

GEOLOGICAL SURVEY CIRCULAR 413



PHREATOPHYTE RESEARCH IN
WESTERN UNITED STATES,
OCTOBER 1958 TO MARCH 1959

Prepared in cooperation with the Phreatophyte Subcommittee,
Pacific Southwest Inter-Agency Committee

UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, *Secretary*

GEOLOGICAL SURVEY
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INTRODUCTION

The increasing demand for water in the arid and semiarid regions of Western United States has emphasized the need for conserving the limited supply that is available. Primarily this may be done in two ways: By reducing waste, and by utilizing the water for a higher beneficial use. This report deals with the use of water by phreatophytes, a special group of plants, and is concerned with both these aspects of conservation.

The vegetation of arid regions may be divided into two general classes—xerophytes and phreatophytes—on the basis of the plants' source of water. Xerophytes obtain their water from soil moisture; phreatophytes from ground water. The water used by xerophytes is not directly available to man, but the water used by phreatophytes is available to him for he, too, can utilize ground water. In recent years there has been increasing competition between man and these plants, each for a larger share of the limited water supply. In competing with one species—saltcedar—a high water using, aggressive, and naturalizing plant—man has up until now been the loser. Phreatophytes, by virtue of their established and direct root connection with the water table, occupy a strategic position with respect to the utilization of ground water. During the growing season, these plants use ground water at varying rates throughout the day with the result that the ground-water reservoir is depleted and water levels are lowered. The economic value of most phreatophytes is low and so the water used by them is virtually wasted. Water dissipated in this manner has been referred to as nonbeneficial consumptive use and, more recently, as consumptive waste. This consumptively wasted water is available for salvage. Salvage with respect to the

use of water by nonbeneficial phreatophytes means converting consumptive waste to beneficial consumptive use.

The phreatophyte problem has many facets. The fundamental and applied research necessary to understand, analyze, and solve the problem may be divided into three categories: Hydrologic and ecologic, eradication and control, and salvage.

Although these three lines of research may be treated separately, in the final analysis and solution they are dependent one on the other.

Phreatophyte research for the purpose of this report includes projects that fall, at least in part, in 1 or more of the 3 categories. It includes only projects that were currently in progress, or for which plans were firmly developed, during the period October 1958 to March 1959.

The report is the result of a need for information by the Phreatophyte Subcommittee of the Pacific Southwest Inter-Agency Committee on current research projects. It is the subcommittee's responsibility to keep abreast of developments in the field of phreatophytes and to keep the parent committee and all interested parties informed of these developments. The objectives and details of some projects were well known to the subcommittee, while the available information for other projects was vague and sometimes contradictory. The need for complete and current information on research in progress was evident. The author, as chairman of the subcommittee's task force on research and coordination, undertook to assemble the information. All agencies and individuals known or believed to be concerned with studies of phreatophytes were requested

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to supply information relative to their studies. In order that the information would be uniform and comparable, and to provide a standard format, a suggested outline was furnished with each request. All of the projects listed follow this outline:

- (a) Title of project.
- (b) Agency or department; if a cooperative project, all cooperating parties are shown.
- (c) Project leader; the person actively and directly in charge of project.
- (d) Description of project; a brief and concise summary, giving the general work plan and objectives.
- (e) Present status.
- (f) Results.
- (g) Publication plans.

The cooperation of all individuals and agencies who contributed to this report is greatly appreciated. The author wishes to thank the members of the Phreatophyte Subcommittee for their whole-hearted support.

PROJECTS

For the purpose of this report, each project has been assigned a number. These numbers, which run consecutively, have no relation to any actual project number and are for reference only. The following is a list of contributing agencies and the numbers of the projects with which they are concerned.

<u>Contributing agencies</u>	<u>Project number</u>
Arizona State Land Department.....	2
Fort Hays Kansas State College	13
Nevada Department of Conservation and Natural Resources	15
New Mexico State Engineer's Office.....	12, 17, 18, 19
Pecos River Commission.....	20
U. S. Agricultural Research Service.....	8, 11, 12, 14, 15, 22, 23, 24
U. S. Bureau of Reclamation.....	1, 8, 9, 12, 13, 17, 18, 23, 24
U. S. Corps of Engineers	1
U. S. Forest Service	3, 4, 5, 6, 7, 12
U. S. Geological Survey	2, 9, 10, 19, 20
U. S. Soil Conservation Service.....	15
U. S. Weather Bureau.....	15
University of Arizona.....	1
University of Nevada, Nevada Agricultural Experiment Station....	15, 16
Utah Agricultural Experiment Station.....	22
Utah State Engineer's Office.....	21, 22
Utah Water and Power Board.....	22
Wyoming Agricultural Experiment Station.....	23, 24

The projects are grouped by States in alphabetical order. If there are some deserving projects that are

not included in the report, it is because they were not brought to the author's attention. It is planned to revise this listing periodically, and any projects omitted here can be included in the revision.

Arizona

Project 1

Title

Effects of clearing phreatophytes from stream channels.

