis and then examine any stumps in the area to deter-

mine age. Students should be advised to determine which species of trees are present and which of these represent the climax.

In several indoor sessions one can cover what might be found in these quadrats.[1] List the small mammals, insects, reptiles, arthropods, birds, etc., that might live with one another in these quadrats. This, of course, could bring out a detailed study of the life cycles, interdependence of organisms, and, in short, the whole idea of what ecology means. This material is recorded as it is collected and later may be duplicated for class use.

When the first field trip is taken to establish the quadrats, the students could make good use of their time by recording their observations on data sheets previously prepared. (example on last page of the chapter)

Not only are students looking for actual sightings of organisms but also for clues indicating their presence. These clues may be in the form of gnawings, traks, droppings, dust baths, nests, etc.

Every rainy day might be spent in analyzing what has been observed and collected. Food chains might be determined for various animals in the quadrats. This is also an opportunity to learn the mechanics of taxonomic keys. Stormy days are also useful for discussing what the next quadrat will be. By using the weather to advantage, the students may have three or four days in the field at a time and one or two days in the classroom.

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[1] Benton and Werner, Workbook for Field Biology and Ecology, Burgess Publishing Company, Minneapolis, Minn., 1957.

There is a definite shortage of teacher reference material in this area of quadrat studies. Much has been written on this subject but little of this seems directly applicable to a high school biology class situation or any other science teaching situation. Therefore, one may have to rely upon many sources for information. The teacher will have to do much searching of the literature to find really useful material.[2,3] The information presented here is only intended to be a stimulant to make teachers aware of what could be done with some effort on their part.

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[2]Morholt, Brandwein, Joseph, A Sourcebook for the Biological Sciences, Harcourt, Brace and Company, New York, 1958.

[3]Benton and Werner, op. cit.

Data Sheet

Student _____ Date _____

Location _____ Temp. _____ Weather _____

Soil Type _____ Quadrat type _____

Species	Growth type (plant)	% of area	Occurence

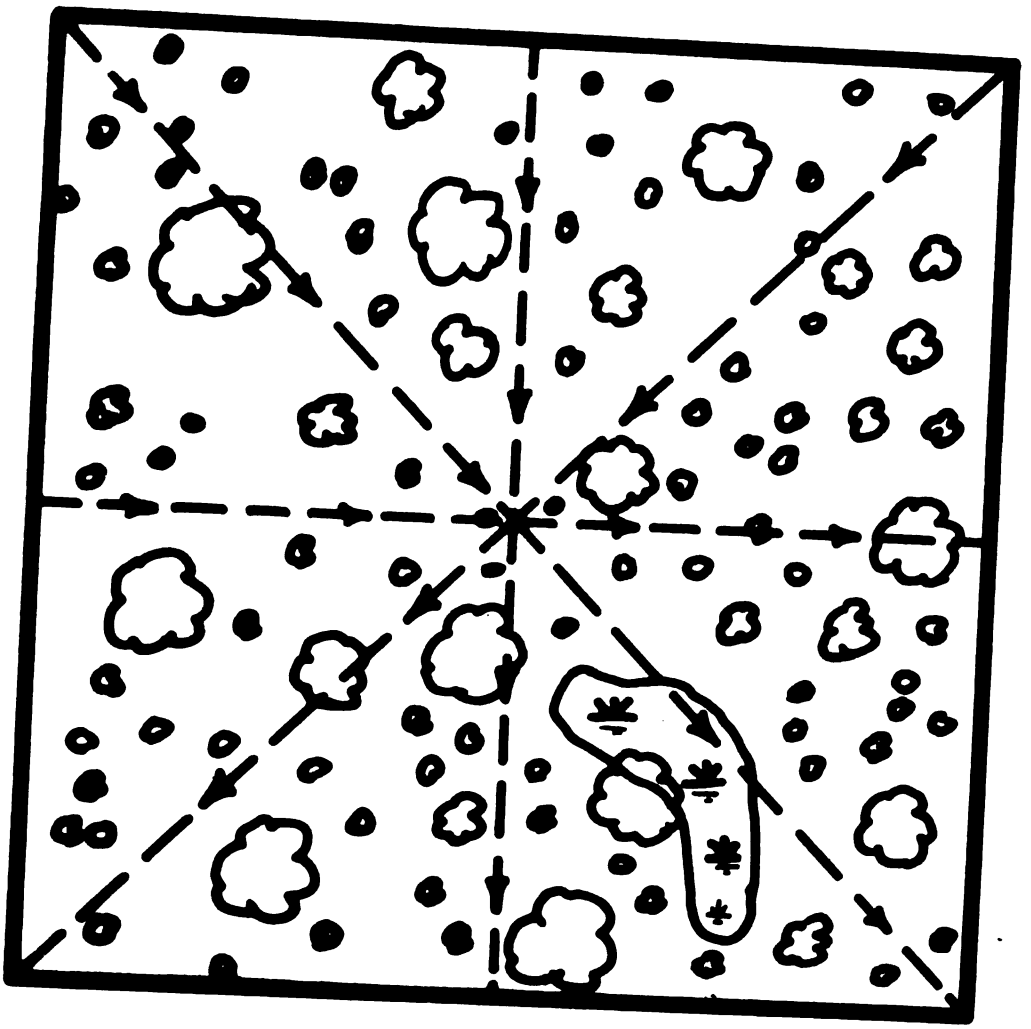
Patterns of Woodlot Quadrats

group III runs quadrats NW-SE

group I runs quadrats N-S

group IV runs quadrats NE-SW

group II runs quadrats W-E



KEY

Mature Tree

Saplings

Slough

A Soils Field Trip

A very definite advantage exists in soils field trips over various other types of trips. Such a trip does not have to be to a far away place since soil is abundant on all sides of almost any school, and a short trip into the country will add appreciably to the type and quality of the study that can be carried on.

There are certain basic facts that should be part of the understanding of any student of biology. Such might be broadly grouped under the following:

1. Some of the less obvious relations of soil to life.
2. Soil-water relations.
3. Physical characteristics of soil.
4. Facts about the soil profile.
5. Relative alkalinity and acidity as related to plant growth and availability of certain plant nutrients.

Life in the soil:

Aside from the fact that soil is the basis of all life, it is composed, at least partially, of living organisms and derives certain nutrient factors from biologic action of these organisms. To be sure, many of these organisms are microscopic in size and to see them one would be required to employ highly specialized cultural techniques. However, many forms would be visible to the naked eye. Accordingly, one might take a twelve inch cube of soil from the surface and examine it for living organisms. The soil might be subjected to the following:

1. Picking apart

2. heat lamp
3. water

to sort out and drive out any living organisms it might contain. A systematic categorizing of the varied forms along with an analysis of their functions in the soil should be made.

Soil and Water relation:

Certain soils will permit water to infiltrate rather rapidly, others less rapidly. A series of tests can be made in the following manner. Select several tin cans and cut out both the tops and the bottoms. Caution should be taken to select cans of equal size. Select sites as mentioned below and work the cans one half to three-quarters of an inch into the ground again making sure in each case that the can is forced into the ground the same distance. Care should also be taken not to disturb the ground any more than is absolutely necessary. Then pour a measured amount of water in each can and record the time it takes for all the water to enter the soil. Test the following soil areas: (See Diagram #X)

1. Cultivated field
2. Unplowed fence row
3. Road way or denuded playground
4. Garden
5. Lawn
6. As wide a variety of soil types as is available.

A test for absorbing properties of soils:

Materials:

Glass beakers
Muck soil
Sandy soil
Silty soil
Clay soil

Loam soil
Others

Fill the respective beakers to within one half an inch of the top with soils to be tested. Put only one type of soil into a beaker. With the aid of a graduated cylinder pour as much water into the respective soil as the soil and container will take. Refill the graduated cylinder each time and measure the amount the respective soils will absorb.

A test to show water is more or less continuously carrying soil particles:

Materials:

Quart mayonaise jars

Collect samples of water from various streams. Allow the water to stand for twenty four hours and compare the respective amounts of sediments.

A test to show the bomb-like explosive action of the raindrop.

Materials:

3-5 wooden stakes three feet long
3-5 pieces of white cardboard four by thirty inches long

Drive the stakes in the following places:

A heavily soded lot
A sparsely soded lot
An area of bare soil but not recently tilled
An area of bare soil recently tilled.

Fasten a strip of cardboard to each stake. After a rain or a simulated rain, observe the respective heights of soil spot stains on the various cards.

A test to determine soil particle size:

Materials:

Quart mayonaise jar

Fill the jar two thirds full of water. Pour in soil until the jar is almost full. Let the jar stand until the soil settles. Put white paper behind the jar and mark off the layers of settled out soil. Diagram this. (See diagram II)

A test to determine the effect of organic matter on soil:

Materials:

Two wide mouthed glass jars
Two small baskets of one-quarter inch hardware Cloth

Collect lumps of soil just under sod from a natural sod fence corner and a cultivated field that has been farmed heavily. The lumps should be egg-sized. Place the soil lumps in baskets and lower these into the jars of water. Watch closely and notice what happens.

Test to compare the water holding ability of different soils:

Materials:

Two old-fashioned lamp chimneys
Two small cloth squares
Two one-quart mason jars

Tie the cloth square over the top of each chimney, invert them and fill them about two-thirds full of soil. One soil type should come from a field or garden that has been cultivated for several years and lacks organic matter. The other soil should come from a well managed field where grasses and legumes have been grown. Be sure the soils are equally dry. Place the chimneys in the mason jars. Pour a pint of water in each chimney. Note how long it takes the water to begin to drip into the jars. How much water comes through each soil and how long the water continues to drip

in each soil should be noted. (See diagram III)

Test to show how crop cover affects soil loss:

Materials:

Two small boxes sixteen by twelve by four inches deep. These may be used for other activities and so are worth making and keeping on hand. Make the boxes watertight by lining with plastic (such as garment bags). At one end of each box cut a V-notch one to one and a half inches deep and fit with a tin spout to draw run-off water into a container.

Two flower sprinklers

Two half-gallon wide mouthed jars

Two sticks of wood one inch thick

Cut a piece of sod from a pasture or lawn and fit it into one of the boxes. Trim the grass down to one inch thickness since this is easier to handle. Fill the other box with the same type of soil but without the grass. Set the boxes on a table and prop the sticks under one end to give the boxes slope. Put the spout ends over the jars. Fill the two sprinklers with water and pour it over the boxes at the same time. Pour steadily and at the same rate for both boxes. Hold the sprinklers at the same height for each box. (See diagram IV)

Test to determine how mulch prevents soil loss:

Materials:

Same boxes as used in the preceding test.

Fill the boxes with the same kind of soil. Place them on a table as before with sticks underneath to give them slope. Cover one box with a thin layer of straw, grass, wood shavings or sawdust, but leave the other box bare. Sprinkle water on both boxes using the same amount of water and pouring each at the same rate and from the same height. Note how fast and how much water runs off into

each jar.

Comparison of soils by growing plants in them:

Materials:

Clay flowerpots
Lima bean seeds
Cotton

Obtain topsoil from an old fence corner, a pasture that has never been plowed, etc.. Fill one flowerpot with this soil. Fill the remaining pots with soil from an eroded hillside, subsoil from a depth of three to four feet, another sample or two taken from areas in your community such as an old lake bed or a woodland. Plant a few beans in each pot, about three or four. Soaking the beans overnight hastens germination. Keep the pots watered and place them where they will be warm and will receive some sunshine. At the same time plant three or four beans in moist cotton in another pot. Compare the rate of growth for several weeks. Keep a record of how fast the beans in each pot grow and how each plant looks. Compare these beans with the ones grown in cotton.

Testing and altering alkalinity and acidity of soil. Soil may be tested in the field by placing a small peice of pH tape in moist soil and noting the color change.

Materials:

Two flower pots
Mortar and pestle
Soil from a heavily eroded bank

Fill the pots with soil. Mix equal quantities of ammonium nitrate or ammonium sulfate and superphosphate. (as much as can be heaped on a dime of each). Grind the fertilizer ingrediants together in the mortar using the pestle. Grind until the particles are fine. Mix this with

soil of one pot (This is the alkaline soil now). The other pot of soil remains acidic. Plant an equal number of tomato, bean or corn seeds in each pot. Observe the growth rate of each. Thin the plants to facilitate growth. Watch the growth for several weeks.

Summary

Many of the principles suggested at the beginning of this paper are directly applicable to the field studies discussed in this chapter. The field studies and the relevant principles which should be taught are as follows.

Life in the soil - illustrates principles A-3, A-8, C-2.

