Implementation and evaluation of the NESA program at Glacier National Park, Montana
by David Vernon Petticord

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Earth Science
Montana State University
© Copyright by David Vernon Petticord (1975)

Abstract:
The National Environmental Study Area (NESA) program was instituted by the National Park Service in 1968 to make the natural and cultural resources of the National Park System formally available to the nation's educational community, Glacier National Park's participation in the program began in 1970. Central to the program has been the selection of environmental study areas, called NESA sites, to be used by students from local schools for environmental study in the park.

The educational objectives of the program were formulated by the National Park Service and the National Education Association. Of primary concern in implementation of Glacier’s NESA program was the means of meeting these objectives to provide the student with an effective environmental education experience. Considerations included selection of NESA sites that had viable educational potential, development of instructional activities relevant to out-of-classroom learning in the sites, preparation of teacher resource information materials, and teacher orientations providing useful insights into NESA site utilization.

After selection of NESA sites in 1970, the first NESA teacher workshop was held in 1971 with Columbia, Falls School System. This resulted in occasional use of park NESA sites by teachers of this school system. The need was then recognized to promote full-scale interest in and awareness of the program in the entire park locale. This was accomplished through various means and respited in a pilot NESA program involving the Whitefish and Kalispell school systems.

The findings of the study, based on the pilot program and questionnaires completed by participating teachers, indicate that the most relevant type of instructional activity is based on inquiry methods. The two methods found to be effective were student analysis of study plots and random exploration of NESA resources under the guidance of a teacher or parent. Findings also indicated that small, informal teacher orientations were preferred over large, and lengthy formal workshops; and that the field aspect of the orientations provided the teachers with the most useful insights into NESA utilization. The study also indicated that teacher resource information materials needed improving to provide more detailed information on resources of the NESA sites. Finally, the study provided insight into definition of the respective roles of teachers and resource persons in the NESA program, determining that the role of the resource person is to provide information to teachers on NESA resources, and that the teachers provide instruction to their classes at the sites.
STATEMENT OF PERMISSION TO COPY

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at Montana State University, I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by my major professor, or in his absence, by the Director of Libraries. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Signature [Signature]
Date 2/22/75
IMPLEMENTATION AND EVALUATION OF THE NESA PROGRAM
AT GLACIER NATIONAL PARK, MONTANA

by

DAVID VERNON PETTICORD

A thesis submitted in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE
in
Earth Science

Approved:

John Montagne
Chairman, Examining Committee

Milton J. Edie
Head, Major Department

Henry L. Parissone
Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

March, 1975
ACKNOWLEDGMENTS

I wish to express my gratitude to Dr. John Montagne for his supervision and counsel as my committee chairman. Thanks go also to Professor M.J. Edie, Head, Department of Earth Science, and to Dr. Joseph Ashley and Dr. Gregory Stefanich for their service as members of my committee.

Special thanks go also to the principals and teachers of L.A. Muldown, Peterson, and Edgerton Elementary Schools who participated in the NESA pilot program and completed teacher questionnaires.

And credit is also directed to members of the Glacier National Park Interpretive Staff, including Edwin Rothfuss, for manuscript review; and Roberta Seibel, for her contributions to preliminary teacher's guide materials.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>vi</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
</tbody>
</table>

## Chapter

### I. INTRODUCTION
- Statement of the Problem  
- Study Methods and Procedure  
- Limitations  
- Definition of Terms  
  
### II. REVIEW OF LITERATURE
- Environmental Education Legislation and Objectives  
- The Meaning of Environmental Ethic  
- The Land as a Focus of Environmental Study  
- Environmental Study Areas and Related Programs in the United States  
- Montana Public School Programs  
- General Factors Involved in Utilization of Environmental Study Areas  
  
### III. NESI PROGRAM IMPLEMENTATION
- Pre-NESI Activities--1968-1970  
- NESI Site Selection  
- Promoting Awareness and Interest in the NESI Program  

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>22</td>
</tr>
</tbody>
</table>
Chapter Page

Pilot Programs 23
Preparation of Teacher NESA Guide Materials 24

IV. NESA PROGRAM EVALUATION 27
Results of School Questionnaire, L.A. Muldown Elementary, Whitefish 28
Results of Questionnaire, Peterson and Edgerton Schools, Kalispell 30

V. DISCUSSION 34
Considerations in NESA Site Selection and Program Promotion 34
Pilot Programs 37
Findings of the Study Based on Class Field Trips 40

VI. SUMMARY 47
SELECTED REFERENCES 53
APPENDIX 56
Teacher Questionnaires 57

POCKET

"Adventures in Environment at Glacier National Park: Teacher's NESA Classroom Guide."

"Apgar National Environmental Study Area: Teacher's NESA Field Guide."
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Number of Students Using Park Environmental Education Facilities from 1969 to 1974</td>
<td>26</td>
</tr>
<tr>
<td>2. The Value of the Teacher Orientation from Part I, L.A. Muldown School Questionnaire</td>
<td>29</td>
</tr>
<tr>
<td>3. The Value of the NESA Field Trip from Part II, L.A. Muldown School Questionnaire</td>
<td>30</td>
</tr>
<tr>
<td>4. The Value of the Teacher Orientation, Peterson and Edgerton Schools' Questionnaire</td>
<td>31</td>
</tr>
<tr>
<td>5. The Value of the NESA Field Trip, Peterson and Edgerton Schools' Questionnaire</td>
<td>32</td>
</tr>
<tr>
<td>6. Teacher Opinion Relating to Inquiry-Oriented Instruction, Peterson and Edgerton Schools' Questionnaire</td>
<td>33</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Map of Glacier National Park Showing Location of NESA Sites</td>
<td>20</td>
</tr>
</tbody>
</table>
The National Environmental Study Area (NESA) program was instituted by the National Park Service in 1968 to make the natural and cultural resources of the National Park System formally available to the nation's educational community. Glacier National Park's participation in the program began in 1970. Central to the program has been the selection of environmental study areas, called NESA sites, to be used by students from local schools for environmental study in the park.

The educational objectives of the program were formulated by the National Park Service and the National Education Association. Of primary concern in implementation of Glacier's NESA program was the means of meeting these objectives to provide the student with an effective environmental education experience. Considerations included selection of NESA sites that had viable educational potential, development of instructional activities relevant to out-of-classroom learning in the sites, preparation of teacher resource information materials, and teacher orientations providing useful insights into NESA site utilization.

After selection of NESA sites in 1970, the first NESA teacher workshop was held in 1971 with Columbia, Falls School System. This resulted in occasional use of park NESA sites by teachers of this school system. The need was then recognized to promote full-scale interest in and awareness of the program in the entire park locale. This was accomplished through various means and resulted in a pilot NESA program involving the Whitefish and Kalispell school systems.

The findings of the study, based on the pilot program and questionnaires completed by participating teachers, indicate that the most relevant type of instructional activity is based on inquiry methods. The two methods found to be effective were student analysis of study plots and random exploration of NESA resources under the guidance of a teacher or parent. Findings also indicated that small, informal teacher orientations were preferred over large, and lengthy formal workshops; and that the field aspect of the orientations provided the teachers with the most useful insights into NESA utilization.

The study also indicated that teacher resource information materials needed improving to provide more detailed information on resources of the NESA sites. Finally, the study provided insight into definition of the respective roles of teachers and resource persons in the NESA program, determining that the role of the resource person is to provide information to teachers on NESA resources, and that the teachers provide instruction to their classes at the sites.
CHAPTER I
INTRODUCTION

The National Environmental Study Area (NESA) program is an environmental education endeavor initiated by the National Park Service in 1968. It was formulated with the intent of making the natural and cultural resources of the National Park System formally available to the nation's educational community. Central to the program has been the development of environmental study areas, called NESA sites, for school use in various parks across the country.

Assisting in the development of the NESA program have been the National Education Association, which in 1969, in support of the program, established Project Man's Environment (NEA, 1970a); and the U.S. Office of Education which maintains a registry of NESA sites in park and non-park areas.

Implementation of the NESA program in Glacier National Park, a major unit of the National Park System, was begun in Fall, 1970. Four NESA sites were selected within the park, and preparation of descriptive resource materials was begun. School administrators and teachers in Flathead, Glacier, and other counties in the park locality were then informed of the program and of the environmental education potential of the park NESA sites. This led to initiation of pilot programs with two school systems near the park.

The educational objectives of the NESA program, set forth by the National Park Service and the National Education Association (NEA, 1970b),
are:

1. To introduce the student to his total cultural and natural environment, past and present.

2. To develop in the student an understanding of how man is using and misusing his resources.

3. To provide an opportunity for the student to work directly with environmental problem-solving.

4. To equip the student to be a responsible member of the world that is shaping him and that he is shaping.

The park NESA sites are, in essence, windows into the ecological, geological, and historical processes and events that have created the park environment. They are used to introduce the student to the natural and cultural environment of the park. This knowledge provides a foundation for helping the student understand other environments, and man's use or misuse of these environments. Hopefully, this will lead the student to become involved in environmental problem-solving and decision-making through available avenues.

STATEMENT OF THE PROBLEM

Glacier's NESA program, having only recently been instituted, is still in the formative stages. The NESA pilot program, involving the park and local elementary schools, is concerned with certain basic questions. What type of instructional methods and techniques are appropriate to out-of-classroom learning and to the resources of the NESA sites? What must NESA resource information materials contain to make them effective? How should teacher NESA orientation be conducted?
What types of resources do NESA sites need to make them useful educational tools for the teacher and classes?

These and other aspects of the program, including the activities involved in promoting interest and awareness of the program in the local educational community are the core of the study problem. All aspects of the study are concerned, in the last analysis, with developing the park NESA program as a useful means of outdoor environmental education for local schools.

STUDY METHODS AND PROCEDURE

The study will include a report on the activities and steps contained in the implementation of the program. The report on implementation will be in narrative form. Sources of information for this will include participating teachers, park resource persons, and park files and records.

An essential part of the implementation has been the preparation of NESA resource information materials. These include the teacher NESA classroom and field guides. They have been prepared primarily by the investigator, assisted by other park resource persons, and by incorporating materials and suggestions of participating teachers.

Evaluation of the program has been accomplished mainly through administration of questionnaires to teachers involved in the pilot program. The questionnaires solicit teacher opinion on teacher orientation and student instructional activities, with emphasis on how these can be improved. The evaluation is presented in narrative and
tabular form.

LIMITATIONS

The study focuses on NESA implementation activities beginning in Fall, 1970, and extending through Spring, 1974. It also briefly includes the events from 1968 to 1970 which, although not part of the NESA program, helped lay some of the foundation for its implementation.

Distribution of questionnaires is limited to teachers participating in the pilot program which extended from Spring, 1973, to Spring, 1974; and included six first grade teachers and classes of the L.A. Muldown Elementary School, Whitefish, Montana, and eleven teachers and classes, grade one through six of the Peterson and Edgerton Elementary Schools, Kalispell, Montana.

For the most part, the teacher guide materials developed during the study are intended for elementary grade teachers, since the greatest demand for utilization of the park's NESA sites is made by elementary schools. However, the materials are adaptable for secondary use also.

Consideration was given to evaluation of the environmental knowledge and aptitude of students from the above-mentioned schools. However, since the focus of the study is on teacher evaluation of the program through the teacher questionnaires, student evaluation was judged to be beyond the scope of this study. It would, however, be a possible problem for any subsequent studies of the park NESA program.

DEFINITION OF TERMS

Environmental Study Area. A place, usually a plot of land on or
off school property, that contains resources used in teaching those aspects of environmental curriculums which can best be taught outside the classroom.

N.E.S.A. or NESA. The National Environmental Study Area program administered by the National Park Service, the National Education Association, and cooperating agencies and institutions.

NESA site. An environmental study area on National Park or other public or private lands. Normally, to qualify as a NESA site, it must meet designated educational criterion, and be registered with the U.S. Office of Education on an inventory of NESA sites.

National Park area. As used in this study, any unit of the National Park System, whether designated as a National Park, National Monument, National Recreation Area, or National Park Service Regional, State, or Field Office.

Resource person. Refers in this study to an employee of the National Park Service who has job responsibility in some aspect of the NESA program. Officially, this person might be a Park Naturalist, Park Ranger, Park Historian, Biologist, Geologist, Environmental Specialist, or other.

NESA resources. These are the various geological, ecological, and cultural factors contained in a NESA site, including plants, animals, soils, landforms, streams, historical sites and artifacts, and the like.

Investigator. Refers to the author of this study, who, as an
employee of Glacier National Park, served as principal resource person and NESAs Coordinator, during the park NESAs pilot program.
CHAPTER II

REVIEW OF THE LITERATURE

There is a wealth of literature dealing with the subjects of environment and environmental education. The review of literature will focus mainly on those aspects which are most pertinent to implementation and evaluation of environmental study area programs.

ENVIRONMENTAL EDUCATION LEGISLATION AND OBJECTIVES

In 1970, Congress passed the Environmental Education Act:

...to authorize the U.S. Commissioner of Education to establish education programs to encourage understanding of policies and support of activities designed to enhance environmental quality and maintain ecological balance (Woock, 1972).

A main thrust of the Act was to encourage and to provide financing and grants to support environmental education innovations, including curriculum developments and pilot studies. The Act also established the Office of Environmental Education, now called the Division of Technology and Environmental Education, to administer the grants.

Prior to, and concurrent with legislative proceedings, educators were defining environmental education objectives. Stapp and associates (1971) wrote this definition:

Environmental education is aimed at producing a citizenry that is knowledgeable concerning the bio-physical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution.

Stapp expressed the concern that urban man, not having intimate contact with the basic biological and physical resources that support life, has lost perspective on their meaning in his life. He believes
that traditional conservation education programs fail to relate the importance of these resources to man's everyday needs. His aim, as expressed by the foregoing definition, is to insure that citizens are equipped with a fundamental understanding of biological, physical, and social processes pertaining to the environment. Thus informed, citizens should be able to analyze and judge actions that affect the environment, and be motivated to express their judgment through social, economic, and political decision-making processes.

Clark's (1971) view of environmental education is:

...to bring home to every citizen, so that he knows it deep in his heart and bones, the simple facts that he is absolutely dependent on his environment, that he is affected by his environment, and that he affects his environment.

Total environmental understanding, according to Clark, involves the engineer who is fully cognizant of the ramifications of soil erosion, the industrial lawyer who is aware of the effects of pollution on watersheds, the realtor who recognizes the suitability of various types of soils for land subdivision, and the sportsman who understands the mechanics of wildlife population regulation. And perhaps most important, the school administrator who considers development of environmental conscience in students on equal terms with other curriculum demands.

Clark (1972) also wrote of the responsibilities of government field level personnel in environmental education, which includes park resource persons. He believes that they are major avenues of contact and education for the public and must be fully informed of
the land management policies of their employing agencies in order to keep the public informed.

A summary of environmental education objectives found in the literature reveals three common fundamental steps. They are first, to help the student understand the environment, of what it is composed and how it operates. Second, to help the student understand man's affect on the environment, positive or negative. Third, to motivate the student to become involved in the environmental action and decision-making processes. Pervading each of these steps is the consideration for development of the student's environmental ethic.

THE MEANING OF ENVIRONMENTAL ETHIC

Leopold (1966) stated that an ethic develops to replace free-for-all competition. Such an ethic occurs in lower life forms in the function of "symbiosis." Symbiotic relationships between organisms involve cooperative mechanisms that assist in support of life of these organisms. Leopold believes that politics and economics, for example, are advanced forms of symbiosis in humans; that is acceptable methods of cooperation to replace free-for-all competition.

Yet, according to Leopold, we have not yet evolved to the point where we have developed a code of ethics in dealing with our environment. He states (Leopold, 1966):

We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.

Regarding land as a commodity, if we see no economic value to it,
including the air, water, plants and animals, we waste or deplete it. In doing so we may be short-circuiting the processes that sustain our existence.

McHarg (1971) writes of the role of man in the environment, observing that man is the most "uniquely perceptive and conscious animal." Man is capable of regulation of the biosphere and conscious of this ability. Because man is of the biosphere, entirely dependent on it, and able to perceive what needs to be done to protect it, the responsibility for environmental management rests with him. The role of man, then, is "steward of the biosphere." Whether or not man accepts this responsibility depends on the development of a citizen environmental ethic and this depends largely on environmental education endeavors.

THE LAND AS A FOCUS OF ENVIRONMENTAL STUDY

The spectrum of environmental problems is broad and confusing. In environmental study it is difficult to know where to begin, on which aspect of the environment to focus. This question is especially significant to the National Park Service in operation of NESA programs because of the need to focus on that aspect of environment which most closely relates to park resource management.

There are writers who offer some valid perspectives for school study of environmental study areas. The Citizen's Committee on Environmental Quality (Jeske, 1973) states:

Of all the factors that determine the quality of our environment, the most fundamental is the use we make of our land.
Similarly, Train (Jeske, 1973) contends:

Land use is the number one environmental problem facing the nation today. The problems of land use are rapidly reaching crises proportions. There is no environmental problem more serious than our land use dilemma.

For the purpose of this study, these statements help narrow the gamut of environmental problems to focus on understanding the land and its use.

Leopold (1966) said that land is "not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals." Land has both structure and function. Structure means the type, quantity and physical arrangement of soils, plants, and other resources. Function includes primarily energy flow through these resources. Leopold is concerned with man's effect on these energy circuits.

McHarg (1971) illustrates how environmental study areas can provide an insight into how man's misuse of resources can affect the quality of the environment and the quality of living. He explains the geological and ecological processes in operation in a sand dune community, a type of natural community frequently used by schools accessible to coastal or desert areas as environmental study areas.

Sand dunes and the organic life that inhabit them are closely interrelated. Plants adapted for survival in dune fields form complex intertwined networks of root systems that stabilize dune movement, especially in the face of storm winds. Understanding this concept is a fundamental in preservation of property and life along heavily inhabited
ocean coastal areas. Barrier dunes prevent flooding of these areas during times of storms. Dunes and dune plant life that have been disturbed by the impact of man's activities, such as house or road construction, are more readily breached by waves, allowing flooding of bays, beaches, and beach communities.

ENVIRONMENTAL STUDY AREAS AND RELATED PROGRAMS IN THE UNITED STATES

A joint study by the Educational Facilities Laboratories and the National Park Service (1972) provides insight into the scope of environmental study programs in the United States. It describes 46 projects that are related directly or indirectly to utilization of facilities outside the classroom for environmental study.

The projects vary in size, from the resident program at Clear Creek Camp in the San Gabriel Mountains near Los Angeles which serves 10,000 students of the school system annually, to a relatively small program serving sixth grade students on Alaska's Kenai Peninsula. The study describes programs found in diverse geographical terrain, from the examination of rain forests by Crescent City Schools in northern California, to the investigation of desert environments by Alamogordo, New Mexico Public Schools, or alpine studies in Aspen, Colorado.

Many of the programs originate in major metropolitan areas, including New York City, Baltimore, Miami, and Pittsburgh. Students in these programs are transported to resident facilities on the fringes of the areas, or conduct their environmental study right in the heart of urban areas. In a blighted area of Brooklyn, for example,
junior high students inventory and catalogue the physical characteristics of their immediate school environment.

Hill (1972) describes environmental study area related programs funded under Title III (ESEA). The Fall River, Massachusetts Public Schools designed a program emphasizing study of water. The students assist in the study of a small pond beset by algae nuisance. They also study the local water supply and a nearby bay, focusing on thermal pollution. The Topeka, Kansas Unified School District No. 501 program takes students on field trips to examine various aspects of the environment. Returning to the classroom the students develop solutions to environmental problems encountered.

The National Education Association (1970a) reports on a comprehensive statistical study of environmental education programs in public schools. A main emphasis is the use public schools make of local and National Park services and other similar resources. It covers all school systems in the United States with 1,000 or more pupils, totaling ninety per cent of the pupils in the country.

MONTANA PUBLIC SCHOOL PROGRAMS

Bennett (1971) describes the Falls Creek Project located near Missoula. Secondary students and teachers went into the Bob Marshall Wilderness to study biotic communities as a basis for comparison with human communities. Subsequent field trips took students along the Columbia River drainage from Missoula to examine rural and urban communities, including Portland and Seattle. Along the way they
studied judicial law to illuminate the conflicts between this and natural law.

