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AUTHOR Junglas, Mary R.; And Others
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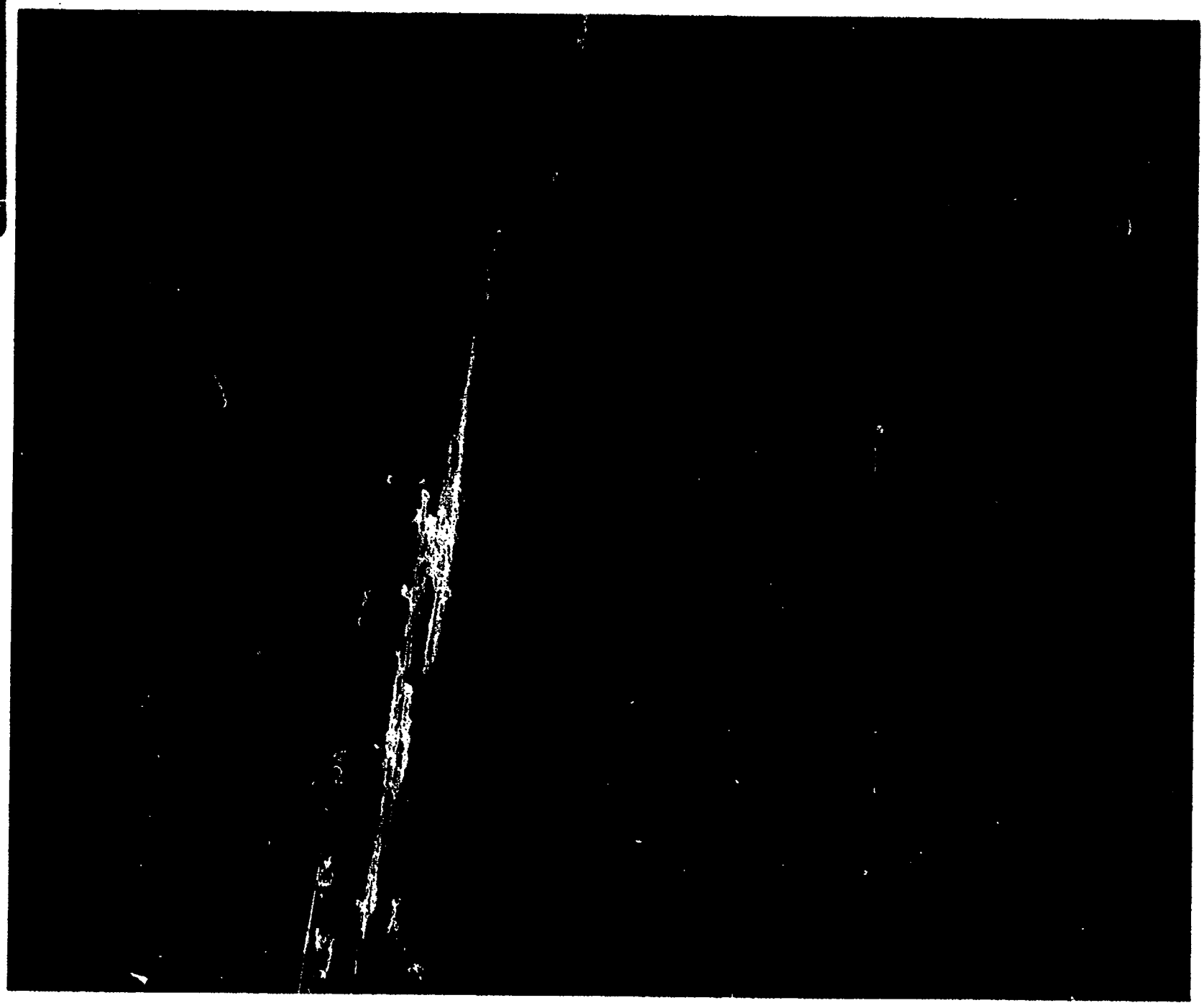
ABSTRACT

This environmental education curriculum guide was developed for teacher use at the senior high school level. Although the guide deals with the bio-physical aspects of the environment, it is designed to encourage an integration of the disciplines into an inter-disciplinary approach. The volume consists of a set of ideas, activities, and opinions which will help teachers and students generate a positive approach to the environment. The guide is divided into the following six units: Earth Thoughts, which focuses on the student as an integral part of the environment; Quality of Life, which encourages the student to establish what determines his personal quality of life; Environmental Inventory, which examines tools and methods used to investigate environmental problems; Environmental Management, which develops an approach to management through the investigation of a system of water management; Community Problems, which develops an awareness of environmental problems; and Futurism, which looks at changes, developments, and directions in technology. Each unit contains an introduction, stating the purpose and background, instructional objectives, experiences, and references. The experiences of each unit are based on an objective which relates to the subject of the unit. Several activities are included in each experience. (TK)

Environmental Learning Experiences

Bio-Physical Senior High School



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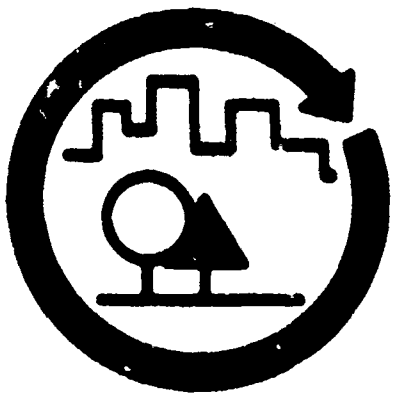
Center for the Development of Environmental Curriculum

Dennis M. Wint,
Director

Curriculum Specialists:
Mary R. Junglas
Laurence E. Pennell
Christine L. Shields
Stoyan N. Topalof
Susan M. Zacher



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INTRODUCTION

Here is this vast, savage, howling mother of ours, Nature, lying all around, with such beauty, and such affection for her children, as the leopard; and yet we are so early weaned from her breast to society, to that culture which is exclusively an interaction of man on man - a sort of breeding in and in, which produces . . . a civilization destined to have a speedy limit.

Henry David Thoreau
(Bode, Carl (ed.), "Walking." Viking Portable Library, p. 621)

Environmental education is an integrated educational process which is only beginning to become a part of our educational institutions. What environmental studies there have been, have been relegated largely to science and elementary teachers, as ecology. The path of ecology (a word popular only since *Silent Spring*) is a noble one, but often unsuccessful in its attempts to create an environmental awareness that is vitally needed to turn our growing environmental dilemmas around. The environmental movement, if it can be called such, is already laced with comfortable cliches and a bumper sticker commerciality which is making hay while the spirit of Naderism rides high, as if taking advantage of a fleeting public fancy. Well-meaning environmental groups are experiencing financial and legislative setbacks, a result of an apathy fostered by ignorance, social-cultural pressures, and a mindless economy, spawned by the superficial concept of goodness in growth.

If environmental education is taken per se, we have been engaged in the process since our ancestral beginnings. But within a very short space of time, the lessons of the environment have been lost, or fall on ears that can no longer hear. We have been steadily engaged in a flight from our real environment to an artificial one. This has been due to a faith in technology that has been blind, and demonstrated to be without limits or qualifications. This is one important reason why environmental education should be a total interdisciplinary approach which focuses upon the means of bringing us back in touch with the real environment. It should be an education which permits the experience of feeling ourselves as an intricate, inescapable part of the web of all life. We must recognize that we function within a delicate balance that requires a caring concern for life and gentle attitudes about the earth that will make us worthy stewards of the land.

Man is a part of the environment, as is the most insignificant form of life, and must derive his basic needs from the same tenuous flow of energy which sustains our entire ecosphere. He has adapted in accordance with the great constructors of change — the environment and heredity — and has met the rigors of survival to the point where his success has become dominion. He has engaged, through his superior intelligence, in an inexorable technocracy which has removed him beyond the realm of real contact with the web of life itself. For these reasons he has altered the environment more than any other living thing.

The significance of our life-ties to the earth has been diminished with the superficiality of plastic and throw-away cultures enraptured with mindless growth. Our tin can technology is in evidence even in mid-ocean. The limits seem to be at hand and a new philosophy, armed with meaningful understanding of the problems we face, is imperative.

It is important that those who have inherited our problems will be able to take a total world view of our deteriorating environment and be able to detect and sift through the obstacles that seem to shackle our present efforts because they will inherit the responsibility of providing solutions. Environmental education can not be approached from any one discipline but must draw upon the entire spectrum of man's ability to express his feelings and throughts. Science is one means of perceiving and interpreting our environment but it is useless without confronting the political, social-economic aspects and empty without the richness of art, philosophy, poetry, and music which have spoken eloquently of man's relationship to the earth.

The Center for the Development of Environmental Curriculum has developed a set of volumes which gives the teacher an opportunity to draw from many disciplines in an effort to bring environmental education to our institutions through as many avenues of learning as possible. The CDEC curriculum volumes have been written by environmentalists and educators from as many areas of education as possible. Each unit may be utilized separately or in conjunction with other units. Although each volume represents a particular theme in a certain area and level (e.g. Earth Thoughs - Biophysical - Senior High), the entire curriculum is designed to encourage an integration of the disciplines into an inter-disciplinary approach. The volumes may be used also, as supplementary guides to activities in any area. It is hoped that the volumes can be viewed as a flexible set of ideas, activities, and opinions which will help teachers and students generate ideas and activities into meaningful educational experiences. They are resources which will enable those who use them to develop a way of thinking and feeling about nature, and it may provide the chance to help clarify our environmental values into sound models for action.

We are in the midst of environmental problems which leave us confused and frustrated in the maelstrom of pros and cons concerning our dilemma. That we are experiencing a steadily deteriorating environmental condition is beyond any doubt. The solutions are not easy. But if you have experienced the flow of water, fresh and cold over your body as it courses through some green mountain valley on its way to the sea, knelt in the cool, damp earth and clutched its rich smell to your face, or watched a Blue Heron in slow flight at sunset, you know it is worth saving. All the care, concern, and love for all life and its necessary place within the intimacys of our "tiny spaceship" is in those knowing moments. At those times we are in touch with the ages of all life's experience. Man is the only creature capable of contemplating his own death; only man can develop an environmental ethic that is futuristic and healing.

Ronald J. Yarian
Concerned Educator and Citizen

EARTH THOUGHTS

In order to begin contemplating environmental problems, be they dilemmas or disasters, it is necessary to consider how and why man arrived at his present state of affairs in relation to his environment, what the consequences of his present predicament are, and where his future direction will take him. Earth Thoughts, in relation to environmental education, is an attempt to bring the student in touch with *himself* as an integral part of his environment. This is done through a learning process in which he can contemplate man's past, present, and future in view of the impact on the environment that he has had and will have. Furthermore, every effort should be made to provide opportunities for him to feel himself as part of this vital web and to develop his own personal philosophy or creed, which will enable him to guide his way through life while considering the delicate balance of his protecting and sustaining Spaceship Earth.

Men of other times and cultures knew what the environment meant to them, and somewhere along the way, today's man lost that capacity. More lamentable is the fact that he has lost the capacity to care, or such is the evidence. Man's philosophy, culture, and ethnic societies have evolved as surely as man himself has changed. Man is now at the doorstep of confronting the global environmental problems which threaten with extinction the organism that has become man. Thus, man's thought has shaped the environment and brought him to a crisis just as surely as environmental crises of the past have shaped the man.

How does the teacher begin to start a unit in environmental education on "Earth Thoughts"? Certainly it cannot be approached from any one discipline, nor should such an attempt be made. Science is only one means of perceiving our environment and, in many respects, a limited one. Art, philosophy, writing, music, poetry, and religion have all spoken eloquently of man's thoughts about the earth. Yet science remains and maintains its tenuous contact with reality and it can provide a hopeful and practical model for mankind to employ in its quest to understand and heal its environmental dilemma. Through awareness of our environment, through being in real touch with nature, and through a caring consciousness (earth thoughts) we can develop such a model. The Ghost Dancers of the Plains Indian tribes believed they could cause the earth to roll up like a carpet, causing all the ugliness of roads, billboards, and the like to disappear. Technology Man may have adopted the same blind faith in his technology to deliver him from his environmental dilemma, but that same technology has placed him in the dilemma, and it will take a new thinking to go with that technology before it can overcome its hitherto short-sighted approach.

Earth Thoughts mean many things. It means reflecting upon both our pioneer ancestors and today's mercantile advertising media, which nurtures and sustains the polluters and the slum landlords in the name of profit. As the ad men have said, "You've come a long way, baby." For different cultures, "environment" means different things, and as a result, their effects on the environment are also different. Our ancestors related to nature as the aboriginals do today. Like the American Indian, they were pantheists who understood or tried to understand nature through placation and sacrifice. His impact was defined by a feeling of oneness with nature, with an accompanying awareness of his integral part of his environment and his absolute dependence upon it. His impact was healable — deliberately so. But man has taken giant steps, and much of this progress has been fostered by his philosophy that man must have dominion over nature. The American Indian knows well this philosophy, because it has extended itself to include man's dominion over his fellow man. The reservation speaks blatantly of this heritage. Certainly our environmental plight does not reflect the gentle stewardship of the land that was the Indian's.

Earth Thoughts are also a realization that an awareness of the outside world is actually a state of the nervous system or of the observer. Knowing the outside world is knowing yourself, a form of values clarification. Think of it, all of our actions and experiences arise mutually from the organism and from the environment at the same time. A mindless expansion of our economic growth without a corresponding expansion of perception will certainly threaten to bankrupt our lands.

Man is, of necessity, a part of nature. His survival is a result of his capacity to adapt and change with the environment. Is it possible that the aesthetic nature of man is but a longing for what has been lost? Our feelings concerning nature, beauty, solitude, and inspiration are quite possibly our attempt to reconnect our lives to the stream, the pulse of nature. The Buddhists have a universal vision of life in which good and evil, creativity and destructiveness are all a part of the balance of nature, inseparable polarities of existence. Getting back into a balance of nature should be part of Earth Thoughts.

Finally, we can consider that man has continually reflected a pre-Copernican outlook of the universe, and we have paid the price of this anthropocentric philosophy. Man-oriented societies reflect deterioration of the quality of life on all fronts. Pollution comes in many forms and wears many hats, from burning rivers, billboard beauty, and plastic values to the insidious effects of anomie, and we can point to the causes. Our throw-away culture, push button demands met by conveyor belt technology, have removed us from nature several times over, and each new technology seems to remove us that much farther. Our thinking must be future-oriented, with an environmental ethic to go with a healing and caring environmental technology.

INSTRUCTIONAL OBJECTIVES

1. The student will begin learning processes which will help raise his level of awareness of the meaning of environment.
2. The student will realize that his thoughts about the environment have an effect on it.
3. The student will establish some attitudes concerning the environment and relate these to his personal values.
4. The student will establish some personal philosophies about man's part in caring for the environment and for other men.
5. The student will consider man's aesthetic nature in relation to the environment.

CONTRIBUTORS TO THE DEVELOPMENT OF THIS UNIT

Author ..... Ronald J. Yarian
Editor ..... Mary R. Junglas
Revisor ..... Sr. M. St. Colette, Miller SND

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EXPERIENCE #1
DEVELOPING EARTH THOUGHTS

OBJECTIVE:

The student should arrive at an understanding of environment and try to define his "earth thoughts."

ACTIVITY A:
DEVELOPING AWARENESS OF ONE'S PERSONAL ENVIRONMENT

1. Have each student keep an environmental journal in which he is to write down everything related to the environment — his feelings, observations, values.
   a. Students may be requested to share with the class.
   b. A journal is private, and it should be emphasized that the students should be encouraged to write in their journals on that basis. (Only that which is voluntarily shared will be evaluated.)
   c. The idea of a journal is to encourage each person to record his total environmental experiences with the idea that this will be an ongoing thing throughout his entire life. Writing a journal is like talking to yourself.

   or

2. Have students follow and keep a journal for one week of any and all articles in the daily paper that pertain to an environmental issue which is of interest to them personally. (This may be easily adapted to a specific community: urban - air pollution, suburban - zoning, etc.)

   At the end of the week, the students could share their insights with the class, in small groups, or individually in writing.

ACTIVITY B:
DEFINING ENVIRONMENT

1. Have each student write his own definition of *environment.*
2. Have the students share their ideas with the class, perhaps by jotting key ideas on the board.

   Through the discussion, the students should hopefully arrive at some ideas regarding the environment and what it means. For instance,
   - it may mean many things to each of us
   - it is never simple
   - in its broadest sense it includes all internal and external factors that affect an individual
3. Environmental problems: This discussion might be used to elaborate on the points made in part 2.
   a. Have each person list the most serious environmental problem he feels we face (or the three most serious environmental problems we face).

      Such things may be overpopulation, air pollution, water pollution, or the energy crisis. (They will probably be sweepingly general.)
   b. Have each person list the most serious environmental problem he personally faces (or again, the three most serious).

      This may take some interesting forms: getting the family car, curing acne, boy-girl relationships, rats, garbage, poverty, or school.
4. The environmental creed is an attempt to get the student to define his thoughts at this time. It might be a worthwhile activity to have the student re-write this later in the unit or even as a culminating activity at the end of the unit.

   Have each person attempt to establish an Environmental Creed, a philosophy that each of them would will willing to live by. This might ne a good place to examine values and to establish the valuing process.

   The creed might start with a statement. I value the environment because _____ and will therefore try to live by the following: _____, in order to see that the environment will be all the things I value in it.

ACTIVITY C:
I.A.L.A.C. STORY
(Introductory Activity)

Teacher's Note:

To consider man apart from nature is to deny his membership in the web of existence. To even think of man as separate is to set in motion a maelstrom of man-activities that operate with a mindlessness counter to the very processes which make man himself a co-survivor with every other living thing on this earth. Yet, we see growing evidence that such a belief is in the mind of man. All the attending marvels of technology are simultaneously his hope and bane. It would seem that we (technological societies) have steeped ourselves so deeply in dependency upon technology that we have removed

ourselves from nature sufficiently enough to have lost the ability to see clearly from where our sustenance comes. And yet we are not enough removed that we do not feel the longing for the natural and the solitude of wilderness. So we operate without our comfortable (by world standards, super luxurious) existence in a kind of paradoxical schizophrenia.

The purpose of this segment of Earth Thoughts is to focus on how man views himself in relation to his environment and to examine how his values, as related to these views, have a profound effect on his surroundings. It is hoped that activities can be generated which will effect a true appreciation of the connectedness and wholeness of our environment (ecosystem) and the realization that the same factors which mold and shape the ecosphere affect man equally. We exist together for a short while as a result of countless and timeless experiments that have set in balance the living and nonliving into a dynamic interdependent network, the ecosphere.

1. The following story (by the author) is an adaptation on a theme (also called the I.A.L.A.C. story) by Sidney Simon.
   a. This activity has two objectives:
      1. The students should consider the environment and the fact that man has a special role as a caring steward of the land.
      2. Develop positive and intergroup humanistic feelings within the class.
   b. Follow-up discussion questions and activities
      1. What is the appeal (if any) in this story? emotional? symbolic?
      2. What are the symbolic correlations with the real environment? (Possibly consider cycles, balance, healing aspects, and technological impacts.)
      3. What might be some of the interpreatations of the I.A.L.A.C. sign other than its actual meaning?

         Significance of getting restored

         Why some pieces never stayed on (stop gap, short-term technology)

         Why some pieces caused more damage (sunergy, short-sighted technology)

2. Prior to the story telling, the teacher should make two signs, with the letters I.A.L.A.C. printed on each. One sign should be pinned on while the teacher is telling the story. It is fun and worthwhile to set the stage by telling the class ahead of time that you are going to tell them a story to get them in an anticipatory and story-telling mood.

   During the story, the teacher should tear off a piece of the sign each time the story indicates that a piece of the IALAC sign should be torn off.

   The story is intended to stimulate further modifications and creations which the teacher might want to work in.

   Examples of these could include the following: The story could be taped and a student (rehearsed or unrehearsed) could take the part of Oikos. Overhead transparencies might be made and used effectively to illustrate the story by either teacher or students.

3. The Story

IALAC and OIKOS

Each day, in the vastness of time and space, a relatively insignificant body, at first glance, reached over and carefully placed a sign on itself. The name of this time-traveler is Oikos and the sign, curiously placed, had equally curious letters which spelled I.A.L.A.C. — IALAC. The story is about Oikos and his sign.

Oikos yawned and, as he had for some time now, reached over and placed the IALAC sign on his chest and proudly started a new day. The first deep breath of life-giving air was always the finest. But today there was a strange pungency in the morning air that left a stale sulfury taste in Oikos' mouth. The acrid taste made him choke and a small piece of his IALAC sign fell off, leaving Oikos a bit disconcerted, but he was not about to let it spoil his day.

Undaunted, Oikos shrugged it all off and began opening his eyes completely to the now full light from Brother Sun. The regenerating energy of his lifelong companion warmed him lovingly and poured into his now wakeful eyes. But what was wrong? Something was definitely wrong. His protecting sky blanket seemed dulled and hazed. Oilos brushed at the canopy, but the sun seemed faded and farther away today, and the diminished light that had always filtered protectingly through his wraps left Oilos weakened and depressed. Two more pieces of his IALAC sign fell, unnoticed this time, to his feet.

The whole episode this morning had left Oikos irritable, but there was always work to be done, and today was no exception. Oikos decided a good cleansing shower would wet his mood right again. Yet, the water rushed with an oil afterfeeling, and there was a subtle odor that sent Oikos' senses withering. It was true, the water was not the clear, clean water he was used to, and what's more, there were prickly radiations that stung him occasionally from the shower. A customary large gulp of previously spirit-lifting fluid revealed a foul taste that seemed to be disguised by another equally foul taste.

Several more pieces of the IALAC broke off and drifted off into the chill but heavy breeze.

Faded memories flickered back to Oikos of friends, gentle friends who had followed the large buffalo herds, which were also friends. These were strong-bodies friends whose thoughts rose above the rest in praise of Brother Sun and his Sister Moon. They gave thanks for the gifts of life and smoothed the hurts of the land, giving Oikos a feeling almost like that a loving stroke gives to a child. They, like the friends before, had had no mind to conquer the land or control the streams, and they gave back what they had taken, and protected and held sacred all life.

Their footprints healed so easily, and their respect for life was composed of the love they felt for the whole web of things, both great and small. In the rocks and trees they saw beauty. They made Oikos feel beautiful, too. Just thinking about that made Oikos forget the day's mishaps, and a tiny piece of his IALAC sign grew back.

Oikos smiled. These days would return, he thought. And besides, there was some healing he had to do himself today. A large area of wilderness seemed to be continually disappearing, and vast tracks of forest land were getting a disheartening look, as if they had been scoured, but, "No," Oikos thought. That was not likely. His friends before had always seen that they did not take more than they needed, and he knew, too, that even his littlest and most insignificant friends protected their own sources of life. But when Oikos swept aside a wisp of fog from the valley, the ugliness of the scarred and eroded hills tore at his emotions. Tears that he had never experienced before welled up in his throat. A huge piece of his IALAC ripped off and was ground into the bare soil.

Times had changed. Strange shapes had appeared whose iron jaws tore and whose joints screeched and howled incessantly. Huge billows of smoke boiled and soiled themselves into the whole network, and the strange and slimy blackness oozed over the very feet of Oikos. Noise now greeted his senses, noise like never before, that ground at Oikos' very fiber, and he held his head in pain, while yet another piece of his IALAC was wrenched away.

That Oikos was in pain, there was no doubt, yet always there was the work to do. He had never really made judgments about his friends, he really couldn't, but their gaudy signs, blinking lights, wires, concrete towers, and the continuously growing network of concrete paths with their moving metal things was something he couldn't understand. He had always been tolerant and even welcomed his new friends, but he felt a strange sensation as a new mood swept through him. Why couldn't they understand? Each day there was less and less of the gentle, tangled greenery he loved and tended. Each day there were more and more friends who brought new things, signs, wheels, towers, gadgets, trinkets, chemicals, and toys for their ever wants, and each day the water grew less refreshing, and the air less invigorating, and the land corroded and became more parched and barren. The pain was almost overwhelming, and another piece of the IALAC sign slipped despondently away.

Even before the day ended, Oikos saw his friends destroy each other deliberately and create war holes and charred landscape, while the gentler things of the land huddled and shimpered in uncomprehending fear, feeling the same strange weight of helplessness that Oikos felt. These were probably the worst parts of the day, and Oikos turned vacantly to his bed while a huge hunk of his IALAC disappeared. Sleep was so welcome now, but before he drifted to sleep, Oikos carefully removed what was left of his IALAC sign and gently placed it beside him with a wistful look.

Oikos always thought of hopeful things before he went to sleep. He thought of other days when he had seen these new friends try to patch the land and clean the air and water. They tried to prevent themselves from destroying each other, and on those days, new pieces had grown on his IALAC sign. But the pieces didn't seem to stick on very well. They often fell off as quickly as they were put on. Sometimes the pieces that were placed on took even more from Oikos' sign when they fell off. Sometimes these were the most devious of damages to his IALAC. Still Oikos was not unaware that some friends made new patches that stayed on his IALAC, but they just never seemed large enough.

Oikos drifted off to sleep stirring in a troubled manner. Each night Oikos repeated the same dream sleep. Each night it grew. Oikos dreamt of all the events of his days, days of countless change, days when friends came to him and time brought all the friends into a balance and feeling that seemed threaded through Oikos' entire being. Every part connected to every other, until there was a beautiful wholeness of friends and activities.

Morning came, as it had for 5 billion years before in Oikos' time travels. Oikos moved and yawned, a bit troubled from his dream sleep this time. But Oikos, as he had ever since he met the new friend called man, rolled over and reached for his IALAC sign. He knew what he would find. Yes, it was still there, and as before, it was restored to its completeness once again: I.A.L.A.C.

Teacher's Note:
This is where the second sign comes in.

The letters were clearly visible; the torn and tattered pieces had been restored as they had been for ages. Yet today, Oikos noticed that the IALAC sign seemed a little smaller. Yes, there were a few pieces that had not been replaced, but it was getting a bit smudged. Oh well, Oikos smiled, as he readied himself for that first good breath and cleansing shower, maybe today will be better.

4. Conclusion:

By now you probably have an idea of who Oikos is. Oikos is many things and has many names: Nature, Environment, Spaceship Earth. For Oikos means household (It is the Greek word, *oikos*, from which the words ecology and economics come), the place where we all dwell with all the living friends of earth.

And the IALAC sign? It means a great deal to Oikos and to us.

I — I
A — am
L — loved
A — and
C — cared for

5. For discussion:
   a. In what ways was the interconnection of the ecosphere portrayed?
   b. What are the implications of tearing pieces of the sign? (rip-offs, who rips off whom? environmental deterioration, decrease in the tolerance of the environment)
   c. What is the significance of man's views and the changes in his views here? (possibly introduce the cultural implications that affect environment).
   d. Encourage the class to pick some environmental theme and write their own short stories related to their "earth thoughts."
   e. Encourage the class members to make illustrations for this story or one they or the whole class might make up.
   f. Dramatize the story of Oikos or possibly do a play that could be put on for elementary school classes.

EXPERIENCE #2
ADAPTATION AND CHANGE

OBJECTIVES:

1. The students should develop the understanding that the world of life has and is gradually changing or adapting in response to the environment: and that the environment, in turn, is changed by these living organisms.
2. The students should become aware of the delicate balance that exists in the ecosystem, which, when disturbed by man or otherwise, can greatly affect the future.

Teacher's Note:
Ever since life began, it has changed and adapted until it has reached the dynamic state of the present in which the ecosystem has grown increasingly complex, with higher number of species, greater diversity, and greater symbiotic relationships. We have an ecosphere characterized by order (low entropy) and stability. To think of man as divorced from the results of this process, as not modified by the great constructors of evolution, environment and natural selection, is to say that the demise of the American bald eagle would have no bearing on the human condition.

ACTIVITY A:
FOSSIL HUNT

1. Plan a field trip to some area (Ohio is one of the best locations for fossils, and they can be found anywhere — check natural science museums) to look for fossils.
2. Before the fossil hunt:
   Students research the different types of fossils and how fossilization takes place. If available, they could examine different types of fossils.
3. After the fossil hunt:
   a. Students identify the fossils found.
   b. As far as possible, students should place the fossils time-wise (by the kind of organism, age or type of rock in which it was found, etc).
   c. Students consider the evidence of change. From the fossils collected, determine the past environment and speculate about how the life form survived, became extinct, adapted, etc. These speculations could be correlated with the scientific theories as determined by research.

ACTIVITY B:
CLASSROOM "FOSSIL HUNT"

1. Students could research the different ages of the primitive environment, individually or in small groups, by doing the following:
   a. describing this age in some way.How valid is the description?
   b. considering the evidence (how much evidence? how much theory? kinds of fossils? etc.)
   c. comparing the present environment to that past one
   d. identifying the theoretical causes for change

   or

2. Students could examine fossils - real or plastic sets - in connection with films (and/or filmstrips) such as *Story in The Rocks* and *The Fossil Story*, put out by Shell Oil Co., and determine what they tell us about life and change.

ACTIVITY C:
OBSERVING ADAPTATION AND CHANGE

Teacher's Note:
Any or all of the following activities can be done by individuals, small groups, or the whole class to illustrate adaptation and change.

1. Temporary Pond Study
   a. This is most rewarding in the spring (February through April). Find a temporary pool and take dip net samples. (Homemade dip nets could be made by the class with a broom handle, a metal hoop, an old nylon stocking or shirt sleeve, and a baby food jar.)
   b. Examine the organisms collected:
      (1) Identification: insect larvae, planaria,

mussels, a variety of crustaceans, and surprises.

(2) Ecological significance (This, of course, has many possibilities for studying ecological concepts): food chains, ecotype, succession, etc.

c. How are these organisms adapted to a special environment?
   (1) Survial benefits of a temporary pool
   (2) Reproductive considerations
   (3) Elimination of large prey (fish, amphibians)

d. How have they changed over geologic time?
   (1) Some of these organisms have exhibited very few morphological changes over long periods of time and are today very much like their ancestors.
   (2) If fairy shrimp (crustacean) are collected, this will be an especially rewarding study. They exhibit unique methods of adaptation and have undergone a great deal of change (evolutionary significance).

e. Physical parameters of a temporary pond. Test for dissolved oxygen, pH, and inorganic and organic matter with simple tests (making no big testing deal of this). The physiological adaptations are significant. Usually this is a low DO and a low pH environment.

2. "Hay Infusion" Study
Have the students make a hay infusion by boiling hay in a beaker of water for about ½ an hour. They can then observe the changes in the animal population over a period of time. They should note the differences in the environment over this period.

3. Terrarium Study
If a terrarium is available or can be set up, students can note changes in the living organisms by moving the terrarium to different environments in the room or in the building for a period of a week or two. Examples of different environments would be a light corner of the room vs. a dark one or a warm room vs. a cold one.

4. Soil Litter Study
   a. Have the students collect about a square foot of leaf litter and soil from any environment. (Low spots are good, as well as forest edges.)
   b. Have individuals place their collections in a battery jar and allow them to completely dry so that it is apparent that living specimens are no longer present or active.
   c. Activate the sample by adding a gallon or so of tap water. (Allow it to stand for at least 24 hrs. to rid it of chlorination effects.)
   d. Examine the sample in a week or several weeks, and the likelihood of finding it active, with a variety of crustaceans, copepods, cladocera, and others, is very good.
   e. Discuss this aspect of change and adaptation. The theory of spontaneous generation could be discussed in connection with this last activity if desired.

ACTIVITY D:
LESSONS FROM THE PAST

(Science fiction discussion activity)

Various species have appeared and disappeared from the earth. There is even some evidence that primitive man may have been responsible for the extinction of the woolly mammoth, not to mention the recent theory that man may have caused the extinction of another species of animals. The reason for extinction are manifold, and certainly man cannot take the blame for all of them, but it seems clear that the past has been the prologue to the present.

Have the class read "A Sound of Thunder" by Ray Bradbury. (This story might also be taped, dramatized by the class, etc.) This short story (about a dozen pocket-book pages) shows how a small indiscretion on the part of a time traveler into the past had a profound effect on the present he returned to find. The purpose here is to consider the possible aspects of the environmental past in shaping the environmental present and to discuss man's outlook in relation to the environment. What is the significance and meaning of the title? Man can shape the environment. Can the environment shape man?

Depending on the level and interest of the students, "A Sound of Thunder" may lead into a discussion of evolution and its concepts. This story can raise some interesting reactions concerning the students' philosophies and reactions to evolution. No judgement should be made in regard to values, and if the situation warrants debate, it might be worthwhile.

Darwinism, fundamentalism, creationism, and preordained destiny might be some of the surfacing philosophies. In conjunction with the concepts of evolution (change and adaptation), it might be worth discussing man in relation to the constructors of change, genetics, heredity, and environment.

ACTIVITY E:
MATERIALS NOT EVOLVED (MADE) IN NATURE

It is a fact of organic chemistry that living things have produced a rather limited variety of organic molecules necessary for life processes out of the vast chemical possibilities that there are. It would appear that there is good reason for this, particularly if life is viewed as a result of a great deal of trial and error experimentation. Furthermore, almost all of the products of living activity have some counterpart in nature capable of breaking them down (biodegradability).

Man-made products, however, more often than not, do not have such counterparts, with the result that these products often accumulate with harmful effects, or even with depleting and offensive effects.

1. Materials Treasure Hunt
   a. Have the class go out into the environment (school, community) and collect as many man-made items as they can. Make sure that a distinction is made between synthesized and processed materials or you will be up to your

neck in materials. Encourage their imaginations. (They don't have to bring in something tangible.) The alternative to this activity would be to make a list or to research one or several of these materials according to the questions below.

Some examples might be these:
styrofoam cups
plastics of all kinds (PCB)
synthetic rubber
pesticides, DDT, dieldrin
herbicides
detergents

b. What nonrenewable resource is being removed from the normal processes of nature?

What is or could be the effect of these nondegradable accumulations on the environment and therefore on living organism? on man?

What alternatives could be adoped to replace these items? Are they necessary?

ACTIVITY F:
THE PRIMITIVE ENVIRONMENT

Teacher's Note:
The following activities, in order to be done effectively and meaningfully, require a certain amount of background information and understanding. They are suggested for students who have this background and/or for students who are able and interested enough to acquire it either through teacher development and discussion or through indpendent research.

1. Research: a study of the conditions of the theoretical primitive environment, its changes, and the causes and results of these changes.
2. Biochemical experiments: simulations of theoretical primitive environments in producing some key organic compounds.
3. Do the Urey-Miller experiment and others. Students might find that investigating experiments like these would lead to some interesting process activities. This is a controversial issue even in the scientific community.
   a. Living material is composed primarily of light elements. Why?
   b. Heavy elements are often toxic to us. Why?
   c. What role did photosynthesis have in changing the biosphere?
   d. What are some biochemical similarities? (amino acids, chlorophyll, and hemoglobin)
   e. Deoxyribonucleic acid (DNA) has what evolutionary role?
   f. Carbon compounds in space have what significance?

ACTIVITY G:
TOWARD BALANCE OR TOWARD REGRESSION

1. The following is a grid which systematizes the factors leading toward a balanced ecosystem (highly evolved or adapted) and those factors doing the opposite. It might be interesting to place some of man's activities on this continuum to assess in which direction his activities are taking him.

Unbalanced ◄———	*Balanced*
Simplicity	Complexity
Uniform	Diverse
Random (high entropy)	*Ordered (low entropy)
Low no. species	High no. species
Unstable	Stable

*Note: Life is low entropy, and energy must be continually added to maintain low entropy. (The tendency to higher entropy must be fought.)

   a. In which direction are the following heading? agricultural practices, wildlife management, container usage, transportation, energy use, advertisements, standard of living, national defense, natural resources, conservation, population growth, land reclamation, city planning, waste disposal methods.
   b. Discussion:
   What seems to be the general direction in which man's activities are taking him? Give specific examples. Give the pros and cons of continuing in this direction; of reversing it.

ACTIVITY H:
VALUES STRATEGIES

The following values strategies might be tried in relation to some controversial aspects of evolution and the human condition. There have been some questions raised as to the effect of man's technology on the genetic pool. In nature, there are many checks and balances, and some of these are related to the genetic aspects of the survival of the fittest.

1. Rank the following in order from the one you would give highest priority to the one you would give lowest priority. After this, have the class discuss the reasons for their choices. (This activity could also fit in the growth and death sections.)

_____ Eugenics and DNA research
_____ Cancer research
_____ Cloning
_____ Euthanasia
_____ Contraceptives
_____ Abortion
_____ Sterilization of the mentally retarded
_____ Marriage laws (restrictions on who can marry)

2. a. Have the class place their positions on the following continuum, and force them to disregard the middle. Discuss their choices in relation to the human genetic pool or survival of the fittest.

Primitive Pete ◄——► Futuristic Fred	
He advocates removing all technology and having everyone fend for himself in any way he can.	He espouses Huxley's *Brave New World* society, where every creature comfort is met and individuals are genetically predestined

b. The teacher should encourage the students to devise their own values strategies. The above are only a sample of possibilities, but the discussions should focus upon the environmental aspect of the human condition.

EXPERIENCE #3
MAN'S RELATIONSHIP WITH NATURE — HIS PHILOSOPHY AND HIS WAY OF LIFE

OBJECTIVES:

1. The students should realize that how we think (cultural heritage, philosophy, values) has an important effect on how we treat our environment.
2. The students should develop an attitude which fosters a conservation ethic based on a caring stewardship of the land.
3. The students should become aware of how we have removed ourselves from nature and begin to reassess our priorities.

Teacher's Note:

Diversity is one of nature's insurances for a stable ecosystem. Man's philosophy and culture is rich in its diversity. Yet, there is a growing trend to bring technology to all parts of the world. We live in a society where ham sandwiches can be dispensed by machines and jumbo jets can put us physically in touch with the farthest environments of this planet. Man has learned to alter his environment, his condition, and his way of life. We have approached the conquest of nature and through all of these accelerate changes, we have steadily removed ourselves from nature at an exponential rate.

Technological man is different man than primitive man, and yet the same thoughts and abilities that put a man on the moon shaped the first stone axe. How then, does our remoteness from nature, the raw environment, in our thoughts and in meeting our needs, influence the way we affect the environment? How can we develop a loving care for the land when the vital signs of life are always invisible to us? How can we appreciate the impact that each one of us has in meeting our needs when needs are met in the form of switches, luxury travel, and processed foods, topped off by an elaborate methodology of removing the wastes of this activity so that all is ever out of sight and out of mind?

ACTIVITY A:
ENVIRONMENTAL CULTURES AND PHILOSOPHIES

Teacher's Note:

Few cultures reflect more love and care of the land than the American Indian's attitudes toward nature do. They saw the interconnection of their lives to the land and to the living things of the land. This was mirrored in their customs, religions, and way of life. Their living styles meshed with the necessities of life so that they were always assured of survival. They protected the resources that sustained them and they praised the earth. The Indian was not remote from nature. He was a part of it, as the fox is a part of the forest web. Even creatures like the African porcupine, who never girdles the trees whose bark it eats, gives lessons to man. The Indian took these lessons into his life. He absorbed the lore of the woods, the hills, and the plains.

1. Plan a study of various cultures and philosophies by organizing research groups to investigate them. The class might consider planning a ceremony which reflects the attitudes of various cultures toward the land. Following are a few starting ideas. An alternate to this activity would be films or filmstrips on the different cultures — one or several.

a. American Indian Tribes
There are myriad resources for research, and the entire class may want to work on various Indian tribes in the United States.

"Once we were happy in our own country and we were seldom hungry. For then the two-leggeds and the four-leggeds lived together like friends and there was plenty for us and for them."

Black Elk

b. Aborigines (Australia)

The Aborigines, as well as primitive tribes in Africa and South America, exhibit how close man can be to nature and how the influence of the technical societies can destroy such culture.

The aborigine hunter can meditate for hours and then be off in a straight line to find game or water 50 to 100 miles away. Without this ability, he might not survive his harsh environment.

c. Buddhists and Hindus

In Buddhism, particularly Zen, and in eastern philosophy in general, there is a oneness with nature. The good and evil are inseparable parts of nature's balance.

"To lengthen the legs of the duck would bring it discomfort. To shorten the legs of the crane would also bring it discomfort." (Alan Watts)

The Hindu's respect for life extends to his ideas of reincarnation and the divinity in all life.

d. Judeo-Christian Ethic

The philosophy that man has dominion (Genesis 1: 28-30) over nature has brought mixed blessings. Man has an anthropocentric concept of nature which has hindered him as well as advancing us to our present technological dilemma.

e. Naturalists

Our country has known great naturalist philosophers. The ideas and thoughts of Thoreau, Muir, Emerson, and Einstein, as well as of today's environmental thinker, Loren Eisley, give all who read and heed their words a sense of a closeness to the earth and a cherishing attitude about the land.

f. Eskimo

Current study of this Indian tribe has been emphasized because of the controversy surrounding the Alaskan Pipeline.

g. Technological Man

This might raise the question of whether or not we have created a special culture with special demands.

"Truly moral acts can only be performed when man is no longer motivated by fear of punishment or love of rewards." (Alan Watts)

2. The previous cultural sketches are only a sampling to get students started on researching other cultures, customs, and philosophies related to environmental ethics.

After presenting the brief research to the class, have the class do some values thinking. This might be by rank ordering (a previous strategy) or by thinking about being members of various cultures.

a. Rank order: (discuss choices)
Which has more possibilities for healing today's present environmental problems? American Indians, technological society, Buddhism? Why?

b. Forced choice:
Which would you rather be, an Aborigine or an Eskimo? Why? Which would you rather be, a ghetto black or Hindu in India? Why?

c. Values continuum

Ego Ed ⟵	⟶ Nature Nel
Man is the center of the universe and it is his power and will which will and shall subjugate the land.	Man is nature and the individual is nothing. Man is but another component of the ecosystem.

Although values should not be imposed, it might be worthwhile to develop a discussion on the values of survival. Where does man stand today? Discuss the adaptations of each extreme and suggest that very likely a modification of both will have the greatest survival value.

ACTIVITY B: VOCATIONAL AND ENVIRONMENTAL OUTLOOKS

1. Interview

Individuals or groups might plan to interview various people in various vocations to determine their outlooks on the environment.

Questions might be made up ahead of time to determine what kind of environmental philosophy each individual has in relation to his job.

a. What outdoor activities do they participate in?
b. What do they consider the most serious environmental problem?
c. How should environmental problems be handled?
d. Do they belong to any environmental groups or participate in such?
e. What indoor activities do they enjoy for leisure time?

or

2. Interview 3 adults regarding their environmental outlooks. Indicate the type of work each does. How serious do they think that our environmental problems are? How close to or far away from nature do they think we really are?

or

3. Arrange to spend a day with someone (anyone). Spend a day (or a portion of a day) with someone of your choice and write down all the attitudes, ideas, and habits that might reflect their relationship to the environment, their closeness to it, or their awareness of it. Examples: doctors, farmers, teachers, ministers, street cleaners, engineers, trash collectors, custodians, cafeteria workers, bus drivers, principals.