Soil and water relations - principles A-5, A-6, A-7, A-9, B-3.

Water carrying soil particles - water conservation principle A-5.

Raindrop action on soil - principle A-2, C-2 (water conservation)

Soil particle size - soil conservation principles A-1, A-4, A-5.

Effect of organic matter on soil - principles A-3, A-5, A-6.

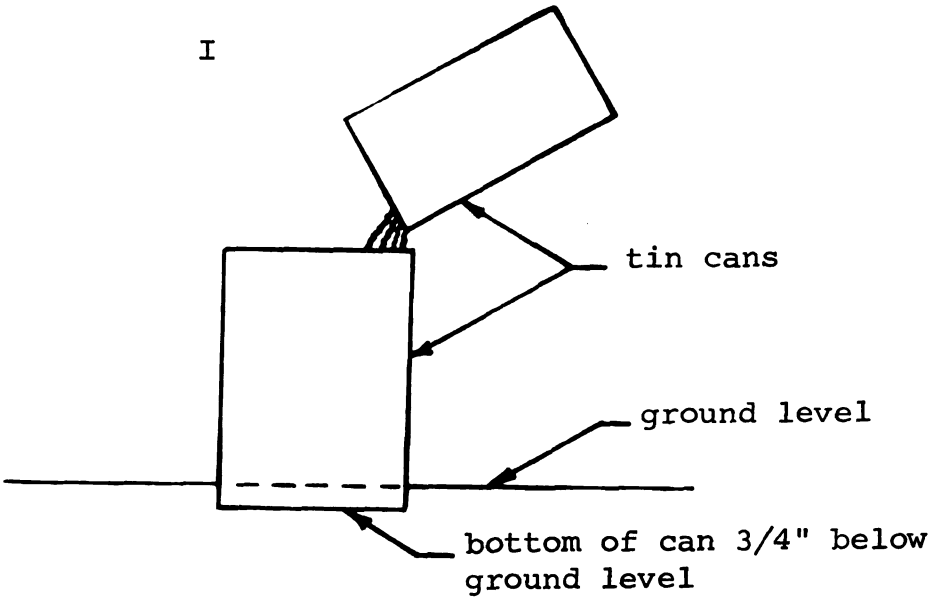
How crop cover effects soil loss - principles A-7, A-9, B-3, C-2, D-1, D-2.

Comparison of soils by growing plants in them - principles A-5, A-7, A-8.

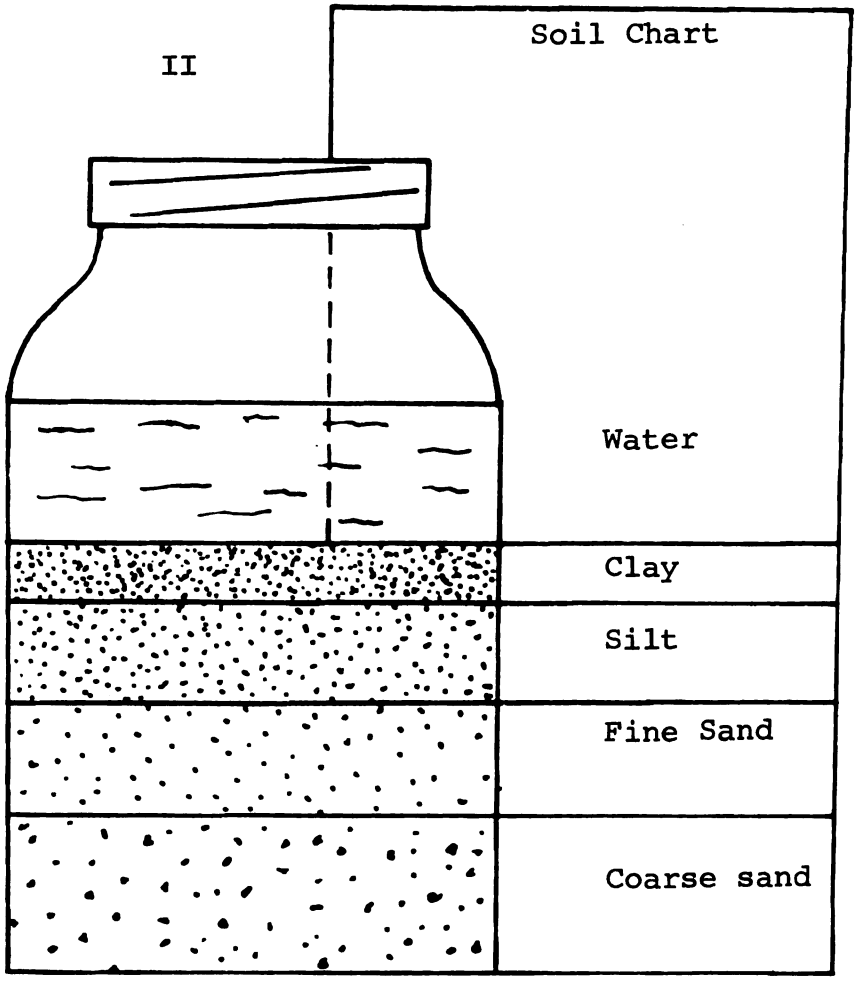
Testing and altering alkalinity and acidity of soil - Principles A-2, A-4, A-5, A-6, A-8, B-3, B-4, C-1, D-2.

Diagrams

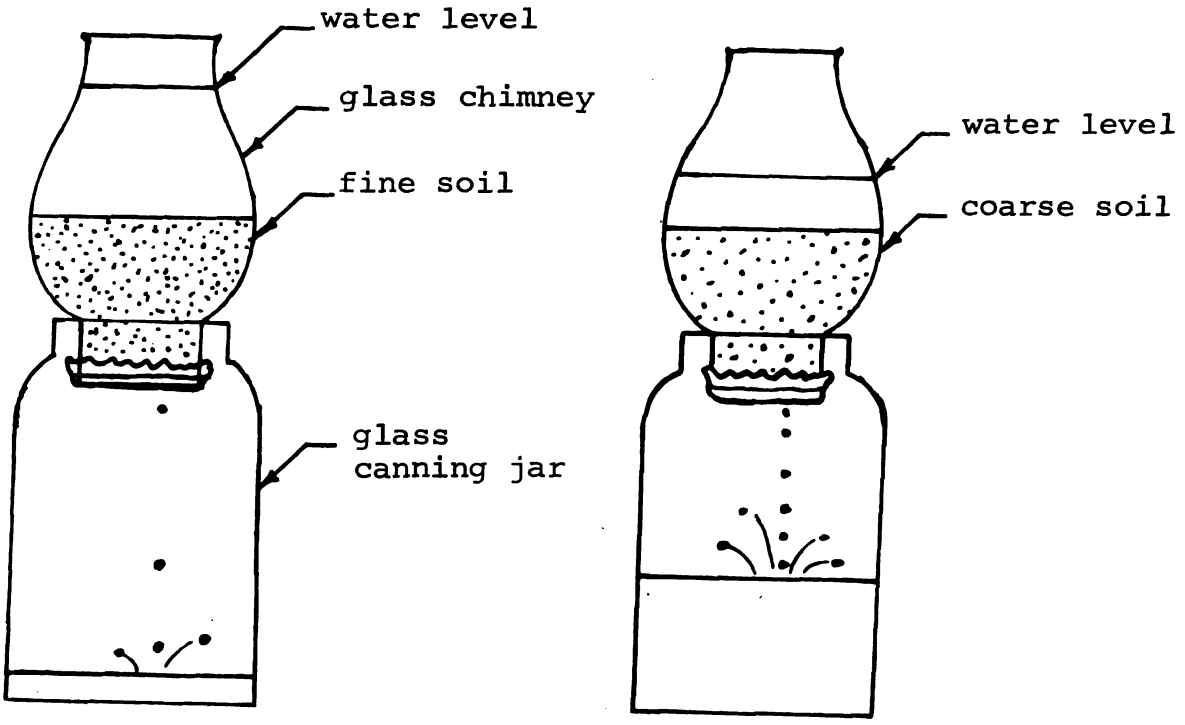
I

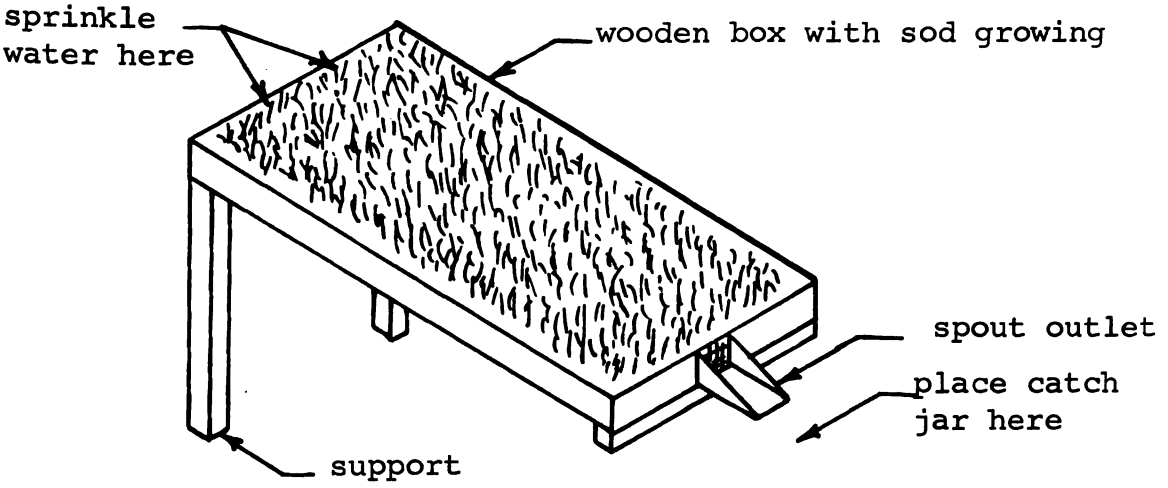


II



III


water level
glass chimney
fine soil
glass
canning jar
water level
coarse soil


sprinkle
water here
wooden box with sod growing
spout outlet
place catch
jar here
support

A Study of Bird Nests

Many and varied types of studies have been made of birds in this country. Recently field identification has come to the fore as a most popular method of bird study. Many good field guides have been written to assist the ornithologist.

One bird study activity which is not so common but still informative, interesting and fun is nest study. Students can learn many things about the owners of the nests if they conduct individual or class observations of the bird at the nest.

One may learn from these nest observations, food, environment, reproductive and migratory habits of birds. No nests should be collected until it is certain they are no longer in use. Since birds will use the same site but not the same nest, year after year, there should be no concern about taking the bird's nest in the fall of the year. Technically a nest is not a home.[1]

The accompanying nest key will serve as a guide in locating studying, and eventually taking bird nests. Once the nests have been collected, they may be arranged and displayed in the classroom and further studies may be made of the occupants of each nest.

To facilitate the study, students should have a small pocket ruler for measuring the depth and width of the nests and a bag or some other container for carrying the nests se-

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[1] G. W. Mouser, Key to Bird Nests, Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan.

curely. This container should ideally be made of polyethylene plastic so that any mites from the nests would be trapped in the bag and not in the collectors pocket.

The season for observing bird nests is from the middle of April to the middle of August. The best time for collecting nests is in the early fall months. To locate nests search through bushes and trees where birds are known to be. A great majority of species nest in bushes and trees not far from the ground. A nest in the thick bush is difficult to see and birds will intentionally build nests where the bush is the thickest and where leaves conceal it. Often if the student can get inside a circle of bushes on his hands and knees and look out, the nests are more readily seen.[2] Thus we can see, nest locating is considerably more difficult than simple field observation. Ground nests are more difficult to locate because they are concealed in grass and weeds or at the bases of thick bushes.

Birds, such as the bobolink, that nest in the thick grass of the meadows are particularly misleading. They will often flush well ahead of the nest-hunter and when we look in the spot where the bird appeared, we find no nest. Actually this type of bird runs under cover for a considerable distance in order to draw us away from the nest. A good way to locate these nests is to have two people walking in parallel paths to each other, a considerable distance apart, dragging a rope between them.[3] When the bird flies, the nest is probably at the same or near the spot.

[2,3]Arthur A. Allen, The Book of Bird Life, D. Van Nostrand Co., Inc., New York, 1954.

Tree nests are often more difficult to see because of heavy foliage. Once the students become better acquainted with the nesting habits of a particular species, they can go almost directly to the nesting site. Some birds help us locate their nest by the noise that the young make as they are fed. Many birds will lead us to the nests and their young if we watch from a distance. Other birds try many methods of diverting people from the nesting site. The killdeer is famous for this with its "broken wing" act.