In a program with the theme "Environmental Education in a Rural Setting," Swant (1972) has developed a program serving elementary and secondary students and teachers in the Deer Lodge area. Included in the program are six environmental study areas that represent the major types of ecological systems, including forest, prairie, lake, and river. The program also provides comprehensive materials, such as classroom audiovisual equipment and field equipment. The overall intent of the program is to assist the teacher and student in environmental education development.

Parsons (1972), in a master's thesis study, outlines six objectives for environmental study. The two most relevant to the Glacier NESA study are:

1. To move the learning experience from an entirely artificial classroom setting to the real life environment.

2. To provide learning experience that cannot be structured in the classroom.

The project involved a unit of ten lessons taught to third and fourth grade students dealing with such things as sensory awareness, the concept of environment, the web-of-life, and various ecological processes. The first seven lessons take place in the classroom; the final three out of the classroom on the school grounds. The unit was then culminated with a field trip to an environmental study area. The study describes in detail methods and techniques of classroom...
and field environmental study.

GENERAL FACTORS INVOLVED IN UTILIZATION OF ENVIRONMENTAL STUDY AREAS

In a survey of teachers, Mirka (1973) listed various factors of concern to teachers in utilization of out-of-classroom environmental study facilities. Among those indicated are:

1. Recognition of outdoor sites as teaching areas.
2. Knowledge of outdoor education activities.
3. Availability of resource persons.

He believes that improvement is needed in these and related areas of teacher training in environmental education.

In regard to "recognition of outdoor sites as teaching areas," the NEA (1970b) feels that educators and resource managers should work cooperatively in the selection and planning of sites as environmental study areas. Teachers should enlist the aid of the resource person for information on the qualifications of the site; and resource persons should consult with teachers and administrators in developing the education potential of the sites.

The NEA lists certain characteristics which the sites should display:

1. Specific educational possibilities.
2. Contain elements that illustrate the effects of human activity.
3. Be easily accessible to students.
4. Have such facilities as parking areas, drinking fountains, and restrooms.
5. Be resistant to repeated use by groups for study.

Hammerman & Hammerman (1969) state, regarding teacher knowledge of outdoor education activities, that the teacher's role is not to lecture and to factualize, rather to "lead pupils to familiarize themselves with ...unknown objects (environmental study area resources) by close first-hand study." The teacher acts as a catalyst to promote inquiry, capitalizing on student curiosity to direct student observations.

Stefanich (1973) writes that "teaching strategies that encourage children to develop skills of inquiry for use in analyzing scientific phenomena ... are of utmost importance." He describes two approaches: (1) conceptual schemes and (2) scientific processes. In the conceptual schemes approach the student comes to an understanding of a concept or "big idea" through assigned exercises and observations. Scientific processes involves those steps which a scientist takes in making scientific investigation. In this process, the scientist observes, measures, classifies and formulates hypotheses. This is done by the student, with skill dependent on his grade level.

Suchman (Stefanich, 1973) offers further insight into the processes of inquiry, defining it as "messing around with stuff, getting ideas, messing around with ideas, developing hypotheses, and messing around with stuff again." His suggested procedure for engaging students in inquiry learning is summarized as follows:

1. Create proper conditions—provide freedom and responsive environment. This may require teaching certain cognitive facts.
2. Present a problem for solution—a discrepant event.

3. Students ask questions to gather data. Questions should be phrased for a yes or no answer.

4. Promote and encourage as many questions as possible.

5. Pupils confer with each other.

6. Theories should be encouraged. Teachers should remain as objective as possible. Students should be encouraged to think out theories with teacher refraining from filling in the gaps.

7. Encourage students to test their theories.

8. Teachers review and summarize concepts presented, and try to relate to concept about the problem.

9. Theories are reviewed and accepted or rejected by the group through discussion.

10. Teachers should follow up with activities relating to the concept that helps student internalize the concept.

Regarding the availability of resource persons, the Mirka survey questions the role of such persons in implementation of an environmental study area program. In reference to this, resource persons of the Bureau of Sports Fisheries and Wildlife state that "our job is not to teach, but to help make our resources available to those who can" (Charles, Landin, Personius, 1973). They stress that teachers do not have to be experts on subject matter to lead successful learning experiences for their students. Through the inquiry approach, the curious and open teacher can captivate his student's interest, and help him get a better "feel" for problem-solving while searching together for answers.
CHAPTER III

NESA PROGRAM IMPLEMENTATION

The period beginning in Spring, 1968, and extending through Fall, 1970, saw Glacier Park personnel involved in environmental education activities which, although not as yet formally designated as NEPA activities, were to play an important role in implementation of the NEPA program in the park. There is no clear-cut definition between the end of this period and the beginning of NEPA implementation. One period more or less blended into the other. However, for the purposes of this investigation, the park's formal involvement in the NEPA program began in the latter part of 1970.

PRE-NEPA ACTIVITIES--1968-1970

The first formal record of Glacier Park's involvement in environmental education is documented in an inventory of potential environmental education resources in the park (Park Files, 1969). This survey included the names of personnel who would be utilized as resource persons, an inventory of existing, ongoing naturalist conducted programs, and a description of facilities that related to environmental education in some way. These facilities included exhibits, visitor centers, audiovisual programs, nature trails, photo and slide files, and park publications.

Also in 1968 a park Environmental Education Keyman was appointed to coordinate the various park efforts in this regard. An environmental education progress report about this time indicated the park had begun presenting film and slide programs on environmental subjects to local schools; during which time, pupil opinion on environmental matters
was solicited (Park Files, 1968).

The most significant environmental education effort on the part of the park in cooperation with local schools during the 1968 to 1970 period was the initiation of an "environmental awareness" program with Cutbank Public Schools. This brought park resources into formal environmental education use for the first time. It was a relatively concisely programmed effort, involving pre-site, on-site, and post-site studies by sixth grade students.

Objectives of the program included study of park ecosystems, as well as study of man's need of and use of the park. Students came to the park in fall, winter, and spring to study lake ecosystems, plant adaptation, prairie-forest transition, and animal migrations. These processes were then related to the student's home environments, in order to study man's impact on these and related environmental processes (Park Files, 1969).

**NESA SITE SELECTION**

Initiation of formal NESA activities in the park began during late 1970. During this time, park resource persons were engaged in a survey and consideration of sites which would meet criteria outlined by the National Park Service and the National Education Association (1970b). The four sites described in the following pages are those selected, and later submitted on an inventory of NESA sites maintained by the U.S. Office of Education, giving them formal status as National Environmental Study Area sites.
MAP OF GLACIER NATIONAL PARK SHOWING LOCATIONS OF NESA SITES

LEGEND:

- NESA SITE SYMBOL
- ROADS
- STREAMS
- LAKES
- SCALE: TEN MILES
Apgar NESA Site. This is primarily an ecological area, and includes a stream ecosystem (McDonald Creek), stream bank vegetation, and pioneer post-fire successional stages in what was once a cedar-hemlock forest. In the Fall, McDonald Creek is the focal point of spawning salmon and a large concentration of migrating bald eagles. The area was the site of a major Civilian Conservation Corps camp in the 1930’s, located there to re-seed the area after a forest fire in 1926. There is evidence of the camp, and other evidence of man’s impact, including an abandoned horse pasture, abandoned roads, and utility lines. A large meander on the creek is in the process of "cut-off" to form an oxbow lake. This and high stream cutbanks and the multi-colored stream cobbles are the main evidence of geological processes in the NESA.

Avalanche Lake NESA. This might be termed a linear NESA, because of a two mile hike required to reach the main feature, a glacial basin. The site is pre-dominantly geological, displaying glacial processes and features, including a U-shaped glacial valley, a glacial basin and oligotrophic lake and hanging valleys. Other processes include the results of stream erosion and sedimentary rock formations. The first part of the NESA trail transects a cedar-hemlock forest. Evidence of man includes a campground at the foot of the trail, as well as the trail itself.

Red Eagle NESA. This area is located near the foot of St. Mary Lake in the wind-swept St. Mary Valley. It is perhaps the most diverse of the NESA sites in the park. It displays ecological processes such
as the transition from prairie to forest, along with attendant animal life, forest and meadows and lakeshore. Historic remains of man in the area include the old St. Mary townsite, a small village that evolved along with early mining culture in the area, the old St. Mary ranger station, a homestead site, and the remains of the St. Mary chalets, part of the early concessions in the park.

Two Medicine NESA. Located in the Two Medicine Valley of Glacier Park, this area displays various elements of ecological processes, including glaciation, plant succession, forests interspersed with meadows and beaver ponds. The effects of man in the area are recent, and include trails, a campground, and various park visitor facilities. An exhibit shelter is located near the site.

PROMOTING AWARENESS AND INTEREST IN THE NESA PROGRAM

Prior to implementation of the NESA program, during the 1968 to 1970 period, the local educational community was aware of the park's involvement in environmental education because of the park's cooperation with Cutbank Schools in its "environmental awareness" program and environmental education presentations to other local schools mentioned in the foregoing. These initial efforts laid the foundation for promoting interest and participation in the growth of the NESA program.

Formal introduction of the NESA program to the local school systems began in late 1971. One of the first efforts in this regard was a teacher NESA workshop with the nearby Columbia Falls School
system. It was attended by thirty teachers and several park resource persons. Although this provided further awareness of the program, it did not result in a formal pilot program. This was mainly due to the fact that the Columbia Falls School system was more conveniently located to lands administered by the U.S. Forest Service which could be utilized as an environmental study area (Park Files, 1973).

During the Spring and Fall of 1973, all public school systems in Flathead and Glacier Counties were contacted by phone, mail or personal visit of resource persons, to invite their participation in the NESA program. This was the first wholesale effort on the part of the park to promote awareness and interest in the program. The cooperation of local press and television was also utilized toward this end. These contacts led to meetings with administrators of Kalispell and Whitefish School systems during the Spring and Fall of 1973. These meetings resulted in the initiation of pilot programs.

PILOT PROGRAMS

The initial activity of the pilot programs was a teacher orientation conducted by the investigator who serves as the park's NESA Coordinator. The teacher orientations were structured as follows:

Phase I. Investigator meets with teachers for in-school NESA orientation. Teachers are given a brief introduction to NESA principles and concepts using a filmstrip, and an introduction to the Apgar NESA site using slides. This is followed by a general discussion, including outdoor and environmental
Phase II. Teachers visit park on following day, or shortly after Phase I, and are guided through Apgar NESA by the investigator. Teachers are familiarized with the physical layout of the NESA site. Geological and ecological resources of the site are discussed within the context of principles and methods of outdoor environmental education. If time and interest permit, teachers participate in a "dry run" of student inquiry problem-solving activity.

Class field trips followed the teacher orientations, with instructional activities performed by the teachers. The investigator accompanied classes during the field trips, primarily in the role of observer. The investigator took part in instruction only when called on by the teacher, mainly when needed to explain the more technical aspects of the ecological and geological processes being observed by the students.

PREPARATION OF TEACHER NESA GUIDE MATERIALS

Park records indicate that preparation of NESA teacher guide materials was underway by Fall, 1970 (Park Files, 1970). Initial materials included leaflets which briefly described the NESA program and each of the NESA sites. Also under preparation were materials discussing ecological concepts, suggestions for preparing for a field trip, and the relation of NESA to the various classroom subjects. An important part of these materials were programmed class activities to
introduce students to fundamental ecological concepts. These were prepared by certified teachers in the employment of the park.

The beginning of preparation of "Adventures in Environment of Glacier National Park--Teacher's NESA Classroom Guide" by the investigator resulted from the pilot programs with Kalispell and Whitefish Schools in 1973. Its purpose was to incorporate materials described above, with minor revisions, as well as to familiarize the teacher with the theory of inquiry as applied to NESA instructional activities. The guide also includes a section on geological concepts pertaining to the park, in order to encourage more emphasis on geology in environmental study. The guide was completed in Winter, 1973-74.

Preparation of the teacher NESA field guides was begun in Spring, 1974. These were intended to provide specific information on NESA resources. To date, field guides for Apgar, Avalanche, and Red Eagle NESA sites have been completed in preliminary form.

**SUMMARY OF SCHOOLS USING PARK ENVIRONMENTAL EDUCATION SERVICES AND FACILITIES, 1969-1974**

Schools using park environmental education facilities and services, in addition to those from Kalispell and Whitefish, include Columbia Falls, Browning, Cutbank, Havre, as well as many of the rural schools under the jurisdiction of Glacier and Flathead County School Systems. Table 1 summarizes school use of the park from 1969 to 1974. The figures for 1971 to 1974 pertain to the NESA program specifically.

Elementary and secondary school students enrolled in city and rural
schools in Flathead and Glacier Counties total 14,523. This includes 11,042 students in Flathead County, and 3,481 students in Glacier County. Thus of total students in both counties, approximately 20% have utilized NESA facilities during 1974.

TABLE 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Students</th>
<th>Year</th>
<th>Students</th>
<th>Year</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>1,193</td>
<td>1971</td>
<td>1,190</td>
<td>1973</td>
<td>2,178a</td>
</tr>
<tr>
<td>1970</td>
<td>1,262</td>
<td>1972</td>
<td>1,182</td>
<td>1974</td>
<td>2,907b</td>
</tr>
</tbody>
</table>

aIncludes 250 students viewing eagle and salmon at Apgar NESA.

bIncludes 800 students viewing eagle and salmon at Apgar NESA.

Since completion of the pilot program in 1973, many teachers have availed themselves of NESA teacher orientation services. Noteworthy among these are the orientations conducted for twenty teachers in Flathead County Schools; fifteen teachers and parents from Hedges Elementary School, Kalispell; and eight teachers from Browning Community Free School. To date a total of 92 teachers and 12 parents have participated in NESA workshops and orientations conducted by park resource persons.
CHAPTER IV
NESA PROGRAM EVALUATION

The initial questionnaire designed by the investigator to be administered to participating teachers from L.A. Muldown School in Whitefish was devised using a format suggested in "A Guide to Planning and Conducting Environmental Study Area Workshops" (NEA, 1972). It was modified to fit the specific needs of this study. On review of the results, which seemed somewhat general and all too encompassing, the questionnaire was re-designed before administration to participating teachers from the Peterson and Edgerton Public Schools in Kalispell.

Common to both questionnaires are two groups of questions relating to the following factors in utilization of Glacier Park's NES sites:

1. The effectiveness of the teacher orientation conducted by the park resource person in introducing them to the NESA program, and assisting them in planning and conducting NESA instructional activities.

2. The effectiveness of the NES experience in helping the student understand the natural environment. This determination was to be based on the teacher's judgment, rather than on formal student testing, relying on the teacher's experience in judging pupil grasp of new concepts.

A primary consideration in the design of the questionnaires was to gauge overall teacher attitude towards the NESA program. Being an innovative educational enterprise, their opinions on how the program
could be improved to better serve them and their students would be of great value. Also of interest would be teacher reaction to conducting their own classes in the NESA site, rather than reliance on resource persons, an experience also new to many teachers. Space was provided in the questionnaires for comments regarding these and other aspects of the program.

RESULTS OF SCHOOL QUESTIONNAIRE
L.A. MULDOWN ELEMENTARY, WHITEFISH

This questionnaire was administered to six teachers, all of whom responded. It consisted of eleven questions divided into two groups. The first group of six questions dealt with the NESA teacher orientation conducted by the investigator prior to the class field trips. The second group of five questions pertained mainly to the class field trips. A copy of the questionnaire may be referred to in the Appendix.

The teachers were asked to rate the value of the various aspects of the orientation and field trips on a scale of one to five; with the number five being the highest value. The results were then scored by multiplying the number of responses in a given category by the number value assigned by the respondent, and totaling the results.

Table 2 summarizes responses to questions dealing with the teacher orientation. The teacher tour of the Apgar NESA (Question 5) received the highest rating, indicating it was the most valuable aspect of the teacher orientation.

Table 3 deals with teacher evaluation of the value of the class
TABLE 2
The Value of the Teacher Orientation from Part I, L.A. Muldown School Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Response scale/Teacher responses</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5 4 3 2 1</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>- 4 1 -</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>1 4 1 -</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>2 3 1 -</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>4 2 -</td>
<td>28</td>
</tr>
<tr>
<td>6</td>
<td>2 3 -</td>
<td>25</td>
</tr>
</tbody>
</table>

field trips in affecting student attitudes and knowledge of the environment. Results indicate that the field trip was of most value to the students in the area of natural science (#7A), and of least value in the area of social science (#7B). Question #8 was another way of asking teacher opinion on cognitive values of the field trip. It received the highest rating in this group of questions.

Question #11, which asked if the teacher planned to use the NESA program in the future, received five affirmative replies. One negative reply was received from a teacher who planned to retire at the end of that school year.

Although comments were solicited on the reverse of the form, only one teacher commented. She stated that her inquisitive first graders benefited greatly from the field trip. It helped them to relate the
things they had studied in class to the real life environment in the NESA. It also helped to develop their perspectives on how seemingly different environments are related through fundamental environmental processes.

TABLE 3

The Value of the NESA Field Trip from Part II, L.A. Muldown School Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Response scale/Teacher responses</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
<tr>
<td>7A</td>
<td>2 2 2 - -</td>
<td>24</td>
</tr>
<tr>
<td>7B</td>
<td>- 3 3 - -</td>
<td>21</td>
</tr>
<tr>
<td>7C</td>
<td>1 3 2 - -</td>
<td>23</td>
</tr>
<tr>
<td>8</td>
<td>2 3 1 - -</td>
<td>25</td>
</tr>
<tr>
<td>9</td>
<td>- 4 2 - -</td>
<td>22</td>
</tr>
<tr>
<td>10</td>
<td>2 2 2 - -</td>
<td>24</td>
</tr>
</tbody>
</table>

RESULTS OF QUESTIONNAIRE--PETERSON AND EDGERTON SCHOOLS

This questionnaire was given to eleven teachers of the Peterson and Edgerton Elementary Schools, Kalispell, in January, 1974, following their class field trips to the Apgar NESA in Fall, 1973. A copy may be found in the Appendix. Eight teachers, representing the following grade levels, completed the questionnaire:

Grade 2—-1 teacher
Grade 3—-2 teachers
Grade 4—-2 teachers
Grade 5—-1 teacher
Grade 6—-1 teacher
Grade not indicated—-1 teacher
Table 4 summarizes the responses of the teachers regarding the value of the teacher orientation. The results are similar to the Muldown School questionnaire in that the teachers indicated the tour and familiarization with the NESA site prior to the class field trip (#1C) was of greatest value.

**TABLE 4**

The Value of the Teacher Orientation
Peterson and Edgerton Schools' Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Response scale/Teacher responses</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>1A</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1B</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>1C</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

Question #2 (Table 5), also consisting of three parts, asked the teacher to rate the value of the field trip in helping the students understand (A) the environment; (B) man's effect on the environment; and (C) what can be done to conserve the environment. The results were again similar to the Muldown School questionnaire, in that the teachers indicated that the field trip was most valuable in providing the students with an understanding of the natural environment (#2A). The value of the field trip in helping them understand social aspects
of the environment (#2B, #2C), was rated lower.

TABLE 5
The Value of the NESA Field Trip
Peterson and Edgerton Schools
Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Response scale/Teacher responses</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td>6 2 - - -</td>
<td>36</td>
</tr>
<tr>
<td>2B</td>
<td>1 6 1 - -</td>
<td>32</td>
</tr>
<tr>
<td>2C</td>
<td>- 4 3 1 -</td>
<td>27</td>
</tr>
</tbody>
</table>

Question #3 attempted to provide some insight into teacher opinion regarding inquiry-type instruction in an environmental study area. The teacher was asked to make one choice from each of four pair of statements. The results of Pair A and B indicated that the teacher preferred to have their students involved in pre-assigned inquiry activities, as opposed to random exploration. The results of Pair C and D indicated that the teachers preferred to have their students form hypotheses based on their own observations. Also, the teachers felt that learning activities should be designed by the teacher (Pair E and F), rather than using activities designed by someone other than the teacher. The results of Pair G and H indicate that instruction can best be carried out by someone experienced in the natural sciences.
There were four questions on the reverse side of the questionnaire in which the teachers were asked to comment or to make general suggestions regarding improvement of services and facilities of the NESA. The main thoughts expressed and the number of times each was expressed is as follows:

- Need more detailed information on resources of NESA site. 2
- Need more suggestions on possible student study projects. 1
- Need to provide teacher with better information on current conservation subjects. 1
- Resource persons needed to assist on field trips. 2
- Resource persons not needed to assist on field trips. 1
- NESA facilities and services quite adequate. 2
CHAPTER V
DISCUSSION

The following evaluative discussion of the investigation is within the context of perspectives and insights provided by the teacher questionnaires, the review of literature, park records, and the observations and experience of the investigator.

