TEACHING CONSERVATION THROUGH NINTH GRADE GENERAL SCIENCE

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By

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CHAPTER I

INTRODUCTION

The importance of conservation of resources to the continued welfare of the people of the United States has been fully recognized by certain governmental agencies. It has been recognized to a less degree by some educational institutions and businesses. Its significance has not reached the majority of the people in this country. The farm population is reached to a limited extent through radio programs devised for that purpose. They are further reached by government leaflets, county farm agents, university extension service, and conducted short courses. The greater part of our population is unaware of conservation except as it might effect their recreation such as a shortage of game or fish.

Several federal and state agencies have done much to remedy the problem of conservation but the majority of these projects have been on a very large scale and in restricted areas of an obvious need. The Tennessee Valley Authority, Boulder Dam, and the Civilian Conservation Corporation are such large scale functions but their proximity to the larger population is rather remote. It is

more difficult to make the people of Ohio, Indiana, Illinois, or New York aware of the need for soil conservation in their relatively fertile states than it is to make Oklahomans aware of a dust bowl.

There has been considerable legislation, both state and federal, in behalf of conservation but it has been of a very general nature and rather sporadic. The various game laws have been an effort in that direction but have often resulted in a disturbance of the "balance of nature."

It appears rather impractical, in the light of our way of life, to enact legislation of a compulsory nature for conservation practices. It is not easy, for instance, to force a farmer to handle his property in a certain manner. Then too, much legislation which in any way deprives an individual of "life, liberty, or property without due process of law" is always subject to challenge in the courts. Legislative action in behalf of conservation should be of a voluntary nature. Appropriations by government to set up educational projects seems to be one way to approach the problem.

It seems apparent that the need for conservation justifies an extensive program in the public schools. Some work has been done at the elementary level but a good program at the secondary level is needed. Compulsory teaching of conservation is probably not the answer either -

the experience of our own state of Ohio with regard to the requirement of the teaching of temperance is suggestive of its probable degree of success. Possibly the only feasible solution is to make the opportunity for conservation education available but not to make it compulsory so as to make it distasteful. The purpose of such a program would not be to develop trained conservationists but to instill in the students an appreciation of its practical applications with a conscious effort to aid its furtherance.

The relationship between man and the land in which he lives is one of the greatest problems of today. It is necessary that young people in our schools learn that their future is dependent upon natural resources protected by conservation. In order to present this topic to pupils in the schools, teachers must have a clear and purposeful understanding of it. Some provision must be made for the training of teachers in presenting this material. A recognition of this problem has been realized by the State of Ohio. The Ohio Division of Conservation and Natural Resources together with The Ohio State University and the State Department of Education have established a teacher's practical training program known as the Conservation Laboratory. This school, during the summer afford the teachers in service a chance to learn first hand, the

fundamentals of conservation. Some universities are also offering courses in conservation, having it as a major subject.

The Problem.

The purpose of this thesis has been two-fold: first, to show the need for conservation teaching in the light of the present existing state of conservation in respect to natural resources; and second, to prepare in some detail a teaching unit which will be helpful to provide in young adolescents a conservation consciousness and to give them a background of information and a realization of present and future conservation problems.

Limitations.

In this study but four of the natural resources are considered: soil, water, minerals, and vegetation. Wild life often given as a fifth natural resource is not included. Human resources are not considered, only in so far as all resources ultimately effect man. The unit that is prepared on the study of soil for ninth grade is not a course of study nor is it a resource unit. It is a teaching or learning unit that has been prepared for use in a rural-urban community. It stresses the one resource, soil, but all are so closely interwoven that not to mention the others in relation to soil is impossible.

Detailed guide sheets have not been prepared but information for carrying out many of the activities are given. The unit is somewhat flexible in use so no evaluation standards are given, each teacher must evaluate according to the use made of the unit.

Previous Studies:

A great amount of materials have been written on conservation and its relation to the school program. Much of it is on the elementary school level. Many of the State Departments of Education and Instruction, which have recently reorganized their curricula have recognized the importance of teaching conservation in the schools and have included it at various places in their course of study.

The United States Office of Education[1] has issued a bulletin which tells of the ways in which different schools throughout the country are dealing with the problem of conservation education. Ohio through the Division of Conservation and Natural Resources[2] have recently issued two large bulletins, with practical information and

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(1) William H. Bristow and Katherine M. Cook, Conservation in the Education Program.

(2) Ollie E. Fink, The Teacher Looks at Conservation Conservation for Tomorrow's America

teaching devices. The bulletins treat all phases of conservation. The suggestions are somewhat lacking in detail. The North Central Association have had prepared unit studies on conservation.(3) These units are approached from the social studies viewpoint. Some activities are given but they are not very explicit. It treats of all the natural resources.

Resource units, both elementary and secondary, on the various divisions of natural resources were prepared by students at the Ohio Conservation Laboratory, in the summer of 1945. These units suggest many sources of material and types of activities for preparing a teaching unit. A thesis by J.F. Frasch(4) develops a source unit on the conservation of soil. It includes many activities with much detail. The unit may be used for planning pupil experiences or for additional activities for interested pupils in any high school science class.

In examining these different studies it seems that very few if any are written to fill a particular need. Most of the studies are of a general nature with no specific setting in the school program. It further appears that a better program has been provided at the elementary than at the secondary school level.

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(3) Conway L. Rhyne and Ellsworth E. Lory, Conservation of Natural Resources.

(4) Joseph F. Frasch, "Conservation in the Science Program with a Source Unit on Soil Conservation," unpublished Masters Thesis, Ohio State University, 1939.

Organization of the Thesis

The materials in this thesis have been arranged in the following manner:

Chapter I Introduction

Chapter II Conservation - Its Need and Present Status

Chapter III Important Natural Resources

Chapter IV A Teaching Unit on Soil and Its Conservation

Chapter V Summary

Bibliography

CHAPTER II

CONSERVATION - ITS NEED AND PRESENT STATUS

What is conservation? The definitions for conservation are many and varied, ranging from a few words to several sentences. Some authors and lecturers use the word in a restricted sense, others use the word conservation with a much broader meaning. Originally the term was used to include those natural resources which man utilizes. More recently the term has been extended to include social, civic, and economic relations with all that concerns man and his development. Whenever we deal, then, with natural resources and their conservation, it is of value only to the extent in that it provides for the use of such resources for the greater welfare of the nation.

Definitions of conservation as used in our literature today are given, as follows:

Henry B. Ward states that

> Conservation demands the wise use and control of natural resources for the permanent good of all the people. It is something more than hatching pheasants or planting fish in what may be a vain effort to maintain a supply for an ever-increasing horde of predators of all sorts.(1)

(1) The Foundations of Conservation Education, The National Wildlife Federation, p. 175.

Rhyne and Lory offer this definition, "An effort to protect, to preserve, to replenish, and to use wisely our natural resources is called conservation."(2)

"The Yearbook of Agriculture," 1940, states that "Conservation in a democracy means wise use of resources for the greatest good of the greatest number in the long run."(3)

We shall assume that the latter statement means, then, that conservation must be concerned with more than the physical conditions of natural resources themselves. It means relating the management of resources to the welfare and increased betterment of the people as a whole.

> The problem of conservation, however, is not merely a matter of passing laws and taking measures to check erosion. Many erosion-control projects cost more than they can possibly save. Sound conservation implies careful consideration of the cost in each case.(4)

R. H. Eckelberry in his lectures at Camp Muskingum reflected that, "Conservation is not saving, but wise use -- why conservation? -- to give a more abundant life. After nature if it makes for a better life."(5)

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(2) C.L. Rhyne and E.E. Lory, Conservation of Natural Resources, p. 7.

(3) Farmers in a Changing World, United States Department of Agriculture, p. 421.

(4) Maxwell S. Stewart, Saving Our Soil, p. 30.

(5) R.H. Eckelberry, Lectures, Education 682, Camp Muskingum, Summer 1945.

Paul B. Sears, Oberlin College, states the basic principles of conservation as follows:

> Physically, human beings are interdependent with the world of other living things and the non-living world of water, air, and earth. From this environment human needs are satisfied. In meeting these needs, man changes the environment, often destroying its resources without providing for their continuance or renewal. He exploits living and non-living resources without regard for the future.
>
> This process has been particularly rapid in the United States. As a result, soil, water, forests, grasslands, and wild life have been depleted to the danger point. The consequences in many places has been a greatly lowered level of living. Much of Ohio, for example, is almost non-productive.
>
> If nature is not disturbed, plant and animal life will continue to build soil and hold it in place. Living cover and soil will retain water, preventing floods and regulation stream-flow. Wild life abounds under such conditions. The kind of plants and animals are adjusted to the variations of climate. Civilization reverses this process, with disastrous results.
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> It is the aim of conservation to restore and use these natural processes. This can be done by adjusting the use and management of land to the pattern of climate, soil, and topography without losing sight of essential human needs.(6)

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(6) O.E. Fink, The Teacher Looks at Conservation. p.5.

A knowledge of science and a trustworthy plan of its instruction must be forthcoming if the needs of man are to be satisfied and at the same time maintain a balance of living nature. To accomplish this balance we have laws to make people change their manner of living. But without public sentiment behind the laws, they will not function. Such was the fate of the Eighteenth Amendment. Another method is to try to bring about this change by teaching conservation in schools. But here again we run into difficulties, for children are much like adults in that they understand by what others are doing better than by what they are saying. The adult world will have to demonstrate that it is willing to put conservation practices into effect before the younger generation will heartily support the plan.

The approach that will be expected to bring about results, then, will be the one that combines these methods. P.B. Sears believes that "Conservation is really an attitude toward life, and a way of living."(7)

Conservation in the class room

In recent years conservation has been introduced

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(7) The Foundations of Conservation Education, Op. Cit., p. 44.

into the public schools. In some schools, conservation courses are set up as separate subjects. In other schools they are introduced not as new subjects, but as a point of view, or a method of departure in presenting the subjects already established in the curriculum. This latter method appears to be the most desirable and lends itself especially well to science and social science teaching.

Secretary of the Department of Interior, Harold L. Ickes, expresses his opinion about conservation teaching in this manner:

> There is no more important subject that can be taught our children than the preservation and use of our natural resources. It is fully as important as history or literature or political economy or domestic science or art or music.
>
> Conservation does not restrict itself to the protection of our forests and our streams and our fertile soil; it is equally concerned that the aesthetic and scenic features of our country should be preserved. I am sure that many will agree with me that those schools which fail to furnish the instruction and inspiration that come from an intelligent consideration of the subject of conservation are in reality as backward as the log schools of our great-grandfathers, however advanced they may think they are.(8)

The great variety and abundance of natural resources which are found in the United States have had a notable

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(8) C. N. Elliot, Conservation of American Resources, p. 32.

influence on the development of the nation. It would have been impossible for the United States to have grown so fast and to have become one of the great powers of the world today had it not been for this large natural wealth. The rapid growth of the nation has increased the demand on its resources. The development of the factory system increased enormously our capacity to produce which in turn created a greater demand for raw materials. Modern science has alaso found new uses for many raw materials which have further reduced our natural resources.

Because of our vast supply of resources the utilization of them has been carried on with waste and inefficiency. That they might become exhausted some day did not seriously concern the early settlers. There was always more and a new supply to the West. The pioneers should not be blamed too severely for this attitude -- seemingly unlimited supply of resources. They were confronted with the task of opening up a new land and had to provide themselves with the necessities of life. Today there are few frontiers to be exploited, thereby demanding conservation through education -- radio, garden clubs, farm women's clubs, service clubs, and discussion groups. The people of the future will not excuse the citizens of today for further neglect of our national heritage with which we have been so richly endowed.

The majority of the people of the nation were either unaware of or were indifferent to the early waste and exploitation that was taking place. Toward the latter part of the nineteenth century some scientists, and other men, with a vision to the future began to protest against the waste of our resources. The alarm that was raised against the waste of our resources spread, and the attention of the nation was directed to the necessity of conserving the resources that remained.(9)

Gradually has developed a movement for the conservation of natural resources which is becoming stronger as our forests, soils, and minerals show signs of exhaustion, and our water supply becomes critical.

In the past few years, more and more of the people of the United States of America have become aware of the future welfare of their country. We are learning that our resources are limited and that conservation must be established. This concern is felt by some in all classes of people. The welfare of all is dependent upon the country's resources and our use of them.

Businessmen and industrialists now realize that the level of economic stability lies in use of the natural resources of our country. They are beginning to realize

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(9) H.S. Patterson, A.W.S. Little, H.R. Burch, Problems in Democracy, p. 391.

that water is not only essential to agriculture, but industry as well. One of the first considerations for the location of a new industrial establishment is an adequate water supply. In many large areas of the country, the water table is constantly sinking. In Ohio many of the industrial districts are in constant threat of a water shortage. J.B. Johnson of Elyria, Ohio, Vice-President of Ohio Public Service, told in a recent talk before a service club how he became interested in the water shortage. He liked to meet and know the customers with whom he dealt, and on one of his trips through the country, he saw farmers hauling water for their livestock. This interested him in a selfish way, for if the farmers spent their money for hauling water, they would have less to buy his commodity. This led to the study of the reason why the farmers had to haul water. As a result, here is an industrialist who has become a conservationist as well. The above incident could be multiplied many times and in various ways to show how people are made conscious of the need for conservation.

