1964

Dry-Plains Conservation: an activity or experimental method of teaching soil and water conservation in Southwestern Dry-Plains natural science classrooms.

David W. Pierson
Fort Hays State University

fort hays studies

science series no. 4
september 1964

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fort hays studies—new series
science series no. 4
september 1964

Fort Hays Kansas State College
Hays, Kansas

Library of Congress Card Catalog No. 64-63579

David W. Pierson

Biographical Sketch of Author

Before coming to Fort Hays Kansas State College as an Assistant Professor of Biology, the writer was a graduate student and instructor at the University of Missouri, Columbia. Previous to this graduate work, he taught high school science subjects in Iowa and Colorado for 9 years, and he has taught General Biology at Monticello College, Godfrey, Illinois.

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Preface

It should be stated that no one experiment, demonstration or activity can fit *all* given situations. Therefore, some modification of the presented activities may be both desirable and necessary.

The activities included in Chapter III are presented in the hope that they will provide suggestions relevant to what has been done by one teacher who teaches in the region, and personal experience does indicate that students can learn when such activities are used for instructional purposes.

Acknowledgement: The maps which appear on pages 8 and 9 and Problems Numbered 5, 6, and 7 have appeared previously in *The American Biology Teacher*, Vol. 23, No. 4, April, 1961, pp. 206-8.

Acknowledgements

Acknowledgement must be given the various co-operating State Departments of Education and State Departments of Fish and Game. The study would have been impossible without the excellent co-operation received from these agencies.

A special note of thanks is extended to Dr. H. Seymour Fowler, Associate Professor of Science Education, Pennsylvania State University; likewise to Drs. Charles E. Lively, Chairman Emeritus, Department of Rural Sociology, The University of Missouri and Ralph K. Watkins, Professor of Secondary Education, Emeritus, The University of Missouri, Columbia.

The patience of G. W. Tomanek, Chairman, Division of Biological Science, Fort Hays Kansas State College, Hays, with the writer's impatience during the preparation of the manuscript is greatfully acknowledged.

DAVID W. PIERSON,
Ass't. Prof. of Biology,
Fort Hays Kansas State College,
Hays, Kansas

January 30, 1964.

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Chapter I

Introduction

This study is predicated upon four assumptions: (1) every individual who resides in the dry-plains region should have some understanding of the environment in which he lives, how he influences this environment, and how the environment, in turn, influences him; (2) the most suitable place to acquire many of the concepts which underlie an understanding of one's environment is in the classroom; (3) each inhabitant of the dry-plains region must develop an understanding of the importance of soil and water conservation in a region of marginal fertility and, (4) this understanding can best be achieved when activities are used to clarify the basic scientific concepts underlying the necessity for soil and water conservation practices within the dry-plains region.

I. THE PURPOSE OF THIS STUDY

This paper is an attempt to provide teachers in the dry-plains regions with certain concepts and techniques believed to be of value in assisting students to develop an understanding of the uniqueness of their environment. While most of the activities, experiments, and demonstrations were first organized for a biology class, many of them should be suitable for use in other classes which involve the natural sciences.

Importance of the Study

The Southern Great Plains, the Southwestern Dry-Plains and the Short-Grass Prairie all refer to the same area. The characteristics of the region will be discussed later in Chapter I. Wheat comprises the major cash crop of this region; and, the region is essentially one of marginal to sub-marginal precipitation. Thus, soil and water remain the basic components upon which the region's survival as an economic unit must be based.

In such a region, an understanding of the inter-relationships between soil, water, and climate would seem to be an imperative need of all human inhabitants within the region.

From the fossilized remains of dinosaurs to the numerous beds of fossilized oyster shells, evidence is offered that the southwestern dry-plains were once submerged in sea water. With the recession of the water, silt was added as a crowning layer to the floor of the sea. Humus was added to the sea floor by the remains of dead plants and animals. By the time man first appeared in the area the soil was very fertile, light brown in color, and well suited to the production of grasses offering much nourishment to animals and birds of the region.[1]

One of the earliest inhabitants of the region was probably an Indian nomad who later moved to large communal houses such as those seen in Mesa Verde National Park.[2] With the advent of dry cycles, community life became impossible; the settler moved to a more desirable environment. After this settler came another. This second settler produced the first irrigation system believed to have been used in the region, engineering his irrigation ditches so that the rushing irrigation waters would not erode his fields. But again, in spite of his feats of engineering, he could not compete with nature.

> The rains diminished in amount; a prolonged drought came; and with no means of livelihood available the second settler moved to a kinder habitat.[3]

By 1540, environmental conditions must have been more favorable, for Castenada tells us that Indians inhabiting the region were utilizing cow buffalo.

> The maintenance of these Indians comes entirely from the cows because they neither reap, or sow corn. With the skins they make their houses, with the skins they clothe and shoe themselves, of the skins they make rope, and also of the wool; from the sinews they make thread, with which they sew their clothes, and also their houses; from the bones they make awls; the dung serves them for wood because there is nothing else in that country; the stomachs serve them for pitchers and vessels from which they drink; they live on the flesh; they sometimes eat the fat raw, without warming it; they drink the blood just as it leaves the cows; and at other times after it has run out, cold and raw; they have no other means of livelihood.[4]

After Coronado's journey, horses were available to the Plains Indian. He became a nomad following the buffalo across, and up and down, the Great Plains. The Plains Indian lived well when buffalo were plentiful, and he suffered many hardships when their numbers were reduced.

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1. *Colorado's Natural Wealth*, A Bulletin on Conservation of Natural Resources, Department of Education, The State of Colorado, date of publication unknown, p. 25.

2. *Ibid.*, p. 25.

3. *Ibid.*, p. 29.

4. Castenada, Pedro de, *et al.* ed. George Parker Winship, *The Journey of Fransisco Vasquez de Coronado, 1540-1542.* (San Francisco, 1933), p. 104. Cited in *Colorado's Natural Wealth*, p. 45.

In 1820, the first white settlers were entering Texas and the great western expansion of the United States was now taking place. With the addition of new territories these places became new frontiers for the settler from midwestern and eastern United States. Leather was an important item to the rapidly expanding eastern industries. This demand for leather was appreciated by a man named J. Wright Mooar who had evidently seen the many ways buffalo hides were used by the Plains Indian. He shipped buffalo hides to New York where they were tanned and used for machine belting. His first order was for 2,000 hides.[5]

Men began to move westward to kill the buffalo. They skinned the carcass and left it to rot. With the stench of the rotting carcasses in the air, the Plains Indian saw his source of food being exterminated, and the Indian Wars of the 1870's began.

By 1875, all the Indians in the Southern Plains had ceased fighting and the white man completed his conquest of the buffalo. Following the virtual extermination of the buffalo, the land that had supported the buffalo now contained cattle, for buffalo and cattle ate the same thing. By 1882, the largest industry in the Southern Plains was the cattle industry.

With the discovery of gold in California shortly before the Civil War, and also through the period of the Civil War, western cattle were driven to ready markets to supply both the miners and the fighting forces.

People from the midwest and states further east had heard of the luxuriant growth of grass. They headed west, for the land that could grow grass could certainly grow wheat and oats; and the prices collected for harvested wheat and oats were high. These factors, plus the willingness of the government to give an adult male 160 acres of land if he would prove up a claim, furnished the impetus needed to accelerate the immigration to the Southern Plains.

Tremendous numbers of cattle were grazing on the range in the winter of 1886 following a crop failure in 1885. The month of January was one of intermittent freezing temperatures and blizzards of such intensity that by the end of the month one cattle outfit had lost virtually all of a herd composed of approximately 6,000 cattle. These same conditions existed over all the Southern Plains.

> In less than thirty days wind and snow and cold had broken the backbone of the cattle business on the Southern Plains. Bankruptcy became as commonplace as high-heeled boots and spurs. Stinking carcasses from the Kansas-Nebraska border to the Canadian River in Texas took the glamour out of the

5. Vance Johnson, *Heaven's Tableland,* New York: Farrar, Straus, and Company, 1947, p. 22.

"wide open spaces." Devastation and loss of loved ones took the heart out of the few nesters who had ventured so far; most of them packed up and pointed their wagons eastward. Easterners and Englishmen salvaged as much as possible from their investments and went off in search of safer enterprises.[6]

In 1896, the rains returned. J. E. Payne of the Dry Land Experiment Station at Cheyenne Wells, Colorado, had something to say to the new settler who was again entering the region in numbers.

'Third, for field crops on sod, plant early amber cane, yellow milo maize, and corn.' Sorghums, such as amber cane and milo, are 'the surest crops on the plains'; they 'practically never fail to produce fodder'—and fodder will sustain livestock even when the grain fails to mature. 'If you can (this was added as if by after-thought) prepare a small field for fall wheat.' [7]

Payne's advice was probably good. It is also, in the author's opinion, the correct procedure to be followed today in the Southern Plains region now used for dry-land farming. However, with good weather prevailing for about ten years, Payne's suggestions were ignored.

The railroads, now crossing the United States from coast to coast began to sell their public lands.

The census of 1910 revealed the population of sixty-one Southern Plains counties had increased nearly 350 per cent in ten years. Expansion of farm operation had kept pace with the increased population. Wheat acreage increased nearly 600 per cent and the corn acreage had expanded nearly four times. Proportionate increases occurred in other cultivated crops, while the number of cattle on the ranges declined sharply.

During all of this wild, hectic period only one small voice of warning was raised. 'Dry-land farming is a continued fight against relentless, unfavorable conditions', said the experiment station at Cheyenne Wells in a 1909 press bulletin. 'Every season it is likely that conditions on the plains will be unfavorable before the season is over . . . Exclusive grain growing . . . has been a failure . . . wherever tried in the past thirty years . . . A dry-land country is always a land with much wind, and the drier the season the steadier and harder the wind blows . . . Sometimes the impression has been disseminated that some newly discovered practice termed 'scientific' has overcome the previous difficulties . . . No practice lessens the need that plants have for water.[8]

Periodic crop failures were occurring on the Southern Plains even as Payne's articles appeared. Texas had a crop failure in the panhandle in 1906. By 1913, increasing numbers of crop failures were occurring in most of the Southern Plains. The plowed lands began to move as winds of high velocity moved into the Southern Plains region. The winds blew and little precipitation occurred for a seven year period.

In 1914, Europe was involved in war, and harvested wheat became a crop of tremendous value. Crop failures still occurred on the

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6. *Ibid.*, p. 44.
7. *Ibid.*, p. 69.
8. Johnson, pp. 84-85.

Southern Plains but little concern was given a crop failure with wheat selling for $2.15 a bushel. New sod was broken, old farms were re-worked and wheat acreages in the Great Plains increased by as much as 14,000,000 acres by the end of the war. The demand for wheat, the development of the large tractor, the development of the combine and its subsequent improvements plus the entry of the implement into the Southern Plains resulted in more land planted to wheat. This expansion lasted until 1933.

In 1933, a drought again struck the Southern Plains and old timers were reminded of the history of previous dust storms during the long droughts. The dust storms came. On March 14, 1934, the Southern Plains had the first of a series of dust storms that were to make the region infamous. By the thirteenth of May the dust storms had reached such intensity that ships 300 miles out in the Atlantic asked by radio why their decks were being covered by settling dust. Dirt blew frequently from 1935 until 1936, and during this time a term was coined that will possibly last as long as man inhabits the Southern Dry-Plains. That term was "Dust Bowl."

The Dust Bowl is the region that this study concerns; it is also the region for which the activities included in the study are and were primarily designed. The Dust Bowl will be referred to as the southwestern dry-plains for the purposes of this study. The unique characteristics of the region will be described in the following paragraphs.

Uniqueness of the Area

The southwestern dry-plains is a region of extremes. The temperatures varied from a record high of 112 degrees Fahrenheit at Hooker, Oklahoma, to a record low of minus 31 degrees Fahrenheit at Las Animas, Colorado. The annual precipitation ranged from a high of 33.4 inches of moisture to a low of 9.78 inches. These readings were obtained at Dalhart, Texas, during 1923 and 1933 respectively.

The average humidity at Lamar, Colorado, a city in the southwestern dry-plains with which the writer is somewhat familiar, approximates 28 per cent. This low figure indicates that the heat of the mid-day sun during the summer is responsible for much surface evaporation.[9] The temperature and rainfall pattern mentioned, the high rate of water loss caused by evaporation, and the frequent winds of high velocity all add to the farmer's difficulty in producing a cash crop in the region.

The topography of the region is quite flat with an average elevation of 3000 to 4000 feet. The vegetation that is native to the region consists of short grasses

9. J. H. Dorroh, Jr. *Certain Hydrologic and Climatic Characteristics of the Southwest,* The University of New Mexico Press, Albuquerque, 1946.

on the more firm soil with taller grasses, shrubs, and scrub oak on lands of sandy composition.[10]

Page 7 of the study consists of a table. This table illustrates the seasonal rainfall pattern for selected cities in Colorado, New Mexico, and Kansas.[11] As a further means of defining the boundaries of the region described in the study, a map of the counties constituting the region not inappropriately called the Dust Bowl is included on page 8.[12] These counties were all severely affected by wind erosion in the 1930's. It may also be noted during a thorough study of the map that some of the region of the southwestern dry-plains that was affected by the 1930 Dust Bowl is the same region that has undergone wind-erosion damage during the dust storms of the 1950's. A second map has been included as page 9 of the study to indicate the major ways in which land is used in that portion of the southwestern dry-plains referred to in the study.[13] This map should reveal the immensity of the dry-land farming area as compared to the small amount of irrigated lands in the region.

Unfortunately, the lack of rainfall in the region for a period of years previous to the early 1950's helped produce further severe wind erosion problems. These problems shall probably continue to increase in gravity if wise methods of land-use are not continuously applied to the light soils of the southwestern dry-plains. In fact, the inhabitants of the region may well expect dust storms whenever lengthy periods of drought are prevalent. Modern conservation practices may lessen the severity of some of the dust storms but without water to provide for protective plant growth, the light soils may be expected to blow during periods in which winds of high velocity occur.

It is therefore hoped that this study will provide some suggestions to teachers interested in teaching the natural sciences and soil and water conservation through the activity method. It is believed that the activities presented later in the study provide students with the opportunity to develop understandings of value to them as residents of the southwestern dry-plains region; and, it is believed that through the use of the activities presented in the study students may develop a fuller realization of the necessity for good land use practices in the southwestern dry-plains.

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10. Arthur N. Joel, *Soil Conservation Reconnaissance Survey of The Southern Great Plains Wind Erosion Area.* Technical Bulletin No. 556, United States Department of Agriculture, 1936, Washington, D. C.

11. Table I.

12. Figure 1.

13. Figure 2.

TABLE I.—Precipitation Records of Cities in New Mexico, Colorado, and Kansas. (Data Obtained from "Certain Hydrologic and Climatic Characteristics of the Southwest," by Dorroh) and *Climatological Data for Kansas*, vol. 75, No. 13, 1962.