CONSIDERATIONS IN NESA SITE SELECTION AND PROGRAM PROMOTION

A fundamental problem in implementation of the NESA program during the early 1970's was the lack of precedent and detailed guidelines for a program of this type. Program implementation in National Park Areas, such as in Glacier National Park, were pioneer efforts in this aspect of environmental education. It was from these efforts that guidelines would emerge to make the program an effective means of environmental education.

The broad program objectives and criteria spelled out by the National Park Service, as cited in Chapter I, assisted during the initial stages of NESA program implementation and provided some direction. Further insight and direction was provided by the environmental education objectives formulated by educators, such as cited in the review of literature.

In selection of NESA sites in Glacier, the single most important educational criteria was that the sites be representative of the geological and ecological processes and events that have shaped the natural environment of the park. The sites also needed to display
some evidence of man's activities in the park, historic or contemporary, as a basis for illustration of man's effect on his environment. These criteria have been defined by the first two objectives of the NESA program as stated on page 2.

Aside from the purely educational criteria, there were practical considerations. The sites needed to be exteriorally accessible by school bus or automobile, and interiorally accessible by established trail. Comfort facilities such as restrooms, water fountains, and picnic facilities for sack lunches were other considerations. If possible, location near park interpretive facilities, such as visitor centers or exhibit shelters would serve to enhance the educational potential of the sites.

Once possible sites had been selected, their viability as environmental education resources could only be established through use of the sites by schools, followed by feedback from teachers who had used the sites. The best means of accomplishing this was through initiation of a pilot program with local schools. This meant promoting awareness and interest in the program in the local educational community.

During promotion efforts, the park resource person acted, in a sense, as a curriculum salesman. His product was the NESA program and his task was to establish the credibility of his product (Little, 1969). Such was the primary intent of the meetings with

The program was presented to administrators of these school systems as one that was guided by broad educational objectives; objectives that had been formulated with the assistance of professional educators and specialists in the field of environmental education. Moreover, these objectives could be translated by teachers into specific study goals for students. These goals could then be used by the teacher to measure student learning progress. As stated by Horn (1973), such is a fundamental need in order to properly evaluate the effectiveness of student environmental study.

Another enhancement of the program was that the NESA sites were definite destinations for class field trips originating from local schools. Frequently, classes come to the park with only vague learning objectives and no definite place in mind to carry out necessary learning activities. The educational quality of this type of field trip is questionable. It might provide the student with a look at the scenery and some recreation, but little would be learned about the concepts and processes involved in creation of the park environment. Utilization of a NESA site, on the other hand, would, in effect, provide the teacher with an outdoor laboratory, an extension of the classroom where concepts and processes introduced in the classroom could be observed and analyzed by the student.

These and other factors were considered in meetings with school administrators and teachers, thus leading to the beginning of pilot
programs with the Kalispell and Whitefish schools. The success of the program promotion efforts is reflected in Table 1. As indicated, the number of students using NESDA facilities in the park increased from 1,182 in 1972 to 2,907 in 1974.

PILOT PROGRAMS

Although the above figures show a definite increase in NESDA use during the 1972 to 1974 period, the pilot programs were needed to establish a definite means of feedback from the teachers. Many of the teachers who were using NESDA sites during this period were doing so on their own, and had not participated in NESDA orientation activities. Thus, the teachers participating in the pilot programs would be in a better position to provide feedback, than those who were not involved in the pilot program.

The relatively small number of teachers (six in the Whitefish group and 11 in the Kalispell group) facilitated small group teacher-teacher and teacher-resource person interaction. Thus the orientations could be conducted on a rather informal basis and structured to more or less meet the individual interests and needs of the teachers.

As indicated by Mirka (1973), outdoor education methods and techniques are a primary concern of teachers conducting out-of-classroom exercises. The teachers are more interested in the practical realities of this problem than the esoteric or philosophic aspects of environmental education. Therefore, after slide and filmstrip presentations on the NESDA program during the in-school portion of the orientation,
discussion was then directed toward mutual exchange of ideas on conducting a class NESA activity. In addition to instructional methods and techniques, discussion included considerations such as relating the NESA experience to classroom activity; and the mechanics of field trips, such as what the children should wear, what equipment they should bring, the location of comfort facilities, procedures for reserving a NESA site, and so forth.

Results of the teacher questionnaire (page 33), indicated that the teachers valued most highly the on-site tour of the Apgar NESA site, which was the second and final phase of the orientation. One of the major benefits to the teacher was getting to know the physical layout of the area, of getting a "feel" for it as an educational resource. The tour also provided an opportunity to help dispel any possible misgivings that teachers might have, real or imagined, regarding potential hazards to students in the natural environment, such as steep river banks or wildlife.

During the teacher field orientation, the investigator attempted to emphasize the qualitative aspects of NESA resources rather than the quantitative aspects. This mainly involved discussions of interrelations of resources, such as suggested by Elton (1927). He said that when an ecologist says "there goes a badger," he should indicate that animal's specific place in the community, just as if he had said "there goes the vicar."
Facilitating this process is the NESA environmental study tool called the Environmental Strands (NESA, 1972). These are five broad concept categories under which the various natural objects and processes in an environmental study area can be categorized. The Strands include Variety and Similarities, Patterns, Interaction and Interdependence, Continuity and Change, and Evolution and Adaptation.

The Strands were demonstrated to the teachers as a tool for conducting inquiry. Based on Interaction, for example, the teacher might ask the student to perceive through sounds. A bird is rustling in the bushes. What is he doing? An insect makes a certain sound pattern. What does it mean? Another activity might be to follow animal tracks to see where the animal was going and what it may have been doing. Looking for signs of Adaptation might include observation of the characteristics and immediate environments of shrubs and trees. This would include distinguishing the types of shrubs that grow in open, sunny areas, versus types that grow in shady, closed-in places. Examples of Change that the student might discover include mud slumping imperceptibly down a steep creek bank which would indicate slow change by erosion; or small trees growing on the edge of a meadow surrounded by forest indicating that the meadow might be changing to forest.

The main intention of demonstrating the Strands to the teacher was to reinforce the premise of resource persons (Charles, et al, 1973)
that teachers do not need to be experts in geology, ecology, or related sciences; rather they need to employ tools of inquiry to arouse student interest, to prompt students to learn through close observation, analysis, and discussion of their findings.

One overall finding of the investigation, regarding conducting teacher orientations, is that a series of small, informal group orientations, as opposed to large formal workshops, has definite merit. The investigator felt most effective conducting this type of orientation, and the teachers indicated their satisfaction with this arrangement. This type of orientation can be conducted conveniently for a few or up to ten teachers. It does not require detailed advance planning and preparation, and can be conducted, depending on availability of resource person's time, on request of teachers without too much advance notice.

FINDINGS OF THE STUDY BASED ON CLASS FIELD TRIPS

The pilot program class field trips have focused mainly on developing effective means of instruction appropriate to out-of-classroom environmental study, and to the resources of the NESAS site. There was also the need to solicit teacher opinion on various factors, including their reaction to conducting their own classes at the NESAS site, the special qualifications needed to conduct instruction, and the value of the NESAS site as an environmental education resource.

Two methods of structuring field inquiry-oriented learning activities have evolved from the pilot program:
1. The student is assigned a study activity which centers either on a given area of the NESA, or a given resource. A group or team of students might, for example, be assigned to analyze study plots, observing the type, quantity, and the arrangement of resources, and determining the interrelations between resources. This would serve to provide the student with an insight into the structure and function of the NESA community. An extension of this would be to have students compare various types of plots, i.e., forest or meadow, to determine how physical factors such as sun, shade, soil, and moisture, decide what types of organisms grow under what types of physical conditions. (See page 22 of teacher's NESA classroom guide for mechanics of setting this up).

2. Students are assigned in small groups or teams under the direction of a team leader (another student, or parent, or teacher assistant) to randomly explore along NESA trails, to observe, analyze, and discuss aspects that arouse student interest and curiosity. The main function of the team leader is to direct the student's attention to items of interest which they may have overlooked, to promote inquiry into resources through questioning strategy, and to act as a moderator of discussion.

The above activities are correlative with Sutton's (1973)
opinion that elementary school students' utilization of environmental study areas is primarily an exercise in generating, collecting, and reporting data. They also correlate with the explanations of the inquiry methods cited in the review of literature.

Results of the teacher evaluation of these activities, Chapter IV, indicate that they prefer the activity which focuses on a given area of the NESA, such as study plots. This is probably because it is somewhat more structured, and more definite study objectives can be assigned upon which to base evaluation of student activities. However, some teachers felt that a combination of study plot analysis and random exploration was an effective way of involving students during the field experience.

Findings also indicate that teachers preferred that the students attempt to arrive at tentative hypotheses, rather than have their activities guided by and geared to pre-established concepts. An example of a pre-established concept would be the processes of soil erosion. Based on the study findings, it might therefore be assumed that rather than explain formation of a given erosion feature, the teacher would prefer to have the students formulate their own ideas regarding how the feature was formed. The class would discuss tentative hypotheses, rejecting those that did not seem to apply, thereby eventually arriving at a hypothesis that correlated with the established concept of soil erosion.

The results of the study dealing with teacher attitude about
their qualifications for conducting their classes in the NESA site, rather than relying on the resource person to do so, were variable. The Whitefish questionnaire asked directly if teachers felt effective leading their classes in this field experience. The results indicate that, in general, they did feel effective. The Peterson-Edgerton questionnaire asked the question indirectly, inquiring who would be most effective: (1) a person trained in formal education principles and techniques, or (2) one trained in natural sciences. The responses were almost unanimously in favor of the person trained in natural sciences. One might conclude that the teachers felt that the resource person, usually trained and experienced in natural sciences, should conduct the class in the field.

However, examination of teacher comments on the reverse side of the questionnaire provide further insight. One teacher suggested that although a resource person need not lead the class, it would be good to have him along to assist in discussion of certain points. Another teacher felt that once introduced to the NESA area by the resource person, the teacher should be able to take it from there to plan with the students for the field experience. Another commented "...a science-oriented person with enough background in elementary education to enable him to communicate with various age levels would be very effective."

The definition of the respective roles of teachers and resource
persons working cooperatively in NESA program development has emerged from these findings and other observations of the pilot program. The resource person provides NESA information and teacher orientation; teachers and resource persons work cooperatively to develop means of instruction; and teachers carry out instructional duties during class field trips.

This definition has evolved, not only as a matter of educational qualifications—the resource person being trained to provide information on resources and the teacher being trained to conduct instruction—but also as a matter of necessity. This is due, in part, to the fact that the NESA program is only one aspect of the duties of resource persons in the park. The figures in Table 1 indicate that the number of pupils using NESA facilities has increased by over 240% from 1972 to 1974. The park has been able to accommodate this increase because resource persons and teachers have cooperatively carried out their respective NESA roles. Had resource persons been relied on to undertake pupil instruction duties also, such an increase might not have been possible.

The teacher questionnaires also provided some insight into the value of the NESA sites, in general, and Apgar NESA site specifically, as environmental education resources. One question of concern is the benefit of taking students to an environmental study area remote from their communities, when most of the environmental problems occur in the
The teachers indicated that the greatest value of the NESA experience was the knowledge gained by the students of the structure and function of the natural environment. The value of the experience in providing the student with an understanding of man's use, or misuse, of his environment was rated lower. Thus, it might be surmised that the NESA sites are most valuable in meeting the first objective of the NESA program (page 2), and less valuable in meeting the remaining objectives. This was as anticipated, due to the fact that the park is primarily a natural area, with evidence of man's impact on the resource being only minimal compared to his impact on lands outside the park.

Providing further insight into the question posed in the foregoing regarding taking students to a remote environmental study area, the value of this is as stated by Heal (1974) who contended that students do not need always to study polluted environments; that developing student environmental awareness using natural areas is fundamental. The student needs to first of all gain a perspective on the efficient functioning of geological, ecological, and other environmental forming and maintaining processes as a basis for understanding how man's utilization can impair these processes. Being little affected by man, the resources at the NESA sites can provide some of these perspectives.
One overall benefit to the National Park Service that should not be overlooked is that exposure of students to the park environment through the NESA program can help develop in the student an awareness and appreciation for the necessity of preserving environments such as Glacier in their natural state, as well as provide an insight into some of the management considerations involved in park preservation. This, in the long run, might be the single most important contribution that the NESA program can make to the National Park Service and to the students as "park neighbors" and users of the park in the years to come.
CHAPTER VI

SUMMARY

The NESA program was formulated in 1968 by the National Park Service to make the natural and cultural resources of the National Park System formally available to the nation's educational community. Implementation of Glacier National Park's NESA program was begun in 1970. Using the objectives of the program and criteria spelled out by the National Park Service and the National Education Association, four sites were selected in the park to be used as environmental study areas by schools in Flathead, Glacier and other counties in the park locality. Descriptive resource information materials were also in the beginning stages of preparation about this time.

Environmental education contacts by park resource persons with Columbia Falls Schools, and the "environmental awareness" program with Cutbank Public Schools, helped set the stage for promotion of the NESA program in the local school systems. Formal introduction of the NESA program was underway by 1973, resulting in initiation of pilot programs with the L.A. Muldown Elementary School, Whitefish, and the Peterson and Edgerton Elementary Schools in Kalispell.

The primary intent of the pilot programs as stated in the study problem, was to launch Glacier's NESA program as an effective means of environmental education for local schools. This included such considerations as the quality of instruction and resource materials, as well as the quality of teacher orientation conducted by park resource
persons. The study includes a description of the various aspects of the program implementation, the development of resource guide materials, and an evaluation of the effectiveness of the program based on questionnaires completed by teachers participating in the pilot program.

The review of literature focuses on those aspects of environmental education which are most pertinent to implementation and evaluation of environmental study area programs. It includes environmental education legislation and objectives, environmental study areas and related programs in the United States, including Montana, and general factors involving teacher utilization of environmental study areas.

The review of literature also attempts to provide a perspective for the study by delving into the development of an environmental ethic, this being an ultimate objective of any environmental education program. The review also provides a focus for the NESA program within the broad spectrum of environmental problems, by stating current thought on the use of the land as a major environmental concern. This helps to make the program more relevant to Glacier National Park because an overriding concern of the park is management of the land resource contained within its boundaries.

The findings of the study based on the teacher questionnaires regarding the teacher orientations indicate that the teachers place high value on the NESA field orientation. It provided the teachers with first-hand familiarization with the resources of the sites, and a free
exchange of ideas on how the resources should be used in instructional activities. It was also discovered that the small, informal type of orientations, as opposed to large, formal workshops, is most preferred by teachers and the investigator.

Findings based on class field trips indicate that instruction should be inquiry-oriented. The resources of the NESA sites lend themselves to student-centered learning, and arouse within the student an inherent instinct to explore and discover. Instruction needs to take advantage of this instinct to enhance and encourage it, to help the student to learn for himself about the area. With this in mind, two methods of inquiry activities were used; one in which the student inventories and analyzes given study plots; and one in which the student randomly explores the NESA area to spontaneously observe things that arouse interest and curiosity. Sometimes a combination of these types of activities proved useful.

All activities were conducted within the context of the community concept. That is, understanding the structure and functioning of the natural community of plants and animals and their physical surroundings. One premise of the NESA program has been that, equipped with this perspective on the natural community, the student could then launch into the study of man's effect on the community environment and what can be done to preserve the environment. Thus, the social studies aspects of environmental study area utilization could begin in the NESA
site and then be expanded to include communities outside the park, whether nature-dominated or man-dominated.

The study found that the teachers consider understanding natural science aspects of the NESA sites as the most valuable aspect of the experience for their students. They rate the value of the social aspects of the NESA experience lower. The teachers, in other words, seem to consider the NESA experience more in terms of science concepts than in social science concepts. This does not completely reinforce the above-stated premise, suggesting that either the NESA sites do not display enough effects of man on the environment to help the student understand this aspect of environmental study, or that this was not emphasized enough during teacher NESA orientations.

The study also indicates the need for improved teacher NESA resource information materials, especially information that provides in-depth information on the specific resources of the NESA sites. This led to expansion of the teacher NESA classroom guide materials, and the beginning of the preparation of the NESA field guides. The former have been completed and are in use. The latter are completed in preliminary form and are in use. The study defines the need to continually refine these materials, based on feedback from teachers and classes utilizing the NESA sites since completion of the pilot program.

The pilot program has also helped to define the respective roles of teacher and resource persons in the NESA program. Each has a role assigned according to training and experience. The resource person
provides information to teachers on the NESA sites in written form by way of materials, and verbally during teacher orientations. The teacher and resource person then work cooperatively to develop instructional methods and techniques. The teacher takes it from there to conduct student instruction in the NESA site, assisted by teacher assistants, if needed. Ideally, as Glacier's NESA program matures, school systems using park NESA sites will become more independent of park resource persons; even to the point of assuming teacher orientation and materials preparation.

The potential for this objective can be illustrated by citing the successful NESA experience of sixth grade classes from Cornelius Hedges Elementary School in Kalispell in the Spring of 1974, one year after completion of the NESA pilot study. Sixth grade teachers, under the direction of a lead teacher, wished to bring eighty sixth grade students in one group to the Apgar NESA. The teachers, assisted by eleven parents were to conduct the field instruction. The investigator was asked to conduct orientation for this teacher-parent group, and to accompany them and their classes in the NESA, mainly in an observational capacity.

Upon completion of teacher-parent orientation, the large student group arrived at Apgar NESA to embark on their field study. The classes were divided into groups of five to six students, each group under the guidance of a teacher or parent. The lead teacher did not conduct any group directly; rather, she acted in the capacity of field trip
director. From the bus unloading point the groups were started on the NESA trail, at regularly spaced intervals, to undertake random observation and exploration study activities. At various locations in the NESA, the groups studied and analyzed assigned study plots. During this time, the investigator circulated from group to group observing the activities. Without exception, each group seemed absorbed in its assigned activity—observing, analyzing and discussing NESA resources. It was evident that the students were collecting large amounts of data for later discussion and study back in the classroom. They were involved in their study assignments for about two hours.

After the field trip, teachers and parents expressed their satisfaction with the experience. They felt that everything had run smoothly. Success had been achieved by dividing the classes into small groups and by the use of parents as group leaders. Although not trained as teachers, the parents were able to apply many of the basis inquiry methods described in the study.

This NESA encounter is cited, not as a model, but as one of the first opportunities to implement some of the findings of the study based on the pilot program. It also illustrates how teachers can work more or less independently of resource persons. With a minimum of orientation and with the assistance of the parents, the teachers were able to provide the students with a successful environmental education experience.
SELECTED REFERENCES


### NESA-TEACHER EVALUATION

Directions: Circle the number in the column that best represents your answer. NOTE: Feel free to comment on the reverse or on a separate sheet. No signature necessary.

Your time and cooperation in completing this form is appreciated.