ACTIVITY C:
THROW-AWAY CULTURE

1. Throw-Away List
   a. Make a list of all the things in society we have built or established to keep certain aspects of our community living out of sight and out of mind. Examples: toilets, sewers, nursing homes, mental institutions, jails, land fills, urban renewal, garbage disposals, junk yards, old people's homes, ghettoes.

      The above examples might come out in discussion, and this discussion can be continued to point out all the ways we have of avoiding the realities. We live and have all the same waste products and needs for living as any other living thing. We grow old, die, get sick, have problems and poverty, and waste things.

   b. A similar activity might be to visit the places and people our society often tries to hide.
   c. Another idea might be to list all the ways these discarding practices might be turned to better advantage and at the same time bring us closer to the realities of our environment.
   d. Use elderly people as educational resources. (Other cultures respect the wisdom of the elderly.) How many people relate to old folks?
   e. Study recycling practices, composting, returnable bottle laws and practices.
   f. Study environmental city planning.

2. Gutter survey - (Most interesting if urban, suburban, and rural communities could be compared.)
   a. Divide the class into collecting teams so that at least one city block can be covered by each team or person.

      Have them walk or bike along the gutter of the street and collect every discarded item they can find.

   b. Arrange all the items collected and classify them according to their part in technology: Are they necessary items, a resource depletion, recyclable, unnecessary litter, etc.? Some interesting items that are often found are the lead weights used for balancing tires.

      Since it is obvious that these come off easily, they represent not only a waste of lead (also possible toxicity) but also tire wear and a drop in auto efficiency.

   c. Conduct a discussion on the evidence of a throw-away society.

      Consider the impact that this has on the environment. It is really aiding the tendency of the environment toward higher entropy, and therefore it increases the random scattering of our resources, which took ages to become consolidated. Furthermore, energy must be expended to lower the entropy and restore the previous order. Life processes are a constant effort to maintain low entropy.

3. Developing Personal Non-Throw Away Attitudes

   Consider making some change in attitudes and habits that would not involve perpetuating a throw-away culture. One of the problems of an affluent society is that we never seem to question whether we really want something or whether it is really worth it. No one has really bothered to ask whether or not the automobile was something we wanted or whether it was worth it, yet the automobile has disrupted and even depersonalized our society to the extent that we are dependent upon an environmental dilemma.
   a. Discuss this statement: "You can't stop progress" Define progress in terms of an environmental ethic and waste.
   b. Make a list of all he things you could do without.
      Expensive, synthetic-fiber clothes
      Bigger cars (or a car at all)
      Unnecessary appliances (incinerators, disposals)
      Jewelry
   c. Make a commitment to put in to practice one non-throw away habit.

      Make a compost pile for a backyard garden or window box
      Never buy nonreturnable containers
      Shop with your own bag and refuse the store's paper bags
      Eliminate one major appliance you can do without. (Wasted energy is also a throw-away cult!)
      Modify your means of transportation (bike, walk, take a bus.)

4. Reflecting Upon the Seen and the Unseen
   It is probably true that we would be more conscious of our impact on the land if the products of our activities were always made apparent to us.
   a. Make a list of the "products" of our apparent activity.
      (1) billboards (general advertising media)
      (2) smoke
      (3) odors
      (4) noise
      (5) wires
      (6) roads
      (7) city buildings
      (8) industry
      (9) agriculture
   b. Make a smiliar list of the "products" of our non-apparent activity.
      (1) sewage disposal
      (2) air and water repositories
      (3) trash, land fills
      (4) runoff
   c. What is the real purpose of being aware of the products of our activity? Everything has to go someplace and the realization of that may change our thinking concerning some of our throw-away attitudes.

ACTIVITY D: EXPERIENCING THE ENVIRONMENT (CONSIDERING HOW REMOVED MAN HAS BECOME)

1. Meeting our needs by remote paths
   a. Take a school survey of the luxuries and necessities you obtain. Trace the means through which you received this luxury or necessity. Examples:
      (1) Cafeteria (food)

      Soil (plants or feed for animals) → farmer → processors → distributors → wholesalers → preparation → retailer → you

      (2) Paper

      Soil → tree → paper mill → processing → wholesalers → distributors → retailers, etc.

   b. Make a survey of your community, home, or wherever most of your needs are met, and make similar paths showing the number of levels you are removed from nature.

   c. Discuss all the processes and levels which the necessities of life must go through before they become a part of the individual.

      Develop the idea that the greater our technological advances are, the more removed from the earth our needs' fulfillments become.

   d. Make a list of necessities vs. luxuries that we may think are necessities. This might include pesticides. fertilizers, autos, radios, etc. How do these help to remove us from nature?

2. Needs directly from nature

   If possible, arrange to have the entire class for an entire day, and spend the time in activities designed to utilize (with conservation in mind) things in the environment for various comforts, recreation, and needs.

   This may involve the class in planning the places they will visit and the kinds of skills they will need in preparing for this experience. Foraging and preparing food may involve considerable research, and a group or team of students may want to prepare this for the class. It could readily develop into a class project.

   The other alternative to spending a day with the entire class would be to assign one of the activities listed below to each student or group of students. Let them choose the one that would be possible for them and that they would be interested in. Allow a week or two for them to complete it (or several days of class time if this is feasible). Have the students write down thir experiences in journal form (first person) and then bring their project to class and share their experiences. It is important to stress that they may not destroy anything of nature, i.e. break a living branch off a tree, if this would cause damage to the tree. In the case of food gathering, they may not strip a bush or whatever so completely as to leave no seeds or food for other animals. Also, in the construction or preparation of their projects, they may use *only* articles directly from nature or those which they have made directly from nature. The purpose of these activities is to increase everyone's sense of dependency upon the environment by satisfying our needs as directly from the environment as possible.

   Plan some time during this activity to reflect upon the needs of man and possibly to develop some personal awareness about the best way to satisfy our needs for comfort, survival, recreation, and creativity.

   a. Wild foods (gathering and preparation)

      Find what foods are available in the environment for the season, and find areas where permission for foraging has been granted. A large amount of food is not necessary, since this could be a symbolic experience.

      Prepare the food for eating and share the food with the class. Reflect on the processes of nature and man that brought the food to you.

   b. Building a fire. (It could be built from scratch, but the best scratch may still be with a match.)

      Consider the warmth of the fire. Contemplate the fire as a friend, and again, be mindful of the impact of having a fire.

   c. Without destroying any part of the environment, gather materials and construct a lean-to or similar shelter, or a model of one.

   d. Make something out of clay.

   e. Draw a picture from plant juices, dyes, or charcoal.

   f. Make a tool from materials in the environment (without destroying anything living).

   g. Design a recreational pastime using nature's materials. (pine cone baseball with sticks and pine cones)

   h. Plan a whole day or at least a half day in which nothing but materials and resources directly from the environment are used.

3. The Aesthetic Nature of Man

   Man is, by necessity, a part of nature; we might consider the possibility that the aesthetic nature of man is the inner longing we have for what we have lost by removing ourselves from direct contact with the earth.

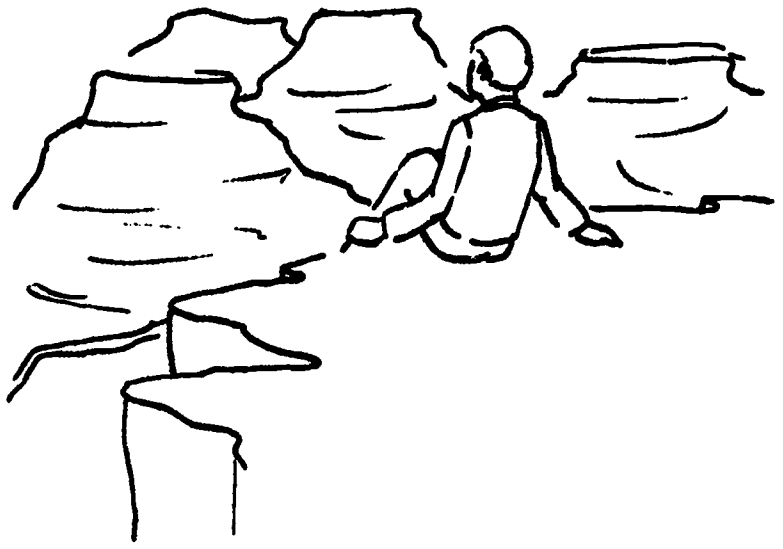
   Most of our dangers are self made: machines, poisons, weapons. We have not been separated from the primitive by so many years that we are comfortably adapted to man-made environment.

   What feelings do we have concerning nature, beauty, solitude, peace, inspiration, oneness?

   How are our lives connected and related to this feeling for nature?

   One or several of the following activities done by individuals, or small groups in some cases, should help that student become aware of his aesthetic sense.

This might also be a good time for students to rewrite their environmental creed if they have already done so in Experience #1. Or, if this was not done, it might prove a suitable alternate for exercise f., number 6.



a. Aloneness in a natural environment

(1) Spend at least one half-hour in a place removed from the general activities of man (if possible), such as a hillside, forest, quiet lake, stream, or meadow, some place that is aesthetically pleasing.

Remain absolutely quiet and tune all your senses in to the environment.

Smell, touch, listen, watch, taste (don't taste unfamiliar things), and think.

(2) Share your experience — What words describe this experience o solitude? (insignificant, insights, uncon.'ortable, lonely). Did you feel yourself to be an actual part of nature?
Was there a special spot that seemed to be yours?

(3) Express your experiences in writing (journal entry).

b. Aloneness in a man-made environment

(1) Try the same experience that you had with a natural environment in an environment where there is man-activity or in a man-made environment.

Repeat the process used in your aloneness with nature.

Concentrate on not being distracted.

(2) Compare the experiences and share with each other your feelings.

(3) Can you find solitude in a man-made environment?

c. Environmental fast (much care and discretion should be exercised if this activity is chosen)

(1) Try going without food for twenty-four hours or some period of time so considerable that the feeling of hunger is acute. Try to record your reaction to this experience. Think about your senses. Are senses other than those related to hunger heightened?

(2) Prior to a decision to fast, discuss these:
World hunger and population
Hunger in America
Malnutrition
Vegetarianism and the pros and ' as of organically grown food

(3) After fasting, share this experience with the class.
What feelings were heightened?
Did you feel that your abilities became sharper or duller?
Did it bring you closer to nature or farther away? Explain.
What activities did you engage in that you would not have engaged in otherwise? Pacing, sleeping, reading, exercise?

(4) This activity might be modified by allowing food to be eaten if it was obtained directly from the environment (fishing, hunting, foraging). This may evoke discussion of predator-prey relationships.

Study energy flow in hunting societies.
Study energy flow in agricultural societies.
Study energy flow in technological society.

d. Survival list (immediate and long range in a specified environment)

(1) Pretend you are totally dependent upon the environment. Make a list of the priorities that you would need in order to survive immediately and over a longer period of time.

(2) Discuss these lists with the class in general.

(3) Develop a survival ethic as a class. How would the class organize for a survival experience?

e. Wilderness

(1) Consider the fact that our wilderness areas can never get larger but only can shrink.

Why is this true?

Why do we need wilderness areas?

Personal value
Scientific (ecological) value
Societal values

(2) Research present wilderness areas and the wilderness acts.

(3) Make legislative bodies aware of your feelings concerning wildnerness areas.

(4) What prevents the establishment of more wilderness areas?

What interest groups are opposed to wilderness areas?

Make connections between wilderness areas and Indian reservations.

(5) "If a man spends half a day in the woods enjoying its beauty, he is deemed a loafer. But if he spends a whole day as a speculator, he is a hearty worker — as if our only interest in trees is to cut them down and lay bald the land."

Thoreau

How does this quote reflect our attitudes toward wilderness?

f. **Considering the "Real" Environment (or the "Natural Environment"**

Man, in his closeness to nature, his longing for the solitude of its wildness and his appreciation of it as beautiful and the source of his needs and satisfaction, sometimes overlooks the truth that our real environment and, to a great extent, our natural environment is the environment we exist in at this moment and in our daily routines. It is important that our attitudes toward the beauty and importance of undeveloped land should extend to our views of our immediate and daily environment.

Some of the following activities could extend into surveys, group research, or discussion within the class:

(1) How do you feel about the environment you spend most of your time in?
(2) What aspects of the environment you live in do you consider negative? Positive?
(3) What evidence do you see in your environment of negative feelings about the environment? (litter, vandalism, urban blight, advertisements, people values)
(4) What do you consider doing about your environment?
(5) Play the Coke game (see bibliography).
(6) Place a picture of yourself on a piece of cardboard and draw a community around it. Blend the picture and the drawing harmoniously.

EXPERIENCE #4
MAN AND HIS ACTIVITIES ARE IN THE MIDST OF EXPONENTIAL GROWTH

OBJECTIVES:

a. Students should develop an awareness of the direction our values have taken us in terms of development and growth, ecologically and economically.
b. Students will consider the consequences of growth and decline.
c. Students should begin to develop world views in relation to the human condition.

Teacher's Note:

We are a species whose activities are continuously growing to meet the expanding needs of an expanding population. But there are limits to all growth. What those limits will be and how they will affect society depends upon man's global view of the environment.

Our habit of technological thinking helps us when we try to forecast solutions to energy needs, food production, and preparation for space and the nuclear age. But there does not appear to be agreement on what is desirable for human life. Technologies that grow, however, have limitations, and it would seem absurd to expect man to adapt to new technologically-produced environments without considering the biological limitations such environments would use.

According to some estimates, man is capable of providing food (through scientific technology) to support a population at least ten times the present one. But such technology would mean a population growth that would have to eliminate all forms of wildlife which competed with it for space and food. The result would be that man would have to destroy all the aspects of the environment through which he has evolved (changed and adapted) to his present condition.

Other conditions besides those needed for fundamental maintenance of the organism have to be considered in our growing society. Room for creativity, independence, quiet, and solitude are as important to the human condition as the functional necessities. Biologically, man has remained constant for a long period of time, but he is being continually subjected to new conditions. The problems of pollution and the related problems of growth have psychological and social effects. Because man can do something should not mean that he must do it. Choice is the key to the human condition, because only humans can make the choice, and the choice is based upon values.

ACTIVITY A:
DETERMINING WHEE MOST OF OUR CONCERNS ARE FOCUSED

1. Strategy: Have students find their positions on the following scale by placing a mark or listing the concern after one of the following areas in answer to questions asked by the teacher.

Personal					
Family					
Friends					
Community					
Nation					
World					

Questions which might be asked include:
Where do your concerns about health lie now?
10 years from now?

. . . about love, food, entertainment, war, sex, protection, money, transportation, beauty, death, etc.?

Students should then analyze their "concerns." This can be done individually, in small groups, or with the whole class discussing the issue. The result will probably be that most concerns are personal over short periods of time rather than global over long periods of time.

3. Some discussion on developing a world view could follow this strategy. Examples of situations that could be referred to are these:

   a. A farmer's life toil is obliterated by international warfare.
   b. Personal values are destroyed by deterioration of life quality.

ACTIVITY B: POPULATION DYNAMICS

One aspect of population dynamics that might be researched is the growth rate in relation to population fluctuation.

1. Investigate population curves (growth).
2. Grow cultures of organisms that can be studied for population studies, such as daphnia, paramecia and bacteria, yeasts, and fruit flies (which might be easiest to count!). Observe these over a period of time and record data for discussion.
3. The discussion of either of these activities would include:
   - the observed fluctuations
   - actual or probable reasons for the fluctuation
   - the effects of controlling some or all of the factors which cause fluctuation on the world ecosystem

ACTIVITY C: FACTORS AFFECTED BY GROWTH AND DECLINE

Discussion questions for beginning the development of a community model which gives consideration to growth)

Teacher's Note:
Somewhere in this discussion it might be brought out that numbers are not always the only determining factor — consumer rate plays a big role.

1. *What are the factors affected by growth or decline (natural or societal)?*
2. *It might be worth while to investigate what is really meant by these five factors. (Have the class define them.)*
3. *How are these factors affected by growth and decline (See above for possible conclusions)*
4. *For students who wish to and are capable of going further there are possibilities for student-initiated investigations of the energy flow in various societies and cultures, in order to consider the effects of growth and development on energy use.*

   Hunting societies
   Agricultural societies
   Primitive societies
   Technological societies
   Schools
   Neighborhoods
   Homes

ACTIVITY D: THE PRICE OF GROWTH

1. Consider some aspects of the cliche, "the effluents of affluence."
   a. What physical things are necessary to maintain growth?

      Food: production up, but *per capita* down
      Land: to grow food; for housing, roads & waste disposal; lost in erosion

   b. Where does it all go?

      The atoms of metals and fuels increase their entropy and when rearranged, are unusable in the soil, water, and air. More energy must be expended here by the ecosystem in order to reprocess the effluents of our activities
2. Crisis signs: Discuss some crisis signs in the environment and in society.

   Food prices, dietary quality, energy demands, wilderness losses, suicide rates, toxic metals, persistant poisons
3. Who benefits from growth and who is most responsible for pollution?

	GROWTH	*DECLINE*
POPULATION	*- rapid growth (exponential)*	*- decrease*
AGRICULTURAL PRODUCTION	*- increased production & malnutrition*	*- decreased production; fewer jobs*
INDUSTRIAL PRODUCTION	*- accelerated*	*- decelerated; fewer jobs*
NATURAL RESOURCES	*- depleted*	*- possibly still depleted because of a certain selfishness and affluence*
POLLUTION	*- environmental deterioration at all levels*	*- deterioration may still continue due to reasons stated above and fewer persons engaged in technology due to decrease in numbers*

The following are some facts which can be used to start discussions:

a. The United States uses 20-50% of the world's non-renewable resources (Complete list, p. 64-65, Meadows) for 6-7% of population.
b. The U.S. is number one in defense but is not number one in literacy, health, education.
c. Ten to twenty million deaths are due to malnutrition.
d. Pollution has been the major factor in a forecast that the life of the biosphere can be measured in decades.
e. Aspects of Pollution:
   (1) Kinds of pollution are increasingly exponentially.
   (2) The upper limits of tolerance to pollutants are not known.
   (3) Distribution of pollution is global and often far from the source.
   (4) What do the above three aspects tell us about our own demands as world citizens?
   (5) In view of these aspects, how are our activities short-sighted? How are our activities related more to what we don't see than what we do see?

ACTIVITY E: VALUES CONTINUUM

1. Conduct a brief discussion about where man is today in relation to his values and the environment, and try to develop some directions that society might take.
2. On the basis of discussion, construct a values continuum which ranges between two extremes:

Back to nature ⟵ Improve the Status Quo ⟶ Futuristics

This might be constructed as a large chart, and each person could place his name where he feels he belongs on this continuum. As the unit progresses, encourage them to move their positions if they wish, and this movement can also be re-evaluated at the end of the unit.

3. An alternative approach to values:
   Where do I Stand on Environmental Values?

Back to Nature	Things aren't too bad as they are	Don't worry, technology will find an answer

Mark where you are on this line. Mark in anyone else you can. Now explain why you think you are where you placed yourself on the line.

ACTIVITY F: THE LIMITS TO GROWTH ARE UNKNOWN

1. Increased energy demands: CO_2, nuclear waste, mercury, lead, and waste heat have all increased.
   Discuss what effect these factors *might* have.
   How long before life processes are irreparably disrupted?
   The point is that we do not know, but we still continue to grow.

2. DDT — Meadow's study indicates that the peak quantity of DDT in fat tissue will be reached 15 years after DDT is banned. This phenomenon is invariably true for other toxic accumulations.
   What does this mean when we detect a harmful effect from some pollutant?
   What about carcinogenic and genetic effects of radiation? What will be the outcome if we should detect harmful effects?

3. What is the implication of the time delay between cause and ultimate effect?
   Delays have serious effects, especially when the system is in rapid change (growth). This might be analogous to a sky diver and a decision about when to pull the rip cord. A decision too late in treating problems with long range technology could result in an overshoot and collapse of the system.

4. Carrying capacity: Discuss this aspect of growth by possibly discussing Hardin's "The Tragedy of the Commons."

5. Postponement of environmental debts.
   a. What trade-offs have been employed to postpone environmental debt payments?
   b. What might be the result when trade-offs become a choice between absolutes?
      Example: more people vs. more food per capita

ACTIVITY G: PROBLEMS WITHOUT TECHNOLOGICAL SOLUTION

Teacher's Note:
Activities G, H and I are included for those groups which may have the interest and ability to probe the problems of growth and development more deeply.

1. Discuss the following problems which seem to have no technological solutions:
   Nuclear arms, racism, unemployment, strikes, social breakdown, anomie, crime
2. Will these problems become limits to growth?

ACTIVITY H:
GENERALLY, TECHNOLOGY HAS FOUGHT LIMITS

1. What are some examples of how technology has fought limits?

   Whaling industry (good example)
   Fishing industry (Lake Erie)
   Fur industry?
   Green revolution?
2. Is it better to live within a limit or to continue to grow in the hope that a technology will allow growth to go on?
3. List as many methods as you can to overcome our limits to growth.
4. Have these methods involved self-imposed restrictions on growth?
5. What are some possible self-imposed restrictions? recycling, pollution control, contraceptives?
6. What kind of thinking, in relation to growth, involves our energy crisis?
7. Before technology is employed to fight growth limits, what questions might or should be considered first? Why?
   a. What side effects (physical and social) will it bring?
   b. What social changes will be needed before it is adopted?
   c. What limit will be encountered later?
   d. What are society's values in relation to technology? Will it prefer present limits to new ones?

ACTIVITY I:

Discuss the following in connection with personal, national, and world values, and rank them in relation to present practices and values.

1. Unrestricted Growth
2. Self-Imposed Limits
3. Natural Limits

ACTIVITY J:
DESIGNING AN IDEAL COMMUNITY

1. Based on the discussions of this experience, have the students develop plans for an ideal community (their community!). Again this can be done as a class activity, as a small group activity, or on an individual basis. This also has the potential for a long range activity.
2. Research
   a. Investigate literature: McHarg, Meadows, Fuller, Dubos, *Blueprint for Survival.*
   b. Write to the city and state planners who are concerned and doing things in this area (the governor of Oregon).
   c. Interview landscape architects, developers economists, and ecologists.
3. Equilibrium state model
   Some guidelines might help in planning a community.

   Meadows *(Limits to Growth)* has posed an equilibrium state world with the following parameters:
   a. Capital (industry, agriculture, services) and population constant
   b. Input and output rates (birth/deaths, investment/depreciation) minimal
   c. Ratio and levels of population and capital in accord with values of society
4. Factors of Ideal Design

   Consider guidelines for an ideal system based on research, and let creativity and imagination do the rest. Planning ahead for this would be a large asset.
5. Futuristics of life in an ideal community or world at a state of equilibrium.

   The following could be considered as factors within the design:
   a. Growth energies diverted to creativity
   b. Leisure time
   c. Incentives for work, improvement of the quality of life
   d. Outgrowths of this system, extending limits
      New disposal methods, recycling and pollution abatement
      Recycling techniques
      Craftmanship, long life quality
      Natural pest controls in harmony with ecological concepts
      Alternative energy sources, solar, wind
      Medical advances
   e. Environmental laws, pollution costs and controls built in
   f. Recreational needs related to the environment, biking, etc.
   g. Transportation

This activity might significantly tie together earth thoughts about the social, psychological, biological, aesthetic, and physical needs of man in relation to a balanced system which is in harmony with nature.

EXPERIENCE #5:
DEATH

Possibly as the final activity segment of Earth Thoughts

OBJECTIVES:

1. Students should see the significance of death in relation to life on an ecological level.
2. Students should consider death, its relation to themselves, and its relation to man and his activities.

Teacher's Note:

Man is unique in that he can contemplate his own death. Contemplating death is something we often do in relation to other things. Environmentalists are vitally involved with death — the death of a species, mortality rates (maybe the most important of negative feedbacks in a system), the death of the

environment, the death of the planet, even the death of man — but only collectively. Death is, almost invariably, something that happens to someone else. Even though we are aware that, ultimately, we must die, we are more apt to conduct our lives as if we were immortal. Certainly this thinking has an impact, not only on the conduct of our lives, but on our relationship to the environment as well. Possibly it is our view (or nonview) of death that lends impetus to throw-away attitudes, short-sighted technology, inexorable and mindless growth, apathy about warning signs, and uncaring outlooks for the future environment of mankind. For surely, if man considers himself immortal by consciously or unconsciously placing death's absolute certainty on someone else, then it follows that he will regard deterioration of the quality of life (the living aspect of our environment) as also affecting someone else. The same attitude that has caused economic, social, and political ills of the past — that it can't happen here — is a sad reflection of the human ability to avoid and postpone the responsibility of now.

The above paragraph is an attempt to set the tone for a segment of Earth Thoughts which has a variety of ramifications. Each teacher may be able to develop these divergent interests into a process activity. This segment also has possibilities for leading into the Quality of Life unit. The contemplation of death would certainly be included in, if not vitally related to our study of the quality of living.

The schools, like most of us, have historically avoided the topic of death, yet over 5,000 Americans die every day. What's more, 10,000 irreplaceable nerve cells die each day in each one of us. After age twenty, we are physiologically on our way down hill at an exponential rate. Furthermore, science has only recently taken the attitude that death is something we can learn from, and although people die often in literature, we avoid any real intellectual or emotional study of death.

Death in a unit on environmental studies can be dealt with at all levels: ecological, social, and personal. In school, as in the rest of our society, death is kept hidden and becomes another toilet-type item that is swept from our minds. But death may be one of the most important questions of our times. It deserves mature thought and study. The following activities are an attempt to broach this thought.

Death is an integral part of the ecosystem, not because of the obvious fact that all life must die, but because death is a necessity for live. Death sustains life and maintains its delicate balance with the earth. Activities A through C concern the ecology of death.

ACTIVITY A: DISCUSS THE PHILOSOPHY OF THE TIMELINESS OF DEATH

1. Premature death
   a. How many organisms die prematurely at the hands of predators? (Consider the social protection of the young and protection of the nest, as well as the kind of animals that prey on the young. Include egg-eating animals.)
   b. Consider the value of premature death. What are some positive aspects? (Consider scavenger species, species which could not survive without preying on young or eggs. Also important in this discussion is the effect on the genetic pool.) What principles of evolution (natural selection and survival of the fittest) help maintain a strong species? Negative aspects: What species is involved with overkill?

2. Postponed death

   Consider the value of death postponed or its rate diminished. What are the positive and negative aspects? (Discuss the positive and negative aspects of man's ability through medicine, agriculture, and technology to prolong his life.) Major points might be population, the genetic pool, competition, life quality, and psychological factors such as anomie.

   Consider aspects of helping certain species prolong its life.

3. Interview people who deal with postponement or premature death.
   a. Spend a day or class period interviewing people involved with prolonging life (postponing death). Question doctors and other medical personnel, particularly those dealing with these aspects directly: gynecologists, obstetricians, cancer and heart doctors, abortion clinics, researchers.
   b. Check on cryogenics and the number of people who freeze their bodies after death.

      How is this procedure done? What does it cost? Who does it?

4. Have a values discussion involving controversial topics:
   a. Abortion
   b. Euthanasia
   c. Right to die/live

ACTIVITY B: IMPACT OF DEATH ON ECOSYSTEM

Teacher's Note:
Not only is the impact of death felt in reckoning population growth, but it has a definite secondary impact on the stability of a community over short and long terms.

1. *Visit some area where ecological succession is evident (sand dunes, forest, meadow, city) A filmstrip or film on succession would be substituted if necessary.*

   Discuss ecological succession as a preliminary to this, and have the class compile a list of how death in each instance laid the groundwork for the succession of the particular ecotype studies.

2. *Eutrophication and death*

   This is an opportunity to relate changes in the environment to death by studying the en-

vironmental phenomenon of eutrophication. (This may have been discussed in relation to succession.) Study algae blooms, oxygen depletion.

3. *An ecosystem which has been maintained successfully might be used to demonstrate the effect of death by adding to it something dead or by killing something already in the system.*
4. *Black Death*

   Discuss global catastrophes, such as the Black Death in medieval times, and the social and psychological impact they had on society. Read Ecotastrophe by Paul Erlich.
5. Roadside Inventory
   a. Have an individual make an inventory, or plan a day when the class can drive a good distance in the country to observe the evidence of the death of animals along the highway. This is a reverse impact. It concerns technology's impact on the system.
   b. Make a list of the number and kind of animals per mile.
   c. Make a note of scavengers — crows, insects.
   d. Discuss whether the high or low incidence of dead animals is a good or bad sign. This activity might as well conducted along an industrially polluted river or lakeshore.

ACTIVITY C: DEATH AND ITS RELATIONSHIP TO LIFE

1. Death in relation to major biogeochemical cycles.
2. Death in relation to the food chain, the role of decomposers

   (These two aspects of the environment involve death, and they can be considered from a cognitive point of view or an activity-oriented point of view. There are a number of activities related to these topics, as well as considerable information in any basic text. The main value of this brief study is to orient the student to some basic ecological principles, as well as to envourage further his thinking about death in the environment.)
3. Death in relation to survival

   There are a vareity of interspecific relationships which have considerable ecological interest, as well as turning students on to the amazing behavior of living things.

   a. Discuss interspecific relationships:
      (1) Outline some of the major interrelationships. There are ten possibilities; here are some:

      Symbiotic (living together) relationships: mutualism, parasitism, commensalism, and protocooperation
      Predator - prey relationships
      Competition for resources or direct interference

      Have the class list as many interspecific relationships as they can in terms of their own natural environment. Better yet, go on a walk through a relatively diverse area and make a list.

      (2) Have the class walk through and around the school and make a similar list. In each case, note where death is a significant aspect of the relationship.

   b. Do a detailed study of a ecotype community in which the interspecific relationships have been worked out to some extent. The Serengeti Plain in Africa is a classical example. *(Natural History,* February, March, and April issues, 1972.)
      (1) Compare this system, in which death is always an important aspect of survival, to the American Great Plains.
      (2) What were predator - prey relationships?
      (3) What impact on other species or other animals, on grasses, and on the American Indian did the killing of the buffalo (by technological man) have?
   c. Play the game Predator - Prey (See Bibliography)
   d. Death in relation to life

      Man, in many ways, has become what he has eaten and certainly now is what he eats. Depending upon the level and maturity of the class, plan an activity in which domestic food is prepared for eating by slaying the animal (chicken?). This is in keeping with knowing where our survival comes from — from death.

      Plan a visit to an area of animal slaughter, a farm or an industry.

ACTIVITY D: HOMES OF THE DEAD

Teacher's Note:
Activities in and related to the homes of the dead are Activities D through H, starting with planning and making a trip to a cemetery. This type of activity can tell us something about what man thinks of death — and life!

Discuss the burial customs of various cultures and possibly visit a museum or an ancient burial ground with the idea of learning about burial customs.

Indian (Ohio mounds)
African native (various tribes)
Egyptian
Hindu and Buddhist
Judeo-Christian

Some Eskimo tribes place their old out alone on the tundra for the polar bears. Read "Marginal Man," a very short story, or in *Eco Fiction.* How do burial customs relfect the culture and the life of the peoples? How are death and aging treated in various cultures?

ACTIVITY E:

Choose a cemetery within traveling distance (hopefully walking) that can be visited by the entire class so that several trips might be made. Older cemeteries are more interesting.

1. The cemetery as an ecotype

   Some students may wish to study the cemetery as a particular ecotype, and cemeteries offer many opportunities:

   a. Bird habitat: nest inventory, territorial studies, count and behavior
   b. Edge-effect environments and ecological successions
   c. Ecosystem: component inventory (brief and general), energy flow
2. Cemetery as an environmental index
   a. Deterioration of head stones (air pollution and climate)
   b. Dates on stones give clues to age of this ecotype
3. Cemetery as an environmental impact
   a. Fertilizer and pesticide practices
   b. Use of nonrenewable resources: decorative, functional, maintenance.
   c. Housing of the dead and their encasement. Is it ecologically sound?
4. Cemeteries in relation to land use
   a. Wild life sanctuary possibilities
   b. Recreational use (picnics, lawn games, relaxation and solitude, biking, jogging)

ACTIVITY F:
LAND-USE STUDY

1. Class might determine the total acreage in the community devoted to burying the dead.
2. Interview cemetery managers. Determine the following:
   a. Who is buried — wealthy, poor, white, black?
   b. How is the cemetery used now, besides for burial?
   c. Would the managers be receptive to other uses? Recreation, wildlife sanctuary, biking paths?
3. Write to a legislative body about possible legislation for land use in cemeteries.
4. What values clashes are apparent in attempts to use cemeteries in other ways? Discuss how this might be resolved.

ACTIVITY G:
VANDALISM STUDY

1. What evidence of vandalism is there?
2. How much is malicious and how much is for profit?
3. How might other uses for the cemetery cut down on vandalism?
4. Discuss the idea that certain kinds of vandalism are often an expression of man' fear of death.
5. Possibly a school survey of vandalism might be meaningful at this point.
   a. How is school vandalism related to death?
   b. How is school vandalism related to school environment?
6. What graffiti did you find? What does it tell you?

ACTIVITY H:

Interview or visit with people and places which are concerned with death.

1. Personally interview or observe the following:
   a. Doctors, daily rounds at hospital, an autopsy, pathologists
   b. Undertakers, emblaming
   c. Homicide detective
   d. Psychiatrists
   e. Rabbis, priests, ministers
2. Go to a place related to death
   a. Hospital
   b. Morgue
   c. Funeral parlor
   d. Suicide unit or prevention center
   e. Terminal patient home (cancer)
   f. Church or synagogue
3. Related activities that can be followed through:
   a. Forensic science. Biological and chemical methods to determine cause and time of death
   b. Embalming — methods and economics (personal values and the cost of dying)
   c. Suicides — statistics, causes, social/economic aspect, etc.

ACTIVITY I:
CONTEMPLATING DEATH

Discuss answers or respond in journal form to questions related to death on a societal level. (Activities may be generated accordingly. Add your own questions.)

1. What are various ideas that people might have about where they go after death?
2. In what ways do the advertising media exploit society's fear of death?
3. How is death dealt with in the entertainment media?
4. Suicide ranks tenth among causes of death (probably higher, and including many notables), raising questions about its causes and morality.
5. How can society better prepare its members for death?
6. What are our attitudes toward death and how are they a reflection on how we affect our environment or the quality of life?
7. Do we have the right to death with dignity?
8. What are your views on euthanasia?
9. What are other society's views of death? How do they influence their lives? How does our view influence us?
10. What would society be like if no one ever died? ("Marginal Man" and "Tomorrow and Tomorrow and Tomorrow")
11. How does popular music reflect death?
12. What do you think of when you hear a siren?

ACTIVITY J:

Check the newspapers over a period of time for articles related to death, including the daily obituaries.

1. What copy space is donated to covering natural deaths?
2. What copy space is donated to covering violent and unnatural deaths?
3. What is the closest you have come to dying? How do you feel about it?
4. Do you have the right to take another life?
5. Contemplate your own funeral and describe it for the class.
6. Where do you think you will go after death?
7. Think about the opportunity to prepare your own obituary and then write out your own obituary.
8. What are you doing to postpone death?
9. Would you donate your body to science? Would you freeze it?
10. Do you consider man an endangered species? Is our attitude or fear of death relected in this answer? (societal question)
11. Do you fear regret death? Why?

ACTIVITY K: DEATH AND THE FUTURE

Consider the following thoughts or questions:

If one's awareness of death allows him to face the possibility that tomorrow he will die, what does the future mean to him? In other words, how would you want your future to be, knowing you have a finite time to live?

We are alive for a very short time on our planetary spaceship (our home). In this short time, how can we create futures of environmental quality?

ACTIVITY L: CREATING YOUR OWN FUTURE

1. Generate ideas and discussions about environmental futuristics and discuss the implications of creating your own future. What kind of person creates his own future?
2. Make a class discussion to do something that would create their own futures — rather than having their futures created for them. This activity should be positive, and any risks the students take should be taken by the teacher as well.
3. Possible activity idea
   The class might decide to take an entire day to talk about the personal aspects of death. An entire symposium, including symbolic dramatizations of death, readings, philosophy, discussion and environmental concerns about death, might be held. Guests could be invited.

The creation of the future needs to be done spontaneously and without interruption. This might include ignoring the bells, excluding other classes, and upsetting administrative routine, parents, and other teachers.

Are the risks of creating your own future worth that future?

How was the future (now the past) a result of your action and decision?

What unexpected results were due to creating your own future?

Was the future you created worth the risks? Why? Why not?

How was this related to the quality of life and your confrontation of death?

ACTIVITY M: EPILOGUE

Man's view of his mortality must certainly influence his view of life and its quality. Is it possible that the fear of death drives us to live so high? Or does the fear of death detour our thoughts from dealing with the quality of life?

We are but a short time in the vast existence that was and is to be. The present is instantaneous, the past determines the present, and the future is determined by it. Therefore, we may not wander here and now without responsibility.

a. Write an obituary for the planet Earth.

b. Read John Donne's poem, "No Man is An Island."

No man is an island, entire of itself;
Every man is a piece of the continent,
a part of the main; if a clod be
washed away by the sea, Europe is the less,
as well as if a promontory were, as well
as if a manor of thy friends or of thine
own were; any man's death diminishes me,
because I am involved in mankind; and
therefore never send to know
for whom the bell tolls;
it tolls for thee. *John Donne*

c. Consider the ecological significance of this poem, and develop some personal thoughts about it.

(1) Share them with the class.

(2) Write them in your own journal.

EXPERIENCE #6
STATE OF THE SPECIES

OBJECTIVE:

Students should re-evaluate their earth thoughts and express them creatively.

Teacher's Note:
Other methods and activities can be devised by students and/or teachers.

The direction of these activities may also be toward how the students "Earth Thoughts" have changed.

ACTIVITY A:
COMPILE AN ENDANGERED SPECIES LIST

Consider pictures, cause and effect relationships, values in conflict (hunting and trapping as well as fur industries and fishing industries), environmental factors.

Conduct group discussions or group research about certain species of individual interest.

Write to organizations: Audubon Society, Wilderness Society, Sierra Club, hunting and fishing organizations, state legislature.

Does man belong on the endangered species list? Why? Why not?

ACTIVITY B:

Have the class (individually or in groups) make a collage from magazines, drawings, or original art work which symbolically portrays relationships in the environment centered around a particular earth thought: the state of the species.

ACTIVITY C:
WRITING A CONCLUDING ENVIRONMENTAL CREED

Have the class collect thoughts which were formulated during the past study concerning cultural and ecological values, philosophies, man's relationship to his environment (nature), quality of life, growth, etc.

Their final environmental creed might include a personal land ethic and an observation of how their creed changed from the original creed they made. It might also include some remarks concerning the quality of life in their school, community, and the world.

ACTIVITY D:
STATE OF THE SPECIES MESSAGE (CEREMONY)

Have the class plan a cooperative culmination of earth thoughts into a State of the Species Message. Encourage them to be as creative as they can be and to use their imaginations in presenting their final message:

Contents (suggested ideas) might include:

- Some reference to earth thoughts
- An environmental ethic statement
- Future commitments to the state of the species
- Values and action
- Environmentalists as revolutionaries
- Predictions for the future state of the species

The entire message could be given complete with costumes, skits, rituals, readings, music, demonstrations, placards and signs, a two-party system (based on values), and lobbyists.

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GAMES:

The Coke Game: Ecology Kit Code X013, Distributed by Bottlers of Coca-Cola.

Predator-Prey, Urban Systems, Inc., $6.00.

TEACHER'S NOTES:

QUALITY OF LIFE

The following unit presents sequential activities that offer a basic from which the individual student may establish what, for him, determines the quality of life. To help define what quality of life means, the unit offers environmental awareness through sense perception, exploration of environmental lifestyles through participation in activities, and experiences designed to help the student contemplate and confront his system of values in relation to his personal view of the quality of life. Since this is a subjective term, dependent on our perceptions of life and our relationship to it, our views of it may, indeed, be quite different and possibly very contradictory. Increasing our awareness of the oneness of man and nature and the part we play within that infinite connection can only lead to a desire and, hopefully, a commitment to protect and preserve our quality of life.

We are continually confronted with what seems to be an inexorable deterioration of the quality of life. What is it that we recognize as this quality of life and what can we do about preserving it? An awareness of the deteriorating quality of life must be prefaced by the knowledge of what constitutes quality. Building this awareness should include a means of having students arrive at the fact that man is not separated from the intricate web of life. The student must learn to assess the real cost of our survival and the impact we create on the environmental quality in sustaining our daily needs. Furthermore, the necessary trade-offs must become apparent to true world citizens in order for them to decide how they will conduct their lives within the complexities of nature.

The unit is meant to be a flexible guide to other activities and is designed to give the teacher some sense of philosophy and direction, but it is planned to leave the creation of further activities to grow out of the class' (teacher's and student's) perception of each structured activity. In many cases, the best advice is to let it flow wherever it goes and be prepared to flow with it.

Students should not be graded, but evaluation (from teacher, class, and the individual) is important in determining the value of experiences. How this can be dealt with in each teacher's situation will vary, but it is important to keep in mind that experiences can't be graded. They just are.

One good method for evaluation feedback is having class meetings from time to time to assess the learning process. Most of this input should be student initiated. Perhaps the use of a self-evaluation form is necessary. (See Appendix A.)

It is helpful to establish trust and to learn to live with periods of silence. "I learned — " statements from the students can be helpful in initiating evaluation discussions.

One should be aware that this unit was designed to give the teacher an abundance of ideas and experiences. All ideas and experiences expressed herein will not fit every situation. It is up to the teacher, therefore, to select or delete the appropriate experience or activity particularly suited to his or her teaching situation.

INSTRUCTIONAL OBJECTIVES:

1. The student will develop a personal view of what constitutes the quality of life and through what he feels, what he needs, and what he has learned and experienced.
2. The student will foster a love for the natural environment and a caring concern for its preservation and restoration.
3. The student will begin to clarify his values about technology and ecological living.
4. The student will confront and appreciate environmental trade-offs related to today's demands.
5. The student will develop the awareness, skills, and knowledge which will lead to some form of involvement.

CONTRIBUTORS TO THE DEVELOPMENT OF THIS UNIT

Author ..... Ronald J. Yárian
Editor ..... Mary R. Junglas
Revisor ..... James Duchon

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EXPERIENCE#1: ENVIRONMENTAL AWARENESS

OBJECTIVES:

1. The student will develop an increased appreciation of the environment through sense awareness.
2. The student will experience the awareness of nature's rhythms, appreciating what some take for granted, the cycles and flow of nature, and create opportunities for sensing a oneness with the environment.