When the nests are located, and are still occupied we are forbidden by law to collect them at that time. Yet this is an ideal situation under which to study them. In studying nests, the best work can be done by the use of a blind in which the observer stays.[4] Birds soon become accustomed to a blind and as long as there is no movement, they will be content. When photography is the main objective, the blind is ideal. Blinds are bulky and often hard to carry along with the other equipment but very worth while. The blind can be any sort of concealment. A small tent, a thick mass of brush, an old stump or even a thick clump of cattails stuck up in the marsh. Chicken wire stuffed with leaves and branches is light and can be bent into any shape.[5] In studying the nests, one final suggestion is needed. Students should at all times sit still and quiet or if movement is necessary, it should be very slow. Birds are natural acting if they are not disturbed and they will even adjust to a strange looking monster such as a blind.

[4,5]Olin S. Pettingill Jr., A Laboratory and Field Manual of Ornithology, Burgess Publishing Co., Minneapolis, Minn., 1950.

Birds will not tolerate a great deal of confusion around their nests. If there is noise and confusion they become excited, upset and act anything but natural or they may even desert the nest.

After a blind has been constructed, one may use this as a means for close observation of the birds. A photographic study is ideal here and some little time must be spent on conditioning the birds to the camera. Remember, the blind may be only a matter of several feet away from the bird's nest. In taking still pictures, aim the camera at the nest, through the opening in the wall of the blind, and after the bird has settled on the nest, click the camera shutter. Do this as many times as needed so the bird will be conditioned to the click of the shutter. Eventually the bird will not be startled. Then put film in the camera and take pictures. A movie camera usually produces more noise than a still camera but the procedure is the same. Run an empty camera near the bird until it is conditioned to the noise and then use the actual film.

The blind is ideal for counting numbers of brood, observing feeding, nest preparation, growth of offspring etc. Make sufficient use of the blind. Much first hand information will be collected.

Some study activities are:

1. Bulletin board or peg board displays of nests. Photographs and magazine articles such as "Nature" and "National Geographic" may be useful here.

2. Have pupils list birds who live and nest in: open fields, thickets, hedges, woods, marshes, on the ground, high up in trees, in holes in dead decayed limbs or trunks, and in man-made structures.

3. Construction of bird houses to study nesting activities of some common birds. (See accompanying charts).

4. List as many different nest construction materials as possible.

5. List of birds which do not build nests but either "borrow" nests or use none at all.

The accompanying chart[6] illustrates some of the birds that might be studied in a nest box situation. Therefore, dimensions are included.

Bird House	Floor Size	Height	Hole above Floor	Diameter of hole
Wren	4" x 4"	6" - 8"	6"	1"
Chickadee	4" x 4"	8" - 10"	6"- 8"	1 1/8"
Titmouse	4" x 4"	8" - 10"	6"- 8"	1 1/4"
Nuthatch	4" x 4"	8" - 10"	6"- 8"	1 1/4"
Red-headed Woodpecker	6" x 6"	14" - 16"	12"- 14"	2"
Tree Swallow	5" x 5"	6"	5"	1 1/2"
Crested Flycatcher	6" x 6"	8" - 10"	6"	2"

House wren, chickadee and titmouse houses should be placed five to fifteen feet above the ground. Nuthatch and flycatcher houses should be placed eight to twenty feet above the ground. Woodpeckers and swallow houses may be placed five to fifteen feet above the ground. All houses should be placed on posts or tree trunks, in the open - not in dense foliage.

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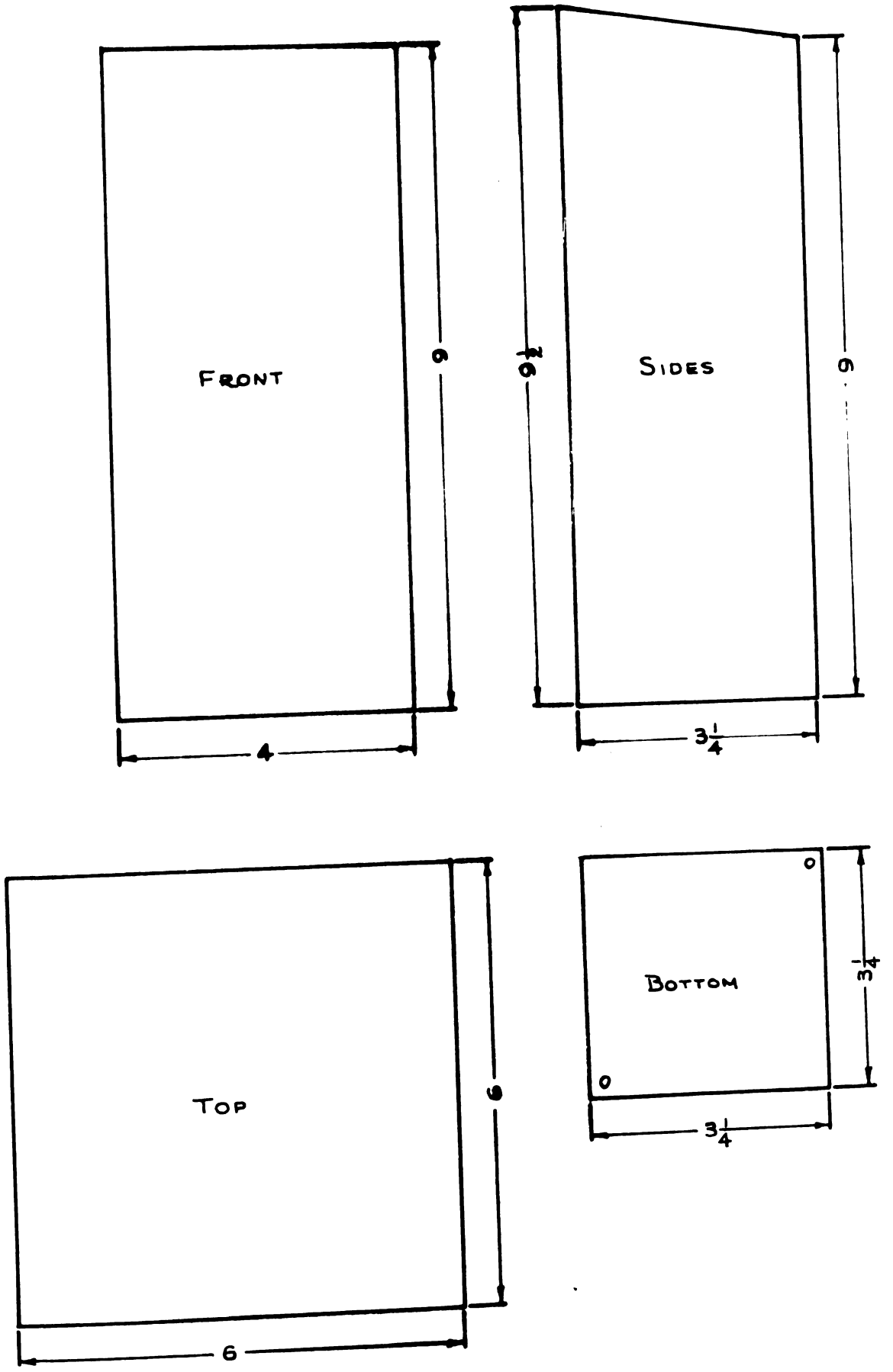
[6]Adapted from Nature by T. S. Pettit, Boy Scouts of America publication, New Brunswick, New Jersey, 1952, p. 50.

Value of Nest Boxes for Wild Birds

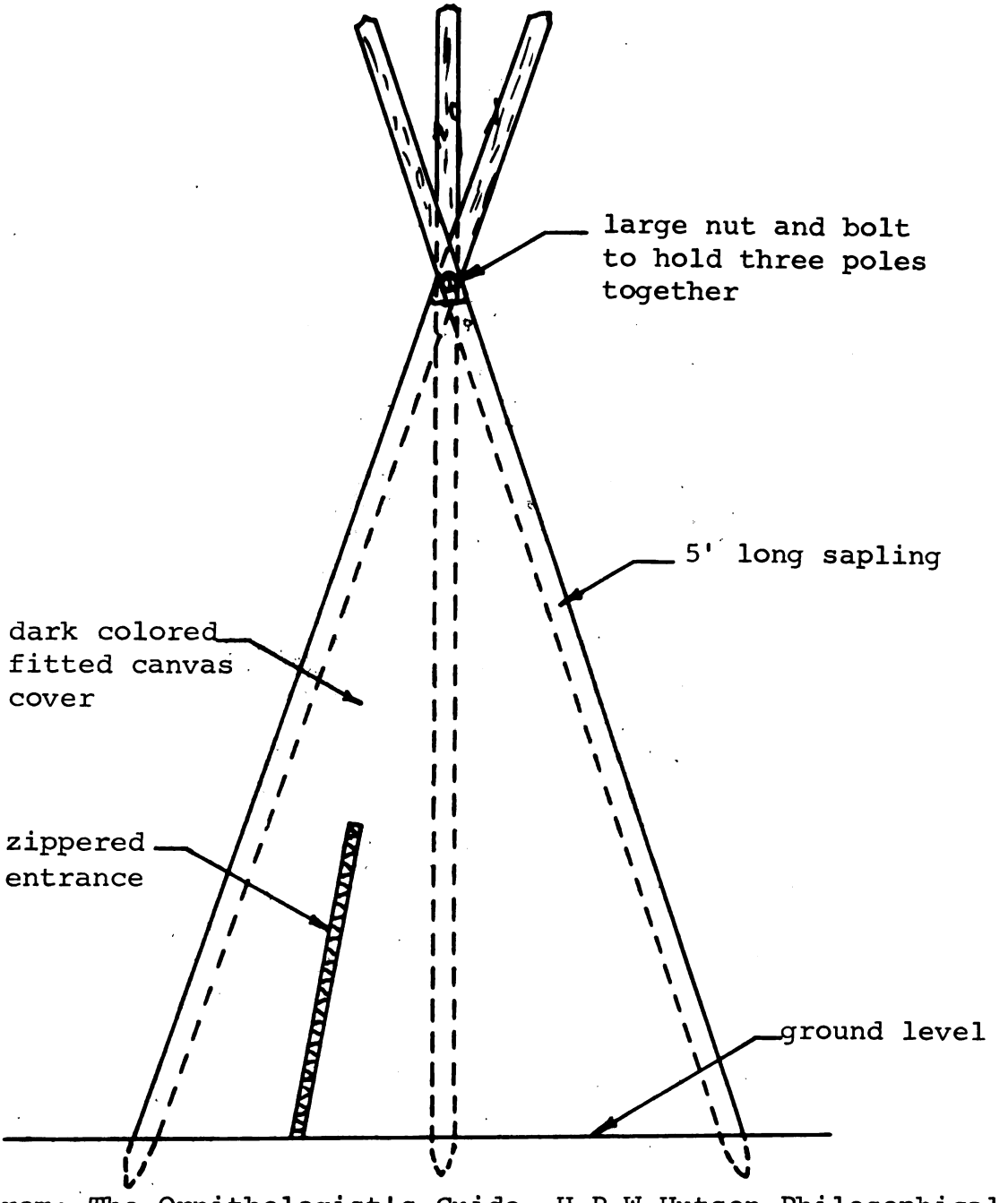
Birds may be observed in nesting habits directly from the classroom. The nesting box is ideal and may be placed near the school but will often be more useable if it is placed in fields some distance from the school. This will allow visiting the nest during class time or necessitate assigning them as extra projects. One ideal box type nest which may be adapted for other birds is shown on the next two pages.