#### REGARDING THE NESA TEACHER ORIENTATION:

<table>
<thead>
<tr>
<th>Question</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you feel the orientation served a valid purpose?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2. Did it meet your expectations in content, format, quality?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3. Did it help you define objectives for your NESA unit?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4. Did you acquire useful information, new viewpoints, attitudes?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5. Was the visit to the NESA site prior to your class valuable?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6. Were the NESA materials (suggested activities, etc.) useful?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

#### REGARDING YOUR CLASS NESA FIELD TRIP:

<table>
<thead>
<tr>
<th>Question</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Did you feel the field trip reinforced previous classroom study:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. In natural science subject areas?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>b. In social science subject areas?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>c. In art, communications, etc.?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8. Was the field trip of value in the overall cognitive aspects of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the natural and human environments?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>9. Were there noticeable results in the affective domain—any changes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in environmental attitudes, etc.?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>10. Did you feel effective in conducting your own class in the NESA site?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Do you plan to use the NESA program in the future? Yes No Maybe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Your school___________________________ and grade__________
ENVIRONMENTAL STUDY AREA PROGRAM SURVEY

This questionnaire has been designed to help evaluate the NESA program at Glacier Park. It pertains mainly to the NESA teacher orientation, class field trip, and related activities. Your time and cooperation in completing it is appreciated.

1. Rate the value of each of the following aspects of the NESA orientation in helping you plan and conduct your class NESA activities and field trip. (Circle your response: 5 highest value, 1 lowest value.)

   A. The initial teacher meetings and discussions at Edgerton School. 5 4 3 2 1
   B. The printed NESA materials, i.e., teacher's guide, resource information. 5 4 3 2 1
   C. Tour and familiarization with physical layout of Apgar NESA. 5 4 3 2 1

2. Rate the value of your class NESA activities and field trip in helping your students:

   A. Understand the natural environment. 5 4 3 2 1
   B. Understand man's effect on the environment. 5 4 3 2 1
   C. Understand what can be done to conserve the environment. 5 4 3 2 1

3. Which of the following would seem to provide the student with the most effective inquiry learning experience in an environmental study area. (Circle one choice from each of the contrasting statements in the four pairs listed below.)

   A. Students carry out pre-assigned inquiry activities and observations.
   B. Students carry out mostly random inquiry activities and observations.

   (over)
C. Students relate their observations to established concepts (i.e., erosion, adaptation).

D. Students formulate concepts (hypothesize) based on their observations.

E. Lesson plans designed by the person directing instruction used.

F. Lesson plans designed by other than the person directing instruction are used.

G. Instruction conducted by person experienced in elementary education principles.

H. Instruction conducted by person experienced in natural science principles.

4. What do you suggest be added or given more emphasis in the WESA orientation and/or teacher resource materials?

5. What services and facilities are needed in the Apgar WESA site to assist in making the field trip more effective in meeting your objectives?

6. Please use this space to comment or expand on your responses to the questions on the reverse, or those above.

7. Please indicate the grade level you teach: K 1 2 3 4 5 6
ADVENTURES IN ENVIRONMENT AT
GLACIER
NATIONAL
PARK

TEACHER'S NESA CLASSROOM GUIDE

Prepared by the National Park Service, Glacier National Park, under the National Environmental Stude Area (NESA) Program - in cooperation with school systems in Flathead and Glacier Counties, Montana.

1974
For information on the NESA Program, to schedule a teacher orientation, or to reserve a NESA site call or write:

NESA Coordinator
Glacier National Park
West Glacier, Montana 59936

(406) 888-5441

Please give two weeks' advanced notice if you wish to schedule an orientation or reserve a NESA site.
ACKNOWLEDGEMENTS

The sections on "Programmed Classroom Activities" and "NESA and Classroom Subjects" were prepared by teachers Carol Hurley and Darrel Sutter during the initial stages of the park NESA program. Roberta Seibel, West Lakes District Naturalist, wrote the section on ecological concepts and provided manuscript review. Edwin Rothfuss, Chief Naturalist, provided ideas and manuscript review also. Appreciation is extended to these people for their contributions in helping me compile this guide.

David V. Petticord
NESA Coordinator
Glacier National Park
WHAT IS A NESA (NATIONAL ENVIRONMENTAL STUDY AREA)?

A NESA is an out-of-classroom site designed for teaching many aspects of environmental study . . . which can best be taught outside of the classroom. It helps the student understand the environment . . . and man's relationship with it.

A NESA site can be on the school grounds, in a city park, in a national forest, national park, or anyplace where students can study natural and cultural environmental forming processes.

NESAS AT GLACIER NATIONAL PARK

There are four NESA sites at Glacier National Park . . . Apgar NESA and Avalanche Lake NESA on the west side and Two Medicine NESA and Red Eagle NESA on the east side. All display various natural and cultural features of Glacier's environment.

Most of the NESA sites have convenient access and comfort and picnic facilities.

OBJECTIVES OF THE NESA PROGRAM

1. To introduce the student to his total environment; cultural and natural, past and present.

2. To help the student understand the effect of man's use of the resources of his environment.

3. To prepare the student for environmental problem-solving and decision-making as they become responsible citizens.

HISTORY OF THE PROGRAM

The NESA Program is a cooperative venture by the National Park Service, U. S. Office of Education, the National Education Association, and local educational organizations and school systems. The program was conceived as a national program in 1963 by the National Park Service. The NESA sites in Glacier National Park were established in 1970 as Glacier's part in this program.

THE NESA INSTRUCTION GUIDES

NESA Instruction Guide Books are being prepared for teacher and class use of Glacier's NESAs. This, the first in the series, deals with NESA teaching methods, class preparation, and general information on geology and ecology. The next in the series will contain specific resource information on the four NESA sites in the park.
Elementary school grade level exercises in NESA are quests for information about the environment. Student investigation or inquiry is conducted through careful observation, keeping notes, and on-site and post-site discussion of findings. In conducting a class in a NESA, more important than academic subject matter knowledge, is the teacher's ability to direct student inquiry . . . to actually get involved in problem solving with the student to search for answers about what is being observed.

About inquiry teaching, Dr. Greg Stefanich, Department of Elementary Education, Montana State University, writes:

Teaching strategies that encourage children to develop skills of inquiry for use in analyzing scientific phenomena, and at the same time to use modern science as a means of improving the condition of mankind, is considered to be of utmost importance.

This statement is true not only for analysis of scientific phenomena that may be encountered in a NESA site, but also for its historical, social, and cultural phenomena. Student inquiry into this requires skills and knowledge . . . or learning new skills and knowledge . . . correlating not only with science, but all subject matter areas taught in the classroom.

Richard Suchman, University of Illinois, defines inquiry as "messing around with stuff, getting ideas, messing around with ideas, developing hypothesis, and messing around with stuff again. Messing around with stuff is the period of accumulation of raw data through observation; getting ideas is similar to a period of incubation in which ideas about the observations develop; messing around with ideas can be a period of illumination as the ideas fit together to form hypothesis; messing around with stuff again is elaboration of ideas, refining and internalizing them, testing the hypothesis to see how it fits in other situations, in another NESA site, or even in the home community.

Practical applications of inquiry theory are discussed in the section on ONSITE ACTIVITIES. A student NESA problem-solving activity, based on inquiry, is shown, beginning on page 21.
FURTHER DEFINING NESA

The following are a few ideas about NESAs from teachers and resource persons in other NESA Programs. These ideas help define NESA and how it fits into the school curriculum:

A NESA can be considered the outdoor counterpart to the classroom . . . it is like an outdoor laboratory.

Visits to NESA sites should complement on-going classroom study . . . they should be used to teach those aspects of classroom study which can best be taught outside the classroom.

A NESA can be used in support of classroom studies pertaining to science, math, history, art, and so forth.

The NESA experience can be planned and taught as a one time unit . . . or it can be a unit interwoven into classroom activities throughout the school year.

The NESA experience should include pre-site preparation and post-site follow-up, as well as the on-site field trip.

PRESITE PREPARATION

The NESA Program is concept oriented; it attempts through the various learning activities to introduce students to fundamental environmental concepts. A good way to begin NESA preparation would be to focus on one of the most fundamental and all-encompassing of concepts . . . the community concept.

Community is, simply, an assemblage of organisms living together, deriving their means of life support from one another and their surrounding environment (plant, animal, human). Glacier Park's NESAs are communities, each being inhabited by plants and animals surrounded by physical attributes including sun, air, soil, and water.

The community concept can be a basis for launching into study of more specialized concepts such as food chains, energy cycles, predator-prey relationships, and so forth. It is also an all-inclusive concept that links plants and animal (natural) communities with human communities. Natural processes operating in plant and animal communities . . . the processes that provide the means of life support . . . are found in human communities also, but in different forms, modified by human socio-cultural factors.
One very important factor in the community concept is that its understanding is necessary in one of our most crucial environmental concerns, the use we make of our land. According to Russel Train, Administrator of the Environmental Protection Agency.

Land use is the number one environmental problem facing the nation today. The problems of land use are rapidly reaching crisis proportions. There is no environmental problem more serious than our land use dilemma.

As your students study the MESA community, it may become apparent to them that their home community or region (the Flathead Valley, for example) is subject to universal biological and physical laws of nature the same as the plant and animal communities of Glacier Park. Their community was, in fact, once a plant and animal community that evolved to become a human community. The actors and props have changed, but the theme of the play...survival...has remained essentially the same. With this realization the MESA experience will have provided a basis for later studies, perhaps in later school years, which focus on human communities...and the human socio-cultural processes which ultimately affect the quality of the land and environment.

Introduction to the concept of community in presite preparation begins in the programmed activities section on page ___. It can be used as is or modified to suit your particular grade level needs. This suggested activity could be supplemented by maps and photos of real plant and animal communities (woodlands, meadows, prairie, etc.) and human communities (neighborhoods, shopping centers, city centers, etc.). Refer to the section on MESA study materials, page 26, for other ideas.

Important in pre-site preparation is the mechanics of the field trip. Some considerations are:

You will need to decide on what materials and equipment to bring. Cardboard with clothespins makes good clipboards. Small magnifying glasses and a few cameras are useful.

Problem-solving activities, if to be done, and group assignments should be made ahead of time. Teacher aides, if available, facilitate breaking the class into small groups.

Restroom and picnic facilities are available at or near each MESA site. Lunches can be left on the bus, or if a long hike, can be carried in daypacks.

Don't forget to call the MESA Coordinator, Glacier Park, to reserve a MESA site.

Suggested field trip dress is sketched below.
SOME PARK RULES AND REGULATIONS:

It is important not to remove, pick, or destroy anything in the park.

Some materials may be picked up for examination, but must be replaced. Taking notes instead of taking specimens should be emphasized.

Wildlife should not be chased or molested. This can be harmful to the animal and/or dangerous to the student.

Observe the Pack-in, Pack-out policy when on hikes. Day packs could be used to carry out litter.

FIELD TRIP DRESS

WARM
A cap helps if it's dizzy.
A shirt with long sleeves that can be rolled down.
Long pants, jeans are great.
Socks.

MAYBE A NAME TAG (IT'S NICE TO KNOW WHO YOU ARE!)

COLD
A warm cap to cover your ears.
A warm jacket (sweater or sweatshirt under it).
Mittens.

EXTRA
Raincoats & boots (weather can change suddenly)
Insect repellent if bug season

Extra with extra warm socks.
Plant and Animal Communities

Programmed activities to use in classroom preparation for a trip to Glacier National Park’s Environmental Study Areas.
If you were building a world for a ground squirrel to live in, what would you put in it?

Sun?  Air?  Tiny Animals?
Beargrass?  grass, seeds, berries?  trees?
Soil and rocks?  Water?  another squirrel?
buildings?  
coyotes?  
birds?

bushes?  
deer?  
people?

All of these make up the squirrel's surroundings or his ENVIRONMENT.

and lots of other things

you draw
What are some of the things in your school environment?

What are some of the things in a bear's environment?

Do you ever find one plant or animal separated from all other living things?

1 flower  1 woman  1 bird
We call plants and animals that live together in an area and affect each other a COMMUNITY.

There are stream communities with grass, bushes, mosquitoes, fish, sun, butterflies.

There are forest communities with ?
you finish drawing

A human community

A lake community

Your backyard community

a circus community
The kind of area a plant or animal lives in successfully is called his home or HABITAT.

Habitat gives the right amount of:

- **Light**
- **Temperature**

Special things each plant or animal may need.
Is the sun in your habitat?

Is your house in your habitat?

What else is in your habitat?

What is in an Eskimo's habitat?

In an ant's habitat?

In a dandelion's habitat?

In a pine tree's habitat?
A plant or animal has many special adaptations to help it fit its habitat.

1. Some have special body parts (such as the webbed feet of ducks).

2. Some have special ways of behaving (such as one animal tracking another animal).
Both kinds of adaptations help the plant or animal live in its own special habitat better than any other plant or animal could.

Could a 🦆 swim on water without his webbed feet?

Could a 🐾 catch food without his keen sense of smelling or hearing?

Beavers have adapted tails and paws for building dams.

Dandelions are adapted so the wind spreads its seeds.

Fish are adapted to breathe oxygen underwater.

Woodpeckers have beaks to drill holes in trees to find food.
Draw a beaver's habitat.

How has he adapted to it?

Who lives here? How has he adapted to winter?

Draw a fish's habitat.

Draw your habitat. How have you adapted to it?
Adaptations help the animals and plants in many ways. They help in

- Making food
- Getting water
- Building shelter
- Getting food
- Protection
While adapting, plants and animals change their environment.

Ground squirrels dig holes and change their environment.

Farmers change their environment to grow corn.

You change your environment when you put on your winter coat.

People change their environment by dumping sewage and trash into streams.

How else do people change their environment?
Summary of Ecological Terms

The surroundings of a plant or animal are called his ENVIRONMENT.

The plants and animals that live together and share an area are called a COMMUNITY.

The smaller area that one particular plant or animal lives in is called his home or HABITAT.

Each animal ADAPTS to his environment and this in turn changes his environment.
Every living thing is adapted to its habitat. Every living thing depends on something else in some way.

What happens to the plants and animals of the forest if this changes?

to this?
ONSITE ACTIVITIES

As has been indicated in the foregoing, inquiry oriented activities are a good way of conducting onsite activities. We suggest one of two methods:

1. Teacher-directed Exploration.

2. Preassigned Problem-Solving

As many teachers have experienced, a combination of these methods during a field trip can be effective.

Teacher-Director Exploration involves mainly exploration and discovery by the class along NESA trails seeing what is to be seen, stopping and observing closely things of particular interest (messing around with stuff), talking about what is being observed (getting ideas and messing around with ideas), and keeping notes on what is observed. Then going on to something else and repeating the process again. A series of such observations then forms the basis for later discussion which brings all the fragments and pieces of ideas together to form a picture of the NESA environment . . . like finishing a jigsaw puzzle. Student observations can be related by the teacher to established environmental concepts during actual observations or during later discussion periods.

Assisting the teacher in directing exploration is a Teacher's Trail Guide, contained in each NESA Resource Guide. The trail guide prepares the teacher for what will be encountered along the trail, also providing specific information on plant and animal life, natural processes, and so forth.

Preassigned Problem-Solving, the second type of inquiry procedure, is somewhat more structured than that just described. The activity is guided by specific action objectives and procedures, and requires compilation of fairly complete and organized data. While it requires more intensive study by the student, it may also provide a more thorough grasp of concepts. A lesson plan illustrating how a problem solving activity may be conducted begins on the next page.
SAMPLE NESA PROBLEM SOLVING ACTIVITY

Concept/Problem. A community is an assemblage of plants and animals living together, deriving life support from each other and their physical surroundings. The problem with understanding the community is that it can be a complex maze of organisms, inter-relationships, and physical factors. In order to begin to understand the community, these components must be understood. The community has both structure and function, and its components can be classified according to whether they are structural or functional. This classification can be the beginning of understanding of the community. Structure includes the type, quantity, and arrangement of plant, animal, soil, rock, water, etc., resources. Function includes such processes as energy cycles, food chains, nutrient cycles, predatory-prey relationships.

Objective. To observe and analyze the structure and function of the NESA community as an introduction to the community concept.

Sub-objectives and Procedures:

1. Pre-designated student groups will pace off 50' square study plots. Plots will be in shaded, wooded parts of NESA site. Plots should not overlap, but should not be too widespread. Corners of plots can be flagged with yellow surveyors tape.

2. Groups will record data on structural components of each plot, on observation cards. They will attempt to classify plants according to whether tree, shrub, grass, and flower. They will record the total number of each kind of tree, grass, etc., and the total number of all plants in each plot. It is not necessary to attempt to give specific names to the plants at this time, but might be attempted later back in class, based on recorded data.

Groups will record data on animal sign (animals are another structural component). This will include types of sign: sounds, feathers, droppings, tracks, burrows, carcasses, feeding, chewing, litter. They should include all types of animals . . . insects as well as birds. Any sign of human activity should also be recorded.

Groups will record data on physical surroundings (another structural component) including type of soil: sandy or clay, dark or light; average rock size: pebble, cobble, boulder; rock outcroppings; terrain whether level or sloping; location of gullies, streams, seeps. Will also record data on prevailing weather conditions.

3. While recording the above data, students will also look for and record evidence of functional components. This would include relationships between plants and animals, and physical surroundings, i.e., moss growing on a decaying log, assisting in decomposition; a beaver cutting on a tree; thick plant growth around a spring, etc. . . . anything that shows a sign of organisms affecting each other or being affected by their physical surroundings . . . wind-downed trees, for example.

4. Once having completed data on plots in wooded areas, students will select plots in open, meadow type areas and carry out the above observations. The purpose of this is to give the students some idea of how the composition of the community is affected by physical surroundings . . . sunlight is a main physical factor in open, meadow areas.
Note: Encourage students to use their imagination in making observations, to be uninhibited, and to note as much as possible. Form and neatness are not as important as gathering a wealth of information.

SOME QUESTIONS FOR DISCUSSION:

What were some of the things observed? Can some be identified using the rock, plant, and animal identification books? Is it hard to tell a tree from a shrub? Were there more shrubs in shaded or open areas? Were any live animals seen? What were they doing? Was there more animal sign in shaded or open areas?

What were some of the plant-plant, animal-animal, plant-animal relationships? Did you notice any organism-environment (physical surroundings affecting plants and animals or vice-versa) relationships? Would it be possible to make a diagram of plant and animal relationships in the plots... like maps of the plots were made? Former lake beds, windfalls, etc. account for some of the meadows and clearings in a forest... what are some of the other reasons? What are some ways in which plant and animal communities are similar to human communities? What are some of the main differences?

Below are some examples of data card format. Cards or larger could be used. The examples below are for a plot in a shaded wooded area.

<table>
<thead>
<tr>
<th>Plot E</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Animals (including human)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Further</strong></td>
<td>Description</td>
<td>Animal</td>
</tr>
<tr>
<td>Tree</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Small bush</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Shrub</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Feathers</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plot E</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Animals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Further</strong></td>
<td>Description</td>
<td>Animal</td>
</tr>
<tr>
<td>Tree</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Small bush</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Shrub</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Feathers</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plot E</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Animals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Further</strong></td>
<td>Description</td>
<td>Animal</td>
</tr>
<tr>
<td>Tree</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Small bush</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Shrub</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Feathers</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plot E</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Animals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Further</strong></td>
<td>Description</td>
<td>Animal</td>
</tr>
<tr>
<td>Tree</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Small bush</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Shrub</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Feathers</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plot E</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Animals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Further</strong></td>
<td>Description</td>
<td>Animal</td>
</tr>
<tr>
<td>Tree</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Small bush</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Shrub</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Feathers</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
The Environmental Strand Method is a learning tool which facilitates study of the MESA community when used in combination with the inquiry methods described in the foregoing. The strands are five broad, environmental concept categories . . . categories under which geological, ecological, and cultural processes and concepts in the MESA can be classified. The strands are:

Variety and Similarities  Continuity and Change

Patterns  Evolution and Adaptation

Interaction and Interdependence

One way of understanding what the strands are is to look at how they apply, for example, to the forest community. There are a variety of plants and animals inhabiting the forest, but based on similarities in form, color, etc., each can be classified into a relatively few groups. The community is organized into a pattern something like a mosaic; groves of trees interspersed with meadows and ponds. Also duck in flight, zigzag movements of a dragon fly, veins on a leaf, a spider's web . . . all are patterns with meaning. Plants interact with soil, air, sun, water for growth; animals interact with plants and other animals . . . forming life-supporting interdependencies. Over time the community changes, different types of plants and animals grow, but change is usually slow enough to life continuity. Organisms adapt to changes through evolution.