Teacher's Note: *The purpose of the initial activities in this unit is to create an awareness of our natural surroundings by enhancing the student's experience and relationship to the environment, with the idea that the quality of life is determined by how each of us experiences our life in relation to our surroundings. How we perceive or sense our environment must, to a great extent, determine how we interact with the environment and how we will embrace our own life styles in relation to it. Those things which have dulled our senses (noise pollution, foods full of additives, air that burns our eyes, sights that offend) and our relationships with our fellow man affect our ability to idealize the quality of life. It is imperative that we fully develop our sense of feeling for the environment in order to establish a caring awareness of our quality of life.*

ACTIVITY A: SUNRISE EXPERIENCE

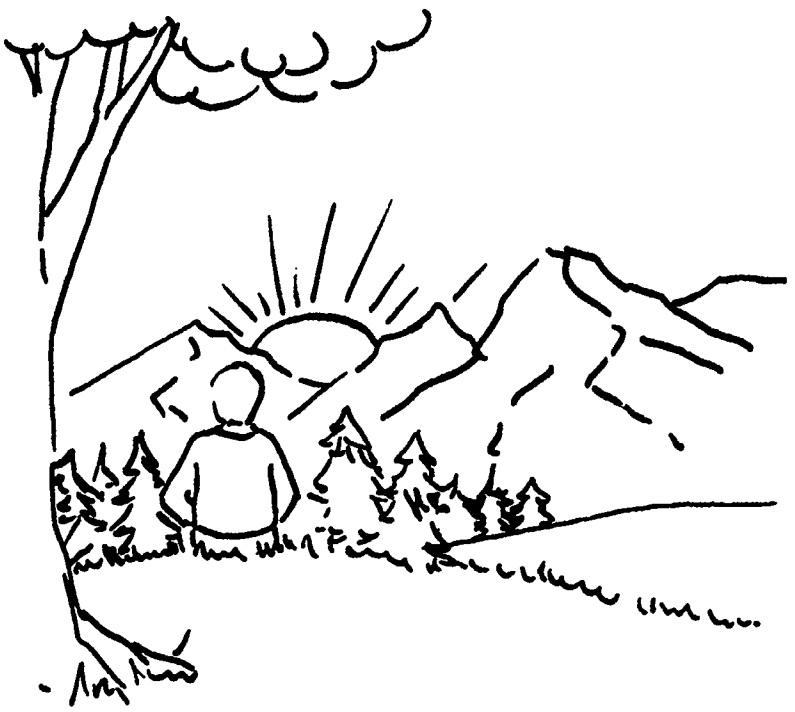
The activities of sections B and C can be incorporated during this activity because the experience lends itself to including such things as the sense exercises quite well. The purpose of this activity is to bring the class together in a common sharing of experiences which, too often, are unique.

1. *Preliminary preparation:*
   Indicate clearly to the class what you are asking them to do. You may wish to elaborate on your reasons, but often, the less said the better the experience.
   Lending a mystical feeling to the activity helps. Have the class decide where they wish to watch the sunrise, within the limits of time and other restrictions. Be sure to tell the class the time of sunrise so plans can be coordinated. Although a natural (aesthetic) environemnt is best, even the top of the school building is good — but get outdoors!

   Hiking or biking to a place to observe a sunrise can set the tone for further activities which can enhance the whole experience.

   Allow for plenty of time before the sunrise because a good part of this activity is in the waiting anticipation. Furthermore, the inconvenience of getting up early can become an important discussion focal point.
2. *Sunrise watch*

   The teacher should decide whether the sense exercises (section B) would be appropriate during the sunrise watch. Some of them could be very valuable at this point.



Whether or not the students experience sense exercises, have each person find a spot which they feel is "theirs," a place where they have good feelings about watching a sunrise. Have them remain in that spot until they have experience the sunrise to their fullest satisfaction.

a. How did they feel about their own spot? Good? Bad? Uncomfortable? Transcending?
b. Ask them how they felt about their surroundings as they waited. Did they feel a part of their surroundings? Were they aware of the surroundings? In what way? Could they become totally absorbed by watching the sun rise?
c. What factors were involved in choosing their spot?

3. *Sunrise Follow-up Activities:*
   a. Discussion:

      What inconveniences or disruptions in their daily life patterns were created by getting up to observe a sunrise?

      Was the experience worth the inconvenience?

      What was their feeling about the day after watching a sunrise?

      Were they more aware or more alive? Or were they depressed and tired? (Try to have students respond about their reasons for this feeling.)

      Did they find it easier or more difficult to slip back into the "old" patterns of school and routine?

      Were they pleased with being or not being able to get back into patterns?

      Note: The preceding questions may lead to some discussion about whether man's return to a greater intimacy (oneness) with nature poses any values clashes. It may be advantageous to recruit the help of an English teacher to lead this discussion.

b. Thoreau:

Have the class consider Henry David Thoreau's concluding words from Walden:

"The light which put out our eyes is darkness to us. Only that day dawns to which we are awake. There is more day to dawn. The sun is but a morning star."

How did these words apply to the sunrise experience and the day itself?

Have the class discuss Thoreau's life style and how he would view the quality of life.

Discuss with the class how each of them might relate to Thoreau's life style in today's society.

What did Thoreau mean when he said, "Only that day dawns to which we are awake"?

Note: The preceding is a good discussion to lead into sense awareness of the environment and can provide further thoughts concerning personal values in relation to the quality of life.

ACTIVITY B:
SENSE AWARENESS EXERCISES AND DISCUSSIONS

Teacher's Note:
These activities can be created anywhere and under any circumstances. It is important for students to learn to develop their senses to the fullest and to realize that our powers of observing the environment through our senses certainly enable us to assess a meaningful quality of life. The use of a cassette recorder with this activity is recommended. The tape can be played back and stopped wherever desired for discussion purposes. Also, the tape recorder will pick up sounds the students may not be aware of.

1. *Listening:*
   a. Have everyone remain absolutely silent for at least two minutes, asking them to listen for sounds not usually heard.
      (1) Have each student pretend that they have a way of turning off each sound as it is heard or noticed until there is silence. Layers of sound can be "peeled" back by ignoring each noticed sound and repressing it by searching for sounds beyond or underneath. In this way, students may become aware of a "layering" of sounds.
      (2) What sounds were they able to discover by simply making an effort to *listen*.
   b. Ask the class and discuss with them what the music they love does for them.
   c. Have the students go outdoors and listen to the sounds. (If not possible, have one or two students with a recorder go outdoors.) Then have them come back inside and listen. What differences were there? (Not only in the kinds of sound but also in how they sounded — expansive? confined?)
   d. Have the class be absolutely silent, only this time extend the silence until it becomes noticeably awkward. Discuss silence in our lives.
      (1) What does silence open up for us? Other senses? Thoughts?
      (2) How do we deal with noise as well as silence?
   c. Discuss noise pollution:
      (1) Is there noise pollution in the students' lives (school, home) which affects them?
      (2) How many turn on radios when they are alone (car, home)? Why? Why not?
      (3) In what ways has noise dulled our senses in relation to our environment? To each other?
2. *Tasting:*
   a. Bring some simple food to share with the class or have the class bring food to share. Encourage homemade foods. A good exercise is to have a loaf of natural whole wheat bread and a loaf of the usual bleached flour bread. Granola (available anywhere) is also a good food to compare with any processed cereals.

      Pass the food around in a sharing atmosphere and have each person hold the food in their mouth until it becomes liquid before swallowing. If processed and natural counterparts are eaten, make certain to have them taste each in the same manner for a comparison.
   b. Consider and discuss cultural taste habits:
      The following cultural groups consider the foods listed repulsive:
      Muslims — pork
      Hindu — beef
      East Africans — eggs
      Chinese — milk

      Bring out the fact that many foods that we reject are nourishing foods: cats, dogs, horses, caterpillars, mature insects, human flesh.
   c. Discuss food additives and preservatives in relation to taste exercises:
      (1) Have students make a list of food additives and preservatives that they know about. The March, 1972, issue of *Scientific American* has an excellent resource article on food additives.

      In what ways do additives and preservatives affect taste enjoyment? (It's nice to know that bread can be eaten a month from now and still retain its pasty flavor.) How sure can we be that FDA regualtions pertaining to what we eat insure subtle and long range effects on life quality. We are what we eat and we may become what we eat as well.
      (2) After students have read labels of frozen, canned, and packaged foods, ask them if they would like to research the chemical ingredients.

      Thin layer chromatography and colorimetric techniques might be useful.

      The FDA publishes simple experiments in testing foods with inexpensive and available materials.

3. *Touching:*
   a. Have students select some object of their immediate (available) environment to pass around to each member of the class while they are blindfolded.

      Ask the class how many tried to experience their natural environment (or immediate environment) through touch (feel)?

      An identification game can be an optional part of this activity.

      How many have touched and caressed a tree or allowed water to flow over their body?

   b. Ask students to experience their feelings about touching each other by first asking them to hold hands with the person next to them or in a large circle.

      Discuss how they felt about that.

      Is touch just that or are other "feelings" or senses at work?

      Discuss the idea of our own personal territories which are guarded by our senses. This could be followed up with a discussion of territoriality in the natural environment and might even include crowding as something which affects our senses and influences our psychological behavior.

4. *Smelling:*
   a. Have students take a walk around the school building with the express purpose of being aware of the smells. This exercise can be repeated the following day by taking a walk through the school building.

      What smells did they consider good? What smells were bad? Why? Did they make any associations with smell?

   b. Discuss smell associations:
      What is the earliest smell you can remember?
      What is the most pleasant smell you have experienced?
      Are there smells you can't describe?
      What is the most unpleasant smell you have experienced?
      How do we try to describe smells?

   c. Have the students describe how a list of things smell to them:

      Hospital
      Grandparent's house
      Rain
      Rush hour traffic
      The city
      The country
      Farms (barns)
      Damp woods

   d. Raise the question of how we react to each other's smell and how our culture has dealt with the "problem" of human smell. Do they consider a human's smell to be good or bad?

      (1) Have students make a brief list of the products on the market which are designed to cover up or change human smells.

      (2) How have the mind-forming agencies sold us or convinced us that we should disguise or change our smell? This could lead to a good discussion of advertising in general.

      (3) How are smells beneficial to living things? Discuss territoriality and smell.

      (4) Explore cultural outlooks on smell besides our own.

   e. Discuss how has air pollution affected our sense of smell?

      Sulfur dioxide reacts with the saliva and mucus in our noses and throat to produce sulfurous acid. This not only affects our sense of smell, but also leaves a taste (associate taste and smell). Furthermore, this affects the ciliary activity of our trachea by paralyzing these cells and leaving us more susceptive to respiratory ailments. This could lead to other examples of energy relationships.

5. *Seeing:*
   a. Sunrise observation (or similar changes or shades of lighting)

      Have the class concentrate on seeing things in total or completely by pointing our that seeing involves a mindfulness beyond the realm of just sight.

      Ask what they experience as the light changes its shades or textures from a gradual fade-in to full sunlight.

   b. Have students look through a deck of cards very briefly, or simply ask them the following questions without looking at cards (most are familiar).

      Which king has one-eye?
      What are the queens holding?
      What are the jacks holding?
      What are the designs on the face cards?

      Details will escape them because card players look at value and label and classify. Discuss this aspect in terms of missing the individualities and differences of the things we look at.

      How many things do we miss in assessing our environment?

   c. Ask the class to describe natural observations, such as snow. Find out how limited our observations are and try to make a comparison between seeing and observing. For example, snow can be fluffy, sparkly, pellets, compact, swirly . . .

   d. Trust walk or sensory hike:

      Have students walk through woods, meadow, or school blindfolded. They will be accompanied by a classmate who will serve as a guide and may help them experience their hike by having them touch things. They should then trade places and afterwards record their experience in a journal, including trust experiences as well as their overall sensory experiences.

Note: The preceding sensory activities can easily be modified and carried out in the school situation. Furthermore, many students may remain very reticent about their experiences, but this should not be a signal that it was not a meaningful activity. Lots of students have not had the opportunity to consider their environment in this manner and may feel awkward. You may feel awkward, too, but go ahead anyhow.

"Learn to apprehend the world with unobstructed senses — If the doors of perception were cleansed, everything would appear to man as it is — infinite." William Blake

Bibliography:

Schrank, Jeffrey, *Teaching Human Beings*, Beacon Press, Boston, 1972. This resource contains further sense education exercises and is an excellent total book for any teacher.

ACTIVITY C: SENSORY THOUGHTS (CYCLES OF NATURE)

1. Conduct a general discussion concerning the class's awareness in relation to basic concepts and principles of ecology, particularly in relation to their sunrise experience.
2. Related discussion questions:

   Where does the energy of the food you ate (during the sunrise) come from? (Making connections!)

   What other cycles are you aware of besides the cyclic motion of the sun?

   What phase is the moon in at this time? Waxing or waning?

   What made the sun an important entity in the various cultures of man? (As a god, as a form of worship, in philosophy)

   Did you feel an awakening of your own energy and the environment as the sun came up? (feelings of warmth, increased activities of the surroundings, stirrings of life)

   Do you feel that by being more aware of the movements of nature that you are able to feel more a part of nature?

   How did the Indian express his relationship to nature?
3. Ecological treatement of energy flow and the material cycles of the biosphere may be introduced here if so desired. A general discussion would be a good introduction to the ecosystem concept.

Note: A sophisticated treatment and a good general overview of the biosphere is found in the entire September, 1972, issue of Scientific American.

EXPERIENCE #2: ECOSYSTEM CONCEPT

Objective:

1. The student will gain an understanding of the concepts inherent in the ecosphere.

Teacher's Note:

The following section deals with the quality of life from a conceptual outlook. It should be stressed that, although the "testing" of environmental parameters might be suggested, this should not be the major purpose behind these activities. In fact, the biological and chemical investigation can actually be eliminated if so desired or if the situation warrants it. It is far better at this point to have the students develop a broad awareness of the ecosystem concept than to get hung-up on testing techniques and laboratory investigations. The suggested uses of measuring and identification should be considered only as a suggested possibility and not as a mandate.

ACTIVITY A: DEVELOPING THE ECOSYSTEM CONCEPT

It may be necessary to spend some time discussing the concepts of the ecosystem and the fundamental principles involved. There are many resources which can help facilitate this discussion for both students and teacher, but no great length of time should be devoted to presenting this. Rather, it should be developed as realistically as possible.

1. *Discussion ideas and questions:*
   a. Pretend that the classroom is a closed system from which no one can escape.

      What would be the essential things needed to maintain life in this room?

      Could life be maintained indefinitely in this room? Why? Why not?

      What factors beyond the essentials would each person want in order to maintain the quality of life he is accustomed to? This last question can lead the class into further discussions concerning recreation, population, mobility, waste disposal — let it flow.

   b. Compare the classroom to a spaceship; discuss life supports on a spaceship.

   c. Develop the idea of the earth as a spaceship. Read something or have the students read something to the class from anything Buckminster Fuller *(Spaceship Earth)* has written on the subject.
2. *Ecosystem:*
   The following ideas should be reviewed in light of the previous discussions to tie things together.

   a. Biological Components
      Producers
      Consumers
      Decomposers

      Discuss the roles in the classroom as an ecosystem and expand this to the entire ecosphere. It may be necessary to review some fundamental principles: photosynthesis, respiration.

b. Energy Flow
Stress that this flow is one way and that energy is progressively lost along the food chain, so that a continual outside source is needed.

c. Nutrient and Material Cycling
Essential nutrients for life are fixed and must therefore be re-cycled.

d. Interdependence.
All components (living and nonliving) are interdependent.

3. *Ecological Principles:*

Commoner, in *The Closing Circle*, Chapter 2, will help facilitate a discussion of four basic ecological principles:

a. All things are interconnected:
Discuss how pollutants which are below tolerance level can cause toxic effects in conjunction with other factors. This is called synergy and is an important concept to develop.

b. All things have to go somewhere:
There is no such thing in nature as "waste." Discuss how things we throw away often accumulate in harmful quantities.

c. Nature offers lessons:
Discuss how evolution made possible our survival and how changing our environment can upset our chances of adapting.

d. There is no such thing as a free lunch:
This basic principle of economics is also a fundamental principle of ecology. Every time we turn on a light, flush the toilet, or even eat, it is at the expense of the environment.

Our environmental crisis is the result of man's delaying the payment ultimately due. Discuss this is relation to our present energy crisis.

4. *Ecosystem Resources:*
See the bibliography for resources which are good for general overview and which can also be recommended for student general reading.

ACTIVITY B:
MAKING YOUR OWN ECOSYSTEM

Have the students choose some particular environment and collect and bring back the necessary materials and components for making their own miniature ecosystem. This can be done individually (if you have space) or in small groups of from three to five.

Although any type of environment can be made into a microcosm, it is probably easier to construct one from an aquatic environment such as a small lake, pond, or marsh.

1. *Materials:*
   a. About 5 gallons of pond water.
   b. Good representation and quantity of producers (green plants).
   c. Good representation of consumers (not large, but a fish or two makes things interesting). Snails are good, but one is enough.
   d. Bottom material: sediment, sand, gravel. (Keep this separate.)
   e. Container for ecosystem at least a gallon size. Large mayonnaise or pickle jars are fine. Five gallon Distillata bottles are ideal.

2. *Water quality analysis:*

This will depend upon class inclination, level, and availability of testing equipment.

   a. Chemical analysis (HACH kit or similar colorimeter methods, as well as *Standard Methods of Water Analysis.*)

      Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Phosphates, Nitrates, Hardness, Dissolved and Suspended Solids, Alkalinity, Turbidity, Color, Carbon Dioxide, Chloride, Ammonia, Hardness, pH, and Temperature.

   b. Biological indexes (analysis)

      Bacteriological and general microbiological analysis (Millipore).

      Identification of organisms — make certain that their role is defined (niche) — position in food chain, bottom, free swimmers, attached, plankton. Determine special adaptations.

   c. If possible, have students make a general assessment of the quality of the water: polluted, eutrophic, partially polluted, clean. Formulate some general opinions about what makes a quality environment. Don't forget to have them make sensory assessments of the environment from which they obtained the materials.

      Check resources listing biological specimens which are good indexes of the quality of the water. Relate this to the parameters observed through either testing or simply observing.

3. *Preliminary assembly of ecosystem (microcosm):*
   a. Place bottom material in a clean container first.
   b. Place any attached plants into the bottom material. One suggestion is to weight them down by tying a small stone to the base to prevent them from floating free until they get rooted.
   c. Pour in a good representative sample of the total water and assess the biological components that went in with it.

d. After the water has settled and cleared, add the remaining plants and animals that are desired.

c. Allow a few days to observe and then make any necessary adjustments by removing or adding components as each student sees fit.

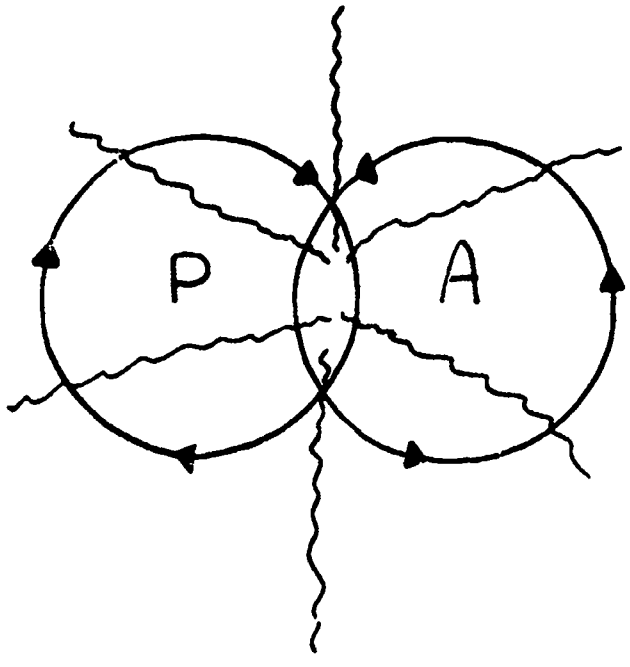
At this point the ecosystem is ready for sealing.

4. *Field collecting apparatus and analysis equipment:*
Homemade equipment should be encouraged once the students have an idea of what they need to collect and how they must collect it. The following is a list of materials (not vital):
HACH colorimeter
Millipore Environmental Microbiological Kit
Plankton nets
Surber samplers
Bottom dredges
Seines
Microscopes
Jars, jugs, aquaria (for storing collections)
Aerators

ACTIVITY C: SEALING THE ECOSYSTEM (MICROCOSM):

Teacher's Note
Have the students develop a real feeling for their ecosystems. You can help foster this by constructing your own ecosystem. They will be observing theirs for a long time (hopefully) and it is important for them to be as aware as possible of the initial state and the consequences of sealing off this piece of the environment.

1. *The Ecoseal:*
Have students create for their ecosystem their own symbol, which represents what an ecosystem is to them. The example below represents cycles, energy flow, plants, and animals:



2. *Sealing Ceremonies:*
Have students plan and develop a "sealing ceremony" for the day that their ecosystems will be permanently sealed. At this time, the ecoseal could be affixed and the system sealed with melting wax or something similar, insuring that it cannot be opened without notice.

Let the students have free reign in creating ideas for this ceremony, for, after all, it is a serious and solemn occasion in which life is committed to the same conditions as "Spaceship Earth."

The following might be some ideas for the ceremony:

a. Readings from Thoreau, Muir, Byron, Whitman, Shakespeare, Fuller.

b. Drama: a class play, with various characters playing the components of the ecosystem, costumes and all.

c. A ceremonious launching like that of a spaceship. (Make the connection.)

d. A new event: reporters, television, celebrity speeches, and interviews. (Invite other classes and the school paper.)

e. Mock and serious ceremonies: Mythological, mystical, student's poetry and prose.

If video tape equipment is available, it might be worth taping this. Make certain the systems are sealed, dated, and placed in a location where they receive light, and then let them be.

EXPERIENCE #3: GROUP PROBLEMS AND INTERACTIONS

OBJECTIVES:

1. The student will develop group skills in the process of dealing with a problem.
2. The student will develop group feeling of cooperation and accomplishment.

ACTIVITY A: DEVELOPING GROUP FEELINGS AND COOPERATION (PRELIMINARY)

The following exercises introduce group problems and situations groups are likely to confront. They will help students develop group strategies and feelings in making group decisions for solving real problems later on. The exercises can be omitted if the class is experienced in group work. Certainly the activities enclosed are only examples and may be readily modified.

1. Six Bits of Information:

Ciammatteo, Michael. *Investigating Your Environment Series.* U.S. Forest Service; Portland, Oregon.

This activity can be accomplished in one class period if preliminary instructions are presented the day before. Six pieces of information are given

separately to each member of a group of six. The information on each piece contains relevant and irrelevant data, but each piece is important in solving the problem (which is itself one of the information bits). They are then simply told to solve the problem.

As the groups work, observe the way they listen to each other and the levels of confusion at first. They can tell what is on their information piece but they may not show it to anyone. Trust, as well as organization, is necessary, and it seems to develop natually out of the beginning chaos.

After the given allotment of time for solving the problem, the solution may be presented or elicited from the class, especially if they were not generally successful. Ask questions which will help them focus on the group process.

What prevented you from solving the problem (at first)?
What enabled you to solve the problem (if solved)?
What procedures seemed to work best?
What is involved in real listening?
Did individuals hinder progress? In what ways? Why? (all must participate in this experience)

Compare group procedure to scientific method.

2. NASA Experiment
This presents a survival problem in which a group decision must be made concerning the priority given to each of a list of materials needed to survive. The group rates the item(s), and, afterward, priorities, and its decision can be compared to an index which indicates why each item was given a certain level of priority.

Note: Both Six Bits and NASA may be modified easily to fit realistic situations, such as an environmental problem, chemistry problem, or even a math problem.

SIX BITS OF INFORMATION

In this session we are concerned with techniques and processes of involving people in problem solving activities. The success of these activities will be measured by the application of group interaction and problem-solving skill to the environmental investigation that we do later.

We are concerned, then, about how to transfer the process of involving people in environmental investigations.

1. Have audience arrange themselves in groups of six, or have chairs grouped that way ahead of time.
2. Pass out the "6 Bits of Information" problem, one bit of information to each person (use problem on page 24).
3. Tell the audience that there is a problem to solve, that they can tell their group what is on their paper, but that they must not show it to others.
4. As the problem solving session progresses, do the following:
   a. 5-8 minutes into problem write on the board *Trust*
   b. 8-12 minutes into problem write *Visual Display*
   c. 12-15 minutes into problem write *Matrix*

Questions and Discussion (After all groups have finished)

1. What kept you from solving the problem to begin with?
2. What helped you to solve the problem later?
3. What were some characteristics of this problem-solving exercise? (List comments from the group and discuss.)

The people who developed the problem-solving exercise feel that it contains elements of involvement that most all groups go through; it also illustrates the way groups work together on common problems.

They hypothesized that the following things would take place during the problem-solving exercise: (Write each item on the board, or have a chart made up with each item listed.)

a. *TRUST* (will develop). You must trust that the instructor gave you a solvable problem. You must trust each other.
b. *RITUALISTIC LISTENING* (will take place). This is a kind of polite listening without really caring too much, because the data offered has no relevance at that time.
c. *REAL LISTENING* (will take place). This happens when statements become more meaningful; data means something. It occurs when people interrup and say, "Say that again!"

QUESTION: When in your group did you change from ritualistic listening to real listening?

When real listening occurs, two things will change:
Vision: Participants will begin to envision the listening by really looking at other people, and by constructing a Visual Display (writing data in a common place). This helps make inferences and eliminates having to listen to everything.
Space: Space factors will change and people will usually move closer together, or move around the table.

Using this type of activity at the beginning of a session is important for these reasons:

a. The problem could not be solved without the contribution of each person in the group.
b. People feel more committed to a session if they contribute by saying something the earlier the better.
c. It's easier to talk to each other in a small group than to talk to one instructor in front of a large group.
d. This exercise illustrates that each person in a group brings information and skills that can be used by the entire group to solve common problems. THE PIECES OF PAPER REPRESENTED THE INFORMATION AND SKILLS THAT EACH OF YOU BROUGHT TO THE GROUP.

We are concerned with providing ways for each person to contribute knowledge, information and skills to the solving of common problems.

The content and activity themselves are not always most important. What is important is the idea that you can use different techniques to get people talking to each other and contributing as a group.

NONE OF US IS AS SMART AS ALL OF US. (Print this on the board during the problem-solving execise.)

B1

Although you may tell your group what is on this slip, you may not pass it around for others to read.

Information:

The Dinosaurs had Tom for a teacher during the third period.

Dick and Belinda did not get along well and so they did not work together.

During the first period the Team Leader taught the group that Harry liked best.

B2

Although you may tell your group what is on this slip, you may not pass it around for others to read.

Information:

All teachers taught at the same time and exchanged groups at the end of the period.

Each teacher liked a different group best. During the second period each teacher taught the group he liked best.

Each teacher taught every group during one of the first four periods of the day.

B3

Although you may tell your group what is on this slip, you may not pass it around for others to read.

Information:

The Freznel Elementary School Intermediate Unit had two teacher's aides, four teachers, and four instructional groups of students.

Each instructional group had chosen its own name.

Sybil was the Team Leader for the Intermediate Unit.

B4

Although you may tell your group what is on this slip, you may not pass it around for others to read.

Information:

Your group members have all the information needed to find the answer to the following question. Only one answer is correct. You can prove it.

IN WHAT SEQUENCE DID THE APES HAVE THE VARIOUS TEACHERS DURING THE FIRST FOUR PERIODS?

Some of the information your group has is irrelevant and will not help solve the problem.

B5

Although you may tell your group what is on this slip, you may not pass it around for others to read.

Information:

Belinda and Ralph disagreed about the best way to handle the Bombers, who always had trouble settling down to work.

Dick preferred to work with the Champs rather than any other group.

The Team Leader had been at Freznel School for five years, the shortest period of time of all the team members.

B6

Although you may tell your group what is on this slip, you may not pass it around for others to read.

Information:

The Team Leader taught the Dinosaurs the second period.

Harry worked with the Bombers in the third period.

Sybil had been at Freznel School a shorter period of time than any of the other teachers in the Intermediate Unit.

THE NASA EXPERIMENT

INSTRUCTIONS: Your spaceship has just crash-landed on the moon. You were scheduled to rendezvous with a mother ship 200 miles away on the lighted surface of the moon, but the rough landing has ruined your ship and destroyed all the equipment on board, except for the 15 items listed below.

Your crew's survival depends on reaching the mother ship, so you must choose the most critical items available for the 200-mile trip. Your task is to rank the 15 items in terms of their importance for survival. Place number one by the most important item, number two by the second most important, and so on through number 15, the least important.

____Box of matches
____Food concentrate
____Fifty feet of nylon rope
____Parachute silk
____Solar-powered portable heating unit
____Two .45-caliber pistols
____One case of dehydrated milk
____Two 100-pound tanks of oxygen
____Stellar map (of moon's constellations)
____Self-inflating life raft
____Magnetic compass
____Five gallons of water
____Signal flares
____First-aid kit containing injection needles
____Solar-powered FM receiver-transmitter

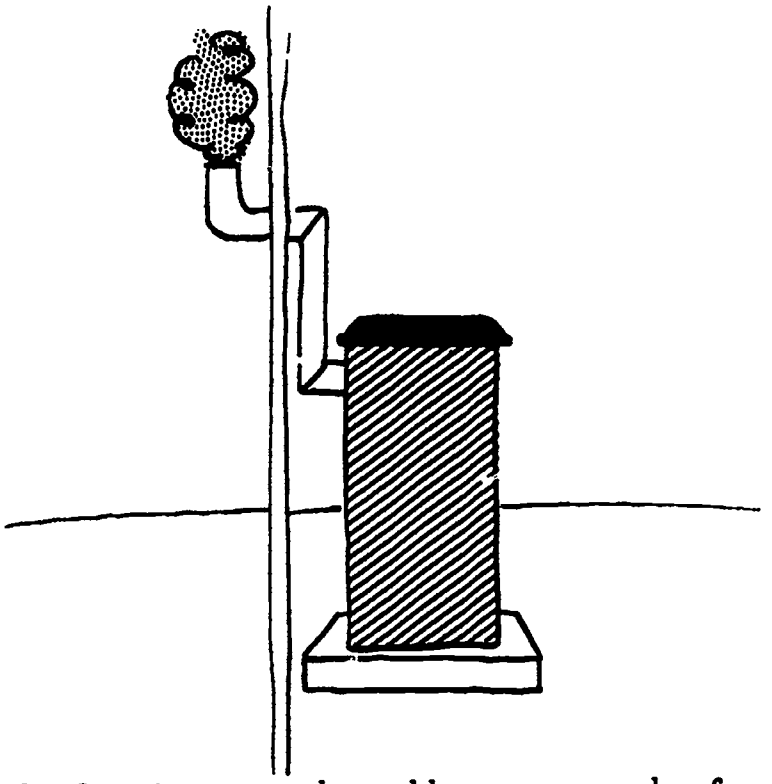
ACTIVITY B: SCHOOL SITE PROBLEMS

A written definition of what constitutes environmental pollution or what can be considered detrimental to the quality of life can be written on the board and discussed with class. Such an example might be the following:

Environmental pollution is the unfavorable alteration of our surroundings, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution, and abundance of organisms. These changes may affect man directly or through his supplies of water and of agricultural and other biological products, his physical objects or possessions, or his opportunities for recreation and appreciation of nature.

1965 Environmental Pollution Panel, President's Science Advisory Committee, U.S.A.

1. Have the class bring a notebook and a pencil and take them on a complete walk around the school. Have them consider the definition of pollution and make a list of all the factors they observe which they feel affect the quality of life. This could also be done within the school, depending on the risk level, but both investigations are too much when done together. One can be picked up later, if so desired.
2. Make a list on the board of *all* the factors each person identified, and discuss how each one of these fits as to its effects on the quality of life.
3. Have the students choose or sign-up for further investigation of the problem which interests them the most. Each factor should be stated as a question to help initiate the investigation. Narrow each problem down to a size that can be handled by groups of four to five.
4. Give the student groups time to investigate these problems (a week) by working as a group and making group decisions and assignments for solving the problem:
   a. The group should establish the following guidelines:
      (1) Identify the problem and related factors.
      Is this really a problem and why?
      Specifically how does it affect the quality of life?
      (2) List procedures intended for solving problems.
      Who can they go to for help and information?
      Where can they go to get more information?
      Is there any data that needs to be collected?
      Student surveys?
      Scientific tests?
      Interviews?
      (3) Discover what can be done to alleviate the problem, to effect change?
      Who can the findings be presented to?
      Who has the authority to make change?
      What support groups do they need?
      What is the procedure or channel of communication for change?
      What or how do they intend to present a request for change?



   b. Here is a sample problem or example of a process problem solving approach for a school site problem:

      While walking around the school, students discovered that the incinerator was giving off smoke. What could be done to alleviate the definite contribution to air pollution made by burning trash in the incinerator?

      (1) Interview with custodians
      Result: They suggested that the building must be kept clean and that burning trash is a practical method of doing so. Students assessed what was being burned in the incinerator; papers were a large portion of the trash burned.

      (2) Interview with principal
      Result: He agreed that custodians do not have time to collect paper for recycling and he agreed to have staff save papers for collection if picked up.

      (3) Contact recycling agencies (Volunteers of America)
      Result: Volunteers agreed to pick up paper once a week, if bundled.

      (4) Action:
      Students assigned themselves to collection duties and set paper out for the volunteers. They made collection boxes for each classroom, and requested custodians not to burn dangerous materials, such as batteries. Teachers and students were requested to use less paper.

      (5) Future action:
      They requested the board of education to use recycled paper.

e. The group should decide values strategies through feedback on school site problems.

(1) Values-reflecting questions:

Were there values clashes encountered (like taking time to set aside paper)?
How many were affected by this problem?
Was any one group more affected by the problem than another?
What were the necessary trade-offs in reaching a solution to this problem? (Trade-offs are those things we are willing to sacrifice or give up in order to gain something.)

(2) Values Continuum:

Have each person draw a line in their journal (notebook) like the one below and have them place a vertical line intersecting this which will indicate where they stand between these two extremes.

Recycling Robert (He never buys throw-away items, and re-uses everything including paper towels) ←——→ Discard Dan (He throws away everything, out of sight is out of mind. Everything is bought for convenience.)

Discuss why each person chose his position and find ut if there were any middle of the roaders and make a forced choice (one side of line or other).

d. Take this ecological questionnaire:

Construct the following questionnaire and have students respond. Have you ever:

a. Thrown away wrappers or anything else (litter) on the ground?
b. Written a letter to a governmental agency or official about an environmental concern?
c. Confronted a litter bug?
d. Asked your employer to recycle items?
e. Asked your family to conserve on electricity and practiced what you preached?
f. Written a letter to a company whose product is environmentally harmful?
g. Burned any kind of trash outdoors?
h. Used items in returnable or bio-degradable containers?

Discuss which items would be most difficult for them to carry out and why?

Try to have each individual confront his own values in relation to a problem.

Do they have a choice of values?
Have they considered the alternatives of their choice?
Are they proud of the ways they chose to confront the problem?
Would they publicly declare their choice?
What have they actually done recently about the problem?
Will they be willing to incorporate this into their own life styles?

EXPERIENCE #4: ENVIRONMENTAL LIFE STYLES

OBJECTIVE:

1. The student will develop a personal sense of his impact on the quality of life.
2. The student will consider and be aware of alternative means of living more ecologically.
3. The student will experience some modification in life style which has the effect of reducing an individual's environmental impact.

Teacher's Note:
The following are suggested activities which relate primarily to how each individual will conduct his pattern of living (lifestyle) in relation to a positive environmental effect on the quality of life. Since this is something which students must be willing to do outside school, it is important to generate a discussion which will create ideas for alternative ways of living, as well as pointing out the significant importnace of adopting new life styles. The "establishment" is now using terms like "changing lifestyles" in view of the energy crisis.

ACTIVITY A: DISCUSSION QUESTIONS

How might each of us modify our own life patterns to help ease the energy crisis? What are the problems we create by becoming more and more a "throw-away culture"? What are some net results in environmental quality deterioration from an increased consumer demand for more energy? (more oil spills, more black lung disease, floods, depletion of resources)

ACTIVITY B: VALUES STRATEGY

Have the class make a list of the twenty things that they like to do more than anything else. It is important to stress that this is a very private list to ensure complete candidness on the student's part.

After they have completed their list, make up symbols describing each thing which can be placed next to each activity. For example,

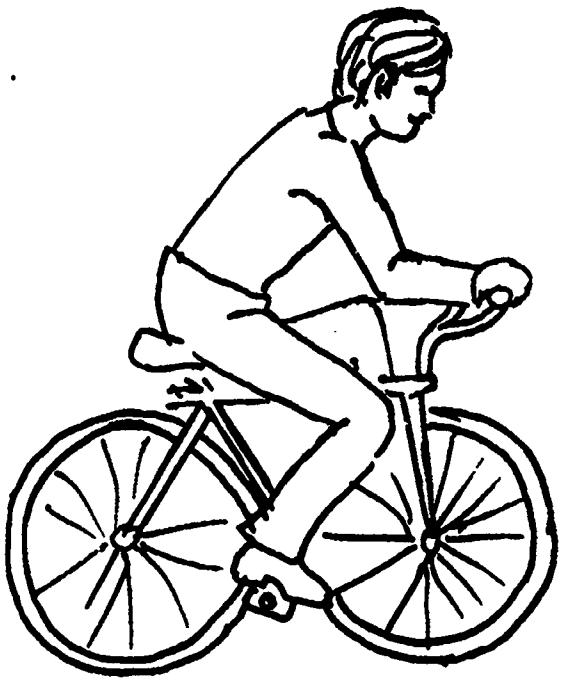
1. Use (A) if done alone; (AP) if alone and with others; (P) if always with others
2. Use (I) if done inside; (O) if outside (IO) if both
3. Use (UE) if it uses depletable resources
4. Use ($) if it costs money every time it's done
5. Use (B) if it benefits others
6. Use (T) if it depends upon technology when done
7. Use (S) if it has survival benefits
8. Use (Po) if it pollutes
9. Use (Pr) if a participant and (Sp) if a spectator.
10. Use (IQ) if it enhances the quality of life, (DQ) if it diminishes it.

After the class have coded their twenty things lists, have them take time to evaluate their lists. Ask them to write "I Learned" statements based on their evaluations of the coded lists.

Example: "I learned that very little that I do deteriorates the quality of the environment and that I

participate in almost everything I enjoy."

Ask them to share their "I Learned" statements. Discuss with them the things we do which have a direct and indirect effect on the quality of life.



ACTIVITY C: LIFESTYLE ACTIVITIES

Have class members agree to some daily change in their lifestyle which will reduce their impact on the environment and to carry this out without faltering for a period of one week. The following are suggestions:

1. *Bicycling*
   If students have a bicycle, make a commitment to bicycle to school every day and to any other locations that make cycling possible.
2. *Diet*
   Try going meatless or modify your diet so that only natural foods are part of your diet. Avoid all foods which contain any artificial ingredients that preserve, color, or otherwise adulterate foods.

   Some might want to experience going without food altogether — but this should only be for one full day.
3. *Walking*
   Walk everywhere and resist temptations to use a car. Make a list of the times it was impossible to walk.

   Get into the rhythm and pattern of walking. Experience it.
4. *Home Ecology*
   Refuse grocery bags and other packages in stores and bring your own non-throw-away shopping bag.

   Encourage the use of returnable or bio-degradable containers.
6. *Trash Survey (could be group activity)*
   Make a thorough survey of the quantity and kind of trash that is discarded by your neighborhood.
7. *Ecological Power*
   Give up one major appliance or machine which uses a major source of fossil fuel. (electrical, gasoline, oil, natural gas)
8. *Spending the Weekend Alone*
   Take bare essentials and find a remote and safe spot to live for two days and two nights. Keep a journal.

ACTIVITY D: SUPPLEMENTAL ACTIVITIES

Have the class keep a daily journal of everything they experienced as a result of modifying their lifestyles. Have them try to make connections between the way they have modified their habits and the differences this will make to the environment and to them. Ask them to express their feelings and to rely on their senses in being involved with change.

The first two activities in this section (A and B) can be used in class while this process is going on.

During this week, have the class assess the trade-offs and inconveniences. If they did surveys, have them present partial results and problems that arose.

In general, share each others experiences. They could take turns presenting their experiences.

ACTIVITY E: FEEDBACK DISCUSSION IDEAS

After the week has passed, have them discuss their feelings and reactions.

In what ways were they inconvenienced (if at all)?
Are they willing to permanently or partially continue this change?
Did they feel good about changing their living patterns?
Would they be willing to share their enthusiasm?

EXPERIENCE #5: RESOURCES

OBJECTIVES:

1. The student will develop a mindfulness of our finite resources and our need to conserve them in order to maintain our quality of life.
2. The student will experience some activity which will have a positive effect toward conservation.
3. The student will develop an awareness of the hidden costs in the use of our natural resources.

ACTIVITY A: DESIGNING A MINI PROJECT

1. *Brain storming session:*
   Through class-generated ideas, develop a list of possible short term activities which can be carried out with a minimal use of materials, money, and time, and which represents a positive and practical solution to some aspect of deterioration and depletion of natural resources.

   Pose this problem to the class and have them get into small group circles and, for a period of at least a half-hour, make a list of as many possible project ideas as possible. Quantity is encouraged. Criticism is not allowed, and far-out ideas are encouraged: they may give others more practical ideas.

After they have accomplished this, lift the ban on criticism and list all the ideas on the board for evaluation. Ask the students to select one idea and submit plans for your approval within one day.

2. *Possible activities:*
   a. Composting
      Construct a compost heap and use it to recycle organic materials which are generated around the home (grass clippings, nonmeat food scraps).

      Learn and understand the biological chemical activity of composting.
   b. Designing a shelter
      Design a homemade shelter from materials that would otherwise have been discarded and make some practical use of this shelter.
   c. Finding alternative power sources
      Design some small scale model or a larger practical model that demonstrates the practical use of alternative sources of power: wind (windmill devices). electrical cells (fuel cells), solar (magnifying lenses).
   d. Finding alternative fuels
      Design an experiment which demonstrates the production of methane gas from fermentation of animal wastes. Pig, chicken and cow manure seem to work best.
   e. Recycling
      Design plans for a practical recycling center on a small scale. Aluminum is convenient and monetarily rewarding. Get publicity.
   f. Re-utilizing
      Devise schemes for using resources in different and useable ways: crafts ideas from old bottles, metal, leather and wood scraps, and can, ecology symbols from old jewelry.

      Create environmental (ecological) collages for the classroom.
   g. Finding new sources
      Create a recipe using algae flour and bake something.

      Devise an experiment for extracting some resource from sea water.

3. *Feedback discussion:*
   Have the class discuss their individual projects by making a very short presentation for sharing purposes. Encourage the class to ask questions and make connections between the project activity and the effect on the quality of life.

   What are the environmental trade-offs that must be made when we refuse to purchase items packaged in depletable resources or plastic?

