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ACTION PROGRAMS FOR WATER YIELD IMPROVEMENT ON ARIZONA'S WATERSHEDS: POLITICAL CONSTRAINTS TO IMPLEMENTATION

by

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INTRODUCTION

The Arizona Watershed Program (AWP) is a network of research, action and public relations projects predominantly designed to supplement the state's water supply by means of vegetative manipulation and modification. It is the principal mechanism in the state for promotion of surface water yield improvement research and management. While a number of state and federal agencies including the State Land Department, Arizona Water Commission, U.S. Forest Service, U.S. Geological Survey, and the Bureau of Indian Affairs has over time financed, promoted, and/or conducted AWP research and experimental programs, a small political interest group, the Arizona Water Resources Committee, has been the AWP's principal sponsor and supporter. Formed in 1956 specifically to further AWP goals and objectives, committee membership includes representatives from the various interests--farming, ranching, mining, municipal, timber, environmental and financial--concerned with efforts to obtain more water from Arizona's watersheds.

The AWP research program objective promoted by the AWRC is primarily designed to further knowledge of the feasibility of vegetative manipulation and modification as a method of increasing surface water yields, and is conducted on experimental watersheds scattered throughout the state. The action program objective is envisioned as the long-term, ongoing and, most importantly, large-scale, application of vegetative management techniques to increase the state's water supplies and to improve on-site watershed characteristics. The success of the research program objective over the past twenty-two years is distinguished and must be considered a significant and notable achievement of the AWRC. AWRC promotion of the action program objective, however, has not, to date, met with similar success.

This paper describes three of the AWRC's unsuccessful attempts to implement ongoing action programs of vegetative management for water yield improvement. Two programs were thwarted in the conceptual stages; one was halted in progress. The first action program was formally proposed upon release of the 1956 Barr Report, a state-of-the-art research document, but research rather than implementation of the action program eventually received the primary emphasis. The second action program, a set of cooperative agreements between the Forest Service and the Salt River Project to treat pinyon-juniper and chaparral watersheds and to create fuel breaks, was initiated in 1964 but was subsequently suspended. Another state-of-the-art research document, the 1974 Ffolliott-Thorud Report, was to lay the foundation for the third action program, but adverse publicity again forced reconsideration of the feasibility of program implementation. The paper examines the factors which have contributed to these program setbacks, and suggests that political as well as scientific constraints account for the repeated failure to implement successfully the AWP action program objective.

THE BARR REPORT

As a result of a growing statewide interest in watershed problems and solutions

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during the mid-1950s the Salt River Project (SRP), State Land Department, and the University of Arizona (UA) entered into a cooperative agreement to conduct an intensive study of watershed conditions on the Salt and Verde river system, and to appraise the possibilities of an action program of plant control to increase runoff and improve range conditions. The resultant report, Recovering Rainfall: More Water for Irrigation, better known as the Barr Report for project leader George W. Barr, can be considered the first formal public announcement of the AWP. Released in October 1956, the report asserted that vegetative modification could be one of the most promising methods for increasing water supplies, providing up to an additional 285,000 acre-feet of water each year. It concluded that the "need for additional water is so urgent and the chances of obtaining it from the watershed so promising, that an extensive coordinated program should be started as soon as possible to increase the yield of irrigation water from the watersheds of the state" (Barr, 1956,7). The Barr Report thus provided the proponents of vegetative management with scholarly justification for their arguments and lent scientific stature to their demands for an immediate commitment of public funds to water yield projects.

The action program scenario presented in the Barr Report suggested extreme treatments of some vegetation types--eradication of 200,000 acres of non-commercial ponderosa pine, for example--and there was little prognostication on the resulting reaction of other resource values. In addition, very little research on water yield improvement was available, so while Barr's assumptions of water yield were the best estimates of watershed experts, the estimates could not be adequately supported by verified research results. Although the Barr Report intended to present the full potential of water yield improvement, realistically it could not serve as the foundation of large-scale action program implementation without further testing of its assumptions. Thus, when it was presented in 1956, the proposed action program drew criticism because its goals were overstated and based upon assumptions that had not been sufficiently tested.