A good way of using the strands in teacher-directed exploration is for the teacher to memorize them or write them down and then recall them as you go along with the students to help you focus in your mind things to observe. As you walk along you may recall interaction and interdependence, for example, prompting you to look for an example or have your students look for one. Simple everyday things can suffice . . . an ant crawling up a stem . . . a bird flying around in tree tops. This relation of strands to concepts is discussed on page 41.

Questioning Strategy is also an integral part of the inquiry process. The following are "tried and true, all-occasion questions" that might be used:

Why do you think so?

How do you account for . . . ?

What reason can you give for . . . ?

What do you mean by . . . ?

What evidence is there here that . . . ?

How does this relate to . . . ?
When something of particular interest is encountered, the teacher might use the following sequence:

1. Ask open-ended questions:  
   What do you notice about . . . ?
   What do you see . . . ?

2. Ask focus questions:  
   Why are these things so?
   How do you account for . . . ?

3. Ask summary questions:  
   What can we say about . . . ?
   How can we summarize what we have been saying?

POSTSITE FOLLOWUP

Onsite inquiry activities have been primarily exploration and/or observation. There has really not been time for detailed analysis and discussion of what has been observed. Therefore, the time for discussion and followup on field activities is back in the classroom.

One activity might be to try and identify some of the plants and animal sign that has been observed using the various field guides that are available. Some of these, as well as ideas for other classroom activities, pre- and post-site, may be found in the section that follows . . .

MESAS STUDY MATERIALS.

Probably the most important part of post-site followup is teacher-directed class discussion. Whether the field trip has been Exploration or Problem-Solving oriented, the class will have gathered a great deal of information and data. Much of this information might seem unrelated, but when students compare and share their findings the scattered bits and pieces may begin to fall together to form a picture of the NESA community . . . how it is composed and how it operates.
MESA STUDY MATERIALS

BASIC GEOLOGICAL PROCESSES

BASIC ECOLOGICAL PROCESSES

STRAIDS AS CONCEPT CATEGORIES

NESA'S CLASSROOM SUBJECTS

BOOKS AND FILMS
Glacier National Park is one of the most significant representations of the physical processes of nature in the National Park System. It demonstrates the results of deposition of layer upon layer of sediments by ancient oceans, massive land deformation by internal earth forces, and the land sculpturing effects of streams and glaciers. In Glacier, these processes are so diverse and on such a scale as to significantly include many of the major concepts fundamental to general geomorphological understanding. In a sense, Glacier Park is an open textbook of geomorphology.

Geological concepts, as they pertain to Glacier, are arranged in three parts in the following. Discussed first is the concept of uniformitarianism and its significance to the park. The second category includes those concepts and processes having to do with the origin of sedimentary rock formations in the region, and their later uplift to create mountains. The third category includes those concepts and processes related to the wearing away of these formations and mountains.

Wherever appropriate, significant examples of how geological processes in operation in Glacier are related to the outside environment or discussed. This is done to show how a concept can be used as a vehicle...a thread tying Glacier's environment to that outside the park. This helps make understanding of Glacier's environment more meaningful in study of the total environment.

The following discussion of concepts follows in an order that generally corresponds to the historic sequence of geological events in the Glacier Park region.

The Concept of Uniformitarianism. This concept is one of primary importance because it pervades most of geologic thought and is vitally related to most geologic concepts. It is especially important to environment education because it is an indication of the validity of relating the park environment to the total environment. It is stated as follows:

The same physical processes and laws that operate today operated throughout geologic time, although not necessarily always with the same intensity as now.

The essence of uniformitarianism is that the present is the key to the past. Applying this to Glacier Park, physical processes such as glaciation in operation in the park today have been in operation in the past with greater or lesser intensity. The small glaciers existing in the upper valleys of the park are by no means as intense as those that carved the park landscape. But comparison of Glacier's valleys with the size of valleys that are presently filled with glaciers, such as in Alaska, can give an indication of the size and intensity of the ancient glaciers of the park.
Uniformitarianism is a key concept in environmental education, not only because it ties the present with the past, but because it also ties the present with the present. It infers that processes presently in operation in the park are related to similar processes presently in operation throughout the total environment. British geologist, John Playfair's statement that it is by the repeated touches of the same instrument (stream erosion) that this curious assemblage of lines (stream channels) has been so deeply engraved on the surface of the globe indicates that physical processes are contemporary with one another on a world-wide scale in any given period of geologic history.

Concepts of Sedimentation and Land Deformation

1. The majority of rock formations that compose the continents were created as a result of deposition of rock and mineral sediments by water; and subsequent compactions and cementation of these sediments into rock.

Sedimentary rock formations comprise about ninety percent of the total land surface of Glacier Park. They originated primarily as deposits in shallow pre-Cambrian seas once covering the park region, and include the Siyeh, Grinnell, Appekunny, and Altyn formations. Their exposure through processes related to uplift and erosion and present appearance as alternating horizontal layers on park mountainsides, are factors in the unique scenic qualities of the park.

2. Faulting commonly results in distinctive land forms because it elevates, lowers, tilts, or horizontally displaces blocks of the earth's crust, often along with their associated topographic features.

This is seen on a gigantic scale in the Glacier Park region. Horizontal displacement during Paleocene times (about 40 million years ago) resulted in a block of the earth's crust twenty miles wide by five miles thick being moved forty miles to the east of its original location (Ross, 1969). Known as the Lewis overthrust, this fault is of major significance in the topography of the region. The contrast in elevation between eastern plains adjacent to the park and Glacier's mountains is attributed to the creation of a high mountain range by the overthrust. The present mountains, still an imposing terrain feature, remain as the roots of this once high range now worn down by erosion.

3. Sedimentary rock formations and various types of land faulting and deformation are evident throughout the total environment and have a significant effect on the activities of man.

In addition to the superlative display of horizontal sedimentary formations exhibited in Glacier and other parks like Grand Canyon, there are other significant examples. These include the vast flats of some interior
basins of the western fault block mountain province, the mesas and buttes of the Arizona Four Corners area, the rolling expanses of the midwest Great Plains, and the southeastern coastal plain. All of these are more or less surface reflections of horizontal sedimentary formations. Conversely, the Sierra Nevadas, the Rockies, and the Appalachian ranges are significant results of land deformation in combination with other physical processes.

One effect of these terrain features and the relation between geological and cultural concepts on a broad scale is demonstrated in patterns of human settlement of the United States. In the early settlement of the Great Plains, populations became concentrated in a few widely scattered areas; whereas the eastern and western portions of the continent, which have been subjected to intense land deformation, became more densely settled. Closely related to this settlement pattern is the fact that lands relatively undisturbed by land deformation (such as the Great Plains), and having a certain combination of climatic variables, are conducive to agriculture. These lands have been a factor in the evolution of farming communities of the Great Plains and to the ultimate growth of grain and livestock centers such as Chicago, Omaha, and Kansas City.

By contrast, some lands that have been deformed are suited to an industrial-manufacturing type economy. Earth deformation is related to creation of highlands, along with exposure of metal and mineral deposits. Industry focuses on these types of lands in the harvesting of timber, extraction of metals and minerals, and fabrication of various products from these. These factors are involved in the evolution of manufacturing centers such as Pittsburg, Detroit, and Seattle.

Man’s adaptation to various geological environments, especially as promoted by his technological advances, often results in negative effects on his economy and environment. One of the classic historical examples occurred in the "dust bowl" times on the Great Plains. Although the plains are suited to agriculture, the soil is subject to rapid erosion when disturbed. The consequences of the absence of soil conservation procedures to the economy of the Great Plains in the 1930s is well known. The results of overlooking the potential of earthquakes in areas of major faulting and land deformation in the location of towns, highways, and utilities are also obvious, as is evidenced by the location of California towns along the San Andreas fault zone. Another example of a negative environmental effect occurs in mountainous regions, such as the Appalachians, which support heavy industry. Climatic factors which cause temperature inversions result in period of extreme air pollution in valley areas from industrial and other types of air-borne wastes.
Proper interpretation of present day landscapes is impossible without a full appreciation of the manifold influences of the geologic and climatic changes during the Pleistocene. (Thornbury)

Most of the earth's topography has been created during the Pleistocene period, which encompasses the last three million years of geologic history. Correlated with this topography are climatic and geologic changes through this time. There were at least four periods during the Pleistocene when the earth's climate was generally more cold and moist than today. Correspondingly, there are at least four stages of alpine and continental glaciation. Relative to Glacier National Park, there is geologic evidence that the general region experienced multiple glaciation during the Pleistocene, and it was during the Pleistocene that the major terrain of the park was carved by glaciers.

The combined effect of physical and chemical weathering processes results in the disintegration and decomposition of bare rock exposures.

Although alpine glaciation is primarily responsible for the steep terrain of the park, physical weathering serves to help maintain this steepness. It involves mainly the prying action on rock of water freezing and thawing in rock joints and cracks, and the expansion and contraction of rock from diurnal heating and cooling. The rock products of weathering in the park include mainly talus and scree slopes. Chemical weathering is prominent in the park, especially in the formation of soil in high alpine meadows, as well as for forest growth in lower elevations and on glacial moraines. One overall role of weathering, relative to stream erosion, is to loosen rock materials in preparation for their transportation by streams.

Running water, through the process of hydraulic action, loosens rock materials which are in turn transported by the water to abrade rock formations and assist in cutting stream valleys.

The action of running water in the form of streams and rivers is conspicuous in Glacier Park in two main stages. Stream action aided in wearing away the high surface of the Lewis overthrust, forming the later erosion surface known as the Blackfeet surface, which immediately predates the Pleistocene period. Stream valleys on the Blackfeet surface have, to a large extent, controlled the course of flow of Pleistocene glaciers. Following the retreat of the glaciers, stream action is now seen in the process of deepening the glacial valleys and wearing away glacial deposits. The recency of the retreat of the glaciers is seen in the fact that streams, such as upper McDonald Creek and upper St. Mary River, flow in relatively deep gorges and have not had time to begin cutting laterally to widen these gorges (Ross).
4. Glacier, through the processes of scouring and plucking, loosen rock materials which are, in turn, transported by the glacier to aid it in abrasion and gouging, to wear away rock surfaces and form glacial valleys.

The small glaciers that exist in the heads of valleys in Glacier Park are of recent origin and are not remnants of the larger glaciers of the Pleistocene. However, they and the permanent snowfields are an indication of the origin of glaciers. If the present climate were to trend toward cooling and increasingly longer winters, winter snow accumulation could eventually exceed spring and summer snow melting, leading to growth of existing glaciers and their extension down into the valleys.

The distinctive terrain of the park is characteristic of alpine glaciation. It includes steep, U-shaped valleys such as St. Mary, Many Glacier, and Waterton Valleys, glacial horns such as Mt. Wilbur and Mt. St. Nicholas, narrow arete walls such as the Garden Wall which separates glacial valleys, finger lakes such as Lake McDonald and St. Mary Lake. The topography of the park includes other distinctive glacial features such as pater noster lakes, hanging valleys, cirques, and glacial moraines.

One interesting example of the down-cutting power of glaciers is exhibited by Flattop Mountain which is believed to have once been the floor of an inter-mountain valley of the Blackfeet erosion surface (Ross). Glaciers wore down the terrain on either side of this supposed valley, leaving it high above the floor of the glacial valleys.

The great size of the alpine glaciers of the park is indicated not only by the size of their valleys, but by the fact that some extended beyond the mouths of these valleys onto the plains adjacent to the eastern park boundary. Their extent is evidenced in the long northeast trending glacial moraine ridges such as St. Mary and Milk River. The St. Mary Glacier is believed to have extended to within a few miles of the edge of the continental ice sheet in the vicinity of the Canadian border, as is suggested by its lateral moraines.

5. Various forms of weathering and erosion are evident throughout the total environment and have had their effect on the activities of man.

As is well known, indications of continental glaciation exists in the present topography and features of the Great Lakes, Northcentral and New England States, while evidence of alpine glaciation is most prominent in the Rocky Mountain, Sierra Nevada, and Cascade ranges. Following each glacial stage during the Pleistocene, were periods characterized by a general warming and withdrawal of glaciers. This resulted in many of the fluvial and lacustrine features of today, including the Great Lakes and the Mississippi River system. Many of the interior basins of Nevada and Utah were filled with lake waters during the interglacial periods. The high shoreline terraces of ancient Lake Bonneville in the Salt Lake region attest to the great extent and depth of this and of other Pleistocene lakes.
While regions of alpine glaciation such as Yosemite and Glacier National Park serve man mainly as parks and recreation areas, the effects of continental glaciation is a major factor in the economic activities of man. In some places continental glaciers have stripped the land bare of soil, making minerals and metals more available for extraction, while in other areas it has enriched the soil for agriculture. Congruently, the action of glaciers in breaking down rock surfaces has resulted in the availability of seemingly endless supplies of sand and gravel for construction purposes. The Great Lakes and Mississippi River system play an important role in man activities, the most prominent being their obvious advantages for transportation of industrial and agricultural products.

The greatest overall net effect of weathering of rock materials occurs in the development of soil. The effects of physical weathering versus chemical weathering manifests itself in the contrast between the extent of development of soils in arid or semi-arid regions compared to humid regions. The soils of the southwest, for example, are relatively underdeveloped . . . this being due in part to the fact that its climate is not appropriate to the processes of chemical weathering. Chemical weathering proceeds most efficiently where there is an ample amount of moisture to react with mineral substances in the breaking down of rock into soil-size particles. The effect of late Pleistocene climate, as related to weathering and soil formation, on the subsequent activities of man is evidenced by the extent of agricultural development in areas of well-developed soil horizons.

The complex interrelation between soil, watershed, and stream management is seen not only in Glacier National Park, but throughout the total environment. Soil erosion, floods, and stream quality are directly related to the condition of adjacent watersheds. Watersheds and associated plant growth are maintained in a natural state in Glacier Park. As a result, when compared to areas where the functioning of watersheds has been impaired, there is a lower frequency of floods, lower water levels during floods, stable stream channels, and streams relatively free of sediment. All of these factors contribute greatly to the overall balance of environmental quality of the park. Urbanization, on the other hand, interrupts the function of watersheds, covers over-drainage basins with concrete and asphalt surfaces which are impervious to water, and channels water into artificial drainage systems. This results in increased frequency of floods, higher water levels during floods, widened and unstable stream channels, and waters clogged with sediments (Leopold, All of these things have a direct impact on the economy of the urban region as well as its cumulative environmental quality.
In the preceding discussion of geological concepts and their relation to man and his environment there is one concept which, like uniformitarianism, is common to all others. This concept is intrinsic not only to geological concepts, but to biological concepts pertaining to the environment. Said concept is that of balance, and may be stated as follows:

Left alone, natural processes tend to offset and equalize one another. Geological processes that create land forms are countered by other geological processes that wear away land forms. Biological processes that propagate organism populations are balanced by other biological processes that limit population growth.

In Glacier National Park the scales were tipped in favor of high terrain with the occurrence of the Lewis overthrust. However, equalizing physical processes such as streams and glaciers have worn away most of this highland. Such has happened continuously throughout geologic history. Lands are created by sedimentary and igneous processes and frequently uplifted to create mountains and highlands. But even as this is occurring, erosion is in the process of wearing these lands away.

Physical processes also serve to control the balance of forest and plant growth and associated animal species in the park, as well as all other natural environments. Plant and animal communities are also controlled by internal biological checks and balances to maintain even distribution and numbers.

When considering the concepts presented in this paper the true essence of Glacier National Park becomes apparent. This essence is its great environmental quality resulting from a balance both within and between physical and biological processes. It is a balance that, when viewed as a whole, approaches ecological perfection. The significance of this to environmental education in its concern for understanding of the non-park environment is that balance among population, technology, and physical and natural environments appears to be an ecological necessity in maintaining overall environmental quality.
Life is a very precious thing to all of us. Many of our activities are directed toward survival. The basic ingredients for survival are air, water, food, and shelter. But where do these things we take for granted come from? Just turn on the tap for water, go to the store for food and clothes, and buy a house from the real estate man. It’s simple! Or is it? What if we did not have the stores and piped water? What would we do if we had only our ingenuity? The answer is not difficult for, as our ancestors did, we could hunt and fish for meat. We could use roots, berries, and other plants for food and medicine. We could use trees for houses and skins for clothing. We could go to streams and lakes for water. It is obvious that our own survival would be dependent upon other living things. Even though few of us gather our own food from the land anymore, it is still obvious that we are dependent upon the natural environment. To go one step further, the survival of all living things ultimately depends upon four major components; air, soil, water, and sun. These are the basic strands in the Web of Life, the strands to which all living things are attached.

Figure 1. The Web of Life

The Web of Life is made up of all the organisms and environmental factors on earth. But this is an extremely complex system and, in order to gain an understanding of the Web of Life, we must examine only a small part. By understanding a part, such as one of the study areas, we can then have an appreciation for the total structure and our relationship with it.
Figure 2. GREENHOUSE EFFECT. The sun's energy comes to earth in short wavelengths to which the atmosphere is "transparent." Some of this energy is absorbed by materials at the surface of the earth, warming the surface. The warmed surfaces radiate energy in the form of long, infrared wavelengths to which the atmosphere is not "transparent." Clouds and carbon dioxide absorb these infrared wavelengths and reradiate about half this warm energy to the earth's surface. In other words, the warm air is "trapped" near the earth's surface. The same thing happens when you leave your car parked in the sun with all the windows rolled up. It will be much warmer inside than outside. Because of the greenhouse effect, the average temperature of the world is 60° F, instead of -7° F.
Let's consider the four basic fibers in the Web of Life. All living systems require energy to carry on life's processes. This energy comes from the sun. But we cannot get our energy directly from the sun. (If we could, just think how simple it would be for a man to feed his family.) We must depend upon other organisms for our energy. Only green plants can convert the sun's energy into usable energy for other organisms. All green plants, from the pines around you to the tiny plankton in lakes or streams, contain chlorophyll. The chlorophyll traps the sun's light energy so that it can be used to convert carbon dioxide and water into simple sugars. This process is called photosynthesis. Not only does photosynthesis make sugars, but it releases oxygen to the environment.

Here is a direct relationship between plants and animals. Plants use carbon dioxide and give off oxygen, while animals (including people) use oxygen and give off carbon dioxide. Plants also use oxygen in the process of respiration.

In the burning of fossil fuels (fuel extracted from the earth, for example, coal and oil) oxygen from the atmosphere is consumed and replaced by an equal amount of carbon dioxide. This may seem beneficial at first—more carbon dioxide for the plants to make more food and produce more oxygen. But the plants can only use so much. If oxygen is used up faster by combustion than it can be replaced by plants, the ratio of carbon dioxide to oxygen is about 1 to 100. Therefore, the replacement of a seemingly insignificant amount of oxygen by carbon dioxide would result in a very significant increase in carbon dioxide. This excess carbon dioxide contributes to the greenhouse effect (Figure 2), which may serve to raise the temperature around the earth. If a temperature increase becomes too extreme, there could be some serious consequence.

The replacement of plant communities with city communities can also contribute to a change in the oxygen-carbon dioxide ratio. As more carbon dioxide replaces oxygen and more plants are eliminated, the possibility of change in this ratio is very real. Since animals (including people) cannot utilize carbon dioxide the way that plants do, the results could be drastic.

There is then, a delicate balance between carbon dioxide and oxygen. If the balance is disrupted, the whole Web of Life will be affected. If you've ever gone to a higher altitude, you have probably noticed some difficulty in getting enough air. The greater the altitude, the less oxygen there is in the atmosphere. So, breathing is more difficult due to decreased availability of oxygen. Within limits, the human body can acclimate to these differences and can soon be operating efficiently again. However, if the level of oxygen is decreased enough (so called "thin air"), humans cannot acclimate. A severe enough decrease in oxygen would result in suffocation.

Sun and air are still not enough. Water also is a critical ingredient for survival. It takes water, as well as carbon dioxide and light energy, to
form sugars. These sugars are both stored in the plant and used by the plant for its growth and metabolism. Some of what is stored by the plant is utilized by other organisms eating that plant. Thus, part of the energy stored is passed on to another organism and the rest is given off as heat energy.