Agency

University of Arizona, U. S. Bureau of Reclamation, and U. S. Corps of Engineers.

Leader

K. R. Frost, University of Arizona.

Description

In the interest of water conservation and flood protection, a 400-foot-wide strip of river-bottom vegetation was cleared by the Wellton-Mohawk Irrigation and Drainage District along the channel of the Gila River from Texas Hill to Dome, Ariz., a distance of 55 miles. The vegetation consisted largely of saltcedar, with lesser amounts of mesquite, saltbush, and baccharis. Clearing operations, using bulldozers equipped with a cutter knife for cutting below the root crown, were begun in the spring of 1958 and completed that growing season.

The objectives of the project are to obtain data and information on: (1) the effectiveness of mechanical methods for controlling saltcedar and other river-bottom vegetation, (2) cost of clearing, (3) plant succession following clearing, (4) effect of clearing on the quantity and quality of the ground water, and (5) effectiveness of methods for maintaining cleared channels.

In order to obtain the desired information, 96 plots, each 20 feet by 100 feet, were established in or adjacent to the cleared area for the purpose of measuring the tree cover and density, and the height, basal diameter, and spread of the trees. Eleven wells were constructed for use in obtaining ground-water levels and water samples. Cost data were obtained for various locations of different plant density.

Status

Active. One season's observations have been completed.

Results

Plant density was found to range from 24 to 63 percent. Clearing operations reduced plant density

90 percent and plant cover 99 percent. Operation costs for undercutting ranged from \$6 per acre for densities of 20 to 30 percent to \$30 per acre for densities of 80 to 90 percent; average, about \$15 per acre. Water levels rose slightly following clearing, and there was an increase in the electrical conductivity of the ground water.

Publication

Progress report in Pacific Southwest Inter-Agency Committee minutes of 58-4 meeting at Las Vegas, Nev., December 3, 1958, as Attachment K of the Phreatophyte Subcommittee minutes.

Final report upon completion of project.

Project 2

Title

Change in water yield by the defoliation and removal of riparian vegetation in Cottonwood Wash near Kingman, Ariz.

Agency

U. S. Geological Survey, Arizona State Land Department; Salt River Valley Water Users' Association.

Leader

U. S. Geological Survey, individual not designated.

Description

The objective of project is to determine if recovery of water is possible, first by defoliation and second by removal of riparian vegetation.

As a check on the site, reconnaissance observations were made of streamflow and ground-water levels during the growing and nongrowing season. Observations were made December 16-18, 1957, when plant life along the stream was dormant and again on June 18-20, 1958, when the vegetation was fully leafed. Permanent installations of 3 gaging stations and 3 ground-water observation wells were completed in September 1958.

The reach of stream being investigated is divided into two sections by the gaging stations. It is proposed to defoliate vegetation in the lower section by June or July 1960 and to remove it during the winter of 1961. In the meantime, a detailed study of the geology and a careful analysis of ground-water storage will be made. Evaluation will be made of the vegetative cover along the stream.

As the foliage leaves out, photographs are being obtained each week from the same observation points to attempt correlation between diurnal fluctuation of streamflow and water table and leaf cover.

The area will be mapped with especial attention given to inclusion of the riparian vegetation and the moist evaporative fringe along the channel.

Additional instruments such as rain gages, anemometers, and pyrheliometers are expected to be installed in the spring or summer of 1959.

Status

Active.

Results

Diurnal effects shown on charts of water-stage recorders at gaging stations and ground-water observation wells. This is attributed to evapotranspiration losses.

Publication

Water-supply paper upon completion of project.

Project 3

Title

Life history of tamarisk and related phreatophytes.

Agency

U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

Leader

J. S. Horton, U. S. Forest Service.

Description

A careful management of vegetation will be necessary to salvage additional water from the phreatophyte zone. Basic information concerning the life history of the principal species is necessary before a management practice can be applied with any assurance that the desired vegetation can be maintained and that undesirable species will not reinvade. Project covers the taxonomy and anatomy of the principal species and the influence of site and climatic factors upon seed germination, seedling establishment, phenological response, and individual growth and development (including roots).

Status

Some phases, such as the seed-germination studies, are nearing completion; others will require several more years.

Results

Tamarix pentandra seeds lose their viability in several months, especially when subjected to high temperatures. They germinate rapidly when moistened, but seedlings develop slowly and can survive only in soil that is continuously wet for a period of several weeks.

Publication

Research notes are in process of publication. Eventually the material will appear in technical publications.

Project 4

Title

Survey of phreatophyte associations in Arizona.

Agency

U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

Leader

J. S. Horton, U. S. Forest Service.

Description

A survey of the occurrence and characteristics of the phreatophyte zone is needed in Arizona for two reasons: First, to properly evaluate the magnitude of the problem by obtaining knowledge of the present area of the existing associations and their species composition and density; and second, to form a basis for determining changes occurring in the associations, particularly the spread of tamarisk into new areas.

Status

Observations of isolated occurrences of tamarisk have been made throughout the Salt and Verde River drainage basins. Assistance has been given by the project to the development of a standard method of estimating density of phreatophyte vegetation.