Much criticism also centered on the extent and intensity of proposed treatments. One press critic, for example, asserted that the Barr Report had been put together by a group of individuals who believed in a "tin-roof watershed." He quoted Barr as remarking that implementation of the proposed program would require virtual liquidation of nearly half of Arizona's forest industry (Avery, 1956). Supporters of the AWP acknowledged that the two principal economic beneficiaries of a program of vegetative management would be upstream ranchers who had grazing permits on national forest lands, and downstream farmers who relied on low cost irrigation water; but they also maintained that other resource values, such as recreation, would benefit. However, the press critic argued that the program would not benefit all the users its advocates claimed, questioning whether any of the expected additional water supplies would be available for game and fish or recreation, and asserting that legally only the SRP, the major downstream irrigator, would probably be able to use the additional water (Avery, 1956).

Dismayed by the negative reactions the Barr Report received, administrators of the State Land Department and the SRP quickly decided to mount a counter-offensive in support of the Barr Report's watershed management recommendations. They decided to form a citizens' committee composed of interests which would support watershed treatment programs and work to offset unfavorable publicity. This select group met for the first time in December 1956, outlined its goals, endorsed the AWP, and decided to call itself the Arizona Water Resources Committee.

The AWRC, enthusiastic about the recommendations of the Barr Report and anxious to move the report's recommendations forward, subsequently proposed that an action program in four vegetative types (spruce-fir, ponderosa pine, pinyon-juniper, and streambed vegetation) be implemented on the Fort Apache Indian Reservation. Testing of the Barr Report's predictions on the reservation was attractive to the AWRC because federal funds for Indian-sponsored projects could be obtained with relative ease, and because the Forest Service had indicated some hesitation about the prospect of develing an action program on national forest lands. The tribal council agreed to undertake projects in two of the four vegetation types, spruce-fir, and pinyon-juniper. Due to federal restrictions on access to the reservation's spruce-fir zones, development of the treatment program in that vegetation type could not be immediately begun. However, proposed treatments of pinyon-juniper zones were soon initiated. The first pinyon-juniper project entailed two watersheds, one as control (Carrizo) and one under treatment (Corduroy). The second project was sited on the Cibeque watershed. The projects entailed conversion of juniper, or juniper and chaparral, to grass by a variety of watershed treatments, including burning, cabling, and chemical applications.

Vegetative treatments on the Fort Apache Indian Reservation were originally planned by the AWRC to be the primary basis for the Barr Report's action program. As

actually implemented, however, the program was limited in scope, and involved only two treated watersheds and only one vegetation type. Research applications, rather than the full-scale, ongoing action program first contemplated after release of the Barr Report, thus became the most salient program feature. In sum, AWRC efforts to implement the kind of action program envisioned by the Barr Report faltered during the early stages of program formulation and plans to develop a large-scale program were trimmed back.

Another questionable assumption which the AWRC made in proposing an action program in 1956 was that agencies had existing capabilities to implement effectively watershed management programs in the near future. In 1956 few existing sites were available for research, funding for research was not extant in agency budgets, and agencies such as the Forest Service were not enthusiastic about undertaking such massive programs on the basis of limited knowledge. The problem of vegetation management for increased water yields in 1956 can be emphasized by noting that very little calibration of water yields from untreated watersheds was available. Implementation was further restrained by the time--approximately two years--required before proper gauging devices could be installed. After installation, calibration would need to occur for approximately five years. Following calibration, a two year treatment period would need to be completed, succeeded by a three to five-year post treatment analysis. Therefore, approximately twelve-years lead time was (and still is) required before any results, either positive or negative, could be ascertained.