Oxygen and carbon dioxide can be dissolved in water, as well as found in air. This is why many kinds of plants and animals can survive in water. They have developed certain structures (such as gills) with which oxygen or carbon dioxide can be taken up from the water. Oxygen can be dissolved in the water in a variety of ways. Rapidly moving water will become aerated easily. One would expect more oxygen in a stream with many rapids than in a lake or slow moving stream or river. Another means of getting oxygen into water is from the photosynthetic activity of the submerged vegetation. Dense mats of waterweed and pondweed can be found in the quiet pool areas of a stream or in parts of a lake. Closer observation will reveal the presence of algae. All these plants contribute oxygen in the daytime when photosynthesis takes place.

The colder the water, the greater the amount of oxygen that can be dissolved in it. Some fish (for example, trout) are found in cold water. If put in warm water, they will die. This is due to both the increased temperature and insufficient oxygen (the fish's activity will also increase causing it to require more oxygen.) So, aquatic animals also depend upon a balance of elements in their environment.

Sometimes when certain substances, such as phosphates, get into the water, they act as fertilizers and cause excessive plant growth. It would seem that this would be good, for then more oxygen could be made. But, since death is an important part of the life cycle, proportionately more plants will be dying. Dead plants are broken down by certain kinds of bacteria and the numbers of these bacteria will increase rapidly. In order to function, the bacteria require oxygen. The greatly increased number of bacteria will serve to deplete the oxygen supply which will, in turn, cause the oxygen-needing animals to die. This process is called eutrophication and is what happens in polluted streams and lakes.

Balance in the environment is like that of a tightrope walker...slight changes in balance are inevitable in a viable system, but a major change practically assures disaster.

Water constantly moves in a cyclic pattern. Moisture from the land and sea is evaporated and carried into the atmosphere, forming clouds laden with water. When these clouds meet cold air over Glacier National Park, the moisture is condensed and falls as rain or snow. The water saturates the soil, from which it is transported via roots throughout the plants for use in photosynthesis. Water is not only used by the plant, but also given off (transpiration) as an end product of respiration. And so, the water is again returned to the atmosphere.
Water in the soil not used by plants continues to soak in until reaching a permanently saturated level known as the water table. Since pioneer days, this level has decreased from 8 feet to 20 feet below the earth's surface and in one western state is 58 feet below. Other water is stored in ponds and lakes where it provides homes for many creatures. It flows down streams and rivers where eventually it will reach the sea and begin the cycle all over again.

The fourth basic fiber is soil. The soil provides support for the plants. But more than that, soil is nature's warehouse of nutrients. All the minerals and organic materials necessary for life are found in the soil. What nutrients are present will vary with the type of soil and location. This is one reason why different kinds of plants are found in different areas. Plants do not really "take" nutrients, but, rather, "borrow" them. The plant dies and is broken down by bacteria, the minerals and organic materials are returned to the soil for use by other organisms. Even when eaten by animals, the "borrowed" nutrients in the plants will be used by the animals and eventually returned to the soil to be used again.

Soil is formed in many ways. Glacial action is one important method. As huge ice masses move and carve the valleys, the broken rocks and dust pile up along the sides and foot of the glacier. These piles are called moraines. Some of the ridges in Glacier are ancient moraines that have become covered with vegetation. Other processes also work to make soil from rock. The alternate freezing and thawing serves to crack and break apart rocks. Stream action will break down rock by the constant tumbling and banging together of rocks. If you have ever stood on the bank of a creek or river during a flood, you will see rocks of many sizes from boulders to sand grains.

Some plants are able to grow on rock and hence also help in soil formation. These plants, called lichens, are crusty looking and come in many different colors. Lichens and also mosses secrete a weak acid which allows the plant to get the minerals and contribute to the breakdown of the rock. Dead plants and dust particles collect in cracks and eventually enough soil is accumulated for larger plants to take hold.

It is green plants that gather and organize the basic units of sun, soil, air, and water into vehicles for the transfer of energy to all living organisms. It is the green plants that complete the framework of the Web of Life.
Energy is transferred from plants to other organisms through what is known as the food chain. Figure 3 shows an example of a food chain. This, of course, is highly simplified, for each link in the chain shown is linked to many other chains. There are basically two types of organisms. The producers are those which are capable of trapping some of the sun's energy to make their own food and make energy available to other organisms. Producers are all green plants (including algae and phytoplankton.) Consumers are all other organisms, whether they eat plants, insects, carrion, etc.

Energy transfer is not 100% efficient, however. With each transfer of energy, most is lost as work and heat. Roughly, only about 10% of the stored energy is passed on. In other words, it would take ten pounds of plants to produce one pound of insects (see Figure 3.) The same thing is true with each transfer and so, ten pounds of insects would have to be consumed to make one pound of trout. Ten pounds of trout would have to be consumed to make one pound of man. You can see that through this food chain it would ultimately take 1,000 pounds of plants to make one pound of man.

If we take our food chain to completion, we see that all nutrients are eventually returned to the soil for further use. For, when an organism dies or waste products are deposited, the decomposers get to work and break down all the complicated molecules to their simple components. These components are then used again in the growth of new plants and the cycle begins again.

Another interesting aspect of the food chain is the food pyramid. The producers are obviously going to be the most numerous since all other forms of life are dependent upon the producers. And, since there is a loss of usable energy with each energy transfer in the food chain, then the farther along the food chain we look, the fewer the numbers of organisms there will be. If we once again think of the food chain in Figure 3, and express it in terms of numbers, we get a pyramid shaped structure (Figure 4.)
Figure 3. Food Chain

Figure 4. Food Pyramid
ENVIRONMENTAL STRANDS AS CONCEPT CATEGORIES

As mentioned previously, the strands are five broad categories under which environmental concepts can be classified. Listed below are the strands and a few concepts taken from various sources. Most of the concepts are, in themselves, self-explanatory and can form the basis for lesson plans which delve deeply into the community environment.

Variety and Similarities

1. Many likenesses and differences occur among living and non-living things.

2. A variety of functions, sizes, and structures exist in plants, stars, rocks, animals, and people.

3. A variety and diversity of plants and animals in a community is an indication of community stability.

4. Environmental management involves the application of knowledge from many different disciplines. *

5. A knowledge of the social, physical, and biological sciences and humanities are important for environmental understanding. *

6. A variety of institutional structures are involved in planning and managing the environment. *

7. Ready transportation, growing interest, money surpluses, and increased leisure that combine to create heavy pressures on existing recreation facilities and demands for new ones. *

8. Water supplies, both in quantity and quality, are important to all levels of living. *

9. Mineral conservation involves the utilization of all known methods of using the minerals of the earth's crust that will cause them to serve more people for a longer time. *

10. Wildlife refuges, undisturbed natural area, and preserves may be of value in protecting endangered species and perpetuating the gene pool. *

11. Wildlife populations are important economically, aesthetically, and biologically. *

* Fundamental Concepts of Environmental Education (K-16)
by Robert Roth
Patterns

12. Patterns of things in the environment are spatial, as in design; functional as in use; and organizational, as in grouping.

13. Organizational patterns are kinds of structures that may be found in rock formations, as well as social groups of people, animals, and even plants.

14. Functional patterns include traffic movements in a city street, the formation of wild ducks in flight, the arrangement of desks in a classroom, or the veins on a plant leaf.

15. Individuals tend to select short-term economic gains, often at the expense of greater long-term environmental benefits.

16. Natural resources, water and minerals in particular, are unequally distributed with respect to land areas and political boundaries.

17. Historically, cultures with high technological development have used more natural resources than those with lower levels of technological development.

Interaction and Interdependence

18. The environmental consists of six basic interrelated things: sun, air, soil, water, plants, animals.

19. Green plants are the ultimate sources of food, clothing, shelter, and energy in most societies.

20. The assemblages of plants and animals living in a given area of land make up a community.

21. Living things are interdependent with one another and their environment.

22. Natural resources are interdependent and the use or misuse of one will affect others.

23. Opportunities to experience and enjoy nature are psychologically rewarding to many and are important to mental health.

24. The individual must develop his ability to perceive if he is to increase his awareness and develop environmental perspective.

* Fundamental Concepts of Environmental Education (K-16) by Robert Roth
25. We have legal ownership of some resources like real estate, and control over others during our lifetime, but ethically we are stewards rather than owners of the resource base. *

26. Individual citizens should be stimulated to become active in political processes. *

27. The culture of a group is its learned behavior in the form of customs, habits, attitudes, institutions, and lifeways that are transmitted to its progeny. *

28. Many has psychobiological and biosocial needs. *

29. Man has a moral responsibility for his environmental decisions. *

30. Conservation responsibilities should be shared by individuals, businesses, industries, special interest groups, and all levels of government and education. *

31. Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles. *

32. Man has responsibility to develop an appreciation of and respect for the rights of others. *

33. Energy is supplied to an ecosystem by the activities of green plants. *

34. Maintaining, improving, and in some cases, restoring soil productivity is important to the welfare of people. *

35. As populations increase, competition for the use of water increases resulting in a need for establishing water use priorities. *

36. Pollutants and contaminants are produced by natural and man-made processes. *

37. Safe waste disposal, including the reduction of harmful and cumulative effects of various solids, liquids, gases, radio-active wastes, and heat is important if the well being of man and the environment is to be preserved. *

38. Conservation policy is determined by the interaction of science and technology, social and political factors, and aesthetic, ethical, and economic considerations. *

* Fundamental Concepts of Environmental Education (K-16)
by Robert Roth
Continuity and Change

39. Everything on earth is part of a continuing cycle of change... oceans, lakes and rivers change, the rocks change, the weather changes, animals and plants change, and even people change.

40. Geological processes like erosion and deposition modify the landscape.

41. One of the main processes that continually changes the face of the land is the erosive forces of water.

42. Water and wind have been the primary natural forces in the forming of the white sands.

43. The rate of change in an environment may exceed the rate of organism adaptation. *

44. Most resources are vulnerable to depletion in quantity, quality, or both. *

45. Soil is classified as a renewable resource, but because it may take a few years to thousands of years to be renewed, it is more practically termed a depletable resource. *

46. As populations increase and/or as resource supplies decrease, the freedom of the individual to use the resources as he wishes decreases irrespective of the form of government. *

47. Family planning and the limiting of family size are important if over-population is to be avoided and a reasonable standard of living assured for successive generations. *

48. Increasing human populations, rising levels of living, and the resultant demands for greater industrial and agricultural productivity promotes increasing environmental contamination. *

49. The management of natural resources to meet the needs of successive generations demands long-range planning. *

50. Increased population mobility is changing the nature of demands upon some resources. *

Evolution and Adaptation

51. Evolution is a slow process by which organisms physically change.

52. Adaptation is the successful interaction of an organism with its environment, making it fit to live in its environment.

* Fundamentals Concepts of Environmental Education (K-16)
by Robert Roth
53. An organism is the product of its heredity and environment. *

54. Man is influenced by many of the same hereditary and environmental factors that affect other organisms and their populations. *

55. All living things, including man, are continually evolving. *

56. Succession is the gradual and continuous replacement of one kind of plant or animal complex by another and is characterized by gradual changes in species composition. *

57. Architecture can be one of the positively persuasive influences in developing a congenial environment.

* Fundamental Concepts of Environmental Education (K-16)
by Robert Roth
SOCIAL STUDIES

1. Energy Flow
Have students bring in food cartons, wrappers, and containers. Group containers into types of foods, etc. Determine where these foods come from. Trace back to dependence on soil, water, and light.

2. Ecology
Find out what a bounty is. Does Montana have a bounty system? On what? What do these animals eat? What is their place in the community? How would a bounty system affect the ecology of an area? What is the purpose of a bounty system? Does it work?

3. Ecology
Find out what the arguments are about for using pesticides to control insects. What do you think? Do all pesticides have the same effect and staying power?

4. Succession
Succession is the orderly change of a community—its plants, animals, and physical conditions—through different stages. (For example: Beaver pond → wet field → dry field → bushy area → woods.) Find areas where succession has visibly been interrupted. Predict the future of the area following the normal lines of succession.

5. Biomes
Make a list of biomes (major worldwide ecological units such as the desert, tropical forest, etc.) Investigate the lives of several plants and animals found in each. Discover their adaptations and changes. Find out about different conditions of climate and weather through the seasons in the biome. Are there species in these biomes which occupy the same niche or resemble each other due to similar surrounding conditions? Compare to countries or cities of the world.

6. Niches
Niche refers to the role an organism plays in a community—its habitat, food, predators, home, habits, contributions, and withdrawals. Figure out the "niches" of different people in a city community (Niches in a city might include location, profession, functions performed in the community.) Who are the producers of the different goods and services? Who are the consumers?
7. Cycles  
Hand out signs labeled Bear Grass, Coyote, Bacteria (Decomposers), Mineral (Inorganic Matter), Squirrel, to any students in any order. Have the labeled students stand in front of the groups and the rest of the class try to put them in various orders. Objective is for the students to discover logical biological patterns, one of which would be Mineral Bear Grass Squirrel Coyote Bacteria Mineral. Once orders have been established short cuts might be developed and discussed.

8. Changes  
Fall or Spring—How many birds and of what kinds can be seen in an area in a certain length of time? If this is done repeatedly over a couple of months time, some conclusions might be drawn about migration patterns, etc.

9. Community  
Find examples of symbioses (relationships of two types of living things) in the world around you. Determine whether they are parasites, commensals, or mutuals. Parasites—one organism benefits at the expense of the other (worms in apples, mosquitoes on people, fleas on dogs and cats.) Commensals—one organism benefits, but is not harmful to the other (robin in trees, fly larvae in goldenrod galls.) Mutuals—both organisms benefit from each other (bees on flower, lichens, red squirrels and pine trees.) List and diagram as many symbionts as you can find.

10. Community  
How many types of communities and micro-communities can you spot from your classroom window? Around your school yard? (Low, wet areas; north-facing sites, bare playground, etc.) What lives in each? Draw some of these communities and their inhabitants, and connect food webs in them with a string.

11. Community  
Choose an animal. Keep in mind such animals as robins, spiders, gophers and ants as well as the less common. Observe it in its habitat. Determine its food requirements, the time of day it feeds, the type of home it uses, and what it does for the winter. Also consider its resting habits and other things.

12. Community  
Find out how insects are important to other animals and plants. Divide the class into groups and have each group list any five insects they may find. Each group is responsible for finding out what the insects on its list do, eat, and where they live.
13. Community

Study the interdependence of plants and animals using snails and Elodea. (Available at a fish store.) Place a pond snail alone in one container of water with a sealed top. Place some Elodea in a similar size sealed container. Place a snail and some Elodea in a third sealed container. Observe for at least ten days.

14. Community

Get some water from a pond or puddle and look at it with and without a microscope. How many different organisms can you see each way? Draw them and tell how they are adapted to life in a pond community. What do they eat? What eats them? This may be done with soil, also. If no pond or puddle is available, a "hay-infusion" can serve the same purpose. From a dried-up area (ditch, puddle) secure a handful of dried vegetation. Include roots if possible. Put this in a container of water and allow to stand for three or four days. Begin sampling after the third day and keep track of population changes as they occur. (To speed up reaction: add a teaspoon of table sugar to one quart of water and use this for the infusion.) Live materials from the infusion can be cultured in sugar water (same strength) to which a pinch of dry yeast has been added.

15. Community

The teacher and students can find pictures of outdoor scenes of animals, forests or ponds. Conceal all of one plant's or animal's surroundings by cutting out an outline of the object and putting it over the picture. Have the students who have not seen the total picture guess or describe what they think the environment of the plant or animal is like. Let them describe or name plants and animals that could be in the background. Remove the covering to show the whole picture. What clues to the plant's needs or the animal's way of life does the picture of the environment now give you that you did not have before? What surrounding animals or plants help to keep it alive?
1. Community

Find out some of the community dependence relationships between the Blackfeet Indians and the American bison. What happened to the Indians when the bison was overhunted? What happened to the wolves which followed the herds?

2. Changes

Determine what changes have taken place on the school ground. What was there before the school was built? What was found there the first year after the school was built? What is there now that is new?

3. Changes

Try to obtain aerial photos of your school area. Compare older ones with newer ones. What caused the changes?

4. Changes

Investigate to discover what is happening in your area to modify the ecosystem. The ecosystem is the units of living and non-living things which interact to produce a stable system. In this system, exchanges of elements and compounds (water, oxygen, carbon, etc.) follow a circular path or cycle. Think of ways man's activities affect and change this system. Determine the long-range results for some of these changes. What action must be taken to stop or remedy these changes if they are harmful? How could you affect such action? How do they or will they affect you?

5. Changes

Find pictures showing changes. Construct a chart or bulletin board comparing:

- Your area - 10 years ago vs. the present
  - Pioneer Montana and 1970's Montana

- Animals - adult and young

- Day and night

- Seasons
MATHEMATICS

1. Habitat

All water environments are not the same. Find out what the differences are between the habitats of a trout, a sucker, and a sculpin. In what habitat are the most fish? What are the kinds of fish? Why? The student would take into consideration temperature, depth, food supply, water movement, and whether the body of water is a lake or stream.

2. Community

Make a study of a tree near your home or on your school grounds. In a notebook, record everything you discover about the tree. What kind of tree is it? Where does it grow best? What lives on or with it? Draw the tree at different seasons. Title this, The Ecology of a Tree. This project can be carried on for a whole year and many activities could result from the observations: sketching the tree; measuring its height, diameter, and leaf growth; or studying the soil under the tree.

3. Community

Examine a leaf litter or soil community for tiny animals by using a Berlese funnel. Place a fine mesh screen (¼" or smaller--window screen is good) across the small opening of a large metal funnel. (Funnel can be constructed from a clorox bottle.) Fill the funnel with leaf litter or soil collected outside, place the small opening over a jar with at least ⅛" of 70% alcohol in the bottom and put a 100 watt light bulb near the large opening. Allow this to stand for at least 12 hours. Then, using a hand lens or microscope, examine the animals trapped in the alcohol. (For a more complete description, see J. Youngpeter, Winter Science Activities; or Hone, et. al., A Sourcebook for Elementary Science. A more scientific approach would include adding insects to sterile soil, using the Berlese funnel to recover them and computing the percent of success to determine the success with "wild" samples.)
SCIENCE

1. Cycles
Transpiration phases of the water cycle can be demonstrated by placing a plastic bag over a house plant. Moisture will condense on the inside of the plastic bag. Remember that the plant will need an air supply if this is to remain for some length of time.

2. Food changes
Find out about food requirements of grown-up and immature birds (example, robins.) Do they remain the same? Do the same for a frog, a butterfly.

3. Food Web
To watch decomposers in action, simply let some food (such as a slice of moistened bread or a piece of fruit) sit in a warm damp dark place for a few days. What is happening? What is making it happen?

4. Community
Place a bird nest in a container such as a wide mouth gallon jar, baking dish, etc. Using a sprinkling bottle, water the nest periodically to keep it moist. In a short time seeds in the nest will sprout and grow. This may give you some indication of what seeds were in the mud and/or what vegetation the bird used in the construction of the nest. Children may be quite surprised to see a bird nest growing.

5. Community
Make an observation or collection of plant galls. Make notes in a field notebook about the types of plants and the location of the galls on the plants. The galls may be kept on the stem or leaf and placed in a glass of water in a cool room (60 to 70° F.) Surround plant and glass with nylon stocking, net or cheesecloth. If insect hatches, try to learn something about interrelationships and life cycles of both plant and insect.

6. Community
Show community interrelationships with the following activity: Pass out signs labeled Sun, Green Plant, Pine Tree, Chipmunk, Caterpillar, Mouse, Hawk, Decomposers, etc., to different members around the class. Have the class tell what the relationships are (Is the hawk related to the tree? How?) Take a ball of yarn and connect each relationship with yarn until the whole room is tangled up. Ask questions like "What would happen to the other members of the community if all the Pines died?" (Have the "Pine Tree" drop all his pieces of yarn.)
7. Adaptation  Watch a goldfish for a while. Describe the adaptations you observe that the fish has for life in the water.