Results

No increases have been noted as yet in tamarisk stands.

Publication

No definite plans for publication have been made.

Project 5

Title

Development of equipment for measuring evapotranspiration of undisturbed vegetation.

Agency

U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

Leader

J. P. Decker and J. S. Horton, U. S. Forest Service.

Description

As a basis for management of streambank and flood plains to reduce water losses by phreatophytes, information is needed as to the amount of water that would be lost from a given area of land if it were occupied by different types of plant communities. This requires an apparatus which can measure accurately water losses from individual plants or segments of plant cover. Of greatest promise is an apparatus which precisely measures water-vapor changes by means of an infrared gas analyzer. This apparatus must be correlated and other methods compared with it.

Status

Active.

Results

The infrared apparatus has been developed until it has been successfully used to measure vapor changes from transpiring shrubs up to 10 feet in height. It is now being applied in the field.

Publication

"An Infrared Apparatus for Measurement of Transpiration," by J. P. Decker and J. D. Wien, in "Symposium for Phreatophytes," Phreatophyte Subcommittee, Pacific Southwest Inter-Agency Committee, 1958. Another article has been prepared and will be submitted for publication as an Experiment Station Research Note.

Project 6

Title

Measurement of evapotranspiration.

Agency

U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

Leader

J. S. Horton and J. P. Decker, U. S. Forest Service.

Description

In order to determine water losses from the different phreatophyte covers and therefore to determine which are desirable to maintain or to establish, evapotranspiration losses must be measured over a wide variety of conditions. These measurements should be made precisely to determine losses from individual plants or small areas and then checked by gross measurements such as those from transpiration wells, stream-gaging stations, or lysimeter studies.

Status

An apparatus using an infrared gas analyzer has been successfully developed for use in measurement of evapotranspiration from shrubs up to 10 feet in height (see project 5). Transpiration wells have been established in an experimental area along the Salt River above Granite Reef Dam. These are being calibrated at present.

Results

The indications are that tamarisk uses more water than a Bermuda grass sod.

Publication

Eventually, research notes and a final technical report.

Project 7

Title

Replacement of undesirable vegetation.

Agency

U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

Leader

J. S. Horton, U. S. Forest Service.

Description

After it is determined that an existing phreatophyte stand is undesirable, a more desirable type of cover must be selected and methods of converting to and maintaining that cover developed. For this purpose fenced areas have been established on the Salt River experimental area above Granite Reef Dam to evaluate the effect of grazing on a tamarisk-Bermuda grass association. In order to evaluate the Fleco root plow as a means of removing a heavy stand of tamarisk, experimental sites have been established along the Gila River near Gillespie Dam. Survival and regrowth counts will be made after treatment by the plow.

Status

Active.

Results

Grazing slows down the development of tamarisk seedlings and sprouts. Root plowing in June killed all but about 15 tamarisk shrubs per acre.

Publication

Eventually, research notes and technical publications.

Project 8

Title

Saltcedar control.

Agency

U. S. Agricultural Research Service, Crops Research Division, and U. S. Bureau of Reclamation.

Leader

H. Fred Arle, U. S. Agricultural Research Service; C. W. Bowser, U. S. Bureau of Reclamation.

Description

A joint investigation of the means for the control of phreatophytes, particularly saltcedar, through chemical and mechanical methods. The effectiveness of various herbicides is tested by varying the rate, time, method, and number of applications on replicated plots of saltcedar regrowth of different ages. At the start of the study, all mature saltcedar plants were cut off at the land surface by a bulldozer, and the area was divided into 100 quarter-acre plots, separated by 12-foot

access lanes. Age of the regrowth is from the date of cutting of the mature plants. Application of the herbicides is by ground-operated equipment.

Status

Tests on the plots which were started in the spring of 1956 are continuing. Consideration is being given to another test area where the regrowth and ground-water conditions are different.

Results

1. Saltcedar is more difficult to kill in flood plains than along irrigation channels and streams.
2. Single-spray operations have never given satisfactory total plant kill of adult saltcedar, and only rarely have repeated treatments eliminated 80 percent or more of the plants.
3. Periodic spraying of infested areas with 2, 4-D and 2, 4, 5-T will defoliate saltcedar and in this manner reduce transpiration losses.
4. Applications of 2, 4-D and related materials appear more effective on young regrowth following mechanical destruction than on adult saltcedars.
5. Application rates of less than 2 pounds per acre have generally given poor results.
6. Low-volatile esters of 2, 4-D or combination of 2, 4-D and 2, 4, 5-T have been consistently more effective than amine or sodium salts of 2, 4-D.
7. Mechanical means, although expensive, are useful in the eradication of saltcedar, especially in areas near cotton or other crops susceptible to 2, 4-D. Mechanical control must be exercised at least yearly to eliminate regrowth from root sprouts and seedlings.
8. Mechanical clearing followed by spraying of young regrowth with 2, 4-D or a mixture of 2, 4-D and 2, 4, 5-T at 2.5 pounds or more per acre repeated as necessary once or twice a year appears to be the most effective and practical method now known for controlling saltcedar.

