ARUNDO DONAX WORKSHOP PROCEEDINGS
NOVEMBER 19, 1993

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FOREWORD

The Workshop on *Arundo donax* was sponsored by Team Arundo and the California Exotic Pest Plant Council (CalEPPC) to exchange information on the biology and control of *A. donax*, as well as the processes involved in working with State and Federal agencies to achieve successful results in *A. donax* control projects. One hundred and two persons attended the workshop, which exceeded our most optimistic hopes.

The core Workshop committee consisted of Paul Frandsen, Shelton Duthoit and Nelroy Jackson. The success of the Workshop is due, not only to their tenacity and dedication, but in large part, to the contributions of all Team Arundo members. The logos of member organizations are given on the back cover.

We express thanks to Mark Iverson and Ricardo Silberman for filling in for Gail McPherson and Bill Tidwell, resp., who were unable to attend the workshop and make presentations.

We thank the following 4 people who worked diligently behind the scenes to ensure the success of the workshop. They are Katrina Britton and Mari Nord, students at UCR, William Jernigan, Product Development Technician for Monsanto Company and Jaynita Spencer. , Administrative Assistant at Riverside County Parks District.. In addition, Lynn Davis-Domme of the Ontario Airport Hilton Hotel was very helpful and professional in making the physical arrangements.

These Proceedings were underwritten by a very generous grant from Monsanto Company, through Nelroy Jackson. The manuscripts are printed as submitted.

Included in the Proceedings are :- A list of attendees, a list of current *Arundo donax* removal projects in California, a "How-to Menu" prepared by Team Arundo Members., and a summary of the Workshop Evaluation Forms. We hope that these proceedings will serve as a ready reference for persons and organizations embarking on new *Arundo donax* removal projects. Additional copies may be purchased from the Riverside County Parks Department.

Since the conclusion of the Workshop, the Army Corps of Engineers has approved the establishment of a Mitigation Bank for removal of *A. donax* from the Santa Ana River., and the first monies have been deposited. This is a breakthrough, and augurs well for multi-agency projects in California in the future.

Nelroy E. Jackson, Paul Frandsen and Shelton Duthoit. January, 1994

Morning Session Chairman:

Paul Frandsen

8:30 - 9:00 am	Registration
9:00 - 9:10 am	Welcome - Paul Frandsen, Team Arundo
9:10 - 9:30 am	"Biology and growth habits of Arundo donax" Gary Bell, The Nature Conservancy
9:30 - 10:00 am	"The effect of exotic pest plants on native habitat" Dick Zembal, U.S. Fish and Wildlife Service
10:00 - 10:15 am	"Arundo donax in the Santa Ana River Basin" Shelton Douthit, Riverside Land Conservancy
10:15 - 10:30 am	"Movement of Arundo donax in river estuaries and beaches", Richard Doucé, Friends of the LA River
10:30 - 10:45 am	Break
10:45 - 11:15 am	"How Arundo donax impairs flood control" Bill Tidwell, Orange County Environmental Management Agency
11:15 - 11:45 am	"Fire threat from Arundo donax" Greg Scott, California Department of Forestry
11:45 - 12:15 pm	"The impact of Arundo donax on water resources" Mark Iverson, Riverside Water Quality Control Plant
12:15 - 1:15 pm	Lunch in the Atrium

Afternoon Session Chairman:

Nelroy Jackson

1:15 - 1:45 pm	"How Arundo donax fits into the Big Picture of Exotic Pest Plants in California" John Randall, The Nature Conservancy
1:45 - 2:15 pm	"Control of Arundo donax: techniques and pilot project" Nelroy Jackson, The Agricultural Group, Monsanto Co.
2:15 - 2:45 pm	"Team Arundo - A model for inter-agency cooperation" Paul Frandsen, Riverside County Parks and Open Space District
2:45 - 3:15 pm	"Environmental Permits: needs and processes" Michell Waltz, U.S. Army Corps of Engineers
3:15 - 3:30 pm	Break
3:30 - 3:50 pm	"Mitigation: banking and credits" Fari Tabatabai, U.S. Army Corps of Engineers
3:50 - 4:10 pm	"Revegetation of habitat after Arundo donax removal" Gary Bell, The Nature Conservancy
4:10 - 4:45 pm	"Watershed planning: future plans of Team Arundo" Paul Frandsen
4:45 pm	Adjourn

Biology and growth habits of giant reed (Arundo donax).

