PHREATOPHYTES AND WATER SALVAGE

Jack G. Koogler*

INTRODUCTION

Phreatophytes -- or, more exactly, uneconomic phreatophytes that consumptively waste water -- are estimated to cover an area of nearly 16 million acres in the 17 western states. Water requirement for this acreage is about 22 million acre-feet annually. This tremendous loss may be more fully comprehended when it is considered that the average flow of the Colorado River at Lee's Ferry is 13,150,000 acre-feet annually. In 1952, approximately 441,000 acres in New Mexico were infested with phreatophytes having a non-beneficial use estimated at 870,000 (1) acre-feet. A major portion of this waste occurs in two of our most important and productive stream systems, the Rio Grande and the Pecos River.

In the Rio Grande, from Elephant Butte to the narrows below Otowi, there are about 60,000 (2) acres upon which a thriving stand of non-beneficial vegetation, principally salt cedar mixed with cottonwoods, is now growing. The same thing is occurring on approximately 42,500 (3) acres in the Pecos Valley from Alamogordo Dam to the Texas state line. It has been estimated that these areas consumptively waste 240,000 and 117,000 acre-feet respectively.

Salt cedar (Tamarix pentandra), the most aggressive of the phreatophytes, has been observed in nearly all stream systems of New Mexico and is rapidly becoming the predominant non-beneficial plant in most of them. In the Pecos Valley in 1915 a mere 600 acres of salt cedars were noted in the delta of McMillan Reservoir. The State Engineer Survey of the Rio Grande Valley in 1918 makes no mention of this species. It had not become significant enough to list until the Scobey Survey of 1936, at which time the infestation in the Middle Valley amounted to approximately 3,570 acres. Today the eradication and control of hundreds of thousands of acres of salt cedar in New Mexico constitutes one of the largest single sources of salvageable water available to water users.

PROBLEMS RELATED TO PHREATOPHYTES

The idea of salvaging water by eradicating phreatophytes is relatively new and must be approached by all with caution. Problems have been created by some of the work accomplished to date, and it might be well to consider a few of these.

SEDIMENTATION OF RESERVOIRS -- Salt cedar invades the normal channel of a stream, thus reducing the carrying capacity and causing flood water to spread out over the flood plain, where it damages areas not normally flooded. As the water spreads and as the velocity of the flow is reduced, ponding and natural levee building result from salt deposition. The open water in the ponds contributes further to water loss by providing more water surface for evaporation

*Chief, Design and Construction Section, Office of State Engineer, Santa Fe, New Mexico.

and also creates a more favorable condition for further phreatophytic growth.

This process makes a very effective sediment screen in the deltas of large reservoirs such as McMillan and Elephant Butte. The life of these reservoirs would be extended many years if this screening process were allowed to continue, but downstream water users would pay a very high price in terms of water loss. It has been estimated that this loss in the swamps of the San Marcial area before the present rechannelization was undertaken amounted to approximately 145,000 (4) acre-feet annually. Channelization through this area is estimated to result in an annual saving of 42,000 acre-feet. A similar channel and floodway now being planned on the Pecos River from Artesia through the delta of McMillan Reservoir will save annually approximately 24,000 (5) acre-feet. The additional clearing of some 35,000 acres of flood plain vegetation in the Pecos Valley would salvage another 114,000 acre-feet annually. Although construction of a channel and floodway through McMillan delta would greatly increase the available water, it would result in a much more rapid loss of storage capacity in the reservoir because of increased sedimentation.

<u>PERSISTENCE OF GROWTH</u>. -- Channels, such as the above, and drains constructed to lower the water table beneath flood plain vegetation tend to lose their effectiveness in salvaging water after a few years. Initially, they concentrate the flow, drain the open ponds, and lower the water table. However, the salt cedars soon extend their root systems to the water table and again use large amounts of water. Also, there still remain the thousands of acres of non-beneficial vegetation on each side of the low flow channels, floodways, and the river channel itself. The obvious way of reducing consumptive waste from these areas would be removal of these undesirable plants, but destruction of salt cedar has proved to be a difficult task. It is not easily burned. If an area is somehow induced to burn through prior spraying with oil or in some other way, by the end of another summer season the roots will have sprouted and a growth of at least six feet will have been attained. Cutting out the plants by means of large crawler tractors effectively removes the brush, but again the roots will sprout, and soon all evidence of the former clearing will be obliterated. Chemical eradication through aerial spraying has been attempted from time to time. Although some spectacular kills have been obtained, generally two or more spray treatments result in less than 50 percent plant kill. When treatment is discontinued, the phreatophytic growth will recover to the original density in about two years. An even more discouraging feature of aerial spraying is that, all to often, it results in expensive law suits for damage to nearby crop land. Spraying by ground rigs usually necessitates the removal of the salt cedar first. This, in itself, is a very expensive process. A combination of mechanical clearing and chemical control by ground spray equipment appears to be the most feasible, but this is not yet an entirely proven method. Recently 1,200 acres in the San Marcial area were sprayed by helicopter. If results are good and the cost not excessive, this method could very well replace the use of ground spray equipment.