Publication

Results of first 2 years published in "Progress Report on Cooperative Saltcedar Control Investigation" prepared for presentation March 11-13, 1958, to Phreatophyte Subcommittee, Pacific Southwest Inter-Agency Committee. Periodic reports will be issued from time to time.

Project 9

Title

Use of water by saltcedar in evapotranspirometers and correlation of evapotranspiration measuring methods.

Agency

U. S. Geological Survey and U. S. Bureau of Reclamation.

Leader

T. van Hylckama, U. S. Geological Survey; C. W. Bowser, U. S. Bureau of Reclamation.

Description

To determine the use of ground water by saltcedar grown in evapotranspirometers, and to correlate and test the validity of other evapotranspiration measuring methods. It is proposed to construct six large tanks by the use of a plastic water-tight membrane. Each tank will be approximately 1,000 square feet in surface area and 12 to 14 feet in depth, located in an environment of saltcedar, and planted to saltcedar of the same density as in the surrounding area. Water levels in the evapotranspirometers will be maintained at predetermined levels of from approximately 4 feet to 12 feet below land surface, in order to determine the effect of depth to the water table on use by the plants.

Instruments for other methods of measuring evapotranspiration, such as the energy-budget and transpiration-well methods, will be installed after the saltcedar has become established.

Status

Plans drawn, test site leased, and construction materials ordered.

Publication

Annual progress reports and final report.

California

Project 10

Title

Phreatophyte research.

Agency

U. S. Geological Survey.

Leader

T. W. Robinson, U. S. Geological Survey.

Description

In the interest of water conservation in Western United States, it is essential that a comprehensive and

coordinated phreatophyte research program be undertaken to estimate the quantity and quality of the ground water consumptively wasted by nonbeneficial phreatophytes, and to evaluate the quantity and quality of that that can be salvaged. The fields of study involved in these objectives are: (1) a knowledge of the habitats and characteristics of nonbeneficial phreatophytes, (2) the factors that control their occurrence, (3) the factors that effect evapotranspiration of ground water by them, and (4) economic methods for effecting salvage of the consumptively wasted ground water. In these hydrologic and ecologic fields of study, data are needed on the occurrence of phreatophytes, the relation of their occurrence to the quality of the ground water, areas and density of growth, depth of root penetration, and annual water consumption for different depths to the water table under different climatic conditions.

Status

Active.

Results

Partial data show that the occurrence of saltcedar is the most widespread in Arizona and New Mexico, that it has spread through all of the Southwestern States, and that it is infesting stream and reservoir areas as far north as central Wyoming. Considerable data have been obtained on the habitat and the relation of the quality of water to the occurrence of phreatophytes.

Publication

"Phreatophytes," U. S. Geological Survey Water-Supply Paper 1423, 1958; this report; and a report on areas of saltcedar occurrence, 1960.

Project 11

Title

Estimate of consumptive use and amount of water available for salvage along Kings River in Kings River Soil Conservation District, Calif.

Agency

U. S. Agricultural Research Service, Soil and Water Conservation Research Division.

Leader

Dean C. Muckel, U. S. Agricultural Research Service.

Description

A large percentage of the area within the levees of the Kings River flood channel in the Kings River Soil Conservation District is covered with heavy growths of nonbeneficial vegetation, water surface, and moist soil. A high water table, maintained by seepage from

a continuous flow in the river, exists along the channel. This, together with high summer temperatures, creates an ideal environment for maximum growth of phreatophytes ranging from large cotton wood and willows to grasses. The objectives of the study were to evaluate the loss by evapotranspiration within the levees and to estimate the water now being lost that might be salvaged.

The unit use of water by phreatophytes was estimated by the Blaney-Criddle formula, $U = Kf$, for each of the following categories of growth: grass and scattered shrubs, and sparse, medium, and dense growths of trees, grass, and brush. Use of water for each category was obtained by multiplying the area by the unit use. Salvage was estimated by assuming conversion of the dense-and medium-growth areas to the grass and scattered-shrub category.

Status

Study completed.

Results

Estimated total evapotranspiration from 2,545 acres including water surface and wet sand was 8,546 acre-feet for the period April to September. Of this, 4,380 acre-feet was by phreatophytes. Salvage was conservatively estimated as 1,450 acre-feet.

Publication

Mimeographed report entitled "Estimate of Consumptive Use and Amount of Water Available for Salvage Along Kings River in Kings River Soil Conservation District, Calif.," January 1959.

Colorado

Project 12

Title

Carbohydrate reserve in tamarisk (saltcedar).

Agency

U. S. Bureau of Reclamation and U. S. Agricultural Research Service cooperating with the U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station, and the New Mexico State Engineer's Office.

Leader

T. R. Bartley, U. S. Bureau of Reclamation.

Description

A study to determine the annual cycle of carbohydrate reserves in tamarisk stems and roots. The amount of carbohydrate reserve is frequently associated with growth, vigor, and susceptibility to injury. Thus, information concerning the low point in the carbohydrate

root reserves may be useful in timing a control program. Studies of tamarisk plants in greenhouses have shown that applications of various formulations of 2, 4-D and 2, 4, 5-T cause a reduction of carbohydrate food reserves present in the stem, crown, and root.