Gary P. Bell, Southern California Area Ecologist, The Nature Conservancy, Temecula Projects Office, 22115 Tenaja Road, Murrieta, CA 92562

Background:

More than 95% of the historic riparian habitat in the southern part of the state has been lost to agriculture, development, flood control, and other human-caused impacts. The greatest threat today to the remaining riparian corridors is the invasion of exotic plant species, primarily giant reed (*Arundo donax*). Giant reed readily invades riparian channels, especially in disturbed areas, is very competitive, difficult to control, and to the best of our knowledge does not provide either food or nesting habitat for native animals. The reed does compete with native species such as willows, mulefat, and cottonwoods which provide nesting habitat for least Bell's vireo, willow flycatcher and other native species.

Ecological value of native riparian systems:

Cottonwood/willow riparian forest is a dynamic community, dependent upon periodic flooding to provide substrate, nutrients, and to cycle the community back to earlier successional stages (Figure 1). Periodic floods of large magnitude, and migration of the river channel, are essential to laying down fresh alluvial deposits where seeds of mulefat, willow and cottonwood can germinate and propagules of willow can take root.

Adequate moisture and an absence of heavy flooding is particularly critical to the survival of the young trees through their first year. As these seedlings mature the river continues to deposit sediment on the floodplain. This sediment deposition builds the river terraces and, as they are elevated, other plant species colonize resulting in further diversification in the floodplain community.

When cottonwood/willow riparian scrub, which may include such species as mulefat, California grape, California blackberry (*Rubus ursinus*), and creek nettle (*Urtica dioica*), reaches four or five years of age, it begins to exhibit the structural diversity required by breeding least Bell's vireo. Least Bell's vireo, along with willow flycatcher, yellow-breasted chat, yellow warbler, and many other species may continue to use this diverse community for another ten to twenty years. Gradually the canopy of the maturing willows and cottonwoods begins to shade out the diverse understory of vascular plants required by these birds. Older riparian gallery forest will continue to be used by western yellow-billed cuckoo, Cooper's hawk, warbling vireo and other species, but as the stand ages the diversity of the flora and fauna within the forest declines. Annual flooding and occasional large flood events maintain this cycle of succession and therefore maintains a mosaic of diverse natural communities.

Giant reed:

Arundo is a genus of tall perennial reed-like grasses with six species native to warmer parts of the Old World. Giant reed, *Arundo donax*, is the largest member of the genus and is among the largest of the grasses (Poaceae), growing to more than 25 feet tall. Giant reed is native to Europe, and is found in freshwaters in the Mediterranean region. Giant reed was purposefully introduced to California in the 1820's in the Los Angeles area as an erosion-control agent in drainage canals. Giant reed was also used as thatching for roofs of sheds, barns, and other buildings.

Giant reed is a hydrophyte, growing along lakes, streams, drains and other wet sites. It uses prodigious amounts of water to supply its incredible rate of growth. Under optimal conditions giant reed can grow more than three inches per day.

Arundo as a competitor:

Within its introduced range, giant reed is an aggressive competitor. Giant reed flowers in late summer with a large, plumelike panicle. Fortunately for California land managers the seeds produced by *Arundo* in this country are seldom, if ever, fertile. As such, spread, and therefore management, of giant reed is essentially an intra-basin and downstream phenomenon. This species is well adapted to the high disturbance dynamics of riparian systems as it spreads primarily vegetatively. Flood events break up clumps of *Arundo* and spread the pieces downstream. Fragmented stem nodes and rhizomes can take root and establish as new plant clones.