STATION	Length of rec. years	Elevation in feet	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average (inches)
							COLORADO								
Cheyenne Wells..	52	4,250	0.25	0.44	0.78	1.89	2.25	2.78	2.70	2.54	1.43	0.96	0.74	0.52	17.28
Holly...........	50	3,385	0.25	0.53	0.59	1.59	2.00	2.19	2.43	2.20	1.26	0.95	0.49	0.46	14.85
Lamar..........	56	3,615	0.37	0.52	0.82	1.56	2.13	2.17	2.50	1.92	1.24	0.98	0.43	0.59	15.13
Las Animas.....	78	3,892	0.21	0.41	0.60	1.48	1.97	1.53	2.08	1.54	0.95	0.76	0.37	0.47	12.34
Two Buttes.....	53	4,075	0.22	0.47	0.74	1.47	2.39	2.62	2.16	1.86	1.23	0.88	0.43	0.45	14.92
							NORTH EAST NEW MEXICO								
Cimarron.......	41	6,497	0.31	0.58	1.01	1.55	1.90	1.61	2.58	2.41	1.69	1.28	0.52	0.40	15.84
Fort Sumner....	42	4,028	0.44	0.66	0.78	1.22	1.57	1.94	2.30	2.46	1.70	1.48	1.26	0.81	17.03
Santa Fe........	94	7,000	0.71	1.35	1.02	1.20	0.98	1.20	3.13	2.74	2.26	1.22	0.64	0.78	17.23
							WESTERN KANSAS								
Colby..........	69	3,170	0.37	0.47	1.23	1.86	2.74	3.04	2.84	2.38	1.05	0.98	0.64	0.43	18.07
Garden City....	70	2,840	0.45	0.53	0.87	1.74	2.62	2.76	2.26	2.54	1.27	1.21	0.63	0.44	17.34
Dodge City.....	86	2,594	0.49	0.59	1.30	2.21	3.55	2.76	2.81	2.43	1.96	0.94	0.87	0.51	21.41
Goodland.......	53	3,645	0.31	0.48	1.09	1.81	2.69	2.74	2.80	2.55	1.37	1.04	0.58	0.47	18.21
Hays...........	92	2,000	0.46	0.68	1.14	2.13	3.78	4.27	2.55	2.92	2.21	1.22	0.94	0.60	22.90

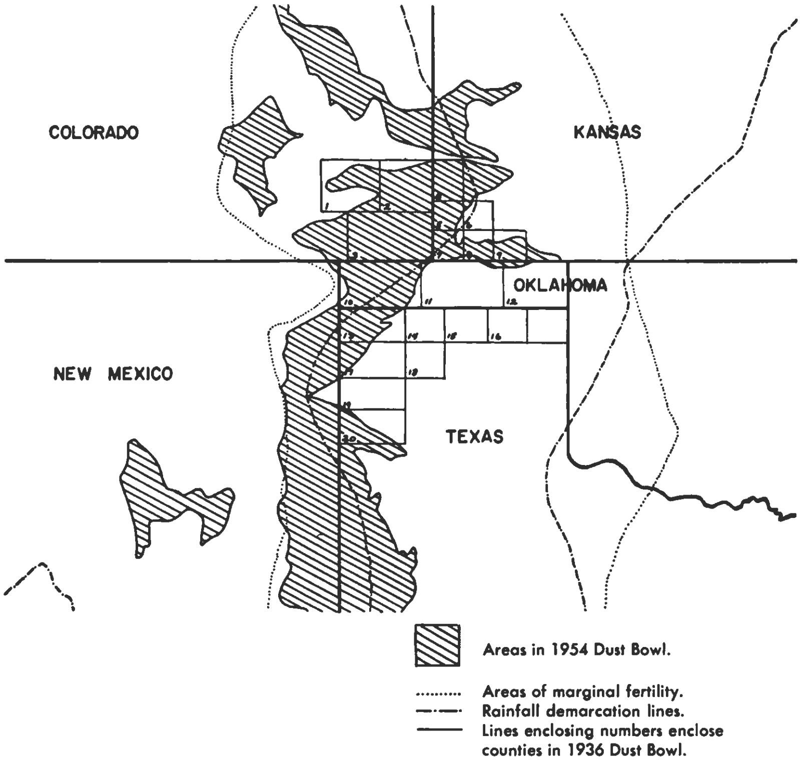

FIGURE 1. Wind erosion areas of the southwestern dry-plains region. Data from Joel, Arthur H., *Soil Conservation Reconnaissance Survey of the Southern Great Plains Wind Erosion Area.* Tech. Bull. No. 556, U. S. Dep't. Agric., 1936. Washington, D. C., p. 185.

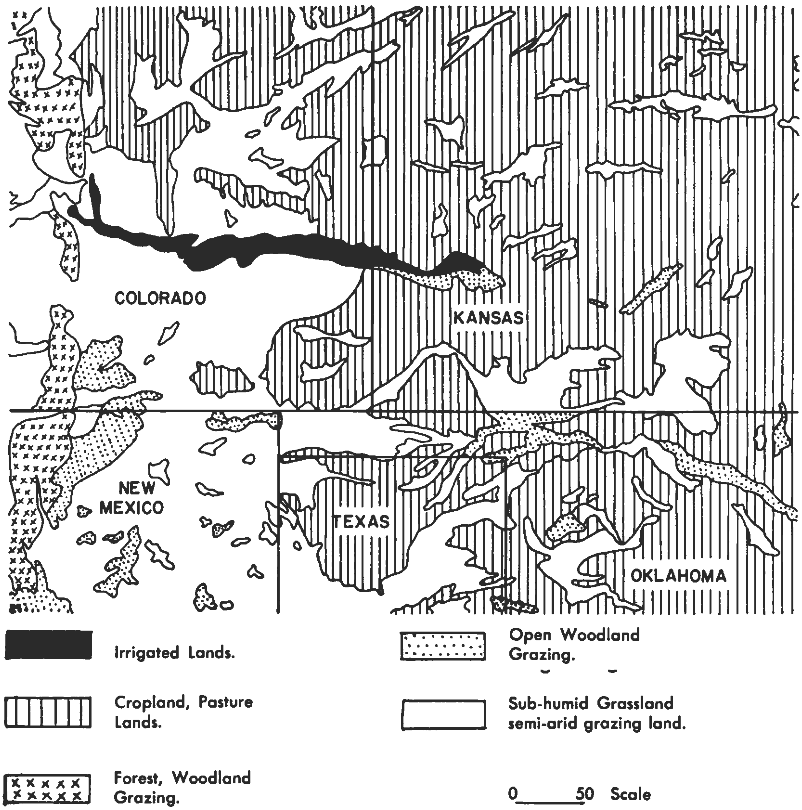

Figure 2. Selected portion of a land use map indicating the magnitude of soil and water conservation problems within the southwestern dry-plains. Data from Major Land Uses of the U.S., Bureau of Agricultural Economics, 1950, Washington, D. C.

Chapter II

Procedure Followed in the Study

I. STATE DEPARTMENTS OF EDUCATION PUBLICATIONS, 1953 SURVEY

SURVEY OF THE STATE DEPARTMENTS OF EDUCATION

The author attempted to ascertain, first, how many of the states included in the Dust Bowl of the 1930's and the later 1950's Dust Bowl produced courses of study in high school biology.

The method used to obtain this information follows: A letter was written to the State Department of Education of Colorado, Kansas, New Mexico, Oklahoma and Texas. In this letter the author requested: (1) a copy of any Department of Education publication directed toward the teaching of soil and water conservation at the high school level and (2) any course of study for biology published by the State Department of Education. The State Departments of Education were also asked if the State's Game and Fish Commission published any materials directly or indirectly concerned with the topic of soil and water conservation. If either of the two agencies did publish this material, the Department of Education was asked to send copies of these publications to the author for inclusion in the study. A summary of the responses to these letters is given in the following paragraphs.

Colorado: No publications on either conservation education or science were issued by the Department of Education of the State of Colorado. One bulletin had been published at an earlier, unknown date but copies of it were no longer available. The Fish and Game Department of the State of Colorado published three pamphlets which provided some information on the game birds, fishes, and animals found within the State, but none of this information was directly related to soil and water conservation. No course of study which involved biology was received.

Kansas: The Department of Public Instruction of the State of Kansas did not publish a course of study in high school biology nor did the Department publish any materials on soil and water conservation. No material was received from the Fish and Game Commission of the State of Kansas.

Texas: The Department of Education of the State of Texas suggested that various city school systems be contacted for copies of local courses of study. The State Department of Education did not publish any material for use in the public schools in biology, or soil and water conservation. The Game and Fish Commission provided the teachers of the state with colored reproductions of paintings of the game animals, birds and fishes of Texas. In addition, outlines of birds were furnished elementary school teachers for classroom use. The outlined figure of the bird could be colored by students. However, the Fish and Game Commission of the State of Texas did not publish any information directly concerned with soil and water conservation.

Oklahoma: The Oklahoma State Department of Education published a course of study in science which included biology. Unit five of the section on high school biology consists of a unit, "Biology and Conservation." [14] The treatment of the unit consists of a brief statement of the purpose of the unit, a list of unit objectives, a listing of content material including an outline of soil conservation, and some activities which could be carried out by the students.[15] Also included in the unit are a list of textbooks and supplementary references, and a list of titles of suitable films and their sources.

New Mexico: The author received two publications from the New Mexico State Department of Education. These publications are: (1) a course of study for high school science and (2) a list of twenty-three conservation projects carried out in various high schools in the State of New Mexico during the years of 1952 and 1953.

In the section concerning biology in the New Mexico course of study in science, an outline on conservation topics was included in a unit concerned with "The Struggle to Maintain Life." [16] The topics mentioned in this outline are the prevention of soil erosion, dry-farming, irrigation, the use of insects in control of injurious forms, and the use of other animals in control of harmful forms. No specific information is furnished the reader on what would be controlled. Forests, wild flowers and animals are also included as topics in the outline. The prevention of soil erosion, dry-farming, and irrigation are topics directly related to soil and water conserva-

14. *A Suggested Guide For The Teaching of Science*, Oklahoma State Department of Education, Bulletin No. 101, 1953, pp. 108-113.

15. *Ibid.*, pp. 108-113.

16. *Science, Tentative Guides for the High School Teacher*, New Mexico State Department of Education, Bulletin No. 5, 1953, p. 14.

tion while the others do not pertain to this topic. No activities were included in the course of study, nor were any references cited that deal with soil and water conservation.

Publications in Conservation Education

In the specific subject matter area of conservation education, one publication was located previous to the study and one publication was received during the study as a result of correspondence with the State Departments of Education. The Department of Education of the State of Colorado published a bulletin which has been reported previously. This bulletin, *Colorado's Natural Wealth*,[17] is, in the writer's opinion, a valuable addition to the teacher's reference shelves. However, this bulletin is now out-of-print and is therefore no longer available to most teachers.

The New Mexico State Department of Education issued Bulletin No. 19, *Conservation Projects For The High School.*[18] This bulletin lists 23 of the 35 projects which were submitted by various high school teachers in New Mexico. These reports were received by the Chairman of the New Mexico section's work under the National Association of Biology Teachers' study on conservation education. These projects describe various techniques or methods which may be used as demonstrations, activities, or classroom projects in the teaching of conservation.

Pictures of some of the activities completed provide suggestions and examples which interested teachers might find most helpful in teaching conservation through the activity method.

Table II, located on page 14 of the study, is a summary of the letters and publications received from the Departments of Education of the States of Colorado, Kansas, Oklahoma, New Mexico, and Texas in 1955-56.[19] It is hoped that the table will offer a comprehensive, yet brief, survey of the information which was then available on soil and water conservation from the Departments of Education mentioned previously.

The materials received from the States of New Mexico and Oklahoma were helpful to the author in the organization of the study. However, the activities included in these publications were not specific enough for them to be reported in the study, and they were

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17. *Colorado's Natural Wealth,* A Bulletin on Conservation of Natural Resources, Department of Education, The State of Colorado, date of publication unknown.

18. *Conservation Projects For The High School,* New Mexico State Department of Education No. 19, 1955.

19. Table I, "A summary of a survey of State Courses of Study in high school biology in the southwestern dry-plains region."

not well-adapted to all of the different climatic conditions found in the Southwestern dry-plains region. Therefore, none of the activities found in the Oklahoma and New Mexico publications are contained in Chapter III.

II. STATE DEPARTMENTS OF EDUCATION PUBLICATIONS, 1962-63 SURVEY

Courses of Study in Biology

The State Departments of Education of the States of Nebraska, North Dakota, and South Dakota were asked to submit copies of published courses of study in biology and conservation in the later survey. The State Departments of Education of Colorado, Kansas, Oklahoma, New Mexico, and Texas were asked to submit any publications in biology and conservation education that were issued between 1955 and 1962.

Table II.—A Summary of the Survey of State Courses of Study in High School Biology and Conservation Education Publications in the Southwestern Dry-Plains Region, 1952-53.

The topics below are those the author appraised in the State Department of Education publications received in response to correspondence between the author and the State Departments of Education.	States included in the survey				
	Texas	New Mexico	Oklahoma	Kansas	Colorado
Courses of study in high school biology published by Department of Education	O	X	X	O	O
Conservation unit included in course of study	—	O	X	—	—
Conservation included as a portion of another unit	—	X	—	—	—
Conservation included soil and water conservation	—	X	X	—	—
Conservation activities included in the unit	—	O	X	—	—
Film bibliography on conservation included in course of study	—	O	X	—	—
Specific reading references on conservation included in course of study	—	O	X	—	—
Specific publication for conservation education	O	X	O	O	X*

X=Publication.
O=No publication, or topic not included in the publication.
—=Does not pertain to this state.
* This publication out-of-print.

New Mexico: Science Aids and Suggestions for Teachers contains activities, the materials needed to carry out the activities, and the concepts which may be taught through the activities. The bulletin contains an activity on weathering and one involving the testing of water for organic materials.[20]

South Dakota: A topical outline was included in *Biology, Course of Study and Teachers Guide for Secondary Schools,*[21] which is concerned with general conservation. No specific activities were found which involved soil and water conservation as such.

Texas: The science excerpt from *Principles and Standards for Accrediting Elementary and Secondary Schools and Description of Approved Courses, Grades 7-12* is a synthesis of course content for tentative junior and senior high school science courses.[22] No activities are contained in this publication and no specific reference was found which concerned conservation. The advanced biology course did include a possible unit on ecology which might be used in teaching conservation since it seems difficult for students to understand plants and animals unless they understand how plants and animals depend upon soil and water for survival.

Oklahoma: The Improvement of Science Instruction in Oklahoma, Grades K-12, was received from the Oklahoma State Department of Education.[23] This bulletin contains concepts related to soil and water conservation in an ecology unit of the biology course. The junior high school science course contained other concepts directly related to soil and water conservation. No specific activities were identified in the materials included in this bulletin.

Nebraska: Six handbooks and two courses of study were received from the Nebraska Department of Education and three of these publications contained materials directly related to soil and water conservation. *The General Science Handbook, Part I,* contained a unit on natural and artificial rocks. This unit contained a problem involving weathering and erosion.[24]

20. *Science Aids and Suggestions for Teachers,* New Mexico State Department of Education, Bulletin No. 31, 1959. pp. 20 and 26.

21. *Biology, Course of Study and Teachers Guide for Secondary Schools,* South Dakota State Department of Public Instruction, Course of Study Bulletin No. 46A, 1960.

22. *Principles and Standards for Accrediting Elementary and Secondary Schools and Description of Approved Courses, Grades 7-12,* Texas Education Agency, Bulletin No. 615, (1961). pp. 209-233.

23. *The Improvement of Science Instruction in Oklahoma, Grades K-12,* (Oklahoma City: The Oklahoma State Department of Education, 1960), p. 95.

24. *The General Science Handbook, Part I.* (Lincoln: Nebraska Department of Education, 1951), p. 197.

The General Science Handbook, Part III included experiments designed to demonstrate the use of water. The publication also contained materials valuable to a teacher wishing to include forest and wildlife conservation as a phase of conservation.[25]

A Handbook of Activities to Accompany the Course of Study in Biology includes a unit which emphasizes the interrelationships between living things.[26] Eleven laboratory activities or experiments are included in the unit which are directly related to soil and water conservation.

Kansas: One publication which could serve as a course of study was located in the Fort Hays Kansas State College Curriculum collection of curricular materials. The *Laboratory Science Guide in Kansas Secondary Schools* was published in 1954. This publication contains one unit, Unit 8, entitled "Conservation of Natural Resources." [27] The unit contains activities that provide assistance in teaching the concepts presented in the unit.

A letter received from the Department of Public Instruction did indicate that materials were available at the Topeka offices of the Department. It is assumed that these are essentially single copies and therefore would not be available for statewide distribution at this time.

In summarization, even though the trend in science education seems to be moving toward the inclusion of materials designed to aid students in learning about the methods of science, a lack of "materials" will probably hamper the busy teacher who may or may not be adequately prepared in the subject matter field he is teaching. As a result, it would appear possible that too many conservation units, and many science course, may involve a memo-writer type of learning—one memorizes content and later writes it down.

An attempt to summarize the findings of the earlier survey and the later survey has been made in Table III, page 17 of the study. This table includes the material received during the 1955-56 study and the later 1962-63 study.