Two collection sites were selected to learn the effect of different ecologic conditions on the seasonal trend of reserves. One site was on the delta of the Caballo Reservoir on the Rio Grande in New Mexico, the other on the Salt River in Arizona. The samples from New Mexico were collected by personnel of the State Engineer's Office and from Arizona by the Rocky Mountain Forest and Range Experiment Station.

Status

The study, which has been in progress since 1957, will continue. Further collection and analysis of specimens will be made to determine if carbohydrate-reserve trends continue as indicated by the first-year study.

Results

Preliminary results indicate that carbohydrate food reserves of roots and stems of tamarisk have well-defined periods of low carbohydrate content. The annual low carbohydrate content of the Arizona specimens occurred during the latter part of April, and in the New Mexico specimens it occurred in June. This difference in time could be due to differences in altitude, as the New Mexico site was about 3,000 feet higher. In the Arizona specimens the average carbohydrate content in roots was 5 to 6 percent greater than in the stems.

Publication

Carbohydrate reserves in Tamarisk (Salt cedar—Progress Report No. 1, July 1957 through July 1958, U. S. Bureau of Reclamation, Chemical Engineering Laboratory Report No. SI-19, October 17, 1958, Commissioner's Office, Denver, Colo. Progress reports will be issued annually and a final report will be published on completion of study.

Kansas

Project 13

Title

Ecologic research on saltcedar.

Agency

Fort Hays Kansas State College, Division of Biological Science, cooperating with U. S. Bureau of Reclamation.

Leader

Gerald W. Tomanek, Kansas State College.

Description

An ecologic study of saltcedar pursuant to distribution at Cedar Bluff Reservoir, Kanopolis Reservoir, Smoky Hill River and tributaries, Kirwin and Webster Reservoirs, and Solomon River in Kansas, and selected areas in Texas and New Mexico; description of vegetation as whole, infestations, description of saltcedar communities as to density, age classes, variations in growth and seedling counts. Studies of life history, reproduction, water usage, and competition are also being considered.

The primary goal of this study is to determine the loss of irrigation water due to this phreatophyte.

Status

Part of the work has been completed, the remainder will be continued until 1961.

Two annual reports have been completed, and work is being done on a third.

Results

The viability of saltcedar as such is not a limiting factor in the spread of the plant. Viability was found to range from 19.0 to 51.4 percent, with an average of 32.5 percent. Each mature plant produces nearly half a million seeds annually. The highest germination occurred with solutions that had a pH of between 5.6 and 7.0 and was weakly saline. Seeds stored at low temperatures had a higher rate of germination than those stored at high temperatures.

Transpiration studies of three phreatophytes, saltcedar, cottonwood, and willow, showed that total water loss for plants of the same size was greatest for saltcedar. On the basis of loss per square decimeter of leaf area per day, the loss was least for saltcedar, 3.80 grams, while for cottonwood it was 5.80 grams, and for willow 8.23 grams. The greater total loss for saltcedar was due to the greater leaf area.

Seedling survival and growth was greatest in sodium chloride solutions of 0 to 3,000 ppm. The seedlings withstood concentrations of up to 4,000 ppm, but at 5,000 ppm all seedlings died.

Publications

"Life History of Salt Cedar (*Tamarix gallica* L.)," Kansas Acad. Sci., Trans., v. 60, no. 4, 1957.

"A Study of the Woody Vegetation at Cedar Bluff Reservoir," Kansas Acad. Sci. Trans., v. 60, no. 4, 1957.

"Annual Report on Ecological Research of Saltcedar and Other Vegetation Primarily at Cedar Bluff Reservoir, Kansas," Fort Hays Kansas State College, Dept. of Biology, Div. of Biological Sciences, 1957. [Mimeographed]

Nevada

Project 14

Title

The effect of water-table depth on irrigation requirements and yield of Lahontan alfalfa.

Agency

U. S. Agricultural Research Service, Soil and Water Conservation Research Division.

Leader

Rhys Tovey, U. S. Agricultural Research Service.

Description

To determine surface-irrigation requirements of Lahontan alfalfa grown on three soil textures with constant water tables at various depths, and on well-drained soil in the absence of a water table; to determine the effect of plant growth stage on the rate of water use by Lahontan alfalfa; to determine the relation between the use of water by alfalfa under various water-table conditions, evaporation from porous atmometer bulbs, and evaporation from a Weather Bureau evaporation pan; and to evaluate the effects of a fluctuating water table on the yield and growth rate of alfalfa.

The expected duration of the project is 3 years. Two years of consumptive-use data will be taken under constant water-table conditions. Then the water table will be fluctuated in order to observe the effect of a fluctuating water table on the yield and root system of the alfalfa.