   What role has plastic played in terms of our craftsmanship?

   What impact would a return to an artisan type of society have?

   Discuss utilization of resources in relation to increased economic growth.

   What does an increased standard of living imply?

   What does Gross National Product have to do with the environment?

ACTIVITY B: TELEVISION INVENTORY

For a period of two to three hours, for an evening or two, have the class make an inventory of the kinds of advertising presented on TV and what is being sold and by whom.

Discuss their inventory list:

How is the advertising media dealing with the energy crisis?
What kind of lifestyles are being glamorized?
What advertisements are subtly or blatantly calling for more energy use?
Are there advertisers using environmental issues to their advantage?
How are they doing this?

ACTIVITY C: VALUES STRATEGIES (ROLE PLAYING GAMES)

There are many possibilities and examples for discussion. Furthermore, these situations or issues can be presented as debates, position papers, dramas, or displays, which all relate to the theme of the quality of life and who pays. Discuss values and the hidden and real costs of consumption.

Which ideas are in conflict? Which are compatable?
Which are in greatest conflict? Why?
Which columns can you relate to most easily in terms of your own values?
Are your actions consistent with your values statements?

Some examples are:

1. Energy Crisis
   - Government Statement (President Nixon's address)
     - Daylight savings
     - Increase use of resources
       - Nuclear power
       - Alaskan Pipeline
       - Strip mining
       - Oil shale
     - Turn back thermostats
     - Drive slower
     - Gasoline tax
   - Environmentalists
     - Increase mass transit
     - Ban large cars
     - Make nonreturnables illegal
     - Recycle tax allotment
     - Diminish economic growth
     - Ban advertising signs
     - Outlaw frivolous power use
     - Gas rationing
     - Fund recycling centers

2. Lake Erie Jetport
   - Cleveland Growth Association
   - City Government and Industry
     - More jobs
     - Recreational harbor
     - More trade
     - Greater tax returns
   - Environmentalists and Citizens groups
   - City Council factions
     - Energy crisis
     - Noise pollution
     - Traffic jams/pollution
     - Lake deterioration
3. Ohio Strip Mining Bill
   - Strip mining industry
     - Energy shortage
     - Economy of state
     - Restoration
     - Jobs
   - State legislators and Environmentalists
     - Alternative mining methods
     - Acid mine drainage
     - Flooding and erosion
4. Nonreturnable Bottle Law
   - Local merchants and bottlers
     - Practicality of non-returnables
     - Handling costs
     - Loss of business
     - Saleability
   - Consumer and Environmentalists
     - Energy crisis
     - Resource depletion
     - Decrease consumer cost

EXPERIENCE #6: ENVIRONMENTAL SKILLS

OBJECTIVES:

1. The student will develop an appreciation for simple living in relation to the quality of our lives and its relationship to the environment.
2. The student's aesthetic appreciation of gifts of nature will be enhanced.
3. The student will develop skills of plain living and survival.

Teacher's Note:
The following activities are suggested as possibilities for class experiences in developing and learning environmental and survival skills. Many of these will help the students establish an environmental ethic which results from developing a love of the natural environment and a deep appreciation for a high quality of life. These are also experiences which help increase the feeling of oneness and provide many more opportunities to make use of sense awareness.

ACTIVITY A: WILD FOOD FORAGING

After checking an appropriate area, and discussing wild foods that may be found in the natural environment, have the class spend a field day foraging for wild foods.

Identification of plants, conservation practices, and general precautions should precede this activity. Make certain permission is granted to forage, although generally this can be obtained easily. By all means, stress the importance of leaving plant material for future growth as well as making a minimum impact on the land.

This activity and the plans that go into it are well worthwhile for the teacher, because you will probably learn more than anyone.

ACTIVITY B: WILD FOOD PREPARATION

This should be a follow-up experience in which the foraged foods are prepared and shared by the class. It might be a good strategy to get the home economics class in on this project. (Don't forget they have kitchens.)

This would be a great opportunity for taste and smell sense exercises.

ACTIVITY C: USING PLANT DYES

This is an activity which is fairly easy to do and has many far-reaching possibilities. Most plants have some dye capability, and plants like oak leaves and sumac berries are around throughout the year. Some plants have natural dye fastness characteristics (oak). Mordants (chemicals which can alter colors as well as functioning as fixing dyes) can be experimented with; their function as complexing agents in creating bonds between dye and fabric can be researched.

Tie-dying white shirts, tee shirts, handkerchiefs, and old bed sheets for tapestry displays can be personally rewarding and create something of pride and value.

ACTIVITY D: CRAFTING

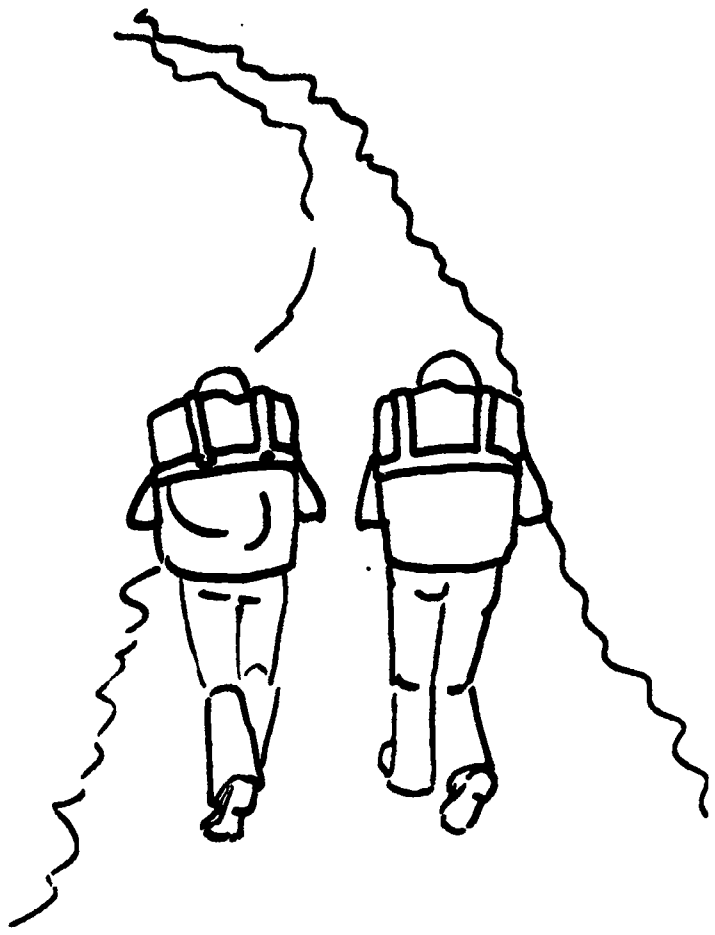
Skills in making simple crafts from natural materials can be researched by the class. New ideas might be generated from the art classes and the reuse of "useless" materials should be encouraged.

Skills in using rope, tying knots, and macrame might be included.

ACTIVITY E: TOOL MAKING

As in D, craftsman and artisan skills can be researched as a class or in groups to develop ideas for inexpensively making tools by utilizing one's ingenuity.

Ecological sampling apparatus might be made, such as surber-type samplers, dredges, and plankton nets.



ACTIVITY F: LEARNING BACKPACKING SKILLS

There is probably some member of the class that is an expert and could demonstrate the art of backpacking. Avoid the commercial aspects as much as possible and stress the fact that this can be done inexpensively.

The class might want to organize a short group backpack hike.

ACTIVIY G: LEARNING BICYCLE SKILLS

Like backpacking, there's probably a biking enthusiast who could put on a meaningful bike clinic workshop, including care and maintenance, repair, riding skills and traffic rules, as well as sharing bike routes. This might lead to checking bicycle ordinances and legislation proposals for bike trails.

The class might organize a bike hike, or sponsor a hike in the community for one day (maybe gasless Sundays).

ACTIVITY H: LEARNING SURVIVAL SKILLS

Setting up wilderness camps, camping ecologically, researching park area which can be utilized close by, learning rock climbing skills, rope tying, shelter building, cooking, fire starting and many more general ideas relate to this.

ACTIVITY I: ORGANIC GARDENING

Start an organic garden. See if this can be done somewhere on school property so it can be a class project. If not, try it in your back yard or window sill box. Consider all aspects of this kind of gardening (pest control, fertilizing, garden plan, plant types, cash crops, kitchen garden) related to needs and situation.

Encourage consumerism toward buying organic foods.

ACTIVITY J: ECOLOGICAL COOKING

Make homemade recipes which utilize natural foods. Share this preparation with the class.

Note: Further values strategies can be tried in relution to the units on environmental lifestyles and skills. In all values strategies, it is important not to make any responses which will influence values choices. Do not make your own value judgements, but try to have the students clarify their own choices in relation to the values process.

1. Values Process Questions:

   How were your senses (you) affected by creating or learning something of personal value?

   Were your sense awarenesses enhanced through your achievements?

   Are you proud of your accomplishments? Why? Why not?

   How does what you achieved or learned affect the quality of life?

2. Values Continuum: (place your position on the line — but not in the middle)

Primitive Pat ←	→ Technology Ted
(She refuses anything that is a product of technology. Her goal is to return completely to natures.)	(He loves technology and abhors primitive living. His goal is a house where everything can be done indoors.)

3. Either/Or Forced Choices:

   Have the class make decisions on what they feel like and have them migrate to designated area of each choice. Give them time to discuss with those who made similar choices their reasons for their choice and then have them choose someone who made an opposite choice and discuss these with each other.

   Have individuals share their reasons publicly with the whole class.

   Do you feel like a

   Limousine — or Economy car
   House — or Tent
   Lake — or Stream
   Hamburger stand — or Restaurant
   Country — or City

4. Rank order:

   Make up a series of related items and ask class to rank order these in terms of best liked to least liked. Have them share their reasons for making their rankings.

   Rank the following (1) Tree Farm (2) Forest (3)Wilderness

EXPERIENCE 7:
PROCESS ACTIVITY

OBJECTIVES:

1. The student will establish some criteria for scientifically assessing the quality of life.
2. The student will utilize the scientific method in investigating a problem of personal interest as it relates to the quality of life.

Teacher's Note:

Strategies for initiating process activities:

a. Brainstorming (see experience 5, activity A-1)

b. Contract (See Appendix B.)
This is a meaningful method for evaluating the student's input into his investigation, giving both of you and the student a chance to determine the quality of his work.

The contract constitutes an agreement between you and the student to accomplish a realistic goal which you both help set. It is probably best to set this up in stages so that the process will move as quickly as possible. The contract is really an agreement to go through the investigation of a problem by means of the scientific method. The student chooses a problem and makes this a question or a commitment.

The next stage is to outline the procedure that is to be employed in solving the problem and to designate clearly the methods and resources that will be used. This should include some aspect of collecting data and the analysis of this data.

Final approval is made when the method of presentation of the results is proposed, along with any action that is to be taken. There should be a clear agreement as to the time alloted for completion. In this instance, two weeks would be sufficient, because it is a quick survey-type process which may become more involved later. It is also important to have the students utilize as many different resources as possible. The telephone is invaluable.

ACTIVITY A: WATER QUALITY

Establish the components of a quality water environment (biotic and abiotic).

Make as many tests as possible on the important water quality parameters.

Make a preliminary statement related to the quality of water under investigation.

Assess the reasons for the particular level of water quality.

In what ways is this water utilized? Where does it go? What methods or channels can be utilized to make the results of this investigation known publicly?

ACTIVITY B: AIR QUALITY

Establish components and levels of the quality of air. Design and utilize as many methods as possible for testing air quality.

Set up air monitoring stations to test for minimal factors (particles).

Make a statement about the quality of air in various tested areas.

What are possible sources of air pollution?
Assess air quality in realtion to public cost.
Make connections between air quality and public health.

ACTIVITY C: LAND QUALITY

Establish quality (depends on whether this is an agricultural, land management, or soil ecology investigation).
Make a set of tests for establishing soil quality.
Compare sedimentation of streams in urban and rural environments.
Determine governmental laws and policies affecting land use.
Interview public officials concerning zoning and developments.
Attend a council meeting or zoning commission meeting.

ACTIVITY D: TRANSPORTATION

Determine transportation needs in relation to quality environments.
Do a traffic survey.
Make a questionnarie for school/community transportation habits.
Assess survey results and make some public statement as to future transportation recommendations.
Interview a bus driver and a transit board member.

ACTIVITY E: LEAD POISONING

Determine sources and uses of lead in the environment.
Develop tests for presence of lead in various environments.
Interview a doctor in a clinic which treats and tests for lead poisoning.
Make a statement about the quality of life in relation to lead.
What are the relationships between presence of lead and consumption habits?
What groups are most affected by lead poisoning? Why?

Teacher's Note:
Process investigations should lead to some plan of action or involvement. The individual or the class could plan environmental impact statements, consumer and community newsletters, legislative proposals, political actions, or similar activities.

APPENDIX A:

SELF-EVALUATION FORM

Name _____

Class _____

Date _____

4 3 2 1 0	1. Works well with others
4 3 2 1 0	2. Joins in general class discussion; shares ideas
4 3 2 1 0	3. Contributes to small group work; shares work load
4 3 2 1 0	4. Accepts responsibility (avoids tardiness, regards deadlines, prepared for class)
4 3 2 1 0	5. Completes written assignments
4 3 2 1 0	6. Completes reading assignments
4 3 2 1 0	7. Shows self-control (behavior)
4 3 2 1 0	8. Listens politely to the ideas of others
4 3 2 1 0	9. Shows respect for the rights of others
4 3 2 1 0	10. Self-improvement

_____
Student signature

_____
Teacher signature

*The intent of this self-evaluation form is to assist the student to identify academic strengths and weaknesses in the area of academic performance. The instructor reserves the right to question any evaluation.

COMMENTS:

APPENDIX B:
CONTRACT (Environmental Science)

1st stage _____ date due Name _____

A. State general area of interest (example: water quality)

B. State specific research problem within area of interest

Put this in the form of a clear statement of intent or purpose, or in the form of a specific question. The latter is probably better because it will focus your work on precisely what you must do.

Approved _____

2nd stage _____ date due Name _____

C. State preliminary outline of procedure you intend to employ.

D. Clearly list the resources you intend to utilize and explore.

E. Tentatively list materials and other resources you will need.

Approved _____

3rd stage _____ date due Name _____

F. State the final procedure employed.

G. List all resources used.

H. Indicate preliminary results and tentative plans for presentation and where results will lead. (action, involvement, commitment)

Approved _____

4th stage _____ date due Name _____

I. Conclusions from overall results.

J. Final presentation with possible future implications. (If not an action, some statement of what can be done with this investigation, if anything)

Approved _____

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TEACHER'S NOTES:

ENVIRONMENTAL INVENTORY

This unit is intended to provide students and teachers with suggested techniques, instructional objectives, activities, skill processes, resources, and equipment for developing an inventory. The importance of learning innventory skills is to give one the tools and methods of becoming aware of one's environment and investigating its problems.

In order to appreciate the community in which a student lives, to direct his energies toward worthwhile goals which benefit his community and its problems, and to gain the maximum results of a learning experience, the student must become aware and develop his ability to think and act for himself. Techniques such as those suggested in this unit provide enough latitude in the teacher's approach to problem solving that the individuality of the student can be realized and the awareness of the student stimulated.

In order to become aware of and concerned about the problems within his environment, the student must consider its population, businesses, traffic patterns, and other related components. The following suggested investigations are designed to aid the teacher in motivating students toward recognizing, observing, identifying, analyzing, and acting upon problems within his community.

A word about the arrangements of activities. All investigations are complete within themselves. They may be executed independently of the others.

If a particular student has an interest in one or another of the problems, but not all of them, he should have a choice and be allowed to feel secure as he makes his own contribution.

However, even though activities are independent, all are related to each other. In many instances, the results of one study will often become the resource of another study, for example, population density and solid wastes or land use by home dwellers and laws governing water pollution.

It is not suggested that only one student can execute one study. Rather, a group of students can work on an individual problem, with each group member having responsibility for an aspect of the study. (Each aspect might well involve processes of isolation, compilation, procedure, explanation, analysis, conclusion, and the drawing of inferences.) With several groups involved in several investigations and with each student contributing independently, a broad scope of learning experiences will develop.

Initiating the Unit: One of the most common problems of teachers is that of stimulating a youngster into constructive activity. There is no one way or series of steps that could apply to all teachers and to all students. No attempt is being offered here to provide one. Instead, a list of possible considerations are being made available to be used at the discretion of the teacher:

1. Present to the student indirect suggestions about problems relative to the subject areas of this unit. This might be done by a reference to a newspaper article, a comment on the newscasts or an observance made on the way to school. Ask students to relate similar experiences that they may have had and to share their particular reactions.
2. Determine by "rap" sessions the interest points or levels of the students. Rather than using a direct question or written inventory analysis instrument, use an informal discussion with the entire class or group within the class. Such an approach might begin by asking the students if they would like to try some new learning methods in class for a few weeks. A point of departure might include a procedure for determining a more effective arrangement of the classroom to improve the flow of traffic within. A student would realize the area (aspect) in which he could make contributions and the teacher would coordinate these individual activities into a logical sequence. The teacher would also determine the rate of progress in reaching the goal.
3. Direct students' thinking toward a real problem. Cause the student to develop an initiative toward solution by guiding his thoughts through carefully arranged questions. This helps the student realize that the teacher does not have answers to all questions. It also stimulates students into realizing that they have something to offer.
4. A chart or blackboard may be provided for students to list particular problems that they feel affect their lives. They should be encouraged to give reasons why investigation is needed and to suggest methods that would be workable. Group students according to their interests, capabilities, and levels of security.
5. Encourage those students who show the greatest interests in a particular area of this unit to solicit aid and manpower from the others in the class.
6. Students and teachers should design methods and forms of evaluation. This may be done by listing what students and teachers felt was right about the investigation, ways in which it could be improved, and spin-off activities suggested by the various aspects of investigation. It may also take the form of written and oral reports. (See Appendix A for suggested evaluation form.)
7. All activities should take four to six weeks if done concurrently by groups. However, grade level, class size, and ability grouping may extend this prediction.

CONTRIBUTORS TO THE DEVELOPMENT OF THIS UNIT

Author ..... Kenneth Norris, Jr.
Editor ..... Mary R. Junglas
Revisor ..... Lou M. Provenzano

INSTRUCTIONAL OBJECTIVES:

1. The student will be able to locate the information needed to solve a problem.
2. The student will make sensory observations concerning a specific problem.
3. The student will be able to sort out pertinent information about a specific problem.
4. The student will be able to sort, arrange, and correlate facts into meaningful patterns.
5. The student will be able to interpret gathered data.
6. The student will form a plan of action to deal with a specific problem.

TABLE OF CONTENTS

EXPERIENCE #1:
LAND USE

OBJECTIVES:

1. The student will use inventory and survey techniques.
2. The student will develop an awareness of the governmental processes involved in community planning, zoning and land use.

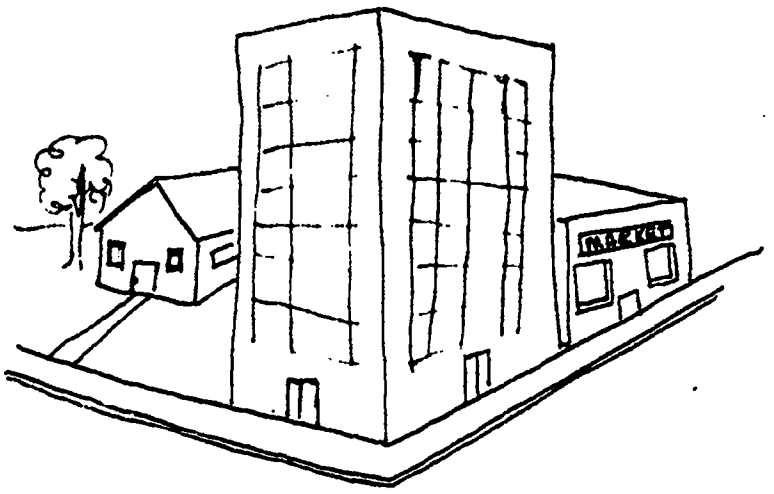
ACTIVITY A: COMMUNITY DESIGN

Teacher's Note:
Maps should be secured before beginning unit. Good sources are zoning and planning commissions and the county engineer's office.

The results of these two procedures relate to the remaining investigations. Also, investigations could be divided on the basis of areas where students live. Each class member or team can eyeball a delineated area in which they live.

1. Purpose:
   a. To determine the boundaries of the community
   b. To determine the classification of the community — whether it be suburban, rural, or urban
   c. To determine the layout of the main streets
   d. To become familiar with reading and working with community maps.
2. Procedure #1:
   a. Have the planning commission explain to students the nature of designing a community.
   b. Have them provide maps and explain how to use them.
   c. Let them suggest activities that would require map use.
   d. Place maps on the wall where they may remain throughout the execution of this unit.
3. Procedure #2:
   a. Obtain a map of the layout of the boundaries of the community.
   b. Section off the map into quarters, drive through each quarter, and view in reality the way it really exists.
   c. Take notes on types of dwellings, businesses, traffic densities, and other significant observances of the given area.
   d. Return to the classroom and discuss results of "eye-balling." Relate observation to the city planner's conversation about the items observed.
   e. Itemize the things that students found surprising, disturbing, unique, beautiful, effective, and puzzling.
   f. Ask students if they had any strong feelings about what they saw, and, if they had an opportunity, whether they would care to delve further.

Materials:
1. Pencil, paper
2. City and community maps, zoning and planning commission regulations
3. Member of the planning commission of the community
4. Transportation



ACTIVITY B: DWELLINGS

Teacher's Note:
It would be advantageous to obtain the most recent map available, since dwellings are built and razed periodically. The data collected can be used in a number of investigations involving land use.

Determining what constitutes a reliable sampling is critical. Densities and sizes of homes and lots and non-home lots must be considered in the conclusions.

Limit the size of the study area so that the survey can be accomplished in one to two hours of field work plus classroom map work.

Where transportation or canvassing is not practical, the use of a cross reference directory may be substituted.

1. Purpose:
   a. To determine (by random sampling) the number of dwellings in a community
   b. To determine the conditions of dwellings
2. Procedure #1:
   a. Refer to community maps and aerial photographs, if available from the county engineer or the agricultural extension agent.
   b. Group students by dividing map into sections.
   c. List all streets in the community.
   d. Count the number of house lots per street and record.
   e. Total all dwellings and record.
3. Procedure #2: (Random Sampling)
   a. Make a plan of the streets that will represent the sampling.
   b. Delegate responsibilities for (a) counting houses and (b) recording the physical conditions of houses and the general conditions of the streets and their appearances.
   c. Starting the house count at the very beginning of the street to be surveyed, count all the houses on one side, then double that number for the full count. (Double the number to include both sides

of the street.) Take care not to include lots that are empty or used for purposes other than housing.

d. Conduct this method for each street in the survey.
e. Chart all streets and house counts in the survey.
f. Using a land use map for the community, list all streets and residential lots.
g. Determine the total number of houses in the community by totalling all houses on each street.
h. Calculate the percentage of houses on each street with the grand total of homes in the community.
i. Combine the percentages of houses in the survey to determine the portion of houses actually studied.

Materials:
1. Transportation
2. Paper and pencil
3. Land use maps

ACTIVITY C: POPULATION

Teacher's Note:
It might be convenient, because of time restrictions, to combine the investigations of dwellings with those of populations. However, because of the method by which the random sampling must take place, use of automobile and walking door-to-door might prove inconvenient. Thus, two separate investigations are necessary.

1. Purpose:
   a. To determine the number of people in a community
   b. To determine the central point of population density within the community
2. Procedure #1:
   a. Extract figures that relate only to boundaries from the census report.
   b. Combine figures for a total.
   c. Record the results and discuss.
3. Procedure #2:
   a. By random sampling, using door-to-door canvassing, ask home owners how long they lived there and how many people live there. (Ascertain the number of school aged children that may be in the home.)
   b. Select an equal percentage of houses per street to survey.
   c. Select the identical percentage of streets in each quarter of the community.
   d. Compile populations for each street and interpolate for each quarter of the community. Compute results.

Materials:
1. Community map
2. Pencil and paper
3. Census report
4. Transportation

ACTIVITY D: NON-DWELLING ESTABLISHMENTS

Teacher's Note:
Care must be given to provide the most efficient method of executing the business establishment survey. Indicated methods are but a few possibilities by which a multi-item survey may be obtained.

The velocity of the vehicle used as well as the visibility of all concerned is of importance. Necessarily, heavy traffic will cause caution on the driver's part as well as keen perception on the student's part. Passing vehicles may block vision.

It might be worthy to define the characteristics of each business establishment. For example a parking lot might be confused with a vacant lot or a used car lot. The yellow pages are a good substitute when transportation or canvassing become problems.

1. Purpose:
   a. To determine the numbers of the following buildings:
      (1) Churches
      (2) Service stations
      (3) Hospitals
      (4) Drug stores
      (5) Restaurants
      (6) Grocery stores
      (7) Fire stations (Police)
      (8) Others
   b. To establish figures relative to the area of land occupied by these establishments
   c. To determine the degree to which the establishments render service to the population
   d. To determine the number of establishments that are not in service to the community
2. Procedure #1:
   a. Have students list all of the different kinds of businesses in the community.
   b. Arrange students into groups according to classifications:
      (1) Churches
      (2) Food markets
      (3) Dining establishments and carry-outs
      (4) Hospitals
      (5) Schools
      (6) Service stations
      (7) Merchandise centers - auto dealers
      (8) Fire and police stations
      (9) Governmental enterprises
      (10) Empty lots
      (11) Closed businesses
      (12) Others
   c. Design a plan that would cover the entire community in an efficient and rapid manner.
   d. Organize investigation teams in the following way:
      (1) Make several trips, covering three classifications at a time, or
      (2) Include enough students so that all classifications may be tallied on one trip.
   e. Starting at an agreed point, students are to

count, by hash marks or tally marks and by visual observation, the businesses that are assigned to them.

f. Written information should be noted with regard to location of the establishment. (This may be done by quartering the community into sections: SE, SW, NE, NW.) Students might wish to prepare data sheets by streets and avenues, using proper directions.

g. Return to school to record and compute data according to
(1) Each classification,
(2) Each quarter of the community,
(3) Any other category necessary.

3. Procedure #2:
   a. Obtain the latest fact sheet on community businesses. (The Chamber of Commerce is usually a good source.)
   b. Follow procedure #1, sections f and g, of this investigation.
   c. Summarize findings and record.
4. Procedure #3:
   a. Students may be assigned to their own particular home locations within the community.
   b. Each student may take all classifications or divide them among themselves if more than one student resides in a given location.
   c. With pre-designed data sheets information can be gathered on the way to and from school or on week-ends.
   d. Return data and proceed as indicated in procedures 1 and 2.

Materials:
1. Community map
2. Pencil and paper
3. Transportation
4. Census report or figures from investigation on population

ACTIVITY E: ASSESSMENT OF SUPPLY AND DEMAND

Teacher's Note:
It is important to assume that the total population makes use of the services in the community. It must be remembered that the population figure most likely will be acquired by random sampling, even though the service survey may be accurate.

It might be well worth mentioning that the population consists of all individuals, including school children. When considering the use of services, there is need of more definition when interpreting and figuring percentages. More accurate results are necessary to obtain the number of students at all the schools in each of the four quarters.

It might be an interesting study to compare the "Supply and Demand" of a community's establishments. The populations density center may not be the same as the geographical center. Establishment of sector may be accomplished in many ways e.g., ward maps, bus route maps, township boundaries.

1. Purpose
   a. To determine the percent of the population serviced by businesses
   b. To survey the location of businesses with regard to population density
2. Procedure #1:
   a. Divide the number of each kind of establishment into the number of total population and record the percent of the total population served by each kind of business.
   b. Divide the community into sectors, the number dependent on geographical size. Determine the percent of population in each. (Students seem to work best when assigned to their home neighborhood or one they have requested. Four to six sectors seems to be most workable.)
   c. Calculate the number of businesses within each classification for each sector.
   d. Compare the percent of population in a given sector with the number of businesses in each classification of that area. Record.
   e. Compare the percent of the entire community with those of the individual sectors.
   f. List the findings. Some considerations are these:
      (1) What percentages are relatively similar?
      (2) To what can the inconsistencies be attributed?
      (3) Has community planning satisfied the needs of the populace for convenient services?
      (4) What do the figures suggest about supply and demand?
3. Procedure #2:
   a. Determine the center of the community by population, by geography, or by central business district.
   b. Divide the community through the selected center, creating sectors as in procedure #1.
   c. Measure the area of each sector.
   d. Using the numbers of businesses in each classifications, determine the area of service it provides. Record.
   e. Determine the average distribution within each sector and record.
   f. Make a chart to compare
      (1) each of the sectors with each other in all classifications and record.
      (2) each of the sectors with those immediately adjacent to it.
   g. List the findings. Some considerations are these:
      (1) In which sector of the community do businesses appear to be more suitably located to meet the needs of the population?
      (2) Does each sector provide the same services in proportion to its population? If not, to what can the discrepancy be attributed?

Materials:
1. Population figures (County auditor, election boards, can all be helpful.)
2. Business establishments (Find it fast in the Yellow Pages.)
3. Pencil and paper

EXPERIENCE #2: SOLID WASTES

OBJECTIVE:

The student will use inventory techniques to assess the solid waste problem in his community.

ACTIVITY A: CLASSIFICATION OF SOLID WASTES

Teacher's Note:
Although only one procedure of classification has been suggested here, there are many others. Students are at liberty to determine the broad divisions that they would feel more secure with. Whatever method they employ, the outcome of locating waste sources would be unaltered.

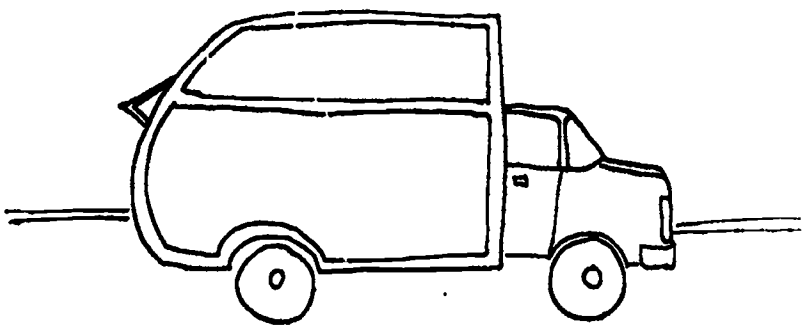
1. Purpose:
   To determine the categories of classification of solid waste substances.
2. Procedure:
   a. Have a small group of students determine all the kinds of solid waste that are found in the community.
   b. Have them list solid wastes according to broad divisions, such as toxic materials, human wastes, garbage, paper refuse, organic refuse, others.
   c. In each classification, ascertain the various sources of these waste materials, such as industry, restaurants, dwellings, etc.

Materials:
1. Paper and pencil
2. Small group or groups. (This activity may be done using the sector maps from Experience #1.)

ACTIVITY B: ASSESSMENT OF SOLID WASTE PROBLEMS

Teacher's Note:
Visual observation or "eyeballing" is a very useful method of stimulating student interest. Often it is difficult to begin a study where the participants have no direct past experience or concern. Observations that are made may not register immediately with the student. After a period of reflection on the student's part, the most relevant aspects of his experience will remain impressed upon his thinking. During discussion periods, many ideas will take form and suggest possible investigations later.

1. Purpose:
   To develop skills in making observations about the problems of solid wastes.



2. Procedure:
   a. Obtain a garbage and trash collection schedule.
   b. Determine the dates of collection in the areas of the community.
   c. Make a route-of-investigation schedule for the purpose of arranging visits throughout the community, or have student present descriptive narration of their neighborhood.
   d. Divide the survey group into divisions of concentration. Such areas might deal with the following questions:
      (1) What is the average number of cans or bags of garbage per street?
      (2) At what location on each parcel of land is the rubbish placed for pick-up? How is the location determined?
      (3) What kind of solid wastes are observable?
      (4) How well does rubbish appear to be packaged?
      (5) How are waste materials dealt with at places of business and industry?
      (6) What is the appearance of the general area of the community on the day of collection?
      (7) What kinds of vehicles are used to place waste for pickup?
      (8) What kinds of vehicles are used for transfer and removal?
      (9) Who are the sanitary engineers and what are their job responsibilities?
      (10) What is the noise level during pick-up and transfer?
      (11) What is the neatness level after pick-up and transfer?
   e. Record on data sheets what the students observe. Items (a) and (b) can be presented well by plotting routes and schedules on a community map in color code.
   f. Return to class and summarize findings.
   g. Make a list of recommendations for action that might improve any problem areas and present or direct it to elected officials in the community.

Materials:
1. Paper and pencil
2. Transportation
3. Waste collection schedule for homes and businesses. (This should be available from the sanitary engineer, health department, or private haulers.)

ACTIVITY C: CONTAINER QUALITY

Teacher's Note:
The two preceding procedures may also be conducted for inside dwelling containers and solid waste handling containers and equipment. Interpretation, using the data obtained, could encompass other areas not included.

Such a study would draw upon the student's mathematical and economic education.

Procedure #2 might well be done in teams with your school's math department if you have a statistics class.

1. Purpose:
   a. To ascertain the variety of containers used in storing solid wastes
   b. To determine the quality of each kind of container sold on the market
2. Procedure #1:
   a. Visit a well stocked merchandising establishment. Call ahead to explain your purpose.
   b. Obtain permission from the manager to make a survey of the solid waste containers.
   c. Note the following information about containers:
      (1) material of which they are made
      (2) size and volume
      (3) price
      (4) weight
      (5) brand name
      (6) unique features in construction, handles, top security, etc.
3. Procedure #2:
   a. Arrange a group of containers having the same size in volume but differing in material.
   b. Perform the following tests on each one:
      (1) Does it bulge under excessive internal stress?
      (2) Does it leak liquids and odors?
      (3) Does it have extra strength at points of stress?
      (4) Does its shape distort from minimal handling?
      (5) Does it erode, tarnish, corrode?
      (6) Does its color and shape detract from the appearance of the environment in which it is located?
      (7) Is it easy to keep as sanitary as necessary?
   c. Record the results of the tests on a chart, using numbers to represent the best rating as #1 and progressing to the worst rating of #5.
   d. Summarize the chart by discussion. Make comparisons and correlations based on the tests performed among the containers. Compare the results with the containers in actual use and interpret what they mean in terms of the problem of sanitation in the community.

Materials: One sample of each container

ACTIVITY D: SOLID WASTE TRANSPORT

Teacher's Note:
This particular investigation makes it possible for the student to determine, by various means, the economic factors in selecting a transport system for a community. It informs him about the factors of finance; sources of funding; costs of maintenance and replacement; and funding for the upgrading of equipment.

1. Purpose:
   To determine the variety of transport systems of vehicles used in a community and how it compares with other areas.
2. Procedure #1:
   a. Make a list of several communities similar to the student's (urban, suburban, rural).
   b. Make a list of communities of varying qualities unlike the student's.
   c. Write to the service departments of communities, requesting information about the types of solid waste transport systems. Responses are quicker, although less detailed, if secured by phone.
   d. Condense the responses into groups and note types of vehicles most preferred.
3. Procedure #2:
   a. Determine the timetable for the various locations of waste pick-up and transport.
   b. Schedule groups to observe the type of equipment used in the community. Examples might be carts, conveyors, hoists (tilt or rear), packers, satellites, chutes, etc.
   c. Take notes in each case of the kind of establishment or dwelling that is involved.
   d. Inquire about the volume of trash and rubbish that can be contained in each kind of vehicle.
   e. Figure the number of dwellings and/or establishments that can be accomodated by one load of each transport vehicle. (The average quantity of waste per unit on the street must be determined. Divide this quantity into the vehicle's volume when fully loaded.)
   f. Evaluate the best transport system in terms of figures. Compare this evaluation with presently used systems.

Materials:
1. List of the addresses of municipal and local service departments.
2. Resource books.

EXPERIENCE #3:
SOIL

OBJECTIVE:

The student will use inventory techniques to assess the quality of the soil in his community.

ACTIVITY A: SOIL ANALYSIS

1. Purpose:
   a. To determine the component of soil in a community.
   b. To determine the physical traits of soil.
2. Procedure #1:
   a. Obtain samples of soil from all areas of the community. Each student might be asked to bring a sample.
   b. Measure standard quantities by analysis. (See handbooks listed in bibliography.)
   c. Following directions of the testing kit, test for the various materials soil contains and record.
   d. Compare the soils and their locations. Plot results on a community map.
   e. Compare weights of the same volumes of soil and record.
3. Procedure #2:
   a. Measure out equal quantities of soil by weight, then by volume. If there is a difference between the two, perform the procedure twice, using each one at a time. If no difference exists, take your choice.
   b. Execute tests for the following:
      (1) Moisture Retention
      (a) Fill the heat resistant containers with the samples of soil. (Use standard amounts.)
      (b) Place soil in oven and leave there until the soil is completely dried out.
      (c) Remove the soil from the oven and introduce enough water to the soil to just saturate it. (Saturation point is reached when no more water will be absorbed into the soil.)
      (d) Record the amount of water taken in by each soil sample.
      (e) Repeat for all samples.
      (2) Moisture Rentention
      (a) Weigh all heat resistant containers. (They should all be the same.)
      (b) Place samples of water-saturated soil into heat resistant containers and re-weigh.
      (c) Determine the weight of the saturated soil by taking the difference in the weights of the containers and of the containers and soil. Record.
      (d) Place samples in oven. They should remain there long enough to become completely dry.
      (e) Remove from the oven and weigh container and soil. Change in the soil's weight is due to the loss of water.
      (f) Compare the difference in weight of soil before and after. The difference in weight is the index for the retention ability of the soil.
      (3) Color
      (a) Group all samples having the same constitution together.
      (b) Compare colors and suggest reasons for the differences.
      (c) Group together all soils having the same color. Compare their consistencies and explain the discrepancies.
      (4) Odor - Follow procedure for color.

Materials:

1. Containers, water proof and heat resistant
2. Soil samples (equal amounts by weight or/and volume)
3. Soil testing kits
4. Water
5. Oven or some other heat chamber

ACTIVITY B: SOIL ENVIRONMENTS

Teacher's Note:

This activity is basically one of observation. The characteristics of a location will have some effect on soil. The question here is whether or not the soil has remained in its present state for a substantial length of time.

It would be an interesting study to conduct an historical survey dealing with the commercial activities over long period of time.

Comparing the various uses and influences of environmental activity on the soil of specific areas of a community is an entire scope of study in itself.

1. Purpose:
   To assess the relationship between the nature of soils and the environment in which they are found.
2. Procedure:
   a. This should be done at the time the soil samples are gathered.
   b. Using the "eyeballing" observation method, record on a community map the following information about the area:
      (1) Surrounding bodies of water
      (2) Surrounding dwellings and businesses
      (3) Specific use being put to soil (turf, landscaping, farming, etc.)
      (4) Signs of misuse (erosion and dumping)
   c. Discuss the relationships. Attempt to give reasons for observations.

Materials:

1. Transportation
2. Pencil and paper

ACTIVITY C: SOIL EROSION

Teacher Note:
The extent to which this activity is pursued can be tailored to individual resources.

1. Purpose:
   a. To determine the evidence of soil erosion within the community
   b. To explore methods of reducing erosion
2. Procedure
   a. Group students into small clusters.
   b. Each group is to discuss their thoughts about what kinds of conditions cause erosions.
   c. Each group is to devise activities to provide data on the circumstances which may cause erosion.
   d. Tour the community, listing sites and conditions of soil erosion.
   e. Observe places where soil appears to have been "brought" rather than formed at the site.

   Circumstances which may cause erosion include these:

   (1) Run-off. Comparing the removal of the soil of slopes (steep, flat, gentle), testing effect of vegetation (present and past, present or absent).

   (2) Highway road construction, soil banks, sewer and water projects.

   (3) Large scale construction of business and homes

   (4) Wind and weather elements (water, ice, etc.)

   f. Test each circumstance by creating mini-situations with fans, water, excavating facsimiles, etc.
   g. Record results of each test.
   h. Record the discussion of the results to include the relationship to the community.
   i. Discuss possible methods and practices which could have prevented the erosion problems.

Materials:
1. Transportation
2. Geology reference books
3. Stream table, if available, or sites which could substitute for the table.

EXPERIENCE #4
TOPICS FOR INDEPENDENT RESEARCH

OBJECTIVE:
The student will be able to pursue an inventory independently on a topic of personal interest. At the conclusion of the four to six weeks of activities, the student hopefully will be motivated to continue and develop courses of independent action.

Teacher's Note:
Listed here are just a few suggested investigations that he might wish to conduct on his own, if he has the time and facilities during or after school. He should be encouraged to use any advantageous home facilities.

The object of follow-up studies is to keep interest alive in the student and to create in him the understanding that investigations relate to each other in very significant ways. Questions left unanswered are the basis for additional study.

The following suggested topics for investigation may be done on an independent basis or by a small group. The following procedure might be offered as a method to accomplish this:

1. *Be sure to have a written record of all results of the activities done during the four to six weeks.*
2. *Allow enough time to discuss all results and to envelop them into some meaningful picture.*
3. *Have students list the good and bad points about the procedures and methods of approach during the four weeks.*
4. *Obtain from each student a written evaluation of his total experience, including those areas he feels need further investigation. (His evaluation may be in the form of questions whose answers have not been given or been understood by him during the course of activities.)*

It is important, however, that the student determine the direction which he desires to take. The ultimate goal for the student is to satisfy his inquiry and the ultimate goal for the teacher is to observe the student's development in those skills and interests stated in the introduction of this unit.

ACTIVITY A: LAND USE

1. Community Zoning
   a. What is zoning?
   b. What is the need for zoning?
   c. Can zones be changed? How?
   d. Who determines the zone boundaries and laws?

2. Tax Base
   a. What is the tax base of a community?
   b. What is the tax base of this community?
   c. What is determined by the tax base?

ACTIVITY B: SOLID WASTE

1. Usage of Garbage in Enriching Soil
   a. Can garbage be recycled in the ground to enrich soil?
   b. What are the ingredients in soil which would be replaced by using garbage?
2. Bacterial Life in Garbage
   a. Does garbage decay? What causes it to decay?
   b. What bacteria thrive on garbage?
   c. Are there environmental hazards caused by the decaying garbage?
3. Relationship Between the Handling of Solid Waste Material and the Affluence of a Community
   a. Is there any correlation between how people treat solid rubbish and their level of education?
   b. What are the attitudes about trash of people of various levels of affluence in a community?
   c. What does the appearance of the containers and properties of the community tell about the life styles of a community?

ACTIVITY C: SOIL

1. How can the humus and loam content of soil be affected by the vegetation throughout the community?
2. Is there any evidence of soil leaching in the community? If so, to what can it be attributed?
3. Two methods of preventing erosion are countour plowing and strip cropping. Have these methods been used in the community? If not, why not?
4. What other methods of soil prevention have been used in preventing erosion in the community?