<u>COST OF ERADICATION</u>. -- The cost of eradication of phreatophytes by mechanical means ranges from $4.00 per acre for light stands of young plants, cleared by rotary cutters, to as much as $80.00 per acre for dense fullgrown stands. Aerial spraying, using 2,4-D, costs approximately $3.00 (6) per acre, and to be at all effective it must be done at least twice a year. Maintenance averages about $2.37 (7) per acre per year when light mechanical clearing

equipment is used. A recently developed root plow, consisting of a horizontal blade drawn through the ground approximately 12 to 18 inches beneath the surface by large crawler type equipment, may prove very effective. There is an indication that very few roots will sprout if the crown is cut off at least 12 inches beneath the surface.

REPLANTING WITH MORE DESIRABLE PLANTS. -- A great deal has been said about replacing high water consumptive use plants with those which would use less water. However, plants which would replace salt cedar in the environments which exist in the river valleys of the southwest have not been found, except to a minor degree. Schemes to salvage water by substituting cultivated beneficial use plants which would consumptively use less water than the salt cedar in the flood plains of our rivers have not been adequately evaluated as to benefits to be realized.

RESEARCH

Progress in solving this difficult problem has been slow for a number of reasons. First, the public has to be made aware of the importance of the problem so that the necessary Federal and State legislation can be enacted to provide funds for basic and applied research. Then after funds are allocated, facilities have to be made available and the necessary skilled manpower acquired. Just 16 years ago probably the most comprehensive study on consumptive waste by phreatophytes was made by the U. S. Geological Survey in the Safford Valley (8) in Arizona. Research is continuing, but still many basic facts concerning phreatophytes are unknown, i.e., (1) the exact acreage and extent of the various species of phreatophytes in New Mexico and the West, (2) transpiration rates for these species considering the differences in climatic factors, altitude, water-table depths, and vegetative densities, and (3) relation of quality of water and soils to occurrence and growth.

It appears that the responsibility for research seeking information pertaining to these problems has been delegated to and accepted by factfinding agencies in State and Federal Government, such as State Universities, Interstate Stream Commission, Agricultural Research Service, U. S. Geological Survey, and Forest Service, and many studies are currently underway. One notable example of the work in progress is the water-use study now being conducted near Buckeye, Arizona. This project is financed by the Bureau of Reclamation, is staffed with personnel furnished by the Geological Survey, and is to operate for a period of 10 years. The installation, located in the flood plain of the Gila River, consists of six 30x30-foot tanks approximately 15 feet deep. These tanks, constructed of a black vinyl plastic membrane, are planted to salt cedar and so arranged that the water table can be maintained at predetermined depths. Instruments have been installed so that accurate measurements can be made on radiation, temperature, humidity, and other factors necessary for an energy-budget study. It is hoped that this investigation will provide data which may be used to better evaluate evapotranspiration drafts and to assess the conservation benefits that can be expected to result from the clearing operations in progress in the Rio Grande and proposed for the Salt, Gila, and Pecos Rivers (9).

The Rocky Mountain Forest and Range Experimental Station at Tempe,Arizona is collecting basic information on the life history of the principle species of phreatophytes. Seed-germination studies for salt cedar are now nearly completed. This organization is developing an apparatus which can accurately gauge water losses from plants by precise measurements of water vapor changes.

An intensive study is being carried on by the Agricultural Research Service near Phoenix, Arizona; to determine the effectiveness of various herbicides by varying the rate, time, method, and number of applications on hundreds of salt cedar test plots. It is hoped that a chemical will be developed which will be economical, safe, and more effective than those presently available.