Implementation of the Barr Report action program was thus constrained by a series of unrealistic assumptions on the part of its principal supporters, adverse reaction to suggested treatments, lack of information on the efficacy of vegetation management for water yield improvement, and agency inability to gear up for the program without extensive periods of time. It became obvious that more emphasis on research was necessary to answer some of the questions raised about the feasibility and operational potential of vegetative management. Water yield improvement potentials and concepts would have to be scientifically established and demonstrated as viable, agencies would have to be adequately funded, and decision-makers convinced of the efficacy of water yield improvement programs before large-scale applications could gain acceptance. Thus shortly after the AWRC's creation, the research program replaced the action program as the priority objective of the AWP.

GLOBE AND CHAPARRAL

The next action program endorsed by the AWRC was the result of cooperative agreements between the Forest Service and the SRP. Pinyon-juniper management was chosen as the first objective of the action program. Areas in the Beaver Creek watershed in the Coconino National Forest were treated by a variety of methods, including burning, cabling, and chemical applications, to convert pinyon-juniper to grass with a view toward increasing forage and water yields. The initial contractual agreement involved some 6,000,000 acres and covered twenty-five years. The SRP, which was extremely anxious to ensure the success of the program, anticipated a cooperative budget of $75,000,000 for operational funding. While expenditures of $150,000 by the Forest Service and a matching amount by the SRP were planned for 1964, actual outlays were considerably less (Warskow, 1977).

A second vegetation type, chaparral, was also investigated. Watersheds on the Tonto National Forest were placed under management designed to replace dense chaparral with forage grasses. These watersheds were located near Globe, Arizona, in the Pinal Mountains, and treatments also included hand, fire and chemical eradication of unwanted vegetation. The first cooperative chemical sprayings of the areas took place in 1965, and subsequent sprayings occurred in 1966, 1968, and 1969. The SRP allocated the greatest part of its watershed management budget to the chaparral program. For two years, 1966 and 1967, SRP expenditures nearly rose to the planned optimal allocation of $150,000 per year (Warskow, 1977).

Convinced of the practicality of vegetation manipulation, the SRP anticipated further need for large-scale applications. Accordingly, in the late 1960s agreements were drawn up with the Forest Service for cooperation in the development of a fuel break program which was viewed as the prototype for future long-term, large-scale watershed management programs. The Forest Service with SRP funding, developed a system which would create 30,000 acre blocks of land separated from one another by fuel breaks. The fuel breaks would serve a three-fold purpose. First, existence of the breaks would aid fire fighters in containing wildfires in the 30,000 acre parcels. Second, they would decrease use of water by vegetation and increase water yields on the breaks themselves. Third, the fuel breaks would develop potential watershed management units which would facilitate the use of prescribed fire or chemical spray-

ing as vegetation manipulation tools. The SRP was primarily interested in the last two objectives, and the third in particular. By cooperating in constructing fuel breaks, the SRP hoped a foundation for future watershed management programs could be built. In 1969, the first operational year, $32,120 was allocated for fuel break construction on the Coconino and Tonto National Forests (Warskow, 1977).

The cooperative action projects were dealt a severe blow in June of 1969, when in the course of helicopter spraying of herbicides to defoliate and kill chaparral near Globe, Arizona, one property owner was unintentionally sprayed. Gathering support from other local residents, opposition to the herbicide spraying mounted. The residents complained of strange illnesses which afflicted their families and pets, wildlife, and of the death of much domestic vegetation. Consequently, a long list of damage claims was assembled (Shoecraft, 1971). These charges encited considerable public interest, particularly since they appeared at a time of growing concern with questions of environmental quality. In addition to a torrent of stories on the state level, the major national wire services and television networks picked up the story.

The SRP, the Forest Service and its parent agency, the Department of Agriculture, responded by sending three official task forces to investigate the claims. One task force, which investigated damage to the four private properties which were sprayed, found that plant life damaged by the accidental one quarter mile drift of herbicides had almost recovered in the period between June and September. In addition, they concluded that any existing damage had been done by drought, insects, alkali, disease, and excessive minerals. Another task force found that there were no significant effects on birds, deer or other wildlife. Two touted examples of animal deformities were dismissed because of lack of contact with the herbicides. Finally, one task force stated that plant damage was probably due more to root rot, woodpeckers and sapsuckers than to herbicides.