Certain large organizations, realizing the dangers of resource waste, are already devoting money and effort to a campaign of investigation and education. They are in a position through finance and organization to spread an educational program rapidly and to a large part of the

people. But the seriousness and necessity of prompt and proper action must be realized by all, including the banker, the industrialist, and insurance man, the property owner, the schoolteacher, the factory worker, the farmer and their families.

The founders of "Friends of the Land" realized that the public must be taught the meaning of "conservation" and that the attitude of the public must be changed from one of indifference to that of active consciousness. In an effort to bring this about, the organization, "Friends of the Land" attempts to present the over-all picture for the necessity of using widely our natural resources by proposing to:

1. Foster investigation, research and experimentation in the science of land and water use.
2. Assemble information regarding the economic and social need for protecting our land and water.
3. Encourage the practice of land and water conservation by all.
4. Promote educational and other measures tending to the accomplishments of these objectives.
5. Carry on educational projects.
6. Cooperate fully with other national, regional, state and local societies to promote conservation.
7. Promote the insertion of the conservation viewpoint into the classroom work of our schools.

8. Arouse an apathetic and self-satisfied nation to the realization of the tragic consequences which are certain to follow the continued devastation of our soil and water resources by wind and water erosion and the exhaustion of underground and surface water supplies.

9. Encourage farmers to make the most of the opportunities they have under the various state enabling acts to band together in locally organized and controlled groups devoted to every kind of soil conservation.(10)

That the United States government is aware of the need for conservation and is doing something about it can be found by taking note of some of the agencies and bureaus of our Federal departments that are principally concerned with conservation. It is the purpose here to mention some of them without going into detail of their function.

In the Department of Agriculture we have: Agriculture Adjustment Administration, Bureau of Agricultural Economics, Extension Service, Farm Security Administration, Forest Service, Office of Land Use Coordination, Rural Electrification Administration, Soil Conservation Service.

In the Department of Interior we have: Bureau of Mines, Bureau of Reclamation, Fish and Wildlife Service, Grazing Service, Geological Survey, National Park Service, Petroleum Conservation Division.

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(10) Friends of the Land, p. 3. An undated pamphlet.

Independent Agencies of the Federal Government concerned with conservation are National Resources Planning Board, Tennessee Valley Authority, Federal Security Agency.

There are many agencies in the government of the State of Ohio that are concerned with conservation. The Division of Conservation and Natural Resources, which is under the State Department of Agriculture, is perhaps the best known by the general public. This agency is supported by license fees of hunters and fishers. It has charge of enforcement of fish and game laws, the raising of game, the stocking of waters with fish, the pollution of streams and many other duties.

The Department of Public Works, the Ohio Water Supply Board, the Department of Highways, the Geological Survey, the Division of Forestry, the Department of Health, the Agriculture Extension Service, the Agricultural Experiment Station, the Soil Conservation Districts and the Conservancy Districts are all agencies within the state that are connected in some way or another with some phase of conservation.

The importance of conservation practice and teaching is expressed in a proclamation made by the then Governor of Ohio, John W. Bricker.

> Conservation Education becomes a high patriotism. It is a patriotic duty to stop wasting our resources and to teach the best means of restoring those which are renewable, especially those so vital to life as soil and water. It is necessary that we teach the child that his future is dependent upon these resources. It is a distinct opportunity that is offered the teachers of Ohio in helping to win the war and to shape the course of the future of Ohio through Conservation Education.(11)

Some of the states require the teaching of conservation in their schools for a specified number of minutes each week. Others have not as yet reached this high a stage in conservation thought. Ohio in the past has been one of the backward states, but

> .....by comparison with near-by states, it may be said that Ohio is moving rapidly to take her place beside New York and Pennsylvania, Michigan, Indiana, and Wisconsin. All of these states have in some respects preceded her in developing broadly unified conservation policies. Ohio has started late in the day, after wasting much substance, but it is not yet too late.(12)

For many years past the only requirement for the schools pertaining to conservation was the Arbor Day proclamation:

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(11) O.E. Fink, Op. cit., p. 2.

(12) Paul B. Sears, History of Conservation in Ohio p. 22.

> Not later than April the governor of the state shall appoint and set apart one day in the spring season of each year, as a day on which those in charge of the public schools and institutions of learning under state control, or state patronage, for at least two hours must give information to the pupils and students concerning the value and interest of forests, the duty of the public to protect the birds thereof, and also for planting forest trees. Such day shall be known as Arbor Day.(13)

During the past six years, we have been doing a little better; the governor of the state has been proclaiming a whole week as Conservation Week in the school climaxed by Arbor Day of Friday of the week.

The alarm and realization of a greater need for the teaching of conservation in the schools of Ohio is evidenced from the Miami Workshop Report. The program for public school education in Ohio was worked out by some of the leading school administrators of the state at Miami University during the summer of 1944. One of the eleven chapters of the report deals with Conservation and Consumer Education.(14)

The report lists specific objectives which should be attained not in a specialized course, but through every subject and interest in the school program. Some of

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(13) Anderson's Ohio School Laws, p. 701.

(14) A Program for Public School Education in Ohio, Miami Workshop Committee, pp. 31-32.

these objectives are a concern for personal conservation, a clear conception of the exhaustibility of natural resources and the social and economic consequences that their depletion will have upon pupils as consumers. A greater emphasis on the importance of scientific research in finding substitutes for scarce raw materials and making greater use of by-products. The pupils should be stimulated and helped to more active and intelligent concern where policies on conservation practices require action.

The consciousness of a greater need for bringing conservation knowledge and practice to more and more of our younger citizens is realized by the National Education Association.

> The National Education Association, knowing that many natural resources essential to life are being depleted in an alarming rate, urges increased emphasis upon the teaching of conservation, and recommends immediate preparation of appropriate materials for this purpose.(15)

The above resolution was adopted by the National Education Association Representative Assembly at its meeting at Pittsburgh in July of 1944.

The need for conservation can be realized by big

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(15) The Journal of the National Education Association, November, 1944.

industrial organizations, by private organizations, by governments both federal and state, and by schools, but until this need is felt by every individual, the nation as a whole will not progress very far. Circumstances that were brought about by the war may help lead us in that direction. Rationing during the hostilities and the shortages that are still with us make everyone, to some extent, question why the shortage?

A.F. Gustafson of Cornell University expresses much the same idea in this way.

> A great need of our nation today is the development by the individual citizen a consciousness of the definite necessity for the conservation of our natural resources. Much of real value has been accomplished during the past three decades, but a wide-spread campaign of conservation education is imperative.(16)

The colleges and universities have taught conservation in a meager way for some years. Information concerning the need for conservation has been made in the public schools. The public school age group must be made to realize that their future needs of food and clothing and other necessities of life are endangered by the careless and wasteful methods which are often prevalent at the present time. If they are guided by instruction which presents this world picture to them as it is today, then, by the

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(16) A.F. Gustafson, et. al., Conservation in the United States, p. 14.

time they are able to vote, they can insist upon wise utilization of our resources.

An increasing interest in conservation is not due alone to a new economic understanding. A greater number of people have more leisure time. The technological advance in transportation has made places formerly inaccessible now available. People who love the outdoors feel the need to get away for a little while from their everyday work, and also have a longing to go where they can play. Many of our metropolitan areas have provided such places. "People are turning to conservation to preserve one of the basic American liberties, that of access to open country for recreation, including hunting and fishing."(17)

However, the increasing interest in conservation is not only due to the peoples' desire for outdoor recreation, but much of their interest has been stimulated by seeing the startling effect on human beings -- poverty stricken, ignorant -- when their land has been washed away, when their forest is cut over and saw mills shut down. They are finding in a real sense that "land is life," and that people who settle on poor land are naturally destined to live a poor life. Hence, their

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(17) Farmers in a Changing World, Op. Cit., p. 424.

interest is mainly in building up and conserving human qualities. Perhaps the American people are beginning to take their land seriously and to think of it as a place in which to live instead of taking the best of the resources and moving on. If their interest is not sincere, and if they do not apply or put to use wisely what they have found, the American people may some day find themselves with a very bleak and poor nation on their hands.

> In the past too often men and women have regarded all of our resources as being wholly unlimited. A realization that the opposite is true must be brought about by education.
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> Future generations have a right to expect that we shall pass on to them a country as little impoverished or depleted as possible. That we may accomplish this, the widest cooperation is essential between the Federal Government, the states, the great corporations, and the individual citizens.(18)

One of the responsibilities of the secondary school is that of giving the youth of the nation an understanding of the functions of natural resources and their conservation. It is important that students realize the way in which our natural resources have been and are being exploited, and of the problems connected with their conservation. Sight must not be lost as to the abundant life

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(18) A.F. Gustafson, Op. Cit., p. 14.

which resources make possible or the social and economic distress caused when they are wasted or ill-used.

Many attempts have been made to teach science from the materials which are found at hand, or from our immediate environment. Louis Agassiz's famous adage "Study Nature Not Books" is still an educational slogan. Often these various attempts, except in isolated instances, have not been lasting. Some believe the domination or influence that the colleges have on entrance requirements is one of the reasons for failure. Others feel that the training in the sciences that the teachers receive in universities for the work that they are to do in public schools is not conducive to practical use of materials at hand through local environment. Too often the high school course in science fails to inspire any form of original investigation.

Originally high schools were planned to prepare the young people for college. There has been a great increase in high school attendance over thirty or forty years ago. Today, however, when only about one out of five go on to college, our courses are taught much in the same manner as in the days when all were prepared to take college training. In our so-called democratic system of education, we should seek to meet the needs of the four who do not go on to college as well as the one who does.

There is no dearth of educational resources material in our environment which may be utilized in teaching conservation in our science classes. Materials found in one region of the country will vary in another. Materials available in an urban area will differ from those in a rural community. In the cities a study may be made of the subsoil and bedrock from a building excavation or the soil in a vacant lot may be examined. The gullies that are formed on a school lot after a heavy rain is another example. Bird life and squirrels are to be found in the parks. The insect life is abundant on weeds, shrubs and flowers in the city as well as in rural areas. There are trees to be found in every community. Rubbish, trash, waste paper, and garbage disposal are a problem wherever one might live. The rural or village school can readily study any aspect of conservation offered by the local environment.

Desirable materials not found in most of the science textbooks have been assembled by science writers in works which present the relationship and importance of science to man and his activities. The popular magazines often contain laboratory exercises that are more interesting and functional than those that are usually required in school nationals.

The lack of functionalism in our education is blamed upon the neglect of not selecting materials for teaching

from the every day experiences of the pupils. This has been a serious defect but the entire subject of conservation cannot be taught from the materials of the local area alone.

The small local area is a part of a larger community and depends on natural resources, scattered throughout the world, for existence. Large cities are dependent almost wholly on resources from distant areas. The problems of conservation that exist in rural areas are of vital importance to the city dweller but most often they are overlooked because of their invisibility.(19) To a certain degree, some of the problems are being realized recently as the city dweller becomes more conscious of certain shortages, such as mineral resources exploited to insure profitable production in factories.

> It is not that there is a lack of material for teaching conservation but the material is incomplete, disorganized and imperfectly related to the subject. To analyze and digest it appears a task beyond the time, energy and knowledge of the average teacher.(20)

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(19) George Renner, Conservation of Natural Resources, pp. 192-3.

(20) The Foundations of Conservation Education, Op. Cit., p. 220.

The fundamental importance of conservation or its right to be included in the school program will be questioned by few today, but the program of conservation as inaugurated by various agencies lacks uniformity in plans and agreement in objectives. Only by starting with elementary grades and continuing on into adult education with a singleness of purpose can an effective program of conservation be instituted. The agency powerful enough and in a position to do this is the public school. However, teachers are ignorant of the full significance of conservation, so they, too, must be enlightened.(21) To aid teachers, some of the best educational institutions in the country are offering special courses in conservation in regular sessions, summer school conferences, summer camp, and workshops. But the total registration at all of these is small in comparison to teachers called upon for such services.

In summarizing it is fitting to quote George W. Hunter, who has spent over thirty years of teaching and supervising in secondary schools.

> All living things including man are placed in an environment which is made up of definite factors. With these factors plants and animals react and interact. Some of the factors are material things: other factors are forces. The

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(21) Ibid., p. 205.

ultimate result of the complexity we call life is this interaction of the materials and forces with the living things on the earth. But man differs from other living things because he alone can control and change the factors of his environment.....In the midst of this world of new opportunities and science progress, children are growing up. Science beckons to them from every side and speaks in every new device used in the home for comfort and efficiency. Why, then, should not science have become the most important of all school subjects in order that it might interpret to the child the man-controlled wonders of his environment?