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25. *The General Science Handbook, Part III.* (Lincoln: Nebraska Department of Education, 1956). 261 pp.

26. *Biology, A Handbook of Activities to Accompany the Course of Study in Biology,* (Lincoln: Nebraska Department of Education, 1960). 286 pp.

27. *Laboratory Science Guide in Kansas Secondary Schools,* Kansas State Department of Public Instruction, 1954, pp. 83-92.

TABLE III.—A Summary of State Department of Education Publications Received in Response to Letters Requesting Copies of Such Publications—1962-63 Study.

The topics below are those which were appraised in the State Department of Education publications	States							
	Colorado	Kansas	Nebraska	New Mexico	N. Dakota	Oklahoma	S. Dakota	Texas
Courses of study received in high school biology	O	O	X	X	No Publications Received	X	X	X
Course of study included a unit on conservation	—	—	X	O*		O	X	O
Conservation material included soil and water conservation	—	—	X	—		—	X	—
Activities directly concerned with soil and water conservation included	—	—	X	X		—	O	—
Film biography included in conservation materials	—	—	O	—		—	X	—
References to conservation reading materials included	—	—	X	—		—	X	—
Specific conservation education publication produced	X	O	X	X*		O	X	X
Soil and water conservation a part of the conservation publication	X	—	X	X		—	X	X
Activities and experiments included in conservation publication	X	—	X	X		—	X	O

X=Publication received or topic included.
O=No such received publication, or topic not included.
—=Does not apply.
* Cited in earlier study.

PUBLICATIONS IN CONSERVATION EDUCATION

Colorado: A 1962 trial edition of a *Curriculum Guide in Conservation Education* was received from the Colorado State Department of Public Instruction.[28] This publication is designed for use in the elementary and junior high school level. Activities are included in manual which could be modified by high school teachers.

Nebraska: The Department of Education issued *Problems and Progress in Soil and Water Conservation.*[29] This publication con-

28. *Curriculum Guide in Conservation Education,* Colorado State Department of Education, 1962.

29. *Problems and Progress in Soil and Water Conservation,* Nebraska Department of Education, 1956, 45 pp.

tains 20 experiments which would be very useful to classes studying soil and water conservation.

South Dakota: Two publications were received from South Dakota which were designed to assist teachers in teaching conservation. The publication, *Conservation of South Dakota's Natural Resources* was produced for elementary teacher's use.[30] The *Conservation Handbook for Secondary School Teachers in South Dakota Schools* also contains numerous activities which can be used by interested teachers.[31]

North Dakota: No information and no publications were received in response to the request; therefore, no information is available as to reference materials which may be available to teachers and students.

Texas: The Texas Education Agency provided "Suggestions for Teaching Conservation, A guide to unit preparation."[32] *Selected References in Conservation Education for Texas Teachers and Pupils* was also produced by the Texas Education Agency.[33] Neither of these publications contained specific activities which could be used in teaching soil and water conservation as such; however, both publications would probably be very useful to teachers.

Publications of the Departments of Fish and Game

The information received in response to the letter sent to the State Departments of Game and Fish in 1963 was so varied that it was believed advisable to sort the publications into two groups. Those materials that were directly related to teaching certain phases of soil and water conservation are reported in this section of the study. The materials which did not seem to be directly designed toward teaching soil and water conservation are identified in Appendix B of the study.

It should be stated that the publications received from the State Departments of Game and Fish provide excellent reference materials for use in a conservation unit. It must be recognized that, in most instances, this information was probably produced for other reasons than to assist teachers in teaching soil and water conservation.

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30. *Conservation of South Dakota's Natural Resources*, South Dakota State Department of Public Instruction, 1953.

31. *Conservation Handbook for Secondary Science Teachers in South Dakota Schools*, South Dakota State Department of Public Instruction, Bulletin No. 78, 1960.

32. "Suggestions for Teaching Conservation, A guide to unit preparation," Texas Education Agency, date of publication unknown, 21 pp.

33. *Selected References in Conservation Education for Texas Teachers and Pupils*, Texas Education Agency, 1962 revision, 82 pp.

Some publications of Fish and Game Departments are produced to provide sportsmen with some knowledge of how license revenue is used. However, these publications do contain much valuable information for a teacher who is teaching a course or a unit on conservation. As such, the content of these publications should be carefully studied.

The only state Department of Fish and Game which provided suggested activities to teachers and students of conservation was the Nebraska Game, Forest and Parks Commission. There, two publication series of materials were prepared for use by the youth of Nebraska in learning more about conservation. Series A consists of a *Youth Manual* and a *Youth Record Book.*[34] The manual serves as a text while the record book contains activities which students might do individually or as a class project.

Series B, the *Nebraska Nature Series* and *Nature Series Record Book*, follow the same type of organization as Series A; a text is provided and a bulletin accompanies the text which contains the activities which students may complete.[35] As in Series A, the record book contains the activities.

The third series is a joint publication. The two manuals, *Wildlife Conservation Program for Nebraska F. F. A. Chapters, Wildlife Habitat* and *Record and Requirement Book for F. F. A. Wildlife Conservation Project* were produced. The latter publication contains many activities to be completed by members of the Nebraska Future Farmers of America.[36]

Three additional publications written by Miss Ivah Green, and others, were received from the Nebraska Game, Forest and Park Commission. The elementary teachers who received these mimeographed publications should have found them to be of much assistance in teaching conservation.

"Growing Trees in Nebraska" attempts to explain the value of trees and tree plantings to Nebraska citizens. The publication also provides many questions and activities which students and teachers may complete.[37]

34. James M. Tische and Dale R. Bree, *Youth Manual for Work in Wildlife Conservation and Outdoor Recreation; Youth Record Book for Work in Wildlife Conservation and Outdoor Recreation, Series A,* (Lincoln: Nebraska Game, Forest and Park Commission, 1961).

35. Chester A. McClain, *Nebraska Nature Series,* and Chester A. McClain, *Nature Series Record Book, Series B* (Lincoln: Nebraska Game, Forest and Parks Commission, date of publication unknown).

36. Dale R. Bree, *Wildlife Conservation Program for Nebraska F. F. A. Chapters Wildlife Habitat;* and Dale R. Bree, *Record and Requirement Book for F. F. A. Wildlife Conservation Project* (Lincoln: Nebraska Game, Forest and Parks Commission, 1959).

37. Ivah Green, "Growing Trees in Nebraska" (Lincoln: Central Plains Forestry Office, Forest Service, and Nebraska State Extension and State Forester, The University of Nebraska, date of publication unknown), 18 pp.

"A Workbook for the Study of Soil and Water Conservation in Nebraska" contains a series of questions which should enable students to gain an increased amount of knowledge pertinent to soil and water conservation.[38] An answer key accompanies the workbook.

"Growing Grass in Nebraska" is, like "Growing Trees in Nebraska," an attempt to explain the benefits which the residents of a state derive from grassland resources.[39] Numerous questions and activities are contained within the publication for those who choose to complete them.

In the opinion of the writer, the three publications cited on the preceeding page are excellent reference sources. It is unfortunate that more teachers do not have materials of like quality available to them. The material is briefly and concisely stated, and topics are presented without the involvement of a large number of technical terms.

Results of the Questionnaire Mailed to Teachers

One of the first projects undertaken by the author was an attempt to determine how much training some of the dry-plains biology teachers had received in the field of conservation education. This information was obtained by sending a questionnaire to twenty-five high school biology teachers selected at random. A sample of the questionnaire is not included in the study; however, the results provided should serve to answer any questions about its construction.

An attempt was also made, at this time, to obtain information pertinent to activities used by teachers in the dry-plains region in teaching conservation. A stamped, self-addressed envelope was sent to the high school principals of the twenty-five schools selected at random in the States of Colorado, Texas, New Mexico, Oklahoma and Kansas. These high schools were located in towns of various sizes within this five state region. The principals of these high schools were asked to see that the teacher doing the most outstanding job of teaching conservation received the questionnaire.

The questionnaire consisted of a brief statement explaining its purpose, and six questions. Of the twenty-five questionnaires mailed, seventeen were completed and returned. While the number of questionnaires was statistically insignificant, it is felt that the

38. Ivah Green, J. Duane Chamberlain, *et al.*, "A Workbook and Answer Key for the Study of Soil and Water Conservation in Nebraska" (place of publication unknown, Nebraska Association of Soil and Water Conservation Districts, 1958), 16 pp.

39. Ivah Green, "Growing Grass in Nebraska" (place of publication unknown, Nebraska Association of Soil and Water Conservation Districts, 1962), 17 pp.

responses to the questions indicate that the teachers who responded were interested in obtaining more information on conservation. Since the next chapter contains activities that may be used in teaching soil and water conservation, it is hoped that this study will provide some additional suggestions on teaching soil and water conservation for some of these teachers in the southwestern dry-plains.

The questions asked in the questionnaires, and a simple summary of the responses to each question will be found on pages 21 and 22 of this paper. As previously stated, a copy of the questionnaire will not be included in the study.

Summary of Responses to Questionnaire Items

As previously stated, seventeen of the twenty-five questionnaires sent to high school teachers in the dry-plains region were returned to the author. Enough information will be provided, however, to enable the reader to determine the general objective of each question before its response is indicated.

Of the seventeen teachers returning the questionnaire, fifteen included some study of conservation in high school biology. Eleven reported that they taught conservation in courses other than high school biology. The responses made by these eleven teachers indicated that six of them were teaching in schools where conservation was taught in agriculture, one reported that he taught some conservation in his high school chemistry course, one reported that he taught some aspect of conservation in a course in world geography, and three reported that conservation was included in their general science course.

Eleven of the seventeen teachers who reported indicated that they had taken no college course in any area of conservation. An answer to some of these teachers' difficulties might be found in a college course, or workshop in conservation education or in some specific aspect of conservation.

A tremendous variation in environmental conditions was reported in the opinions listed by the teachers on the questionnaire. This was particularly obvious when they specified the major conservation problem in their immediate areas. Seven teachers reported the greatest problem in their area to be that of wind erosion. Three listed the insufficient amount of water available to the farmer, three listed flood control, and one listed an individual problem of little personal investigation in the area of conservation. Two teachers did not specify any problem and one teacher called attention to the "Suitcase farmer" who plowed, planted seed, and left, returning only when a crop was ready for harvest. In the latter case, possibly no problem would exist if the wind did not blow with its normal spring velocities, if adequate amounts of precipitation fell to nourish the seeds, and if much of the region had not been changed from grassland into cropland.

None of the responses indicated the use of activities as a prime method of teaching soil and water conservation. Since the author believes that classroom activities are essential to the development of an understanding of some of the conservation problems that exist in the southwestern dry-plains region, this study is an attempt to bring together activities which might be useful to the teachers of the natural sciences in the dry-plains region who are interested in teaching soil and water conservation as one aspect of a natural science course or unit. These activities will be found in the next chapter of the study.

The selection of the activities included in the study involved, in part, the determination of the major reasons why soil erosion occurred in the Great Plains region. The first activities included in the study are related to the structure of the soil itself. The second series of activities should serve to illustrate the relationship between various surface conditions and wind erosion. A final series of activities are included in the study to illustrate the need for the conservation of water.

It should also be re-stated that each activity is not an end in itself; activities are only vehicles or means to ends. The end remains to be the development of an individual's understanding of his environment.

Chapter III

A List of Suggested Activities

The activities included in this chapter are designed to be used by the teacher of natural science. To be more specific, the teacher of high school biology in the southwestern dry-plains region is the individual who may be the most interested in the activities described in this study. However, the activities included in this list may be modified to a large degree. It is, therefore, the author's belief that the teachers should find some of the activities applicable to their needs. The author also believes that many of these activities are suitable for classroom use in any region where a conservation problem exists because most of our natural resources are derived from, and exist because of the soil and water found on the earth.

It is further hoped that persons who use these activities will modify them according to their own needs. The author's needs for classroom activities in soil and water conservation where he taught and is now teaching in the dry-plains region will not be the same as those of a teacher elsewhere, especially if he is not teaching in the southwestern dry-plains region.

The activities chosen to be included will be described by: (1) stating a problem, (2) listing the necessary materials to perform the activity, and (3) describing the procedure used in developing the activity. Included in step three may be a brief statement describing what results, or conclusions, the teacher may expect to discuss with the class.

In some instances, pertinent information has been inserted between certain activities. This information should provide further explanation about the activity or activities and the nature of the concepts to be illustrated by the activity.

The following is a list of the activities included in this paper. They are organized under these headings: (I) Activities for the study of the components of soil, (II) Activities for the study of wind erosion, (III) Activities for the study of water as a natural resource, and (IV) Activities illustrating oil field pollution problems.

I. Activities for the study of the components of soil
   1. Soil particle size and capillary action
   2. Humus as a soil constituent
   3. Soil profiles

II. Activities for the study of wind-erosion

4. Mapping an active wind-erosion area relating the direction of the prevailing winds to the direction of the drifting soil
5. Movement of soil in a blow area
6. Effect of wind on uncovered soil
7. Value of windbreaks
8. Value of different types of windbreaks
9. Value of soil lost by wind-erosion
10. Value of cover crops to prevent wind-erosion
11. Relation between blowing of "poor" lands and "good" lands
12. Sand dune stabilization project
13. Student's report of a dust-strom
14. Soil temperature as affected by cover crops

III. Activities for the study of water as a natural resource

15. Annual precipitation by graphing
16. Annual rainfall and well depth
17. Rate of stream cutting
18. Insect life and fish populations
19. Kinds of water erosion
20. Effect of rain on covered and uncovered soil
21. Evaporation of water from soil
22. Temperature and the evaporation rate
23. Plant-water loss through transpiration
24. Plant adaptability related to transpiration rate
25. Stubble mulching related to soil water loss
26. Dust mulching related to soil water loss
27. Soil types and water retention
28. Effect of rain on grazing areas
29. Reappearance of minerals following evaporation
30. Demonstration of leaching
31. Run-off from protected and unprotected areas
32. Rainfall and run-off from sloping areas
33. Soil carried by run-off water
34. Siltation and impoundment capacity
35. Plant adaptability and root structure
36. Effect of dirt-storms on animal health
37. Food availability and animal population
38. Over-grazing related to land value
39. Annual precipitation related to community economics

IV. Activities which illustrate Oil Field Pollution problems

40. The location and examination of salt scars
41. Seed development in soil from salt scars
42. Salt scar soil leaching
43. Oil field brine pollution of area wells
44. Oil field brine and stream pollution
45. Oil field brine and fresh water bottom dwelling organisms

ACTIVITIES

Problem Number 1

To relate soil particle size to capillary action, or to illustrate that capillary action occurs in soils.

Materials

Enough clay, sand, and gravel to fill three one-pound coffee cans; three metal or glass tubes over four inches in length and one-half inch in diameter (lamp chimneys function effectively); three cheese cloth filters large enough to cover the end of the tube that is placed in the water; a dissecting pan full of water (cake pans will function equally well); and two yards of string or three large rubber bands.

Procedure

1. Tie the pieces of the cheese cloth filters over the ends of the three tubes (or the lamp chimneys if they are used).

2. Fill one tube or chimney with clay, one with sand, and one with gravel.

3. Place the three tubes vertically in the water with the covered end immersed and observe the contents for moisture. If metal tubes are used, only the ends of the tubes may be observed, while the capillary action may be traced as it proceeds up the tube if glass is used. Water containing dye may be used for an even clearer illustration if a light-colored soil is used.

Problem Number 2

To demonstrate the difference in rate of plant growth in topsoil and subsoil.

Materials

Navy or lima bean seeds, two unglazed flower pots—one containing topsoil and the other subsoil—and water.

Procedure

Plant four to six bean seeds about one inch below the surface of the two different kinds of soil.

2. Keep the soil moist in each flower pot.

3. Call the class's attention to the cotyledons, or seed leaves on each bean plant and explain their use in the development of the plant.

4. Measure, at definite intervals, the growth of each plant.

5. Watch for a decline in the rate of growth of the beans planted in either of the soils.

6. Try to explain why the bean plants in the subsoil did not continue to grow, or were not as healthy as those in the topsoil.