Once established this species tends to form large, continuous, clonal root masses, sometimes covering several acres, usually at the expense of native riparian vegetation which cannot compete with *Arundo*. Giant reed is also highly flammable throughout most of the year, and the plant appears highly adapted to extreme fire events. While fire is a natural and beneficial process in many natural communities in southern California it is a largely un-natural and pervasive threat to riparian areas. Natural wild fires usually occur during rare lightening storm events in late fall, winter, and early spring. Under these conditions the moist green vegetation of riparian areas would normally act as a fire break. Human-caused wild fires, in contrast, often occur during the dry months of the year. Dryer conditions in riparian zones at this time of year make them more vulnerable to fire damage. Because it is extremely flammable, once established within a riparian area giant reed redirects the history of a site by increasing the probability of the occurrence of wildfire, and increasing the intensity of wildfire once it does occur. Giant reed effectively changes riparian forest from a flood-defined to a fire-defined natural community (Figure 2).

Rhizomes respond quickly after fire, sending up new sprouts and quickly outgrowing any native species which might have otherwise taken root in a burned-over site. Fire events thus tend to help push riparian stands in the direction of pure *Arundo donax*. This usually results in significant stands of giant reed with little additional plant species diversity.

Giant reed as habitat - NOT!:

Establishment and success of giant reed within a riparian corridor thus results in a decline in the diversity of native riparian plant species - reed supplants native habitat. All evidence indicates that giant reed does not provide either food or habitat for native species of wildlife. Areas largely taken over by giant reed are therefore depauperate of wildlife. This also means that native flora and fauna do not offer any significant control mechanisms for giant reed. It is uncertain what the natural controlling mechanisms for this species are in the Old World.

Recent studies by SAWPA have indicated that reed also lacks the structure necessary to provide significant shading of bank-edge river habitats, resulting in warmer water than would be found with a native gallery forest of willows. As a result, riverine areas dominated by giant reed tend to have warmer water temperatures and lower diversity of aquatic animals, including fishes. In the Santa Ana River system this lack of streambank structure and shading has been implicated in the reduction of rare native stream fishes including the arroyo chub (*Gila orcuttii*), three-spined stickleback (*Gasterosteus aculatus*), speckled dace (*Rhinichthys osculus*), and Santa Ana sucker (*Catostomus santaanae*).

Other studies have indicated that in addition to higher water temperatures, this lack of stream-side canopy structure may result in increased pH in the shallower sections of the river due to high algal photosynthetic activity. In turn, high pH facilitates the conversion of total ammonia to the toxic un-ionized ammonia form which further degrades water quality for aquatic species and for downstream users.

Conclusions:

By virtue of its growth characteristics, adaptations to disturbance, especially fire, its lack of natural predators and competitors in North America, and its unsuitability as food or habitat for native wildlife, giant reed has established itself as one of the primary threats to native riparian habitats in the western United States.

BIBLIOGRAPHY

Chadwick and Associates. 1992. Santa Ana River use attainability analysis. Volume 2: Aquatic biology, habitat & toxicity analysis. Santa Ana Watershed Project Authority, Riverside, CA.

Franzreb, K. 1989. Ecology and conservation of the endangered least Bell's vireo. U.S. Fish and Wildlife Service, Biological Report 89(1). 17 pp.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41:540-551.

Pike, J. and L.R.Hays. 1993. Final Report: The status and management of the Least Bell's Vireo within the Prado Basin, California, 1986-1992. Prepared for The Nature Conservancy, Temecula, CA.

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. Non-game Heritage Division, California Department of Fish and Game, Sacramento, CA. 156 pp.

Hoover, D.A. 1990. Unnatural plant communities in the Santa Monica Mountains. Fremontia 18:26-29.

Hoshovsky, M. 1989. *Arundo donax*. Element Stewardship Abstract. The Nature Conservancy, San Francisco, CA. 10 pp.

Munz, P.A. 1974. A flora of southern California. Univ. of California Press, Berkeley, 1086 pp.

Richter, B.D. and H.E. Richter. 1992. Development of groundwater and ecological models for protecting a southwestern riparian system. Proceedings, First International Symposium on Groundwater Ecology, Tampa, Florida.

Robbins, W.W. 1940. Alien plants growing without cultivation in California. Cal. Agric. Exp. Sta., Bull 685, 128 pp.

Schoenherr, A.A. 1992. A natural history of California. California Natural History Guides, No. 56. University of California Press, Berkeley, CA. 772 pp.