It is not that we lack the material with which to work, for science material lies in abundance at our doors, in our home, and round about us. The child of today is brought up in an atmosphere of practical science, and yet how many of us are explaining to him the problems with which he comes in contact in his daily life? .....Let us not be superficial. Let us teach scientifically. Let us make our laboratory a place for experiments and for thought projects. Let us train, above all, for straight thinking, but let us remember that the nation's greatest assets are the health of its citizens and the proper use and conservation of its resources. This means that courses in science should first of all interpret the environment of the pupils so that they may best prepare themselves for a sane and healthy life in that environment or for bettering of that environment, if it is humanly possible; and second, that the scientist of today should act as a leader in all school projects with application which make for human welfare and for faithful, intelligent and law-abiding citizenship.(22)

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(22) George W. Hunter, Science Teaching, pp. 12-13.

CHAPTER III

IMPORTANT NATURAL RESOURCES

In order to maintain life we must have food, clothing, and shelter. These three essentials of living have their sources in nature -- air, sunlight, soil and water. These sources are the support of all life -- human or animal.

Soil.

"Soil is that part of the earth that is specially suited for growing crops."(1) One hundred and thirty million Americans depend directly upon this soil for the three essential of living. One-third of these one hundred thirty millions Americans depend on this soil for a livelihood. Industry depends on this soil for approximately two-thirds of its raw materials.(2)

The United States was abundantly rich in soil, timber, and minerals when the Pilgrims landed, but today many of these riches are so greatly reduced that the

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(1) Rhyne and Lory, Conservation of National Resources, p. 11.

(2) Ibid., p. 11.

situation has become alarming.

> When the colonies declared their independence from England, the topsoil of what is now the United States averaged about nine inches in depth. Today the approximate average is five inches. That thin layer of soil is all that stands between us and starvation. When the topsoil goes, man goes. The desert is not thousands of miles away, but only five inches.(3)

Paul B. Sears discusses the loss of topsoil and the reduction of fertile land to deserts. Man must learn to keep this topsoil or perish. It is our insurance against starvation.(4)

A handful of soil looks dead to the average individual; yet it is actually teeming with life, with tiny organisms too small to be seen with the naked eye. These organisms are constantly active, breaking down plant materials and increasing fertility. Nature has been at work for millions of years making the precious topsoil upon which our very existence depends. Rain, snow and ice, wind, heat, and cold have been at work changing rocks into fine particles forming the subsoil. Uniting

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(3) Rhyne and Lory, Op. Cit., p. 12.

(4) Paul B. Sears, Deserts On the March, Chapt. XIII.

with these fine particles or mineral material has been vegetable matter and bodies of dead animals finally forming the topsoil.

A fertile topsoil abounds with such nurturing elements as air, water, and mineral matter, chiefly nitrogen, phosphorus, and potassium, plus hosts of infinitesimal bacteria which are constantly at work. These soil substances nourish the seed when it has been planted and release the inner life which results in growth. Without these soil substances, the seed would lie dormant or die. Seeds of wheat have been found in the tombs of Egyptian mummies, still dormant because they could not grow into wheat until life was released by the chemistry of the soil.(5)

The question now arises -- what has happened to the approximate four inches of topsoil lost since Revolutionary War days? Nature with her wind and water, and man with his activities are responsible for the destruction. It has been no simple process. Nature herself has seriously undermined many sections of our country, washing away immense quantities of topsoil yearly. " Each year three billion tons of topsoil -- enough, if loaded on freight cars, to make a train that would reach around

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(5) Katherine Glover, America Begin Again, pp. 23-24.

the world eighteen times at the equator -- is washed or blown from the croplands and pastures of the United States.[6]

> It has been estimated that erosion removes one hundred twenty-six billion pounds of plant food material from America's fields and pastures every year. This is more than twenty-one times as much as is extracted by crops, and entails an annual loss to farmers of $400,000,000. Altogether our soil has suffered approximately 10 billions dollars' damage as a result of erosion, and the loss may reach the staggering total of 25 or 30 billion in another fifty years if the process of deterioration is not checked. By that time a large section of the United States would be as barren as the once fertile fields of North China.[7]

Erosion is also increasing the costs of maintaining highways and railways by about $280,000,000 a year.[8]

For millions of years the forces of nature have been gnawing away on land surfaces; mountains have been worn away and valleys cut deep. This gnawing or erosion, a slow process, is beyond the control of man. What is now beyond the control of man in man-made accelerated erosion of land. Usually under natural conditions the topsoil is not washed nor blown away faster than it is rebuilt,

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(6) Rhyne and Lory, Op. cit., p. 13.

(7) Stewart, Maxwell S., Op. Cit., p. 2.

(8) L. A. Hawkins, Help Save Productive Soil, p. 4.

grasses and forests prevent loss. The balance of soil depleting and soil building forces is upset by man. The pioneers started to break the balance by clearing forests and plowing the soil to build homes and grow food. Then rain and wind began their devastation, unchecked by natural barriers.

If the land had been properly treated by man, much of the damage would not have resulted. The "Dust Bowl" originally was grazing land for great herds of buffalo; then followed early settlers who grazed their cattle on open range. Next came the homesteaders who plowed under the grass to raise wheat. Grass had held the topsoil in place, but when the rainfall failed and the soil lost its moisture, the wheat failed to hold the topsoil. Dust storms were the tragic result.(9)

Soil depletion results from the chemical extraction of chemical elements from the soil, from the breakdown of soil structure or from the actual removal of topsoil. Crops gradually remove minerals from the soil; methods of tillage and rotation have an important effect upon soil structure; and unchecked erosion by wind or water can remove the entire body of the soil. The readiness with which the topsoil depleting process start to work,

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(9) Rhyne and Lory, Op. cit., p. 22.

and the absence in the past of adequate measures to check those processes have resulted in a rapid and serious change in the fertility and productivity of much of the soil of this country. It is a significant fact that 75 per cent of our total cropland is now subject to soil erosion. Even this figure does not reveal the full significance of the problem of erosion to the individual farmer. Land he possesses, which is failing in productivity will destroy his earning capacity and livelihood. Part of the land now in crops must be set aside for pasture and reforestation if further deterioration of soil through erosion is to be checked. This policy is one of the basic principles of the soil conservation program.

Louis Bromfield states:

> .....Through erosion, bad farming methods governmental indifferences, and ignorance on the part of the people, the income in our nation and the assets which make the income possible, have been constantly in a progress state of destruction for the past one hundred years.
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> Let us take a farm of 160 acres which is about the average size in the United States. A hundred years ago it was covered by forest and sod which protected the soil and husbanded the rainfall. In the succeeding years, forest or sod was destroyed and the topsoil was allowed to wash or blow away until now in 1942, the farm has become practically desert land. On it stands a ruined house built long ago out of the profits of the once rich land. The barn, deserted and neglected, has fallen down. The place is deserted, the fields barren and unable to produce enough per acre to keep a bird or a rabbit alive.

Then let us examine what that means to our economic structure.

Once that farm supported, fed and clothed a family ranging from eight to twenty people. Once it produced grain and potatoes, fruit and fat cattle, chickens, eggs, milk, butter, and countless other products. Once the farmer who lived there borrowed money from time to time from banks; he paid insurance premiums; he paid taxes. Once the family which lived there bought clothes and machinery, books, shoes, etc., all out of the revenues from that piece of land. Today that piece of land pays no taxes, no interest to banks, no insurance premiums, buys none of the products of industry and produces no food. More than that, the family which it once supported has become a liability as well; it has taken to the road in a jalopy, seeking work where it can be found, on relief for more than six months of the year, becoming instead of a producing asset of the nation a grave economic liability. There is also the social aspect of the disaster, that the children of the roving family which once lived on that farm grow up without a home, without proper education, without moral background to become future citizens of the United States.

This is a single farm. Mutiply this case by three or four million and you can see the disastrous effect upon the nation. Each year the number of these ruined farms increases. During the past ten years, it is estimated that we had a wandering, dispossessed, unemployed, rural population of about 6,000,000 men, women, and children. War booms may take up the slack of unemployment, but the problem is a permanent one of increasing gravity to the Nation. In some of our agricultural states, notable those which produce single crops like wheat, cotton, tobacco, or corn, seventy-five percent of the rural population has already been dispossessed through the destruction of the soil. The condition of most of those who remain is so bad from poverty and wretched diet that in some cases they are worse off than those who have taken to the road.

> Remember that the misfortunes of this particular family are not confined to it alone. The small town banker's business is diminishing to nothing in some areas. Because that land no longer pays taxes or produces wealth, you and I have to pay more taxes and higher prices. Because of that family which is on relief for half or more of the year, you and I have to reach into our pockets for more taxes to pay for their food and shelter. These hard facts have nothing to do with politics or New Deals or anything else. They are fundamental, and the growing disaster can be cured only at the source.(10)

There is the economic problem of the moving farmer -- the one who is primarily interested in obtaining all he can from his temporary farm. There is also the economic problem of certain rural areas where farmland of a high proportion is unfit for production. These are critical economic problems and the American individual will need to recognize them as being an integral part of the Soil Conservation program.

Erosion, man-made depletion through cropping and leaching are the three plagues of America. They are as deadly to the nation as a World War and the control of erosion is never ending. Soil erosion is like a cancer, the longer it goes unchecked the more difficult it is to stop, but indifference is shown by many farmers. Leaching is the result of bare cropland and can happen when the land is level and water is allowed to stand on it, thus dissolving essential minerals.

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(10) Louis Bromfield, Primer of Conservation, pp. 7-8.

"Bare ground left by the plow will have as much soil washed off in ten years as the unbroken prarie will lose in four thousand."(11)

The ideals of farming people erode first, then, the fields. We have the technical knowledge to stop erosion and maintain the fertility of the land but until it is used by the people, erosion will take place. A poor country school is as sure a sign of erosion as a large gully down a sloping field or hill. The farm land surrounding it may still be good, but the school is a rivulet which will grow into a gully. Children suffering from such substandard environment will not look upon the land as a heritage. Poor churches, poor roads, lack of conveniences also create erosion because they create dissatisfaction with farm living. If we as a nation are to maintain a permanent agriculture, we must start by promoting on the land which is attractive and satisfying; a life which makes soil protection a natural and desirable goal for farmers.(12)

In soil conservation, the people are first and the soil is second. As a nation, we usually think of our

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(11) Paul B. Sears, Op. cit., p. 3.

(12) Arthur Moore, "Saving the Soil," Atlantic Monthly, April, 1945, p. 88.

social and economic problems in terms of patchwork after the damage has been done. Our way is to build a dam after the gully has been cut. The time to stop more gullies and more rural problems is now, and the way to look at agriculture is in terms of the people who live by it. We need the technicians, but first we need farmers who have the vision to see what is needed.(13)

"He is the greatest patriot who stops the most gullies," said Patrick Henry and after one hundred and fifty years, America suddenly heard the words. More than a decade ago in "The Farm" Louis Bromfield had old Jamie say in bitter prophesy,

> Someday there will come a reckoning and the country will discover that farmers are more necessary than traveling salesmen, that no nation can exist on any solidity which ignores the land. But it will cost the country. There'll be hell to pay before they find it out.(14)

There are many signs that the awakening has come. Protection of the land certainly belongs on any list of fundamental conclusions about farming for an industrial society. The danger is that we shall adopt the language

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(13) Arthur Moore, Op. Cit., p. 89.

(14) Louis Bromfield, The Farm, p. 342.

of Jefferson's agrarian philosophy, speaking in comfortable generalities about saving the land while all the time the land is being misused. Right now there is a hopeful balance between intellectuallizing and action.(15)

A nation wise enough to see the importance of soil conservation should also see the importance of starting at the beginning -- the individual American.

The United States began as a food exporter, and the belief in surplus has deep roots in our past. Because we paid for our industrial system on the returns from exported food, the idea is firmly imbedded in our business thinking.(16)

"During the past twenty-five years, the population has increased about a third, but during the same period our total production of food and feed crops increased only a seventh," said M.C. Bond, a Cornell economist. Professor H.C.M. Case, head of the Agricultural Economics Department at the University of Illinois College of Agriculture, carried the scholar's view to the 1943 convention of the Illinois Agricultural Association. One of

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(15) Arthur Moore, Op. cit., pp. 84-87.

(16) Arthur Moore, "Pushing the Hog from the Trough," Atlantic Monthly, Dec., 1944, p. 89.

the fundamental reasons for the wartime food pinch, he declared was the failure of production to keep pace with population over the past thirty years. "In fact, for fifteen years prior to the present conflict the imports of food products into the United States exceeded our exports in value."(17)

If the decline in production as related to population is news in farmers meetings, it may seem even more strange to city dwellers. The idea that we are a country of great exportable surpluses will be a long time dying.(18)

It is just as humane to save people from discouragement and possible destruction in the dust bowl and flood areas as it is to save others from a storm at sea. And it is certainly as economical to call out our man power to save our land heritage from constant destruction as it is to call out the Coast Guard to save sea going property.(19)

A bank is robbed of fifty thousand dollars and every paper in the country carries headlines. Ten lives are

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(17) Arthur Moore, Op. Cit., p. 89.