7. At the end of the experiment remove the bean plants and wash all soil from their roots. Air-dry the plants thoroughly.

8. Weigh the dry plants and explain, or discuss why a difference should exist between the weights of the plants grown in the subsoil and the topsoil.

Problem Number 3

To develop an understanding of what is meant by a soil profile.

Materials

A rectangular box about the size of those containing a lug of peaches, a glass or heavy cellophane cover for the open side, some flour, brown watercolor paint, and a number of old newspapers; some small rocks ranging in size from that of the diameter of a half-dollar to that of a quarter; some lath or small strips of flat wood to nail over the openings in the box (if necessary) to hold the contents inside; and some topsoil which may contain some plants or plant parts if desired.

Procedure

1. Mix the flour and water until they reach the consistency of heavy cream. Add brown color and some small pieces of the old newspaper. This makes what is commonly called papier mache.
2. Stand the box on one end with the open side facing you. Place the mass of papier mache in the bottom side of the box. Fill the box to about one-third its depth. Allow the mass to dry. This layer will represent bed-rock.
3. When dry, place a one to six inch layer of the rocks on the surface of the papier mache. Place the larger sized rocks on the surface of the papier mache and work up toward the top of the box, adding progressively smaller sized rocks.
4. Add enough topsoil to fill the box completely.
5. Tape the heavy cellophane, or glass, window in place over the open end of the box as the final step.

Note: Soil profile samples may be made using a second method and, on a much smaller scale. In this case use parent material, subsoil, topsoil and place a layer of each in an olive bottle. If this method is used, the parent material must be the first layer, the subsoil the second layer and the topsoil the final layer. The layers should be settled by tapping the bottom of the bottle on a solid surface such as the knee. The bottle must be completely filled and shaken down to prevent mixing.

The use of the olive-bottle method will enable each member of the class to obtain a small soil profile for himself. Class members living on farms can also obtain soil profiles from their own farms.

The Dust Bowl was caused by the effect of wind erosion upon the area of the Southern Great Plains which is referred to as the dry-lands. It occurred when the protective vegetation had been destroyed or depleted over large portions of the region by cultivation, overgrazing, and prolonged drought. These conditions plus the failure of the farmer to provide cover for his idle fields during periods of prolonged drought are considered to be the major causes of the Dust Bowl.[41]

Problem Number 4

To develop an understanding of the techniques required in making a contour map of a sand dune which is being eroded by the wind. This activity will facilitate the use of problem 10.

Materials

A compass; a fifty foot steel tape measure, a specific location, or plot, where evidence of active wind erosion is found; and a number of stakes to which a strip of cloth has been attached at one end.

Procedure

1. Place a stake at one side of an active erosion area and measure, or pace off a distance of fifty feet around the perimeter of the active blow.
2. Drive a stake into the ground at this point.
3. Repeat the procedure until the entire perimeter of the dune has been covered by the spaced-ring of stakes.
4. Locate the position of the stakes on a map. Record the distances between the stakes.
5. Walk a known distance upward toward the peak of the dune and place a stake in position. Record the distance from the outermost ring of stakes to the stake just placed in position.
6. Repeat step number three until a second spaced-ring of stakes is placed in position above the first. On the map, locate the position of each stake as they now appear.
7. Continue moving upward and around the dune placing stakes at the same intervals as that used in steps three, four and six.
8. Finally, after the peak of the dune is reached, the distance from the top of the dune to its base can be determined. From the stakes ringing the dune, the area may be determined. From the lines and distances already recorded, the slope of the dune will be seen.
9. For a comparison between the size and shape of the dune before the windy season, and after the windy season, one map of the dune could be made early in the spring and another later in the fall after the wind had acted as an agent of erosion.

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41. Joel, *op. cit.*, p. 185.

10. If step nine is followed, after the second map has been made, the stakes may be left in position, or removed. This decision may depend upon the desire of the instructor and class to carry out the additional work necessary. If a second map is not desired, and the stakes are not needed, it is usually interesting to compare the amount of erosion that will occur through the winter months with that which has occurred during the windy season.

"The 1935 census listed 3,039,822 acres as cropland failures while 2,206,079 acres were listed as cropland harvested. The preliminary reasons given for the crop failures were drought and wind erosion. The cultivated land was listed as idle land that, during a period of prolonged drought, is unable to support a crop. It is therefore, subject to wind-erosion throughout the windy season." [42]

Problem Number 5

To illustrate the movement of soil in an active wind erosion area.

Materials

A fifty-foot tape measure, two bundles of lath or long poles, an area being eroded by wind at the present time, a strip of cloth to attach to each pole to indicate the direction of the wind. This activity may be carried out in an area being eroded by either wind or water. Certain suggested procedures may require modification.

Procedure

1. Determine, roughly, the area of the active blow. It is suggested that a small corner, or a small blow area just beginning to develop, will lessen the time required for the experiment.

2. Lay the laths flat, side-by-side, and paint, cut or burn a mark in each lath one and one-half feet from one end. Then repeat the process marking each pole, or lath, at a six-inch interval for the entire length of the stake.

3. Encircle the perimeter, or outer portion, of the active blow that is to be observed, with the prepared stakes. Drive them into the ground to the depth of one and one-half feet according to the markings on the stake. As each stake is driven into position, tie a strip of cloth to the end exposed to the wind.

4. Make a map of the blow area indicating the location of the stakes, their distance apart, and the direction of the prevailing wind. Record the date when the stakes were placed in position.

5. After each wind storm, return to the area and determine whether the area being eroded is becoming larger, and if so, in which direction it is being enlarged.

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42. *Ibid.*, p. 33

6. It is sometimes desirable to enclose the enlarging blow area with stakes so that a determination can be made of the increased size of the blow at the end of the windy season.

7. It will also be noted that some of the stakes may be entirely removed from the earth. This should demonstrate the severity of the wind-erosion in that immediate location.

During periods of prolonged drought, the cover of unplowed lands is reduced to the extent that it is not able to protect the light textured soil. When the high winds, normal during the spring, strike the surface, the weakened grasses are unable to provide adequate protection or cover for the soil and some soil particles are moved. The cutting of the plant by the blowing soil weakens the plants still further. If the blowing soil continues to move, the leaves are literally shredded and the roots are exposed to the drying air at the same time. Once the roots of the plant are destroyed there is nothing to bind the soil particles together.

Problem Number 6

To illustrate the value of windbreaks in a wind erosion area.

Materials

Ten to fifteen poles varying in length from two foot to fifteen feet; (two, two feet long; two, four feet in length; two, six feet in length; two, eight feet in length; two, ten feet in length; two, twelve feet in length; and two, fifteen feet in length). Ten to fifteen tin cans of equal size should be obtained to serve as dust catchers (number two and one-half cans were used by the author's classes). Fifteen feet of flexible, yet strong wire, a nail, a hammer, and a post-hole auger. Two fields must be selected, one having a hedge or a low windbreak about five feet in height.

Procedure

1. Punch four holes in the side of each of the cans and insert wire through the holes so that the can can be attached to the poles at one end.

2. Attach the cans to the poles so that the open end of the can is about one inch below the top of the pole.

3. Place half the mounted cans on one side of the windbreak facing the wind; that is to say, on the windward side. (Include one of each of the various sized poles.) The poles will have to be properly dug in to withstand the force of the wind. Dig each hole about one foot deep for those poles up to five feet in height, and two feet deep for those poles that are over six feet in height.

4. Repeat the same operation, step three, on the side of the windbreak, or hedge, away from the wind. This is the leeward side.

5. After a dust storm have the students examine the contents of each can to determine which contained the most windblown soil. By examining the contents of the cans from one side of the windbreak, and comparing their contents with the contents of the cans from the other side of the windbreak, the advantages obtained by using windbreaks should be apparent.

Problem Number 7

To demonstrate, in the classroom, the value of wind breaks.

Materials

A large pan full of "dirt" obtained from that which piles up during a "dirt," or dust storm; a table, a fan, and twenty-five pieces of quarter-inch dowel about four inches in length. The dowel rods may be available from the industrial arts teacher or purchased at the local lumber yard. Fifty wooden matches will also work satisfactorily. Some old newspapers should be obtained to spread over the table and under the pan.

Procedure

1. Cover the table with the old newspapers.
2. Fill the pan with dirt and place the fan in such a location that the main air current from the fan will strike the surface of the dirt.
3. Turn on the fan, then examine the surface of the paper.
4. Point out the blow-dirt to the students. This experiment will require experimentation until the fan will definitely move the dirt.
5. Slide the wind-blown dirt back into the pan, and place the dowel pins in the pan about one-half an inch apart. If matches are used, place them about one-eighth of an inch apart. Place the dowels, or matches, in a line across the pan perpendicular to the air current produced by the fan.
6. Again start the fan and observe the soil behind the pieces of dowel, or matches, as the case may be.
7. Move the pieces of dowel or the matches until they are touching and call the class's attention to the fact that the density of a windbreak increases its value.

Problem Number 8

To compare the value of different types of windbreaks: (1) single-row windbreaks, (2) double-row windbreaks, (3) multi-row tapered windbreaks.

Materials

Identical materials to those used in problem seven with the addition of about thirty more pieces of doweling of various lengths. It is suggested that ten pieces of doweling be two inches long, ten pieces be four inches long, and ten pieces be about eight inches in length.

Procedure

1. Compare the results of problem seven with the results obtained when a double-row windbreak is used. A double-row windbreak is merely a second line of trees planted parallel to the first line. A comparison can be made by weighing the amounts of wind-blown dirt obtained in each case, and comparing the difference in weights of the dirt.

2. Compare the results of each of the preceding activities in this problem with those obtained when a multi-row windbreak is used. The results of the multi-row windbreak activity may be obtained by using dowels of various lengths. By using the double-row windbreak as the base of the multi-row windbreak, it is possible to construct a multi-row windbreak by adding rows of doweling of shorter length. As an example, if the double-row windbreak is composed of pieces of doweling that are eight inches in height, then place one row of doweling of six inch length next to each row of eight inch doweling. Then place a row of four inch doweling next to each row of six inch doweling. When no more doweling is to be added, the effect that is created by the various sized pieces of doweling is that of a triangle with the apex, or peak, in the center.

3. An additional series of demonstrations could be shown by using a fan that is capable of revolving at various speeds and by varying the height of the dowel sections representing trees and shrubs.

The following data are provided to illustrate the necessity of successfully stabilizing active wind-erosion areas.

Collected drift soil	24.6 percent organic matter
Previous top soil	2 percent organic matter
Organic matter, nitrogen ratio	
Cropped soil	22.47
Virgin soil	23.30
Drift soil	24.44
Collected dust	62.5 percent silt
Original soil	42.0 percent silt
Drift soil	15.0 percent silt [43]

43. Claude Fly, *A Preliminary Report of the Chemical and Mechanical Analysis of Dust Deposited by Wind at Goodwell, Oklahoma*, Panhandle Agricultural Experiment Station Bulletin No. 57, United States Department of Agriculture, (Washington: Government Printing Office, 1935) in J. H. Stallings, *Erosion of Topsoil Reduces Productivity*, United States Department of Agriculture, (Washington: Government Printing Office, 1950), p. 5.

Problem Number 9

To determine if soil carried by the wind is as valuable as, more valuable than, or less valuable than, soil not eroded by the wind.

Materials

A packet of garden seeds, a twelve inch ruler, six unglazed flower pots, enough blow dirt to fill two flower pots, enough normal soil to fill two flower pots, enough soil remaining in an active blow to fill two flower pots. An active blow is a region where wind erosion has removed so much soil material that only the subsoil remains.

Procedure

1. Prepare the seed beds by filling two of the flower pots with soil from each of the samples obtained.
2. Plant the selected garden seeds in the prepared seed beds about one-half an inch below the surface. Water the seeds by moistening the soil.
3. Continue watering the seed beds once a day, or once each two days. Cease adding water when surplus water appears on the surface.
4. Once the young plants make their appearance, begin measuring their rate of growth. A table can be made on a blackboard for convenience and the height of the tallest plant in each pot can be recorded when the experiment is completed.
5. Continue the experiment for two weeks after the plants have shown good growth.
6. Be prepared to discuss why the seeds planted in the soil remaining in the active blow did not support plant life for any long period of time while the other two seed beds apparently could nourish the seeds.

Problem Number 10

To demonstrate a technique for illustrating the effect of strong winds on the vegetation in an active wind erosion area. This will be simpler if a sand dune (undergoing active wind erosion), under vegetation, may be found.

Materials

The materials are the same as those needed to carry on problem number 4.

Procedure

1. The procedure used in this activity is basically the same as that used in problem number 4 with one additional feature added.

2. Show how the wind will first remove the soil from the plant roots, and then blow the unanchored plant away. Indicate, on the original map of the area showing the stakes in position as the contour lines were laid out, the various kinds of vegetation and their location on the dune.

3. After the season of high winds has been partially completed, return and recheck the location of the previously recorded plant types. Note any changes. The season of high winds is normally from the early part of February to the latter part of April in southwestern Colorado.

Problem Number 11

To demonstrate the difference, if any, in the movement of soils high in organic matter content by wind erosion.

Materials

A pie tin containing soil high in organic matter; a pie tin containing soil low in organic matter, a fan, some newspapers, and a platform balance.

Procedure

Place the newspapers on a table, placing one of the tins filled with soil at one end of the table. Place the fan so that its wind currents will move the soil from the pan onto the newspapers.

2. Collect the soil moved and weigh it.

3. Repeat the process described in step two using the other soil sample contained in the other pie tin.

4. Weigh the soil moved during this phase of the experiment.

5. Compare the amounts of the soil moved during each phase.

6. Discuss the difference, if one exists, between the two soil "types", in terms of the value of organic matter in the soil as a condition affecting the amount of soil eroded by the wind.

The native grasses and shrubs of the region are not capable of re-establishment on an active wind-erosion area. The factors responsible include: (1) the blowing sand particles destroy the young, tender grass seedlings, (2) the sub-soil does not contain enough organic material to support the developing grasses, (3) a shortage of water to nourish the seedlings exists. Therefore, before the native grasses and shrubs of the region will "tie down" the dune, something must be done to allow the grasses and shrubs to exist long enough to establish themselves.

Problem Number 12

To stabilize an active wind erosion area. (This experimental activity required a great amount of planning and co-operation on the part of the U. S. Soil Conservation Service; local units from the Boy Scouts of America; and the Lamar, Colorado, Fairgrounds Committee. Without the co-operation of all the individuals who volunteered their services and the students taking biology at Lamar Union High School, this activity would not have been possible. A note of thanks should also be extended to the organization supplying the shrubs and trees used in the project.)

The high school biology classes at Lamar, Colorado, decided to plant trees and shrubs as a class project. It was decided that these trees and shrubs could be planted in an area undergoing active wind erosion and would serve as a windbreak for the local fairgrounds. Since the Boy Scouts of the community were also interested in a similar project, it was of benefit to all the groups to consolidate.

Materials

4,000 trees and shrubs of the following types were obtained: cottonwood, caragana, Russian olive, saltbush, American wild plum, tamarisk, honey locust and Chinese elm. The permission of the board of directors of the fairgrounds was received. The laborers furnished their own shovels.

Procedure

1. The 4,000 trees and shrubs arrived and were heeled in to prevent the roots from drying.

2. To prevent the wind from removing the soil from the roots of the trees and shrubs after planting, it was decided to pile brush over the entire area of the active wind-erosion area. This brush was obtained throughout the city and was brought as near the active blow as possible. The brush was dispersed throughout the area.

3. A date was set and each student, or scout, was asked to bring a shovel of some type although a tile-spade was found to be the most efficient tool with which the holes for the trees could be dug.

4. Since about forty individuals arrived on the planned date, about one hundred trees and shrubs were given each individual to plant.

5. Holes were made by inserting the tile spade, or shovel, into the ground and pulling it toward the spader while still in the ground. The participants were in two rows four yards part and were spaced three yards part. The shrubs were planted in two rows around the outer perimeter of the blow.

6. Some of the shorter trees were placed in two rows inside the two rows of shrubs. The shorter trees were placed approximately eight yards apart.