Despite the findings of the three task forces, the fervor of the opponents of chaparral eradication caused the Forest Service and the SRP in 1970 to reconsider the feasibility of additional spraying on the Tonto National Forest. By June 1970 both agencies, which had been served with lawsuits, had decided to eliminate their planned herbicide spraying activities other than for maintenance. Thus, in 1970, the chaparral program was stagnated and awaiting further support from the cooperating agencies. The AWRC, particularly disconcerted with this turn of events, sought assistance in August of 1970 from Arizona Congressman John Rhodes, asking him to increase chaparral research funding by $40,000 in 1971. The hoped for influx of federal funds was visualized as an impetus to revitalize the chaparral program on the Tonto National Forest.

Additionally, the Forest Service, in hopes of safeguarding its investments in chaparral research, developed a set of guidelines for brush control by herbicides when there was no practical alternative. These guidelines were presented at a March 20, 1971, public meeting in preparation for development of a firm chaparral policy later in the year. The guidelines drew praise from representatives of some Arizona agencies attending the meeting, but criticism from others. While several agency officials lauded the Forest Service for coming forth with a chaparral management plan, the representative of the Arizona Fish and Game Department, for example, claimed that the guidelines did not specifically spell out the goals of chaparral research.

However, both these efforts to revitalize the program failed. The first effort, to raise total chaparral funding in 1971, was not reflected in the 1971 funds allocated for cooperative action on the Tonto National Forest. Indeed, the converse occurred: in 1971 no water yield improvement treatment funds were allocated from federal coffers. Second, the Forest Service, sensitive to the still rampant hostility toward herbicide use on the Tonto National Forest, resorted to contingency treatment plans for chaparral watersheds. Herbicide use was discontinued, and eradication of chaparral by hand was substituted. Third, Forest Service funding of the program fell from a high of $65,000 in 1969, to $7,250 in 1970, and the SRP's contribution fell from $31,300 in 1969 to $2,600 in 1971 (Warskow, 1977). The entire cooperative agreement was finally abandoned late in 1971 when the regional forester--in direct response to the citizens' protests--suspended use of herbicides in the chaparral program on the Tonto National Forest.

While both the Forest Service and the SRP retained an active interest in the AWP and conducted other research and management programs, both reacted to the unexpected confrontation at Globe. A degree of reserve had been introduced into their cooperative agreements, and when cooperation on chaparral was halted, both organizations became more reticent about their involvement with controversial projects. The SRP, in particular, became reluctant to conduct programs on federal lands. The Forest Service disappointed the AWRC by halting the chaparral program, and thus the strength of long-established communicative ties was weakened.

Shortly after the suspension of the Tonto National Forest chaparral program, two other related events further stagnated the AWP action program. First, research results obtained from the initial pinyon-juniper eradication attempts proved not to yield an increase in water. Evidently, one of the major thrusts of the AWP was not going to pay off, and the AWRC was confronted with making a decision about the priority of pinyon-juniper research. In addition to frustrating research results, the agencies conducting the research programs began to dissolve their cooperative agreements. The SRP and the Forest Service, in particular, began to wind up their action programs on the Coconino and Prescott National Forests. For example, total SRP cooperative funds available for pinyon-juniper research on both the Coconino and Prescott National Forests fell from $27,251 in 1969 to zero in 1971 (Warskow, 1977).

The Globe controversy serves to illustrate that the AWRC, the Forest Service, and the SRP failed to anticipate the public's unacceptance of certain watershed management objectives and treatment methods and the strength of heretofore silent environmental interests. The first errant assumption made by the agencies involved in implementation of the chaparral action program was that chaparral conversion was accepted within the target action area. The second was that traditional methods of herbicide use were not disturbing to the general populace, and the third was that the public would not respond with such fervor to the controversy. From the reaction of the residents of Globe, the first two assumptions were incorrect. The third assumption, however, proved to be the undoing of the action objective. The local public was concerned enough about the environmental reactions to treatments that it actively sought political support from a national audience and chose to engage in extensive and lengthy litigation processes.