(18) Ibid., p. 91.

(19) The Role of Education in Utilizing Regional Resources. p. 6:2.

lost in an accident and again the headlines appear. Our soil, upon which nearly one hundred thirty million people depend is robbed at the rate of four billion dollars a year, and the fact remains almost unnoticed.(20)

The great battle to save the soil began in 1929 when Congress made a small appropriation to the Bureau of Chemistry and Soils of the Department of Agriculture for the establishment of ten Soil Erosion Experiment stations in as many major agricultural regions of the country.(21)

The present conservation program is a complex one. Soil differences, sectional variations, types and practices of farming, cropping systems, topography, climate and many other factors play their parts and have to be considered in working out the best plans. Conservation needs and practices vary from farm to farm, from acre to acre.(22)

Our leading conservationists say there is a means by which we may save ourselves and it is the duty of every American to interest himself in the subject of

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(20) Katherine Glover, op. cit., p. 36.

(21) Ibid., p. 45.

(22) L. A. Hawkins, op. cit., p. 13.

soil conservation. It is a problem which directly affects every citizen of the United States.

SOS --SAVE OUR SOIL

Water

If we had eyes powerful and penetrating enough, we could see that everything that lives is swimming in a sea of water. The tissues of the plants we eat are three-fourths water -- our own human bodies and those of animals are 80 per cent water.(23)

Water is not only an actual part of living things, but great quantities are necessary to production, and the continuance of life. Nature has been lavish in her supply of water, but she failed to give us water and land in the right proportion in a great many sections of the earth. Our United States has been especially blessed in this respect with our ocean boundaries, Great Lakes, rivers and streams. There is only one area, a marginal area between the 95th and 103rd meridian, which is semi-dry or subhumid. Two-thirds of the nation's rainfall occurs east of this area and one-third falls west of it.(24)

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(23) Katherine Glover, op. cit., p. 89.

(24) Ibid., p. 91.

As we have wasted our heritage of soil, we have also been careless in our use of water.

Water is nature's most mysterious resource; it is continually changing form and place; it is never still, never the same. Between the earth and the air there is a constant change of water -- precipitation, the downward movement, and evaporation, the upward movement. There is also the constant give and take of streams, rivers, and oceans. In water is concealed power.

Some of our rainfall drains into streams and rivers. This is called "surface run-off." Soil absorbs another part of the rainfall with the surplus flowing off beneath the surface of the ground. Stored water is the friend of the soil, of all plant life. Even beneath the reservoir of ground water there is still a deeper zone where water trickles into every crevice of rocks. This storage space alone contains enough water, it has been estimated, to cover the United States seventeen feet deep.(25) The total supply of water is constant; only its distribution can be upset and unbalanced. Our constant misuse of the soil and destruction of the forests through the years has upset the balance and hastened the return of rainfall to the ocean from whence it originally came, -- thus hurrying

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(25) Katherine Glover, op. cit., p. 94.

nature's cycle. When this has occurred, water has been robbed of its usefulness to mankind. What are these services to mankind? Water feeds his land and crops; it provides him with navigation, with power for lights; it contributes to his recreation. Life is dependent on water, not only in quantity, but also in quality.

Water is our own inexhaustible national resource. Water covers a large proportion of the world's surface; below the earth's surface lie other equally vast stores of water; water is ever present in the air coming from surface evaporation of bodies of water, from the ground, from the breath of animals and plant life. This atmospheric moisture is ever changing, with recondensing as dew or hoar frost or rising into the air where eventually it vaporizes forming clouds. Clouds may be kept suspended as air currents but if the support fails, the water contents of the clouds fall back upon the earth as snow or rain.(26)

Rainfall is normally a beneficial thing, for it returns to the earth the moisture needed by animals and plants. Where the earth has its normal cover of vegetation, the rainfall is held in the soil where plants may use it and water is slowly released to streams and rivers, where it is available to animal life. Wherever man,

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(26) Frederic Nordsiek, "The Natural History of Water," Nature Magazine, June-July, 1945, p. 314.

through his blundering, has stripped the land of forests, vegetation, and grass, the rainfall starts its deadly process of erosion, -- the wasting away of fertile topsoil. Streams and rivers become clogged, impeding navigation, brooks run dry destroying water for animals to drink.

Paul B. Sears tells us:

> Water from the oceans is constantly being drawn up, falling on the land as rain, and finding its way back to the oceans again. This is the Water Cycle. One of the best ways to prolong it is to keep the ground covered with growing plants and living animals. Bare ground hastens water on its way. And when water moves rapidly, it does damage. Highways and other engineering works need to be planned with this thought in mind, and a naked field must be regarded as more indecent than a naked human being.(27)

In the areas, both east and west of the subhumid section of our country, we have had great catastrophes during the past few years due to Nature's distribution of rainfall. In the eastern area, there have been floods in the western area droughts.

Flood waters tearing through our valleys bringing devastation and havoc were first merely rain drops multiplied by millions and millions. The place to control these millions and millions of raindrops is where they

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(27) The Foundations of Conservation Education, Op. cit., p. 46.

first fall upon the earth. Many conservationists believe that halting this rainfall upon the land by methods of erosion control and wiser cultivation will reduce the flood peak along many of our streams 15 to 25 per cent.

Droughts are even more of a calamity than floods; they are more difficult to combat. A single severe drought may change the history of an entire region. The fight against drought in the West is under way, -- great dams have been built and vegetation increased.

Water in nature only rarely contains materials unfavorable to life, but where man enters the picture conditions are changed. Our waters have been polluted by waste materials seriously affecting fish and animal life, and drinking water in many areas.

> The greatest waste of water is caused by its wide spread pollution which not only destroys its biological value, but also transforms what is normally the primary and indispensable stimulus at the source of all life into an active agent for the destruction of life.(28)

Water resources and climate are intimately related and associated. The industries and ways of life are very different in various regions, depending on ample snow or rainfall. In certain areas of the United States, the only item lacking to make desert waste into rich agriculture

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(28) The Foundation of Conservation Education, p. 167.

land is water. Human life and activities are more vitally influenced by water than by almost any other resource.

Water is a primary resource in the controlling of all life. It plays a fundamental role in shaping the external world.

Minerals.

Fertility of the soil may be maintained or restored if the topsoil has not been destroyed by erosion; water is an inexhaustible source; forests can be regrown; fields and streams may be restored with bird, game and fish. Mineral alone stand as our one non-renewable resource. They may be exhausted and are non-reproducible. Why is this? Because millions of years were taken to produce them.

Unlike the living, moving things, mineral sources are depleted year by year no matter how much we safeguard them. Yet modern civilization is founded upon them. Without coal, oil, snd metals, we should be shooting waterfowl and one another with bow and arrows, living fifty centuries in the past.(29)

Civilization today is dependent on mineral resources as never before in history. Minerals in the form of metals of building materials, and of fuel "form the keynote

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(29) Stuart Chase, Rich Land, Poor Land, p. 192.

of this era." Minerals in the form of metals and petroleum derivations form both the machine and the driving force. America has been blessed above all other single countries in the variety and abundance of its mineral deposits.

No country in the world can match us in the variety and abundance of our minerals. From the earth, our great storehouse, we provide half of the total value of all the world's mineral production. In other words we produce nearly half of the mechanical energy of the world. Our mineral wealth is second only to our agricultural wealth. If we accept the present estimates of ten horsepower available per person in the United States, it means that each person would have the incredible mechanical equivalent of no less than four hundred slaves at his beck and call, doing what never could have been done by hand.(30)

We have become the most mechanized and highly industrialized nation of the world. The fuel cost is lower than in other countries. Our mineral resources have been a prime factor in helping the nation achieve its present status, and have effected the ways of living of the whole country.

To an even greater extent the presence of a commercial deposit of mineral is a major item in influencing

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(30) Richard Lieber, America's National Wealth, p. 37.

the ways of living in its vicinity. Life in a mining camp, for instance, is very different from life in port cities or in agricultural communities. The degree of prosperity changes as the demand and price of the mineral fluctuates. People realize that when the mine runs out they must move on. Mining is a hazardous task and this fact is noticed in the personalities of the workers.

In "company towns" the people's lives often are directed by the mineral and its owners to a degree unbelieved to those unacquainted with such conditions.

Minerals may be classified into three groups; metals, such as gold, silver, platinum, iron, zinc, copper, tin, nickel, lead, magnesium, chromium, radium, tungsten, mercury, beryllium and many more; non-metals such as clays, fertilizers, asphalt, quartz, asbestos, mica, and others; mineral fuels, such as natural gas, coal, and petroleum. The war is making unprecedented demands on our mineral resources. This is a significant fact and emphasizes the need for conservation. Fortunately, steel, the backbone of war materials comes from iron ore of which we have a large supply. Many other minerals are vital also to the war effort.(31)

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(31) Rhyne and Lory, Op. cit., p. 91.

> Wars are fought to get possession of minerals, so that nations may have the raw materials with which to arm and equip themselves to fight further wars. Italy and Japan are among the hungriest of nations in respect to minerals. It was partly to meet a mineral hunger that Italy invaded Ethiopia, that Japan raided China, and that Germany seized Austria.(32)

Stuart Chase, noted conservationist, gives the following scale for the United States to aid the individual in his knowledge of need for conservation of various materials.

1. Superabundant minerals about which we need not worry: sand, clay, abrasives, gravel, stone, cement, arsenic, aluminum clays, gypsum, salt, borax.

2. Minerals abundant enough to cause no immediate worries: bituminous coal, low grade iron ores, barite, fluor spar, magnesite, molybdenum, potash, and others.

3. Materials which are running thin and require care: anthracite coal, antimony, phosphate rock, and others.

4. Scarce materials which call for active conservation: petroleum, natural gas, lead, zinc, mercury, tungsten, and vanadium.(33)

Mr. Chase also declares that

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(32) Katherine Glover, Op. cit., p. 185.

(33) Stuart Chase, Op. Cit., p. 195.

> If we had intelligence enough to maintain a World Raw Material Control, many of the reasons for modern warfare would evaporate, and concern about minerals would greatly be lessened. Each nation would know that it would receive its fair share of the available world supply.(34)

Until that day comes, we shall need for our nation a national planning in wise use of mineral resources. As the richest ore disappears, costs must rise. Waste has accompanied nearly all mining. The "blowing off" of gas in oil fields still continues at an alarming rate. The economic loss in energy value of the fuel itself is enormous; gas equivalent to 48,000 tons of coal daily is wasted in the Texas Panhandle -- more than enough to operate all the steam generators in the land.(35) In the process of "skimming the cream" much lower grade materials is lost forever. Re-mining in most cases is unpractical or impossible. It is obvious that our mineral resources cannot last at the present rate of exploitation.

Fortunately, not all the substances taken from the earth are lost even though they may no longer serve their original purpose. This salvage and reuse helps to

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(34) Stuart Chase, Op. Cit., p. 196.

(35) The Role of Education in Utilizing Regional Resources, 1939, p. 8:3.

postpone exhaustion of much iron and steel and copper.

The junk man is one of our most active conservationists.

> The minerals that we have mined to win the war have bankrupted some of our most vital mineral resources. Without the mineral resources, the United States could never have turned out the implements of war that we did. We should be convinced by now that our supply of mineral resources is not inexhaustible or irreplaceable. The greater we grow in industrial strength the more rapid are our minerals used up.
>
> Taking an inventory of our mineral resources, we mined some 5,000,000,000 tons of mineral between January 1, 1940 and January 1, 1945. Here are some figures that will give an idea of the amount of our mineral resources that the recent war has cost us.
>
> 3,061,060,000 tons of coal
> 516,158,500 tons of iron ore
> 2,278,000 tons of lead
> 3,642,000 tons of zinc
> 5,000,000 tons of copper
> 14,169,000 tons of bauxite
> 17,118,000 tons of sulfur
> 3,155,000 tons of potassium
> 1,000,000,000 tons of petroleum
>
> besides 15.7 trillion cubic feet of natural gas. While the United States has but 30 per cent of the known oil reserves of the world, we have been furnishing 60 per cent of the petroleum used in the war. If we are to continue as a world power, we must question ourselves not so much what we have used, but what we have left.(36)
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> No phase of conservation is more controversial than the subject of mineral resources.

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(36) Harold L. Ickes, American Magazine, Dec. 1945, "The War and Our Vanishing Resources," pp. 20,21, 128.

> Estimates, for example, of the oil reserves of the United States vary so much among experts that any effort to formulate a constructive policy becomes most difficult. Technology is changing rapidly, and with it the nature of mineral requirements. There are many experts who sincerely oppose any attempts at restriction, believing that scarcity stimulates technical advances. Certain of the mineral industries spend large sums to keep in touch with legislative action which they feel might have an adverse effect. A recent expense account for such a lobbyist in one of the North Central States included hotel bills averaging over $2,000 a month.(37)

Since minerals and national welfare are so closely related, it would be wise for the federal government to take a more active part in their control. Whenever the accidents of market threaten to force private business into exploiting mineral resources, the government should be able to use public money to counteract these influences. Private industry in return should be required by the government to cooperate in preventing waste of resources.(38)

Vegetation.