APPENDIX A:

SELF-EVALUATION FORM

Name _____

Class _____

Date _____

Rating Scale

4 3 2 1 0	1. Works well with others
4 3 2 1 0	2. Joins in general class discussions and freely shares ideas
4 3 2 1 0	3. Contributes to small group work; shares work load
4 3 2 1 0	4. Accepts responsibility (attendance, tardiness, assignments)
4 3 2 1 0	5. Completes written assignments
4 3 2 1 0	6. Completes assigned reading
4 3 2 1 0	7. Completes lab and field investigations
4 3 2 1 0	8. Listens politely to the ideas of others
4 3 2 1 0	9. Shows respect for the rights and property of others
4 3 2 1 0	10. Shows self-control in class and lab situations (behavior)
4 3 2 1 0	11. Self-improvement

Please enter your grade for the marking period (_____)

_____
Student Signature

_____
Teacher Signature

The intent of this evaluation is to assist the student in identifying the strengths and weaknesses of academic performance. The instructor reserves the right to question any evaluation.

REFERENCES:

TEACHER'S BOOKS:

Andrews, William A. *Soil Ecology.* Englewood Cliffs: Prentice Hall, Inc., 1973. Causes of pollution (air, soil, solid wastes, noise). Suggested investigative activities.

Emmel, Thomas C. *An Introduction to Ecology & Population Biology.* New York: W. W. Norton & Co., Inc., 1973. Deals with solid waste pollution, incineration, landfill, reclamation.

Hagevic, George. *Planning to Air Quality Management.* New Brunswick: Center of Urban Policy Research and University Extension Division, Rutgers University, 1970. Deals with urban planning (state & local, related to air pollution management resulting from emission [vehicular], citizen's participation in decision making, growth in population.)

Hammerman, Donald R. & William M. *Teaching in the Outdoors.* Minneapolis: Burgess Publishing Co., 1973. Intended for teacher, suggests ways of initiating, conducting, and wrapping up environmental studies.

Jones, Claire; Gadler, Steve J., and Engstrom, Paul H. *Pollution: The Land We Live On.* Minneapolis: Lerner Publications, 1971. Land usage, garbage, zoning. Useful as a reference for increasing the community's efforts in the above areas.

Pringle, Lawrence. *The Only Land We Have.* New York: McMillan Co., 1969. Methods of personal involvement about community problems. Suggests what one can do.

Stroble, Maurice A. *Environmental Science Laboratory Manual.* St. Louis: C. V. Mosby Co., 1972. Deals with particulate matter in air and water. Suggests possible investigations in this area.

U.S. Environmental Protection Agency. *Summaries of Solid Waste Research and Training Grants — 1970.*, 1971.

Van Tassel, Alfred J. *Our Environment: The Outlook for 1980 — Studies in Social & Economic Process.* Lexington: D. C. Heath and Co., 1973. Discusses water, air solid waste disposal in various states in the country. Informative for inventory. Indicates problems, solutions, and results.

STUDENT'S BOOKS:

Boy Scouts of America. *Boy Scout Environmental Science Merit Badge Handbook.* Excellent source of simple and revealing activities related to soil, water, and air pollution problems. Inexpensive and practical.

Kaskel. *Investigation: The Living System.* Merill Publishing Co.

Lamotte. *Soil Handbook.* Handbook of soils including descriptive information, investigative activities and both qualitative and quantitative testing techniques.

PERIODICALS:

Sellig, Marshall. "Water Pollution Control and Solid Waste Disposal," *Chemical Progress Review.* No. 32, 1969. Discusses methods of treating solid wastes, handling liquids, sewage disposal process. Suggested for the advanced student.

GAMES:

Selected Topics from Houghton-Mifflin's series developed for ESCP: *Pollution, Planet Management.*

ENVIRONMENTAL MANAGEMENT

The *purpose* of this unit is to

a. identify several environmental areas in which management is being effected.

b. develop a general approach to the study of environmental management systems, a strategy which is applicable to the areas identified in (a).

c. investigate one specific example of environmental management, water treatment.

The *methods* used by the teacher should be *process oriented;* content will be introduced as needed. Students will

a. identify and become familiar with the local facilities and services which are a part of an environmental management process by means of field trips and/or carefully screened and selected resource people.*

b. study the concepts and processes involved in the management system.

Emphasis will be on the collection of solid data followed by interpretation of this data through group discussions and needed explanations, the *teacher functioning in the role of facilitator.*

The *guidelines* for teaching strategies which follow can be used as a model for developing units and/or experiences in a consideration of management in any of the environmental areas identified in unit purpose (a).

1. Identification of environmental areas suitable for study within the management context. (Air, land use, food production, energy sources, forests, animal resources including game and fish, water.)
2. Analysis of the management system for the area selected, including
   a. awareness of and need for management
   b. understanding of principles involved and degree of technology involved.
3. Analysis of the effectiveness of the system
   a. comparison of old and new technologies
   b. consideration of new and developing technologies and their feasibility
   c. comparison of local management system with those of similar communities
   d. consideration of the impact of the system on the environments
   e. determination of the degree of compliance with established standards
   f. evaluation of the adaptability of the system in meeting possible future standards
4. Data retrieval, including
   a. location of facilities and investigation of management skills and background
   b. organizational structure and function
   c. identification of biological, chemical and physical processes in treatment stages
   d. input and output of the management system
   e. statement of standards established locally, statewide and nationwide

*The resource people should be more informed than the teacher and able to present the material as effectively, if not more so.

Since this unit is lab oriented, the instructor should order water analysis kits and the reference *Environmental Pollution* early. If the material cannot be purchased, the instructor should prepare some sample analysis sheets and teach from them. (See Environmental Pollution)

It would be wise to preview the entire unit and judge what you will be able to accomplish within your time budget.

If field trips are not possible, teach the procedures from flow charts and/or diagrams, sketches, etc.

This unit will include the environmental management of water and waste water, and the main emphasis will encompass the following major points:

1. Determination of needs and water uses in the local community*
   a. Biological
   b. Agricultural
   c. Community
   d. Industrial
2. Determination of the sources and facilities available for the local water supply*
   a. Wells
   b. Rivers or streams
   c. Lakes
   d. Man-made impoundments or reservoirs

   Question for discussion:
   How is the local physical environment (for example, geological) related to the source or supply?
3. Determination of general types of water treatment needed to produce potable water *
   a. Chemical (chlorination)
   b. Physical (microfiltration)
   c. Aeration
4. Description of general methods of waste water treatments
   a. Septic tanks
   b. Sewage system
      1. primary treatments
      2. secondary treatmnts
      3. tertiary treatments
5. Investigation of the disposal of sludge wastes.
   a. Landfills
   b. Incineration
   c. Digesters
   d. Organic filler on land
6. Determination of local water quality standards
7. Determination of compliance with standards of waste water discharges
   a. Investigation and set-up of a monitoring system by students
   b. Comparison of their data with that of the local facility
   c. Determination of the environmental impact of waste water discharges (water enrichment or eutrophication)

*The trend of the material which follows will be determined by the relevancy of the items to the area where the students live, urban, suburban, or rural.

INSTRUCTIONAL OBJECTIVES:*

1. The student will be able to identify community (local, municipal, county, regional, etc.) services needed for the management of water supply, waste water and solid waste.
2. The student will be able to describe methods of pollution control and monitoring which are being used in the environmental management process in the community with regard to water quality.
3. The student will be able to determine the environmental impact of the management process (for example, of waste water on local watersheds or lakes).
4. The student will be able to develop a plan for the environmental management of resources which will include these two aspects: (a) compatible use and (b) acceptable water quality standards and land usage using federal or state government EPA guidelines.

*The objectives for the study of any of the other environmental areas will follow this general form, with modifications in the wordings to suit the specific problem being investigated.

CONTRIBUTORS TO THE DEVELOPMENT OF THIS UNIT

Author ..... Edward Hauser
Editor ..... Stoyan N. Topalof
Revisor ..... Yvonne Mather

TABLE OF CONTENTS

EXPERIENCE #1:
INDIVIDUAL NEEDS AND WATER USES IN THE LOCAL COMMUNITY

OBJECTIVE:

The student will be able to determine what his household needs are with reference to water consumption and usage.

Teacher's Note:

1. *Instead of home consumption, school consumption could be determined.*
2. *Appropriate tables or logs should be constructed by students for the recording and computing of all data. An entire class can record and graph the data for all students and compute class averages.*
3. *The unit for measuring is M.C.F. or 1,000 cubic feet. By using standard conversion tables, students can convert to gallons.*

ACTIVITY A:

Each student will examine the water bills that are received at home and calculate the water consumption for the past year (12 month period). A sample bill can be seen in Appendix A.

Calculation: (1) Determine the number of days in the billing period and divide that figure into the consumption. (2) Divide the consumption per family just obtained by the number of individuals living at home; this figure represents the average consumption per day per individual.

An alternate method is to have each student read the water meter daily for a one-week period and determine the average daily consumption per individual.

ACTIVITY B:

Discuss the following questions in class:

Is it apparent from graphs that large families consume more water than small ones?

What are the limitations in computing averages based on a one-week period? (Consider any seasonal variation.)

How do class averages on per capita consumption compare with regional or national ones?

What is the cost of water per individual per day? How do cost figures compare with other municipalities?

Determine if there are additional costs included in the water bill. For example, in the sample bill illustrated, there is a SR-CLEAN WATER CHARGE. What does it represent?

Apartment dwellers should try to find out from the management the cost for water and determine the answers to the questions.

Children from rural families might estimate volume of water consumption used to water stock, clean stalls, etc.

EXPERIENCE #2:
INDUSTRIAL NEEDS AND WATER USES IN THE LOCAL COMMUNITY

OBJECTIVE:

The student will be able to identify what industry exists in the community and the water needs of each industry (cooling, cleaning, etc.) and to determine the water consumption of these industries. (For example, it is estimated that, on the average, 20,000 gallons of water may be needed in producing a ton of steel.)

ACTIVITY A:

It is recommended that the teacher use a group approach. Each individual group would be responsible for examining the needs and consumption of a particular group of industries in the local area: steel mills, electrical power, generating plants, chemicals, etc. Rural dwellers often work in nearby industries.

Sources of information: correspondence or reports from industry, state and national agencies (such as EPA), or service agencies of local communities (water works plant).

If one industry, such as steel dominates the local community, a class field trip is highly advisable.

Appropriate tables or logs should be constructed by students for recording and computing of all data. The entire class can record and graph the data provided by groups.

At the conclusion of the activity, discuss the following questions in class:

How does the consumption of water by industry compare wih household consumption?

In how many ways is water used by industry?

Are there potential pollution problems that exist as a result of certain type of water usage (thermal pollution when water is used for cooling)?

EXPERIENCE #3:
COMMUNITY WATER SUPPLIES

In this section, it is assumed that the student has an understanding of the amount of water needed or used by his local community as result of studying Experiences 1 and 2.

OBJECTIVE:

The student will be able to determine the source of the local water supply and how geophysical aspects of the environment affect it.

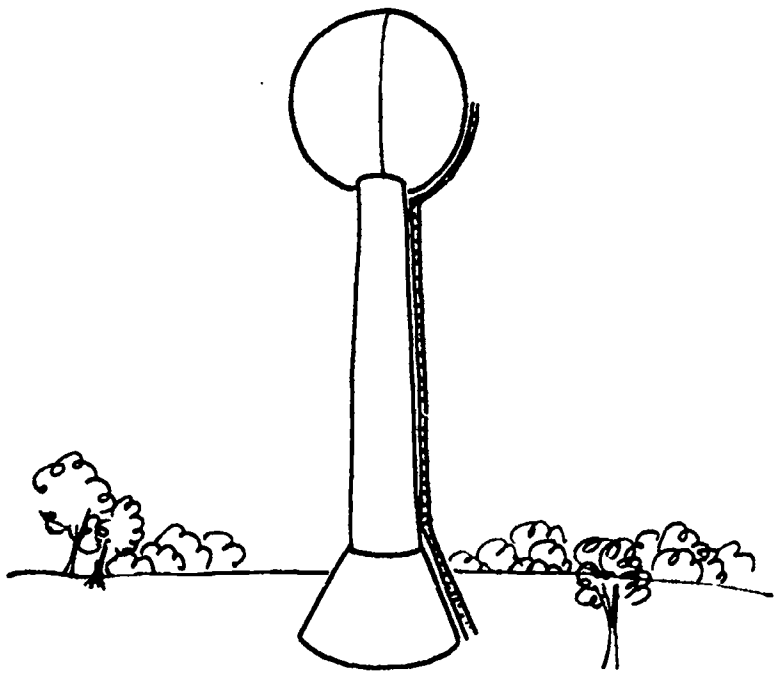
Teacher's Note:

Emphasize the study of the source in your area (urban, suburban, or rural).

ACTIVITY A:

Have a class discussion in which the following questions are asked:

Where does your tap water come from (home or school)? If the source is a river or lake, the following basic question can be raised:



What is the watershed of the water supply?

An excellent activity is to provide students with tracing paper or outline maps of the region which includes the local watershed. Topographic maps or other maps can be used as resource materials. The object is to have students construct a map of their immediate watershed and identify the following items:

a. source of input and/or treatment facility (water works plant)
b. borders of watershed or lake system
c. location of nearby communities (including population figures)
d. location of industrial sites
e. potential sources of pollution or effluents which might affect the water supply
f. If the source is an impoundment along the stream, it should be identified: dam location and area of impoundment (including effects downstream below the dam).

The student should be able to write a summary of the watershed source, taking into consideration such aspects of the physical environment as run-off and topography, stream flow, and quantity, Cultural influences, such as the control of human activities, including multiple uses, should be summarized. If there exist known problems of water contamination and pollution, these should be noted; existing laws should be examined; provisions for enforcement of laws should be evaluated.

Once again, emphasize the supply source.

Material:
Topographic maps.

ACTIVITY B:
IDENTIFICATION OF WATER SUPPLY SOURCE

Teacher's Note:
A local well driller may be asked to talk to the class about his experience in drilling wells in that locality. The state agencies under Ohio Department of Natural Resources provide teachers with numerous brochures and booklets as well as lowcost maps and publications. The two to which a teacher should write are the Division of Water and the Divison of Geologic Surveys. Local county agencies such as USDA, board of health, and the Ohio EPA can provide information and/or resource people.

Underground well water is almost exclusively the only source available to homes and farms of rural areas. Thus, it is a major source which is vital and must be given high priority in environmental protection.

Types of Aquifers: To generalize, there are four basic types of aquifers found in Ohio: (1) buried outwash glacial valley deposits, (2) upland glacial deposits, (3) limestone-dolomite bedrocks, and (4) sandstone-shale bedrocks.

Using local topographic maps, ground-water availability maps, and geologic maps, the student should be able to identify what possible aquifers are found in his area. Specific objectives of this activity include these:

1. Identification of loacl aquifer(s)
2. Determination of what the potential ground water flow is in gallons per minute.
3. Determination of what the water chemistry is, i.e., hardness, potability, etc. A simple litmus test can be used to determine relative pH.

Since water chemistry is a complex study in itself, the teacher could list some of the more common analysis made: pH, nitrates, hardness, total suspended solids, total dissolved solids, dissolved oxygen, phosphates, coliform count, Secchi disc readings, free CO_2.

Divide class into interest and/or ability groups (small) and assign one analysis to each group. Allow time for sampling procedures.

Each group reports findings on the chalkboard and explains the significance of the findings. (See procedure in *Environmental Pollution*, pp. 22-35. See bibliography.)

Materials:
Tracing paper or topographic maps and a map of the principal watersheds in Ohio.

Lamotte Kit, $95.00, Ward's Natural Science Inc., Rochester, N.Y.

EXPERIENCE #4:
WATER SUPPLY TREATMENT

OBJECTIVE:

Students would be able to determine what types of treatment are needed to produce potable water.

ACTIVITY A:

Laboratory Analysis: Water samples can be collected from the source and obtained from the tap and later compared after chemical analysis. With Hach or Lamotte Kits, simple colorimetric tests can be made for chlorine, iron, phosphates, dissolved oxygen, etc.

Millipore filters can be used to determine the needs and effects of microfiltration. Suspended solids, suspend algae, and bacterial counts could be made using standard analysis techniques. Students would then make comparisons and infer what types of treatment had occurred.

Field Trip: A field trip could be arranged to a water works plant. The teacher should construct a flow chart of stages in the process and an outline of questions to be answered regarding treatment of water. Objectives from earlier activities could be reviewed on site with resource people.

Questions:

What types of chemical and physical treatment are used in producing potable water?

Why are these necessary?

What is the cost of treatment?

Could water quality from the source be improved?

Materials:
One Hach or Lamotte testing kit

EXPERIENCE #5: WASTE WATER TREATMENT

OBJECTIVES:

1. The student should be able to list the methods which are used in treating waste water.
2. The student should be able to identify the environmental management process which is used in treating waste water.
3. The student should be able to determine the effectiveness of the environmental management process by interpreting the total qualitative and quantitative input and output of the system.
4. By collecting data or examination of data sheets, the student should be able to write a constructive plan for improving the environmental management of the sewage treatment system.
5. The student should be able to construct a set of water quality standards which can be used as a guideline for evaluating the environmental management process.
6. The student will be able to make an evaluation of the qualifications of the personnel used in the environmental management process and determine if additional skills or training will be required in improving or upgrading plant operations. Included in the evaluation would be alternative methods currently available which might improve the environmental management process. (optional)

ACTIVITY A: FIELD TRIP TO A LOCAL SEWAGE TREATMENT PLANT

It is highly recommended that a field trip be arranged to a sewage treatment plant. Assuming the administrative mechanics for arrangement have been met, classroom preplanning will involve an introductory discussion session. The following questions will provide guidelines for inquiry:

a. What is waste water?
b. What are its constituents? What kinds of organics are there? What types of nitrogenous and phosphorous wastes?
c. How can you remove constituents of waste water? What kinds of stages or treatments might be involved?
d. Why do you need to remove waste water constituents?

ACTIVITY B: A FOLLOW-UP SESSION

Teacher's Note:
T? primer on waste water treatment (cited in the bibliography) represents an excellent publication which should be used by students and teachers during this session.

In this session, students should be provided with a flow chart of the local sewage treatment plant visited. This will require some earlier contact with the plant superintendent. A sample flow chart is provided in Appendix B and can be duplicated if no other source is available. Questions which can be used to lead the discussion include these:

a. Are primary and secondary treatment a part of the environmental managment process? Advanced or tertiary?
b. How is sludge disposed of in the management process?
c. What are the inputs and outputs of each component?

ACTIVITY C: LABORATORY FIELD EXPERIENCE

Teacher's Note:

1. *The advantage of using a Population Diversity Index is that students* do not *need to identify organisms by taxonomic name. Each organism which is different can be given a letter or number symbol.*
2. *If time allows (see Appendix D), organisms may be identified taxonomically. Especially important are "indicator" types of relative water quality. See the list of dominant bottom organisms for the Rocky River Basin.**
3. *Most studies indicate that a complete survey of all organisms is most useful in constructing a Population Diversity Index. Thus, one group could collect algae, another microinvertebrates, another macroinvertebrates, another fish, etc. (See Appendix E)*

Students should be able to determine the impact of effluents on the biophysical environment. (The student groups set up in Experience 3 could use the techniques they learned to gather data in this experience.)

1. Students can collect water samples for chemical analysis at several points along a stream. At least two should be above the point of effluent dis-

*More motivated students could do #2. Less able or less motivated students could opt to do #1.

charge; another should be just below the point of discharge; at least three stations at ¼ to ½ mile intervals should be established below the stream. These water samples can be analyzed on site or in the school laboratory using the Hach Kit colormetric technique.

2. As an alternative, the students may be able to obtain data from the sewage treatment plant, as daily records must be kept for public record.
3. Find the Population Diversity Index. (See Appendix E).

Field Trip Guideline Questions:

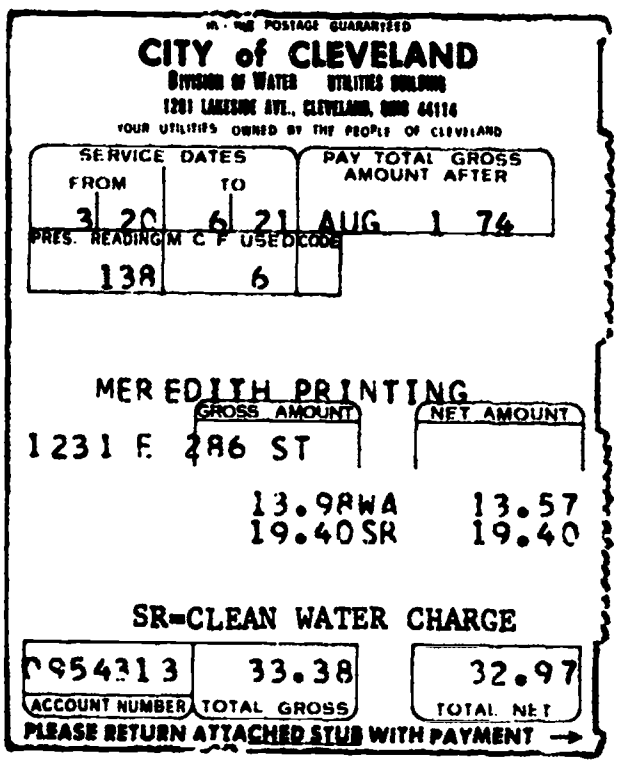
1. Is the basic waste water treatment adequate for the load it handles?
2. To what extent are phosphates and nitrogenous compounds removed?
3. Is any type of advanced or tertiary treatment used? Is it needed?
4. What type of water quality standards exist for the receiving waters?
5. Does the plant discharge alter water quality within parameters of these standards?
6. What methods are used for sludge disposal in the environmental management process? Are these adequate? Are any alternative methods available?
7. Does the efficiency of the plant operation conform to existing standards for waste water treatment?
8. Do the staff technicians and operators have adequate training for the type of work required?
9. Is any anticipated population growth of the local community, including future expansion, considered in the operation of the plant?
10. Are there any operations of the plant that might add to its cost efficiency? For example, an aerobic sludge digester could be used to generate methane gas for fuel purposes.
11. Are sanitary sewers separate from storm sewers?
12. Can the plant hold excessive runoff from a storm rather than letting water bypass the plant?
13. Are any municipal, regional, or state planning agencies involved with developing a comprehensive plan for waste water management? If so, what plans have been proposed? Are they preliminary or final?

ACTIVITY D (alternative):

Investigate the procedure used by farm dwellers to determine the effectiveness of their cesspools. (Testing for D.O. using the Winkler Method.)

Find out if there are local ordinances limiting sites of cesspools on properties adjacent to your home.

APPENDIX A:



POSTAGE GUARANTEED

CITY of CLEVELAND

DIVISION OF WATER UTILITIES BUILDING

1201 LAKESIDE AVE., CLEVELAND, OHIO 44114

YOUR UTILITIES OWNED BY THE PEOPLE OF CLEVELAND

SERVICE DATES FROM	TO	PAY TOTAL GROSS AMOUNT AFTER
3 20	6 21	AUG 1 74

PRES. READING	M C F USED	CODE
138	6	

MEREDITH PRINTING

	GROSS AMOUNT	NET AMOUNT
1231 E 286 ST		
	13.98WA	13.57
	19.40SR	19.40

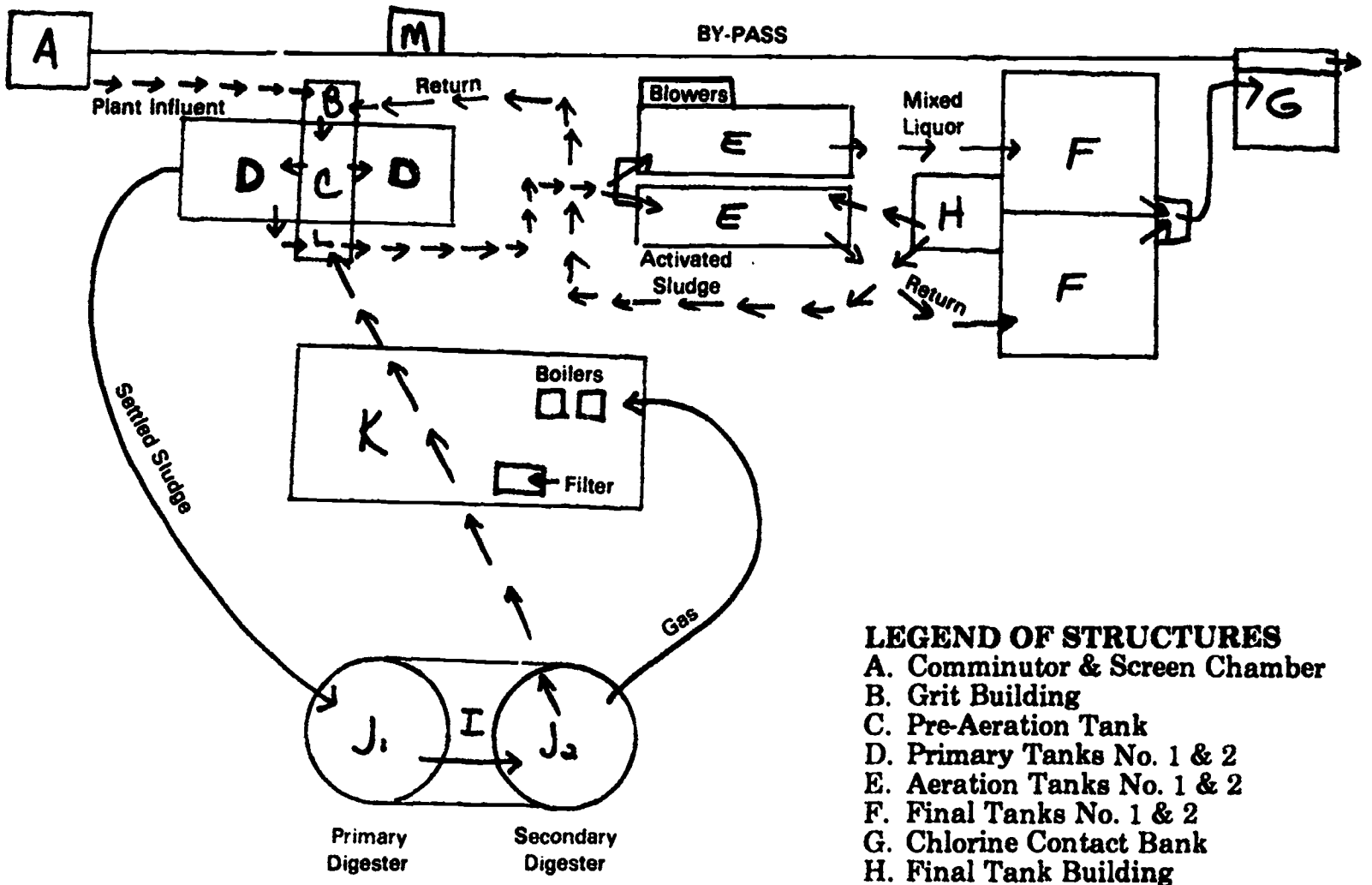
SR=CLEAN WATER CHARGE

ACCOUNT NUMBER	TOTAL GROSS	TOTAL NET
954313	33.38	32.97

PLEASE RETURN ATTACHED STUB WITH PAYMENT →

APPENDIX B:

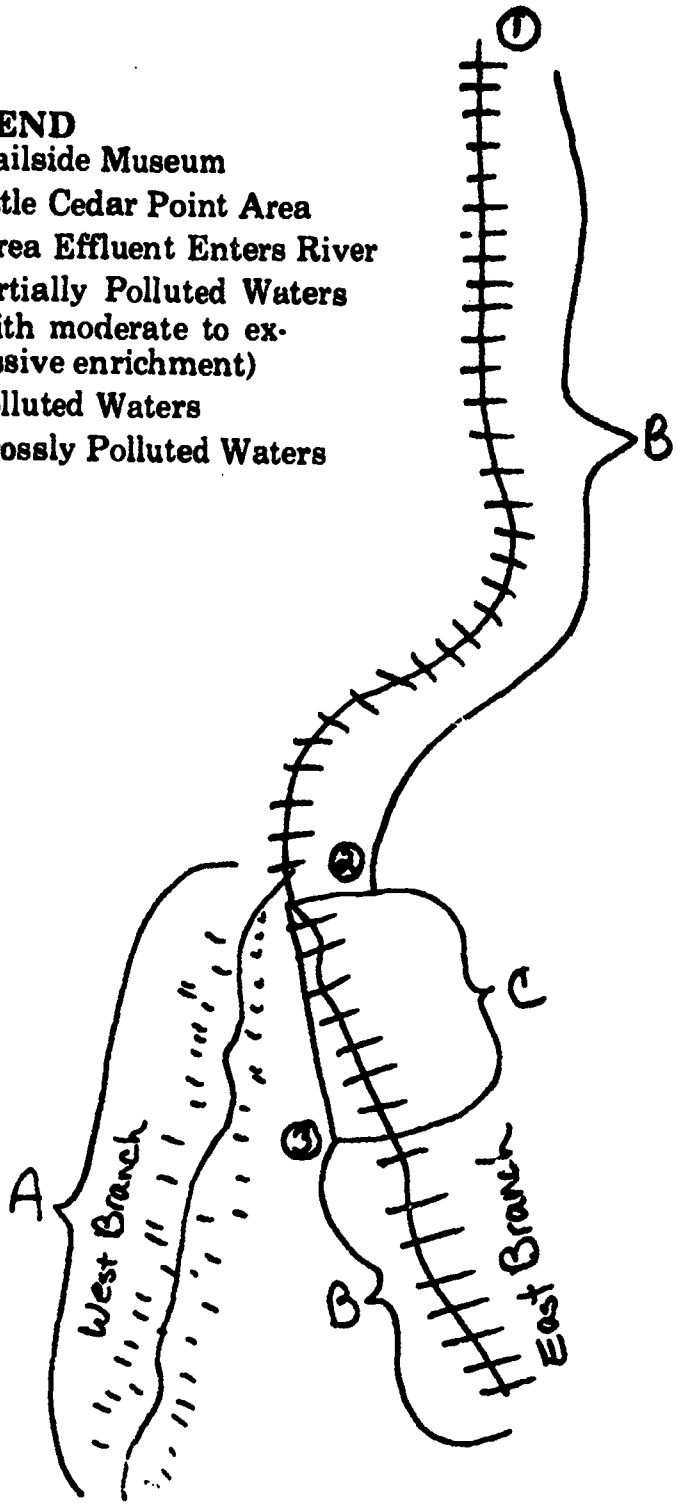
FLOW DIAGRAM OF THE NORTH OLMSTED SEWAGE PLANT



LEGEND OF STRUCTURES

A. Comminutor & Screen Chamber
B. Grit Building
C. Pre-Aeration Tank
D. Primary Tanks No. 1 & 2
E. Aeration Tanks No. 1 & 2
F. Final Tanks No. 1 & 2
G. Chlorine Contact Bank
H. Final Tank Building
I. Control Room
J. Digesters
K. Administration, Lab & Filter Bldg.
L. Sludge Holding Tank
M. Sub-Station

APPENDIX C:
PORTION OF ROCKY RIVER BASIN



SOME COMMON DOMINANT ORGANISMS IN THE ROCKY RIVER BASIN

A. *Grossly Polluted Waters* (below Berea effluent)
   Oscillatoris (blue-green alga)
   Culex (mosquitoe larva and pupa)
   Tubifex (tubifex or sludge worms)

B. *Polluted Waters* (most of the Rocky River proper)
   Hydrodictyon (water net, a green alga)
   Lemna (duckweed, a reduced flowering plant)
   Scenedesmus (4-celled colony, a green alga)
   Hirudo (leeches)
   Physa (pulmonate snail)
   Bosmina (water fleas)

C. *Partially Polluted Waters*, with moderate to excessive enrichment (West Branch of the Rocky River)
   Cladophora (a branching filamentous green alga)
   Cambarus (crayfish)
   Dugesia (planarian flatworm)
   Viviparus (operculate snails)

BENTHIC (BOTTOM) ORGANISMS

Many times biologists speak of "pollution indicator" benthic macro-organisms. This phraseology is erroneous to the uninitiated. There are no macro-organisms that indicate pollution by their presence. The benthic macro-organisms referred to as "pollution indicators" also exist in the natural environment. The "pollution indicators" have existed long before man began to dump his wastes into any environment. They have not recently evolved to occupy new environmental niches. These organisms are the species that are adjusted physiologically and morphologically to survive environmental conditions that are adverse for most benthic macroinvertebrates. Their less adjusted relatives are driven from the area or killed by the adverse conditions imposed on them.

When only a few varieties survive in an area, they reproduce and their young survive in enormous abundance. With the removal of less tolerant forms, competition among kinds is reduced, thus allowing the remaining form to increase until they compete among themselves. The level at which individual species begin to compete among themselves varies from situation to situation. At some point in their growth, some factors apparently create so many limitations that further increase in the population is not possible. If food, oxygen, and other environmental conditions are not limiting, eventually the population stops growth because there is no more space, physically, to put additional organisms. Populations would reach this level in exceedingly rare cases. Usually such things as food, temperature, toxicity, currents, light and other factors will limit the populations before the area is physically saturated. In many situations, it is food availability that controls the level at which competition limits the size of the population. In areas of heavy organic (food) deposition, the associated physical and chemical factors drive competitive forms from the area. The quantity of food material being deposited limits the growth of the few remaining forms. Thus, as organics are added. competitive forms are driven from the area, and surviving forms increase in number due to both the removal of competition and increased food supply. If enough organics are added, eventually a "breaking point" occurs, when organic decomposition products create an environment so severe that few, if any, organisms can survive.

APPENDIX D:
STREAM DETERIORATION DUE TO EFFLUENTS

A. Introduction

The purpose of this experiment is to show the student the effect of an effluent upon the fauna of a specific area within an aquatic system. Due to the nature of this experiment, these activities would take place at a secondary level.

B. Questions

1. What is an effluent? Give several examples and their sources.
2. What are the tasks involved in studying effluents?
   a. How could we determine the effect of an effluent?
   b. How could we collect the data?
   c. How could we compile the data?
   d. What do the data show?

   NOTE: After the students have discussed the ways in which the data can be compiled, introduce diversity index.
3. Do effluents affect the bottom dwelling organisms in a stream? How?
4. Did the population diversity change? How? Were the changes readily observable?

Teacher's Note:
Emphasize interdependence of organisms and environment.

C. Equipment

Teachers should encourage their students to develop equipment whenever possible. Bacteriological equipment may be used if students are interested in further study.

1. a plankton net
2. a Surber sampler or an Ekman dredge
3. containers for collected plants and animals
4. lab equipment: microscope, white enamel pans, hand magnifying glasses.
5. thermometers
6. Secchi disc (for measuring turbidity)

Teacher's Note:
Students can construct much of this equipment themselves after viewing it in the catalog.

D. Procedure

1. Select a stream containing at least one effluent.
2. Pick sites which are suitable for your equipment 50 meters above and below the effluent. If the stream is wide, take three samples at each site, one close to each bank and one in the center.
3. Place samples in separate containers, identify by number, date, and temperature of water.
4. Make a map to show where the samples were collected.
5. If time permits, more than one effluent site may be sampled.
6. During warm weather, samples should be refrigerated until studied in the laboratory.
7. Pour contents of each bottle into separate white enamel observation pans.
8. Begin separating, counting, and tabulating.
9. Compile data.

Teacher's Note:
Class discussions are very important. Plan your time accordingly so that data can be interpreted completely and conclusions drawn.

E. Previous studies have shown that

1. Some tenth-grade students were amazed at the number of species contained in one square-foot sample.
2. One member of the team spent an afternoon in working on a method for feeding information into the computer to develop our diversity index.
3. The team selected a stream named Needleshop Brook. Upon arrival at the stream, we searched for and found an effluent entering the stream. Samples were taken above and below the effluent entrance. Also, samples were taken 200 years further downstream. Indexing indicated a sharp reduction of fauna directly below the effluent and a 70% restoration of the fauna further downstream.
4. The data collected at sites along a stream are shown in figure B-1. As the stream had effluents added(increasing site numbers), the population diversity changed.

F. Limitations

The appropriate stream may be difficult to find within a reasonable distance from the school and in an accessible area. Clothing and footwear sometimes become a problem.

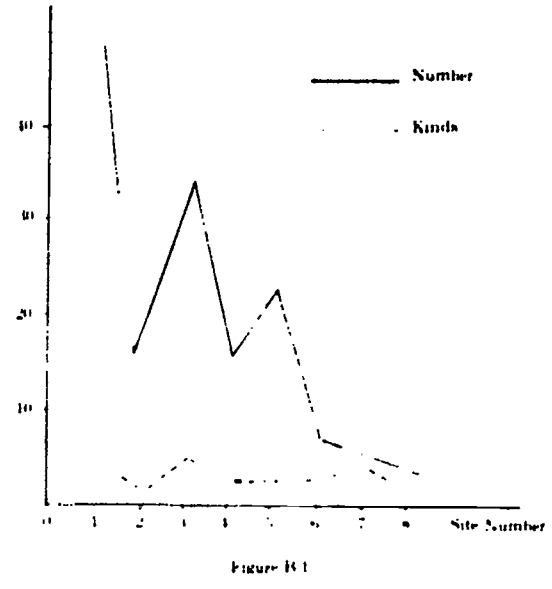


Figure B-1

Teacher's Note:
Nothing is as effective as the field trip. However, this data could be duplicated, the vicarious experience described, interpretations discussed, and conclusions drawn without anyone going out of the classroom. A second alternative: Ask some students to gather the data over a weekend.

APPENDIX E:
POPULATION DIVERSITY INDEX

A. Introduction

This activity enables the student to determine what the species population of macroinvertebrates in a stream are. The student may also determine by investigation whether the diversity index changes as one samples at random sites downstream. The activity will acquaint students with macroscopic samping techniques and will hopefully provide them with results that will initiate other kinds of water quality tests and activities. Seventh graders and above may do this activity.

B. Questions

1. To lead to the activity, ask these questions:
   a. How many kinds and numbers of macroinvertebrates are in the stream?
   b. Do you think this diversity index should change as you go downstream?
2. Initiate the activity with this question:
   a. Where are organisms found and how can they be collected?
3. Continue by asking this question:
   a. If there is a change in the diversity index, how can you account for it?
4. Evaluate the results of the experience by asking the questions below:
   a. How many species were present in the students' samples?
   b. Were the samples representative?
   c. Given the change in the diversity index, did the students account for this change?
   d. Were the students interested in the activity?
   e. Did any of the students want to pursue the activity to a greater depth?

C. Equipment

1. Basic Introductory Level
   a. Hip boots, screen (for bottom dwelling organisms, use close mesh) or cloth, i.e., nylon.
   b. Collecting jars with preservative (optional); shallow pan; and forceps.
   c. Pan with white background.
2. More Advanced Level
   a. Surber sampler (for other samplers, see *Standard Methods*, pp. 673-83).
   b. Can to rinse attached invertebrates to bottom of net; collecting jars; shallow pan; forceps.
   c. Pan with white background; key to identify invertebrates.
   d. Dissecting scope to facilitate identification.

D. Procedure

Choose several sites randomly spaced along the stream. At each site, take three samples, so that the area is well covered. Water should not be too deep or too shallow and should be fast running. Avoid large rocks; find gravelly bottom with stones hand-sized or a little larger. Try to make each sample site the same type of bottom and same area.

1. For Basic Level
   a. Place screen so that it will trap macroinvertebrates that have been loosened from upstream at the chosen sites. Disturb bottom by moving stones above screen.

      Note: Area should be constant for all sampling done. It may be desirable for students to wear boots.
   b. Remove organisms from screen, placing them in a suitable container.
   c. In the lab, place the specimens in pan with white background; separate them as to kinds and number. (This will determine species population.)
   d. Assign letters to the specimens, each type of specimen having a letter, with specimens within each group having consecutive numbers. For example, if there are 37 worm-like specimens with black heads, these might be in Group A and have numbers 1 through 37; 14 snails of one type might be Group B and have numbers 38 through 51 and so on.
   e. Randomly select (by putting numbers in a hat and pulling them out, for example) numbers 1 to 200 and list them.
   f. Determine the number of "runs" (the numbers of continuous series of similar organisms). If the numbered specimen is in the same group as the one immediately proceeding, it is part of the same run; if not, a new run is started. (It does not matter that the specimen is part of a run three or four runs back; we are concerned only with the specimens immediately following one another.) For example, take the following list, with groups assigned. Suppose that the first number chosen is #10. Number 10 organism is from Group A. This will begin run #1. Organism number 3, chosen next, is of the same Group A and is therefore also included in run #. However, the next organism, #6, is of Group D. Hence, a new run, #2, has begun. The remainder of the runs are formed in a similar way.

Organism number	Group	Run
10	A	1
3	A	
6	D	2
7	B	3
2	A	4
5	C	5
4	C	
9	B	6
8	B	
1	A	7

These are a total of 7 runs in the 10 specimens listed.

g. The total number of runs reported over the total number (200) of specimens equals the Diversity Index.

$$D.I. = \frac{\text{number of runs}}{\text{number of specimens}}$$

2. For Advanced Level
   a. Place Surber sampler in the water at a chosen sampling site. Pick up stones and remove organisms so that they will flow into the collecting net.

      Note: Be sure to collect all possible organisms in the square foot area.

   b. Remove sampler from water and transfer organisms to collecting bottles

      Note: It may facilitate transferring organisms if the organisms are first placed in a shallow pan and then in the collecting jars.

   c. In the lab, place the specimens in pan with white background; differentiate them as to kind and total numbers of each kind.

   d. If the students are interested, they should identify the organisms they have collected with the aid of a dissection scope and a key. (This would be for advanced students and would be useful to relate organisms being found at different sites on the stream.)

   e. To determine the diversity, one divides the number of types by the square root of the total numbers of individuals for all samples taken at each site.

$$D = \frac{S\ (\#\ \text{of Species})}{\sqrt{n}\ (\text{total}\ \#\ \text{of individuals})}$$

      For further interpretation of data, consult *The American Biology Teacher*, "Patterns of Numerical Abundance of Animal Population," by Jerry Wilhm, March, 1969, Vol. 31, No. 3, p. 147-150.

E. Previous studies have shown that
   1. A freshman class sampled 22 different locations on a watershed, collected and massed the macroinvertebrates.
   2. A 2nd year biology class used this method to determine species diversity.
   3. A field study of this type was used by sophomores to illustrate the numerical abundance of a population of grasses on a lawn.