Continuing environmental criticism of the goals and methods of chaparral treatment pointed out that there were powerful interests which could constrain the AWP that were not represented in the decision-making structure of the AWRC. To satisfy these interests, the AWRC attempted to include and strengthen the representation of environmentalists and allied resource interests on the committee. This reaction, however, was largely the result of hindsight and did little to halt the demise of the second action program. In particular, it failed to satisfy critics who questioned the commitment and association of the new committee members picked to represent environmental concerns. These critics also remained opposed to water yield improvement programs on the ground that there was still inadequate understanding of the ecological consequences such programs would entail.

THE FFOLLIOTT-THORUD REPORT

The third action program never progressed from suggestion to implementation. Believing that comprehensive evidence existed by the early 1970s to prove that an action program was feasible, the AWRC initiated and fostered the preparation of another state-of-the-art research report, the Ffolliott-Thorud Report. The report was to summarize the progress of the AWP research program and provide a platform from which to launch a new action program. Questions which impeded action program implementation following release of the Barr Report were to be answered and criticisms of the AWP were to be stemmed. In addition, the report was contemplated as a prescription to accelerate recovery from the Globe setback. Finally, the AWRC felt that such a document would provide supporting information necessary for passage of the Pacific Southwest Water Yield Improvement Act.

The Pacific Southwest Water Yield Improvement Act, an AWRC drafted and supported bill, was first introduced in Congress in 1969 by members of the Arizona congressional delegation. Formulated in anticipation of the move from a research orientation to an action program, the bill would help settle a fundamental economic and political issue confronting advocates of watershed programs and practices: who would provide the large-scale expenditures that ongoing action programs would require? The bill, which has yet to pass Congress, would ensure a long-term federal commitment to finance water yield programs in the Southwestern states, a commitment which individual states like Arizona would likely be unwilling and unable to make. It would shift the burden of program payments from the local beneficiaries to the federal taxpayer, and by including several Southwestern states, it would increase the political support and consensus necessary for congressional passage.

The Ffolliott-Thorud Report, Water Yield Improvement by Vegetation Management: Focus on Arizona (1975), presented the findings of UA scientists Peter F. Ffolliott and David B. Thorud in a comprehensive format. Their findings were also summarized in a UA Agricultural Experiment Station Technical Bulletin, "Vegetation Management for Increased Water Yield in Arizona" (1974). Along with these two documents, the AWRC also prepared and released a popular version of the report. This publication, More Water for Arizona (1974), examined Arizona's need for water and the potential for water

yield increase as discussed in the Ffolliott-Thorud Report. It presented the AWRC's conclusion that action programs could and should now be implemented. While the Ffolliott-Thorud Report outlined the maximum hypothetical upper limits of water yield improvement (upper limits which were not modified by all the management constraints that would necessarily be applied), and AWRC's own analysis tended to treat the upper limits as realistic and realizable goals. Moreover, the committee interpreted the scientific evidence in the report as a basis for concluding that there was now "sufficient knowledge and technology to launch immediately a full-scale operational program of watershed management for the purpose of increasing water yield" (AWRC and Arizona Water Commission, 1974, 25). Thus, the AWRC envisioned the long-awaited implementation of an action program based on the results of eighteen years of research