8. Adaptation  Get tadpoles and watch them develop into frogs. What are the adaptations fitting them for each type of life? (You can buy tadpoles at many pet stores or collect them in late spring.)

9. Adaptation  For a variation of #8, get tadpoles from the same source. Keep one group at room temperature and one at a slightly higher or lower temperature. See if you can observe a difference in growth rate.

10. Adaptation  Put a pond snail in a dry jar for one day and then return it to water. How does it react to both situations?

11. Adaptation  Collect some soil from different places (forest, rich field, beach area.) Label each pot. Try to grow the same kind of plant in each one. Treat all pots the same way. What kind of soil is your plant adapted to grow in? Try the same activity with several kinds of plants.

12. Adaptation  Catch a caterpillar. Place in a cage and supply with proper fresh leaves daily. Watch it construct a cocoon or crysalis, noticing its adaptations. Keep over winter in a cool place and observe the adult emerge in the spring. What are the differences in the niches occupied by caterpillar and adult?

13. Adaptation  Discover how a tree is adapted to its climate. Why doesn't freezing weather kill the tree? Does its growth pattern take advantage of the climate? What structures protect the tree?

14. Physical Factors  To show that some plants need light to grow, conduct an experiment with potted plants over a period of time. Obtain a pair of similar plants. Place one in a completely dark place. Keep the other plant in the light. Water both the same. Observe daily for one or two weeks. Notice if there is any color or growth difference in the plants. Explain.

15. Physical Factors  Locate thermometers at and below soil surface in shade and in sunlight. Record temperatures periodically. Discuss the differences in temperature and how they might affect living things.
6. Physical Factors
Have students make daily (or more frequent) observations of some object (or objects), and record their observations over some period between a month to a year. Examples: (1) Development and change of birds in a nest. (2) Development and change in a particular plant. (3) The plant and animal communities in several different environments. A few cautions: Don't attempt too much; select something which may show appreciable change; refresh your memory on scientific "controls;" design an adequate record-keeping system.

17. Physical Factors
List the different parts of the environment in the classroom and at home. List the different parts of the environment of a tree outside the school. Compare the lists. Which factors are the same? What factors are different?

18. Physical Factors
Cover completely several leaves of a plant by clipping black paper around them. Place the plant in light and water as needed. After two weeks, take paper off and check leaf color. Is there a difference? What is it? What does this have to do with chlorophyll and light?

19. Physical Factors
Examine some soil. Some methods of separating soil include: simple sorting under microscope or hand lens; stirring in water and examining the layers as they settle from the water; baking the soil for a long time in a very hot oven to remove the organic matter and leave the minerals. This activity could be further developed by using different soil samples from strongly contrasting areas such as lawn, a forest, a playground, a sand beach.

20. Physical Factor
Think of ways that weather affects and changes your own lives, as well as those of other living things. Consult weather and cloud charts and learn how to interpret weather maps in daily newspapers. Then give a report to the class.

21. Environment & Physical Factors
People can control many parts of their environment. How do you control yours? (houses, coat, etc.) How does a bird? (nest-building) How does a chipmunk?

22. Changes
Ask the students to see how many examples of "soil making in action" they can find. Can they find soil being made in the city?
leaves decay, crumbling logs, pond filling in, rock with lichens, grass next to sidewalk, grass coming through sidewalk
COMMUNICATION AND ART

1. Adaptation

What kind of adaptation is migration? Choose a bird that migrates, and pretend that you are that bird. Tell where you go, when, what you find.

2. Cycles

Pretend you are a molecule of $\text{CO}_2$, $\text{H}_2\text{O}$, carbon, $\text{O}_2$, calcium or nitrogen and tell the story of your cyclic travels orally or in a composition or drawing.

3. Adaptation

Seeds show adaptations for dispersing the species of plant. Make a poster with a collection of seeds telling how they are adapted to travel.

4. Adaptation

Study "Evergreens". What is an evergreen? Do evergreens lose their leaves during winter? Do evergreens always have needles for leaves? Are all evergreens conifers? Are all conifers evergreens?

5. Adaptation

Find some specific examples of protective adaptations which keep the organisms from being noticed (mimicry, protective coloration, camouflage, color changes.)

6. Changes

Construct dioramas showing:

A. Before and After changes where some housing development replaced a community or to show how fire changed a climax community.

7. Ecology

The student who likes photography or has a camera may wish to take photographs of the following to illustrate a report dealing with ecology. Or a student may wish to tape the sounds of nature.

A. Forests or fields in various stages of succession
B. Stream inhabitants
C. Plants in various communities
D. Animals or plants, emphasizing certain adaptations.
8. Succession  
Make an original class mural showing the plant succession (the orderly change of a community through different stages) from pond to woods. Draw in the kinds of birds and animals you might find in each area.

9. Adaptation  
Invent an animal adapted for life in a pond, woods, air, or stream. Draw it in color, name it, and explain the useful adaptations you gave it.

10. Community  
Birds depend on other life for material for their nests. Collect some bird nests in autumn and see if you can figure out what bird built them. List the materials used in making them. Compare lists. Following are some other activities using old bird nests: Take a bird nest apart. Try to put it back together again. Can you do as well as the original builder? Using only bill and feet how do you think the bird did it? Be sure to put the nest outside after you have finished, as other birds may want to use the materials.
1. Publications dealing with the geology and ecology of Glacier National Park for sale by the Glacier Natural History Association (some are available in local bookstores).

Adventures in Environment, 80 pp  Rocks, Ice & Water - The Geologic Story of Glacier, 218 pp
Animal Tracks in Glacier, 57 pp  Glaciers, 73 pp
Birds of Glacier, 49 pp  Checklist of Vascular Plants of Glacier, 63 pp
Mammals of Glacier, 37 pp  
Wildflowers of Glacier, 47 pp  Birds Field Checklist of Glacier, 4 pp *
Trees and Forests of Glacier, 49 pp  Mammals Field Checklist of Glacier, 4 pp *

2. The following are various publications from various sources dealing with ecology and geology in general.

Our Living World of Nature Series, McGraw Hill
Living World Books Series, Lippincott
Peterson Field Guide Series, Houghton-Mifflin
Golden Nature Guide Series, Western Publishers

3. Some films and slides available on loan from Glacier National Park.

Glacier National Park, set of 30 slides with text on history and natural history of the park.

Glacier Legacy, 16mm colored film on the works of glaciers, 27 min.
So Little Time, 16mm colored film on conservation, 23 min.
... and others

4. Some filmstrips on geology and ecology from other sources:

Earth Science Series, McGraw-Hill, six filmstrips

* No charge.
Apgar NESA is a quite, forested area of the park near Park Headquarters. Although spectacular mountain peaks can be seen in the distance, most of things in the Apgar area are on a lesser scale. These are the 'everyday' things that are often overlooked in nature. They are the types of plants and animals that in essence form the backbone of the park's ecological scheme. McDonald Creek flows through here, silently eroding its banks and bed. The sun, air, soil, water, plants, and animals here make up a community of living things interacting with and interdependent on one another.

There are things that are unique about the area. In fall thousands of salmon migrate up McDonald Creek to spawn and die. These are preyed upon by hundreds of eagles that come at this time also. Other types of animals stalk the banks and waters of McDonald Creek to prey on salmon. Altogether for a month or two in the fall the Apgar area displays one of the most unique examples of animal interaction to be found anywhere.

In 1929 the Apgar area was almost completely burned over by forest fire. What was once a cedar-hemlock forest is now mainly lodgepole pine. The area was replanted in lodgepole pine seedlings in the 1930s by the Civilian Conservation Corps (CCC). Some faint remains of the CCC Camp are the main evidence of man's impact on the area.

Apgar NESA is an area that can be used to introduce students to the natural environment and to illustrate man's effect on the environment.
INTRODUCTION

This guide has been prepared for use by teachers in preparation for and directing student learning activities in the Apgar NESA. Included are a NESA Trail Guide, resource drawings and diagrams, a list of geological and ecological concepts keyed to features along the NESA trail, and suggestions for student problem-solving learning activities.

The resource information (geological and ecological facts) contained in this guide discussed in more general detail in "Adventures in Environment at Glacier National Park - Teacher's NESA Classroom Guide."

Many teachers read both guides, this and the classroom guide and then use the information as a basis to develop student inquiry-learning activities. To assist in development of these activities, suggestions for student problem-solving activities are included in this guide. Hopefully, these will enable the teacher to act in the capacity of director of learning activities in the NESA, to help the students find facts and answers for themselves.

CONTENTS

Geological and Ecological Concepts

NESA Map and Trail Guide

Eagles and Salmon Story

Resource Drawings and Diagrams

Suggested Student Inquiry Learning Activities

NESA LAYOUT

Please refer to the map on the next page for the NESA layout. The NESA is transected by three trails: The Woodland Loop, The Meadow Loop, and the Bike Trail. Total hiking distance along these trails is about two miles.
ECOLOGICAL AND GEOLOGICAL CONCEPTS

Listed below are established geological, ecological, and conservation concepts. These are from various sources including textbooks. The concepts are cross-referenced with the numbered sections in the Trail Guide.

A. Running water, through the processes of hydraulic action, loosens rock materials, which, in turn, are transported by the water to abrade rock formations, cut stream-canyons and valleys, and wear away the land. (Sec. 4)

B. Layered rock formations are the result of deposition of rock and mineral sediments (sand grains, etc.) by water and other agents, and later compaction and cementation of these sediments into rock. (Sec. 4)

C. Physical and biological factors in an area determine the type of life forms present. (Sec. 4)

D. Each life form is adapted through the processes of evolution to survive under certain sets of physical and biological conditions. (Sec. 4 & 5)

E. The assemblage of plants and animals living in a given area of land make up a community. (Sec. 7)

F. Living things are interdependent with one another and their environment. Ecosystems are communities tied together with nutrient-energy transfers and exchanges. (Bald Eagle-Salmon Food Chain Diagram).

G. Ready transportation, growing interest and awareness, money surpluses, and increased leisure combine to create heavy pressures on existing recreation facilities and demands for new ones. (Sec.1)
MAP AND TRAIL GUIDE

The Mesa Trail Guide is divided into sections. The Woodland Loop Trail and the Meadow Loop Trail. The numbered sections below explain the geological, botanical, and man-made features seen along the trail. The explanations are necessarily short and designed to promote student discussion and involvement.

The trail begins at the bus parking area. Look for the bright fluorescent orange markers on trees to get started in the right direction and to stay on the right trail.

The large canyon adjacent to the bus parking area is for People and horses. People might use this canyon to enter and exit the park. How do people come to the park each year? What are the purposes of this national park? How do horses on trails affect the park's wildlife? The horse management is necessary even in national parks. The park is

In the process of putting new utility lines underground. How do these underground utilities preserve the scenery? How burial utility lines preserve the scenery and the wildlife.

For safety's sake on the trail, Ahead. The students get ahead of their group leader.
The NESA Trail Guide is divided into two sections: The Woodland Loop Trail and the Meadow Loop Trail. The numbered sections below explain the various geological, ecological, and man-made features seen along the trails. The explanations are necessarily short and designed to assist the teacher to promote student curiosity -- and engage them in exploration and discussion about the features.

The Woodland Loop Trail

1. The trail begins at the bus parking area. Look for the bright fluorescent orange markers on trees to get started in the right direction and to stay on the right trail.

The large corral adjacent to the bus parking area is for park concession horses during summer. People rent horses here for trail rides. The teacher might use this to lead into a discussion of how people use national parks. Over a million people come to the park each year. What is the impact of this number of people on the resources of the park? How do campgrounds affect the park? How do horses on trails affect the park? How about the thousands of automobiles? (CONCEPT G)

Notice the utility lines overhead -- and the wide swath through the forest cut for these. These lines and those buried underground here bring electricity and water to the Apgar area. These things are necessary even in national parks. The park is now in the process of putting many utility lines underground. How does this help preserve the scenery? How would burying utility lines preserve the scenery of city and town areas if this were done?

FOR SAFETY'S SAKE ON THE TRAIL AHEAD . . . DON'T LET THE STUDENTS GET AHEAD OF THEIR GROUP LEADER.
2. YOU ARE NEARING THE FIRST CLEAR VIEW OF MCDONALD CREEK. THE TRAIL WILL BREAK OUT OF THE PINE FOREST INTO A SMALL CLEARING. LOOK FOR SIGNS OF MAN'S EFFECT ON THE ENVIRONMENT HERE.

Notice the barren exposed mounds that look like piles of gravel. Why are these bare of vegetation while other places are covered? Notice to the left as you break out into the clearing, what seems to be an old road, now partially grown over, coming toward the river. Could the piles of gravel have been gravel pits from which gravel was hauled using the old road? Or did the river scrape the vegetation from the gravel here during a flood? Have the students 'mess around' with some ideas and see if they can come up with some hypotheses.

Look for other signs that man has used the area here . . . litter, old boards and planks, cut tree stumps. Anything else?

3. THE FEW SCATTERED PINE TREES ALONG THE TRAIL LEADING FROM THE CLEARING ARE LODGEPOLE PINE. LOOK AT THE LONG SLIM NEEDLES, TWO TO A BUNDLE. THIS IS CHARACTERISTIC OF LODGEPOLE.

This type of tree is one of the first to grow after forest fires have burned an area. There are signs of the old 1929 forest fire here. Have the students find examples.

Refer to the plant diagrams as an aid in identifying other plants growing here. Most are shrubs in this area of the trail.

The group may encounter some straight, limbless logs lying near the trail. Look closely at them. Did they get here naturally? These are old utility poles. How can you tell?
Notice the ground to the left of the trail slopes steeply upward and is heavily forested. If you were able to walk along the top of this small ridge (it's too thickly covered with trees to do this easily) you would come to places where there are steep drop offs into the river. What does this tell you about the ridge? How was it formed? Remember, rivers erode and cut steep banks in places . . . but the river isn't flowing here right now. Could it have been here at one time? (CONCEPT A)

4. YOU ARE NOW ABOUT ONE-HALF MILE FROM WHERE YOU LEFT YOUR BUS. YOU ARE GETTING CLOSE TO THE RIVER AGAIN. BE CAREFUL, THE RIVER IS DEEP ALONG THE BANK HERE. IN PLACES YOU CAN SEE WHERE IT HAS FORMED DEEP AND SUDDEN DROP OFFS IN ITS BED.

Why did the river erode so deeply here? One hole here is about 8 feet deep. Refer to the concept on running water and the one on layered rock formations. Do you see layered rock formations on the streambed? Can you imagine how the power of the moving water may have loosened large chunks of rock from these formations, eventually scouring out this deep hole? Notice the river currents here -- how they swirl and eddy. (CONCEPTS A & B)

As you proceed along here, notice the charred tree stumps from the 1929 forest fire.

There are a lot of shrubs in this vicinity. Refer to the plant diagrams. Most of the high, thick shrubs are willows. The medium-sized shrub with dark red bark is red-osier dogwood. Why do you suppose only shrubs grow here, while on the ridge to the left there are mainly pine-type trees? What are the physical factors here? Along the trail it is flat and swampy. The soil is moist. On the ridge the soil is well-drained and dry. What does this tell you about the type of soil that shrubs like versus soil that the pine trees like?
5. THE TRAIL VEERS SHARPLY TO THE LEFT AWAY FROM THE RIVER. IT CLIMBS UP THE RIDGE AND BACK INTO THE FOREST.

You are now back into the lodgepole pine forest. Notice how straight and tall they grow in places. Why are they green at the top with dead limbs on the lower trunks? (Trees, as they grow taller and taller, shade out their lower parts and the lower limbs die from lack of sunlight ... only the upper parts exposed to sunlight remain alive and green). (CONCEPT D)

In some places along the trail here you will notice large patches of jumbled, fallen, broken dead trees. What happened is a good question. Possibly high, cyclone-like winds.

6. SHORTLY YOU WILL ARRIVE AT THE BIKE TRAIL. YOU HAVE COMPLETED THE WOODLAND LOOP TRAIL. STANDING ON THE BIKE TRAIL YOU CAN LOOK BACK TOWARD THE BUS PARKING AREA. YOU PROBABLY DIDN'T REALIZE YOU ARE SO CLOSE TO WHERE YOU STARTED.

FROM HERE THE TRAIL GOES BACK INTO THE WOODS FOR A SHORT DISTANCE, ALONG THE TOP OF THE CUTBANK, AND THEN BREAKS OUT INTO THE LARGE MEADOW.

The Meadow Loop Trail

7. BE CAREFUL AS YOU NEAR THE EDGE OF THE CUTBANK. IT DROPS OFF STEEPLY INTO THE RIVER. THIS IS A GOOD PLACE TO GET A LOOK AT WILDLIFE, SO APPROACH THE CUTBANK QUIETLY.

Looking into the creek at the edge of the cutbank you will notice a large beaver lodge. It appears to be a helter-skelter pile of tree branches and twigs. As you explore this vicinity, look for signs that beavers have been active. This would include freshly-chewed tree stumps and branches.
If the water in the creek near the beaver lodge is muddy, this is a sign that the beavers are active. One other animal that shares this beaver lodge is the muskrat. In fall they swim back and forth from the lodge gathering moss. (CONCEPT E)

The metal frame on the edge of the cutbank is for a canvas blind for viewing eagles in the fall.

8. THE BIG BEND IN THE CREEK HERE IS KNOWN AS A MEANDER. NOTICE THAT THE WATER IN THE MEANDER IS BARELY MOVING. MOST OF THE FRESH FLOWING WATER IN THE CREEK BYPASSES THE MEANDER, FLOWING ACROSS ITS NECK. WHEN THE MEANDER IS COMPLETELY CUT OFF, IT WILL BE AN OXBOW LAKE.

What do you think causes meanders to form in the first place? Why do streams that seem to be flowing fairly straight, bend to the right or left all of a sudden? Did the stream cut its own channel or is it flowing in a channel that existed before the stream?

9. THE TRAIL WILL SOON BREAK OUT INTO THE LARGE MEADOW. THE MEADOW IS NOT REALLY A MEADOW IN THE ALPINE SENSE. IT WAS ONCE A HORSE PASTURE. BEFORE THAT IT WAS THE SITE OF A LARGE CCC CAMP (see photo opposite). BEFORE THAT CAMP AND THE 1926 FOREST FIRE THE MEADOW WAS PROBABLY FORESTED.

Located in the meadow are many signs of man's past activities in the park, mostly related to CCC activities. Look for old building foundation remains, old roads and trails, water storage facilities. Look at the big trees in the middle of the meadow. Did they grow naturally here or were they planted?

The meadow is a good place to carry out group problem solving activities, such as the Community Problem, Making a Map of the NESA, or Classifying Land Capability. See the section of Student Problem-Solving Activities for examples and suggestions.
Photograph of the CCC Camp that was located in the Apgar NESA meadow in the 1930s. Photo was taken from out in the meadow looking back toward Belton Hills. Notice there are few living tall trees; they are mostly small. The small ones extending clear to the base of the hill were planted by the CCC after the fire. See if you can locate some of the old foundations of the buildings shown in the photo.
THE EAGLES & SALMON STORY

The story of the eagles and salmon is a classic example of an ecosystem with interdependent relationships. Eagles rely on salmon as a primary source of food, while salmon live in streams and rivers where eagles hunt. This interdependence is crucial for the survival of both species and the ecosystem as a whole.

In the early days, the salmon population was thriving, providing abundant food for the eagles. However, as humans began to exploit the environment, the salmon population began to decline due to pollution, habitat destruction, and overfishing. This decline had a direct impact on the eagles, as their primary food source was becoming scarce.

To address this issue, conservation efforts were initiated. This included the protection of salmon habitats, restoring degraded streams, and implementing sustainable fishing practices. As a result, the salmon population began to recover, and so did the eagle population.

This story serves as a reminder of the importance of maintaining a healthy ecosystem and the interdependence of all its components. It also highlights the role of human intervention in preserving the balance of nature.