Zembal, R. 1990. Riparian habitat and breeding birds along the Santa Margarita and Santa Ana Rivers of southern California. Pp. 98-114 In: A.A.Schoenherr [ed.] Endangered plant communities of southern California. Southern California Botanists, Special Publ. No. 3.

Zembal, R., K.J. Kramer and R.J. Bransfield. 1985. Survey of vegetation and vertebrate fauna in the Prado Basin and the Santa Ana River Canyon, California. U.S. fish and Wildlife Service, Laguna Niguel field Office.

Figure 1: Conceptual model of successional processes in southern California cottonwood/willow riparian forest

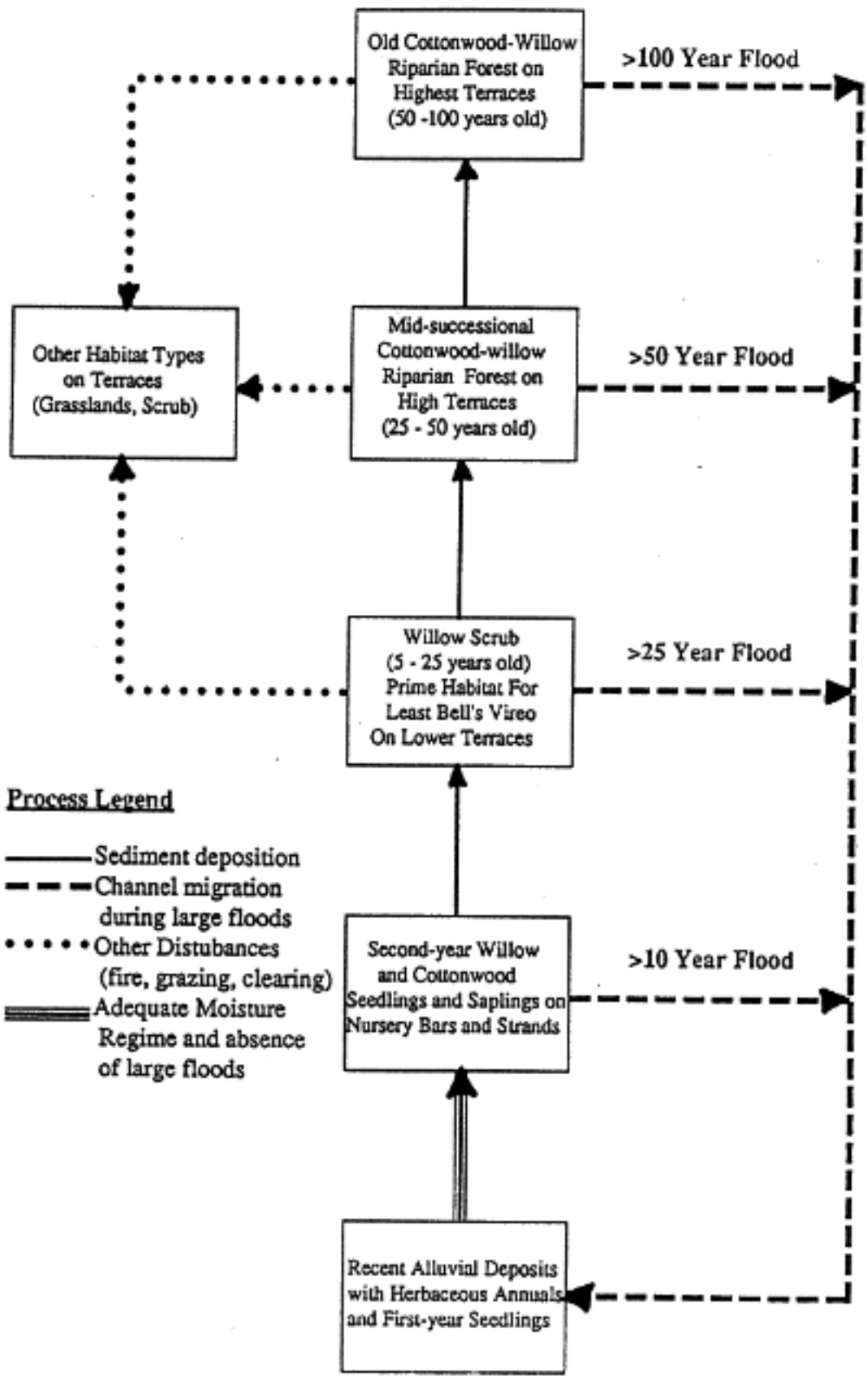
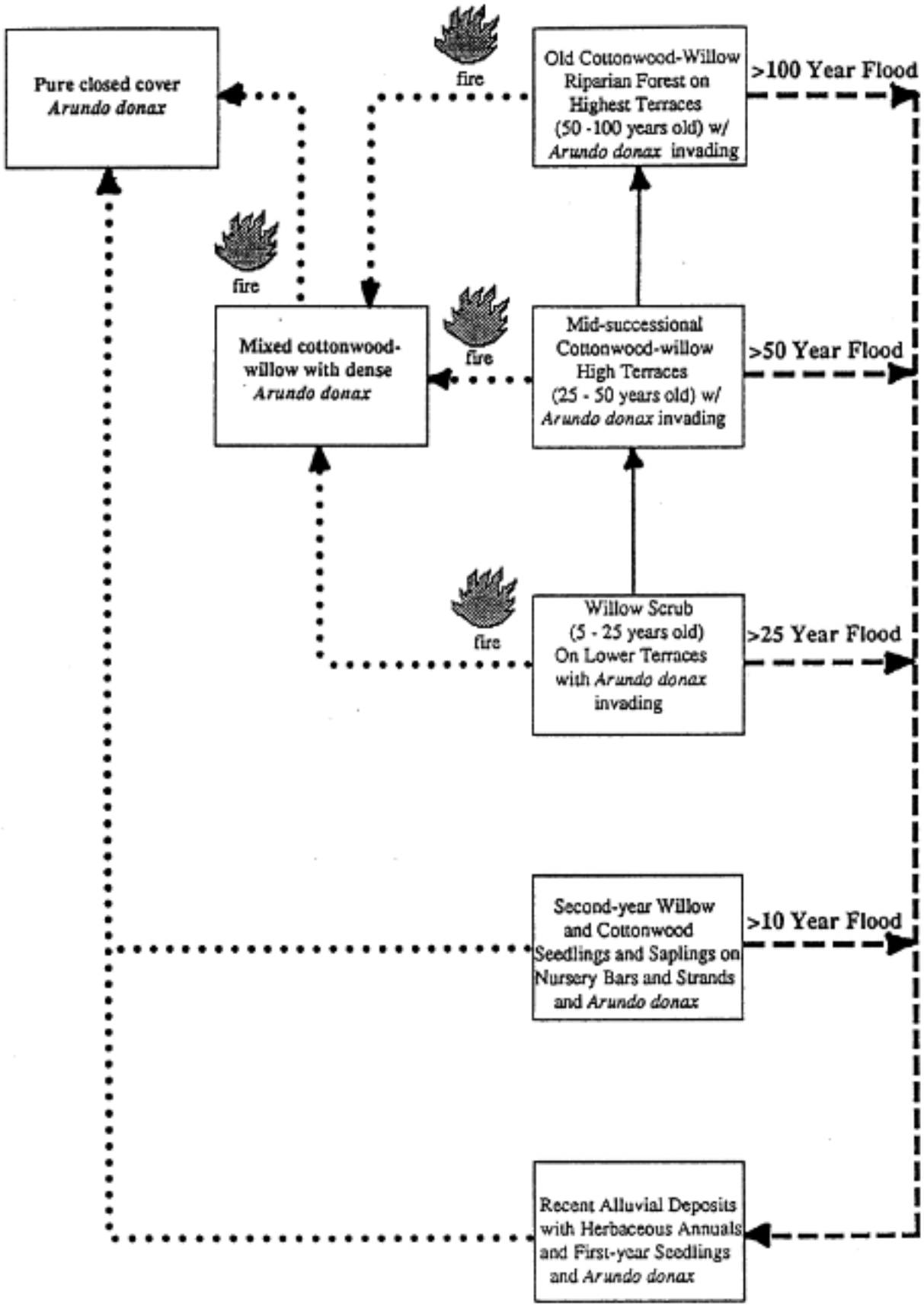


Figure 2: Conceptual model of succession in cottonwood/willow riparian forest after invasion by giant reed.