Diagram of a Bluebird Nest Box



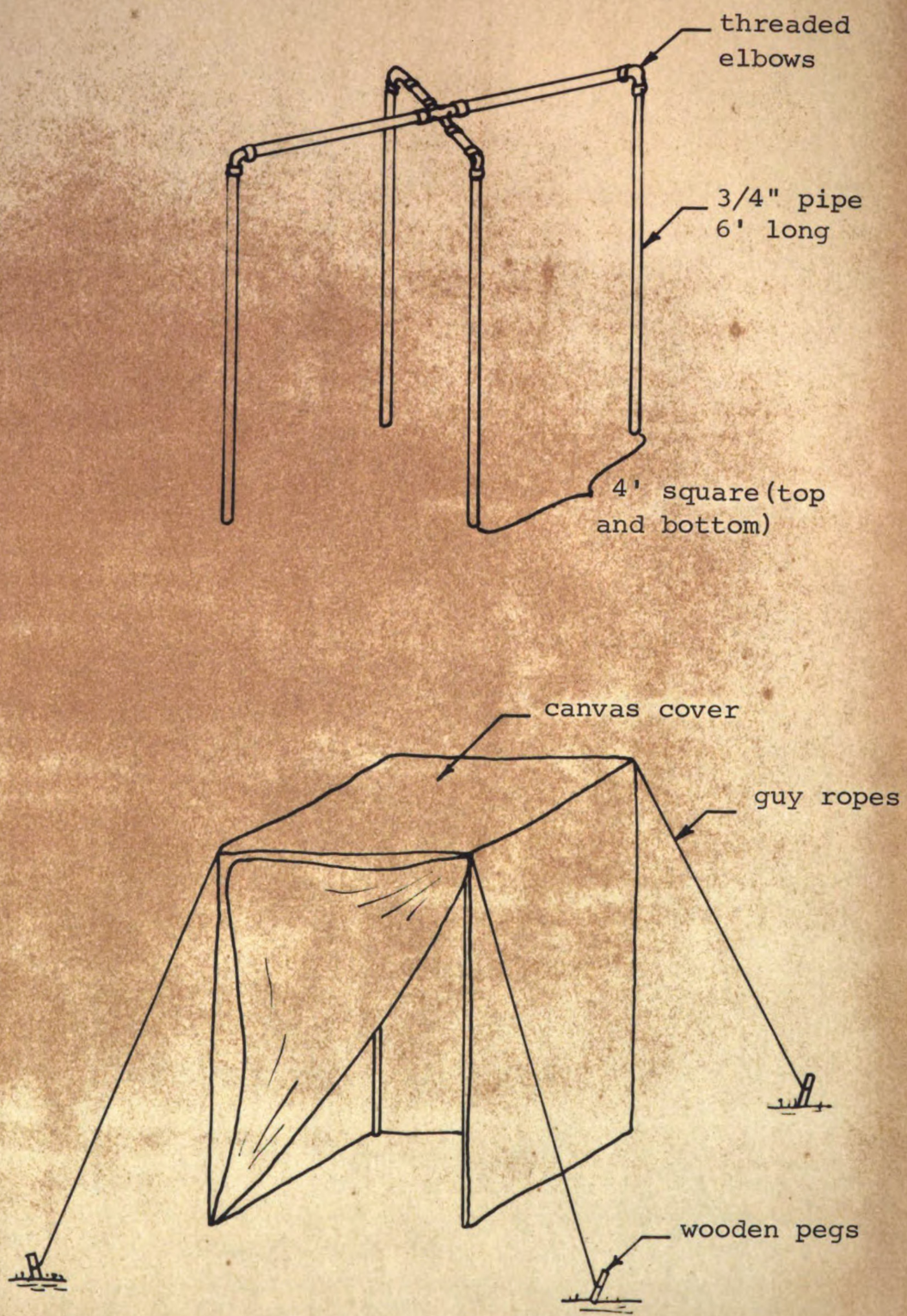
From: Nature, op.cit., p.46.

Portable Bird Blind



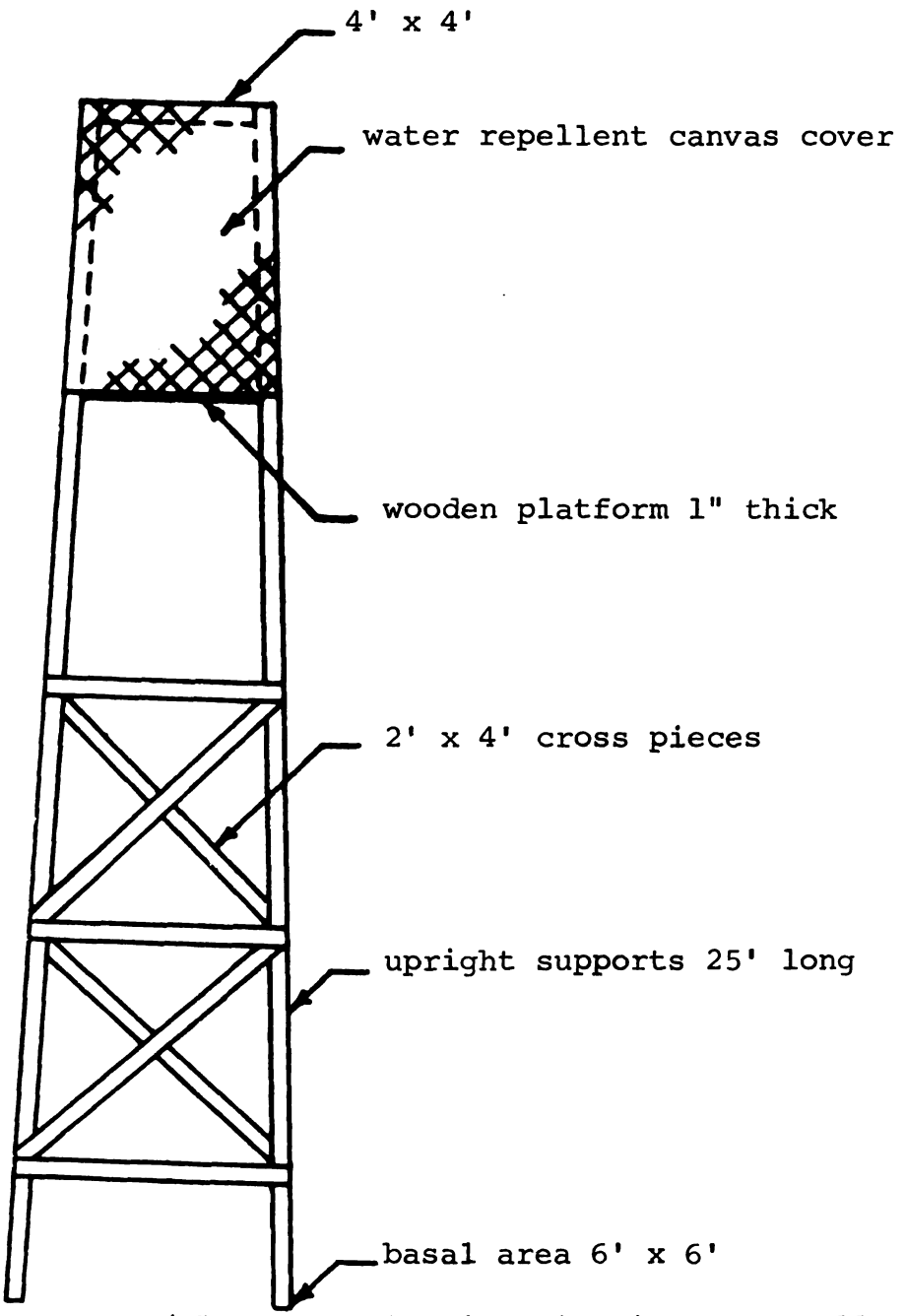
From: The Ornithologist's Guide, H.P.W.Hutson Philosophical Library, New York, 1956, p.165.

Portable Bird Blind



From: Olin S. Pettingill Jr., op.cit., p.215.

Portable Bird Blind



Scale: 1/4" equals 1'. Side view is shown. All four sides are the same.

From: Olin s.Pettingill Jr., A Laboratory and Field Manual of Ornithology, Burgess Publishing Co., Minneapolis, 1950, p.215.

Summary

Wildlife study is presented in many different ways throughout this paper. With this study of birds, we are dealing with a specific type of animal which is readily available to all and easily studied with little equipment and technical knowledge. One section of the introduction to this paper was concerned with wildlife conservation. In this study, it should become apparent to the students why birds, as wildlife, need to be preserved. We can consider game birds, insect eating birds, rodent-destroying birds, etc. Some of the conservation principles which are useful to the teacher in this area of bird study are as follows.

Water conservation - B-1.

Forest conservation - A-6, A-7, C-1.

Wildlife conservation - A-1, A-2, A-3, A-4, A-5, A-6, A-7, B-1, B-2, B-3, C-1, C-2, C-3, C-4, C-5, C-6, C-7, D-1, D-2, D-3.

Detailed Study of a Rotten Log[1]

In one of the previous papers, the study of plant ecology using the quadrat method of study was discussed. One can carry the study of succession further by studying the plant and animal life present in a limited environment such as a rotten log. One of the good features of such a study is the availability of rotten logs. It is not necessary to go into the deep woods to find these, as even a roadside fence post will rot and exhibit the organisms needed for study. In studying succession from one stage to a more advanced stage of growth or decay on such a limited scale and area, one may term this study microsuccession. Thus one or several field trips to the nearest rotting wood may be taken to study the microsuccession of a rotten log.

As the microhabitat undergoes physical and chemical changes which bring about its eventual destruction, its remains will become part of the soil. These changes will be brought about by bacteria, fungi, invertebrates, and vertebrates. The beginning of the microsuccession in a rotten log may be while the tree is still standing. Insects and other invertebrates will inhabit the outer wood and bark even though the tree is still alive. Eventually the tree will be weakened to such a point that it will fall. By this time the bark is usually off and the wood will be further eaten by boring animals, and fungi may begin to show their effect. The new group of plants and animals

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[1] Benton and Werner's Handbook for Field Biology and Ecology, Burgess Publishing Co., Minneapolis, Minn., 1957.

change the wood entirely until a new community is established in the fallen tree. The inside of the tree may be soft and spongy while the outside remains hard. These logs often furnish living space for small mammals such as the white footed mouse and shrew, as well as salamanders and lizards. After months of decay, the outer shell finally falls apart and the log becomes a part of the forest floor. Snakes and other subterranean organisms may move in, and their movement coupled with that of fungi and bacteria and a few left over invertebrates will finally bring the log down to the litter of the forest floor where it will not be distinguisable from any other part of the forest's floor.

After the teacher or an advance scout has located several rotten logs, all of the same species, the class may be taken to these logs and can begin their study of the microsuccession. Care should be taken to pick logs of the same species, but after, for effect, of various stages of decay. In this way, a class may examine many of the stages of log decay in a few hours rather than just one or two stages. The rotten logs may be divided and studied in four stages: The standing dead tree, the newly fallen tree, the log rotting inside but hard on the outside, and the completely rotten log. (This is Denton and Horner's classification found in the Handbook for Field Biology and Ecology, pages 137-8.)

The class should decide which one of these stages their specimen is in and then examine the entire specimen. Notice what is apparent just by looking at the dead, standing tree. It appears to be decaying. How is this obvious? Note the animals and plants living on and in this tree. All of the living organisms found in the tree should be listed.

These same points may be stated about each stage of succession that is found. Be sure that the class lists all the living things found and collects those that are not known to them. Upon returning to class and examining the data sheets, it will be apparent to the class that certain changes take place in the tree; in its living inhabitants and in the area in which the tree was living.

This is a handy way to study plant and animal ecology at the same time. The teacher is limited to an easily handeled situation, and the time which is consumed on actual field work should average no longer than two class periods. Parts of rotting trees may even be brought into the classroom if they are wrapped beforehand to keep the organisms on the wood and not scattered all the way from home to school. It is wise to use data sheets in the field and committees should be established before the field work commences. Thus reporting and observation may be handled back in the classroom.

Included here is a sample data sheet which may be duplicated and used by each student or committee for recording field observations. The first part is a check list. The second half is for listing specimens. It is suggested that one sheet be used for each separate stage.

Data Sheet

Study of Rotten Log

Name: Date:

Locale: Weather: Temp:

	Yes	No
1. Is the bark still on the tree?		
2. Can a nail be pushed into the wood?		
3. Are borings apparent in the wood or on the surface?		
4. Are nests of birds and other animals apparent?		
5. Is tree standing or fallen?		
6. Estimate how long it has been dead:		
7. How many invertebrates have you seen?		
8. Vertebrates living on or in the tree?		
9. Have you collected or recorded all the organisms?		
10. Did you see or collect any salamanders or lizards?		
11. Are any mammal runways apparent?		
12. Is the wood moist or dry in this specimen?		

List all organisms (plant and animal) collected or seen.

Species	Estimate of number present

[2] Benton and Werner, ob. cit.

Summary

In carrying out this study of a rotten log (micro-succession), the teacher should be able to illustrate the interplay between environments and the effect of this on living things. Conservation principles can be brought in here and the teacher should attempt to connect the rotting of this living organism to others around it and then the whole significance of the dying tree on the environment. Some conservation principles which could logically be used are as follows.

Soil conservation - A-3, A-5.

Forest Conservation - A-3, A-5, A-6, A-7, D-3.

Wildlife conservation - A-4, B-3, C-5, C-6.