The Agricultural Research Service has very recently completed a new hydraulic laboratory near Tempe, Arizona, which will work through cooperative agreements with the State universities of New Mexico, Arizona, Utah, and Nevada on problems such as the consumptive use of phreatophytes, the use of radio-isotope tracers in the study of plant physiology, and the reduction in evaporation from stockponds by the use of chemical films.

The research work cited is only a small part of what is beginning to be an intensive study of the phreatophyte problem. Work also is being done by various agencies in Kansas, Nevada, Wyoming, Colorado, and California.

OPERATIONS

Although much study is still required before we can reliably estimate the actual amount of water that is or can be salvaged as a result of phreatophyte control, various agencies are now actively engaged in channelization and floodway construction, drainage, and eradication. The Bureau of Reclamation, in cooperation with the New Mexico State Engineer, has recently cleared 5,300 acres of salt cedar in the delta of Caballo Reservoir. It has been estimated that this will prevent the consumptive waste of about 15,000 acre-feet a year. The initial clearing was accomplished by large crawler tractors. Maintenance of the cleared area is to be carried on by a combination of the rotary brush cutter and the applications of chemicals. The cost of this maintenance work is being shared equally by both agencies. For Fiscal Year 1960 the New Mexico Interstate Stream Commission has authorized about $12,000. The Interstate Stream Commission has also authorized $150,000 for Fiscal Year 1960 toward the maintenance of the San Marcial Floodway and for the construction of water-salvage drains along the Rio Grande in the middle valley.

The U. S. Army Corps of Engineers is currently planning two 2,000-foot-wide floodways in Arizona, one about 70 (10) miles long from Gillespie Dam to Granite Reef Dam on the Gila and Salt Rivers and the other 94 (11) miles long, in two segments on the Gila River, from the upper end of Safford Valley to San Carlos Reservoir and from the mouth of the San Pedro River to the Butte Reservoir site. These plans do not propose a low-flow channel in connection with the floodway, but it is estimated that the salt cedar clearing will salvage annually 16,000 acre-feet and 19,800 acre-feet respectively.

CONCLUSION

In conclusion, it is evident that we still have a tremendous amount of work to accomplish in our efforts to effectively salvage the hundreds of thousands of acre-feet of water now consumptively wasted by non-beneficial vegetation. It is, therefore, felt that basic and applied research by governmental agencies should be accelerated so that plans to salvage water effectively and economically may be carried out in the near future.

The responsibility of basin-wide salvage would seem to properly belong to those public agencies which can integrate a water-salvage program between projects and across state lines.

State law and interstate compacts must, of course, be recognized in the distribution of the salvaged water.

REFERENCES CITED

1. Robinson, T. W., 1952, Phreatophytes and their relation to water in western United States: Transactions, American Geophysical Union, Symposium on Phreatophytes.

2. Dortignac, E. J., 1956, Watershed resources and problems of the upper Rio Grande Basin: Rocky Mountain Forest and Range Experiment Station.

3. Thompson, C. B., 1958, Importance of phreatophytes in water supply: Journal of the Irrigation and Drainage Division, American Society of Civil Engineers.

4. Elliott, E. W., 1957, Salt cedar control and channelization in the San Marcial area of middle Rio Grande in New Mexico: Symposium on Problems of the Upper Rio Grande.

5. U. S. Dept. of the Interior, Bureau of Reclamation, Region 5, 1959, Plan of additional development for Pecos River Basin, New Mexico-Texas.

6. Lowry, O. J., 1954, Salt cedar control investigations: Western Weed Control Conference.

7. U. S. Dept. of the Interior, Bureau of Reclamation, October, 1958, Caballo Reservoir area: Progress Report.

8. U. S. Dept. of the Interior, 1950, Use of water by bottom-land vegetation in lower Safford Valley, Arizona: Geological Survey, Water Supply Paper No. 1103.

9. Robinson, T. W., and Bowser, C. W., 1959, Buckeye Project -- water use by salt cedar: U. S. Geological Survey and Bureau of Reclamation, prepared for 59-3 Phreatophyte Subcommittee Meeting, Pacific Southwest Inter-Agency Committee, 26 p.

10. U. S. Army, Corps of Engineers, Los Angeles District, 1957, Interim report on survey for flood control, Gila and Salt Rivers.

11. U. S. Army, Corps of Engineers, Los Angeles District, 1957, Report on survey for flood control, Gila River.