Release of the Ffolliott-Thorud Report did not signal a new action program due to some of the same reasons the Barr Report did not. First, in calling for vegetation manipulation and modification to supply water to alleviate the drain on present supplies, the AWRC over-estimated the effectiveness of water yield improvement programs. As the committee stated in More Water for Arizona, Arizona's 1974 water needs were seven million acre-feet per year. The lowest Ffolliott-Thorud estimate would supply 602,561 acre-feet of water per year (excluding riparian treatments), and the highest estimate would provide 1,229,946 acre-feet. While the highest estimate would supply approximately seventeen percent of a year's water needs, it is based on severe and nearly comprehensive treatments of Arizona's watersheds--treatments too harsh for inclusion in a multiple-use framework. The lowest Ffolliott-Thorud estimate would supply approximately nine percent of Arizona's annual water needs, but there are also severe constraints on this expectation. Management guidelines and social, economic and environmental constraints would limit the extent and intensity of vegetation treatments. Therefore, a realistic figure of water needs which could be met by an action program would necessarily be less than the nine percent suggested by the most conservative Ffolliott-Thorud Report estimate. The water supply goals reported by the AWRC could only minimally be met through widespread applications of vegetative manipulation and modification techniques.

Many were fearful of the results of the extent and intensity of vegetation treatments; the possibility of eradicating other resource products or amenities troubled concerned individuals as much in 1974 as it did in 1956. The press and certain environmental groups focused on the hypothetical upper limits described in the Ffolliott-Thorud Report, and reported that the committee was advocating a water runoff program to derive up to 1,200,000 acre-feet of water by stripping undesirable vegetation from six million acres of Arizona's forests and deserts. The regional forester, aware that the Ffolliott-Thorud Report did not apply all the necessary constraints within its defined research framework, felt obliged to publicly present a more realistic interpretation of Ffolliott's and Thorud's estimates of water yields which could be expected in a multiple-use management context. He consequently proceeded to outline some of the management constraints which he felt made the theoretical upper limits "far too optimistic" (Hurst, 1974). Members of the Audubon Society and the Student Chapter of the Wildlife Society, and the Outdoor Editor of the Arizona Republic applauded the regional forester for his concern about what they perceived as a proposal to denude six million acres of land. They also challenged whether the AWRC represented Arizona's best interests, citing the representation of monied special interests such as banking, ranching, farming, mining, and water utilities on the committee. The entire watershed program was labeled a "pork barrel natural" because the "private sector solicits, politicians fund, universities receive grants, and bureaucracy administers" (Thomas, 1974; Wildlife Society, 1974).

In the face of these criticisms, the AWRC responded by reorganizing its structure, expanding its membership base, designating more members to represent environmental interests, and placing greater emphasis on selecting members who would bring about the development of expanded committee goals. As it became apparent that an action program would not be accepted without further documentation of water yield increases, alternative resource values and resource interactions, the committee also reconsidered its basic program objectives and the priority it placed on operational watershed programs. Despite the intensive research program that had been conducted since 1956, even more research on multiple-use values and environmental impacts appeared to be necessary before an action program could be implemented. Once again, the committee gave its research program first priority, with action program implementation in a secondary role.

CONCLUSIONS

The three unsuccessful attempts described above to implement operational action programs for surface water yield improvement on Arizona's watershed can be character-

ized by a number of factors including: overstated program goals, unrealistic assumptions about the political feasibility of treatment types, extent and intensity, failure to recognize the emergence of significant new decision-making participants, and unsettled questions concerning program costs and beneficiaries.

The two non-implemented action programs, announced concurrently with release of the Barr and the Ffolliott-Thorud Reports, received sharp criticisms because of the extent and intensity of the treatments which would be required to attain program goals. The Ffolliott-Thorud Report, for example, presented the AWRC with hypothetical upper limits of water yield potentials. By no means were these potentials the results that could be expected once all water yield goals were placed in a realistic management context. By allowing actual program goals to become associated with these upper limits, the AWP's most ardent supporters, including the AWRC, were perceived as advocating extreme and severe treatments of vast amounts of watershed acreage. The scenarios envisioned by program critics--tin-roof watersheds and denuded landscapes--were seen as the price of providing more water to the special interests represented within the AWRC's membership.