A Study of Plant Succession From Bare Soil to Prairie

When undertaking a class study of plant succession, the teacher will find it necessary to present some background information before the class takes to the field. Most students need a clear understanding of the term "succession" before they try to undertake extensive field study.

Starting with bare ground and proceeding from there (as might be done in an actual field situation), point out to the classes that plants grew here at one time but due to such disturbances as fire, grazing, and plowing, there is now bare ground. What happens next ? The first types of plants that might be expected to return to this area would be the annuals similar to those found in gardens. Roadside weeds whose seeds have blown into the area might also be expected. Grasses and perennials will get started at the same time and eventually crowd out the annuals. The next steps depend upon the climate to a great extent but it is anticipated that the grasses will become dominant. Then shrubs and trees will move in and gradually take over the land. These last steps may be of long or short duration depending upon the proximity of seed trees and weather conditions, etc.. When the area has reached the final stage and seems to be in a static state (although it never is) the climax stage of growth has been reached. From here only maturation and then deterioration will take place.

The following chart[1] is presented as an outline of the

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[1] Ted S. Pettit, Nature, Boy Scouts of America Publication, New Brunswick, N. J., 1952, p. 28.

types of plants one might expect to find in each step of the succession.

Appearance	Life expected in area
Bare soil	Not many animals, no food available, no plants.
Early Weed Stage	Ragweed, plantain, foxtail, other annual weeds. Birds such as sparrows, larks, and mammals such as mice.
Late weed stage	Perennials such as asters, pokeweed, quackgrass, goldenrod, etc., some bird nests, few pheasant, quail, rabbits, and meadow mice.
Prairie sub-climax	Clover, Kentucky blue grass, more animals because of sod, insects, birds eating insects, food and cover for small rodents and thus food for foxes, hawks, etc..
Prairie climax	If the grass is the climax, long lived perennials will dominate, other species of prairie birds will move in and foxes, ground squirrels, coyotes, etc.. These will find shelter suited to their needs in the long grass.

In the actual study of these areas, the collecting of various plants in each successive stage is useful. One favorable aspect of this type of field study is that these areas are easily available to all. By simply walking along the roadside, one may see several of these stages of succession from bare soil to prairie.

Presented below is a check list of steps that might be taken in the study of the stages of succession.

1. Test the soil with pH paper by scooping a finger bowl in the soil and adding water. Then test the mixture with a strip of pH paper and note the color. Write down the pH in your notes.

2. What type of soil is this? Sandy, clay, loamy?

3. Is the soil porous or compressed? Will water stand on it?

4. What percentage of the area under study is covered by plant growth? (Make a rough guess at this.)

5. What general types of plants are seen? Perennials? Annuals? How do you know?

6. Does the entire area receive sunlight at all times? What percent does not? What is the temperature in the open? The wind velocity?

7. How much rainfall does this area receive in a 72 hour period? (Set up a rain gauge and leave for 72 hours.)

8. From your observations of this area, what animal life is apparent?

9. From your observations of this area, what would the next stage of plant growth likely be? Why? Are you able to see any nearby growth areas which are different from this one?

10. Collect a sample of each unknown plant and place these in a moist container for return to the classroom. These plants should be identified and mounted for future reference.

In carrying out the steps mentioned, it may be necessary to devise some simple equipment which may not be on hand or be purchaseable. Simple anemometers can be made and rain guages are easily made from any glass container

which has been calibrated.

Either while in the field or later during class discussions the aspects of soil conservation as related to the study just completed should be discussed. Why did the soil revert to a naked, unproductive state? Why did it take so long for new plants and animals to return to the denuded area? What are the chances of great amounts of valuable top soil being lost when the soil has not cover of plants? What types of soil erosion were apparent when one studied the weed stages? What is the importance of plants like legumes and perennial grasses in soil and water retention?

In answering these and the other questions related to the study, the students get a deeper understanding of the conservation aspects of plant succession and why land is more valuable in some stages of plant growth than in others.

Summary

In this study of plant succession from bare soil to prairie, the teacher has ample opportunity to illustrate soil conservation principles as well as water conservation, some forest conservation and wildlife conservation. These concepts may be directly observable in the field or the students may have to apply themselves to thinking in terms of what could happen to the areas under study in certain predictable situations.

Soil conservation - A-1, A-5, A-6, A-7, A-8, B-1, B-3, C-2,

Water conservation - A-4, B-1.

Forest conservation - A-3.

Wildlife conservation - A-2, A-3, A-4, A-6, B-2, C-1, C-2, C-6, C-7.

Study of Plant Succession From Meadow to Forest

When the lowland are built up so that the soil is saturated only in spring and early summer, certain species of shrubs and trees appear.[1] Those that tolerate waterlogged soil are the pioneers. Examples of such pioneers would be Salix, Cornus, Cephalanthus, Alnus, and Populus. These occupy more and more of the area, producing shade and lowering the water table by building up soil and rapid transpiration. The resultant dry, shaded soil becomes intolerable for the sedge-meadow species and these gradually disappear. Shade-enduring herbs replace them, growing among the trees and shrubs.

The climax forest begins as the humus accumulates. Soils become filled with bacteria and fungi and other trees begin to invade. Mixed forests of alder, willow, cottonwood, hackberry, elm, ash, oak, and shagbark hickory with their accompanying characteristic shrubs and herbs may result. Gradually some shifting of the species may occur and the intolerant species will disappear, i.e., the ones which cannot adapt to deep shade, better aerated soil etc.. A rather pure forest of oaks and hickories may develop in this fashion, or, if the even more shade enduring maple and beech are present, they may replace the oaks and hickories.

When the amount of moisture in the ground drops off markedly, the drought resistant oak-hickory association becomes dominant. Oak-hickory climax forest ranges through

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[1] Henry J. Oosting, The Study of Plant Communities, W. H. Freeman and Co., San Francisco, 1956.

much of the Piedmont Plateau and the Atlantic and gulf states coastal plain in an arc that widens westward to eastern Texas. The dominants of the oak-hickory forest are not the same throughout its extensive range, but rather there are numerous species of oak. Often the oak-hickory turns into a mixed mesophytic forest climax which includes a combination of many other species.

North of the boundary of Wisconsin glaciation there are the climax species of beech-maple. These extend over up into Wisconsin with virgin forest in Michigan. The original forests of southwest Michigan, Indiana and Ohio, as reconstructed from land survey records, were beech-maple on good sites and oak-hickory on coarse soils with poor moisture conditions. This conforms with present conditions and may be called climax and subclimax.

The preceding is some of the background for an actual field study of plant succession from meadow to forest. One must keep in mind that the climax stages will vary from one part of the country to another. Below is information for the land areas of north central states. Also summarized is what one might expect to find in the three studies areas into which this topic may be divided.

1. The shrub stage[2] — If the shrub stage succeeds the grass, shrubs such as sumac, sassafras, prickly ash etc. will grow and birds such as cardinals, catbirds, indigo buntings, and sparrows will nest here. There will be insects of varied kinds,

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[2] Ted S. Pettit, Nature, Boy Scouts of America Publication, New Brunswick, N. J., 1952.

		and there are likely to be cottontails.
2.	Sub-climax tree stage	Tree nesting birds such as bluejays, crows, flickers, flycatchers, warblers, hawks will be found. Insects living under tree bark and in dead wood will appear for the first time. Also there are likely to be deer, squirrels, opposum, raccoons, etc..
3.	Climax forest	Many of the plants and animals mentioned above will be found here while others will be replaced by new plants and animals that find in the forest the exact conditions they need for optimum growth.

In attempting a field study of this type of plant succession where large tracts of land are under consideration, woodlots, forest, meadows etc., it might be wise to point out to the students that the areas under study will have to be limited to a certain size. In this manner one has a practical area on which to work and the students will not attempt to analyze an entire tract of forest.

The mode of analysis most appropriate to the study of succession from meadow to forest is the quadrat study. This is discussed in another article of this series and the mechanics of it will not be repeated here. Students should be allowed to collect unknown specimens of plants and return these to the lab for further study. Such things as soil conditions, temperature of soil and air, moisture content and pH of soil, relative humidity, shade area etc. should be all carefully observed and noted. A photographic study is aplicable here and students may work in groups

making a photographic survey of the successional stages. These photographs may be either black and white prints which may be processed by the students themselves or color slides which the students will probably need to have commercially processed.

As a final analysis of the work that has been done by the students and of how much usable knowledge they have attained, the following technique is useful. When students have finished their observations of the areas under study and done all their collecting and analyzing, the teacher may divide the class into small groups with one student leader to a group. The groups then return to the areas the students have been studying. The student leader should be able to start at the meadow stage and take the rest of his group on a guided tour of all the plant successions studied. The student should be expected to analyze the growth types, give reasons why the situations exist and otherwise conduct the tour as an expert in his area. Three or four of these groups may be going simultaneously, having been started from different points. The teacher may then visit each group and can readily observe what has been learned and what has not.

Summary

In this study, ample opportunity was available for the teacher to vividly point out evidences of actual environmental changes taking place in nature. In so doing, the teacher had the opportunity to also illustrate conservation principles applicable to the meadow situation and then different principles applicable to the forest environment. Some of these principles are as follows.

Soil conservation - A-2, A-3, A-5, A-6, A-7, C-2.

Water conservation - A-1, A-3, B-1.

Forest conservation - A-1, A-2, A-3, A-5.

Wildlife conservation - A-6, C-2, C-6.

A Study Of The Relationships Of Plants And Animals of The Meadow

In attempting the study of a meadow, the quadrat method of study is ideal. This method, outlined in an earlier study, gives us a rather complete analysis of the meadow. The vegetation of this climax area undoubtedly affects the distribution of animals. Some birds require trees in which to build their nests while others are able to nest on the ground in grassy areas. The unrelieved summer heat and the constant exposure to wind may prove undesirable to certain animals. Some species requiring trees may still be able to exist in this area as inhabitants of the wooded river bottoms. Lack of source of water may have its limiting effects on animal populations. Agricultural practices may also tend to dry out the land and drought may reduce the populations considerably.

To facilitate study, one or more quadrats of one square meter size should be established. Students should then count and record all the plants in this area. The approximate height of each kind of plant found in the quadrat should be recorded. Are the plants crowded together forming compact sod or is there open area between clumps of grass? Is there a great variation between plant types in wet and dry areas? Are there any woody plants present?[1]

Traps which have previously been set out must be examined daily. No more than twenty-four hours should elapse between checks. Signs of mammals should be noted. If

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[1] Benton and Werner, Handbook for Field Biology and Ecology, Burgess Publishing Co., Minneapolis, Minn., 1957.

there are any damp areas in the vicinity, look for the presence of amphibians. Sweep the vegetation for invertebrates and record the kinds and relative numbers caught. What is the nature of the soil here? Soil maps of the area may be used to give the students the exact type. The pH should taken. Is the area well-drained or not?

This area lends itself to a nocturnal study. Since many of the animals here are active at night, and many are not active at the same time during the night, a rather extensive study must be undertaken. Students may be advised on the procedures necessary and then do the work in groups on their own time or with the instructor. An appreciation of the complexity of the interrelationships of plants and animals may be gained by a night's study of the activities of the animals. A trail containing several stumps or logs or likely looking habitats should be set up beforehand by the instructor and students. Commencing at dusk, the class will cover the trail, stopping to record the kinds and numbers of animals found.[2] The trail then may be retraced at regular intervals throughout the night. Light traps and sugar lures to attract the insects may be used. When the students are not occupied in observing animals on the trail, they can make hourly observations of the wind, relative humidity, evaporation rate and temperature. A sample data sheet for the nocturnal study is outlined on another page of this article.

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[2]Benton and Werner, op. cit.

The accompanying chart shows the relationships that exist between some plants and animals of the meadow stage.[3]

Sedge-meadow stage

Sedge
Rush
Spike Rush

Muskrat
Mink
Red-winged Blackbird
Bobolink

Lowland Prairie

Big Bluestem
Indian Grass
Switch Grass
Slough Grass

Ground nesting birds
Prairie Mammals
Prairie Insects

Climax Prairie

Little Bluestem
Needle Grass
Grama Grass

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[3] Handbook of Biology, Soil Conservation Service Publication, United States Department of Agriculture, Washington, D. C.

Summary

While studying the plants and animals of the meadow, students could, logically, become involved in counting different species collected and sighted and forget the actual purpose of the study. The effects of the various types of plant and animal life on each other and man should be looked into. Some of the animals sighted here may also be found in other areas quite unlike the meadow under study. The plants and animals which are unique to this area are those which should receive closer scrutiny. What would happen if some or all of these organisms were to disappear? Why should conservation practices of various kinds be carried out in an area such as this? What are some of these practices? Appropriate conservation practices are listed here.