F. Limitations

Ample time should be provided for collecting of samples. Sites should be well planned before class activity. Since this activity will probably take longer than one setting, specimens may be kept in preservatives until time allowed; however, it is best to work with live samples (they can be kept up to four days by refrigeration). Time is required in transferring the specimens from net to jar (they tend to cling to the net). Often there is a feeling of inadequacy and a consequential fear to try this activity. If many samples are obtained, they should be clearly labeled to avoid mixing; keys are often difficult to apply.

G. Bibliography

1. American Public Health Association, *Standard Methods For the Examination of Water and Wastewater*, New York, 1965.

APPENDIX F: SOURCES OF HELP

Your telephone books are good places to start making contacts with the following:

LOCAL AREA

Boy Scouts
Chamber of Commerce
city forester
county agricultural agent
farm bureau
Girl Scouts
industrialists
libraries
museums
nature centers
newspapers
park superintendent
science hobby clubs
soil conservation district manager
sportsmen's and conservation clubs
superintendent of sewage disposal plants
TV and radio stations
water board
local branches of national societies

Consult your local library. You will be surprised at the wealth of information available to you from this basic source.

STATE

The organizations listed below (or their equivalents) will have written materials, films or filmstrips available, and resource personnel in your immediate area to call upon:

conservation department
conservation committee or council, natural areas council
county agricultural agents
department of public instruction
farm bureau
soil conservation districts
state and regional offices of federal agencies
tourist council
universities and colleges
water resource commission

FEDERAL

Many federal agencies, in addition to having materials and films relating to their area of expertise, have local offices ready and willing to help of contacted.

U.S. Atomic Energy Commission, Washington, D.C. 20545

U.S. Dept. of Agriculture, Forest Service, Washington, D.C. 20250

OTHER SOURCES:

Most organizations listed below have a monthly or quarterly publication or charts and other visual materials that are well-designed to develop specific concepts. They also have written materials and films.

American Forest Institute, 1619 Massachusetts Ave., NW, Washington, D.C. 20036

The American Forestry Association, 919 17th Street NW, Washington, D.C. 20006, *American Forests* (Periodical)

American Geographical Society, Broadway at 156th St., New York, N.Y. 10032

Boy Scouts of America, National Council, New Brunswick, N.J. 08903, Handbooks, Merit Badge Pamphlets

Conservation Education Association, Robert O. Ellingson, Secretary, Box 450 Madison, Wis. 53701

Food and Agriculture Organization of the United Nations, North American Regional Office, Harold Voge, Regional Representative, 1325 C. St. SW, Washington, D.C. 20437

The Izaak Walton League of America, 1326 Waukegan Rd., Glenview, Ill. 60025

National Association of Biology Teachers, 1420 N. St. NW, Washington, D.C. 20005, *The American Biology Teacher* (Periodical)

National Association of Soil and Water Conservation Districts, Manager, Service Dept., Box 855, League City, Texas 77573

National Audubon Society, 1130 5th Ave., New York, N.Y. 10028, *Audubon, Audubon Field Notes*

National Parks Association, 1701 Eighteenth St. NW, Washington, D.C. 20009, *National Parks Magazine* (Periodical)

National Wildlife Federation, 1412 16th St. NW, Washington, D.C. 20036

National Wildlife Magazine, (Peridical), 534 N. Broadway, Milwaukee, Wis. 53202

Conservation News (Periodical), 1412 16th St. NW, Washington, D.C. 20036

The Nature Conservancy, 1522 K. St. NW, Washington, D.C. 20005

Publications Unit, National Air Pollution Control Center, Ballston Center, Tower #2, 801 N. Randolph St., Arlington, Va. 22203

The President's Council and Citizen's Advisory Committee on Recreation and Natural Beauty, 1700 Pennsylvania Ave. NW, Washington, D.C. 20006

Soil Conservation Society of America, 7515 N.E. Ankeny Rd., Ankeny, Iowa 50021 *Journal of Soil and Water Conservation* (Periodical)

The Wildnerness Society, 729 15th St., NW, Washington, D.C. 20005 *The Living Wildnerness* (Periodical)

U.S. Dept. of Agriculture, Soil Conservation Service, Washington, D.C. 20250.

U.S. Dept. of Health, Education and Welfare, 330 Independence Ave., SW, Washington, D.C. 20202.

U.S. Dept. of Health, Education, and Welfare, Office of Education. Coordinator for Environmental Education, 400 Maryland Ave., SW, Washington, D.C. 20202

U.S. Dept. of Interior, Bureau of Land Management, Washington, D.C. 20240

U.S. Dept. of Interior, Bureau of Mines, Washington, D.C. 20250.

U.S. Dept. of Interior, Bureau of Outdoor Recreation, Washington, D.C. 20240

U.S. Dept. of Interior, Bureau of Reclamation, Washington, D.C. 20240

U.S. Dept. of Interior, Bureau of Sport Fisheries and Wildlife, Washington, D.C. 20240

U.S. Dept. of Interior, Federal Water Pollution Control Administration, 633 Indiana Ave. NW, Washington, D.C. 20242

U.S. Dept. of Interior, Fish and Wildlife Service, Washington, D.C. 20240

U.S. Dept. of Interior, Geological Survey, GSA Bldg., Washington, D.C. 20242

U.S. Dept. of Interior, National Park Service, Washington, D.C. 20240

Tennessee Valley Authority, New Sprankle Bldg., Knoxville, Tennessee 37902

BASIC LIBRARY

For about $25, a sound, basic library can be developed. These books together with materials from other sources listed previously, will give the teacher or group leader the information materials needed for most environmental-conservation programs.

HIGH SCHOOL

Ecology

Odum, Eugene P. *Ecology.* Holt, Rinehart and Winston, 1963.

Natural Resources

Hich, Allen S. and Marian Sorenson. *Conservation and You.* Van Nostrand. 1964.

Land Use

Clawson, Marion. *Land for Americans: Trends, Prospects, and Problems.* Rand McNally, 1963.

History of Conservation

Clepper, Henry, ed. *Origins of American Conservation.* Ronald Press, 1966.

Quality of the Environment

Battan, Louis J. *The Unclean Sky: A Meterologist Looks at Air Pollution.* Anchor, 1966.

Carr, Donald E. *Death of the Sweet Waters.* Norton, 1966.

Social Implications of Conservation Landsberg, Hans H. *Natural Resources for U.S. Growth: A Look Ahead to the Year 2000.* John Hopkins Press, 1964.

Population Planning

Wrong, Dennis H. *Population and Society.* Random House, 1961.

Nunzer, Martha E. *Planning Our Town.* Knopf, 1964.

BASIC ECOLOGY BIBLIOGRAPHY

Overview of Ecological Problems

Bardach, John.
Harvest of the Sea. Harper & Row, 1968.

Fortune, Editors of. *The Environment: A National Mission for the Seventies.* Harper & Row, 1970.

Graham, Frank, Jr. *Since Silent Spring.* Houghton Mifflin, 1970.

Leinwand, Gerald. *Air and Water Pollution.* Washington Square Press, 1969.

Linton, Ron M. *Terracide: America's Destruction of Her Living Environment.* Little, Brown and Co., 1970.

Longgood, Williams. *Poisons in Your Food.* Pyramid, 1960.

Marine, Gene. *American the Raped.* Simon and Schuster, 1969.

Marx, Wesley,. *The Frail Ocean.* Ballatine/Sierra Club, 1967.

Paddock, William and Paul. *Famine 1975: America's Decision: Who Will Survive?* Little, Brown, & Co., 1968.

Reinow, Robert L. and Leona Train Reinow. *Moment in the Sun: Report on the Deterioration Quality of the American Environment.* Ballantine/Sierra Club, 1967.

Roosevelt, Nicholas. *Conservation: Now or Never.* Dodd, Mead, 1970.

Rudd, Robert . *Pesticides and the Living Landscape.* University of Wisconsin Press, 1964.

Shurcliff, William. *SST and Sonic Boom Handbook.* Ballantine, 1970.

Stewart, George. *Not So Rich As You Think.* Houghton Mifflin, 168.

Udall, Stewart L. *1976: Agenda for Tomorrow.* Brace & World, 1968.

TEACHERS AND GROUP LEADERS

Ecology

Bates, Marston. *The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man.* Random House, 1960.

Natural Resources

Smith, Guy-Harold, ed. *Conservation of Natural Resources.* Wiley, 1965.

Land Use

Clawson, Marion. *Land for Americans: Trends, Prospects, and Problems.* Rand McNally, 1963.

History of Conservation

Udall, Stewart L. *The Quiet Crisis.* Winston, 1963.

Quality of the Environment

Herber, Lewis. *Crisis in Our Cities: Death, Disease and the Urban Plague.* Prentice-Hall, 1965.

Social Implications of Conservation

Landsberg, Hans H. *Natural Resources for U.S. Growth: A Look Ahead to the Year 2000.* John Hopkins Press, 1964.

Population

Freedman, Ronald, Ed. *Population: The Vital Revolution,* Anchor, 1964.

Planning

Von Eclardt. Wolf. *The Challenge of Megalopolis: A Graphic Presentation of the Urbanized Northeaastern Seabord of the United States.* McMillan, 1964.

This book list was compiled by the Conservation Education Association.

If your group is interested in more extensive lists and would like to purchase more books, write to The Interstate Printers & Publishers, Inc., Danville, Ill., and request their book, *Conservation Education: A Selected Bibliography,* by J. Carvajal and M. Munzer, $2.50. This book has a short description of contents of each book listed, number of illustrations, suggested grade level, etc.

REFERENCES

Books:

Andrews, William A. *A Guide to the Study of Environmental Pollution.* Englewood Cliffs: Prentice-Hall, 1972.

Benarde, Melvin A. *Our Precarious Habitat.* New York: W. W. Norton and Co., 1973.

Institute for Environmental Education. *A Curriculum Activities Guide to Water Pollution and Environmental Studies,* Volumes 1 and 2. Washington: Government Printing Office, 1971. Information concerning these publications may be obtained from the Training Grants Office, Water Quality Office, EPA, Washington, D.C. 20242.

Mason, William H. and George W. Folketts. *Environmental Problems.* Dubuque: Wm. C. Brown Company, 1973.

Ohio Department of Natural Resources. *Ohio's Underground Waters: How Do We Protect Them?* Columbus: State of Ohio, 1972. This and other material is available for free from Donna L. T. Szuhy, Environmental Education Coordinator, State of Ohio Department of Natural Resources, Fountain Square, Columbus, Ohio 43224.

Pettyjohn, Wayne A. *Water Quality in a S essed Environment.* Minneapolis: Burgess Publishing Company, 1972.

Sorvall, Vivian. *Water Pollution: Our Troubled Waters.* West Haven: Pendulum Press, Inc., 1972.

Stocker, H. Stephen and Spencer L. Seager. *Environmental Chemistry: Air and Water Pollution.* Glenville: Scott, Foresman and Co., 1972.

United States Government Printing Office. *Water Quality Criteria.* Washington: U.S. Government Printing Office, 1968. This publication defines water uses in the United States and offers criteria for different water usage. An extensive glossary with numerous references is included.

Wagher, Richar H. *Environment and Man.* New York: W. W. Norton and Co., 1971.

PERIODICALS:

Elazam, O. E. "Sewage Sludge: A Valuable Resource." *Ohio EPA.* Vol. 1, No. 11, page 3. This free publication is available from the State of Ohio Environmental Protection Agency, 361 E. Broad Street, Columbus, Ohio 43215.

New York State Dept. of Environmental Conservation. *The Conservationist.* Published bi-monthly at the department's office, Albany, N.Y. 12201. Feature articles cover areas of natural history, ecology, environmental problems, and environmental management. Although there is obviously much emphasis on New York problems, many articles offer application to other states.

TEACHER'S NOTES:

TEACHER'S NOTES:

COMMUNITY PROBLEMS

The general purpose of this unit is to help secondary students develop a sense of awareness of community problems as related to the environment. This sense of awareness should be followed by developing a questioning attitude toward local problems in the environment and constructing a set of criteria using different methods for scientific research in this area. It is hoped that the students, with the help of the teacher, can develop their own objectives about what they hope to learn from the work and research on their topics.

This unit includes methods of identifying problems and developing plans of action which recognize both economic and political realities and which may lead to the eventual solution of the problem. These solutions may occur over a long term basis rather than over a short period of time. We must realize that high school students are limited by time and resources in their endeavors to solve problems of our environment, but they should be able to recognize, analyse, and suggest possible alternatives or solutions to proper authorities for their information and/or action. The students should be encouraged to delve deeply into their selected problem using available resources in their area and community. This will enable them to find out more information about their problems and to determine what research is being done in this area and what solutions have been proposed.

The school and local library should be utilized, along with any local community resource personnel. Local resource people could be interviewed or surveyed as well as different types of groups. Books, periodicals, and newspapers should be used. The regional U.S. Environmental Protection Agency, city officials, and city and state environmental agencies along with the county agent should be contacted. It is suggested that you allow the students to list sources of information, and only if they need help should you offer suggestions.

The students should be encouraged to tie together all the facts which they have compiled and to decide upon some plan of attack, some action, or a solution to their problem. If the students can't solve the problem, they should be able to select an agency or individual to inform of their research so that action toward a solution can be taken.

Since the classroom setting will be somewhat individualized, with the students working as groups on their problems, the class should be brought together at periodic intervals to discuss the problems they have chosen, their research, and their plan of attack. This should be an integral part of the curriculum.

The students should cite all books, periodicals, speakers, and any other resource material used in researching their problem. The finished report will contain an explanation of their bio-physical problem, how they researched their problem, and their proposed solution to the problem.

As this is identified as a "bio-physical" unit, you may be concerned over specific science activities. Part of this unit is the students' selection of group problems, and they will have to develop their own methods of investigation. Surveying, interviewing, graphing, photographing, percentage rankings, counting, observing, tabulating, planning, analysing, and experimentation or testing are all forms of science activities and should be considered as such.

Several of the objectives are "value" objectives in feelings or awareness, and these ypes of objectives are difficult to evaluate. You may want to develop an evaluation form as shown here for this unit.

Name	Always	Usually	Seldom	Never
Starts work on time				
Works well with group				
Applies himself during class time				
Recognized the problems to be solved				
Can make accurate observations				
Can collect complete data				
Able to recognize pertinent facts				
Can draw reasonable conclusions				
Follows safe lab practices				
Shares in clean up				
etc.				

INSTRUCTIONAL OBJECTIVES:

Upon completion of this unit, the student should be able to:

1. become aware of existing environmental problems in his community.
2. identify, analyze, and then formulate a plan of action for investigating the community problems.
3. learn the methods and procedures used in scientific research.
4. interpret both verbal and written material as it applies to the community problem.
5. interpret both verbal and written material as related to the source of the information.
6. show an awareness of human needs and social concerns as related to the community problem.
7. show a maturing relationship to classmates.

CONTRIBUTORS TO THE DEVELOPMENT OF THIS UNIT

Author ..... Forrest E. Kuhn
Editor ..... Stoyan N. Topalof
Revisor ..... Arthur H. Olson

TABLE OF CONTENTS

EXPERIENCE #1
GUIDELINES FOR SOLVING A COMMUNITY ENVIRONMENTAL PROBLEM

OBJECTIVES:

The student will be able to

1. use basic skills and knowledge in identifying, analyzing and selecting community problems.
2. use five different sources and/or techniques for acquiring information concerning the community problem.
3. organize his findings in an informative report using five different methods of reporting.
4. identify an agency or individual to whom the findings can be submitted for information, consideration, and/or action.

Teacher's Note:

The following activities should be covered in general as a class discussion seeking to get as much of the material from the class as you can. This depends on the class. After the class discussion, allow each group to meet and plan their own procedures as to how they will find answers to the listed questions of their community problem. You should be available to the various groups in the classroom and offer suggestions if requested.

The amount of detail that comes forth in the discussion will depend upon the maturity and level of the class. Some classes will need a lot of help in finding sources or ways of getting information other than the library. You will have to do what your class needs.

Techniques of reporting observations and findings may also have to be explained to some classes, while other classes will be able to find the different methods of reporting on their own. This again depends on you and the class with which you are working.

This type of research requires an open atmosphere where the students can come and go during the period. Some students may be in the library and others in the office telephoning, while others may be outside or on an interview with a parent driving them to the appointment during the class period. All teachers are not comfortable with such an open class. If you feel that this is true in your situation, you may have to schedule regular visits to the library or a class field trip to answer some general questions.

Research with the groups on their own requires that you keep continual awareness of where groups are and what they are doing. You must make yourself available to help where needed. You should be able to secure different school materials (transparency material, audio-visual tapes, cameras, films, etc.) fo use by the groups.

ACTIVITY A:
SELECTING A PROBLEM

The teacher should introduce the unit as a question to the class. Ask what the students feel are community environmental problems. The teacher lists all suggestions on the board. It is expected that the teacher would also participate in this activity.

1. If nothing comes from the class, you might prime them by beginning with some of the following:

   air pollution
   soil erosion
   sanitary conditions
   energy crisis
   pesticides
   solid waste disposal
   watersheds
   noise pollution
   comparative prices
   recreational facilities
   golden agers
   traffic
   water pollution
   population explosion
   acid mine drainage
   conservation
   radiation
   water treatment
   thermal waste
   shop lifting
   regional planning
   zoning restrictions
   building inspections
   abandoned cars
   stray dogs
   rats
   uncollected garbage
   stealing
   drugs
   people not keeping up property
   deserted houses
   unkempt lots
   unemployment
   public transportation
   welfare

2. Students organize into small groups and select a problem of their interest and choosing.
3. Students list questions related to the selected problem that they will investigate. It is suggested that at least ten questions per problem be listed for investigation.

ACTIVITY B:
DATA COLLECTING AND RECORDING

Teacher's Note:

Before going on to this and other activities, all students should be in groups and have a community problem selected for investigating. We suggest that you allow the class to select the community problems, as students will get more involved if the problems selected are local and of their choice. Some community problems may be school problems such as school rules, dress code, or food in the cafeteria. So allow the

students as much freedom in identifying community problems as you desire.

1. What kind of data needs to be collected?
2. Which places are available for data collecting?
3. What methods and materials are available for collecting this data? (visual observation, testing equipment for bio-physical data, past records, interview, survey, telephone)
4. Which methods and materials (letters, authorities in field) would be most appropriate for your investigation? (These should come from class discussion.)
5. How can this data be recorded in a manner that will allow for significant interpretations? (tables, charts, graphs, written observations, maps, sketches, photos, cartoons, video and audio tapes, filmstrips, transparencies, personal comments) These should also come from class discussion.
6. What additional information may be needed to help interpret the data you collect?

ACTIVITY C: DATA INTERPRETING

1. What does the collected data tell you about the problem or issue involved?
2. What comparisons, contrasts, or cause-and-effect relationships can be inferred from the collected data? Relate them to the source of the information.
3. What ideas are suggested by the interpretation of this data?
4. What implications do these ideas have for environmental management?

ACTIVITY D: EXTENDING THE INVESTIGATION

Teacher's Note:
This activity should be held after groups have been working for a week or so, and then each group should report to the entire class on their problem and what they are doing to solve it. The reporting group should be able to report any success or ask if anyone can make other suggestions that they might follow.

1. *Which parts of the investigation can be explored more fully by further data collecting or experimentation?*
2. *What further data needs to be collected? (where, how often, time of year)*
3. *What might be significant about collecting the additional information?*

ACTIVITY E: WHAT ARE WE DOING?

Are there any alternatives or combinations of alternatives that might bring about an improvement or suggested solution to our selected problem.

1. Are there any suggested alternatives?
2. How can we bring about the desired change? (individual, group, or governmental)
3. What is the best way of reporting to the agency for action — letter, personal visit, invitation to class, tapes, photographs?

ACTIVITY F: LARGER DEFINITION OF A COMMUNITY PROBLEM

Teacher's Note:
This is an optional activity that should be used according to the maturity and ability of the class.

As the previous activities are going on and the students are working in groups, you may want to plan this activity as a total class discussion. This activity will require that the students have some background in local pollution problems or local community problems so that they can participate in the discussion.

1. What is our community: local, state, national, world?
2. What responsibility does our local community have regarding state, national and world problems?
3. Do our community problems get passed along to other communities — water pollution, solid waste, air pollution, etc.?
4. Are some of our community problems sent to us by other communities upstream or up-wind or because other communities are larger and more powerful?
5. Is any community really "separate" from others?

EXPERIENCE #2 AIR POLLUTION (Example)

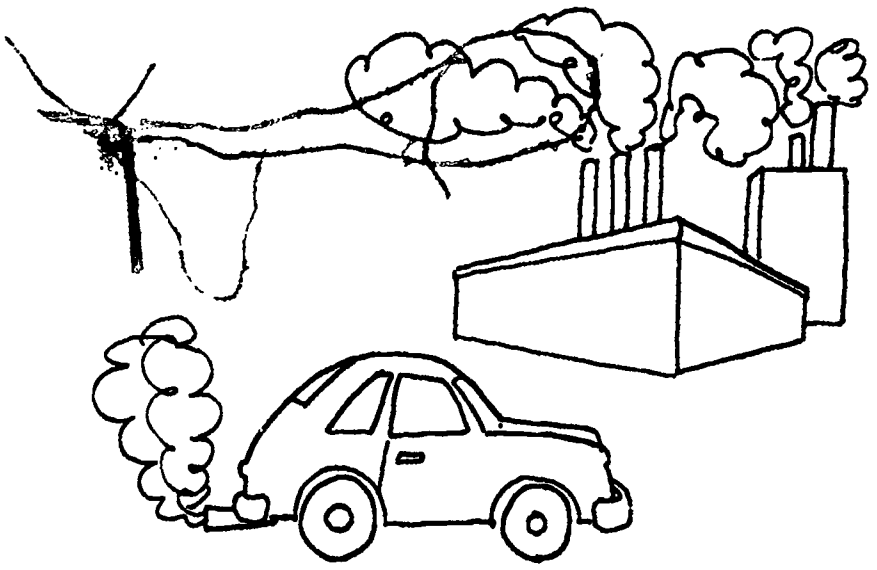
OBJECTIVES:

1. The students will learn how to employ the methods and steps described in the previous experience in a practical manner.
2. The students will get acquainted with the air pollution problem in their community.

Teacher's Note:
The following experience is an example only and should not be used unless the class doesn't come up with any local community problem. If it does come up with Air Pollution as a local problem, the groups could use this material as one of their resources. They should not use it as written as the value of this unit is in the student developing the research pattern.

Under an extreme case or unusual conditions, you may want to use this experience as an example of what student groups could do. This, of couse, depends on you and the class with which you are working.

Remember that you are to answer the questions or statements in five different ways: observations, interviews, reading, photographing, experimenting, etc., and that the finds are to be recorded by five different methods: graphs, photos, charts, audio or visual tapes, written interviews etc. This information is then to be used to solve a problem or presented to an agency or person who would use this information to work toward a solution to the community problem.



ACTIVITY A:
DEFINE AIR POLLUTION

1. What are some of the constituents of polluted air?
2. What are the standards set by the Air Quality Act?
   a. Are state and national standards equal?
   b. Are the standards attainable?
3. What does industry say about clean air standards or air pollution?
4. What can you as an individual citizen do about polluted air? (See Appendix A)

Materials:
Much of the required equipment needed for the activities can be ordered from Turtox/Cambosco, Macmillan Science Co., Inc., 8200 South Hoyne Avenue, Chicago, Illinois 60620.

ACTIVITY B:
DETERMINATION AND EFFECTS OF SO_2

1. Sulfur dioxide at certain concentrations in the atmosphere is a hazard to human health.
2. SO_2 also affects vegetation and building materials. (Show pictures from books and magazines, or go on a visit to a local area if possible.)
   a. Grow radish or lettuce seeds in SO_2 and normal atmosphere. (pellets available from Wards)
   b. Expose copper plates to SO_2 fumes.
3. Find sources of SO_2.
4. Do tests for SO_2.
   a. Huey plates
   b. Lead peroxide methods (See Appendix B)

Materials:
1. Magazines
2. Seeds (radish, lettuce)
3. Pellets of sulfur
4. Copper plates

ACTIVITY C:
PARTICULATES

1. Windblown particles can be seen with naked eye, 20 microns and larger.
2. Collect these using adhesive wrapped around a jar.
3. Compare particulates.
   a. Use equipment as in Appendix B.
   b. The results are compared with known standards.
   c. They are recorded in particles per square inch.
   d. They vary with each sight direction (N-S-E-W). (See Appendix B.)
4. These may be determined by putting a greased dish (vaseline) on the windowsill and observing and recording the change everyday for a week. (Use different windows.)
5. These are types of particulates.
   a. Smoke particles
   b. Ash particles
   c. Dust particles
6. Use a vacuum cleaner with a hose, place cheese cloth or filter over the opening and allow to run for 20 minutes. Observe cloth. Test different locations at different times.

Materals:
1. Jars
2. Adhesive materials
3. Vaseline
4. Vacuum cleaner

ACTIVITY D:
OZONE DETERMINATION

1. Expose the rubber strips for seven days. (See Appendix B)
2. Ozone increases the number of cracks on rubber strips.
3. Stretchability decreases

Materials:
rubber strips

ACTIVITY E:
DETERMINATION OF PLUME OPACITY (RINGELMANN NUMBER)

1. Get a Ringelmann Chart (See Appendix C)
   a. No. 1 - 20% dense
   b. No. 2 - 40% dense
   c. No. 3 - 60% dense
   d. No. 4 - 80% dense
   e. No. 5 - 100% dense
2. Smoke generation is caused by incomplete combination of fuel.
3. Opacity is determined this way.
   a. Hold chart at arm's length
   b. Make sure the sun is behind the observer.
   c. Note the speed of polluted air.

ACTIVITY F:
MOTOR VEHICLES
(Internal Combustion Engine)

1. Hydrocarbons
2. Carbon monoxide
3. Nitrogen oxides

Show that cars pollute by tying or taping with electrical tape a piece of gauze over the car's exhaust pipe.

Materials: Gauze

ACTIVITY G: CLASS DISCUSSION

1. Other Air Pollutants
   a. *Photochemical oxidants*
      (1) These are formed by chemical reaction of different pollutants under the influence of the sunlight.
      (2) Reactions occur more rapidly in sunlight.
      (3) Oxidizing agents help the conversion.
2. Air Pollution Episode
   a. Stagnant air is produced by low wind speed and temperature inversion.
   b. As pollutants increase, coughing, eye irritation and sickness increase.
   c. Certain types of death increase as pollutant levels reach peaks.
   d. Death and illness occur in all age groups.
   e. Excess deaths increase with increasing age.
   f. Deaths are generally caused by respiratory or heart problems.
   g. The impacts on health are rapid and are due to a combination of several pollutants.
   h. The episode lasts two to seven days.
   i. At the emergency stage of the episode, these occur.
      (1) SO_2 level = 0.8 ppm, 24 hour average or
      (2) Particulates reach 7.0 CO HS (carbon monoxide and hydrogen sulfide), 24 hour average, or
      (3) Combined SO_2 and particulates product reaches 1.2, or
      (4) CO reaches 40 ppm, eight hour average, or
      (5) O_3 reach 0.6 ppm, one hour average, or
      (6) NO_2 reaches 1.6 ppm, one hour average, and 0.4 ppm, 24 hour average, and
      (7) Meterological conditions are such that this condition can be expected to continue for 12 hours or more.

APPENDIX A:

CITIZEN PARTICIPATION

Possibilities to get citizens involved in the environment:

1. Don't litter. Use litter baskets and barrels.
2. In the winter, turn your thermostat down a few degrees.
3. Drive your car at a slower speed on long trips to conserve gasoline.
4. Insulate well when building a house.
5. Use a hand mower if your lawn is small.
6. Plant trees and shrubs.
7. Use insecticides sparingly.
8. Don't burn leaves or trash.
9. Acquaint yourself with anti-pollution ordinances.
10. Start a campaign to save newspapers, cans, and bottles for recycling.
11. Measure detergents carefully.
12. Walk, bicycle, or use mass transportation whenever possible.
13. Get an engine tune-up every 10,000 miles.
14. Carry a litter bag in your car.
15. Help reduce noise pollution.

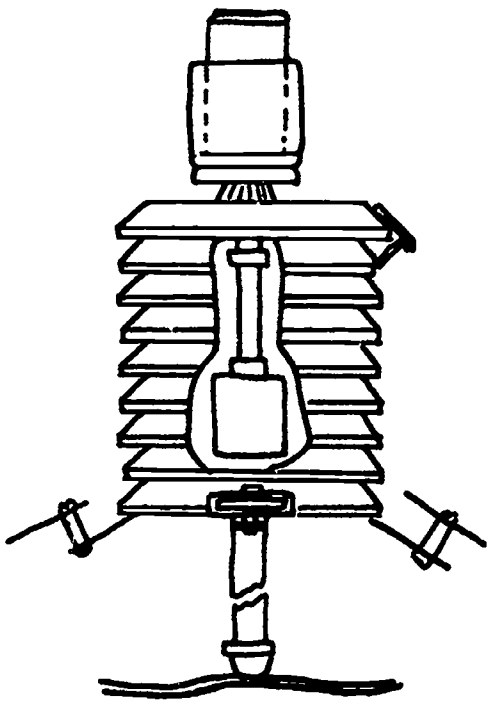
The Citizen's Role in Environmental Decision Making:

1. Get informed
2. Know the law
3. Pick your targets carefully
4. Lobby
5. Fight for funds
6. Tell your story (media)
7. Know your rights

APPENDIX B:

EDUCATIONAL AIR POLLUTION STUDY KIT

Basic air pollution sampling station provides much information yet occupies only 1.5 square feet of floor space. By setting up one or more of these kits, samples can be taken for at least six air pollutants. Ideal for science classes in high schools or universities, also for preliminary air pollution control data for small communities and industries.



Samples are evaluated by using a balance, microscope, Gruber Comparator and analytical procedures. Educational Air Pollution Study Kit includes stanchion, louvered shelter for rubber strip and all supplies for one year. (Does not include laboratory supplies.)

Size — 18" x 18" x 50" high

Weight — 13 lbs.

Please specify — Educational Air Pollution Study Kit, Catalog No. 2350.

Gruber Comparator for Wind Blown Particles, Catalog No. 2341.

Illuminated Magnifier — Catalog No. 38-005.

Air Pollution Balance — Catalog No. 2336.

Order from: Research Appliance Co., Allison Park, Pa.

Heavy Particulates
Open top plastic dustfell jar of known surface collecting diameter obtains representative sample of particles greater than 20 microns in diameter from industrial, combustion, or wind-soil erosion. After one month's exposure, dustfell collected in jar is washed into previously weighed beaker. Water is evaporated in an oven at about 105° C. Beaker and dustfell are again weighed and net weight, is converted to amount of fallout per square mile per month or mg./m^2/mo. Chemical tests can be determined also for total water and benzene solubles and total combustible and non-combustible matter.

Photochemicals
Continuous monofilaments of nylon are more prone to attack and deterioration from photochemical pollutants, corrosive aerosols, or particulates when stressed or stretched. Nylon is stretched on standard slide mount for 30 days. Nylon panels are then examined microscopically recording physical degredation such as broken fibers causing runs or perforations. (Microscope NOT supplied with kit)

Corrosives
Two plates are exposed (one for 90 days, the other one year) on south side of a shelter at 30° to horizontal. A low carbon (0.019%), low copper (0.8%), steel plate approximately 4" x 3" x 0.030", is quite sensitive to atmospheric corrosion, as SO^2 converts to a sulfuric acid-aerosol in presence of moisture. The degree of corrosion measured by weight loss method, involves weighing clean plate prior to exposure. After exposure, products of corrosion are cleaned by immersion in inhibited acid solution maintained at room temperature. The plate is re-weighed and difference in weight provides a measure of the amount of metal lost by corrosion. (Balance NOT supplied with kit.)

Wind Blown Particulates
An adhesive coated paper, wrapped around circular plastic jars, traps wind blown particulates. The general range of trapped particulates is between 20 and 100 microns (transition range between suspended and settling particulate matter). This group of airborne particulate matter is responsible for major portion of area-wide air pollution nuisances in many urban areas. Exposed sticky paper, seven day duration, is analyzed by comparison with nine different standards placed on rotating cylinder. Standards indicate number of particles/square inch. Standard and samples are viewed through a comparator magnifier and the number of particles/square inch are recorded with respect to eight directions corresponding to eight different points of compass. Particulates are also classified as industrial, combustion, wind-soil erosion, or vegetation products. (Comparator and Magnifier NOT supplied with kit.)

Ozone

Under strain, rubber experiences cracking in presence of ozone. A 360 gram weight provides stress. A linear reaction exists between average depth of crack and exposure time. To analyze, a rubber strip is cut lengthwise. Cross-sections of nine consecutive cracks near center of strip are measured with a microscope and average depth in millimeters is computed. (Microscope NOT supplied with kit.)

Sulfur Dioxide

This sampler provides simple index of sulfur dioxide activity in ambient atmosphere. Sampler basically consists of 48 mm. ID plate with paste containing lead dioxide. Lead dioxide reacts with sulfur dioxide as follows: $Pb\ O_2 + SO_2 = Pb\ PO_4$. After one month exposure period, the amount of sulfation (mgms. SO_3/100 sq. cm./day) is determined by turbidmetric barium sulfate method.

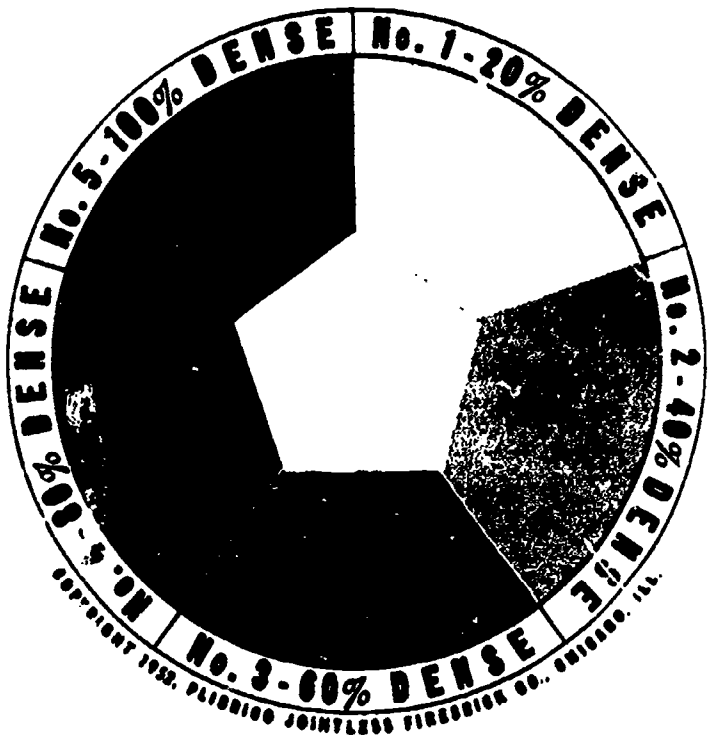
Samples are evaluated by using a balance, microscope, Gruber Comparator and Analytical Procedures. Educational Air Pollution Study Kit. Includes stanchion, louvered shelter for rubber strip and all supplies for one year. (Does not include laboratory supplies)

APPENDIX C:

PLIBRICO SMOKE CHART

RINGELMANN TYPE

SMOKE CHART



INSTRUCTIONS

This miniature Ringelmann smoke scale will enable the observer to conveniently grade the density of smoke issuing from the stack.

The scale should be held at arm's length at which distance the dots in the scale will blend into uniform shades.

Then compare the smoke with the chart, determining the shade in the chart most nearly corresponding to the shade or density of the smoke. Experienced observers often record in half chart numbers. By recording the changes in smoke density, the average "percentage of smoke density" for any period of time can be determined.

Observer's line of observation should be at right angles to the direction of smoke travel.

Observer should be not less than 100 ft. nor more than ¼ mile from the stack.

Observer should avoid looking towards bright sunlight. The background immediately beyond the top of the stack should be free of buildngs or other dark objects.

APPENDIX D:

SOLID WASTE SUGGESTIONS

This appendix contains information not directly connected with the material discussed in the unit. However, in the writer's opinion, it can help a teacher or a student who intends to develop further or study the topic of solid waste disposal. It has been decided that there are many useful pointers that can significantly help in his research. Also, this could be regarded as a list of possible research topics for the students to explore individually, using the format.

1. Salvageable Materials
   - A. garbage
     1. Cooked-in digesters
     2. Feed for livestock (hogs)
   - B. Rags
     1. Filler material
     2. Insulating material
     3. Papermaking
     4. Linoleum
   - C. Paper and paper products
     1. 19% waste paper with new paper
     2. Roofing materials
     3. Box board
   - D. Glass (cullet)
     1. Sort and segregate
     2. Match industry
     3. Flashlight lens
   - E. Tin Cans (Ferrous Metal)
     1. Recover ferrous metal
     2. Tax not important
   - F. Rubber
     1. Various grades
     2. Used in new rubber items
     3. Recapping tires
   - G. Plastics
     1. Protective coatings
     2. Packaging materials
     3. Toys
   - H. Industrial wastes
     1. Copper, brass, lead, zinc, aluminum, nickel, magnesium
     2. Feathers - hydrolized and fed back to poultry
     3. Chicken manure fed to cattle
     4. Charcoal made from fruit pits

II. Special Salvage Items
   - A. Incineration wastes
     1. Utilization of waste heat to produce steam
     2. Residue as fill material
     3. Fly ash in concrete and fertilizers
     4. Pyrolysis can yield gases, oils, tars and charcoal
   - B. Automobile bodies
     1. Approximately six million per year
     2. Newer furnaces reduced percentage of scrap added
        a) Open hearth furnace - 30 to 50% scrap
        b) Oxygen convertor - 25 to 30% scrap

III. Solid Waste Collection Equipment
   - A. Manually loaded compacting bodies
   - B. Mechanically loaded bodies
   - C. Small covered, compacting, sideloading bodies
   - D. Non-compactor, open body collection vehicle
   - E. Vacuum truck for leaf collection
   - F. Vacuum collection system for high population densities (hospitals)

IV. Site Selection (Sanitary Landfill)
   - A. Land requirements
     1. Cover material requirements
     2. Per capita refuse production
   - B. Relative location to generating areas
     1. Time spent in hauling
     2. Highway systems available
     3. Capacities of vehicles
   - C. Relationship to community growth
     1. Direction of projected growth
     2. Industrial development
   - D. Utilities
     1. Electrical power
     2. Water supply
     3. Sewer service
     4. Telephone, communications
   - E. Soil conditions
     1. Cover material may be brought to site
     2. Ground water
        a) Water table
        b) Leaching from fill
   - F. Access to site
     1. Preferable over high speed routes
     2. Traffic controlled by signs and lights
   - G. Public Opinion: positive or negative
   - H. Political consideration
   - I. Climatic condition
     1. Wind
     2. Rain or snow
     3. Temperature
   - J. Ultimate land use
     1. Parks and playgrounds
     2. Industrial sites
     3. Agriculture

V. Sanitary Landfill Equipment
   - A. Crawler tractor
   - B. Rubber-tired tractor
   - C. Steel-wheeled tractor
   - D. Auxiliary equipment
     1. Water truck for dust
     2. Dump trucks - haul cover material
     3. Motor graders to finish grading of fill
     4. Refuse shredders
     5. Dragline
     6. Rubber-tired roller for more compaction

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PERIODICALS (Annotated)

National Geographic
A profusely illustrated magazine of geography and associated subjects - travel, discovery, exploration, and scientific research - in various parts of the world and in various cultures. Excellent maps are issued as supplements from time to time.

Natural History
A magazine on the natural sciences for the general reader. The authoritative articles are written in non-technical language and are profusely illustrated. The life sciences, astronomy, and archaeology are included.

Parks and Recreation
Directed to administrators of recreation programs, park supervisors, counselors. teachers, and others in the recreation field. Articles cover general aspects of recreation programs, conservation, parks and park facilities, outdoor life and the administration of programs.

Science
The foremost United States medium for the publication of reports of original research in all fields of science. Articles also describe important trends and developments in research in physical, biological, and behavioral sciences.

Scientific American
Edited for the scientist and intelligent layman, this venerable (established in 1845) periodical offers articles on recent scientific developments and the interrelationships of the humanities and natural sciences. The periodical also contains a section for the amateur scientist, science news highlights, mathematical games, and detailed book reviews.

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A well-illustrated bi-monthly publication featuring articles on cultural and natural life around the world with special emphasis on the United States. Intended for the general reader.

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FILMLOOPS

Pollution, set of six, Hubbard, Northbrook, Ill.

Air Pollution I
Air Pollution II & Emission Control
Land Pollution I
Land Pollution II & Sanitary Landfill
Water Pollution I
Water Pollution II & Water Treatment

TRANSPARENCIES

Pollution, Hubbard, Northbrook, Ill.

CATALOGUE

Turtox/Cambasco, Macmillan Science Co., Inc., 8200 South Hoyne Avenue, Chicago, Ill., 60620.

MISCELLANEOUS

"An Environmental Action Program for High School Students (9-12)"

The Ecology Council of America is sponsored by the Pepsi-Cola Company. For information write to: Eco America, Room 2200, 99 Park Avenue, New York, N.Y. 10016.

GAMES

Dirty Water, Urban Systems, Cambridge, Mass. Water Pollution game in which students meet the various problems associated with "clean up."

Ecology, Urban Systems, Cambridge, Mass. Students build a better world by combining inventions and the environment.

Make Your Own World, Coca-Cola Co. (local dist.) A simulation in which students represent different segments of a community. They discuss their vote on proposals; the interrelated effects of these actions are then discussed.

No Time to Waste, Continental Can Company, Cleveland, Ohio. Environmental action units.

The Pollution Game, Houghton-Mifflin, Boston, Mass.

Recycling Resources, Continental Can Company, Cleveland, Ohio. Environmental action unit.

The Redwood Controversy, Houghton-Mifflin, Boston, Mass. Students acting as senators and witnesses ,debate proposals for a Redwood National Park. Many factors are involved in decision making.

Resource in Space, Coca Cola Co. (local dist.) A simulation in which the class divides into two groups. A spacecraft breaks down on Mars and the concept of the Earth's closed ecological system is discussed.

Smog, Urban Systems, Cambridge, Mass. Air pollution game combining business problems and clean air policies.

FUTURISM

The purpose of this unit is to study some of the past changes in technology and the possible directions which technology might take in the future; to teach the students to recognize the possible impact of these directions on our total environment; and to enable the student to learn some of the values that will influence the character of future developments. Also, this unit of study will attempt to show a pattern of technological effect on past and present human environment and to speculate on some future areas of impact. There is no such thing as "the future"; there are only "futures," a loose set of possibilities which might occur in varying degrees. The future which will occur is not to be forecast passively; it must be developed out of the materials presently at hand. If future technology is to benefit us, we must become adept at assessing its impact. In October, 1972, the U.S. Congress recognized this by passing a law establishing the Office of Technology Assessment within the federal government. Its purpose is to provide the Congress with information on technologies and their effects. This sort of independent review is important, because, in the past, the practitioners of technology have been corporate or military interests with their own financial or tactical considerations held uppermost. As citizens of Planet Earth, we should develop the habit of assessing technological change and evaluating its impact on the future. How we view and prepare for the future will determine the impact of our existence in the present. A future-oriented outlook is a world outlook for survival.