7. The taller trees were placed in a fifth and sixth row about ten yards from the shorter trees. These trees were planted about fifteen yards apart in the row and the rows were spaced about fifteen yards apart.

8. Rows seven and eight of the windbreak were composed of shorter trees. As in step six, these were also placed eight yards apart; row seven was placed about fifteen yards from row six and row eight was placed about eight yards from row seven. By following this procedure, a tapering windbreak was planted that completely encircled the active blow.

9. An agreement was made with the city to have water delivered to the area, and the trees were watered through periods of prolonged drought.

10. A check of the trees and shrubs made three years later showed that a fair number of the shrubs were doing well; some of the trees had well-established root systems in spite of three years of drought and blowing.

Problem Number 13

To report on a dust storm and relate the severity of the wind to the barometric readings recorded during the week.

Materials

A barometer.

Procedure

This is an activity that loses much of its value if it is not done during certain periods of the year when climatic conditions promote blowing of the light uncovered soils of the region. The months of February through April normally have the highest wind velocities; therefore in the drier years the barometer could be observed and the approach of a dust storm forecast.

As an example of this type of activity, during the spring of 1953, a similar experiment was carried out in a biology class taught by the author in Lamar, Colorado. The barometric readings obtained at that time are found below.

Barometric readings corrected		*Date*
66.9 Cm.	Tuesday	16 February
66.0 Cm.	Wednesday	17 February
65.1 Cm.	Thursday	18 February
65.3 Cm.	Friday	19 February

A normal barometric pressure recorded at Lamar is approximately 76 Cm. of Mercury when the barometer is not corrected for the rise in elevation above sea-level. If the barometer is corrected, the normal reading becomes approximately 66.82 Cm. of Mercury. Thus the difference between normal barometric pressure at Lamar, Colorado and sea-level is approximately 9.28 Cm.

In the data reported above, the most critical point is the lowness of the barometric reading since winds blow from a region of high pressure into regions of lower pressure. From the data above, it is evident that a lowering of air pressure had occurred between Tuesday and Friday.

The details of the dust storm that occurred on Thursday follow. The wind velocity began to increase about 9:00 Thursday evening. It began to rain slightly after 11:00 and the precipitation changed to snow at about 11:30. By 12:00 the snow had ceased falling and the wind, and dirt, began to blow. On Friday, the wind blew all day with a velocity of twenty-five to fifty-five miles per hour according to the local weather observer.

The biology classroom of the Lamar Union High School was located on the ground floor, rear, facing West. The window sills, with the windows closed, were covered with fine dirt when school was opened. The floor was also heavily coated with dirt for as much as ten to fifteen feet away from the windows. The first period biology class cleaned the floor and the window sills thoroughly; they also cleaned the laboratory bench, their study tables and chairs. After a period of twenty minutes had elapsed, the cleaning of these surfaces should have been repeated.

A 3:45 p. m. when school was dismissed, the wind still had not stopped blowing hard. As an indication of the severity of the dirt storm, the high school enrollment for the day showed ninty-four absent of the 427 students normally attending classes.

It is hoped that a picture taken from the author's residence, at noon, will emphasize the severity of the storm during the noon lunch hour. This photograph is included in the appendix on page 61.

Problem Number 14

To determine if soil covered with vegetation is cooler than that soil which is not covered with vegetation.

Materials

Two or four large mercurial thermometers and a watch or a clock.

Procedure

1. Select an area that is being eroded by wind, and a second region of similar soil composition not being eroded. These two areas could be adjacent to each other if an active blow area is used for one region, and the perimeter not yet eroded is used as the second region.

2. Work in the eroded region first. Dig a hole and insert one of the thermometers into the soil of the hole to a depth of about two inches. *Note.* It is important that the two thermometers be inserted to identical depths. It is suggested that a piece of tape be placed around the barrel of each thermometer at identical points on the thermometers. A distance of two inches between the mercury reservoir and the tape is suggested.

3. Repeat this procedure in the region supporting vegetation.

4. Allow the thermometer to remain in the soil for approximately five minutes in the shade, then record the temperature reading obtained in each area.

5. Place a thermometer in each of the two regions in such a manner that the bulb of each thermometer is ten inches below the surface. Leave the thermometers in this position for five minutes and again record the temperatures.

6. The temperature reading at the greater depth in each region probably will be lower than the temperature reading in the topsoil if the experiment is done during the warmer months.

7. The temperature readings obtained in the vegetated areas will probably be lower than the temperature readings obtained in the area where active wind erosion is occurring.

Problem Number 15

To illustrate the difference in the amount of annual precipitation received in a given area.

Materials

Data obtained from the nearest Weather Bureau reporting station; or data obtained from the nearest Irrigation Co-operative.

Procedure

1. Obtain the annual precipitation record of your area from the Weather Bureau, or an Irrigation Co-operative. Greater benefit will result if these records have been maintained over a period of years.

2. Have a student make a graph showing the amount of annual precipitation received for each of the reported years. A bar graph shows the changes in the amount of precipitation quite clearly.

3. If it is desirable, it is also possible to examine the graph for evidence of a cycle in the amounts of annual precipitation received in your immediate area.

Problem Number 16

To illustrate the relationship, if any, between the depth of water in wells and the annual rainfall reported during the previous ten year period.

Materials

Information containing the figures for the depth of the water table in your location.

Procedure

1. Contact the state Geological Survey and obtain the level of the water table in your immediate area for each of the preceding ten years. A pipe and pump dealer is also an excellent source of information.
2. Contact well-drillers and find out how many wells have been deepened during the current year.
3. If wells are used for irrigation in the region, find out if any corresponding lowering of the water table has resulted. The Geological Survey would be of much assistance at this point.
4. Ask the students to determine how many wells of their classmates have gone dry. They will be able to furnish information about the wells on their own farms.
5. Determine the relationships, if any, between annual precipitation and the depth of the water table.

Note: Since all the water in the world is a natural resource that is often overlooked, and since irrigation water wells are a major source of water in the southwestern dry-plains region; the inclusion of activities dealing with the lowering of the water table is, in the opinion of the author, of great value to students.

Problem Number 17

To determine the rate at which streams cut into their banks.

Materials

Stakes prepared in the same manner as they were prepared in Experiment thirteen, (shorter lengths may be used if desirable) and a stream.

Procedure

1. In a curve of the stream bed, place enough stakes three feet apart along the edge of the stream to cover the length of the bend. More stakes should be placed four feet from the actual stream, if possible, and they must be driven firmly into the stream bed.

2. After a rain, return to the area and examine the stakes to determine whether the water has changed the course of the stream, or its channel; and, if so, how much it has changed.

Problem Number 18

To study the relationship between insect life in creek bottoms and the stream's ability to support a fish population of bottom-feeding fishes.

Materials

A tin can, some pint jars and jar lids, and some fine-meshed screen wire.

Procedure

1. By removing some of the material on the creek bottom some insect larvae will possibly be found. Since two of the fishes feeding on bottom dwelling organisms are the bullhead and the catfish, a lack of insect larvae in the stream, when carefully checked, may indicate one reason why neither of these two fishes are found.

2. To best check for insect life, strain the bottom samples through the screen wire sieve. The bottom and top may be removed from a cigar box and the screen taped in place, or tacked to the sides, to make a suitable screen. *Note.* It is also suggested that the tin can (a coffee can works very well) may be used to scoop up some of the bottom ooze, or debris, which can then be carefully screened and checked for the presence of small worm-like larvae.

Problem Number 19

To illustrate the various kinds of water erosion.

Materials

Flour, water, newspapers cut in one-quarter to one-half inch strips, and a large piece of plywood. A suggested size is twenty-four inches wide by thirty-six inches long.

Procedure

1. Make an amount of papier mache that will cover the plywood sheet to a depth of approximately four inches on one end to a depth of about one inch on the opposite side.

2. Cover the board with the papier mache, tapering the amount used to obtain a slope.

3. With a straight edge smooth the surface of that part of the papier mache about one-inch in thickness. However, leave about a one inch strip at the edge and do not level it, and do not smooth it. This uneven part will represent deposits from sheet erosion.

4. Press the length of a pencil in the papier mache before it hardens to make a series of small furrow-like lines on the surface. This may be used to represent rill erosion.

5. To demonstrate gully erosion use the thumb and push aside some of the papier mache where the smaller rills, or fingers, join. Continue making this depression through the remaining portion of the papier mache. Make the depression wider and gradually deeper as you work from the thicker end of the papier mache to the shallower portion of it. This portion of the board could be used as a replica of gully erosion.

6. For further clarity, color the three various replicas of the types of erosion with a water color after the papier mache has dried.

Problem Number 20

To demonstrate the effect of rainfall on covered and uncovered soils.

Materials

Two pie pans, one full of covered soil, such as sod, and the other pan full of bare soil; one to five coins to be added to the top of the soils, and a bottle with a sprinkler cap such as those used to sprinkle clothes.

Procedure

1. Place all of the coins on the surface of the bare soil. Place these coins so that they do not touch each other.

2. Sprinkle the surface of the soil covered, in part by the coins until the coins are elevated above the soil surface on mounds of dirt.

3. Repeat the procedure followed in step one, placing the coins on the sod-covered surface. When the coins have been placed on the surface, sprinkle the coins using the same amount of water as that used in step two.

4. Point out the difference in the amounts of erosion that has occurred on the two surfaces. This may be illustrated by the pinnacles formed under the coins when the bare soil was sprinkled with water. Relate the difference existing between the covered and uncovered soils (after sprinkling) to the farming practices followed in the region.

5. It should also be possible to relate the observed phenomenon to sheet erosion.

6. This experiment can also be used with a mulched soil and a barren soil to show the degree of penetration of falling raindrops into the soil. However, if this is done, be sure that the height that the water falls is the same in both instances. Coffee cans with holes punched in the bottom will function as well as clothes sprinklers for this activity.

Problem Number 21

To determine the rate at which water is lost through evaporation from stubble-mulched and from fall-plowed areas.

Materials

Two coffee cans; enough soil from a stubble-mulched area to fill one can, enough soil from a fall-plowed area to fill the other can; a pint of water, a small graduated cylinder, a watch or clock, and a platform balance.

Procedure

1. Weight each empty coffee can. Record their weights.

2. Add 250 grams of fall-plowed soil to one can and 250 grams of stubble-mulched soil to the other can. Record the combined weights of the cans plus soil samples.

3. Add fifty milliliters, or cubic centimeters, of water to the contents of each can.

4. Observe and record the time when the water was added.

5. Record the total weight of each can plus water.

6. Place both cans containing the soil and water on a table in the classroom.

7. After twenty-four hours, weigh each can again and record the time and the weight.

8. Repeat step seven after forty-eight hours.

9. Repeat step seven after seventy-two hours.

10. Determine the rate of evaporation after a twenty-four hour period by subtracting the weight of the cans and their contents, obtained in step seven, from the weight of the cans and contents obtained in step five; then divide the difference by twenty-four. This will furnish the loss of water-per-hour.

11. Repeat to determine the amount and rate of water loss in forty-eight hours; in seventy-two hours.

12. Discuss the difference between the two rates of evaporation of each can in terms of soil water loss over a large area and of water-holding capacity of the two soils.

Problem Number 22

To illustrate how temperature affects the rate at which evaporation will occur from a surface.

Materials

A cardboard box with a lid that can be closed; a heat lamp or hot plate; a coffee can; a graduated cylinder; enough soil to fill the coffee can two-thirds full; a platform balance; and a thermometer.

Procedure

1. Insert the thermometer into the box so that its bulb is exposed to the air inside.

2. Weigh the coffee can.

3. Pour a known amount of water into the can.

4. Add the weight of the known amount of water to the weight of the can. Record this combined weight.

5. Place the can inside the box shutting the lid and allow it to remain inside the box for two days. Reweigh the can and its contents and record this weight. It is suggested that two to four temperature readings be taken each day the can is inside the box.

6. Place the operating hot plate, or heat lamp, on the floor of the box; place the filled can with its known weight inside the box and again close the lid. After four hours, remove the can containing the water and reweigh it. Record the loss in weight after the four hour period of heating. If no loss in weight is found, allow the experiment to continue for a twenty-four to a forty-eight hour period and then reweigh the partially filled can. If a heat lamp is used, caution must be observed to prevent the cardboard box from burning.

7. If the thermometer is used, it is possible to calculate the amount of water lost as the temperature increases; however, the same interval should be maintained between readings as that interval used in step five.

8. Point out that any loss of weight is due to the evaporation of water.

9. Compare the data obtained and discuss the effect of heat on the rate at which evaporation occurs.

10. By using a known amount of soil and by adding a known amount of water, it is possible to show the effect of heat on the loss of soil water.

11. If the can contains sod, or soil with a cultivated plant growing in it, it is possible to demonstrate the comparison between the loss of water from vegetation and the temperature of the environment.

Problem Number 23

To determine the rate at which soil water is lost through the transpiration process of various plants grown in the region; and to determine the amount of soil water that is lost through this process.

Materials

Four unglazed flower pots containing fertile soil; two potted geranium plants; four dried lima beans; five yards of string; six or eight alfalfa seeds; a graduated cylinder; and six unperforated vegetable bags made of clear plastic; and a platform balance.

Procedure

1. Plant the seeds selected about one-half an inch to one inch under the surface of the soil of the flower pots containing only soil. Plant two of the flower pots with lima beans and the remaining two with alfalfa seed. When planting the alfalfa use about four seeds to each flower pot.

2. Water the plants and the planted seeds as often as is necessary. If the soil is moist about one-half an inch under the surface, there is no need to water the plant until this condition no longer exists. Each time water is added record the amount of water used.

3. After the plants have reached a size approximately four to five inches in height, place the unperforated plastic bags over one of the plants and over one of the geranium plants. Tie the bag to the stem of the plant but do not tie it so tightly that the plant tissue is harmed.

4. Allow transpiration to continue for twenty-four hours. Remove the plastic bags and weigh them and their contents. Record this weight. By allowing the plastic bags to dry and then weighing them, one may determine the difference between their dry weight and their "wet" weight. If this weight of water lost is divided by twenty-four, or by the number of hours between the weighings of the plastic bags, the hourly rate of transpiration can be determined.

5. Repeat this experiment with each of the plants covered with plastic bags.

6. As an additional procedure, place the plants outside the classroom in the sun for an additional twenty-four hour period; or during the heat of the day. Again observe the amount of water

lost during the heat of the day, or during this twenty-four hour period. By doing this, you may compare the per-hour average transpiration loss obtained with that obtained in the procedure specified in this paragraph.

7. Discuss with the class the difference between the two rates of transpiration among similar plants during different temperature conditions.

8. Since alfalfa is one of the cultivated crops grown profusely on irrigated lands, it is suggested that its transpiration rate be given special attention.

Problem Number 24

To illustrate why certain types of vegetation are native to the region and why certain cultivated crops grow better than others.

Materials

Leaves of alfalfa, one of the maizes, wheat, cacti, buffalo grass, and sand love grass; a microscope, ten to fifteen cover glass slips, a small glass of water and an eye dropper. Select some thin and some thick leaves of a hot-house plant.

Procedure

1. Prepare a cross section of one of the leaves of the plants and place it on the microscope slide. Add some water, and place a cover glass slip on the prepared tissue section.

2. Examine the section with the aid of the microscope and indicate the stoma, and guard cells to the students.

3. Determine the number of stomata, and the number of guard cells in a diameter view of the microscope and record this number.

4. Repeat this procedure for each of the plants selected to be used in the experiment.

5. Compare the results obtained in each instance and explain why certain plants are better adapted to the region than certain other plants. It may even be possible to use the hot-house plant to show more stomata than were previously found.

Problem Number 25

To develop an understanding of the effect of stubble-mulching on a soil's ability to retain water.

Materials

Two coffee cans, a small beaker or graduated cylinder, samples of soil from a field that has been stubble-mulched, samples of soil from a field that has been fall-plowed, and a platform balance.