Arundo donax in the Santa Ana River Basin

Shelton Douthit
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Introduction

The Santa Ana River Basin, estimated to include over 24,000 square miles of drainage area, is considered the largest of the seven river systems that drain Southern California. Originating at springs high in the San Bernardino and San Jacinto Mountains, the Santa Ana River flows to the Pacific Ocean through over 300 miles of natural and straighten river channels.

According to a 1989 United States Department of Interior, Fish and Wildlife Service Biological Report (85 7.27) an estimated 46% of these channels (main channel and major tributaries) contain riparian vegetation. This vegetation includes cottonwood (Populus fremontii), willow (Salix spp.), sycamore (Plantanus racemosa), and Mulefat (Baccharis glutinosa). Increasingly Arundo(Arundo donax) is also found invading this once "natural" riparian habitat.

Vegetation Mapping

During the past two years, The Nature Conservancy (TNC) has begun mapping streamside vegetation within the Santa Ana River basin. This effort appears to be the first comprehensive riparian vegetation mapping effort ever attempted on the Santa Ana River outside of the National Forests. A preliminary literature search indicates that no other watershed-wide riparian vegetation mapping has occurred, even though numerous biological studies have been conducted. These past studies have been focused on a specific segment of the river and do not attempt to assess vegetation throughout the entire river system.

TNC's initial riparian vegetation mapping efforts have been targeted at the Prado Basin located in western Riverside and southeastern San Bernardino Counties. This mapping has involved aerial photography interpretation and mapping using a computer-based geographic interpretation system (GIS). Initially mapping is at 1:24,000 scale using U.S.D.I. Geological Suvery(U.S.G.S.) topographic base maps. Currently two U.S.G.S. quadrangles have been completed and provide a startling look at the extent of Arundo infestation.

Initial vegetation mapping efforts involve the central portion of the Santa Ana River. This portion of the river is roughly 22 miles in length and contain the largest contiguous stand of alluvial riparian forest within the entire river system. Most of this riparian forest is located within the Santa Ana River Regional Park, a network of publicly owned lands that include Prado Basin, Hidden Valley Wildlife Area, and the Anza Narrows Regional Park. This area is considered to be the "most natural" segment of the main channel of the Santa Ana River below 2000' in elevation, and serves as the last remaining sanctuary for many of the riparian species once found throughout the entire Santa Ana River System.

As of September, 1993, two U.S.G.S. 7.5 minute topo quadrangles have been mapped, the Riverside West, and San Bernardino South. The Corona North, and Prado Dam quads will be completed in late October.

A look at the Riverside West quad provides one with a startling look at the Arundo infestation problem. There is an estimated 1,116 acres of riparian vegetation (including Arundo), of which 535 acres consist of pure stand Arundo. An additional 227 acres are mixed stands of vegetation including Arundo, while 354 acres are relatively natural riparian vegetation. Mixed stands of Arundo are considered to be stands of native riparian vegetation that are actively becoming invested and will eventually become a pure stand of Arundo. With this in mind, of the total 1,116 acres of riparian vegetation, 762 acres are impacted by Arundo. This is roughly 68% of the total riparian vegetation found within this segment of the Santa Ana.

These initial numbers are estimates and do not represent a final assessment of conditions. But this sample does indicate that of the 46% of the Santa Ana River that is still relatively natural and contain riparian vegetation, potentially as much as 50-60% of that vegetation is Arundo, having no habitat value and is actively invading the remaining un-impacted 20% of the river. These numbers are rough estimates, but combined with field sampling, does suggest that the Santa Ana River's remaining natural riparian habitat is endanger of being totally overrun by Arundo.

Initial Sampling of Tributaries

Any attempt to control Arundo must involve its removal and control throughout the watershed. Initial mapping efforts have been focused on the main channel, but field sampling has occurred on many tributaries.