INSTRUCTIONAL OBJECTIVES

At the conclusion of this unit

1. The student will appreciate that our society is a product of "future shocks."
2. The student will understand that future technologies will influence the quality of life as past technological change has influenced the present quality of life.
3. The student will see that technologies of the future will have an impact upon the environmental integrity of the planet and that a world or global view of the future will set the present course for our survival.
4. The student will appreciate that the future is not a single, inevitable monolith, but an array of "futures" which may "come true" in varying degrees.
5. The student will begin thinking about creating and exploring his own mode' and outlook of the future.
6. The student will understand the limits of our environment and prepare for the technologies of the future with an appreciation of the values and tradeoffs inherent in the future.

CONTRIBUTORS TO THE DEVELOPMENT OF THIS UNIT

Author.....Steve Bass
Editor.....Stoyan Topalof
Revisor.....Ronald J. Yarian

EXPERIENCE #1:
THE PAST HISTORY OF TECHNOLOGICAL CHANGE AND ITS EFFECTS ON MAN

OBJECTIVE:

At the conclusion of this experience, the student will understand some of the past technological advances which have shaped the present (then future).

Teacher's Note:*

Before performing the activities included in this experience, the teacher should make copies of the following reading material and distribute them to the students. The material can be given as home work, or it can be read in the class in about 15 minutes. It is also advisable for the teacher to show a film about some of our past technology (Indian, colonial). The teacher may, of course, use only sections of the reading material or make deletions or additions.

THE FUTURE OF TECHNOLOGY HAS QUITE A PAST

In 1655, much of Ohio was populated by an Indian tribe calling themselves the Eries. But in that year, the Iroquois attacked them from the east and obliterated or scattered the Erie, who were their equal in numbers, courage, and resourcefulness. Why? The Iroquois had received guns from the British and colonials in trade for beaver fur. The Erie, armed only with bows, stone-timmed arrows, hand weapons, were no match for the Iroquois' superior firepower. Beyond this, the Eries were emotionally overwhelmed by an opposing technology so radically different as to appear magical. They could not design, in the short time the Iroquois left them, adaptations of their own weapons technology or any helpful changes in social organization. They were the victims of a rather violent form of "future shock," the disruption of groups or individuals facing technological changes in their environment to which they are not yet ready to adapt.

The succumbing of the Erie way of life was not the first such case. The history of Ohio, America, and the world present numerous examples of two technologies mixing, to the detriment of one of them. Perhaps neither disappears, but when technologies mix, change isn't far off. The Iroquois had adapted the European musket technology to their way of life, and it was that technology and its traditions which defeated the Erie, not the Iroquois themselves.

The people who lived in Ohio prior to 1655 have their own technological history, of course, although we have only very recently begun to get some glimmerings of it. Human artifacts found with mammoth remains in Ohio bogs show something of the hunting technology of postglacial Ohio hunters, 10,000 to 15,000 years ago. These pre-Indian, pre-mound builder Ohioans were adept at driving large mammals into the then-numerous Ohio bogs and killing them with spears and by throwing stick projectiles. Indeed, some anthropologists now believe man's use of fire-and-flint technology in hunting was a major factor in the extermination of many large native mammals, including the mammoth. We know progressively more about the technologies of native groups living in the time between these primitive hunters and the Erie. The technologies of even the later Ohio Indians seem primitive in some ways.

They did not invent gunpowder. They hadn't discovered the principle of the wheel. And yet, they established towns, taught the white man agriculture, cared for the sick, and travelled farther from home than the average European of the time. There were a number of important Indian towns in Ohio. Some were on the sites of present day towns such as Chillicothe. These were interconnected by trails (which later became roads) and by a kind of commerce. Four water routes were in use when the Europeans arrived that carried Indian travellers between the river and the lake. These routes were later used by the white men in their canal-building. Flint Ridge, near Newark, a rich source of flint for points, knives, and other implements, attracted Indians from far away. Implements made from the distinctive Flint Ridge stone have been found as far away as present-day Virginia and Illinois. In agriculture, the Indians did quite well. Corn, beans, and squash were originally domesticated in Mexico, but were carried northward and were universally grown when the Europeans arrived. These species and other American natives have now been grown around the world to the benefit of all nations.

There is evidence that the Indians had a medical knowledge exceeding that of Europe in an age when bleeding was the medical fashion there. They apparently even possessed an herbal birth control method, perhaps compensating for the low carrying capacity allowed by their hunting-farming lifestyle.

These native American technologies — tools, agriculture, medicine, travel — were not pure, self-conscious, scientific, and mechanical. They were partly mystical and religious. But they represented successful attempts to do what all technology does: manipulate energy and materials to derive a better human environment. Technologies evolve as human responses to the environment, and in turn, change the environment itself. The growth of our native technologies may even have changed the environment to the point of extirpating some of its animals.

The technological heritage that Europeans brought to America is a long and interesting one. Actually we might term the colonists' technologies Eurasian, rather than strictly European. The Iroquois' gunpowder was actually a Chinese invention, although the musket which put it to deadly use was European in origin. This example of adaptation is not unique. European technology had built upon other technologies, as well as on the ingenuity of Europeans. The Crusades injected Europe with many aspects of alien technology, which the Europeans were quick to exploit. The Rennaissance was fueled by scholarship into the past (Greece and Rome) and

* *Supplemental readings or alternative readings. "Marginal Man," a short story, or "A Sound of Thunder," in Eco-Fiction.* (See Bibliography)

by exploration of new territory (Africa and the Orient) both of which brought new or long forgotten technologies into current thought.

When Europeans came to North America, they introduced their complex and changing technology to people who had been isolated from such radical confrontation since the Ice Age. The Indians were simply overwhelmed by the more "advanced" European technology. The motivating force of the Europeans was the resource needs of their technologies.

The Iroquois moved in on the Erie not because they wanted land but simply because they had trapped all the beaver in their area and wanted to gain access to even more beaver fur to sell to the white men. They, in turn, would convert the fur to high quality felt for fashionable men's hats.

European technology, provided with the stupendous resources of this continent, grew rapidly. In its American form, it represents an enormous force in today's world and in our lives. Our technology makes practically 100% of our environment. Think of it. How many hours of the day are you out-of-doors? How about the other members of your family? When you are out-of-doors, more than likely you are walking on concrete, driving a machine, or at least within sight of an incandescent light bulb. The Erie, the Iroquois, and the colonist all would marvel at this change if we brought them into today's world.

Technology is the manipulation of energy and materials for the betterment of the human environment. In recent years, though, we have learned that what is good for one environment is not necessarily good for another and that maintaining our widespread artificial environments might harm the total life-support system of the planet. To participate in the future growth and use of technology, we need to understand not only the past history of technology, with its successes and mistakes, but some of the possible ways in which energy and materials will be used in the future.

ACTIVITY A:

After completing the reading, begin the class discussion with the following questions:

1. Can you find examples of technological advances which have had a great effect on man and his world? List some.
2. Start a journal which will be kept throughout this unit. The journal should include past, present, and future change which will affect or has affected the quality of your life. Include, also, an imaginative description of what you think life will be like in 2074.

   Follow this journal activity up at the end of the unit by writing another description of what life might be like in the future (2074) and discuss through comparisons within the rest of the class any changes in their views concerning the future. (This might also serve as an evaluation for the unit for the teacher.)
3. What happened to man as a result of these:
   a. the invention of the auto
   b. the invention of the airplane
   c. the landing on the moon
4. Project into the future:
   a. Does change stop?
   b. Can change end?
   c. What happens to man meanwhile?
5. Who decides what technologies should be exploited?
   Have class make lists of or brainstorm about the mind-forming agencies and vested interests of society which will attempt to influence our values concerning the future.

Teacher's Note:
Assign some readings to the students from the bibliography section at the end of the unit.

ACTIVITY B:

1. Divide the class into groups and ask them to research and report on the following life styles:
   a. Indian
   b. colonial
   c. pioneer
   d. "modern" society — example: carpenter, doctor, lawyer, etc.

   Consider how food was prepared, what homes were like, how homes were heated, what kind of tools were used, etc.

   Describe a 24-hour day in your life as an Indian, colonist, etc. When would you rise? Would you wash? How? What would breakfast be like? etc.
3. Invite elderly members of the community to discuss with the class about technology and life styles 50 years ago. This could also be accomplished through student interviews with the older members of the community or community survey questions.

   Some discussion questions or topics (presentation, interview, or survey):

   How was the automobile utilized as compared to today?
   How was leisure time spent?
   What was science's influence upon the community at large?
   Was there a fear of world annihilation?
   How was the environment viewed then as compared to now?
   What do they think about present life styles today as compared to those of their youth?
   What was the Depression like?
4. Reading and listening are quick (sometimes) and mess-free (mostly), but the trouble is that many students learn best by more active participation. Visit any of the state or local historical museums. Two which are particularly fascinating are the Ohio Historical Museum in Columbus and Flint Ridge State Park Museum near Newark. An appreciation of the technologies of Ohio's aboriginal inhabitants can be gained in both locations, and pioneer technology is well presented at the former. Information on historical

society museums (there might be one near you) is available by writing to The Ohio State Historical Society. Good Cleveland area museums are the Western Reserve Historial Society and the Museum of Natural History in University Circle.

Teacher's Note:
Assign some readings. Use the bibliography of the unit.

ACTIVITY C:
TIME LINE OF INVENTIONS
(A class activity for all students)

The teacher assigns a time span to each individual student, beginning with pre-historic time. Students look up data on their spans and find out what important scientific discoveries and inventions took place at that time in history. A section should be included for future inventions and discoveries, and this section should be assigned to especially imaginative students. Science fiction might be used as a reference.

Spread out a roll of paper in the hall, mark off sections for the time spans, and let students write and draw pictures in their own sections.

Teacher's Note:
This may be done on a completely in-class basis with students using reference books in class, or assignments may be made ahead of time so students can look up information outside.

Materials:
A roll of shelf paper and crayons

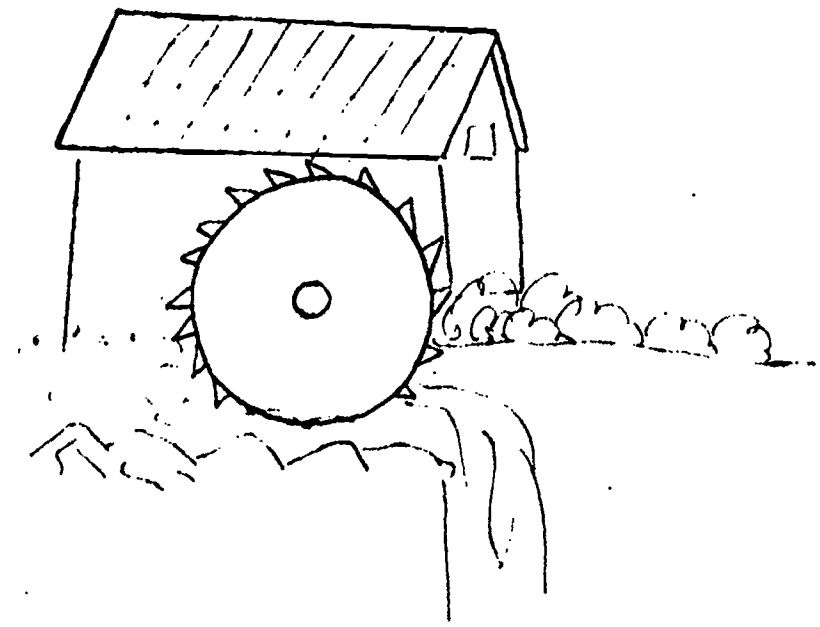
ACTIVITY D: EVOLUTIONARY TIME LINE
(Class activity to coordinate with Activity C)

Make a time line chart similar to that of Activity C which depicts geological time as well as an inclusion of biological occurrence and its adaptation and change.

1. Although this has been done a great deal, have class show how long man has been a part of the biotic environment by giving man a time span which uses a twenty-four hour day as the total time of life on planet earth.
2. See if student can research points where extinction has occurred and try to correlate this with other biotic and abiotic changes.
3. Make a field study of adaptation and changes in the past (fossil studies).

   Ohio is one of the richest areas in the world for fossil studies. Throughout the state, there are areas such as quarries, bogs, road cuts, ravines, etc. which afford rewarding opportunities to study life of the past.

   Describe environments of the past (Devonian Seas). Identify specific fossils such as brachiopods and trilobites. Contemplate the reason for their extinction.



ACTIVITY E:

1. Chip an arrowhead. You will acquire great respect for the Indians' flint technology when you use a large *nail* to chip implements out of glass. (Pop-bottles are OK, but you can use practically any kind of glass.) Remember, safety first; use goggles and hold the glass in a gloved hand. Strike the edge of the glass at an angle to produce crescent-shaped chips which give the implement its edge. You're succeeding when you produce a tool which can be hefted or hand-held and used to cut leather.
2. Build a working model of an historic technological device, such as these:
   a. a water wheel
   b. Archimedes' screw
   c. an Egyptian lever (See Telleson's book in the bibliography.)
3. Select a chore you hate to do. Design a tool to do it for you. Or design a tool for a likeable chore. (Imagination counts.) How about
   a. a conveyor belt from the kitchen to carry out the trash
   b. an automatic gardener
   c. a garage-cleaner
   d. carrier devices

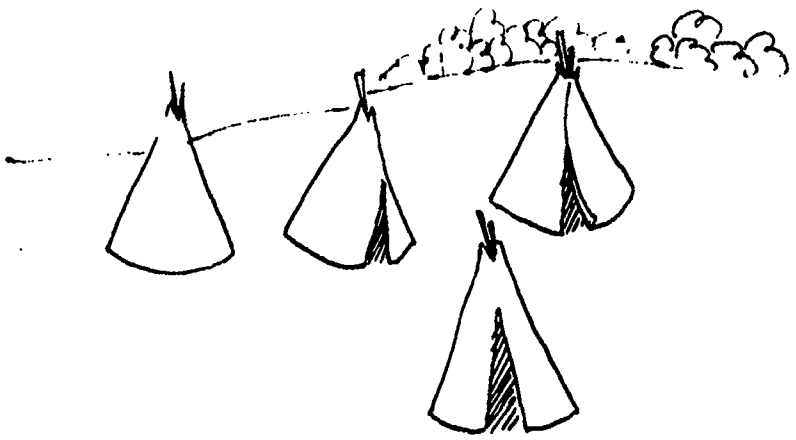
   Present plans and build a scale model if you can.
4. Discussion Sessions

   Relate questions to experience
   Was the tool necessary?
   Was the chore necessary?
   What was the impact of the invention upon the environment: materials, pollution. . .?

   A list of possible materials for this activity should be brainstormed by the class in order to get a master list and to help each other in creating their invention. (Often other class members get interested in someone else's idea and provide the most help in getting it accomplished, forming theory and experiment teams.)

   Examples:

Roller skates	Old lawn mower engines
Ball bearings	Ropes
Levers	Sacks
Pulleys	Bags



ACTIVITY F: DRAMA OF THE PAST

Have the class organize their interests into presenting a drama of the past by assigning roles, responsibilities, and research teams to provide background.

Examples might be:

Colonial Village
- Craftsman
- Aristocrat
- Freeholder
- Farmer
- Slave
- Artisan

Indian Village
- Hunters
- Children
- Squaws
- Elderly
- Leaders

Cave Man
- Women
- Men
- Children
- Elderly

Roaring Twenties

This could be coordinated with other classes such as U.S. History classes. The Colonial Williamsburg Foundation has excellent films on craftsmanship and colonial life.

ACTIVITY G: LIVING THE PAST

Have the class (individually, group, or whole class) experience living a part of their life (a day, a week) without a technology which they find convenient, useful and possibly necessary.

Such deprivations might include these:

TV and radio
Automobile
Telephone
Hot showers
Processed conveniences
Anything plastic
Habits: snacks, cigarettes, etc.
Electric lights
Air conditioning
Recreation

Follow-up discussions:

Encourage the class to share their feelings concerning their experience of going without.

Did they feel miserable?
Did they feel good about the sacrifice?
Would they consider continuing this?
How do they think their ancestors felt?
What is classified as necessity, comfort, non-necessity?

ACTIVITY H: SUMMARY FOLLOW-UP

As an optional activity, it might be worthwhile to develop discussions, debates, or values clarification strategies which tie together previous activities into some relationship which will bring them to a future-oriented outlook.

Possible Ideas:

1. Correlate time lines of invention and adaptation and change and discuss the rate of technological developments in relationship to man's preparation for their psychological, social, and environmental impact.
2. Develop a debate discussion related to the significance and importance of the family in the past, present, and the future. Where does the family seem to be going?
3. Discuss nostalgia and its appearance recently in various forms: collections, movies, songs, etc.
4. Develop a values continum related to automobile technology and have each person place their position on this continum:

Walking William ←	→ Auto Andy
Despises the invention and refuses even an offer of a ride during a blizzard.	Lives in his car and drives from door to curb to take out the trash.

Make two columns related to the automobile:

Benefits	Detriments

What would our life be like today if we never had the automobile? Why have we never considered engine types other than the internal combustion engine?

5. Consider our weapons technology — past, present, and future:

   What has been the impact of weapons technology in the past, present, future? How has nuclear threat influenced our society?

   Think about nuclear holocaust. Think about ecocide during war, particularly in Vietnam (Southeast Asia). Research what the environment is now like in Vietnam, Cambodia, and Laos.

EXPERIENCE #2:
FUTURE PRODUCTION OF ENERGY

OBJECTIVE:

At the end of this experience, the student will have become aware of the limitations of our fossil fuel sources and will be able to identify future sources of energy.

Teacher's Note:

Before teaching the next activity, the teacher should study the following introductory information and decide what portions of it should be known by the students. He can either lecture on or discuss the sections which, in his opinion, will enhance the learning process while the class performs the following activities. Although some background information may be necessary for better understanding of the studies that follow, much of the following material can be omitted and generated from activities and discussions which follow.

INTRODUCTORY INFORMATION

Before we explore the future possibilities for energy technologies, let's review briefly the energy context of the planet we live on. First, the Earth-Moon system exists in an energy flux produced by the sun. Each day, enough solar power reaches earth to equal 100,000 times the world's electrical capacity. This sun energy expresses itself in a number of ways. Some areas of earth are more warmed by the sun than surrounding areas. This differential heating is what produces winds. Ocean currents are produced by the same differential sun heating of water, although both water and air circulation patterns are somewhat affected by the rotation of the earth. Solar energy is also expressed in the water cycle. It is really solar energy that is responsible for "hydroelectric" power. Sun heat vaporizes water, and wind blows it to distant parts, where it condenses, falls to earth, and flows back to the sea.

Much of the sun energy falling on earth is lost, but some is captured and used by green plants. Their cells are able to use sun energy to fuel a set of chemical reactions which do the following: split water into hydrogen and oxygen, split carbon dioxide into carbon and oxygen, and synthesize new compounds composed of carbon and hydrogen (hydrocarbons). In the process, photosynthesis liberates (as a waste product) oxygen, which just happens to make it possible for animal life to exist on earth. Photosynthesis is the key process in the great "balanced terrarium" we live in.

The sun energy, which is "fixed" in photosynthesis, is mostly cycled through the bodies of animals and decay organisms, which "burn" it in a fairly efficient manner. But many millions of years ago, some of this fixed energy was fossilized under unique environmental conditions to produce the fuels, coal, oil, and natural gas.

The environment of great swamps produced coal. Enormous amounts of plant tissue were covered with water and mud. The mud turned to rock as more and more of it accumulated. Through countless centuries, the buried plant tissue carbonized more and more, until it turned into the black, combustible substance we call coal.

Oil was similarly formed, except the "raw material" was the combined bodies of trillions of tiny sea creatures. Oil droplets from this ooze coalesced and moved upward in the mud-rock that was forming over it. When these rising oils encountered an impervious stratum, they stopped, forming oil pools. Natural gas was apparently formed under much the same conditions, for it is often found associated with oil. We know little, though, of the specific conditions under which these fossil fuels were formed because there are very little of them being made today. The coal, oil, and gas existing on earth today represent essentially static "bank accounts" of energy. To the best of our knowledge, "deposits" are almost nil, compared to "withdrawals."

The Earth-Moon system itself is a generator of tremendous energy. The moon constantly pulls the ocean waters of the world a bit closer to it. This pulling results in tidal rise and fall. The rise and fall of tides, channeled through turbines, can produce electricity. The interior of the earth is a molten mass. The heat to produce it comes partly from the tremendous pressures on the earth's interior and partly from natural radioactivity, the heat energy derived from splitting atomic nuclei. This ready-made and free heat is in use by man.

Today, we use fossil fuel to provide over 90% of the energy we use. The rest is derived from hydroelectric power and atomic power. But we're using fossil fuels at such an incredible rate that some authorities project an end to our reserves of gas and oil in the year 2,000 or before. Our reserve of coal will last much longer, perhaps some hundreds of years, but coal presently forms much less of our fossil fuel budget than do oil and gas, which are easier to extract and transport and cleaner to use. (In 13th century England, before the invention of the brick chimney, the burning of coal was punishable by beheading.) This situation of technology eating up the world's reserves of nonrenewable energy resources offers a challenge to those of us who will live in the future. Can we adapt our technology to cope with the declining supply of fossil fuels that now support it?

There are many possibilities for the use of coal. Many of them depend on its "gasification" or some other treatment which would make coal easier to transport and cleaner to burn. But even if we learn how to manipulate coal cleverly, there is still the matter of its extraction from the earth. At present, strip mining provides much of the coal used for fuel. But the exploitation of coal in this manner in the future will, if present methods are followed, remove enormous quantities of land used to produce crops, pasture, or wood. The same problems are associated with oil shale, which can be stripped and processed to produce oil. At best, the reclamation of this strip mined land would be costly; at worst, impossible.

In what ways can our technology "plug in" to the energy flux of the planet? Can we cut back on the social and environmental costs of such activities as strip mining by utilizing this "free energy"?

ACTIVITY A:

Show the film, *Our Mr. Sun*, by the Ohio Bell Telephone Company.

This readily available film is worth repeating to help reinforce the introductory material to this unit or as an alternative in helping start this experience.

ACTIVITY B:

Present the carousel slide program, *The Energy Crisis*, available from the Gould Company in Willoughby, Ohio.

This program has been demonstrated to be a good alternative to the introductory information.

DIRECT SOLAR POWER

The ideal energy source is sunlight. It is non-polluting, falls on all parts of the earth, and is abundant. The question, of course, is how to use it directly. Here are some of the schemes that have been suggested:

Solar Cells:

It is possible to utilize some of the natural qualities of *crystals* to produce an electrical current by their exposure to sunlight. At present (1973) levels of solar-cell technology, it would require 400 square miles of such cells to equal the U.S. electrical output. Work is proceeding on improving the efficiency of solar cells and lowering their cost.

Solar Cells in Outer Space:

One of the problems with solar cells on earth is the fact that the sun must be shining to make them work. In space, without clouds to block it out, sunshine is constant. A system has been proposed that would beam the energy to receiving stations on earth in the form of microwaves. This system is also waiting for improvements in solar cells and the lowering of their cost.

Solar Heat Systems:

It is difficult to turn sunlight into electricity but comparatively easier to make the sun's heat work for you. Home systems are already available which absorb solar heat, store it in water or rock, and then extract it later for use in space heating or even refrigeration. Obviously, this sort of arrangement is a solar water heater, so it could fulfill that need at least.

A solar heat storage and retrieval system, coupled with solar cells, could supply a house with all its energy needs. On a larger scale, a plan has been proposed to turn over 10% of our deserts (some 14,000 square miles) to a bank of solar heat collectors that would produce hydrogen fuel by "splitting" water. To do this, one would have to raise the water's temperature to 1500 C. Use of such a system to produce energy on a significant scale awaits advances in the technology of heat-absorptive surfaces. Such a system would supply 50% of projected energy needs by the year 2,000.

ACTIVITY C:

1. Students build a solar battery or buy one and use it to power various devices like a small motor, any battery driven toy, etc. (The solar batteries will work with a sunlamp if direct sun light is not available.)
2. Students construct a solar reflector and use it to boil water, cook an egg, or anything else they can think of.
3. The teacher can demonstrate the power potential of tides by using a wave tank and sand.
4. Students view a movie to get some idea of the energy realized by a volcano, followed by a discussion of how such energy could be harnessed.

ACTIVITY D:

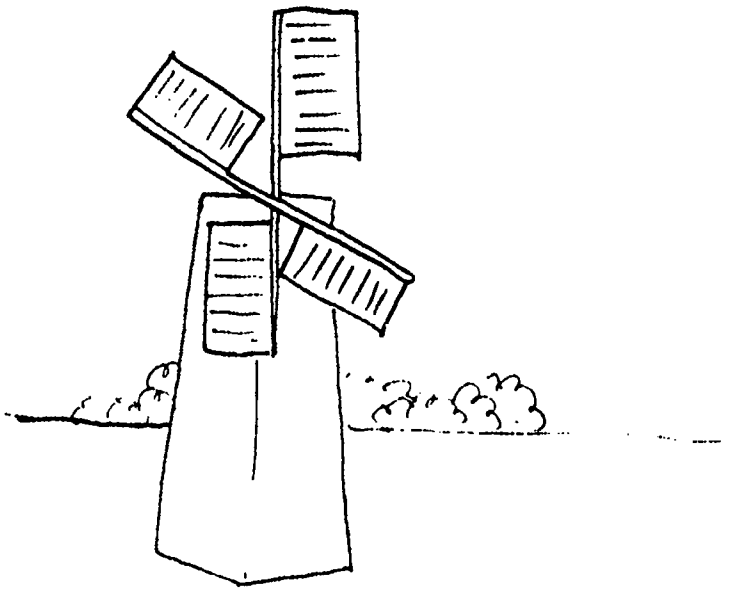
Ask the students to build one or more of the following contraptions driven by solar energy:

1. Solar steam cooker
2. Solar water heater
3. Solar still
4. Wind machine for pumping water
5. Solar fire-starter, using a magnifying glass

Teacher's Note:
Directions and materials for building these gadgets can be obtained from the Edmund Scientific Company, 300 Edscorp Building, Barrington, New Jersey 08007.

WIND POWER

There have been many proposals to use the free power of the wind to provide cheap energy. There are undoubtedly many places in the world where the wind is fairly constant, but the problem is how the energy generated is to be stored up for use in periods when there is no wind. Perhaps the answer lies in the conversion of *electric power* through the electrolysis of water to create hydrogen, a storable fuel. One successful wind generator in Vermont solved the problem by supplementing a hydroelectric operation, allowing that facility to store energy in the form of water behind the dam. When the wind didn't blow, more water was let through.



ACTIVITY E: WIND POWER

Construct any kind of wind powered device (ordinary plastic toy windmills demonstrate the point satisfactorily, but this could evolve into a very sophisticated class project. See articles from the *Mother Earth News*).

Ask class if they consider wind as a solar energy source.

If possible, have groups or individuals hook up a simple generator to the windmill for a class demonstration by connecting to a detection device such as a galvanometer.

Is wind power a viable alternative energy source for the future in Ohio?

Teacher's Note:
In the Octol r, 1971, issue of Scientific American, there is an article which contains two activities involving wind power:

1. *Making a simple pendulum aneometer*
2. *Making minature tornadoes*
   If time permits, look into it.

GEOTHERMAL POWER

Heat energy from the earth's interior flows to the surface at greater rates in some places than in others. Such places include volcanoes, geysers, and hot springs. Quite simply, the use of geothermal energy involves tapping this heat to produce steam, which in turn powers generators. Several such operations are now running in different parts of the world. The main drawback to the use of geothermal energy seems to be the *local nature of its availability.*

FISSION POWER

The energy evolved from splitting atomic nuclei now accounts for less than 10% of our energy needs. There are several obstacles to its unrestrained development as our major source of energy:

1. Transport and disposal of long-lived radioactive wastes even now presents a problem.
2. The efficiency of atomic power plants as compared with conventional ones has not developed as expected.
3. The safety problems involved in operating a nuclear power plant are quite critical. An "accident" could contaminate many square miles of countryside, not to mention the danger of wider contamination by air and water. More plants increase this risk.
4. Thermal pollution of water and air by atomic power plants would be enormous It is estimated that by the year 2000, atomic generating plants could be emptying hot water into the Great Lakes at a rate equal to the discharge of the Mississippi at its mouth. Even if this excess heat were dissipated by cooling towers, it could disrupt climate locally. Some have suggested uses for this hot water, such as the stimulation of higher growth rate in pen-reared fish.
5. The supply of atomic fuel on earth is limited, too, just like oil and coal.

ACTIVITY F:

Visit a nuclear plant if it is possible.

FUSION POWER

This is the ultimate source of abundant clean power. The sun itself a giant fusion reactor. The basis of this source is the enormous energy released when atomic nuclei fuse at incredibly high temperatures. To make a fusion bomb detonate, you must first raise the temperature of the fuel by exploding an ordinary atomic bomb around it. There are two problems to solve before we can use fusion power:

1. How do you heat up the fuel to the proper temperature? The method used to produce a fusion bomb is obviously not suitable to the production of useable energy.
2. How do you contain the "fusioning" fuel once the reaction is started? Research is proceeding now on this energy source and new developments are announced at frequent intervals. A breakthrough could occur in a few years, but estimates about the first possible use of fusion range up to the year 2020.

ACTIVITY G:
VISIT TO LOCAL POWER PLANT

1. If possible, visit an electric power plant.
2. How does your town get its electrical energy? Is that the only form in which energy is available? Make a list of every plant in your town and find out the following about it:
   a. Its fuel source
   b. Its efficiency
   c. The cost of a killowatt hour of produced energy
   d. Its pollution control measures
   e. Its planned future development

ACTIVITY H: ENERGY CRISIS HEARING

This is an activity which could be substituted for the entire experience by spending enough time in developing a simulation/role-playing game which would bring out information about energy sources, values clashes, and environmental impact relative to the energy crisis now and in the future.

Have the class conduct an International Energy Crisis Symposium. The format for this could be similar to the symposium held in Stockholm (Special issue, *Science and Public Affairs Bulletin*, AEC).

Have the class research energy alternatives for the future. The symposium could be conducted as if it were in the year 1984 or in the present.

Geothermal energy
Nuclear fusion
Nuclear fission
Solar energy (direct) — batteries, stills, furnaces, steam generators, home heating
Hydroelectric power
Wind
Solar energy (indirect) — thermal decomposition of water for hydrogen fuel (See note below)
Fuel cells
Tidal energy
Oil shales, coal, and exploration, including space

After research has been completed, assign roles to individuals for the hearing symposium.

Chairman, committee members (with vested interests in each alternative)
Witnesses for testimony
- Oil companies
- Auto industry
- Atomic energy commission
- Space officials
- Financial experts
- Scientists
- Environmentalists
- New private industries representing alternative technologies

Delegates from each nation represented
- Developed countries
- Developing countries
- Underdeveloped countries

Concluding debate and discussion (possibly limited to committee) should be decisive and weigh the technology of future energy sources under realistic and environmentally sound conditions.

Note: It might be interesting to throw this in to the debate:
The technology for thermal decomposition of water into hydrogen and oxygen through solar energy is known. Hydrogen is a relatively non-polluting fuel and oxygen has important industrial uses (possibly coupled with using hydrogen as a fuel) as well as being a limitless resource. Why, then, is there not a great research thrust to put this into a practical full-scale operation? What industries might oppose this?

Considerations in debate discussion might be these:

1. Who decides the energy alternatives that will be exploited?
   Introduce the question that if big business will not find new energy alternatives, who will? What is the implication behind private research?
2. What advertisements influence the use of more energy?
3. What are impacts on the future environment?
4. How are values clashes resolved?
5. What are present priorities for energy sources?

ACTIVITY I: TELEVISION INVENTORY

Have class compile a TV inventory of all programs by listing all factors which influence our energy uses.
Types of programs (life styles depicted, conveniences shown)
Commercials

How many of these are future oriented?

Readings For Discussion

A series of reprints from *Environment* magazine is available from the Scientists Institute for Public Information, 30 East 68th Street, New York, New York, 10021. The cost is 35¢ per reprint.

1. "Power from the Earth," by David Ferner and Joseph Klaman, December, 1971. On geothermal power.
2. "The Black Box," by Terri Aaronson, December, 1971. A good article on the fuel cell, a futuristic energy source.
3. "A Clean, New Gas," by Hinrich L. Bohn, December, 1971. This article concerns the production of methane fuel from human and animal waste.
4. "Windmills," by Julian McCaull, January/February, 1973. A good review of a successful experiment in wind-produced power and a present proposal.
5. "Fusion Power," by Lowell Wood and John Nuckolls. Fission and fusion technology reviewed with projections for the use of fusion power.
6. "Fuel From City Trash," by Dennis Wilcox, September, 1973.
7. "Oil Drum Technology," by Julian McCaull, September, 1973. Some good ideas in this one for projects.
8. "Energy and Well-Being," by A. B. Mahijani and A. J. Lichtenberg, June, 1972. A discussion of the necessity for improving efficiency in United States energy consumption.
9. "Solar Energy," by Arthur R. Tamplin, June, 1973. An excellent review article on possible schemes for using solar power.
10. "Healing Wounds," by E. A. Nepher, January/February, 1972. Examines the strip-mined land is returned to productive use in Germany.

More Periodical Reading

1. William C. Guagh; Bernard J. Eastland. "The Prospects of Fusion Power." *Scientific American*, February, 1971.
2. Derek P. Gregory. "The Hydrogen Economy." *Scientific American*, January, 1973. One key to the nonconstant energy sources like the wind is storing energy to use later. Electrolysis of water to produce hydrogen could be the way to do it.
3. Andrew Hardy. "Man's Age-Old Struggle for Power." *Natural History*, October, 1973.
4. Moshe J. Lubin. "Fusion by Laser." *Scientific American*, June, 1971. One possible way to raise the fusion fuel to high enough temperature is by using the laser.
5. *Mother Earth News*. Any issue.
6. *National Wildlife*, August, September, October, 1973. These periodicals carry excellent, easy to read, well-illustrated articles on energy resources.
7. Richard F. and Stephen F. Post. "Flywheels." *Scientific American*, December, 1973. Inertia as a form of energy storage.
8. *Scientific American*, September, 1971. The whole issue is on energy — a good comprehensive survey.

EXPERIENCE #3:
RENEWABLE RESOURCES IN THE FUTURE

OBJECTIVE:

After studying this experience, the student will develop an appreciation of our renewable resources and learn more about foods we might use in the future.

Teacher's Note:
The following introductory information should be presented to the students, either with additions or deletions or in its present form, at the discretion of the teacher. This material can also be given as a reading assignment in the classroom or be read as homework. If time is available, the teacher may add more information by using the books and periodicals listed at the end of the experience. Whatever portions the teacher may use, we believe that learning some of the material is necessary in order for the activities that follow to be useful.

THE PRODUCTION OF RENEWABLE RESOURCES IN THE FUTURE

These technologies are those that concern materials which can be harvested over and over and over again from the same area. Included are *agriculture*, *fisheries*, and *forestry*. The way in which these technologies have sometimes been practiced in the past has led to losses which would be intolerable in a more crowded future. The commitment of vast areas in the American Southeast to cotton and tobacco in the 18th and 19th centuries drastically lowered fertility in that area. The pattern in which the soil was worked in the American Southwest added significantly to drought and wind to produce the "dustbowl" of the 1930's. In the more remote past, entire civilizations have risen on the expectation of renewable resources and fallen on their failure to renew them. Many presently barren areas of the Middle East were heavily forested in the historic past. The now defunct Cedars of Lebanon are a famous example of the type of despoliation. The results of poor resource management were escaped in times past by migration or immigration. Perhaps your ancestors came to this country to escape a shortage of something. Potato famines caused significant portions of the Irish population to migrate to America in the late 1800's. (Ironically, the potato was introduced into Ireland from the New World, although the dependence upon potatoes or any other single crop was and is a mistake of agricultural technology.) In our rapidly shrinking world, there are few frontiers to which we can run to escape a resource shortage.

Even the sea, formerly thought of as a nearly limitless resource bank, is now seen to have its limitations. Advance fisheries technology (plus enormous demand for resources) has made it possible to destroy a whole resource, as you know if you read "Can Leviathan Long Endure so Wide a Chase?" (See the bibliography.)

To insure a continuing harvest, steps will have to be taken to regulate the harvest and, perhaps, manage marine resources in some other ways as well. Since the oceans belong to all men by international law, such regulation will be difficult to provide. The sea still represents a cornucopia of resources and the technology is still developing for its harvest and management. The important thing to remember about the ocean's future is that it represents a storehouse of not only renewable resources, such as food, but also of all the rain and most of the oxygen we "inlanders" harvest continually. *The oceans also make climate.* This water holds a great deal of sun heat, which it releases slowly, lengthening the growing season in many parts of the world. These services provided by the seas cannot be taken for granted in the future as they sometimes have been in the past.

The development of land areas to provide renewable and other resources in the future is bound to affect the oceans, too. Materials are now being dumped into the ocean that affect it on a global scale. In the future, the oceans will be exploited to produce much that we need. But they must also be protected.

From the foregoing paragraphs, you may have gathered that we have not only the future of renewable resource production to deal with but today's resource problems as well. There is presently a shortage of protein in much of the "developing" world. This is a shortage which stems partly from improper resource use in the past and partly from the inefficiency of energy use by animals. As the population grows, these shortages are bound to become more acute. Much of even the developed world uses small amounts of protein compared to the United States, and we're sooner or later bound to feel the shortage ourselves. If world and United States population is to be returned to a healthy state and if the world ecosystem is to function in the future as a "farm," technology and human institutions must work together with the natural world. Don't forget that the deprived and sometimes starving present for millions of people was once their future. It may be ours.

The sun's energy cycles through the earth's communities, taking first one form, then another. All animals and plants exploit this cycling energy in some way, but man is the only animal capable of making his own communities. Here in the Midwest, we've substituted one-species "prairies" of corn and bean fields for the diverse forests the Eric and the Iroquois hunted in. We use a lot of energy to maintain these monocultures. But this intensively mechanized agriculture has enabled us to increase the carrying capacity of the land. New methods of forestry have arisen as lumbering turned from the old cut-out-and-get-out mentality of the 19th century to the resource-management attitudes of today. There is very little virgin timber left anywhere today, and what there is is disappearing. Modern forestry is moving toward methods that either "farm" single-species stands for harvest and reseeding or "manage" natural stands for a clear-cut or selectively-cut harvest.

There are several problems with these resource technologies which could haunt us in the future.

Energy

Unless some new ways are found to provide it, the energy to run tomorrow's agriculture will be paid for dearly. American agricultural technology has grown mostly on the basis of cheap fossil-fuel energy. This energy represents not only the gasoline for tractors, but that needed to run trucks and trains taking the produce to far-flung markets as well. Add to this the fuel it takes to produce and transport the herbicides and fertilizers on which our agricultural style seems to be dependent. A look at the table comparing caloric output vs. input in several different types of agriculture will be instructive. As fossil fuels become scarcer, the cost of energy available to agriculture and other renewable resource technologies will rise. Perhaps the day will return when muscle-power will be more efficient and economical to use "down on the farm."

Monoculture

A rule of ecology is "diversity implies stability." What this means is that the more different kinds of plants and animals there are in a community, the more likely it is that their population levels will not rise and fall sharply. For his own purposes, man creates monocultures which are single-species communities. These communities are more susceptible to pests and diseases. The "tree farms" mentioned above, as well as corn fields and apple orchards, are more susceptible to this type of danger in monoculture than the same species would be in a more diverse community. In the past, the widespread use of long-lived chemicals to control insects and diseases has led to persistent contamination of air, land, and water and to the near-extinction of several species of animals. Agricultural chemicals (including fertilizers) do not just vanish when we apply them. Fertilizers run off into streams or percolate into the water table. Hard pesticides appear throughout food chains. Both kinds of chemicals can cause severe and widespread ecological and public-health problems. If intensive agriculture must continue to provide our food, it seems that it must adapt to what we know about diversity in the natural world. The use of biological controls for insects and diseases might represent one useful avenue.

Resource Loss

The materials and energy represented in a standing forest are constantly being recycled. But, in most cases, the products of our man-made plant and animal communities leave them, never to return. The flush toilet and the incinerator dispense with the materials which should be returned to the fields and forests which produced them to begin with. The loss to our agriculture of phosphates and nitrates in sewage effluent alone must be enormous. In older types of agriculture, human wastes are collected, composted to kill any dangerous bacteria, and returned to the fields. In this way fields in many parts of Asia have been kept productive for centuries with nothing more than hand labor.

Loss of a Productive Environment for Human Growth

Our grandparents were closer to the land and to the physical sources of their lives than we are today. Most of them lived on farms. One social cost of agricultural technology and the economy it makes possible is the displacement of rural population to the cities. This urbanization is a trend which many predict will continue. Whether this change in our culture will help it grow or whether it will be harmful is a question which stirs up hot debate today. The final answer lies in the future.

ACTIVITY A: GREEN REVOLUTION - SUCCESS OR FAILURE?

1. Look up world population figures and growth predictions; make graphs of population growth since 1800 and of predicted growth.
2. Answer the question: "How will we eat in the future if population growth continues?"
3. What foods will we eat in the future?
4. Find articles about food production and foods of the future. Read and write abstracts of these articles.
5. Write to Stouffer Foods for information on/or samples of the new foods they are manufacturing to replace old.
6. Visit a local grocery store to read labels on packages of food which now contain substitute ingredients. These will become more prevalent in the future. (Interested parents may be asked to accompany the students.)

Materials:

The teacher should be able to use several of the following books or articles:

Arthur Galston. "Bios: New Ways to Increase Man's Food." *Natural History*, October, 1973. This essay deals with using plants' responses to light and dark cycles in order to increase productivity.

Marvin Harris. "The Human Strategy: The Withering Green Revolution." *Natural History*, March, 1973. This article deals with the advances in the genetics of food crops and one view of why this "revolution" will do little to help the food problems of the world.

Frances Moore Lappe. *Diet for a Small Planet*. New York: Ballantine. Your students who are interested in nutrition and cooking will like this book. The basis for the title is that animal protein is becoming harder to obtain all the time. The recipes included utilize vegetable protein entirely.

Paul S. Martin. "Wanted: A Suitable Herbivore." *Natural History*, February, 1969. About the possible use of African grazers to produce meat on the American plains.

ACTIVITY B: WHO BENEFITS FROM AGRICULTURAL TECHNOLOGY?