Procedure

1. Fill one can with soil and stubble. Weigh it. Record the obtained weight.
2. Fill the other can with fall-plowed soil and weigh it. Again, record the obtained weight.
3. Add an equal volume of water to each can. Weigh the can and its contents in each case. Record the weights.
4. Allow evaporation to occur from each can for one day. Weigh the cans plus their contents. Record these weights.
5. Calculate the amount of water lost from each can. Divide the amount of water lost by the number of hours the experiment was in operation. This is the rate at which evaporation occurred.
6. Compare the rate at which soil water loss occurred in each case and discuss why a difference exists between the two rates.

Problem Number 26

To illustrate the value of dust-mulching, or cultivation, as a water conservation practice.

Materials

Two coffee cans; soil to fill the coffee cans; a small jar of known capacity or a graduated cylinder.

Procedure

1. Fill the two cans with "dirt."
2. Add a known amount of water.
3. Weigh each of the cans and the water.
4. Record the data obtained.
5. Scratch, or by some means, break up the surface of the soil to a depth of about one-half an inch in one of the cans while the surface of the soil in the other can remains unscratched. The scratching process should be repeated every day at a specified time.
6. Allow the two cans to remain on a table or window ledge for a day and reweigh them.
7. More water will probably be lost from the scratched surface than will be lost from the unscratched surface.

Discuss the amount of water lost in each case, and direct the attention of the class to the similarity, on a small scale, between cultivation and scratching of the soil in this experiment.

Problem Number 27

To demonstrate the water-holding capacity of three types of soil over a given two-day period.

Materials

A coffee can filled with two hundred grams of sandy loam; a coffee can filled with two hundred grams of sandy loam and straw; and a third coffee can filled with an equal amount of blow-dirt. A graduated cylinder, a platform balance and a source of water will complete the materials that are needed to perform the experiment.

Procedure

1. Pour twenty-five cubic centimeters of water into each coffee can after the weight of the can and its contents has been determined.
2. Allow each can to remain inside the classroom for two days.
3. Reweigh the cans and determine the amount of water lost.

Problem Number 28

To determine the effect of precipitation on a well-managed grazing area and on an over-grazed area.

Materials

A grazing area which has been properly managed and one which has been over-grazed.

Procedure

1. Locate a well-managed grazing area.
2. Locate an over-grazed area.
3. Discuss and attempt to determine without observing the areas what evidence of erosion will be apparent when wind erosion is occurring on the over-grazed area.
4. Repeat the speculation but discuss how the properly managed area will have reacted if wind erosion is occurring in your area. Use an area that is either mowed or unmowed.
5. Compare the normal vegetation of each of the two areas.
6. Speculate and discuss what you might expect to find after a severe rain storm.
7. Observe the surface of the area after a rain storm and relate the actual conditions found as they compare to the theoretical conditions the class anticipated.

Problem Number 29

To show how some minerals are dissolved and may reappear as the result of evaporation.

Materials

Four saucers or shallow dishes (evaporating dishes may be used if they are available), water, a level tablespoon of salt, a level tablespoon of soda, a level tablespoon of lime, and four large beakers.

Procedure

1. Fill each of the beakers about three-quarters full of water.
2. To one of the beakers add one tablespoon of one of the listed chemicals.
3. Repeat this procedure until three of the beakers contain water and a chemical. The fourth beaker will be the control and will contain only water.
4. Dissolve the chemicals in the water.
5. Fill one of the evaporating dishes, or saucers, with some of the water from one of the beakers containing the dissolved materials.
6. Repeat step five until all four of the saucers, or dishes, have been filled.
7. Allow the contents of the dishes to evaporate and direct the attention of the class to the residue remaining on the bottom of the dish.
8. Relate the occurrence of the residue to the appearance of the alkali deposits in soils.

Problem Number 30

To illustrate the process by which minerals are leached from the soil. Leaching is the process by which valuable minerals are removed by dissolving in water as the water passes through the soil on its way to the water table. Sand will be used in this experiment and while it is not a soil, its use will lessen the time requirements of the experiment.

Materials

Enough sand to fill a flower pot, an unglazed flower pot, five cents worth of potassium permanganate, or copper sulfate, and a source of water.

Procedure

1. Dissolve potassium permanganate to illustrate how it will appear when dissolved in water.
2. Fill a flower pot with sand.
3. Wash the sand by flooding it with water until the water running through it is no longer muddy colored.
4. After the sand has dried, "plant" potassium permanganate crystals, or copper sulfate crystals, in it.
5. Rinse the sand in the flower pot with water and observe the color of the water passing out of the bottom of the flower pot.

Problem Number 31

To determine the rate and amount of run-off water from a sod-protected surface, and from a barren soil surface.

Materials

A piece of plywood, eighteen inches wide by twenty-four inches long; two strips of plywood one inch wide and twenty-four inches long; one strip of plywood one inch wide and eighteen inches long; a pan at least twenty inches long and one inch deep (a large cake pan will be adequate); a piece of sod about six inches wide and six inches long; a similar amount of barren soil; a source of water; a graduated cylinder; and about fifteen one-inch finishing nails.

Procedure

1. Nail the two longest strips of plywood to the long sides of the plywood sheet. Nail the shorter strip of plywood across one end of the sheet so that the sheet of plywood now has three sides. Nail the sides so that the bottom of the three-sided "box" is flat.
2. Place the box so that the closed end is higher than the open end. Also place the open end of the box over the open part of the cake pan, if this is used.
3. Place the sod on the inclined sheet and add a known amount of water to the center of the sod pouring it steadily, but slowly. Note that little water will run off.
4. Measure the amount of water that has run-off the sod covered surface. Record these data.
5. Record the time required for the water to run-off.
6. Repeat steps three through five using the barren soil and record the results obtained.
7. Compare the results recorded in each case to determine the type of surface offering the greatest resistance to rapid run-off.

Problem Number 32

To demonstrate the effect of rainfall and the effect of run-off on a sloping area planted to various crops.

Materials

The seeds of some of the cultivated crops found in your region such as corn, alfalfa, wheat, maize, and sorgo, plus the seeds of some of the grasses recommended by the soil conservation service for the grazing lands of your area.

This experiment will require the use of a small plot of ground, preferably on a slope, that could be used by the class as a demonstration area.

Procedure

1. Cultivate the area chosen as a demonstration plot. A suggested size for this plot would be one of about twenty feet square.

2. Plant one-half of the acquired area to the cultivated crops to be used in the experiment.

3. Plant the remaining half of the demonstration area to the recommended grasses.

4. Water the seeds to aid their development if this step is deemed necessary. Weed the area planted when and if it becomes necessary.

5. After a rain, return to the area and determine the effect of rainfall on the soil between the rows where the plants are at any early stage in their development, and check the effect of rainfall after the plants are large enough to protect the soil between the rows.

6. It should be possible to see how the rain will cause erosion of planted fields if the vegetation is not large enough to protect the soil; or if the seed is not planted in a heavy enough pattern to completely cover the soil when the young plants appear.

Note: The seeds of some of the grasses may be secured from a local seed dealer, from the local soil conservation service office, or from the Range Management Department of the nearest College of Agriculture.

PROBLEM NUMBER 33

To determine the percentage of soil carried by run-off water.

Materials

A pint of clear creek water and a pint of muddy creek water obtained at the same location; a platform balance, a graduated cylinder, a pyrex beaker holding about one-half pint, a source of heat such as a hot plate.

Procedure

Shake one pint of water until any material on the bottom seems thoroughly dispersed.

2. Pour the contents of the pint jar into a beaker that has previously been weighed.

3. Weigh the beaker, and its content, recording this weight. Subtract the weight of the beaker from the weight of the beaker and its contents. This gives the weight of the water.

4. Place the beaker on the source of heat. Heat the contents until the water has evaporated.

5. Repeat steps one through five using the silty, or muddy water, and obtain the weight of the silt that is left behind.

6. Divide the weight of the water into the weight of the silt. Convert the decimal obtained to per cent. This is the percentage of silt carried by the sample of water you obtained.

7. This experiment can be repeated under various conditions and the difference between the stream's velocity and the percentage of silt carried can be calculated. The difference between the percentage of silt in normal run-off from uncovered fields and from planted fields can be determined by this same method.

Problem Number 34

To study the effect of siltation on the holding capacity of a dam.

Materials

No special materials are required for this activity.

Procedure

1. Contact the Soil Conservation Service or the Corps of Engineers in charge of a dam in your area.
2. Find out how much water the dam impounded, or held back, when it was first completed.
3. Find out when the first water was stored behind the impoundment.
4. Obtain the data on the amount of siltation that has occurred within the impoundment up to the present time.
5. Calculate the holding capacity of the dam now and calculate the percentage of loss of its holding capacity.
6. Calculate how many years the dam will be able to impound water at the present rate of siltation; then compare this figure with the normal "lifetime" of the dam.
7. From the total cost figure, find out the loss in value of the dam as it now stands.
8. Discuss the reasons why it is impractical to remove the silt deposited in the impoundment.

Problem Number 35

To determine the adaptability of certain native and cultivated grasses to the southwestern dry-plains region by a study of their root structure.

Materials

Specimens of wheat, corn, maize, buffalo grass, gramma grass, and sand love grass. Include as much of the root structure of each of these plants as possible.

Procedure

1. First learn the water requirements of each of the grass

samples collected. This information in generalized form may be obtained from the Soil Conservation Service or from the nearest agricultural college.

2. Determine the main purposes of the various kinds of roots found in plants.

3. Classify the grasses collected on the basis of their type of root structure.

4. Compare the root systems of the various collected species to find out which of the grasses best meet the requirements imposed upon the plants by the environmental conditions found in your immediate area.

5. If it is possible to obtain information pertaining to the holding ability of the plant and to its ability to secure water, this would also be of value in the discussion. Such information should be available from the Soil Conservation Service.

6. A valuable reference book that could be used in connection with this experiment is the 1945 Year Book of Agriculture titled *Grasses*.

Problem Number 36

To illustrate that the physical health of an organism is affected adversely by a dust storm.

Materials

Geese and ducks that suffocated during a dust storm.

Note: This problem may not always be solved using the same animals as those which happened to be placed at the author's disposal; however, many animals are killed during severe dust storms.

Procedure

1. Ask the students to bring in any specimens of animals that died during dust storms.

2. After determining where the animals were killed, and how they died, certain conclusions may be reached. For instance, in one case, a wheat field had a small body of water at one end. About 350 Canadian Geese and Mallard Ducks evidently used this field for their feeding grounds. While the fowl were feeding, a dirt storm of unusual severity blew into the area. The water fowl did not leave the water and suffocated. While investigating the accident later, pictures were taken and the dirt removed from the bills of the ducks and geese. After the pictures had been developed and printed, the wedges of dirt taken from the bills of the fowl were presented to the class with pictures of the

dead fowl. Reprints of these pictures will be found on page 64 of the appendix.

On a second excursion to the area, some of the trachea of the suffocated birds were removed and brought back to the classroom. Sections were examined under the microscope and the dirt particles lining the trachea were pointed out to the students.

Problem Number 37

To demonstrate that rabbits inhabit these areas where they can find food.

Procedure

1. If it is possible for the class to go on a field trip, take them to a local area where cattle are found grazing on range land, and where an established rabbit population exists.
2. Take the class to an area where over-grazing exists and search for rabbits or signs of rabbit populations in this location.
3. Compare the evidences of rabbit populations in the areas mentioned.

Problem Number 38

To show that over-grazed land will be less valuable, as a grazing area, than land that has been properly grazed.

Materials

Two areas; one over-grazed; the other, properly grazed, or well-managed.

Procedure

1. Locate an over-grazed area during the winter months. As soon as the weather permits visit the area and show the students that animals have eaten the roots of the grasses.
2. Locate a properly-managed area and measure the height of its grasses.
3. Return in the spring after the grass in the area has begun to appear green and show the students the barren places in the over-grazed field in comparison to the more luxuriant, and even vegetation in the properly-managed, or properly-grazed area.
4. Attempt to relate future soil losses to the areas studied and effect of the over-grazing on permanent pastures.

Problem Number 39

To compare the annual precipitation and the economic status of your community over a period of years.

Materials

Data obtained from the county assessor or county clerk.

Procedure

1. Ask a student, or several students who go as a group, to obtain the assessed evaluation of their farms during the 1920's, the 1930's, the 1940's, and the 1950's.

2. Ask another student to obtain the total assessed evaluation of your county during these four periods. It is suggested that this student call the individual who has such information and make an appointment.

3. Compare the results of steps two and three after finding out the effect of inflationary tendencies on the evaluation.

4. Ask a farm student to obtain the average amount of farm income in the county during each of the four years. This income should not include the benefits obtained from oil or natural gas wells located on the farms or ranches.

5. If possible, from a source unknown to the students, find out the average farm income on a certain sized farm during these four periods.

6. Ask a student to obtain precipitation records from an Irrigation Co-operative or the Weather Bureau.

7. Compare the results and relate the effect, if any, of annual precipitation to the lowering of farm income within your immediate area.

Problem Number 40

To locate, examine and develop an understanding of the effect of oil field brine on vegetation.

Materials

A "salt scar" resulting from the escape of oil field brine from brine pits, settling tanks, or other retaining structures.

Procedure

1. After a salt scar has been located, a field trip to the area can be made for the purposes of examining the scar for vegetation, and to obtain soil from the scar site which may be used later in classroom experiments and demonstrations.

2. The toxicity of high salt concentrations on plants may be readily demonstrated. This problem involves a visit to an area almost if not completely devoid of vegetation. This is normally enough to illustrate the need that plants and animals have for usable water.

3. A discussion of osmosis and plasmolysis may be desirable at this point to enable students to understand the movement of fluids into plant root systems and in and out of cells. A review of osmosis

was of benefit to the writer's classes even though the subject had been studied in some detail.

Note: The shrinkage of potato strips of measured length in salt brine solutions of various strengths proved to be most helpful.

Problem Number 41

To illustrate the difficulty in re-establishing plant life on salt scars.

Materials

Salt scar soil, four open-bottomed unglazed flower pots, a filter and filter paper, some seeds, water, and soil obtained from a field which supports plants at the present time.

Procedure

1. Fill two of the flower pots with the soil removed from the salt scar, plant a few seeds in each of the pots, and water the newly planted seeds.
2. Fill the remaining flower pots with soil from the vegetated area, plant the seeds as suggested in procedure 1.
3. Water the planted seeds just often enough to keep the soil just below the surface *moist* but not wet.
4. Observe the pots. The development of the plants in the "normal" soil should occur; the seeds planted in the "salty soil" may not germinate at all. If the seeds do germinate, the plants may and probably will not progress much beyond the seedling stage.

Problem Number 42

A variation of problem 40 may be done in conjunction with it. The variation involves the attempt to illustrate the difficulties involved in leaching (flooding) the salt from salt scar soil.

Materials

Those needed for problem 40 with the addition of more flower pots and some silver nitrate solution (a 5 per cent solution is adequate).

Procedure

1. Place some of the salt scar soil in the additional flower pots.
2. Flood the surface of the flower-pot soil with water and allow the wet soil to dry. Enough water should be added to the surface to allow the water to drip from the bottom of the flower pot.
3. Catch some of the water in a small bottle, jar, saucer, or *clear* container of some sort. Add 1 drop of silver nitrate solution and observe the formation of the milky white precipitate which indicates the presence of silver chloride.

4. Steps two and three may be repeated for a period of days or even weeks. The characteristic milky white precipitate will most usually be clearly evident.

Note: If the amount of water added to the soil is recorded and if a known weight of soil is used, it is possible to calculate the amount of water that would be necessary to "leach the salt from the soil" if students are persistent in the flooding operation.

It will probably be necessary to filter the water dripping from the flower pots to remove the dirt before the silver nitrate is added.

Problem Number 43

To illustrate the economic effect of oil field brine pollution on fresh water.

Materials

The determination of an area in the vicinity which has undergone fresh water pollution from oil field brine.

Procedure

A letter should be written to the State Board of Health or the State Geological Survey to determine the most immediate location of fresh water well pollution due to brine contamination.

2. Consultation with a district geologist employed by the State Board of Health may be arranged and a field trip scheduled to a community where oil field pollution has contaminated fresh water wells. This is probably most possible in Kansas.