Status

Sixty-three lysimeter tanks, 3 feet in diameter and varying in depth from 3 to 9 feet, have been installed on the University of Nevada Main Agricultural Experiment Station Farm at Reno. The variables, which are replicated, include the following:

1. Three soil textures (sandy loam, loam, clay loam).
2. Three water-table depths (2, 4, and 8 feet).
3. Irrigated and nonirrigated conditions.
4. Well-drained soil conditions.

Alfalfa stands have been established in the tanks and in the surrounding area. Tensiometers are being installed in some of the tanks to study the movement

of water in the capillary fringe of the nonirrigated tanks. A weather station is being established at the site to measure the following climatic and weather factors, which will be related to evapotranspiration wherever possible: Net radiation, temperature, humidity, precipitation, evaporation from an evaporation pan, evaporation from atmometer bulbs, and wind.

Results

Results to date indicate that alfalfa grown under constant high water-table conditions has a considerably higher consumptive-use rate than alfalfa grown under well-drained field conditions.

Publication

None.

Project 15

Title

Utilization of available water supplies in the Colorado River basin of Nevada.

Agency

U. S. Agricultural Research Service, Soil and Water Conservation Research Division, cooperating with University of Nevada, Nevada Agricultural Experiment Station; U. S. Soil Conservation Service; Nevada Department of Conservation and Natural Resources; and U. S. Weather Bureau.

Leader

V. I. Myers, U. S. Agricultural Research Service.

Description

To determine the present disposition of Colorado River basin water in southeastern Nevada, both for beneficial and nonbeneficial uses, and to evaluate potential water supplies available for beneficial use in the Colorado River basin in southeastern Nevada.

Status

Salt grass is being grown in tanks, with a 2-foot water table, at 3 locations, Logandale, Caliente, and Mesquite. Records of weather and evapotranspiration have been gathered for 2 years. Correlations and regression equations that relate evapotranspiration to weather records have been computed.

Results

At one location, the salt-grass yield was nearly 10 times greater and the evapotranspiration nearly 4 times greater than that occurring at another location having almost identical climatic conditions during the growing season. This demonstrates the importance of relating the consumptive use of phreatophytes to stand densities or yields.

Publication

None.

Project 16

Title

Increased streamflow and forage production through eradication of undesirable vegetation, seeding, and grazing management.

Agency

University of Nevada, Nevada Agricultural Experiment Station, Reno, Nev.

Leader

J. H. Robertson, University of Nevada.

Description

To explore the feasibility of using a combination of herbicides and fire to clear riparian vegetation, largely willow, for increased streamflow, increased forage, and easier handling of livestock.

Status

Since start of the project on July 1, 1958, 5 Parshall flumes and two 8-day water-level recorders have been installed on Knoll Creek and its tributaries near Contact, in northeastern Nevada. Knoll Creek is a tributary of the Little Salmon Falls, in the Columbia River basin. The recorders can be moved from flume to flume. Water-stage records have been obtained through September and October.

Preliminary trial of the spring spraying-winter burning method of streamside brush eradication has been made on one tributary. Most of the burned area has been seeded to forage plants. Electric fence proved ineffective in protecting the seeded burned areas from either sheep or cattle.

Profiles of two sections of the main channel of Knoll Creek have been charted as a basis for detection of accelerated bank cutting.

Results

Peak flow occurred in early morning, and minimum flow about 12 hours later. Daily water loss early in

September 1958, in 1 mile of a small tributary was estimated at 1,370 gallons per day.

Publication

None.

New Mexico

Project 17

Title

Water-conservation measures and control of vegetation in Caballo Reservoir area, New Mexico.

Agency

New Mexico State Engineer's Office and U. S. Bureau of Reclamation.

Leader

T. H. Moser, U. S. Bureau of Reclamation.

Description

The reservoir area of Caballo Dam, a storage diversion below Elephant Butte Dam, is covered with a moderate to dense growth of phreatophytes, largely saltcedar. Other phreatophytes are mesquite, cottonwood, willow, and baccharis. A high water table in and adjacent to the river channel and reservoir delta and dam, maintained by water from Elephant Butte Reservoir, offers a favorable environment for phreatophytes. Saltcedar, an aggressive and naturalizing plant, has spread throughout the bottomland area along the river and in the reservoir. The phreatophyte growth, estimated to total 5,500 acres, consumptively wastes many thousands of acre-feet of water annually that is intended for downstream irrigation. A program of conservation was undertaken in 1957 with the following objectives: (1) Conservation of water through the removal of saltcedar and other phreatophytic growth and control of regrowth, and (2) to evaluate the possibility of lowering the water table by re-channeling the river through the reservoir delta area. Preliminary analysis of streamflow and ground-water conditions indicated a saving of about 7,000 acre-feet a year after allowing a usage of 1.0 acre-foot per acre for substitute vegetation.

Status

About 4,000 of the 5,500 acres had been cleared to October 1958. Of this amount 75 percent was saltcedar, 20 percent cottonwood, and 5 percent mesquite. Sixty-three wells have been installed to observe ground-water conditions. Aerial photographs were taken on October 23, 1957, of the river channel and reservoir area between Elephant Butte and Caballo Dams. These photographs will be used in density surveys of the phreatophyte growth.