Soil conservation - A-3, A-5, A-8, C-1, C-2.

Water conservation - B-1.

Forest conservation - A-3, A-8.

Wildlife conservation - A-1, A-2, A-3, A-4, A-5, A-6, B-2, C-1, C-2, C-3, C-5, C-6, D-3.

Nocturnal Activity Data Sheet

Location:_____ Date:_____

Time:_____ Weather:_____

Trip I	Trip II	Trip III
Time:		
Air Temp:		
Rel. Hum:		
Wind Vel:		
Species	Species	Species

A Study of the Relationships Of Certain Plants and Animals Of The Woodland or Forested Area

When planning a study of woodland flora and fauna, one might well have introductory discussions with the class previous to actual field work. Much time can be spent on the significance of food chains and environmental factors. Since it is difficult to study the relationships between all of the plants and animals one might expect to find in the wooded area, the more obvious inhabitants of these areas are stressed.

As in previous studies, the quadrat method is useful here. Quadrat size should be increased to a manageable limit. A suggested size might be fifteen feet by fifteen feet. This may be increased or decreased as the instructor sees fit. Unlike a weed quadrat where most of the vegetation is alike in structure and size, the forest quadrat will exhibit great extremes in size of flora and density of both flora and fauna.

Assuming a good-sized woodlot has been chosen for analysis, it is recommended that student teams (four or five students) measure out and work their quadrats in an orderly fashion. One team might begin at the north end of the woodlot and work to the southern end. This assignment of directions or paths for the quadrats to follow, encourages students to establish quadrats in a manner that should give a more representative woodlot sampling. In addition, this method of sampling discourages arbitrary choosing of quadrat sites by students based upon dryness, accessibility, amount of sunshine available, etc.. (See diagram)

As an outline guide to the communities of the forest,

consider the following:

A Communities in the ground

1. Typical members

Plant	Animal
Algae	Protozoa
Fungi	Worms
Bacteria	Molluscs
Yeast	Insects
Molds	Spiders
Mildews	Vertebrates

2. Community activities

Soil formers
Vegetable disintegrators
Initial links in forest chains
Water regulators

B Communities on the Ground

1. Typical members

Plant	Animal
Algae	Molluscs
Fungi	Insects
Moss	Spiders
Ferns	Amphibians-reptiles
Club Moss	Birds
Herbs (Wild flowers)	Whip-poor-will
	Partridge
Woody Plants (low shrubs)	Ducks
	Mammals
	Mice
	Chipmunk
	Rabbit
	Deer

2. Community activities

Soil formers
Water regulators
Soil conservers
Primary links in food chain
Secondary links in food chain

C Communities above but near the ground

1. Typical members

Plant	Animal

Tall shrubs	Black and White Warbler
Young trees	Others

2. Community activities

Soil conservers
Water regulators
Food consumers
Probably final link in food chain

D Communities high above ground

1. Typical members

Plant	Animal
Maturing trees	Birds
	Scarlet Tanager
Mature trees	Baltimore Oriole
Declining trees	Fox and Gray Squirrel
	Raccoon
	Hawks
	Owls

2. Community activities

Soil formers
Soil conservers
Water regulators
Quantity
Quality
Temperature
Final links in food chain[1]

As an additional guide to the study of plants and animals of the forest or woodsd area, also outlined are a series of questions which all the students should be able to answer before they finish their study of the area.

PLANTS: What is its name? What does it look like? Is it a green plant? How does it reproduce? Does it have roots? What kind? Does it have leaves? What kind of

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[1] G. W. Mouser, Forest Conservation (supplement) Department of Fisheries and Wildlife, East Lansing, Michigan, Pps. 1-2.

leaves? Where does it grow? In water, on rocks, in soil? If it has seeds, how long does it take them to form? How long to germinate? How are they spread? What do the flowers look like? How does pollination take place? Are male and female flowers on the same plant? How old does the plant get? What is its relationship to animals? Food? Cover? Does it have any particular use to man? Food? Fiber? Wood products?

BIRDS: What is its name? What does it look like? Are the male and female different in appearance? Does it migrate? Where does it spend its winter? When does it come back from the south? When does mating take place? Does it go through a special dance? When is its nest built? What are the bird's natural enemies? Are there any special conservation practices necessary to preserve their numbers? What?

MAMMALS: What is its name? What does it look like? Do the male and female look alike? Are they the same size? Does the mammal hibernate in the winter? Where? If not, how does it spend the winter? Where does it live in the summer? What kind of wildlife community? When does mating take place? How long before the young are born? Are the young born helpless and blind? How big are they when they are born? How long before they can take care of themselves? How long before they leave the adults? How old are they before they mate? What is their means of defense? What are their natural enemies? What do they eat? How do they get their food? Do they feed in daytime or at night? Are there any special management practices needed to maintain their numbers or to keep them from increasing too rapidly?

REPTILES AND AMPHIBIANS: What kind? What does it look like? Where do they live? What kind of wildlife community? When does mating take place? Are the young hatched from eggs or are they born alive? Can the young take care of themselves? What do they eat? How do they get their food? What are their natural enemies? Have they a distinctive call? What does it sound like? How do they spend the winter? The heat of the summer? Are they common or unusual in your area? How do they move? How do they grow? Do they shed their skins? Are there any conservation measures affecting the animals? What? Why? Is the animal useful to man? As food? As a control of insect or rodent pests?[2]

If any student is to answer all of the above questions, he must have a good knowledge of the organisms being studied. This is best obtained by first-hand observation either in the area being studied or in the laboratory with a captured specimen.

There are a number of collecting techniques which could be outlined here and all of them would be useful in certain situations. One predominates as being particularly applicable to the forest situation. This is a photographic study of the nocturnal animals, particularly the mammals.[3] Briefly, one sets up the camera on a tripod, in a likely looking spot. This should be placed in a known trail that raccoons or opossum or some other larger mammal frequent. This is

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[2]Ted S. Pettit, Nature, Boy Scouts of America Publication, New Brunswick, N. J., 1952, pps. 54-7, 91-3.

[3]T. S. Pettit, op. cit.

done at night. The camera is aimed at one spot on the trail and then the film is advanced and the shutter is put on the bulb or open setting (after dark). A thin string runs from the tripping device to a stake on the other side of the trail. As the animal comes by and runs into the string, the tripper is pulled, setting off the flashbulb and one has a picture of the intruder. The observer must return from a nearby hideout and advance the film and insert a new flashbulb. (See diagram).

Mammals and other small animals may be trapped in live traps and returned to the classroom for study. It is relatively simple to make these traps. Sketches are included on the next page. Plants may be gathered for identification and studied in the usual manner. Avoid drying the plants out before returning them to the classroom. Setting up a woods' terrarium sometimes helps to illustrate the living woods to students.

It should always be remembered that these plants and animals are being studied in order to discover what the relationships are <u>between</u> these living things. If this is not taken seriously and a few samples are collected which are not representative of the entire area, then the study is inadequate. Students should be encouraged to work out and diagram food chains of the organisms collected. Conservation practices should be discussed and attempted. Much can be done with this type of study and the ordinary high school biology course becomes a living, breathing study which will appeal to all.

Summary

The forest community is one of the most complete examples of interaction among living organisms in this series. Many different aspects of conservation can be brought out here. If we advocate the preservation of the forest, then what does this mean to conservation of the inhabitants of that forest ? If we do away with this forest, what will happen to the many living organisms now present there? Will they adapt? Will they move? Many concepts relevant to the entire conservation philosophy should be brought out. Some of these are listed below.

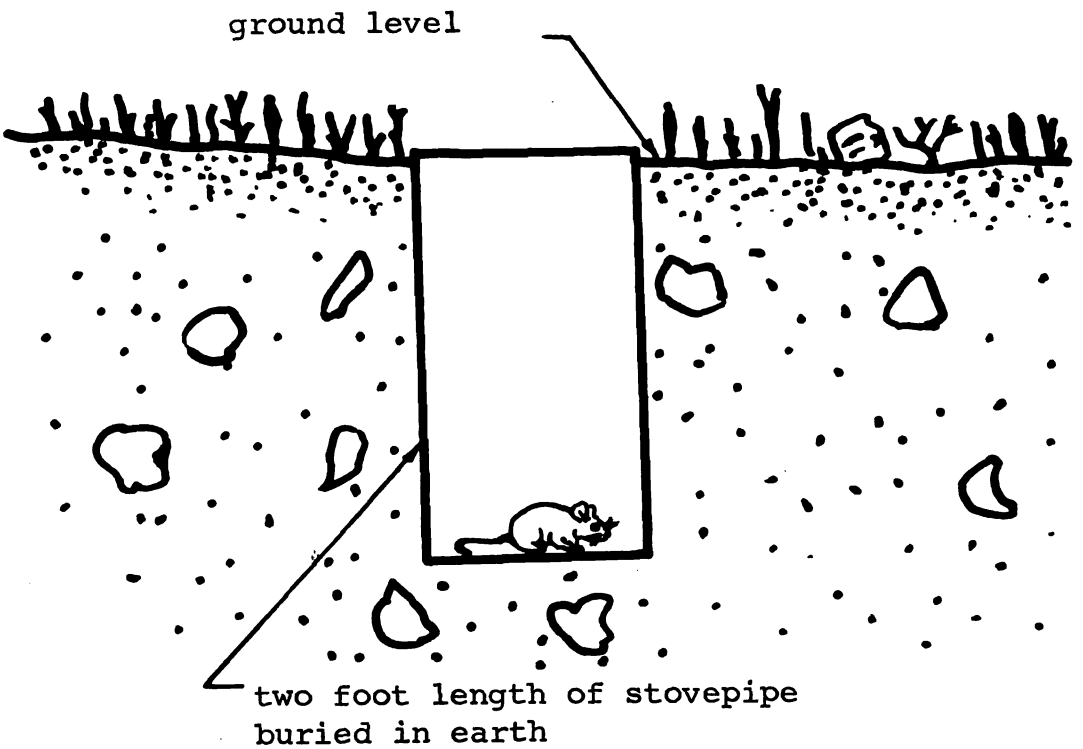
Soil conservation - A-2, A-3, A-5, A-6, A-7, A-8, A-9, B-4, C-1, C-2, D-2, D-4.

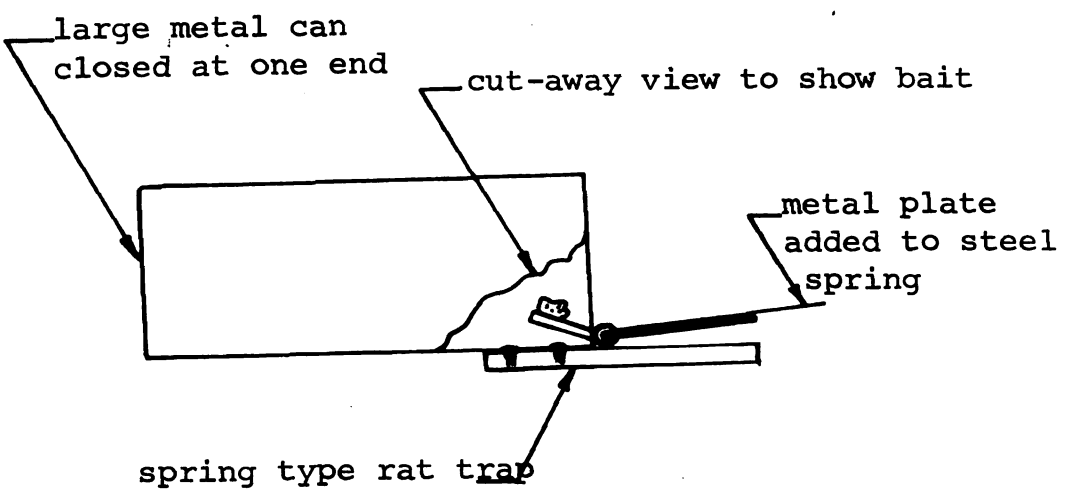
Water conservation - A-2, B-1.

Forest conservation - A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, B-1, B-2, B-3, C-1, C-2, D-1, D-2, D-3.

Wildlife conservation - A-1, A-2, A-3, A-4, B-1, C-1, C-2, C-6, C-7, D-3.