3. Where community water supplies have not been contaminated in a region as-a-whole, it may be possible to obtain the name and location of a farm family whose water well has been contaminated by the action of oil field brine.

4. A possible estimate of the economic value of this type of pollution is possible for expenses may be determined in bringing fresh, uncontaminated water to the farm home, home, or community. The rate at which water is used by a single family and the community and the cost of the water over a year's time determined. If the community pays for the water, the cost of the water per-family-unit may be determined from information usually obtainable at the city clerk's office.

The rate at which water is used will depend upon the size of the individual family and the season of the year.

Problem Number 44

To determine the effect of oil field pollutants on fresh water stream dwelling organisms.

Materials

Water from a stream contaminated by oil field products and some silver nitrate solution, some white enamel pans, several pair of forceps or tweezers.

Procedure

1. The same basic procedure may be followed as used in Problem 18 with a few rather minor changes.

2. The stream bottom should be investigated to determine the presence or absence of insect life; deep pockets of water or pools should be seined to determine the presence or absence of "fish" life. Record the number and kind of organisms found and estimate the relationship between the abundance and type of animal life found in the contaminated waters and those identified in Problem 18.

3. It may be possible to move away from the source of the pollutant and to locate areas where aquatic life is more varied in type and more numerous.

4. A marked decline may occur in the growth of vegetation growing on the stream banks. This may be especially noticeable in terms of the abundance of grasses.

5. A discussion of the cumulative effects of this type of fresh water pollution should follow this series of activities. The importance of an adequate supply of usable water to man may be the most important outcome to be gained from this type of activity.

Note: It would seem more important to consider *all* the types of possible contamination of fresh water supplies than to limit the study of water pollution to that resulting from brine contamination. Such occurrences are rather rare while other types of fresh water pollution are much more common.

The photographs located on pages 70 to 73 in Appendix B will serve as explanatory material of one aspect of oil field pollution. It should be made clear to students that such occurrences are rare for a vast majority of the individuals engaged in the petroleum industry are aware of their responsibilities to both farmers and city dwellers. The use of detergents by housewives and industrial concerns may be the largest problem to be dealt with in terms of stream contamination. In fact, the writer used to require students to write a formal term paper on any of the various aspects of the southwestern dry-plains water problems. No two students were allowed to write on the same topic and, the students never complained of not being able to find adequate topics or material to write about.

Chapter IV

Summary

The Problem

This paper has as its objective the development of a list of activities for teaching soil and water conservation which might be of use to teachers of the natural sciences in the southwestern dry-plains region. More especially, this thesis is a compilation of those activities which, in the opinion of the author, are of value to teachers of high school biology in the southwestern dry-plains region.

The Activity Approach

The approach to soil and water conservation which is used by the author is the experimental, or activity approach. It is felt that this method not only allows the students to see the naural processes which are making necessary soil and water conservation, but also allows the students to participate in the development of these activities and gain experience in using simple laboratory equipment.

Recommendations

The author is convinced that the teachers of high school biology in the dry-plains need a course, or a series of courses, in the field of ecological conservation, and/or conservation education. Such a course might be made available not only to teachers-in-training but to teachers-in-service.

It is believed that this can be accomplished by conservation-education workshops during the summer months, for a series of week-ends, or over one of the longer vacation periods during the year when the teacher-in-service has an opportunity to avail himself of the facilities offered.

The author also believes that a co-ordinated effort should be made by all the agencies concerned with conservation to join with the colleges in the region in offering such a conservation program.

Since the questionnaire sent to various high school biology teachers in the southwestern dry-plains region indicated a need for information in the field of soil and water conservation, the writer would like to suggest that perhaps a committee on conservation education should be formed in each state. This committee could be composed of members of the faculties of various colleges in the state, a representative of the state Game and Fish Commission, a representative of the Soil Conservation Service, the Forest Service, the Public Health Service, the Extension Service, and any other agencies interested in the field of conservation.

If such a committee were formed, it is believed that one of the most valuable aids to all teachers in the state that could be offered would be a handbook, or a course of study in conservation that contains a summary of the most important conservation problems of the state.

The author would like to suggest to the teacher that the natural sciences in the southwestern dry-plains region that the students who are now in school must have an opportunity to develop an understanding of their environment and its effect upon them. The most readily-accessible material for this is the actual out-of-doors. The out-of-doors is the most inexpensive laboratory that the students can use; hence, the reason for including so many experiences to be used in the out-of-doors in the list of suggested activities.

The author also feels that the study of soil and water conservation should be incorporated into the high school biology curriculum, not as a special field, but as an integrated part of the biology curriculum. New conservation units should be developed in some cases. For the situation that will not lend itself to the integrated type of program the author feels that a comprehensive unit in the area of conservation would be of much value to the students. Further, the author feels that such a unit should consist not only of soil and water conservation but should include the various natural resources that are derived from, and exist because of their dependence on soil and water. It is evident, the author believes, that water is of no value to man unless it exists in a condition wherein he can use it. Soil is of little value to man unless it is of such material that it is able to provide for him, and for his animals, the basic materials they require for life. These are basic understandings around which any conservation program in the southwestern dry-plains region might well be built.

As Huxley states, "The chessboard is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of Nature. The player on the other side is hidden from view. We know that his play is always fair, just and patient. But we also know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well, the highest stakes are paid, with that sort of overflowing generosity with which the strong show delight in strength. And one who plays ill is checkmate—without haste, but without remorse.[44]

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44. Aldous Huxley, "A Liberal Education," Martin Gardner (ed), *Great Essays in Science* (New York: Affiliated Publishers, Inc., Washington Square Publication Number W-582, 1957) p. 240.

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JOEL, ARTHUR N. *Soil Conservation Reconnaissance Survey of the Southern Great Plains Wind Erosion Area.* United States Department of Agriculture Technical Bulletin No. 556. Washington: Government Printing Office, 1936.

C. COURSES OF STUDY IN SCIENCE

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Biology, Course of Study and Teaching Guide for Secondary Schools. Course of Study Bulletin No. 46A. Pierre: State of South Dakota, Department of Public Instruction, 1960.

Laboratory Science Guide in Kansas Secondary Schools. Topeka: Kansas State Department of Public Instruction, 1954.

Principles and Standards for Accrediting Elementary and Secondary Schools and Description of Approved Courses, Grades 7-12. Bulletin No. 615. Austin: Texas Education Agency, 1961.

Science Aids and Suggestions for Teachers. Bulletin No. 31. Santa Fe: New Mexico State Department of Education, 1959.

Science, Tentative Guides for the High School Teacher. Bulletin No. 5. Santa Fe: New Mexico State Department of Education, 1949.

The General Science Handbook, Part I. Lincoln: Nebraska Department of Education, 1951.

The General Science Handbook, Part III. Lincoln: Nebraska Department of Education, 1956.

The Improvement of Science Instruction in Oklahoma, Grades K-12. Oklahoma City: The Oklahoma State Department of Education, 1960.

D. COURSES OF STUDY IN CONSERVATION EDUCATION

Colorado's Natural Wealth, A Bulletin on Conservation of Natural Resources. Denver: Department of Education, The State of Colorado, Publication Date Unknown.

Conservation Projects for the High School. Bulletin No. 19. Santa Fe: New Mexico State Department of Education, 1955.

Conservation of South Dakota's Natural Resources. Pierre: South Dakota State Department of Public Instruction, 1953.

Conservation Handbook for Secondary Science Teachers in South Dakota Schools. Bulletin No. 78. Pierre: South Dakota State Department of Public Instruction, 1960.

Curriculum Guide in Conservation Education. Denver: Colorado State Department of Education, 1962.

Problems and Progress in Soil and Water Conservation. Lincoln: Nebraska Department of Education, 1956.

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E. SELECTED PUBLICATIONS RECEIVED FROM STATE FISH AND GAME DEPARTMENTS

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GREEN, IVAH. *Growing Grass in Nebraska.* (Place of publication unknown.) Nebraska Association of Soil and Water Conservation Districts, 1962. (Mimeographed.)

GREEN, IVAH. *Growing Trees in Nebraska.* Lincoln: Central Plains Forestry Office, United States Forest Service and Nebraska State Extension Service, The University of Nebraska, publication date unknown. (Mimeographed.)

GREEN, IVAH and J. DUANE CHAMBERLAIN, *et al. A Workbook and Answer Key for the Study of Soil and Water Conservation in Nebraska.* (Place of publication unknown.) Nebraska Association of Soil and Water Conservation Districts, 1958. (Mimeographed.)

MCCLAIN, CHESTER A. *Nebraska Nature Series;* and, *Nebraska Nature Series Record Book.* Series B. Lincoln: Nebraska Game, Forest and Park Commission. Date of publication unknown.

TISCHE, JAMES M. and DALE R. BREE. *Youth Manual for Work in Wildlife Conservation and Outdoor Recreation;* and, *Youth Record Book for Work in Wildlife Conservation and Outdoor Recreation.* Series A. Lincoln: Nebraska Game, Forest and Park Commission, 1961.

F. UNPUBLISHED MATERIALS

PIERSON, DAVID W. *An Activity or Experimental Method of Teaching Soil and Water Conservation in a Southwestern Dry-Plains Biology Classroom.* Unpublished Master's Thesis, The State College of Iowa, Cedar Falls, 1957.

Appendix A

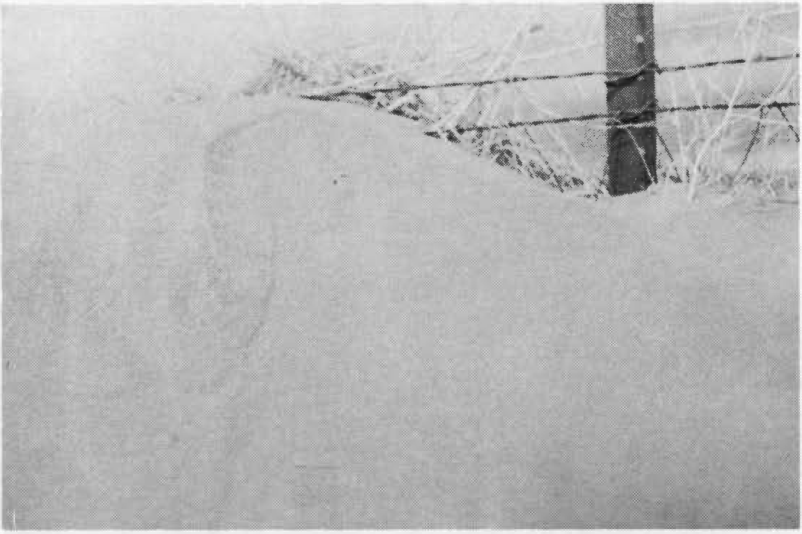
PLATE I

SETTLING DUST DURING A DUST STORM
April 23, 1953, Lamar, Colorado.

PLATE II

WIND-ERODED SOIL
Fence Row Drift—U. S. Highway 50.

PLATE III



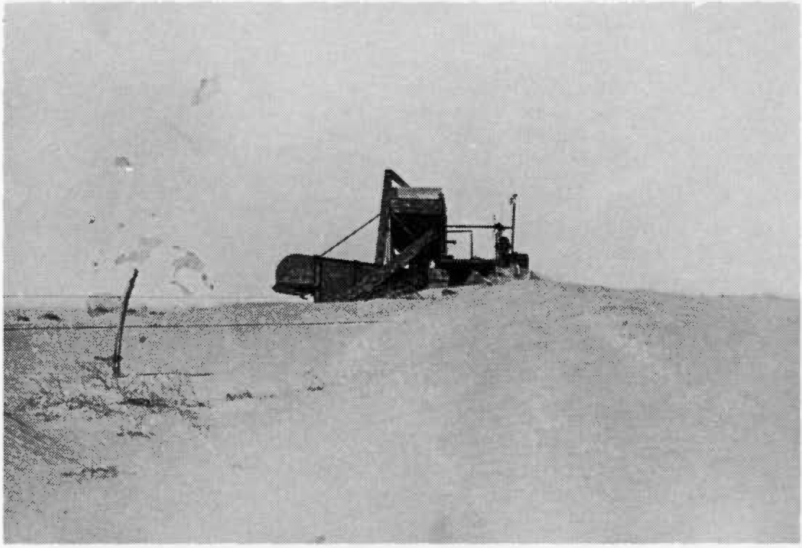
CLOSE-UP OF FENCE POST In Plate II

Tumble weeds were first caught in the barbed wire fence. As the weeds piled up, the passage of wind blown soil was blocked; it too piled up. Where this occurred on planted fields the fences were cut or broken and the drift-soil spread back out on the fields to be plowed under if necessary.

PLATE IV

ABANDONED SHED

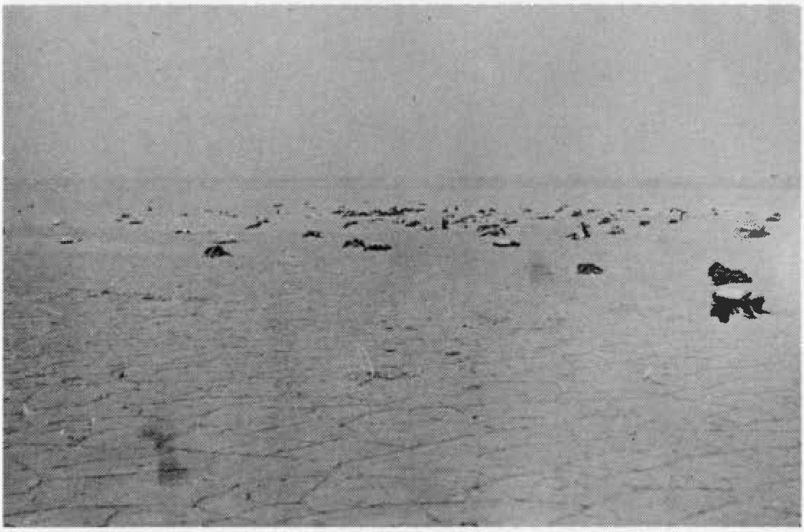
PLATE V



OLD COMBINE, FENCE AND DRIFT SOIL

A close examination of the fence and the drifted soil around the combine will indicate the severity of the wind-erosion problem in certain of the affected areas.

PLATE VI



SUFFOCATED DUCKS AND GEESE

PLATE VII

CLOSE UP—SUFFOCATED GOOSE

PLATE VIII

MALLARD HEN

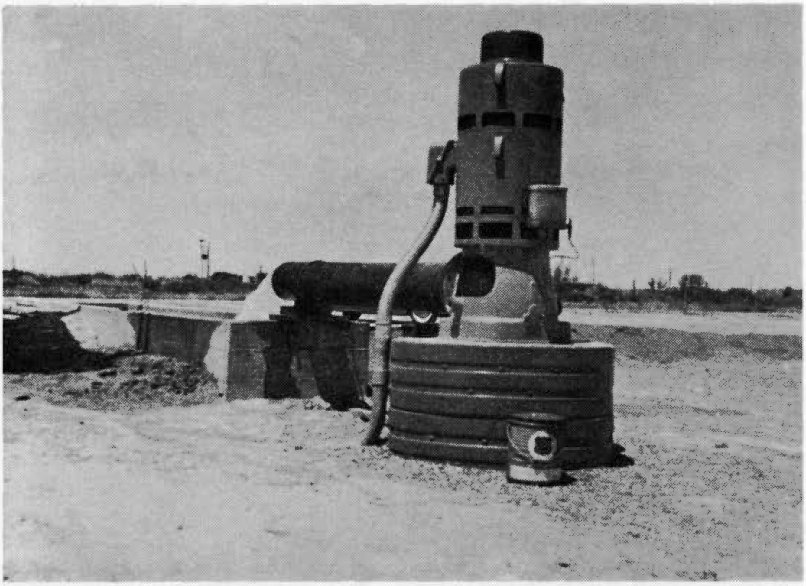
It snowed; the snow melted. Whether the waterfowl landed to feed on the wheat near the pond made in the wheat field by the melted snow or whether the dust forced them to land is a question. Once down the fine silt-like particles filled the nostrils, the trachea and these photographs were possible.