To manage our forest lands as a public trust and to make the best possible use of all public and privately

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(37) Paul B. Sears, History of Conservation in Ohio, p. 17.

(38) Rhyne and Lory, Op. cit., p. 96.

owned forests in the United States is a problem which captures the imagination of many men. Forestry, to our national foresters, means making the fullest use of the land consistent with economic practicability. It means an adequate supply of timber and its products to meet domestic needs, along with a surplus for exportation. As a basis for many private forest activities and industries, it would provide the economic foundation for many American communities in whole or in part.(39)

The forests of yesterday covered half a continent. Out of them America has been built. If these forests had been used wisely we would still have a tremendous capital wealth and not depleted forest areas. We could very nearly solve our land-use problems, and many of our economic problems. During the past century, our population has doubled every thirty years. More people meant more use of wood.(40) Richard Lieber states, "When populations were small and resources abundant, no crganized efforts were ever put forth to conserve natural wealth. Abandoned waste always characterized such periods.(41)

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(39) Farmers in a Changing World, Op. cit., p. 458.

(40) Katherin Glover, Op. cit., p. 145.

(41) Richard Lieber, Op. cit., p. 91.

When we consider these facts, we immediately see the need for forest conservation. Sustaining and increasing the annual yield and restoring forests to land that have been depleted is a big problem and one that will not easily be solved. Private owners of forest lands, as a rule, have not been cooperative in protecting forests from fire, pests and disease, or to reforest its cut-over land. The public has been unwilling to pay the price of proper management and reforestation.(42)

Man's devastation, careless use, and exploitation of our forest lands have not been the only reasons for depletion, and are not the only reasons for the conservation movement. Nature, herself in the form of fire, disease, and pests has caused the loss of many forest areas. Fire is the tree's greatest natural enemy from the time it is only a seed in the ground till it stands tall and straight in the forest. Forest fires existed even before the white man came, but have increased many fold since man's entrance into this country. Stuart Chase estimates the average annual loss of forests through fires as about $75,000,000.(43)

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(42) The Role of Education in Regional Resources, Chapter VII, p. 2.

(43) Stuart Chase, Op. cit., p. 125.

Fire acts quickly while most of the fungus disease of trees act slowly. The alert forester generally sees them in time to control them. Most of them do little harm, but occasionally, some species attack, killing thousands of trees before the forester is aware. For example, there is a tiny beetle which attacks the lodge-pole pine. A few beetle scouts flying ahead of the main body first attack the trees, with the main body arriving the next year. These beetles, not more than one-fifth of an inch long, bore in between the bark and wood and form a girdle around the tree, and proceed to do their killing.(44)

Our American forests have many functions to perform and these functions must be developed to their fullest extent regardless of private or public ownership. Wildlife preservation demands constant and greater planning; the recreational value of our forests is important, and desirable land for this purpose must and is being secured; the use of forest areas as grazing land for sheep and cattle owners is also a function, but must be carefully regulated or erosion may result; the value of forests for water-shed purposes is almost if not as important as the value of the timber. The forest is the most natural and the best storage reservoir of water

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(44) Rhyne and Lory, Op. cit., p. 54.

that can be provided and forests maintained on high ranges and steep slopes produce an even flow of water. No one denies the value of forests as a source of timber supply, but much must be done in proper management to sustain the yield and to keep all related industries on an even basis.(45)

This interesting example of what may be done in reforestation by proper management is cited. In reforestation of land that had formerly supported hardwood forests, we now plant pine trees. The pine is not a native of such places. Why are pines planted? Very much for the same reason that weeds enter the bare spots in overgrazed pastures or on other barren soil. Reforestation is practiced on land that is eroded and almost sterile; there is very little nutritive value left in the soil. But there is enough for the pine to grow. As the pine grows, it shades the ground, allowing moisture to accumulate and the needles form humus matter. The seedlings of the hardwood now have enough shade and moisture to get a start. In a few years, the hardwoods will be higher than the pines. The shade of the hardwoods will cause the pines to die, and a hardwood forest will again be established.

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(45) The Role of Education in Regional Resources, Chapter VII, p. 76.

Without trees we could not carry on our daily existence; without trees, birds, big and small game have no protection, no home, without trees fishing streams dry up and aquatic life suffers; without trees our hillsides and slopes would become desert lands.(46)

In 1934 the dust storms in our western states continued for days. Within a year, over this same region, the rainfall increased to a higher degree than it had ever been previously. The time of drought changed to one of floods. The fields that had been parched and partly blown away were now marked with gullies. On the praries, where grass held the topsoil in place, in the forests where the trees remained, neither drought nor flood produced their havoc. This observation should make it clear that grasslands and forests should be regulated "because they represent sources of return under all conditions."(47)

The waste of our timber has been and still is tremendous. It has been estimated that through logging operations one-fourth is wasted directly. Losses estimated from thirty to sixty per cent are added when the logs go to the mill. This destruction has been going on

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(46) Richard Lieber, Op. cit., p. 100.

(47) Paul B. Sears, Op. cit., p. 231.

since American lumbering started in the New England States. All talk of conservation is futile as long as this condition prevails.(48)

Human greed and carelessness are the reasons for the suffering of all humanity. These two sins affect each one of us now and will later cause our children to suffer even more. We may fulfill the prophecy of the sage: "Where there is no vision, the people perish."(49)

One-third of our commercial forest land is an integral part of farms. Too often farm woodlands are mismanaged and subject to heavy cutting due to the need of supplemental income by the farmer. Benefit payments to farmers for improved forest practices are a part of the agricultural program of the Federal Government, but have not yet assumed great importance.(50) Many private owners of woodlands have been slow to accept good forest practices because of lack of knowledge. Some farmers do not observe good practices because of high taxes. In most states, forest land is taxed according to the value of the timber on that

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(48) Richard Lieber, Op. cit., p. 103.

(49) Ibid., p. 109.

(50) "New Forest Frontiers," U.S. Department of Agriculture.

land. The man who tries to grow timber or practice good forest habits is penalized by having to pay more taxes over a longer period of time than the man who cuts his mature timber. Various ways have been worked out to make the tax on timber land an aid to conservation rather than a destructive measure. The best tax system worked out so far is the differential property tax which puts the tax on timber land lower than on other types of property, the amount of reduction being based on the number of years the timber has been standing.(51)

The Federal Government owns 170 million acres of national forests which are managed by the United States Forest Service, a division of the Department of Agriculture. The principle of this department is "multiple use," i.e., the greatest number of uses for the greatest number of people.(52)

It has been observed that public ownership of our forests has been wise in its guardianship. Some conservationists feel that government ownership is the only way to save our forests. The democratic principle is that conservation should be voluntary, but it is clear that what the private forest owner does with his trees is of

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(51) Ayres Brinser, Our Use of the Land, p. 197.

(52) Ibid., p. 199.

great concern to many others besides himself.(53)

Science and research tell us that though the forest has contributed to our industrial advancement amazingly, we have really seen nothing yet, for great wonders are in the offing.(54)

The grasslands of our land are the buffer between civilization and desert land. Yet many people are only conscious of grass as being a covering of beauty for the earth. Enemies of the grasslands through the years have been cattle, sheep, and the plow; back of these three has stood man. Early cattlemen and sheep herders realized that overstocked ranges would eventually kill the sod. However, since they only possessed grazing rights from the government, rather than title, there was that temtation to take a profit where it was possible to get it regardless of the results. The third and worst enemy of the grass is the plow and tractor which have overturned the soil and exposed the earth to the ravages of wind and rain; the results being gullies and dust storms.

A lonely sheep herder in Texas expresses himself:

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(53) Katherin Glover, Op. cit., p. 162.

(54) Richard Lieber, Op. cit., p. 98.

> It's a screwy life. But anyway you get the open air. You get time to get acquainted with yourself. You get use to the grass. And grass is what counts. It's what saves us all -- far as we get saved. Men and towns, and such as that, don't amount to a particular damn nohow. Grass does. Grass is what holds the earth together.(55)

This sheep herder in his simple philosophy gives us the inherent policy of soil conservation.

The role of plant life as harbinger of other life can be illustrated by the lichen. Its growth starts on a barren rock where it can endure extremes of light, temperature and moisture. During its growth it produces an acid which dissolves the rock upon which it lives, also by contraction and expansion it breaks up the rock surface, small though it may be. When the lichen dies its dead parts along with the particles of rock, form soil for other plants which could not gain root or survive where the lichen has been able to do so.(56)

Weeds have a place in our environment though often overlooked. Weeds can grow on soils where more desirable vegetation is desired. They, like the lichen, can stand extremes of temperature and moisture and besides live on

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(55) Stuart Chase, Op. cit., p. 117.

(56) Paul B. Sears, Life and Environment, p. 107.

a meager diet. They provide a cover for the ground which will hold moisture and contribute waste material when they die. The environment is changed and the soil now "becomes hospitable to more permanent types of organisms than the weeds which first invaded it."(57) In fact, a mixture of weed seed with grass and clover seed was used on the Ohio Conservancy dams north of Dayton. Today there is a good sod where at first there were only weeds.(58)

Plants do not occur scattered indiscriminately over any part of the land. Individual species of plants will, for the most part, occupy definite habitats. They will be found only where the conditions are such that they are able to grow. Conditions were such that other things could grow on the grasslands of the prairie and forest covered slopes. Through bitter experience, we have learned that this type of vegetation was not good conservation practice. We are just now beginning to restore the type of vegetation to which the land is best suited.

A fitting close for this chapter on resources is the Eleventh Commandment, which was suggested by Walter C. Lowdermilk, Chief of Research, Soil Conservation Service,

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(57) Paul B. Sears, Op. Citation, p. 108.

(58) Paul B. Sears, Deserts on the March, p. 131.

Thou shall inherit the holy earth as a faithful steward, conserving its resources and productivity from generation to generation. Thou shalt safeguard thy fields from soil erosion, thy living waters from drying up, thy forests from desolation, and protect thy hills from overgrazing by thy herds, so that thy descendants may have abundance forever. If any shall fail in this stewardship of the land, thy fruitful fields shall become sterile stony ground and wasting gullies and thy descendants shall decrease and live in poverty or be destroyed from off the face of the earth.(59)

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(59) Walter C. Lowdermilk, "The Eleventh Commandment," Reprinted from American Forests, January, 1940.

CHAPTER IV

A TEACHING UNIT ON SOIL AND ITS CONSERVATION

For Ninth-Grade General Science
Approximate Time: Two to Three Weeks

A reasonable degree of learning may take place even when the student feels no specific need for the subject being learned. Today there is rather general agreement that the conditions necessary for learning are more favorable when the learner experiences a feeling of need for the subject-matter.

In many instances subject-matter is assigned without attention to any need felt by the pupil or for a clarification of any experience. The lessons often seem unfair tasks assigned by the authority of the teacher, the execution of which appears needless. If the task is done at all, it is performed in many instances without interest. The student is given no choice as to how the work is to be done. Opportunity for originality or responsibility is not offered the student.

It seems reasonable that by more progressive teaching methods the compulsory type of teaching can be reduced. There has been a tendency to reorganize both

content and method of instruction on the basis of psychological units rather than by so called logical procedure of subject matter. The unit emphasizes the taking of responsibility by the student, in larger tasks than that of daily assignments.

The larger unit assignments are expected to leave more of the planning and the carrying out of the work to the student. The learning or teaching unit makes an effort to produce learning situations taken from everyday experiences, where the endeavors of the pupils are stimulated by a need or desire, rather than by the arbitrary assignment of textbook tasks. The role of the teacher then becomes that of a guide in helping pupils to carry on their various activities.

As a means of providing worthwhile experiences in this unit a series of activities have been given. The activities have been classified under the following headings:

A. Demonstration
B. Discussion
C. Appreciation
D. Creative
E. Reading
F. Excursion

It should be pointed out that although activities are listed under one heading they might have fitted equally well under another type. An activity that involves drawing or illustrating while listed under creative is also an appreciation activity for the rest of the class. Some of the reporting activities are also reading activities although not so listed.

It is not expected that all of the activities will be done by each member of the class. Some of them may not be done by any member of the class, and others may be added. When a small group or an individual performs an activity that the whole group does not do, a report of that activity probably would be presented to all members of the class. In this way some knowledge of the activity would be attained by every pupil.

The activities are so designed that some are suitable for individuals, others for small groups and still others for the class as a whole. At the end of the chapter is a bibliography of books, pamphlets and encyclopedias that are pertinent to the unit. Following many of the activities references are made to the bibliography where suitable material may be found. Pupils should be encouraged to try different types of activities. Those with creative ability should try some types where other abilities are used, and those with apparent small creative ability

should try some of those activities by which creative ability is developed.