Results

Results of the operation are now being compiled by the New Mexico State Engineer's Office.

Publication

Publication proposed late in 1959 by the New Mexico State Engineer's Office.

Project 18

Title

Water salvage in the Middle Rio Grande Valley.

Agency

New Mexico State Engineer's Office; U. S. Bureau of Reclamation.

Leader

C. H. Clark, U. S. Bureau of Reclamation.

Description

The water table in the Rio Grande Valley above Elephant Butte Reservoir is such that it supports a dense growth of phreatophytes—saltcedar, willows, and some cottonwoods. These plants consumptively waste many thousands of acre-feet of ground water that could otherwise be used for irrigation, and they also impede flood flows. The objective of the program is to increase available flow in the river by (1) eliminating or controlling water-consuming vegetation, (2) increasing the efficiency of existing drains by enlarging them and clearing them of vegetation, (3) constructing new drains, and (4) channeling side inflow directly to the river, thus lowering the water table.

Status

Active in 1958, with continuing eradication of phreatophyte growth and control of vegetation regrowth.

Results

Water table lowered, which resulted in water being salvaged from water-loving vegetation. Amount salvaged has not been estimated.

Publication

None.

Project 19

Title

Appraisal of potential ground-water salvage along the Pecos River between Acme and Artesia.

Agency

U. S. Geological Survey and New Mexico State Engineer's Office.

Leader

R. W. Mower, U. S. Geological Survey, and J. W. Hood, New Mexico State Engineer's Office.

Description

In the bottomlands of the Pecos River, between the Acme and Artesia gaging stations, the water table is at or near the land surface. This condition, in combination with the prevailing climate, has established an ideal environment for the growth and spread of saltcedar and other phreatophytic vegetation. The area covered by these plants in this reach of the river was estimated to be more than 43,000 acres in 1956, and the consumptive waste to be several tens of thousands of acre-feet of ground water annually. Recorded field observations and comparison of successive aerial photographs show that the areal extent and density of the saltcedar are progressively increasing, indicative of progressive increase in consumptive waste.

Studies were begun in 1956 to determine the amount of the consumptive waste and the feasibility of re-covering a part of it, the effect on the flow of the Pecos River and on the ground water, and the probable changes in the chemical quality of the ground and surface water if salvage is attempted.

Status

Preparation of a final report is underway.

Results

Preliminary determinations suggest that the loss of water to phreatophytes in the Acme-Artesia reach is not less than 40,000 acre-feet annually and that 20,000 to 25,000 acre-feet per year might be salvageable.

Publication

Publication of a final report as a technical report by the State Engineer's Office in late 1959 or early 1960.

Project 20

Title

Use of water by phreatophytes in the McMillan Delta, Eddy County.

Agency

U. S. Geological Survey and Pecos River Commission.

Leader

E. R. Cox, U. S. Geological Survey.

Description

The bottomlands of the Pecos River between the Artesia gaging station and Lake McMillan contain about 25,000 acres of saltcedar and other phreatophytic plants. Between the Artesia gaging station and the Rio Penasco the water table is at or near the land surface and is above the level of the Pecos River. Between the Rio Penasco and Lake McMillan the water table is below the level of the river, which flows through a constructed low-flow channel. During periods of low flow in the river and low stage of Lake McMillan, water levels decline and the consumptive use of the saltcedar is small between the Rio Penasco and Lake McMillan. However, periodic flooding of the lowlands by the Pecos River and the Rio Penasco and high stages of Lake McMillan recharge the water table in the lowlands south of the Rio Penasco, and the consumptive use by the saltcedars is large.

Studies were begun in 1956 to determine the amount of consumptive waste and the relation between the ground water in the post-McMillan deposits, the valley fill, and the Permian rocks in the area.

Status

Basic-data collection period.

Results

No results to report as yet.

Publication

Final report to be published by Pecos River Commission.

Utah

Project 21

Title

Utah phreatophyte survey.

Agency

Utah State Engineer, with assistance by individuals from several State and Federal agencies.

Leader

R. Keith Higginson, Utah State Engineer's Office.

Description

The State has been divided into hydrologic units, and each member of the survey group is responsible for the development of new data within his unit. Reconnaissance surveys will be made of the entire State to determine the location, density, and effect of phreatophytes upon the State's water supplies.

Status

About one-third of the State has been covered by surveys, and a progress report was issued in August 1958.

Results

The parts of the State covered show a total of 700,000 acres covered by phreatophytic vegetation of various species and densities. This includes 6,000 acres of saltcedar which has been reported as far north as the Provo Bay area.

Publication

The group is continuing to work, and the data will be compiled from time to time. There are no definite plans for publication at this time.

Project 22

Title

Consumptive use of water by native vegetation and irrigated crops in the Virgin River area of Utah.

Agency

Utah Agricultural Experiment Station; U. S. Agricultural Research Service, Soil and Water Conservation Branch, Western Soil and Water Management Section; Utah Water and Power Board; Utah State Engineer.