PLATE IX

FELLOW LAMAR, COLORADO, TEACHERS

The cracked mud forming the "pond bottom" was at the approximate center of the wheat field. A partially buried duck may be seen near the right border of the photograph. The downward slope of the plowed field may be seen to the rear of the two teachers.

PLATE X



A DRY-LAND IRRIGATION WELL AND DITCH

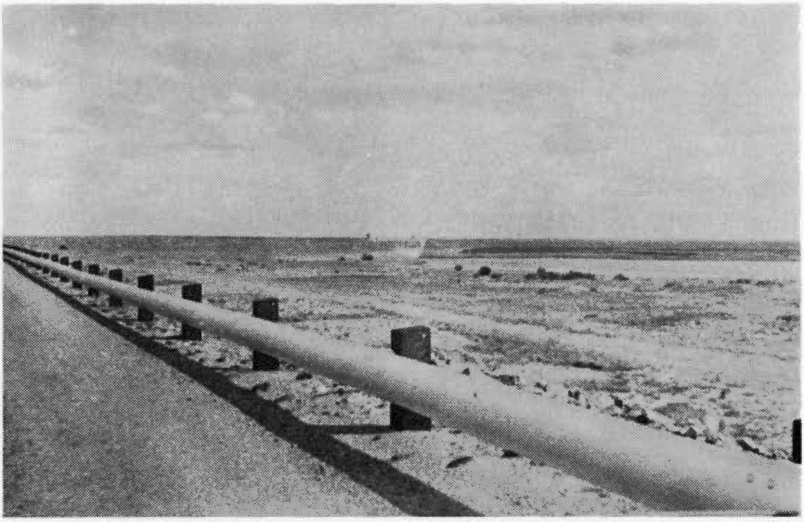
The cost of such an irrigation well is high; the yield from irrigated lands is great. The net effect is the extensive installation of such wells. However, the decline in the level of the water table must also be considered.

PLATE XI

NATIVE GRASSES GROWING ALONG AN IRRIGATION DITCH

The soil in the area is fertile; water is the limiting factor.

PLATE XII



JOHN MARTIN DAM AND RESERVOIR

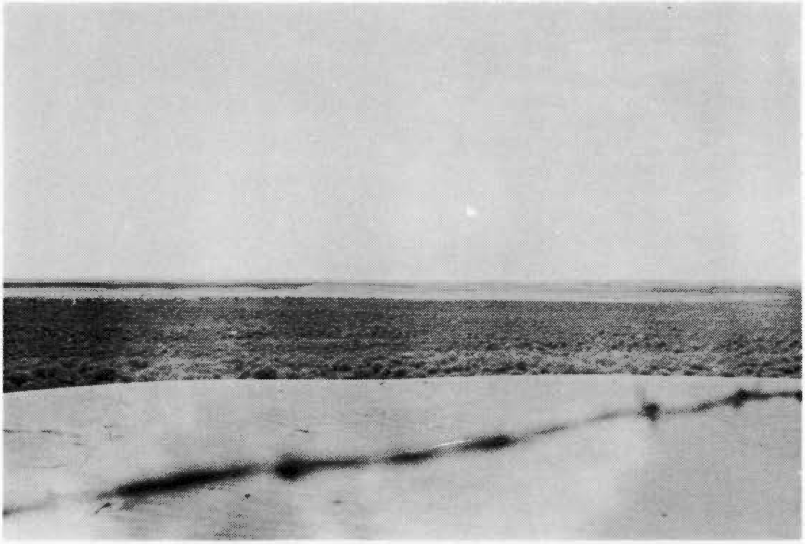
A flood control and water storage project operated by the Corps of Engineers on the Arkansas River west of Lamar, Colorado.

PLATE XIII

DEVELOPING SAND DUNE

This dune and blow-out area was the site of the mapping activity mentioned in the study as PROBLEM NUMBER 4.

PLATE XIV



SAND DUNES AND SAGE BRUSH

PLATE XV

BUFFALO GRASS AND SAGE

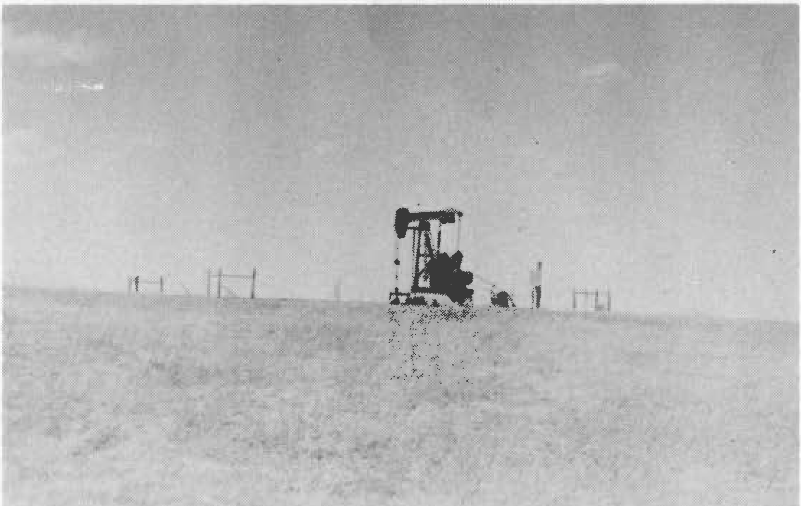
Buffalo grass is a native to the Southwestern Dry-Plains. Notice the extremely long root structure of the grass and the height of the grass-covered surface as compared to the level of the sandy area in front of the Buffalo grass clump. To the extreme left may be seen a sage plant which had fifteen inches of its stem and root structure exposed.

PLATE XVI

SOIL STABILIZATION PROJECT 1953

This photograph should illustrate the amount of debris which was hauled in and dispersed throughout the area where the stabilization project was being carried out. Tree trunks, tree limbs and most other kinds of material were used in the attempt to protect the seedlings to be planted in and around the accumulated debris.

PLATE XVII



OIL WELL PUMP JACK

The break in the main line is to the left of the photograph.

PLATE XVIII

OIL PATHWAY

An artesian spring drains down slope flowing from lower right to upper left. The creek follows the route of the willows in the background.

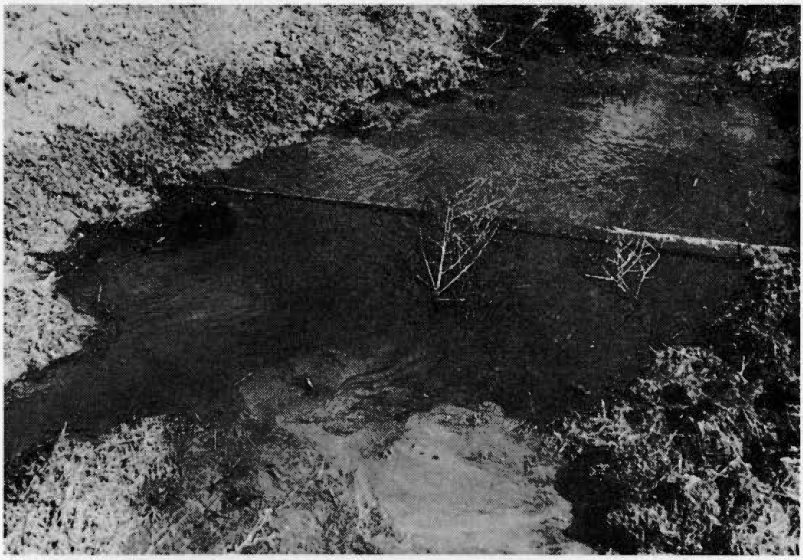
PLATE XIX

CLOSE-UP—OIL PATHWAY

PLATE XX

OILY WATER, OILY VEGETATION

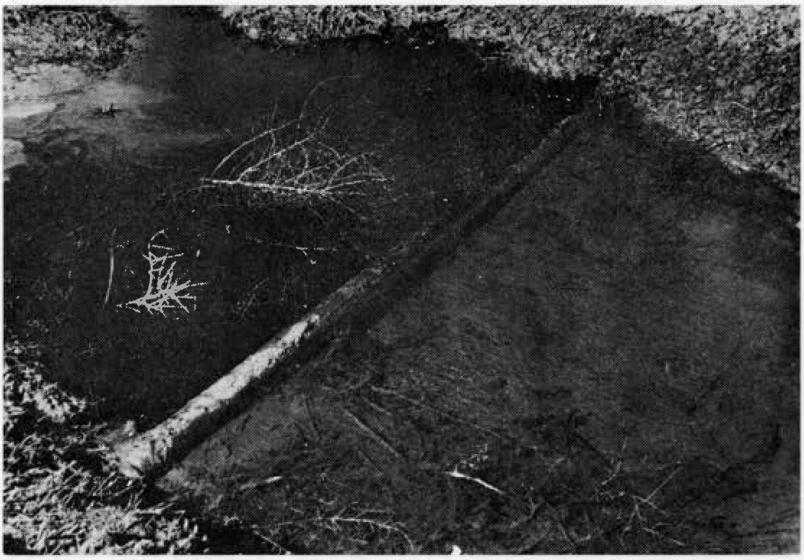
PLATE XXI



TWO-CREEK JUNCTION

The oil was carried by the left fork. The right fork carried no oil. The spread of the oil may be seen in the foreground. The effectiveness of the surface pipe barrier may be seen by comparing the oily surface of the water above the pipe barrier and below the barrier in both Plates 21 and 22.

PLATE XXII

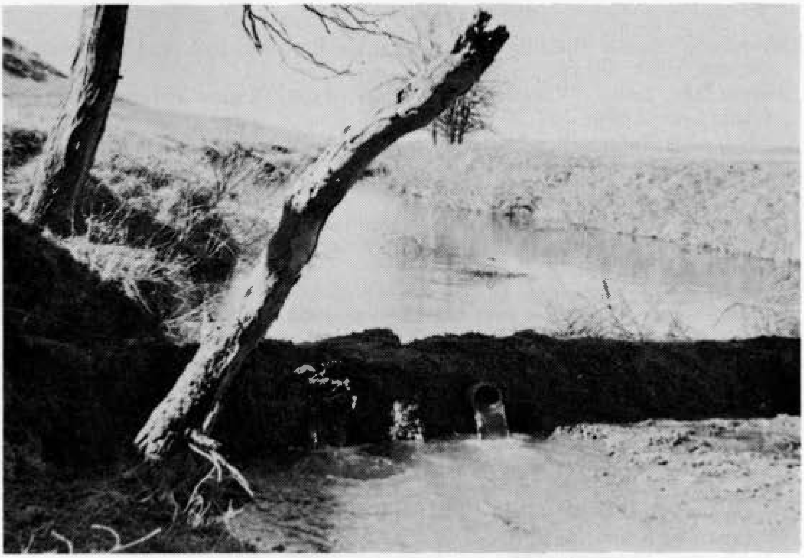


SURFACE PIPE BARRIER

PLATE XXIII

OIL GLOBULES ON STREAM SURFACE

PLATE XXIV



EARTHEN CHECK DAM

A series of eleven such check dams were constructed to stop the spread of oil into a grazed pasture. No oil was visible on the stream surface below the dam in this photograph.

Appendix B

MISCELLANEOUS PUBLICATIONS RECEIVED FROM STATE DEPARTMENTS OF FISH AND GAME

COLORADO

A Look Back, A 65 Year History of the Colorado Game and Fish Department. Denver: Colorado Game and Fish Department, 1962. 65 pp.

Selected References on Wildlife. Denver: Colorado Game and Fish Department, 1962. 2 pp. (Mimeographed.)

KANSAS

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BRUEKELMAN, JOHN. *What Have I Caught?* Pratt: Kansas Forestry, Fish and Game Commission, 1947. 36 pp.

A group of 5 "Information Bulletins" relevant to Kansas game and fish species.

NEBRASKA

HEMSTROM, MORRIS. *4-H Wildlife Conservation*. Lincoln: The University of Nebraska, College of Agriculture, Extension Service Circular No. 18-51-2, 1956. 42 pp.

SCHILDMAN, GEORGE and J. H. SATHER. *Nebraska Pronghorn*. Lincoln: Nebraska Game, Forest and Park Commission, 1955. 21 pp.

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NORTH DAKOTA

MILLER, WILFORD C. *Wildlife in North Dakota*. Bismarck: North Dakota Game and Fish Department, 1955. 144 pp.

ADAMS, ARTHUR W. *Furbearers of North Dakota*. Bismarck: North Dakota Game and Fish Department, 1961. 102 pp.

The Central Flyway Council. *North Dakota Waterfowl Identification Guide*. Burlington, Vermont: The Lane Press, Inc., 1962. 55 pp.

OKLAHOMA

Fifteen information sheets describing Oklahoma game birds and animals were received.

A film bibliography of free films available from the Oklahoma Department of Wildlife Conservation, Oklahoma City.

Leaflets which describe how to attract ducks, raise fish bait; construct bird houses, bird feeders, quail feeders, and turtle traps.

SOUTH DAKOTA

Looking Back Past Fifty Years. Pierre: South Dakota Department of Game, Fish and Parks, 1959. 154 pp.

Conservation Highlights, 1960-61 and 1961-62. Annual Reports of the South Dakota Department of Game, Fish and Parks. Pierre: South Dakota Department of Game, Fish and Parks. 48 pp. respectively.

ERNEST HUGGHINS. *Parasites of Fishes in South Dakota*. Agricultural Experiment Station Bulletin No. 484. Brookings: South Dakota State College, 1959. 73 pp.

TEXAS

The Texas Game and Fish Commission, Austin, Texas, forwarded copies of the following leaflets: "Pines, Profits with Problems"; "Texas Tracks, Do You Know Them."

Fifteen colored reproductions of native Texas animals and birds in "The Dawson Series" were also received.

The materials which have been identified as miscellaneous publications received from the State Department of Fish and Game are probably all very suitable for inclusion on a teacher's reference shelf or in a teacher's resource file. While some of the publications are perhaps somewhat technical in nature, the attractions that publications in wildlife conservation have for students has often overcome what might have been classed "a serious reading problem."

PRINTED BY
HARRY (BUD) TIMBERLAKE, STATE PRINTER
TOPEKA, KANSAS

30-4329

FORT HAYS STUDIES—NEW SERIES

1960

Science Series

No. 1. Distribution of Native Mammals Among the Communities of the Mixed Prairie by Edwin Perry Martin. March 1960.

History Series

No. 1. San Martin—One Hundred Years of Historiography, by Katharine Ferris Nutt. June 1960.

Economic Series

No. 1. The Long-Run Supply Curve: Some Factors Affecting Its Shape, by Eugene Darrel Pauley. September 1960.

Art Series

No. 1. Search and Research: An Approach, by Martha Dellinger. December 1960.

1961

History Series

No. 2. The United States and the Independence of Buenos Aires, by Eugene R. Craine. March 1961.

Bibliography Series

No. 1. Henry Miller: An Informal Bibliography, by Esta Lou Riley. June 1961.

In 1961, two issues of the Fort Hays Studies—New Series were not issued but a history of the college was published.

Wooster, Lyman Dwight. *A History of Fort Hays Kansas State College—1902-1961.* 200 p.

1962

Economics Series

No. 2. Women's Contribution to Industrial Development in America, by Hazel M. Price. March 1962.

Literature Series

No. 1. English Literary Criticism 1726-1750, by Samuel J. Sackett. June 1962.

Bibliography Series

No. 2. Bibliography of Master's Theses: Fort Hays Kansas State College 1930-1962, by Paul K. Friesner. September 1962.

History Series

No. 3. Frémont's Expeditions Through Kansas, 1842-1854, by Lilburn H. Horton, Jr. December 1962.

1964

Science Series

No. 2. A Preliminary Survey of the Cheyenne Bottoms in Kansas, by Henry J. McFarland, Edward A. Brazda, and Ben H. McFarland. October 1964.

Literature Series

No. 2. A History of the *Hays,* Kansas, *Daily News,* by Robert J. Spangler. December 1963.

Science Series

No. 3. Euphthiracaroidea of California Sequoia Litter: With a Reclassification of the Families and Genera of the World, by Neal A. Walker. June 1964.