Overview

All life whether plant or animal, is dependent on the soil. There are few problems, if any, of greater importance to the nation than the problem of the soil and its care. Topsoil is the farmer's principal asset, and it is upon the fertility and productiveness of this top soil that all business ultimately depends. Productive farm land is indispensable to man and to all business, and none can survive if there is no fertile soil to produce crops for food.

There are a little less than two billion acres of land in the United States. Hugh Bennett, Chief of the United States Soil Conservation Service, estimates that the United States has 610 million acres of tillable land. Of these approximately fifty million acres have been ruined by erosion for further cultivation. Another fifty million are in almost as serious condition. There are one hundred million acres which are still in cultivation that have been seriously effected by erosion, and about one hundred million acres more that are being rapidly depleted.

In the early days of American agriculture there seemed to be a limitless supply of new fertile land.

If the farm wore out the farmer was not alarmed. He could move farther west to a new one. Today there is no large area of new land to move to. Something must be done to conserve the soil that is left.

The losses from erosion are realized first by the farm families, but the results finally affect everyone. It is estimated that the farmers of America have an annual loss of four hundred million dollars from erosion.

It takes years to make one inch of fertile top soil as nature does it. Over most of the land today the average is five inches. Up and downhill plowing, continues single-cropping, overgrazing and deforestation have hastened the rate of soil erosion.

For over fifty years a few men have seen the need and fought for soil-saving programs. National awareness of this problem has come about only recently. Because of past exploitation of the land it behooves us to take care of what is left. If not we are likely to face a serious land shortage for crop production.

Objectives:

1. To gain an understanding of how all living things, including man are dependent on the soil.

2. To teach the origin of the type of soil in

in the community and how it compares with other soil types.

3. To teach what the effects of natural forces and the activities of man have on the land.

4. To acquire a knowledge of the practices that are useful in soil replenishment and erosion prevention.

5. To help the pupils develop an increasing sense of responsibility in regard to the resources, especially the soil in the community.

Outline for the Unit on Soil and Its Conservation

Soil: Its Formation, Composition and Conservation

I Its Formation

A. Rocks from which soil is formed

Sandstone

Limestone

Shale

Granite

Feldspar

B. Agents of Formation

Water

Wind

Plants

Animals

Glaciers

Temperature change

C. Deposition

Residual

Transported

Water - wind - glaciers

II Its Composition and Physical Makeup

A. Physical and Organic

1. Rock particles

2. Water

3. Air

4. Decayed organic matter - humus

5. Living organisms

B. Texture

1. Gravel

2. Sand

3. Clay

4. Loam

5. Silt

6. Muck

C. Chemical Composition

The elements that are essential for plant growth.

III Its Conservation

The two main phases of soil conservation is (1) to keep the soil in place and (2) to improve what is left.

A. To keep it in place

Most noticeable erosion is in the formation of gullies, but loss of soil by sheet erosion is the more serious, not only from the standpoint of amount lost, but because one is so unaware of the loss. Even upon a one degree slope the loss may be large.

1. Contours
2. Terraces
3. Grass waterways
4. Strip cropping
5. Planting steep slopes to forests and pasture.

B. Improve what is left.

To improve the soil scientifically it is necessary to know why it has lost its fertility and then take measures to compensate for this loss.

1. Loss of fertility

a. Erosion or soil washing
b. Cease to hold water properly
c. Cease to grow bacteria properly
d. Loss of organic matter
e. Nitrogen and lime leached or washed out.
f. Using up of plant food by continuous growing of one crop.

2. Methods of renewing soil fertility

a. Increasd acreage of pasture and cover crops
b. Inoculation with bacteria when legumes are grown.
c. Green manuring
d. Use of commercial fertilizers, lime, and manure.
e. Rotation of crops
f. Growing crops that are suitable to the soil.

Approaches:

1. A display of rocks from which soils are derived.

2. A motion picture from the State Department of Education, Slide and Film Exchange Save the Soil, Grades 7,8, 2 reels, a general presentation of the problem of soil conservation.

3. A talk to the class by the County Agricultural Agent on Conservation.

The purposes of the approaches given is to motivate the learner. Call attention to the fact that we are about to start a unit on soils. Here on the desk is displayed some rocks from which our more common soils have been formed. An explanation follows as to the type of soil that is formed from the examples displayed.

To morrow we will have a sound film entitled "Save the Soil". The running of this film will not take the entire period, so be thinking, while viewing the picture, of some questions that you would like to ask concerning anything that is not clear to you. The remainder of the period after the running of the film will be spent in answering questions and a discussion of the film.

The rest of the period today will be spent in discussing the field trip which will be taken day after tomorrow. The types of observations that the pupils should be expected to find are then pointed out. The route to be covered has been well planned and gone over by the instructor beforehand.

Field Trip to observe the action of different forces on Soil Formation

The trip should be made if possible in the open country where a stream can be found. Look for the action of water. Notice the undercutting of the banks of the stream. Find a place where the stream bends. Observe the greater cutting action on the outer side of the bend. Where is the spread of the stream slowest? Observe the deposit of eroded material and where it is located in relation to the stream velocity. Examine pebbles in the stream bed. Account for their shape. What becomes of the worn-off material from the pebbles.

If small rivulets are running into the stream find those that are entering from different types of terrain such as sod, ploughed ground, wooded hillside and row crops. Catch some of the water from each and evaporate on returning to the school, noting the relative amount of residue from each. From your observation what type of covering is best for preventing soil erosion?

Look for the action of the wind. Is the dust blowing? Where does it come from? Where does it go?

There are several actions of plants to observe. Examine some soil to see if it contains any parts of plants. Can one find any places covered with weeds? What becomes of the weeds? What becomes of the leaves that fall from the trees? Look for a flattish gray-green, brown or blackish plant found in irregular patches on rocks and bark of trees. These are lichens and are very essential in the breaking up of rocks to form soil. The growth of plant roots when they penetrate into the crevices of rocks and splint off pieces of rock is a soil forming agent to observe.

The action of animals is another force in soil formation. The earthworm is considered of value in this respect. Observe its action. Insects, many of which are injurious when living contribute to the soil when they die. The manure of grazing animals contribute humus and fertilizer to the soil. Burrowing animals are another contributing factor. Be on the lookout for as many of these as you can.

Oxygen, carbon dioxide and moisture are the chief factors of the air in aiding soil formation. Can you find rocks which appear rusty? Iron occurs in many rocks and in its contact with the oxygen of moist air "rusting" takes place. Many rocks are crumbling on the outside due

to long exposure to the atmosphere and to the extremes of temperature, find examples of this on your trip.

To best understand the principles to be undertaken in soil conservation it is necessary to gain an insight of how the soil is formed and to learn some of the physical and chemical laws to which it is subjected.

A series of activities follow which are given as a guide to further arouse the pupils interest in soil conservation and to aid the teacher in planning his teaching in such a unit. The writer realizes that it is impossible in the classroom to carry on true to life experiments as one would in the field, but demonstrations involving the principles of such practices are possible.

The class period following the field trip will be devoted to performing some teacher demonstration activities which will later be done by the pupils. These demonstrations concern the make-up of the soil and are listed under A activities below.

The demonstrations that are then performed by the teacher are those dealing with the moisture, humus, air, capillarity and retentivity of water, and acidity of the soil. A activities respectively 3 c,d,e, 7 and 13.

After the demonstrations the instructor informs the pupils that they are each to bring a soil sample the following day. A pupil in town can bring one from the

lawn or garden spot. They will then perform with their samples what has just been demonstrated. Instruction is given as to the method of taking a soil sample. See unit bibliography, F.J. Salter,

Soil Testing Have each pupil bring at least a two quart sample. Put it in a clean container and label it with their name. Two quarts will be needed if all the activities requiring soil samples are performed.

Enough apparatus will not be available for all pupils to be doing the same thing, with their sample at the same time. While one group is measuring and weighing, another may be determining the acidity or the amount of air.

As the results of the various samples are posted on the bulletin board, in such manner that comparison can be made, it will be found that some are low in humus content. This should bring out questions. Why is the humus content in my sample so low while it is high in another sample? Where was the sample taken? How can the humus content be increased? What is green manuring? Does barnyard manure have any advantage over commercial fertilizer? Another sample does not retain its water well. How about the amount of humus it contains? Maybe it has more gravel and sand in it than other samples. Try some of the same sample by sorting the soil as to particles,

activity A 11. It may be that the results shown by this activity can give an answer to the question. When and if this stage is reached the teacher is well on the way to extend the unit with further activities.

A Demonstration or Experimental Activities

1. Collect samples of different soils and display in glass bottles.

   Secure as many kinds of soil as you are able to find. Try to get a range from very gravely soil to one that is made largely of humus such as muck or peat. Display in four or eight ounce bottles labeled as to type and where found.

2. Obtain leguminous plants and examine the nodules on the roots. Compare with non-leguminous plants.

   The original source of all nitrogen is the air. Nearly four-fifths of the air is nitrogen. There was little, if any, nitrogen in the rocks from which the soil was formed. The nitrogen has been added to the soil largely through

plants. . . . Certain plants, the legumes, can use the nitrogen from the air in the soil and combine it into forms that can be used by the plant . It should be noted that no plant takes in nitrogen through its leaves. When legume plants decay, their nitrogen is left in the soil.

The bacteria that live on the roots of legume plants work their way under the outer covering of the root and there begin to multiply. This causes nodules to form on the roots. These nodules may be seen if the plant is dug up and the dirt carefully removed. The plant should be dug up not pulled for when pulled the nodules are usually broken off as the roots come up through the soil. The nodules found on different kind of legumes vary in number and size. Cowpeas and soybeans have fewer, but larger, nodules than do the clover plants. Nodules may not be found on all legume plants because the necessary bacteria may not be present in the soil. If the bacteria are not present then the plant must get all of its nitrogen from the soil just as any non-legume plant. It is very important then to notice if the legume plant is really doing the good that it should be doing.

See E.E. Slosson, Creative Chemistry

H.J. Waters, Essentials of Agriculture

A.J. Pieters, Legumes in Soil Conservation Practice

3. Composition of Soils

a. Kind of particle

The purpose of this demonstration is to show the different kinds of particles of which a soil is composed. Examine under a strong magnifying glass samples of the various types of soil. Notice the different kind of particles and the shapes of the particles.

b. Put a handful of ordinary loamy soil into a fruit jar or milk bottle nearly full of water and allow it to stand for a day or two shaking occasionally. At the end of this time shake very thoroughly and after allowing it to settle for a minute, pour off the muddy water into another jar. Allow this to stand for about an hour and then pour off the water and evaporate it slowly, being careful not to burn the material left. Examine the three substances thus separated with the eye, by rubbing between the thumb and fingers, and with a magnifying glass. The three separates will be composed largely of sand, silt, and clay.

Mix a small bit of the silt and of the clay in drops of water and put these drops on glass

slides and examine under the microscope. Notice the little black particles of decayed vegetable matter, also the little bunches of particles that may still cling together. What are these black particles? Are they of any benefit to the soil?

c. Moisture

To find the amount of water that is held by the soil take about a quart of soil from a few inches below the surface of the ground and after sifting out the large chunks, put it in a sheet iron pan and carefully weigh it to the fraction of a gram. Place the pan containing the soil in a drying oven or an ordinary oven, the temperature of which is but little above one hundred degrees centigrade. The soil should be spread out as thin as possible. Allow it to remain in the oven for some time until it is perfectly dry. Weigh again. The loss of weight will be the weight of the water contained in the soil. As there was no free water in the soil how was this water held? Dip your hand into the water and notice how the water clings to it after it is withdrawn. Examine with the eye and a hand lens several particles of the original soil as taken from the ground and see if there is a water

film on each of these as there was on the wet hand. Of what value is this hydroscopic water? The fineness of particles effect the amount of film water. Does this cause a greater amount of dissolved mineral matter to be available?

The little root hairs are adapted to take up these films of water which surround the soil particles. Small amounts of soluble material have dissolved in the water, thus the plant in growing obtains the minerals that are necessary if present in available form.

d. Humus

Take the soil that has been dried and weighed in the preceding experiment and heat it throughout to a red heat over a Bunsen burner or in a very hot oven. Weigh again. The further loss in weight is due to the burning of organic matter such as rotten twigs, roots, and leaves. Soils differ greatly in the amount of water and organic matter present. It should be of great interest to carefully compare the samples, brought in by the pupils, in this respect when they have tabulated their results. What is the value of humus in the soil? Is it essential for plant growth? Many people make it a practice

to burn over their field before replanting. Is this a reasonable thing to do? What results will it have upon the wild animal life another conservation feature closely related to soil conservation?

e. Air

Fill an eight ounce bottle with soil as before taken from a few inches below the surface. Fit the bottle with a two-holed rubber stopper having the long tube of a three or four-inch funnel pushed as far as possible through one hole and a bent delivery tube just passing through the other hole. Be sure there is no air space between the stopper and the soil. The soil in the bottle should be as hard packed as it was originally in the ground. Push a wire down through the stem of the funnel to free all hard-packed particles of soil in it.