In conclusion, the eagles and salmon story is a powerful example of how interconnected our natural world is, and how our actions can have a significant impact on the survival of species and the health of our environment.
Each fall large numbers of bald eagles concentrate along McDonald Creek to feed on spawning kokanee salmon. The non-native salmon were planted in the Flathead Lake by the Montana Fish and Game Department around 1912. Since the mid-1930s the salmon migrate each year up the Middle Fork of the Flathead River and lower McDonald Creek to spawn, a distance of 60 miles.

Salmon feed on zooplankton (microscopic, suspended animal life) in Flathead Lake, but do not eat while spawning. Shortly after spawning, they die.

Bald eagles were first observed to congregate here in 1939. As many as 373 bald eagles have been counted in one day, making this the greatest known concentration of bald eagles in the contiguous United States. Bald eagles are only found in North America with an estimated total population of about 3,700.

The eagles generally begin to arrive in late September, reaching a peak in late November. In the beginning there are often more immature than mature eagles. The immatures are all dark and are often confused with golden eagles, which are rarely seen along McDonald Creek. The bald eagles do not become fully mature for seven years at which time they attain the typical adult plumage of white head and tail.

During this period the bald eagles are scavengers, feeding almost exclusively on dead and dying salmon. They generally ignore the abundant ducks, gulls, and magpies.

The eagles roost in areas along McDonald Lake and arrive at the creek at dawn. Unless disturbed, they stay until dusk, alternately eating salmon and resting. They prefer perches overlooking the creek and will swoop down to the water and pluck a fish out or wade in to get one. They fly to a perch, stand on their catch, and tear off strips of meat.

It is thought that the eagles may be migrating from Canada to more southern states, but this is not certain.
Another scavenger of dead salmon observed in recent years is the grizzly bear. Apparently most grizzly activity is in the early morning and late evening, but these bears can be out at any time. The grizzlies stay around to feed on the salmon until they are all gone, even when there is snow on the ground. Once the salmon are gone, the bears den up for the winter.

The above diagram is a very simplified illustration of energy relationships. All life requires energy which initially comes from the sun to plants, from plants to plant eaters (herbivores), from herbivores to meat eaters (carnivores and scavengers) and from scavengers and carnivores to decomposers (bacteria and fungi), and back to plants in the form of soil nutrients. Thus, through death, the cycle of life continues. (CONCEPT F)
RESOURCE DRAWINGS & DIAGRAMS

Stream erosion features.

Mammals and birds.

Common trees.

Common shrubs.

Fungi

Insects
Diagram of a meandering creek. Notice how the meander below has been bypassed by the river to form an oxbow lake. This is the process which will eventually cause the Big Bend in McDonald Creek in Apgar NESA to become an oxbow lake.

Photograph of oxbow lakes being formed by a river in another locality.
MAMMALS & BIRDS

Bald Eagle

Canada Goose

Red Squirrel

Chipmunk

Grey Jay

Steller's Jay

Clark's Nutcracker
Lodgepole pine - two needles in a bundle. Most common tree in Apgar NESA.

White pine - five needles in a bundle.
Englemann spruce - stiff, spiky needles.

Douglas fir - flat, blunt needles.

Western larch - sheds needles in fall.
Black cottonwood.

Paper birch.
Common shrubs

Sageleaf willow (*Salix candida*).

Thinleaf alder (*Alnus incana*).

Common snowberry (*Symphoricarpos albus*).

Douglas hawthorn (*Crataegus douglasii*).
American devil's club (Oplepapax hirridum).

White stemmed gooseberry

Red oyster dogwood

Mountain maple (Acer spicatum).

Western thimbleberry (Rubus)
INSECTS

DRAGONFLY

BLACK FLY

MIDGE

MOSQUITO

CADDISFLY
STUDENT INQUIRY LEARNING ACTIVITIES
Understanding the Plant & Animal Community

Concept/Problem. A community is an assemblage of plants and animals living together, deriving life support from each other and their physical surroundings. The problem with understanding the community is that it can be a complex maze of organisms, inter-relationships, and physical factors. In order to begin to understand the community, these components must be understood. The community has both structure and function, and its components can be classified according to whether they are structural or functional. This classification can be the beginning of understanding of the community. Structure includes the type, quantity, and arrangement of plant, animal, soil, rock, water, etc., resources. Function includes such processes as energy cycles, food chains, nutrient cycles, predatory-prey relationships.

Objective. To observe and analyze the structure and function of the NESA community as an introduction to the community concept.

Sub-objectives and Procedures:

1. Pre-designated student groups will pace off 50' square study plots. Plots will be in shaded, wooded parts of NESA site. Plots should not overlap, but should not be too widespread. Corners of plots can be flagged with yellow surveyors tape.

2. Groups will record data on structural components of each plot, on observation cards. They will attempt to classify plants according to whether tree, shrub, grass, and flower. They will record the total number of each kind of tree, grass, etc., and the total number of all plants in each plot. It is not necessary to attempt to give specific names to the plants at this time, but might be attempted later back in class, based on recorded data.

Groups will record data on animal sign (animals are another structural component). This will include types of sign: sounds, feathers, droppings, tracks, burrows, carcasses, feeding, chewing, litter. They should include all types of animals ... insects as well as birds. Any sign of human activity should also be recorded.

Groups will record data on physical surroundings (another structural component) including type of soil: sandy or clay, dark or light; average rock size: pebble, cobble, boulder; rock outcroppings; terrain whether level or sloping; location of gullies, streams, seeps. Will also record data on prevailing weather conditions.

3. While recording the above data, students will also look for and record evidence of functional components. This would include relationships between plants and animals, and physical surroundings, i.e., moss growing on a decaying log, assisting in decomposition; a beaver cutting on a tree; thick plant growth around a spring, etc. ... anything that shows a sign of organisms affecting each other or being affected by their physical surroundings ... wind-downed trees, for example.

4. Once having completed data on plots in wooded areas, students will select plots in open, meadow type areas and carry out the above observations. The purpose of this is to give the students some idea of how the composition of the community is affected by physical surroundings ... sunlight is a main physical factor in open, meadow areas.
Understanding the Plant & Animal Community (cont’d)

Note: Encourage students to use their imagination in making observations, to be uninhibited, and to note as much as possible. Form and neatness are not as important as gathering a wealth of information.

SOME QUESTIONS FOR DISCUSSION:

What were some of the things observed? Can some be identified using the rock, plant, and animal identification books? Is it hard to tell a tree from a shrub? Were there more shrubs in shaded or open areas?
Were any live animals seen? What were they doing? Was there more animal sign in shaded or open areas?
What were some of the plant-plant, animal-animal, plant-animal relationships? Did you notice any organism-environment (physical surroundings affecting plants and animals or vice-versa) relationships? Would it be possible to make a diagram of plant and animal relationships in the plots... like maps of the plots were made? Former lake beds, windfalls, etc. account for some of the meadows and clearings in the forest... what are some of the other reasons? What are some ways in which plant and animal communities are similar to human communities? What are some of the main differences?

Below are some examples of data card format. Cards or larger could be used. The examples below are for a plot in a shaded, wooded area.

<table>
<thead>
<tr>
<th>PLOT 1 PLANTS</th>
<th>PLOT 1 ANIMALS (INCLUDING HUMAN KIN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TREES</td>
<td></td>
</tr>
<tr>
<td>Total Type 9</td>
<td>Total Shrubs 12</td>
</tr>
<tr>
<td>Total Trees 24</td>
<td></td>
</tr>
<tr>
<td>Remaining: Fungi on dead logs</td>
<td>Relationships: Undisturbed</td>
</tr>
<tr>
<td>SHRUBS</td>
<td></td>
</tr>
<tr>
<td>Total Type 2</td>
<td></td>
</tr>
<tr>
<td>Total Shrubs 12</td>
<td></td>
</tr>
<tr>
<td>PLANT-PLANT RELATIONSHIPS</td>
<td>ANIMALS</td>
</tr>
<tr>
<td>Tree stump</td>
<td>Small tree, chewed, chewed</td>
</tr>
<tr>
<td>Small holes in ground</td>
<td>Small tree, chewed, chewed</td>
</tr>
<tr>
<td>Fungus</td>
<td>Scattered about, no signs</td>
</tr>
<tr>
<td>Rotten plants</td>
<td>Scattered about, no signs</td>
</tr>
</tbody>
</table>

Below are some examples of data card format. Cards or larger could be used. The examples below are for a plot in a shaded, wooded area.
ACTIVITY: Making a map and inventory of Apgar NESA.

OBJECTIVE: Understanding the necessary steps in environmental and urban land planning.

To introduce the concept that environmental planning requires skills of people with various training.

PROCEDURE: The class could be broken into groups or teams with each team having a geologist, ecologist, recreational planner, engineer, economist, etc. (These are some of the skills necessary in planning).

Geologist makes map of the area showing relief and other geological features.

Ecologist makes a map showing the distribution of forested places, meadows, types of trees.

Recreational planner could decide where to put recreational facilities.

Urban planner where to put neighborhoods, streets, etc.

Engineer make map showing existing roads, trails, utility lines.

Economist determines costs of things to be put in.

STUDENT DISCUSSION: If the planning had been left to one individual only, what would the finished plan look like.

A geologist might concentrate on mines, an ecologist on preservation, an engineer on bridges, streets, etc.

Why is it necessary to have different types of planners? How do you maintain balance in the environment?
ACTIVITY: Study of water

OBJECTIVE: Understand what water is, where it comes from, what it can do, the need for it.

PROCEDURE: From meadow overlooking McDonald Creek...the big bend...or down by shore of creek (See map).

How has the water shaped the land here...cut a meander...formed an island? What will happen in the future here?

Look for other water...soil moisture, puddles, clouds.

Look for aquatic life under rocks in creek, in puddles.

Discuss purity of water. Is the water good for drinking? What might be in it to make it unsafe?
ACTIVITY: Understanding man's influence on Apgar NESA site.

OBJECTIVE: Determining the changes man has caused in the area.
Record examples of man's influences that are observed.
Determine how the water, soil, plants, and animals have been affected.

PROCEDURES: Class is broken into groups, teams, or pairs.
Groups explore and observe; record things that man has done or left behind.
After about 20 minutes groups come together for discussion.
Each group will give an example of what they saw and how it might have affected the environment.

OTHER QUESTIONS FOR FOLLOW-UP DISCUSSION:
Is Glacier National Park good for man? Why?
Is man good for Glacier National Park? Why?
What can be done to balance park use with park preservation?
ACTIVITY: Involvement with nature through the various senses.

OBJECTIVE: To use all the senses to be aware of one's surrounding environment.

To introduce the student to the concept that a variety of sights, sounds, etc., providing they are complement to the senses, enhance the quality of the environment.

PROCEDURE: Look, touch, smell, feel... Intensely.

Write impressions, describe them verbally.

Compose a poem.

Create a story which was influenced by the area.
ACTIVITY: Leaf awareness. Leaves and needles of trees help identify the names of trees.

OBJECTIVE: Look at various leaf patterns as an introduction to the concept that there are many different patterns in the environment. (See explanation of environmental strands).

Understand a basic step in tree identification.

PROCEDURE: Students in teams with pencil and paper. Walking along trails will sketch and trace outlines of leaves or pine tree boughs. Then will compare the various types of patterns.

RESULTS: Although this activity may not result in exact identification of plants, it can be used to place plants in broad categories.

Two categories would include leaf-bearing trees and needle-bearing.

Another group of categories would be tree, grass, shrub, flowering plant.

Depending on the skill of the class the categorization might be carried to exact identification of the plant.
**IS IT A WASP? IS IT A FLY? IS IT A BEETLE?**

- On a warm, sunny day watch flowers for visiting insects striped yellow and black. Some may be wasps, but not all are necessarily wasps.

- **WASPS** have four wings and can sting. Certain common wasps are striped yellow and black—warning patterns that tell birds, and us, to let them be.

- **FLOWER FLIES** resemble wasps by wearing similar yellow and black stripes. Flower flies, however, have only two wings and cannot sting.

- **SOME BEETLES**, like flower flies, gain protection by resembling stinging wasps.

- In nature many things that sting are poisonous, or just taste nasty, have bright warning patterns so that other animals may quickly learn to leave them alone. A few "mimics" such as the flower flies share the benefits of the scheme.

**Find a Flower Fly**

- **WASPS** have four wings and can sting. Certain common wasps are striped yellow and black—warning patterns that tell birds, and us, to let them be.

- **FLOWER FLIES** resemble wasps by wearing similar yellow and black stripes. Flower flies, however, have only two wings and cannot sting.

- **SOME BEETLES**, like flower flies, gain protection by resembling stinging wasps.

- In nature many things that sting are poisonous, or just taste nasty, have bright warning patterns so that other animals may quickly learn to leave them alone. A few "mimics" such as the flower flies share the benefits of the scheme.

**Learn Animal Tracks**

- **MULE DEER**

- Night prowlers may be identified by their tracks. Look for these signs of animal activity in mud or sand near the edge of the water of sea, lake, or stream.

- **SPOTTED SANDPIPER**

- *Tracks shown are not to scale.*

- **MUSKRAT**

- See how many different kinds of tracks you can find and identify. Make sketches and record the different animal tracks you see.

- **GLAUCOUS-WINGED GULL**

- Make a collection of plaster casts of animal tracks. Ask a Park Naturalist to tell you how to do this.

- **RACOON**

- **BEAVER**

- **GREAT BLUE HERON**

**Find the Singing Insects**

- On hot summer days or evenings the "songs" of insects are often heard. See if you can find what made the song and how it was done.

- Approach the "songster" with care. Don't use a flashlight until you are sure there is an insect nearby. Turn on the flashlight to see what is singing.

- **SNOWY TREE CRICKET**


- **COMMON OR BLACK CRICKET**

- Sings day or night—mostly in coastal areas. Males sing. Another grasshopper relative.

- **CICADA**

- Males sing on hot days in dry pine forests and sometimes elsewhere. Look like a big fly.

- **LOCUSTS AND GRASSHOPPERS**

- Some make loud clicking sounds as they fly.

- See if you can observe how the insect makes its "song."

- Try to locate the female that mister insect is "serenading.

- None of these insects will-bite or sting, so don't be afraid to examine them.
“Read” a Tree

- Find a smooth-cut stump or log end, and look closely at the pattern of growth rings.

  - There is a layer of wood for each year of growth. Some trees kinds will show light spring wood and dark summer wood in each year’s growth. Count annual rings low on the trunk to find the tree’s approximate age.

1. Drought years cause occasional narrow growth rings.
2. Crowding causes zones of narrow rings.
3. A leaning tree has rings narrower on one side than the other. A tree on a clearing edge may have similar uneven rings.

- Look for branches deep within the wood—also for insect and disease damage.

What kind of life has your tree had?

Find a Pine Tree

- All pines have long needles, and these are joined at their bases into bundles of two, three, or five.

  - Lodgepole pines have two needles.
  - Yellow pines have three needles.
  - White pines have five needles.

- These are our common native pines. One of these grows in your neighborhood.
  - Two more grow only on high mountains—
    - Limber pine,
    - White-barked pine,

- Both of these have five needles.

- Several pines from other parts of the world are sold for garden use. Books in your public library will help you name them.

Find a pine near your home or summer camp.

Name it from its needles.

Learn to Know the Cones

- Can you find five kinds of cones today?

  - Two species, both pines, have a prickle on each cone scale.
    - Lodgepole pine cones are 1 to 2 inches long.
    - Ponderosa pine cones are 3 to 5 inches.

- The cones of all true firs (Abies or “bal-sams”) fall apart as they dry on the tree.

- No other species has cones as large as We-tern white pine. They are 8 to 10 inches long.

- Most native spruces have distinctive cones, 1 to 4 inches long, with papery scales, often wrinkled, and ragged at the edges. In the Interior, white spruce has a soft cone 1 to 2 inches long, with smooth scales.

- Two trees have small cones only an inch or less long—
  - Western hemlock cones have 18 or more scales.
  - Western red cedar cones have only 9 or 10 scales.

- When most cones dry out, they open and the seeds escape. Open a closed cone to see where the seeds are kept.

Look at Lichens

- Can you find five kinds of cones today?

  - Two species, both pines, have a prickle on each cone scale.
    - Lodgepole pine cones are 1 to 2 inches long.
    - Ponderosa pine cones are 3 to 5 inches.

- The cones of all true firs (Abies or “bal-sams”) fall apart as they dry on the tree.

- No other species has cones as large as We-tern white pine. They are 8 to 10 inches long.

- Most native spruces have distinctive cones, 1 to 4 inches long, with papery scales, often wrinkled, and ragged at the edges. In the Interior, white spruce has a soft cone 1 to 2 inches long, with smooth scales.

- Two trees have small cones only an inch or less long—
  - Western hemlock cones have 18 or more scales.
  - Western red cedar cones have only 9 or 10 scales.

- When most cones dry out, they open and the seeds escape. Open a closed cone to see where the seeds are kept.

- Every lichen is a plant partnership being part fungus and part algae.

- How many kinds can you find?

Lichens grow on rocks, trees, living trunks, and fallen logs, as well as on the ground. Many people confuse lichens with mosses. Black, yellow, and grey “mosses” which festoon trees are really lichens. They are not feeding upon the tree’s substance.

- A hand lens or magnifying glass will help you to better see and appreciate the world of lichens.

- Lichens may be broad and leaf-life (foliose), shrubby (fruticose), or crust-like (crustose).

- How many kinds can you find?
Consider the Sand

- Sand is so commonplace that we seldom stop to think about it, yet it, too, has an interesting story to tell.
- Look closely at a handful of sand. Use a magnifying glass if you have one.

Most sand particles are white. These are bits of quartz (silica), a hard white mineral that is the most abundant material in Earth's crust. Window glass is made from quartz.

Are the sand grains angular, or are they rounded like nearby pebbles? (Most sand grains have changed little since they broke from their parent rock, perhaps high in the mountains.)

- Watch for ripple marks left by waves. Wind leaves similar marks on dry, sandy deserts.
- Scan the beach or a stream mouth at low tide. See how sand is found in some places, gravel in others, and larger boulders in still other places. Can you explain how they got sorted out?

Look at Rocks

- Rocks may carry their own story of how and where they were formed. Pick one up and read its story.
- Is it rounded and smooth or rough and irregular?
- Smooth rocks were tumbled together in rushing torrents or rounded by wave action.
- Jagged rocks have not been in tumbling water for any length of time, perhaps not at all.
- Does your rock consist of layers or bands?
- Layered rocks are usually formed of sediments on the floor of vanished lakes or seas.
- If not layered, it is probably "igneous" and was forced to the earth's surface as molten rock that has since cooled.
- Is it coarse or fine grained, hard or soft?
- Granites are examples of hard coarse-grained igneous rocks. They contain imperfectly crystallized particles.
- Sandstones are soft, coarse, sedimentary-type rocks, often having visible layering.
- Many hard, fine-grained rocks are igneous, and may have been part of a lava flow.
- Softer fine-grained rocks with visible layering may have been slits which have become slate, argillite, etc.
- Rock classification is complicated, but these observations may help you make a start.

How Far That Storm?

The next time you see lightning and then hear thunder, you can figure out how far away the flash was.

Light travels so fast that you saw the lightning the instant it was there. But it takes sounds, like thunder, about 5 seconds to travel 1 mile.

5 seconds for 1 mile.
10 seconds for 2 miles.
15 seconds for 3 miles.

So for every 5 seconds between lightning and thunder, the flash is a mile away.

- Use a watch, if possible, to tell you the number of seconds. You can also use a watch to help you learn to count at just the right speed to count seconds. Try it.
- Count 15 seconds and it was 3 miles away. Count 7 or 8 seconds and it was about 1½ miles away. When the flash and crash are close together, you know it's close.

Be a Cloud Watcher

- Clouds may warn of weather changes. Note the kind and amount of cloud, then see what weather arrives in the next 24 hours.
- CUMULONIMBUS are heaped clouds with flat bases and castle-like tops.
- CUMULONIMBUS are anvil-topped cumulus bringing thunder and rain.
- CIRROUS are white featherly lines or bands at great height.
- STRATUS are layer clouds usually smooth and dark.
Petticord, David V
Implementation and evaluation of the NESA program at Glacier National Park, Montana