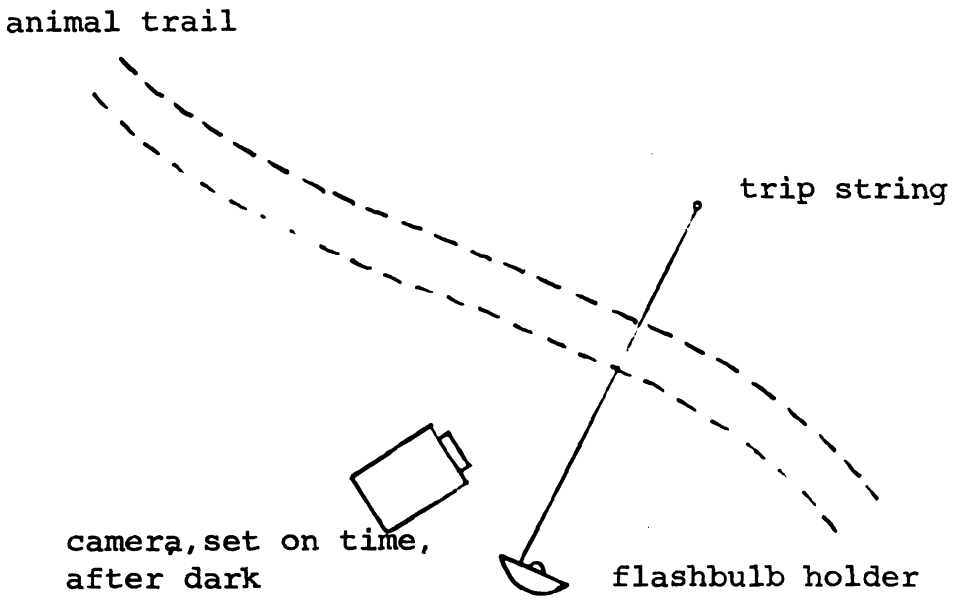
Mammal Traps

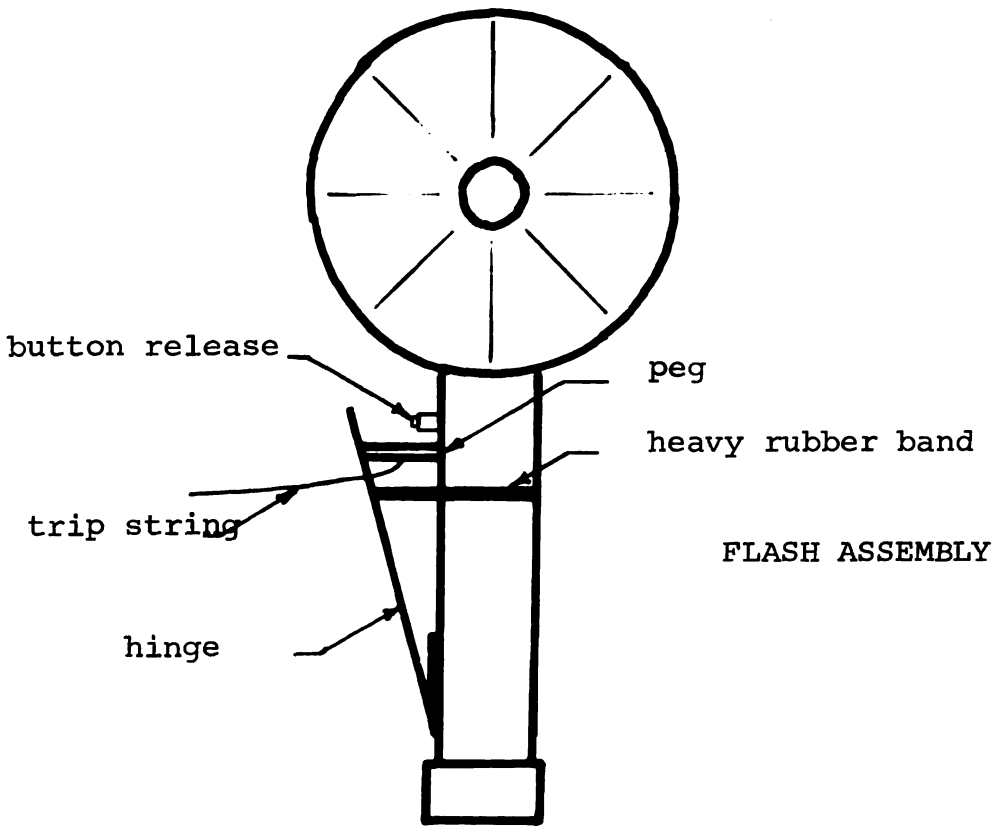




From: T.S.Pettit, op.cit.

Flash Trap





From: T.S.Pettit, ob.cit.

Biology of Ponds, Lakes, Marshes, And Like Bodies of Water

When one attempts a study of aquatic relationships between plants and animals, there are several problems which become apparent at the outset. First is the availability of the water areas. Are there several different representative aquatic communities in your area? Second is the ability of the class to handle the wet situations in which they will often find themselves. Third is the possibility that there might be a small element of danger involved when one is working with large numbers of students near water. With a little thought and planning, one finds that these problems can be overcome. It is recommended that with younger students, high school age or less, bog areas not be employed and that study be confined in these instances to areas that have been thoroughly tested by an experienced outdoors man. Also it is not the intent of the writer that the sum-total of the activities presented herein are suitable for an entire class. Yet with adequate instruction such could very easily be valuable for smaller groups as individual investigations.

Inland bodies of water are known by various names depending to a great extent on the part of the country in which they are situated. Regardless of the term used to describe the water area, and whether the impoundment be of glacial origin or man-made, certain biological successions take place. To be sure the events within the succession will vary depending on whether the impoundment has deep vertical edges with sudden and complete drop-off or whether the waters gradually deepen from a few inches to a few or many feet in depth.

Since the gradual deepening shore line is the more favorable type for study (from the standpoint of safety) background information for this type of study is as follows. For purposes of simplification of terminology, from this point forth we shall call the impoundment a "lake".

There are three general zones of vegetation which may be studied. These are the emergent plants, the floating plants and the submerged species.[1] Early in the developmental stage of a lake, glacial or man-made, microscopic life appears. These are plants akin to free-floating algae with no roots, no fibrous supporting tissue, no water regulation, no vascular system, and as such they are virtually a part of this total environment being constantly bathed in their food source. They have no need of complex reproductive systems as they simply part company, each half going one way or another. They are found in shallow and deep water alike. As one leaves the shore line and heads toward the lake middle, an area of submerged plants is encountered where the water is five to ten feet in depth. Vallisneria is an example. These plants have dwarf-like male plants near the bottom and the somewhat taller female plants at times in contact with surface activity through their flowers which are attached to a slender, filamentous stalk.[2] Elodea, Potamogeton, Ceratophyllum, Myriophyllum and Ranunculus are likewise to be found in this area. These plants

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[1] Black, J. D., Biological Conservation, The Blackisten Co. Inc., New York, 1954.

[2] Watt, M. T., Reading the Landscape, Macmillan Co., New York, 1957.

have no mechanical tissue but are rooted. Perch, bluegill, bass, and other fish in the sunfish family dart in and out among them. Fish such as bull head and mud-minnow are often present.[3] Such submerged life gradually raises the level of the bottom in two ways - by organic debris and the slowing down of mineral soils that wash in.

The next zone is the floating leaved zone with a depth of two to five feet.[4,5] Lily pads with leaves seemingly more highly developed than plants, with flexible stems that permit the large leaves to rise and fall with the water depth, are prevalent. Yellow pond lilies are present and flys, bees, and beetles are involved in the cross-pollination of these plants. Sunfish, small cricket frogs and peepers bull and green frogs and certain potamogetons are all present in this zone. Fill in takes place much the same here as it did in the previous zone.

The next zone is that of the emergent plants in six inches to two feet of water.[6] Cattails, sedges, bulrushes,

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[3]Benton, A. H. and Werner, W. E., Principles of Field Biology and Ecology, McGraw-Hill Book Co., New York, 1958.

[4]Costing, H. J., The Study of Plant Communities, W. H. Freeman and Co., San Fransisco, 1958.

[5]Odum, E. P., Fundamentals of Ecology, W. B. Saunders Co., Philadelphia, 1959.

[6]Odum, Op. cit.

pickerel weed, and arrow leaf are common. These are different kinds of plants entirely in that they have stiff rugged stems and leaves for the greater part. Animals such as whirly-gig beetles, back swimmers, water striders, dragon flies, and damsel flies are in constant appearance.

At the edge is found an area of constantly shifting width and composition depending on bottom characteristics. Here are found animal footprints, mollusk shells, parts of animals, shed insect skins etc..[7] Beyond this area there are small willows, alders, tamarack and soft maple trees.

In time, these trees will take over the cattail area. The cattails will move in on the water lilies. The water lilies will crowd out the eel grass or Vallisneria and in time the eel grass (Vallisneria) associates will meet one another somewhere near the hypothetical middle. These will later be down trodden by lily pads coming in from all sides, and these in turn will give way to cattails which grow into the area. By this time the lake is all but extinct because the area is already near to being too dry for cattails, and willows, aspens, maples, and associated under story plants will take over. The story is not ended because the march of specific tree types will in time take over the willow, aspen, and maple pioneer types.

The progression will, of course, vary with bottom characteristics, surrounding topography, climatic conditions, latitude, and other factors. In the event that this process occurs in prairie regions, the marsh grasses will substitute for the willows, aspen and maples and the lake

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[7] Dansereau, P., [illegible], The Ronald Press Co., New York, 1957.

will become more prairie.

One must never forget the fact that man is the key to the entire sequence. Especially is this true with the tremendous earth moving equipment he posseses today. In a matter of days he could arrest, abolish, and start anew the entire chain of events. Water lilies could soon be floating where the woodland flowers have just bloomed, or the blue-bell could be growing where the cattails gently waved in the breeze. Which is the more desirable - the natural succession or the man induced sequence. Only the one who really knows and understands natures' intricate processes is and will be in a position to answer such questions. This constitutes significant reason in itself for young students of biology to get into the field for a first hand look at biological history in the making.

Suggested activities:

1. Locate lakes or ponds that have shore lines and bottom conditions otherwise suited for and safe for younger students to explore. Locate various lakes that will best illustrate the respective zones of vegetation.

2. It might be of interest to check temperature readings at various depths at various times during the season.

3. Collect plankton samples - see direction sheet the end of this paper.

4. Study plankton samples under the microscope in the laboratory.

5. Operate seines along the shore in the respective and specific zones (6"-2' to 2'-5' - as far beyond five feet as possible.)

6. Collect with dip nets.

7. With an ordinary garden rake pull in bottom materials from the respective zones.

8. Using large kitchen sieves, collect water and bottom samples from the same areas.

9. Search for frogs, salamanders, and snakes.

10. Collect all species of plants again keeping separate those found in the various zones.

11. Spend time just watching for animals that make up the animal members of the community.

12. Since, as has been stated, a pond, a lake, or a slough will mean varying things in different parts of the country, the writer would suggest that the above outline might well apply to any one of these water areas. Study will then center itself around how typical the area is compared to the hypothetical standard. It should be noted that any recently constructed (man-made) pond or lake may not be old enough to exhibit vegetative zones. This in itself furnishes an opportunity to observe accurately just what the situation is in this new impoundment.

Summary

The field study of ponds, lakes and marshes enables one to witness the continual change of one environment into another. If a farmer or some other individual wanted to maintain a farm pond in a productive state from the standpoint of game and fish, this person would have to be aware of what could happen to his pond if left to nature's way. Various conservation principles can be applied here. Some of these are as follows.

Soil conservation - A-3, A-5, A-6, C-2.

Water conservation - A-1, A-3, A-4, A-6, B-1.

Wildlife conservation - A-2, A-3, A-4, A-6, B-1, C-1, C-2, C-5, C-6, D-1, D-2, D-3.

A Study of Plant Succession From Water to Dry Land

One of the most challanging and interesting studies that a class may make is the study of plant succession from one stage to another. To understand, for instance, the mechanics of plant succession from water to dry land the stages of plant succession one might expect to encounter are outlined here.

Just how do bogs and their associated plant life go through their various stages of succession? The following outline illustrates this process commencing with a wide open pond and continuing through to dry land.

The hydrosere is the submerged plant stage. These are the pioneers. Examples of these pioneers might be Elodea, Potamogeton, Najas and Ceratophyllum. These and other plants sometimes become so dense that boating is impossible. As the plants increase, the incoming silt and sand is trapped in the entanglement and as the plants die they fall to the bottom where they are only partially decomposed. Thus the bottom builds up and a rich substratum is formed When the water is only six to eight feet deep, floating plants begin to appear. Their rhizomes shoot out from shallower water. Such plants as Nymphaea, Potamogeton, and Polygonum are typical. As the floating plants become more dense, the submerged plants receive less light and gradually relocate themselves in deeper water. The floating plants have dense systems of stems and rhizomes which collect much debris and any other material which washes in. The substratum continues to build up rapidly until the swamp plants are able to pioneer on the shoreward margin of the floating plant zone.