Connect the delivery tube with a bottle of water inverted in a pneumatic trough. Pour water into the funnel until it is full, and keep it full during the rest of the experiment. Allow the apparatus to stand for several hours. Air from the soil will displace the water in the inverted bottle. When the soil in the bottle has become entirely saturated with water compare the amount of air collected with the volume of the bottle containing the soil.

Air is needed if plants are to thrive and it is necessary that soil air be changed frequently. The soil must be ventilated. If water excludes all air from the soil, most crops will drown as a person drowns. Aside from its direct use to crops, soil air is essential in several indirect ways. It is necessary for soil organisms to remain active. It is from the soil air that leguminous plants secure free nitrogen for crop use. Do you see any connection between this demonstration and the necessity of crop cultivation?

f. Bacteria

It is estimated that in a fertile soil there are millions of microscopic organisms in a small bit of soil. If a microscope capable of magnifying five hundred diameters and up is available, bateria and other organisms may be examined. Moisten soil with water, take a drop of water that has filtered through the soil and place on a glass slide and examine. It may be possible to see some of the larger microorganisms but there are many that are not visible even with the microscope.

4. Eroding power of water

You have observed how muddy or dirty looking a stream is after a heavy rain. It can be demonstrated

in the laboratory that the eroding force is due in great part to the particles of soil it carries. Prepare two troughs several feet long and three or four inches wide. Line the sides and bottom of these troughs with gelatine. Prepare the gelatine as directed on the container. When the gelatine has "set" in the troughs cut a small winding channel in each trough. Run heavily silted water through one trough and clear water through the other. Compare the amounts of gelatine that have been removed. Can you see the connection between this demonstration and the conservation practise of checking the rate of water flow upstream?

5. Show water and soil loss with different coverages by dripping water exhibit.

This exhibit is done by making three boxes, three feet long, eight inches wide, and four inches deep. Fasten a screen at the lower open end of each. Fill one box with soil but bare, another with sod, and the other with soil in which oats or corn have been planted and are sprouted to a height of one or more inches. Place the three boxes on a table and block up the unscreened end to make a slope. Sprinkle equal amounts of water at the high end of each

box. Collect the soil and water washed from each. Make charts showing the relative amount of erosion and water runoff of each. Vary by changing the degree of elevation. What kinds of crops are most severe on land from the standpoint of erosion and water retention? In a similar way, muddy streams are carrying valuable soil to lakes and oceans.

Reference: H. Wales and H. O. Lathrop
Conservation of Natural Resources

6. Determine weight of different soils

To show how soils vary in weight and texture obtain samples of gravel, sand, clay and garden loam. Measure exact amounts of each one half pint, and weigh. Make a record of the results. Examine as to texture and describe differences you observe.

7. Water retention and capillarity

To show the variation in water-retention power and capillarity of different soils, line as many glass funnels with filter paper as you have soil samples and arrange in a stand. Fill each funnel with one of the dry soils and place beakers beneath the funnels. Rapidly pour over each a measured equal amount of water. Record

the time required for the water to pass through the different samples.

Empty the funnels, line with fresh filter paper and fill with more of the same dry soils as before. Place simultaneously in full beakers in such a way that water reaches up to the soil contained in the filter paper. Observe the rapidity in which water is absorbed upward. Continue the observation to see if the rise continues through the soil to the top at the same rate.

An alternate method to show the retaining power of soils is the use of flower pots of the right size to fit into the tops of tumblers. Fill the pots with different kinds of dry soil. Stand each pot in a tumbler. Fill a graduate with water. From the graduate pour some of the water into a large salt shaker, and from it sprinkle water slowly on the surface of the soil in the first pot. As soon as water begins to drip into the tumbler below, stop sprinkling, and pour back into the graduate any unused water. Calculate the amount of water the soil absorbed before allowing any to pass through.

In the same way sprinkle water into each pot, keep a tabular record of the amount of water absorbed by each kind of soil.

Soils vary in their holding power of water. Clay soils will hold more water than will sandy soils. Organic matter holds moisture well. Peat, which has a good percentage of organic matter, will hold more moisture than clay. The value of soil depends to some extent upon the sub-soil. Sometimes the sub-soil may not let the water through and the soil will drain slowly. Again the sub-soil may be gravel or sand and the water will drain out freely. Sandy soils warm up more quickly in the spring than silt or clay soils, because the water drains out faster and more air can get into the soil. On the other hand sandy soils are more affected by drought.

References:

H. J. Water The Essentials of Agriculture

F. E. Bear Soil Management

Soils and Men Yearbook of Agriculture 1938

8. Determine the presence of soluble minerals in soil

A chemical analysis of the soil does not tell what fertilizers are needed. It does tell how much food there is in the soil but cannot tell how much the plant is able to get. To illustrate, a soil may contain enough phosphoric acid for a hundred crops and yet the addition of phosphoric acid may be a good thing, because that already

present is not in soluble form. It is necessary to know something about the cropping system, how the soil has been previously handled, and any problem that the area has that is peculiar, before a trained soil analyst can make recommendations.

It should be made clear that the testing done on student soil samples are not done with the authenticity of that of a trained analyst. In doing such testing as is done by the student a greater respect is gained for one who is trained.

To a fifty gram sample of air-dried soil add one hundred ml. of distilled water and one gram of lime. Shake and mix thoroughly. Filter and save the filtrate for the tests that follow.

Nitrates: Put in a test tube two or three ml of diphenylamine solution. Add fifteen to twenty drops of the filtrate obtained above. The appearance of a dark blue color indicates the presence of nitrates. An estimate of the amount of nitrates present can be gained from the shade of blue obtained. The diphenylamine solution is made by adding two grams of diphenylamine to one hundred ml of concentrated sulfuric acid.

Ammonium nitrogen: To five ml of the filtrate

add one ml of Nessler's solution. A yellow to brown color indicates the presence of ammonium nitrogen. The solution may be warmed gently to aid the reaction.

An alternative test is to mix a portion of air-dried soil with an equal quantity of soda-lime and heat gently in a Pyrex test tube. The presence of ammonia is detected by the odor of the fumes given off.

Sulfur: To about ten ml of the filtrate add two or three ml of barium chloride solution, the formation of a white precipitate which is insoluble in hydrochloric or nitric acid is indicative of the presence of sulfur in the form of soluble sulfates.

Phosphorus: It is possible to test for phosphorus in soil by simple chemical means but the test does not necessarily tell if the phosphorus is in a soluble form available for plant food. The following test then is the show if phosphorus is present.

Place five grams of air-dried soil in a beaker, add ten ml of nitric acid cover with a water glass and heat for ten minutes. The nitric acid oxidizes to phosphoric acid all the phosphorus compounds present. Add a few drops of the

solution to ten ml of a solution of ammonium molybdate and warm gently. The formation of a yellow precipitate indicates the presence of the phosphate ion. The precipitate is soluble in ammonium hydroxide but insoluble in nitric acid.

Potassium: Boil one-half teaspoonful of air-dried soil with fifteen ml of distilled water and five ml of hydrochloric acid. Filter and evaporate the filtrate nearly to dryness. By means of a clean platinum wire, with a loop in one end, bring some of the filtrate into the outer film of the base of the Bunsen flame. If potassium is present a characteristic violet color is imparted to the flame.

By adding sodium cobaltnitrite to some of the filtrate a yellow precipitate is formed, this gives a more quantitative test for potassium.

As a student in the ninth grade has not had chemistry the performance of this activity and the one that follows will be performed by students in the upper grades of high school who have had Chemistry. This is good educational practice too for it gives these older students a practical application of some techniques they have acquired.

References: F. J. Salter Soil Testing.
La Niotte Soil Handbook

References (cont.): Any Laboratory Manual in Chemistry.

9. Determine the mineral content of a fertilizer.

Thoroughly shake a fifty gram sample of a commercial fertilizer with one hundred ml of distilled water and filter. Test the filtrate obtained for nitrates, ammonium nitrogen, sulfates, phosphorus, and potassium as in the preceding demonstration. This may be done for several brands of fertilizers. Are the fertilizers tested complete fertilizers? How do the results obtained by the tests compare with the analysis as listed regarding elements present? What do the formulas on bags of fertilizers signify? An explanation might be given at this time as to the meaning of the chemical formulas.

References: Oswald Schreiner, Albert R. Merz, and B.E. Brown, Fertilizer Material

F.E. Bear, Theory and Practice in the Use of Fertilizers

10. Effect of texture on capillary rise of water in soil

How the texture of the soil effects capillary rise of water is compared by tying or taping over one end of each of five glass tubes three-fourth to one and one-half inches in diameter and two feet long. Fill one with finely sifted and pulverized

clay, another with finely sifted sandy-loam soil, and a third with sand. Tar each gently and in the same manner in order to settle the soil equally. Pour four inches of finely sifted sandy-loam into the fourth tube, and insert enough finely cut straw to fill in for two inches then pack the straw with a stick. Finish filling the tube with the fine sandy-loam. In the fifth tube put clods instead of straw to serve as a barrier to the rise of capillary water, but do not compact with the stick. Support each tube upright with the cloth-covered end in a pan of water and observe the height to which the water has risen in each soil at the following intervals: five, ten, thirty, and sixty minutes and longer intervals of several hours and several days.

Plot curves of each to show results. Observe that water will rise by capillarity much higher in the finer soils such as clay and loam. It rises quickly but not so high in the sand. How does the cut straw and clods effect the rise? Is there any reason for having the seed bed of a farm crop in fine condition?

11. Mechanical sorting of soils.

To observe how soils are sorted according to the size of particles of which they are composed

select several types of soil including gravelly soil, sandy-loam, peat-loam, and clay. Weigh out the same quantity of each, about twenty grams. Using long glass tubes of the same diameter and length, all stoppered at one end and each containing the same amount of water, place one sample of soil in each tube. Shake well, stand in upright position, and observe at intervals, to see the way in which the soil settles in each case.

12. The erosive force of wind

To show the erosive force of wind on soil make two gently sloping hills, one covered with sod or grown up with grass from planted seed, and the other bare soil. These are more easily handled if made on a strip of plywood or thin board. Move the one that is covered with sod or grass into the path of a wind blown by an electric fan. Follow by bringing the bare slope into the wind but be prepared for the results.

Wind is necessary to man yet it can be very harmful if man does not do his part in keeping it from carrying away the topsoil. Can you see any relationship from this demonstration and what has happened in the "Dust Bowl" where the land was covered by grasses for years until men moved in and began to plow the land?

13. Mulches for the conservation of soil moisture.

Water rises toward the surface from the lower layer of soil by a force called capillarity. A large amount of water can be lost in this way, particularly when the weather is dry, warm, and windy. The water from the soil is thus wasted in crop growing. To prevent such loss of moisture to plants during the growing season a mulch is used. Any loose material over the soil is called a mulch. The type of mulch depends upon the crop and the extent to which it is grown.

To illustrate thus in the field find a board or stone that has been lying unmolested for some time. Turn it over; is the soil dry or moist underneath? Now examine the soil under a strawpile or a rotten log. Is it dry or moist? Explain the conditions of moisture found in each case?

As a laboratory demonstration take a lamp chimney, tie a piece of cloth over one end and fill with clay soil. Stand the chimney in a shallow pan of water. When the water has risen to the top sprinkle about an inch of very dry, finely powdered dirt over the wet surface. Do not pack it in any way. After several hours, see if the water has come up through the dust layer. Now make a compact hole into the

layer with your finger. Notice if the water has moistened the layer where it has been compacted. Draw conclusions as to why row crops are cultivated. What is the objective of compacting the soil over seeds when planted? Why is peat used in gardens and in starting a lawn?

A mulch can also be illustrated by lowering the end of a cube of sugar in water which has been colored. On top of the cube is placed some powdered sugar. In a very short time the colored water will rise to the top of the cube but will stop when it reaches the powdered layer.

References: Sydney Franklin, Mulching to Establish Vegetation on Eroded Areas of the Southeast

14. Testing soils for acidity and alkalinity

In analyzing or testing a soil it is usually advisable to determine first of all whether it is "sour" or "sweet." Knowledge regarding the reaction of a soil tells whether or not it needs lime, gives information regarding the availability of plant foods and general fertility. It also gives information as to which crops or plants may be most adaptable to the soil being tested.

Some plants will not grow well in a soil that is "sour" and the use of fertilizer alone will not

give these plants the proper kind of soil even though there is plenty of plant food in the fertilizer. The problem of adjusting the reaction of the soil to suit a specific plant or to select plants which are suitable to a certain soil has been made practicable through the development of simplified soil tests.

The procedure for the testing of acidity of the soil is as follows: By means of a spade or other sharp tool, secure a slice of soil extending to a depth of six inches. To get a good sampling several such slices should be obtained of the plot to be tested. Thoroughly mix the sample, discarding any sticks or pebbles, breaking up all lumps. With the fingers sift a small amount of the soil into the container provided with the testing outfit or into an evaporating dish. Thoroughly saturate the soil with the indicator provided and let it soak into the soil for one minute then drain the liquid to one side. This liquid assumes a color characteristic of the reaction of the soil. The sweetness or sourness, or the pH value as chemist says, is determined by comparison with a color chart that comes with the testing kit.