1. Students prepare a display based on the development of the high yield grain varieties, with statistics and nutritional information.
2. Students can research the effects of pest control projects in their area and present results.
3. Student groups can do research on the adequacy of the diet of peoples in various sections of the world. Present results in the form of graphs comparing needs to consumption.
4. Discuss the following:
   a. How effectively are we meeting the nutritional needs of the world?
   b. What effects will population increases have on the rate of food production?
   c. Can you think of any solutions to the problems that now face us? To future problems?

Materials:
Display materials, copies of discussion questions, Articles:

Addeke H. Boerma. "A World Agricultural Plan." *Scientific American,* August, 1970. The sort of planning necessary for full future production and protection of renewable resources.

Byrd Curtis; David R. Johnston. "Hybrid Wheat." *Scientific American,* May, 1969. The history of wheat development and its recent advances.

E. Raymond Hall. "Down on the Farm." *Natural History,* March, 1972. A famous mammalogist discusses the issue of whether or not we need pesticides as much as their manufacturers tell us we do.

Marvin Harris. "One Man's Food is Another Man's Whitewash." *Natural History,* November, 1972. The author takes a look at food-resource uses and prejudices around the world.

ACTIVITY C: FLOW OF ENERGY IN THE SEA

1. Students research and report on seawater contents and sea conditions concerning food growth and usage.
2. Teacher or student presents a film or film strip on the comparison between ocean characteristics and plant growth needs, followed by a discussion of implications for food production.
   a. Why is the ocean considered a possible future food source?
   b. What chance is there that the use of the ocean as a food source could lead to even greater future food shortages?
3. Students examine the food chain in the ocean and discuss these questions:
   a. As compared to land resources, is the ocean a good protein producer? carbohydrate? fat?
   b. Would seaweed or plankton be a practical food source for man?
4. If possible, students bring in and sample various seafoods.

Materials:
Transparency of ocean food chain, projector, film or filmstrip, copies of discussion questions.

Articles
1. Bascom, Willard. "Technology of the Ocean."
2. Holt, S. J. "Food Resources of the Ocean."
3. Peixoto, Jose P. and Kettani, M. Ali. "The Control." *Scientific American,* April, 1973. A fascinating scheme to alter normal weather patterns technologically.
4. Pinchot, Gifford B. "Marine Farming." *Scientific American,* December, 1970. Some schemes for farming the sea to obtain foodstuffs.
5. Wooster, W. S. "The Ocean and Man."

Check the Reader's Guide to Periodical Literature for sources for 1,2, and 5.

ACTIVITY D: POPULATION GROWTH

Have students start various cultures of organisms with a finite supply of food.

Examples of possible cultures might be these:

Daphnia
Paramecia
Fruitflies
Yeasts
Bacteria

Check almost any biological resources book for specific culture media and methods related to cultivating and making quantitative determinations in counting population.

1. Monitor populations and prepare population curves.
2. Try variations such as adding another species to a population, for example, two species of paramecia or daphnia.
3. It may prove beneficial to monitor chemical and physical changes in relation to population changes. See water chemistry techniques in any source book.
4. Compare these cultures with a balanced ecosystem.

ACTIVITY E: CRISIS ENVIRONMENTS OF THE FUTURE

Have class read Paul Erhlich's *Ecocatastrophe.* Discuss it.

1. One possibility might be to dramatize what an ecocatastrophe would be like in the future.
2. Debate and utilize opinionated versions of the future from controversial citizens:

   Ehrlich
   Commoner
   Dubos
   Fuller
   Nader

3. Consider limits which are not perceivable:
   Genetic changes
   Quality of environment
   Levels of radioactivity
   Psychological impacts — noise, crowding

ACTIVITY F: RECYCLABLE RESOURCES — FUTURE ORIENTED

Have a small group do a project on production of methane gas from animal wastes as a demonstration. (Farm kids have the advantage here.) See Gobar Gas in *Mother Earth News*.

Research the recycling plant in Franklin, Ohio, or better still, plan a field trip to this nationally funded and publicized project.

Research aluminum recycling — is it possible to establish this in the community?

Try composting and organic gardening.

EXPERIENCE #4: FUTURE ENVIRONMENTS OF MAN — EXTERNAL AND INTERNAL

OBJECTIVE:

After studying this experience, the student will have a better understanding of his likely future environment.

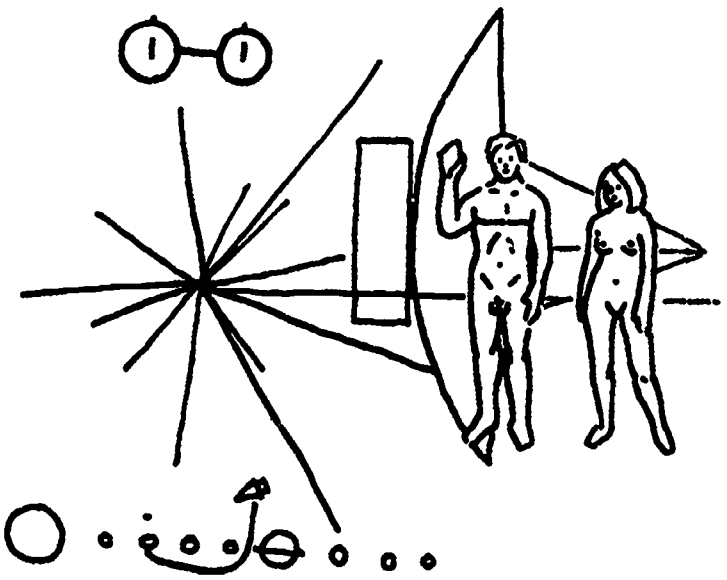
Teacher's Note:

Before performing the activities included in this experience, the teacher should make copies of the following reading material and distribute them to the students. This information can be given as home work, or it can be read in the class in about 15 minutes. It is also advisable for the teacher to show a film about some of our future technology (laser, computer, space travel).

The teacher, of course, may use only portions of this reading material or even make deletions or additions.

FUTURE ENVIRONMENTS OF MAN — EXTERNAL

Predicting the future development and environmental effects of a complex subject such as modern technology becomes progressively more difficult as the date in question gets more remote from the present. One especially difficult problem is the "instant" nature of technological change. It is a matter of documentation that the very year the Wright brothers were building the first successful airplane in Dayton, significant numbers of their fellow Americans were sure man would never fly. There are people at present who believe man's journey to the moon was an elaborate hoax staged in a television studio somewhere. The following discussion is meant only to suggest the immense changes that will certainly lie in the future. The technological event of the future is the (some believe inevitable) first meeting between Earthian and alien technologies. The mathematical probability of a humanly habitable planet within 22 light-years of the earth was recently calculated. It turned out that the chances for there being such a planet were good. Perhaps you've read or thought about alien encounters. Would such a confrontation cast the aliens as the Iroquois and us as the Erie in a replay of that technological mismatch? Perhaps, by the time a culture gains the technological expertise to traverse great distances in space, it will automatically treat the other life it meets with respect. Two things are sure about such a meeting: it will unite the people of the earth as never before, and it will change our technology (presuming it survives) radically. Some thought and effort are now being expended toward that day. The accompanying illustration shows a plaque that was sent on a deep-space probe from Earth in March, 1972. The intent of the mission is to send back information concerning the planet Jupiter, but the probe, after completing that chore, will continue into space outside our solar system. The plaque is designed to inform aliens about our planet's position and about ourselves.



PIONEER 10's PICTORIAL GREETING

This pictorial greeting to interstellar beings was carried away from earth by the space vehicle Pioneer-10, launched by the United States on March 2, 1972. Pioneer-10 reached Jupiter in December, 1973, and after investigating that planet streaked out into interstellar space. It is the first man-made object designed to escape from our solar system.

The message is etched on a gold-anodized aluminum plaque, 152 by 229 millimeters, attached to the craft's antenna and protected against erosion by intersteller dust.

The radiating lines at left represent the positions of 14 pulsars (cosmic sources of radio energy) arranged to indicate our Sun as the home star of the launching civilization.

At the ends of the lines are binary numbers that represent the frequencies of the pulsars at the time of launch, relative to that of the hydrogen atom shown in two states at upper left with a "1" unity symbol. The energy difference between the two states

provides the most precise standard of time known to science. The hydrogen atom, the most abundant atom in the universe, is thus used as a "universal clock," and the regular decrease in the frequencies of the pulsars may enable another civilization to determine the time that has elasped since the launching.

The figures at right are in proportion to the size of the spacecraft and represent the type of creatures who created it. The man's hand is raised in a gesture of good will.

Across the bottom are the planets, ranging outward from the Sun, with the spacecraft trajectory arching away from Earth, passing Mars and swinging by Jupiter.

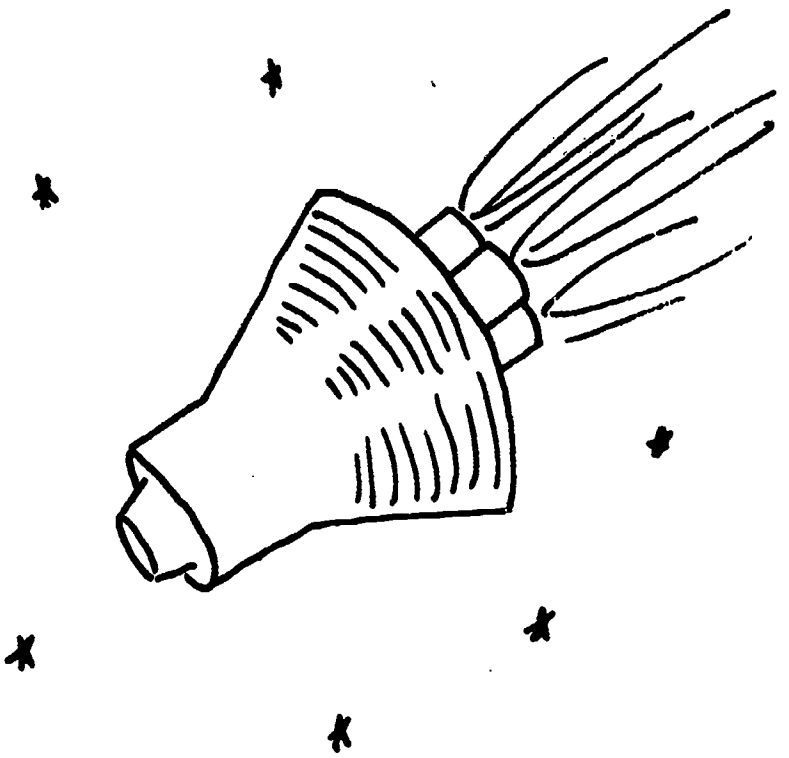
Even if we knew the exact location of extraterrestrial civilizations, the present level of our space-travel technology would not allow us to reach them. Some science fiction, like *2001: A Space Odyssey*, and some non-fiction, like *Chariots of the Gods*, is based on the idea that extraterrestrials have been participating in our development for centuries. Although our space technology cannot now reach much beyond Mars and has carried men only to the moon, we have used it to surround the whole earth, for the first time, in a man-made environment. This web is made of satellites, artificial moons, carrying men or electronic extensions of their senses. Originally exploited for military spying, space technology is offering us an unprecedented opportunity to learn about and plan for the earth. As Marshall McLuhan, communications philosopher, has remarked, "For the first time, we can regard the earth as a work of art."

We have been able to wrap the earth in a communications network using these satellites. Using them as telescope platforms, we can learn much about space; as camera platforms they can help us learn more about our own planet. Pictures from the U.S. space program are available.

The future expansion of space technology might include the exploitation of phenomena such as weightlessness and natural space-vacuum for medical or industrial purposes. Imagine space "hospitals" in which patients' healing and recuperation could be aided by the ability to manipulate gravity. Schemes such as this await a practical way to shuttle people and materials from surface to orbit.

Space travel does not seem to be in the immediate future, although there are a number of plans for expeditions to Mars if the benefits seem to outweigh the costs. The past effort to send men to the moon engaged the interest and excitement of the world, but the next effort, at least for the coming decade, will very likely be to consolidate the gains from Earth-Moon travel and satellite technology to apply to terrestrial problems.

Manned space travel within our solar system would require enormously powerful engines and elaborate life-support systems. Increasingly sophisticated unmanned probes, such as the Mariner series and the Pioneer series (one of which carried the message to aliens), are able to send back great amounts of information, including TV pictures, to Earth. Arthur



C. Clarke, who wrote *2001: A Space Odyssey*, contends that exploration beyond the Earth is the most significant event in human history and that the trip will ultimately benefit not only technology but the human condition generally. Clarke's ideas in *Voices From the Sky* make interesting reading. Others see us "kneedeep in garbage, firing rockets to the moon" and deplore the expenditure of funds on unearthly projects while our earthbound problems multiply. Perhaps the question goes back to one of man's ultimate perfectability. Are we really "striving upward," or are we doomed to remain a "planetary disease" which will finally kill its host and itself?

We are already altering the total earthly environment through several means. There is worldwide circulation of pollutants in the air and water which is not only detectable on the surface but visible from earth orbit. There is a concern that carbon dioxide, put into the atmosphere in massive amounts by the production and use of energy, will increase the insulative properties of the atmosphere, triggering large-scale changes in the earth climate.

The future external environment of man will be even richer in information than at present. Non-verbal means, speech, pictures, writing, reproduction printing, telegraphy, telephone, movies, radio, and television are the communications "media." They are the means by which man communicates information. A media explosion has occurred within the last century with the rise of electronic communications. The nature of a new communications medium has, by itself, a tremendous impact on a culture that adopts it. Since television is multisensual, it is more involving than a monosensual medium. Hence, TV has created a generation (whether in the United States, France, or Japan) which has more in common than its parents ever could have had. There are strong implications here for the future of nation-states. Indeed, McLuhan has coined the term "global village" for the all-pervading information flux we live in. In the future, the coaxial cable may make a number of services possible to us, such as shopping,

working, or selecting the movie of our choice through 2-way cable TV (CATV).

One more device that deserves mention is the laser. It produces an extremely intense beam of light. Research is now underway that would use this device for two kinds of communications. One involves the transmission of messages long distances by laser beam. The other is holography, a new technology which produces 3-dimensional photography using a double laser beam. The production of 3-dimensional television or movies, into which the viewer could step, would be a different kind of medium indeed.

Urbanization, as a trend, is widely expected to continue. There are presently developing three "megalopolises" in the United States. Futurists have even come to suggest names for them. There may be, by the year 2000, houses and streets stretching from Boston to Washington (BOSWASH), from Chicago to Pittsburgh (CHIPITTS), and from San Francisco to San Diego (SANSAN). These aggregations are growing partly by population increase, partly by the migration of employers and employees to them, and partly by suburban sprawl. Suburban sprawl is the immigration of city people outward to homes that take up more space than formerly. One interesting offshoot of this urbanizing trend is the thinking that has gone into "building" land in the sea. Platforms such as those now used by oil companies for offshore drilling could be the bases for whole cities. Buckminster Fuller has suggested an enormous floating dome which would house a town and could even be towed to different locations. Such a community would be in a unique position to exploit the resources of the ocean, including energy. (Far out question: Could the future of our culture depend on teaching the crowded Orientals our sea-platform technology?)

How will man move about in the future? The transportation technologies demonstrate a fascinating struggle to overcome friction on the one hand and to apply greater force on the other. Future indications point to more development of energy-efficient modes of transportation. This would mean the use of more mass-transit, smaller and perhaps electric-powered vehicles, and more dependence on bicycling and walking. In the air, vertical-take-off-and-landing planes might be used for short hops (to avoid using great amounts of land for airports). Supersonic passenger travel and rocket travel seem a long way off, partly because of the tremendous cost in energy, partly because we may be approaching a limit to the rate at which people can go dashing about, due to logistics on both ends. It now takes almost as long to drive to the airport as it does to fly great distances.

The acceleration in the pace of life and the rate at which change occurs do not seem to be slowing down much. Some of these changes will directly affect our bodies and our minds, the internal environment, and that is what the next section is all about.

THE FUTURE ENVIRONMENTS OF MAN — INTERNAL

Have you ever stood between two mirrors? Perhaps you were amused by the endlessly repeating reflections of you and your surroundings. We have said that man's technologies are a response to the environment and in turn, have altered it. Our altered environment then reflects back on us to work changes in our internal environment, which prompts other technological changes, and so on.

It is a well-documented fact that you are, on the average, larger than your parents. The same can be said for your generation almost worldwide. The age of menarche (sexual maturity) in females has been declining in Europe and the United States for many years. These internal changes can be laid almost directly to technology's ability to produce an environment that fosters such growth and maturation. These trends are long term and what the effects will be we do not yet know. (They must level off sometime, of course.) Let's identify some other ways that technology affects the internal environment and speculate on them.

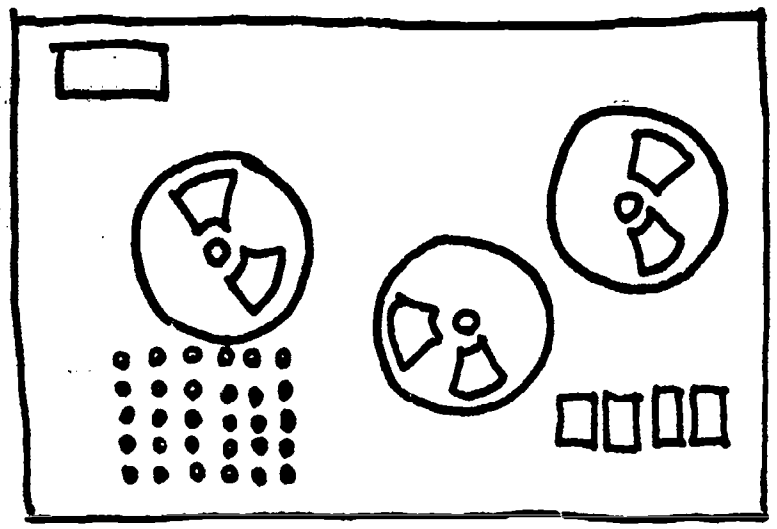
The almost universal cigarette smoking of the last forty years in this country was made possible partly be the large-scale production of cigarettes and partly by the massive punch of media advertising. This use of tobacco, it has been well documented, has led to high rates among our population of lung cancer, emphysema, and other respiratory tract illnesses. We could make much the same point about air pollution in our larger cities. No one would defend, we hope, the point of view that these are "acceptable" prices to pay for our technology. In the future, we must find ways to avoid public health nuisances stemming from technology. What steps are being taken to eliminate the threat to the upper respiratory tract represented by cigarette smoking and air pollution?

Our technological achievements, on the other hand, have made such positive contributions as the availability of physical comfort unequalled in human history, medical care, and clean food and water. Travel and other educational opportunities made possible by technology can benefit us greatly.

Some changes in the internal environment are conscious and direct. When a doctor uses a heart-lung machine or an electroencephalogram, he is putting technology to work for the good of a patient's internal environment. Drug taking is another example of a conscious attempt to alter the internal environment and, sometimes, the external performance of man. The ways in which we manipulate our own bodies in order to change their internal state, whether by organ transplants or by taking mood drugs, will probably increase in the future.

Man and Machine Together

You probably know someone who wears a hearing aid. These devices electronically amplify environmental sound for the benefit of the hard-of-hearing. This little bit of technology makes life somewhat easier than it would have been. Another small



electronic device, the pacemaker, makes life possible, period. It electronically stimulates the heart muscle to contract at certain intervals eliminating the chance for a malfunction to bring on a fatal heart attack. "Cyborg" is the name futurists have coined to refer to man-machine linkups. How far can the mating of man and machine go?

It is already possible to tap into certain areas of the brain and by their electrical stimulation to achieve predictable responses. We can reverse the procedure and receive electrical brain-waves which indicate the general mind-state of the subject. The direct linkage of the human brain, with its portability and storage capacity, to a computer, with its speedy manipulation of data, is still in the future. (See *The Terminal Man* by Michael Crichton listed in the references.)

The use of large machines as extensions of man's body is well known. Each time you drive a car, you become a kind of cyborg, tying your muscular, respiratory, and information systems into those of the automobile. Drive-in restaurants, theaters, churches, and banks are support systems reinforcing this cyborging process. In a totally hostile environment, such as outer space, cyborging is necessary for survival. The space suits that astronauts wore on the moon represent self-contained human environments which allow great freedom of movement, sort of like a mechanical mother.

Manipulating Human Reproduction

Reproduction of a species is a biological function, which formerly only the process of evolution affected. Due to chemical ("the pill") and physical forms of contraception, we can stop reproduction when circumstances dictate. The availability of contraceptive devices has had a profound effect not only on the women and men who have used them, but also on the world environment. The science of biology is producing procedures and substances which promise even greater impact.

1. In the future, it may be possible for a woman to buy a quick frozen fetus and have it implanted to develop within her.
2. Using the same surgical and culture techniques, it may be possible for her to pay a surrogate mother to bear a child which would be genetically hers. Fetus transplants have been successfully done in sheep.
3. Using almost available technology, we could offer couples the option of choosing the sex of their child. We can almost guarantee the sex of an artificially inseminated calf at present.
4. It is not yet possible to "grow" babies inside glass bottles, but the technology needed is growing bit by bit. When this does become possible, a lot of options will be open.
5. Given a minutely-controlled environment, we could combine genetic and envrionmental factors (high or low oxygen, sugar, protein, etc.) to produce geniuses or subnormal humanoids.
6. Probably the ultimate manipulation is cloning. In theory, any cell in your body has the necessary information to produce another you. In practice, however, muscle cells only produce other muscle cells, liver cells produce liver cells, and so on. In embryological development your cells lost this total reproduction capacity. We know now that it is possible to "unlock" chemically this potential of your body cells. In the future, if we acquire the skills and equipment necessary to grow babies, we could produce from a single cell hundreds of individuals, all as completely alike as identical twins.

Advertising: Affecting the Internal Environment for Fun and Profit

When Eli Whitney invented the cotton gin, there was a crying need for such a device. Many man-hours were then being spent laboriously picking the seeds out of cotton bolls. There was a demand that Whitney learned of and was able to supply with his new invention. In our modern times, a product can be invented, and a demand for it can then be produced by advertising. We mentioned watching a TV program as a way you can choose to alter your internal environment. But advertising on TV can alter it without your choice by carefully presenting packages of information about products or services that are for sale. Where do you get most of the information about products or services that are for sale? Where do you get most of the information about things that you buy? Does it come exclusively from advertisements produced by the company which makes the product? At present, advertising supports the media by using their educational/entertainment capability to sell more products. Perhaps a TV show you particularly liked has been taken off the air because it did not sell well enough. The subtle persuasion techniques of advertising and the media time they use can also be used for political purposes.

George Orwell's *1984* and Aldous Huxley's *Brave New World* are views of the future in which not only communications technology but also medical technology are used to produce an inhuman environment.

ACTIVITY A:
After completing the reading, begin the class discussion with the following questions:

1. Can you name some technological advances which might have profound effects upon man's life and his world? List and discuss several.
2. What possible advances might be very effective? How might they affect me? What might they mean to me? Make a board and put on it clippings about new discoveries and the direction in which they might develop in the future.
2. What possible advances might be very effective? How might they affect me? What might they mean to me? Make a board and put on it clippings about new discoveries and the direction in which they might develop in the future.
3. What might happen to man as a result of these achievements?:
   a. landing on the moon
   b. invention of the laser
   c. advancement in computer technology

Teacher's Note:
Assign some readings to the students from the bibliography at the end of the unit.

ACTIVITY B:

1. Divide the class into groups and ask them to research and report on the follow topics:
   a. using computers in our personal lives
   b. populating other planets (exporting Earthlings to other, desolate planets)

Teacher's Note:
Assign and suggest some of the reading materials in the bibliography.

ACTIVITY C:

1. On a map of Ohio, identify future megalopolises. What parts of the state lie within the future CHIPITTS? Is your town a part of this swath? Identify areas near your town that are presently "developing." Your teacher can help you with this.
2. Spend a day in a big city. Take pictures and record the sounds of it. Ask your family and friends beforehand what there is to fear there (crime, smog, traffic, nameless dread). After your visit, discuss the possibilities of you living there. Do you think this likely? Did you encounter any of the dangers you were warned about?
3. Go to a grocery store and find the origins of as many items as possible. After doing this, use a map of the world or the United States and stretch string from those points to your town, using pushpins.

Materials: Map of Ohio, United States, and the world.

ACTIVITY D: "FUTURE SHOCK"

View the film *Future Shock.*

Discuss this film in relation to the impact of the future on our personal lives. Psychological, social, and environmental considerations are superbly treated as they apply to the biolgical and physical quality of life.

This film should be previewed by the teacher before showing. It has a number of controversial sections, but this film is one of the best means of starting off this type of experience. It could be the first activity for this experience.

Let the discussion flow, but be prepared for values clashes and do not impose values. It tends to limit severly any open dialogue if the students feel you have a bias.

Listen to the record "In the Year 2525" by Zaeger and Evans.

This record is a popular song recording of what the future will be like in this year. It could provoke a good discussion.

ACTIVITY E:
DECISION MAKERS FOR THE FUTURE

Conspire with a colleague(s) or organize the class to provide some experience which will provoke feelings, insight, or discussion about how our future could be manipulated, shaped, and even controlled.

1. Have a volunteer dressed in some wild costume go for a walk, and have an interview team follow secretly behind to record other's reactions.
2. Have a group from the entire class dress indentically or uniformly in some way to raise comments from their classmates.
3. Have another teacher come into the class and drag a student out who is kicking and screaming. You protest this brutality but finally shrug it off after some superfluous explanation from the other teacher. The student involved better be informed ahead of time. This same version could be changed to having yourself dragged out over your protests.

Follow-up discussions (depends upon your presence or absence):

What were your thoughts during this process?
Why didn't you do anything about it?
What did you think was happening to the victims?
What emotions and fears overruled your actions?

Discuss classics such as *1984* and *Brave New World.*

ACTIVITY F: CREATING YOUR OWN FUTURE

Lead a discussion on what factors make decisions for the individual which program his future. Make a list of all these factors with the class.

School bells
Peer pressures
Social pressures
Threats
Security
Fear
Ignorance
Blind belief in authority

Make a group decision to create your own future. Brainstorm this and discuss it prior to action. Consider the consequences of creating your own

future. This becomes a good values clarification exercise.

Anything new or different which is decided upon will create the future. The plan should be one which has some consequences, but be careful not to get carried away to the point where this becomes a high threat experience. There is an exhilaration involved with creating your own future that stimulates creativity and is a huge motivational influence once a decision has been made.

Possible activities migh be these:

Ignore school bells, substituting a constructive activity.
Demonstrate against a polluter.
Carrying a placard in support of a cause.

Discussion:

Is it really possible to create your own future?
What are the consequences of creating your own future?
Is creating your own future important?
What environmental impact does creating your own future have?
Are your values and others' important to consider in creating your own future?
Is only your future involved?
If you do not create your own future, who will?
Is the automobile an example of how someone else created our future?

ACTIVITY G: DEATH AND FUTURE

Discuss how we view the future in relation to how it affects our present. If we know we had only one year to live, what would we do (action)

for ourselves?
for our friends?
for our family?
for the community?
for the country?
for the world?

Rank these in the order for which you would concentrate the most time and energy.

ACTIVITY H: DEBATE TEAMS

Have the class form debate teams and, in the spirit of debate competition, choose from futuristic topics a focal point for debate.

Cloning and other genetic programming
National defense
Euthanasia
Birth control
Cyrogenics for the dead
Space travel
Green Revolution
Alternative energy sources

ACTIVITY I: VALUES AND OUR FUTURE

Rene Dubos has stated that we have the technology to feed a growing world population at the sacrifice of almost every square foot of wilderness. We will have all creature comforts but no woodlands, flowering fields, wildlife, or nature. Solitude and nature will become rare and possibly extinct.

Compare and discuss the two columns relative to the future:

solitude
work/leisure
privacy
creativity
psychological outlooks
family
medical research
  transplants
  cancer
genetic programming
advanced technology
agricultural technology

Discuss statements like these:

If we have to go, it might as well be first class.
Man is an endangered species.
Cockroaches or dolphins will carry on the process of civilization.

ACTIVITY J: CREATING A COMMUNITY OF THE FUTURE

This could be a culminating research experience which could involve a rather lengthy and involved process. Again, it has options of being a short or long-term project.

Research:
Energy flow in a community
Environmental impact and quality
Limits to growth
Basic ecological principles

Possible prototype communities are discussed in the following resources:

Limits to Growth by Meadows
Design With Nature by McHarg
Blueprint for Survival by Goldsmith
Survival Manual for Spaceship Earth by Fuller

Make certain that all aspects of community life in the future are considered. It may be possible to construct a model community from building materials, depending upon interest and time.

Things to consider (very incomplete list):

recycling
energy source and flow
food production
use of time
division of labor
government
environmental quality
waste disposal
jobs
housing
space
transportation
communication
research and development

ACTIVITY K:
GRAFFITI POSTER ON FUTURISM:

Have the class add graffiti to a large sheet of paper which starts with this statement: In the year 2050 there will (will not) be _____.

Don't forget to discuss the journal started at the beginning of the unit.

APPENDIX A:

REPRINTS

The "Environment" reprints listed below are available from *Scientific American*, and they can be ordered from the following address:

Scientific American
415 Madison Avenue
New York, New York 10017

Aaronson, Terri, "World Priorities." July-August, 1972. The developing nations want a piece of the technology action to improve their standard of living.'

Berlin, Edward and Paul P. Craig. "The Air of Poverty." June, 1971. Public health effects of 500 million pounds of lead put into the air yearly in automobile exhaust.

Commoner, Barry. "Soil and Fresh Water: Damaged Global Fabric." April, 1970.

Corr, Michael and Dan MacLeod. "Getting it Together." November, 1972. Communes are a form of modern life-style which seems to be energy and materials efficient.

Edel, Matthew. "Autos, Energy and Pollution." October, 1973. How our cities get to be dominated by cars.

Environment Staff. "Fast Trains." April, 1973. High speed passenger railroads are competing with aircraft and autos in Europe and Japan.

Fay, James A. and James J. Mackenzie. "Surveying Highway Impact." November, 1972.

Hedgpeth, Joel. "The Oceans: World Swamp." April, 1970. Resources of the ocean threatened by pollution.

Hoehnemser, Kvet. "Aircraft in the Balance." December, 1971. Vertical and short take-off aircraft.

"Last Year of Deauville." July-August, 1971. Your chances of getting sick at many European beach resorts are doubled if you go in the water.

"A Life for the Auto." December, 1971. A report on the progress of flywheel technology.

McCaull, Julian. "A Broader View." June, 1972. A profile of a physician who looks to broader environment as a cause for disease.

McCaull, Julian. "Building a Short Life." September, 1971. Public health hazards of cadmium in the environment.

Noviek, Sheldon. "Looking Forward." May, 1973. Recommended as a synopsis of environmentalist hopes for the future.

Peterson, Eugene K. The Atmosphere: A Clouded Horizon." April, 1970. Human activities will affect future climate.

Squires, Arthur M. "Clean Power from Dirty Fuels." October, 1972.

Stein, Richard G. "A Matter of Design." October, 1972. How to cut down on the inefficient use of energy and materials with a more rational architecture.

Tuck, James A. "The Iroquois Confederacy." February, 1971.

Tzu, Raphael. "High Technology in China." December, 1972.

Wallace, Robert Keith and Herbert Benson. "The Physiology of Meditation." February, 1972. Humans can radically affect their internal environments witout the use of technology.

Wiess, Jay M. "Psychological Factors in Stress and Disease." June, 1972. The stress resulting from psychological factors can open the body up to disease.

Westing, Arthur and E. W. Pfeiffer. "The Cratering of Indochina." May, 1972. These two articles (accounts) detail the destruction wrought on the human environment of Southeast Asia, mostly American weapons technology.

Wilson, S. S. "Bicycle Technology." March, 1973. A human on a bicycle is among the most efficient of energy users.

York, Herbert F. "Multiple-Warhead Missiles." November, 1973.

Young, Vergnon R. and Nevin S. Scrimshaw. "The Physiology of Starvation." October, 1971. What happens when you skip breakfast . . . and lunch . . . and dinner.

APPENDIX B:

COMIC BOOKS

Much fiction has been written concerning technological change, history, and the future. Imaginative teachers and interested students should use it to suggest ideas for discussion. These books can be found in most school libraries, or, in the Classics Illustrated comic book versions. The latter offer a quicker, and perhaps more entertaining, introduction to new ideas.

A Connecticut Yankee in King Arthur's Court is Mark Twain's classic of a 19th century man transported back in time to medieval days. The hero's "advanced" technology makes an impressive showing, but he's still human, after all.

20,000 Leagues Under the Sea is Jules Vern's story of 19th century adventurers who stumble into a world of advanced technology. They are taken on an undersea voyage on Captain Nemo's atomic sub, *Nautilus*.

The Conquest of Mexico, by Bernal Diaz do Castillo, is an eyewitness account of this great technological mixing. The encounter was staggering for both sides and can be fascinating for us.

The above may be ordered from Classics Illustrated, Dept. S, 101 Fifth Avenue, New York, New York 10003.

REFERENCES

BOOKS:

Caudill, Harry. *Night Comes to the Cumberlands.* Boston: Little. Brown and Co., 1963. This book is especially recommended because it details the growth of the exploitation of the coal in the Cumberland region of the Appalachians.

Clarke, Arthur C. *Lost Worlds of 2001.* New York: New American Library.

Farb, Peter. *Man's Rise to Civilization.* New York: E.P. Dutton and Co., 1968. Surveys beautifully the development of American culture, including technology.

Forbes, R.J. *The Conquest of Nature.* New York: Praeger Publishing, 1968. Especially relevant is section one, "Man and Machine." It provides a good summary of the history of technology.

Kroeber, Theodora. *Ishi in Two Worlds.* Berkley: University of California Press, 1967. A poignant story of the last wild Indian in California. Some excellent analysis of Ishi's reactions to European technology.

Mesthen, Emmanuel. *Technological Change: Its Effect on Man and Society.* Cambridge: Harvard University Press, 1970. A good survey of current thinking on technological change and its assessment.

Stadler, John (Ed.). *Eco-Fiction.* New York: Washington Square Press, 1971.

Wells, H.G. *War of the Worlds.* New York: Airmont Publishing Co., 1964. Gives a perspective on what it must be like to encounter a superior technology.

PERIODICALS:

Bordaz, Jacques. "Flint-Flaking in Turkey." *Natural History.* February, 1969. A look at a flint-using technology still being practiced.

Brant, Lynwood. "Rudolph Diesel and His Rational Engine." *Scientific American.* August, 1969.

Calder, Lord Ritchie. "Conversion to the Metric System." *Scientific American.* July, 1970. A future change now no longer in doubt.

Chinitz, Wallace. "Rotary Engines." *Scientific American.* February, 1969.

Chisolm, J. Julian. "Lead Poisoning." *Scientific American.* February, 1971.

Cole, David E. "The Wankel Engine." *Scientific American.* August, 1972.

Commoner, Barry and Paul T. Stamler. "The Causes of Pollution." *Environmental Magazine.* April, 1971. It is an excellent review article about the effects of modern technology on the general environment.

Darlington, C.D. "The Origins of Agriculture." *Natural History.* May, 1970. It is an overview of this important phase in the evolution of technology.

Dudrick, Stanley J. and Jonathan E. Rhoads. "Total Intravenous Feeding." *Scientific American.* May, 1972.

"East is a Big Bird." (Parts I and II.) *Natural History.* April and May, 1970. This gives valuable insights into the navigational technolgies of South Pacific peoples, who perform amazing feats of navigation without map, sextant, or compass.

English, Richard D. and Dan I. Bolef. "Defense Against Bomber Attack." *Scientific American.* July, 1973.

Feit, Harvey A. "The Twilight of the Cree Hunting Nation." *Natural History.* September, 1973. Details the decline of a modern Amerindian hunting society.

Ferguson, Eugene S. "The Measurement of the Man-Day." *Scientific American.* October, 1971. What constitutes an "honest day's work"?

Friedman, Theodore. "Prenatal Diagnosis of Genetic Disease." *Scientific American.* November, 1971. It is becoming possible to predict some human abnormalities.

Galston, Arthur. "Attitudes in Acupuncture." *Natural History.* March, 1972. Details the response of American physicians to a medical technology beyond their experience.

Galston, Arthur. "The Immortal Carrot." *Natural History.* April, 1972. Deals in a whimsical way with the history of agriculture.

Garwin, Richard L. "Antisubmarine Warfare and National Security." *Scientific American.* July, 1972. It might be best if we and the Russians don't learn too much about the subject.

"The Global Circulation of Atmospheric Pollutants." *Scientific American.* January, 1971.

Gruss, Daniel R. "The Great Sisal Scheme." *Natural History.* March, 1971. It tells how natives were recruited to take part in a technological enterprise that fell through.

Hamilton, William F. and Dana K. Wallace. "Systems Analysis of Urban Transportation." *Scientific American.* July, 1969. Mostly about PRT (personal rapid transit) systems.

Hauser, Phillip M. "The Census of 1970." *Scientific American.* July, 1971.

Holm, Henry H.and Richard D. Thornton. "Electromagnetic Flight." *Scientific American.* October, 1973. Tracked travel for wheeled vehicles has just about reached its limit in speed. Electromagnetic flight offers possibilities for a more friction-free mode of land travel.

Howard-Jones, Norman. "The Origins of Hypodermic Medication." *Scientific American.* January, 1971.

"How Ideology Shapes Women's Lives." *Scientific American.* January, 1972.

Icky, Jacques. "The Great Automobile Race of 1895." *Scientific American.* May, 1972. This event shaped the future of automobile development for years.

Kaufmann, Manfred. "The Sling as a Weapon." *Scientific American.* October, 1973. An early weapons technology. Crude, but effective.

Kermode, G.O. "Food Additives." *Scientific American.* March, 1972. Do the substances we add to food to preserve or enhance it harm humans who eat the food?

Knox, William T. "Cable Television." *Scientific American.* October, 1971. Discusses the possibilities for using 2-way TV.

Kozak, Vladimir. "Stone Age Revisited." *Scientific American.* October, 1972. Complete directions for making a stone axe.

Langer, William F. "Checks on Population." *Scientific American.* February, 1972.

MacLeish, Kenneth and John Launois. "Stone-age Men of the Phillipines." *National Geographic.* August 1972.

McKusick, Victor A. "The Mapping of Human Chromosomes." *Scientific American.* April, 1971.

McVay, Scott. "Can Leviathan Long Endure So Wide a Change?" *Natural History.* January, 1971. It touches on the history of whaling technology, as well as on present-day methods and their effect on an important marine resource.

Miller, Patrick M. "The Crashworthiness of Automobiles." *Scientific American.* February, 1973.

Murray, Bruce J. "Mars from Mariner 9." *Scientific American.* January, 1973.

Odum, Howard T. "A Printout of the Future Systems of Man." *Natural History.* May, 1971. A well-known ecologist speculates on the materials and energy cycling in the future.

"The Prospects for a Stationary World Population." *Scientific American.* March, 1973.

Scientific American. September, 1972. The whole issue is devoted to the subject of communication.

Scientific American. September, 1973. The whole issue deals with technologies involved in healing the internal environment.

Schwartz, Mark, Ph.D. "How Efficient is Mechanised Agriculture?" *Organic Gardening.* October, 1973.

Schools participating in the pilot progr. · :tween February 1, 1974 and March 31, 1974

Akron City Schools
- Buchtel High School
- North High School
- Goodyear Junior High School
- Jennings Junior High School
- Kent Junior High School
- Perkins Junior High School

Chardon Local Schools
- Chardon High School
- Chardon Middle School

Cleveland Diocesan Schools
- Byzantine Catholic High School
- Cleveland Central Catholic
- Cathedral Latin High School
- Lake Catholic High School
- Notre Dame Academy
- St. Edward High School
- St. Joseph Franciscan School
- St. Justin Martyr
- St. Mary School
- St. Michael School
- St. Patrick School
- St. Richard School
- St. Rose School
- Trinity High School

Cleveland Heights/University Heights City Schools
- Heights High School
- Monticello Junior High School

Columbus City Schools
- Central High School
- Eastmoor Senior High School
- Linden McKinley High School
- Mohawk Senior High School
- North High School
- Eastmoor Junior High School
- Everett Junior High School
- Linmoor Junior High School
- Starling Junior High School
- Yorktown Junior High School

Euclid City Schools
- Euclid Senior High School
- Forest Park Junior High School
- Shore Junior High School

Geneva Area City Schools
- Geneva Area Senior High School
- Geneva Area Junior High School

Kirtland Local Schools
- Kirtland High School

Ledgemont Local Schools
- Ledgemont High School

Madison Local Schools
- Madison High School
- Memorial Middle School
- Red Bird Middle School

Mayfield City Schools
- Mayfield High School

Painesville Local Schools
- Riverside High School

Perry Local Schools
- Perry High School

West Geauga Local Schools
- West Geauga Junior High School

Willoughby-Eastlake City Schools
- North High School
- Kennedy Junior High School
- Willowick Junior High School

Youngstown City Schools
- North High School
- Haynes Junior High School
- Hillman Junior High School
- Princetown Junior High School

CONSULTANTS:

Albert Acierno, Teacher
Columbus City Schools
Columbus, Ohio

Charles Koelling, Teacher
South High
Willoughby-Eastlake City Schools
Willoughby, Ohio

David Yanchunas, Teacher
Chardon High
Chardon, Ohio

Alice Holly, Teacher
Marion Franklin School
Columbus, Ohio

Elliot Ross, Asst. Principal
Lincoln Junior High
Cleveland City Schools
Cleveland, Ohio

Vernon Bowman, Asst. Superintendent
Chardon Local Schools
Chardon, Ohio

Kenneth Wulff, Professor
Kent State University
Kent, Ohio

Robert McNemar
Science and Mathematics Director
Columbus City Schools
Columbus, Ohio

Dr. Herbert Coon, Professor
The Ohio State University
College of Education
Columbus, Ohio

Dr. Robert Roth, Assoc. Professor
School of Natural Resources
The Ohio State University
Columbus, Ohio

Ruth Melvin, Geologist
Ohio Academy of Science
Columbus, Ohio

Alan M. Voelker, Assoc. Professor
Science Education
Northern Illinois University
DeKalb, Illinois

William Stapp, Professor
School of Natural Resources
University of Michigan
Ann Arbor, Michigan

Dean Freund, Director
Environmental Education
Worthington City Schools
Worthington, Ohio

Dr. Craig Chase, Professor
Environmental Education
Slippery Rock State College
Slippery Rock, Pennsylvania

Gary Rudolph, Teacher
Cleveland Central Catholic High
Cleveland Diocesan Schools
Cleveland, Ohio

Jeff Wilson, Teacher
Riverside High
Painesville, Ohio

Sister Mary Kendra, Teacher
Notre Dame Academy
Chardon, Ohio

Dr. Chris Bartlel, Director
Institute of Environmental Studies
Miami University
Oxford, Ohio

Dr. Bill Gordon, Assoc. Professor
Department of Education
Miami University
Oxford, Ohio

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