When this stage is reached we are near the next stage, the reed swamp stage. This stage is typified by plants that root at the bottom and are partially submerged but whose foliage is above the surface. Scirpus, Typha, and Phragmites are a few examples. Also one may see Sparganium and Zizania. The reed-swamp plants greatly overshadow the floating plants and the latter disappear, or move outward toward the submerged species.

Gradually, even the reed-swamp plants destroy themselves by collecting too much sediment and dead, decaying foliage. As the soil builds up, this stage is replaced by a group of plants accustomed to less water, the sedge meadow stage. Carex, Juncus, and Eleocharis are good examples of these. Gradually the soil becomes merely saturated with water, not submerged, and the water level sinks a few inches below the surface. Islands of Cattails may persist in a depression for a long time giving indications of a former swamp.

Many species begin to mix with the Juncus, Carex, and Eleocharis group. These are Mentha, Clatha, Iris, Calium, Cicuta, Eriophorum and Campanula. All of these help to bind the soil, accumulate plant debris and transpire great amounts of water. Finally the environment becomes too dry for the hydrophytes to thrive and they are gradually replaced by another community. In dry climates this may be grasslands or some other xeric (dry) climax, but in more moist climates, the wooded area developes. (See diagrams I and II)[1]

There are several approaches to this study of plant succession. One method which may be used is that of making

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[1] Weaver and Clements, Plant Ecology, McGraw-Hill Book Co., New York, 1933.

a photographic study of different localities. This can serve to illustrate the different stages and plant representatives mentioned earlier. Class committees might be set up to handle planning, photographing and preparation of slides for a slide talk. Color transparancies are ideal for this.

Method two involves taking the class into the areas mentioned and actually showing them how the plants vary from the submerged stages through the terrestrial stages. The class should be briefed beforehand on what to look for. Then they might be taken to the area under study and allowed to collect unknowns, take water or soil samples, and collect other pertinent data such as topography of the area, temperature, relative age of pond or bog under study as determined by depth of ooze, etc.. This type of field study is then carried our for us as many separate study trips as the teacher cares to use. A suggested and workable field trip schedule is as follows:

Trip I - Pond: Study of submerged and floating vegetation.

Trip II - Pond-Swamp: Study floating and emergent vegetation.

Trip III - Bog-Marsh: Study emergent and shallow water species

Trip IV - Edge of Bog and Woods: Study damp soil species and terrestrials.

One interesting collection that might be made is that of leaves from as many different plants as possible that are seen on one trip. These leaves should be stored in damp containers to keep them fresh until they are returned to the lab. There the students may make sections of the

leaves collected and compare leaf morphology as seen under the microscope. The differences in vascularization, parenchyma layers etc., are obvious when comparing aquatic specimens to terrestrial types.

As a final step in this field study, students should be urged to compare all areas studied and then, given one specific community, be able to forecast its future. If students are able to do this simple exercise, then they have grasped the fundamentals of plant succession.

Summary

In this study of plant succession from water to dry land, it may not be apparent to the teacher or the students just how conservation principles can be illustrated. After some serious consideration of the following principles, the teacher should have no difficulty in tying in field study with principles.

Soil conservation principles - A-3, A-5.

Water conservation principles - A-6, B-1.

Wildlife conservation principles - A-2, A-3, A-4, C-1, C-2.

Diagram I

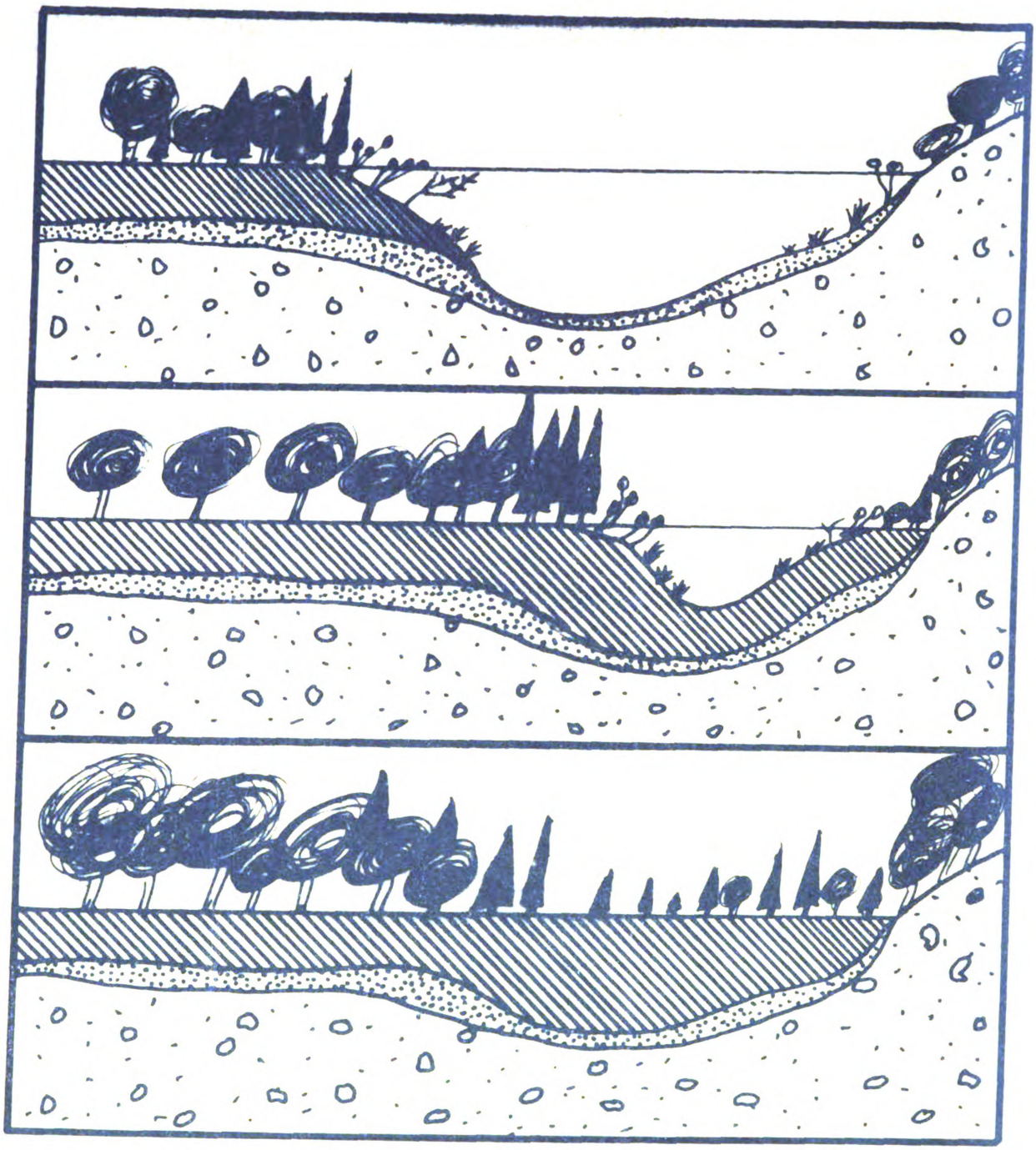


Diagram showing stages of peat deposits in lakes from open water with submerged plants to climax forests.

KEY

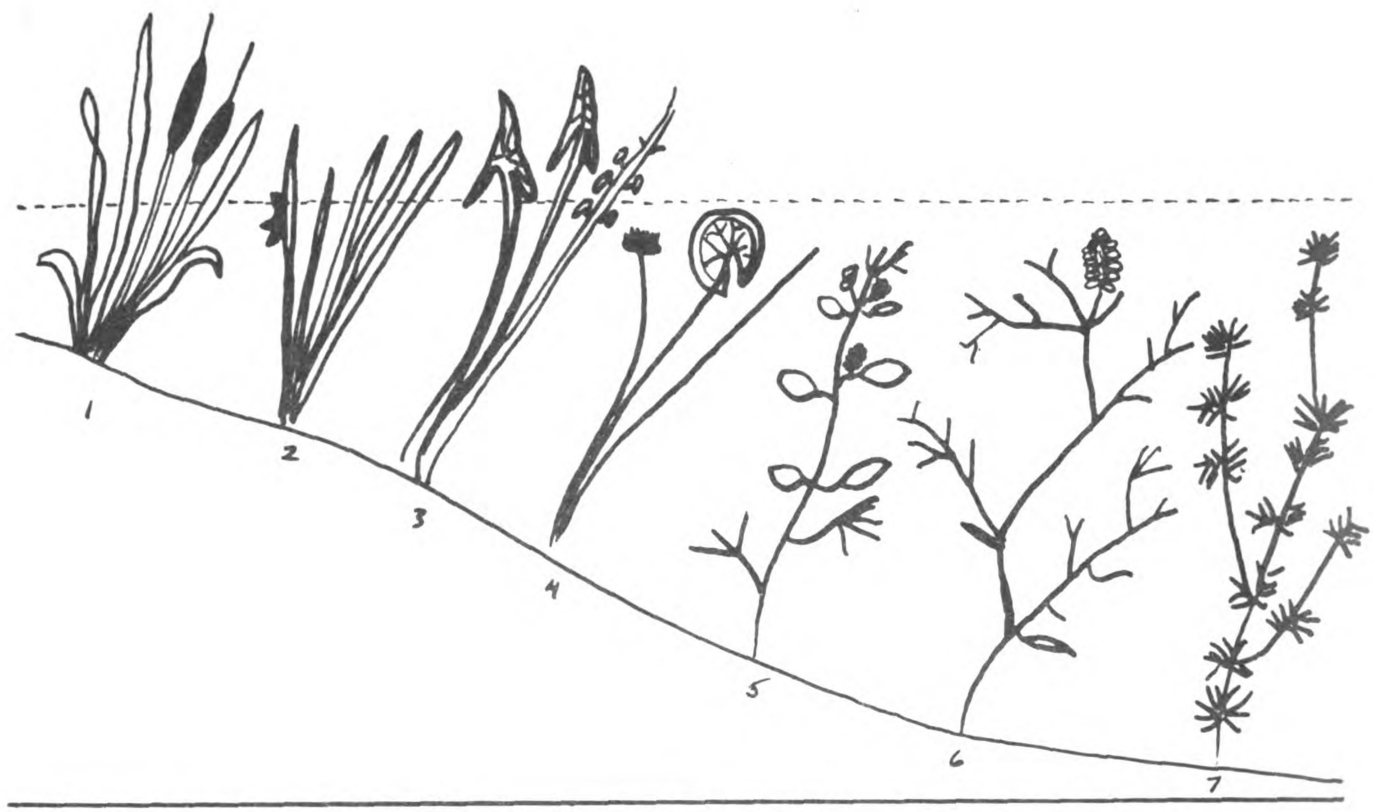
peat

silt

sand-gravel

From: Weaver and Clements, Plant Ecology, McGraw-Hill Book Co., New York, 1938, p.77.

Diagram II



Organisms diagrammed are:

1. cattail (Typha)
2. bulrush (Scirpus)
3. arrowhead (Sagittaria)
4. water lily (Nymphaea)
5. two species of pond weeds (Potamogeton diversifolia and
6. P. pectinatus)
7. muskgrass (Chara)

The above diagram illustrates some of the emergent and submerged aquatic plants one might expect to find in very shallow and deeper portions of a pond or lake.

From: Eugene P. Odum, Fundamnetals of Ecology, W.B. Saunders Co., Philadelphia, 1953, p.226.

Summary

It has long been known that students, especially those of high school age, learn by experience. This learn-by-doing idea has reached varying stages of success with many types of teaching-learning experiences. I have found that high school biology students are particularly susceptable to field work.

Students rapidly become aware of the learning possibilities in outdoor work if they are gradually introduced to field study through An Introduction to Field Work, (article one). The remaining articles in the series, if used in the order presented, enable the teacher to proceed from relatively simple field experiences to more complex and meaningful ones. Above all, I have used these studies with considerable success and student enthusiasm. These studies can be worked into any science curriculum either singly or in their entire sequence. The teacher has the material at hand and may use or improve upon it as he or she sees fit. I do believe, however, that there should be no hesitancy on the teachers part to use the material I present here. This affords the teacher with a start. The students will provide the rest.