There are several of these simplified testing kits on the market. LaMotte soil teskit and Soiltex are easy to use and reliable.

If a kit is not available a less accurate determination can be made by the use of litmus. Make a thick paste with about a teaspoonful of soil and distilled water. Moisten a strip of blue and a strip of red litmus paper and lay them on a watch glass. Pour the thick paste over the litmus paper and allow it to stand for at least fifteen minutes. At the end of that time note whether the paper indicates an acid, basic, or neutral condition.

References:

F. J. Solter, Soil Testing
LaMotte Soil Handbook
High School Chemistry Manual

15. Making a soil profile

To make a soil profile a pit or hole is dug into the soil so that layers or horizons may be seen. The points to be noted and recorded are: depth of leaf litter or decayed vegetable matter; depth, texture and color of the different layers; and the pH of each layer.

The profile of a well-developed soil consists of three chief levels or horizons. They are re-

ferred to as the upper, middle, and lower levels or as A, B, and C horizons. Not all soils will show the three horizons. A number of physical, chemical and biological factors are instrumental in bringing this about.

The lower level is the unchanged parent substance, such as limestone, sandstone, gravel or glacial drift. The upper level is that which has been exposed most completely to the action of weather and living organisms. The middle level is between the other two in character.

It is the A horizon in which the conservationist is most concerned. It is in this layer that the roots of most plants are found and when it is gone soil fertility is lost. Does any relationship exist between the depth of the A horizon and the type of vegetation? If profiles are taken at different levels on a slope what is observed as to the depth of the A horizons? How does the A horizon of a badly eroded soil compare with the A horizon of a similar soil that is well managed?

References:

H. Wales and H. O. Lathrop
Conservation of Natural Resources

Soils and Men, Yearbook of Agriculture 1938

B. Discussion

1. All members of the community should be concerned about the use of the soil.

2. Soils vary as to formation: Residual or transported.

   See any textbook on general science.

   The World Book Encyclopedia, Vol 15.

   Compton's Pictured Encyclopedia, Vo. 5.

3. What is meant by green manuring? What benefits are derived from it?

4. The economic effect of using more mechanical power in farming.

5. Trace land use from pioneer days to dust storms and

   Russell Lord, Behold Our Land

   Stuart Chase, Rich Land, Poor Land

6. Limiting element - availability.

   P. E. Karraker Soils

   Carsie Hammond and Ralph Wood, Today's Agriculture.

7. Inoculation - What it is and how it is done.

   See Henry J. Waters, The Essentials of Agriculture.

8. Estimate the evils of the one crop system.

9. Determine the importance of crop rotation as a means of enriching the soil. Discuss the advantages and secure data to show the dollar value gain of such procedure.

See P. E. Karraker, Soils

A. F. Gustafson, Conservation of the Soil

10. Farm manure and its value

See P. E. Karraker, Soils

J.A. Slipher, Manure: Its Management in Barn and Field

C. Appreciation: Hearing, Listening, or Viewing

1. Display a series of posters showing the different types of soil erosion and depletion. Make a parallel series showing the methods used to correct the above.

Compton's Pictured Encyclopedia, Vol. 1.

The World Book Encyclopedia, Vol. 5.

Russell Lord, Behold Our Land

2. Examine topographic map of the quadrangle of which your town is a part.

3. Keep a scrapbook of significant articles and pictures relating to soil erosion and conservation.

Note: Look for illustrations in such pamphlets as Consumer's Guide and Soil Conservation. Watch daily papers. Check Life and Saturday Evening Post.

4. Obtain motion pictures and slides that are and would be useful in teaching this unit on soils. See Catalogue of the State of Ohio Department of Education Slide and Film Exchange. Soil Conservation Service, 6800-16 Market St., Upper Darby, Pa.

5. Attend the motion picture "The Southerner." Tells the story of the love of a young man for the soil and the hardships endured in making a farm living.

6. Examine newspapers for radio programs and tune in on those that deal with the farm problem and any phase of conservation.

7. Motion Pictures

The increasing use of visual aid materials should not be overlooked. Many films are available from a lot of sources. Those available from the State of Ohio, Department of Education, Slide and Film Exchange, Columbus, Ohio,

pertaining to the soil are:

"Conservation of Natural Resources"

"Dangerous Dust"

"Deserts"

"Earthworms"

"Nitrogen Cycle"

"Old Land - New Use"

"Pioneers of the Plain"

"Save the Soil"

"Wearing Away of Land"

"Wise Land Use Pays"

"Youth in Conservation"

From the Soil Conservation Service 6800-16 Market Street, Upper Darby, Pa. are obtainable

"For Years to Come"

"Muddy Waters"

"Rain on the Plains"

"The Heritage We Guard"

Many manufacturers have films available, the only expense is that of express charges. They are generally excellent teaching devices and the advertising material should not prove objectionable. The Educators Progress Service, Randolph, Wisconsin issues a yearly catalogue, for three dollars, which

will keep one up to date on this service.

D. Creative: Drawing, Illustrating and Constructing.

1. Construct a large piegraph showing the use that is made of the land acreage of the U.S.

See Firman E. Bear, Soil Management, p. 11
Russell Lord, Behold Our Land, p. 50.

If the entire 1903 million acres of the United States were laid out as if it were a one hundred acre farm, there would be nineteen acres of tilled fields, thirty-seven acres of pastureland, some thirty-two acres of woodland, about half of it pastured, and some eleven acres given over to wasteland, roads, and buildings.

2. Construct a simipar graph as above for the county.

See County Agricultural Agent or County Auditor.

3. Draw maps to show the location in the United States where the raw materials for commercial fertilizers are obtained. In addition to spotting the raw materials, tell of their preparation and treatment.

See Firman E. Bear, Theory and Practice in the Use of Fertilizers.

E.E. Slosson, Creative Chemistry, Chapts. 2,3,
Henry J. Waters, Essentials of Agriculture
Edmund C. Shorey, The Liming of Soils,
Compton's Pictured Encyclopedia, Vols. F.P.N.

4. Draw a topographic map of some small local area.

Explain meaning of contour lines and visit a place where contour lines are "bunched" to see the steepness of the grade.

5. Illustrate by cartoons the consequences of erosion.

6. Make a survey of the land use situation in your county
Pupils that live on farms make land use maps and discuss what they reveal.

Note: If this is not feasible have the county agricultural agent or someone suggested by him to show to the class the meaning of the land use survey map and how it is being used.

See Charles E. Kellogg, The Soil that Supports Us

William R. Dersal, The American Land, Its History and Uses.

Tom Dale and W.A. Ross, Conserving Farm Lands
Comptons Pictured Encyclopedia, Vol. 1
Gleen K. Rule, Conserving Corn Belt Soil

7. Take Kodochrome slides of examples of soil erosion

such as a gully, sheet erosion, a muddy stream, an overpastured field. Contrast with slides showing good farm practices such as strip cropping, contour fields, or a field of leguminous plants.

8. Prepare a chart showing the ways in which nitrogen is fixed.

   See E.E. Slosson, Creative Chemistry,
   Any high school chemistry textbook.

9. A large poster to show the important part nitrogan plays in the life cycle.

   See a high school biology text.

E. Reading: Informational and Recreational

1. Make a list of organizations and agencies interested in soil conservation and state the contribution of each . Separate as to government and private.

   See various Department of Agriculture Bulletins.

2. Read a novel of farm life.

   See Louis Bromfield, The Farm

Depicts farm life of the pioneer. Contrast with farm life today.

Pearl Buck, The Good Earth

Farm life in China. Compare and contrast with American farm life.

3. Read the biographies of men who were pioneers in soil study.

Reference:

Firman E. Bear, Theory and Practice in the Use of Fertilizers.

Some short sketches of men like Leibeg and Toll are given and their beliefs.

4. Reading for Fun

Encourage the reading of magazines and books for materials which the pupil does not "have" to read. Suggestions: Farm Journal, Better Homes and Garden, The Land Ohio Conservation Bulletin, Outdoor Life, Nature Magazine, Hunger Fighters, Pioneers of Plenty, National Geographic.

F. Excursions

1. Field Trip to observe the action of different forces on soil formation.

Refer to introductory material leading to activity section of teaching unit.

2. Field trip to observe a field of alfalfa or other leguminous plant. Compare one limed field with one unlimed one.

3. Plan a trip to the Ohio Agricultural Experiment Station, Wooster, Ohio.

4. Visit Louis Bromfield's farm at Lucas, Ohio.

5. Visit one or more of the farm ponds in the community.

   Note: Shortage of water in last few years has increased tendency to build such ponds in this area.

6. Plan a trip to secure individual soil samples.

7. Make a trip to an area where more contour farming is in use than in our own community.

G. Reporting

1. Interview the County Agricultural Agent and solicit his supervision and assistance in making a land use survey.

2. Talk with farmers, business men, and members of civic organizations to get their views on soil erosion and conservation.

3. Interview and secure information from one or more farmers in the community on the following points:

   Does the farmer use fertilizer?

   What brands and formula?

   On what crops?

   How much per application?

   Time and method of application?

   Farmer's opinion on profits and benefits from using the right fertilizer.

4. Ask local fertilizer dealers the following questions:

   How much fertilizer is sold?

   What are the chief brands sold? Their formulas?

   Is the use of fertilizer on the increase?

   For what crops is fertilizer bought?

5. Investigate the relationship of rainfall and the growing season to crop yield over a period of years in the community.

6. Report on Johan Von Helmont's classic experiment of determing how much of the soil a plant uses?

   Note: An account of this experiment is found in Firman E. Bear, Theory and Practice in the Use of Fertilizers.

7. Investigate the use of cover crops in your community as an erosion preventative.

See A. J. Pieters, Legumes in Soil Conservation Practices

8. Give a combination of crops best suited for crop rotation in your community. Compare with actual practices in the community.

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BOOKS

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Deals with the application of the facts and principles that are of use in planning systems of soil management improvements.

_____ Theory and Practice in the Use of Fertilizers.

This book brings together in one volume the various points of view concerning fertilizer practice that have been developed since the time of Liebig.

Bromfield, Louis. The Farm

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_____ Pleasant Valley

The chapter "My Ninety Acres" is especially pertinent. The tale of one who loved the land and how it thrived with good management.

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A practical exposition of the new science of soil conservation for students, farmers and the general public.

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Contains rather novel ideas on soil cultivation and soil srosion.

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Hammond, Carsie and Wood, Ralph. Todays Agriculture

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Kellogg, Charles E. The Soil That Supports Us

This book tells of the building material for soils, life and the soil, the parts of a soil, deserts, different crops, fertilizers, planning the use of soil, soil classification and soil maps.

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Offers suggestions on where one might go and what to look for and what to do concerning conservation problems.

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	p. 116	Alfalfa
C.	pf. 341	Conservation
F.	p. 27	Fertilizer
L.	p. 61	Right and Wrong Land Use
N.	p. 147	Nitrogen, Preserver and Destroyer of Life.
P.	p. 323	Potassium
S.	p. 190	Soil

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15. pp. 6676-78 Soil - Formation - Transportation - Kinds.

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Chapter V

Summary and Recommendations for Further Study.

The purpose of this thesis has been two-fold: first, to show the need for conservation teaching in the light of the present existing state of conservation concerning natural resources; and second, to prepare a teaching unit which will be helpful to provide in the young people of the secondary schools a consciousness of conservation and to give them a background of information and a realization of conservation problems. This thesis shows in some detail how this could be done by a teaching unit utilizing familiar materials.

Chapter II discusses the need and present status of conservation. Here it has been suggested that conservation has many meanings. An explanation of what conservation is and how used by the foremost conservationists today was given. The apathy of the pioneers for conservation in the westward development of the United States was noted. Today more people are coming to the realization that our resources are not inexhaustible. There is a growing feeling, in government, in business, and in education for a greater emphasis upon the wise use of resources, both for the present and future generations. The public schools through the use of familiar and near at hand materials have a great opportunity for the dissemination of the ground work of broad conservation principles.

Four of the important natural resources are briefly touched upon in Chapter III. These are Soil - Water - Minerals - Vegetation.

Chapter IV consists of a teaching unit on soils. It was written for a class in General Science at the ninth grade level. The time to be spent on the unit is from two to three weeks. The unit starts with the formation of soils and then develops into its conservation. The notivation and development is carried on by a number of activities so designed to give insight into the necessity for soil conservation. Different types of activities propose to develop the individual to the utmost.

Recommendations for Further Study.

This problem has been concerned with a unit on soil conservation only. It is recommended that teaching units on other phases of conservation such as water, plant life, and minerals be worked out in a similar manner. Units in conservation for other science subjects would also be very helpful. Teachers of some of the more closely related subjects should make an effort to work out units together in order that the best from each area might be incorporated.

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