The Globe controversy halted the third action program, a complex of chaparral and pinyon-juniper conversion projects. Criticism of the type and extent of treatments in the Globe area, and the pressures which concerned individuals placed on the implementing agencies had a detrimental and cascading effect, resulting in the eventual demise of the other program segments. Herbicide use for vegetation management became a controversial tool, and it remains so today.

The Globe controversy also coincided with a major development in resource management politics. The late 1960s and early 1970s witnessed the birth of the environmental movement and the entrance of new decision-making participants challenging the traditional assumptions and practices of natural resource managers. Groups and individuals emerged to speak loudly in support of values--recreation, wildlife, wilderness, aesthetics--they felt had not been adequately emphasized in policy-making. They demanded that information about environmental impacts be as salient to decision-makers as information about technical feasibility and developmental benefits. Soon, by law and by political necessity, agencies and interest groups were compelled to accommodate these emergent interests and to consider carefully environmental consequences. Other groups, in addition to the AWRC, were thus able to claim they represented the public interest concerning watershed management objectives. The AWRC was slow, however, in recognizing the entrance of these new interests into the decision-making process, acknowledging the significance of their claims, and adjusting AWP program goals and objectives accordingly.

Finally, the failure to establish who will assume program costs and receive program benefits has hindered efforts to establish ongoing action programs. Whether limited public funds should be invested in water yield improvement programs, or whether greater social and economic returns could be realized if funds were invested elsewhere is another important consideration. In the future, these questions will almost certainly be receiving closer scrutiny. Already there are more frequent political challenges to federally-financed water development projects, and growing national concern over their environmental and economic price-tags. Increasingly past assumptions about the availability of the federal treasury to fund water supply projects which lack thorough and persuasive environmental and economic cost/benefit information appear politically unrealistic.

Although AWRC efforts during the past twenty-two years to initiate and maintain action programs for surface water yield improvement have faltered, AWRC efforts to develop the AWP research program have achieved notable success. The AWRC has been an important catalyst and coordinator in the development of watershed management research in the State of Arizona. Extensive research of the multiple-use potentials of Arizona's watersheds has expanded the pool of scientific knowledge available to watershed managers, providing useful information about an array of marketable and amenity resources. Moreover, many of the techniques developed and tested during the research program have been integrated into overall multiple-use management strategies, and as a result, they are increasing water yields as well as enhancing other resource values.

Yet, while scientific progress has been significant, much more remains to be done. Many unanswered questions--and especially those concerning ecological and economic effects and tradeoffs--will continue to inhibit the transferability of water yield improvement research results to large-scale operational applications. But as this paper has shown the failure to implement AWP action programs cannot simply be attributed to a lack of adequate scientific information. Political constraints have also stymied implementation. Future action program proposals will benefit from awareness

and understanding of the political constraints which have affected program development in the past. Sound watershed management planning in Arizona needs to consider the limits imposed by both insufficient scientific knowledge and the exigencies of the changing political arena.

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REFERENCES CITED

Arizona Water Resources Committee and Arizona Water Commission. 1974. More Water for Arizona. Arizona Water Commission, Phoenix. 28 p.

Avery, Ben. 1956. Arizona Republic, Phoenix. October 25, 26, 28.

Barr, George W. 1956. Recovering Rainfall: More Water for Irrigation. Part 1. University of Arizona, Department of Agricultural Economics, Tucson. 33 p.

Ffolliott, Peter F., and David B. Thorud. 1974. Vegetation Management for Increased Water Yield in Arizona. University of Arizona, School of Renewable Natural Resources, Tucson. NTIS #PB 246 055/AS. 1,094 p.

Hurst, William D. 1974. The Application of Water Yield Research to the National Forests of the Southwest. Arizona Watershed Symposium, Proceedings 18:43-46.

Thomas, Robert. 1974. Arizona Republic, Phoenix. September 26.

Warskow, William, Vice-President, Arizona Water Resources Committee, and Lead Watershed Specialist, Salt River Project, Phoenix. 1977. Interview.

Wildlife Society, Student Chapter. 1974. You Can Have What's Left. Wildlife Unlimited News. October.