Leader

Wayne D. Criddle, Utah State Engineer's Office, and Jay M. Bagley, Utah Agricultural Experiment Station.

Description

Several types of phreatophytes were grown in tanks at an experimental site near the Virgin River. Measurements were made of the rates of water consumption by the vegetation within the tanks. These measurements were compared with water-table fluctuations and with potential evapotranspiration as indicated by data from atmometers. Data were also obtained on rates of consumptive use by irrigated crops in the area. The project began in 1955 and the fieldwork was completed in 1957.

Status

The final draft report is in preparation.

Results

Frequent floods of the Virgin River and its tributaries caused interruptions of measurements and necessitated

some replanting within the tanks from time to time. However, results show the general range of use rates by irrigated crops and native vegetation.

Publication

It is expected that the report will be published as a special report of the Utah Agricultural Experiment Station.

Wyoming

Project 23

Title

Chemical control of saltcedar.

Agency

U. S. Agricultural Research Service, U. S. Bureau of Reclamation Region 6, and Wyoming Agricultural Experiment Station, cooperating.

Leader

F. L. Timmons and L. W. Weldon, U. S. Agricultural Research Service.

Description

Basal applications of butoxyethanol esters of 2, 4-D and 2, 4, 5-T and a 50-50 mixture of the two were made on mature saltcedar at concentrations of 2 and 8 percent in diesel oil at spring dormant, summer, and fall dormant stages of growth in 1956 and 1957. All treatments were replicated three times.

Another experiment was begun in April 1958 comparing basal applications of butoxyethanol ester of 2, 4-D at concentrations of 0.5, 1.0, and 2.0 percent with broadcast applications of fenuron pellets at 10, 20, and 40 lb per acre active ingredient (ai) and of monuron at 20 lb per acre ai.

Status

The experiment begun in 1956 is completed. Final results on the experiment begun in 1958 will be obtained in 1959. Probably a new experiment comparing various herbicides as foliage applications will be begun in 1959 or 1960.

Results

The basal applications of 2, 4-D and 2, 4, 5-T made at full-leaf stage in 1956 gave 100-percent kill of saltcedar. Basal applications at the fall-dormant and spring-dormant stages were less effective, the survival being 18 to 23 percent for the 2-percent concentration and 4.5 to 10 percent for the 8-percent concentration.

Preliminary results from treatments made in April 1958 showed complete defoliation by all rates of fenuron and monuron and complete kill by all rates of basally applied 2, 4-D. Some regrowth from saltcedar crowns had developed in plots treated at the lowest concentration of 0.5-percent 2, 4-D.

Publication

One brief report published in the 1958 Research Progress Report of the Western Weed Control Conference.

Project 24

Title

Ecologic study of saltcedar.

Agency

U. S. Agricultural Research Service, U. S. Bureau of Reclamation, and Wyoming Agricultural Experiment Station, Cooperating.

Leader

F. L. Timmons and L. W. Weldon, U. S. Agricultural Research Service.

Description

Eight plots, most of them 33 feet by 66 feet, were permanently staked out in May 1956 in typical saltcedar infestations ranging in age and size from seedlings less than 1 inch tall to mature trees 10 feet tall. Four additional plots were established in 1957 and 1958 in new infestations or on areas subject to invasion by saltcedar. The 12 plots are distributed in representative situations along 10 miles of Five Mile Creek from its juncture with Boysen Reservoir in central Wyoming. A total of 33 individual saltcedar plants within these plots was labeled for detailed study.

In May of each year measurements are made on number of living saltcedar plants per plot, number of shoots per plant, range and average in height of plants, range and average diameter of shoots, distance from edge of Five Mile Creek, height of plot above water surface in Five Mile Creek and other ecologic measurements. A picture of each plot is taken from the same location in June of each year.

Supplementary phenological observations are made each year on dates of first leaf, full leaf, first bloom, full bloom, first seed maturity, and fall leaf drop. Amount of seed produced and seed viability are also determined.

Status

Observations were made for 3 years on 8 plots and 2 years or 1 year on the others. Observations will be

continued in May of each year for an indefinite period until at least 5 years of results is recorded on all plots.

Results

An abundance of mature saltcedar seed of good viability has been produced every year. New seedling infestations have developed each year at distances up to 2 miles from seed-bearing plants. The infestations appeared to develop from current-year seed which germinates in late July or August on wet sandbars, siltbars, or at the waterline of the reservoir. Seedling plants only $\frac{1}{2}$ inch to 2 inches tall grew to 1 to 3 feet in 1 year and 2 to 5 feet in 2 years.

One plot with a dense stand of saltcedar 4 to 7 feet tall was washed away completely by undercutting of Five Mile Creek and another was destroyed by submergence under water and silt during an unusually high flood stage in Boysen Reservoir. Nearly 100 percent of the saltcedar has survived partial submergence by water, but 99 percent has been killed by complete submergence for several weeks in midsummer.

Publication

One brief report published in 1958 Research Progress Report of Western Weed Control Conference.