Preliminary sampling consisting of field surveys and the establishment of photopoints currently is underway within three Santa Ana River tributaries located in western Riverside County. The upper San Timoteo and Sycamore Canyon drainages are currently being surveyed, while the Alessandro Arroyo was surveyed early this past summer (July 1993). The results of these surveys indicate that Arundo is found in mixed and pure stands throughout

each tributary, even at remote headwaters and springs.

Conclusions

Invasion by Arundo may potentially be the final in a series of impacts that has degraded and destroyed the once extensive riparian forest found growing along the Santa Ana River and its many tributaries. It is actively invading publicly owned and managed ecological preserves and parks that were established to serve as pristine sanctuaries for the many threatened and endangered riparian plants and animals found within the region.

A watershed-wide habitat recovery effort must be carried-out if the remaining riparian habitat within the Santa Ana river basin is to be protected. A component of such recovery effort must involve a comprehensive vegetation mapping and monitoring effort utilizing aerial photography, computer-based Geographic Information Systems and field sampling. Mapping and monitoring are essential for planning of on-the-ground removal efforts and monitoring there effectiveness. Any large scale habitat management and recovery effort should initiate mapping and assessment efforts as early in the planning process as possible. Local colleges and universities can provide low cost mapping and GIS assistance. But all mapping efforts must be accompanied by accurate field sampling so the "ground-truth" interpretations of aerial or satellite images.

Van Buren Bridge Unit
Giant Reed Infestation

Legend

Hydrology

Roads

Habitat

- Non-riparian
- Pure Arundo
- Mixed Arundo
- Uninfested

N

meters

0 700 1400

THE BIOLOGICAL POLLUTION OF *ARUNDO DONAX* IN RIVER ESTUARIES AND BEACHES

BY

RICHARD S. DOUCE'

The main purpose of my presentation today will be to introduce the audience to the on-going problem of marine debris in our riparian and coastal environments and to broaden the definition of the problems caused by *Arundo donax*. Although, marine debris is normally thought of in terms of man-made objects that are discarded by people (i.e., plastics, glass, rubber, metal, etc.), the term can also be extended to include natural objects such as seaweed, tree branches, driftwood as well as the most problematic of all: a non-native plant species known as *Arundo donax*.

Originating in North Africa and intentionally introduced by the Spanish in the 19th Century to control erosion, this pest plant today has taken on a new dimension as a water quality problem in addition to the problems normally associated with it such as flood-control, water conservation, habitat loss and fire threat. In terms of water quality, the problem of Arundo is the most severe when it is ripped out from the soft bottom sections of river channels and washed downstream along with all the urban trash into the flood control channels after major storms. Eventually, floating up on the foreshore of the beach, Arundo is combined with sand and trash into huge debris piles for removal by work crews. In this sense, the plant is just as much a problem when it is dead as when it is alive (the plant's moniker is the "Plant from Hell" is justifiably accurate).

The problem is especially severe in Long Beach along the shores of San Pedro Bay where most of the beach sits between the mouths of two major rivers that drain much of Los Angeles County: the San Gabriel River and the Los Angeles river. At peak levels of inundation, the debris has been known to be consolidated into as many as 200 separate piles for removal. Anyone who visits the shoreline in Long Beach between December and April is well acquainted with the sight of these artificial dunes; some measuring up to 15 by 30 feet wide stretching in a linear row for miles down the beach.

Even more alarming is the fact that marine debris pollution is fast becoming a year-around problem in San Pedro Bay where because of the length of time it takes to clean the beach as a result of the severity and/or frequency of storms, the debris is becoming ubiquitous to the shoreline. To make matters even worse, Arundo is taking up an ever-increasing portion of the debris pile composition as compared with the urban trash (some studies show Arundo accounting for the greatest percentage of debris composition). In one of the worst years to date, the 1993 rains left an estimated 7,000 tons of debris to be removed from the beaches and marinas in Long Beach. Combined,

Arundo and urban trash cause major problems in terms of cleanup costs, threats to human and animal safety, as well as the degradation of beaches from the standpoint of aesthetics. A study conducted by this author documenting the condition of the beach from December 7, 1992, to October 19, 1993, can be found in my thesis project for graduate school entitled: *Nonpoint Sources Water Pollution of Marine Debris from Urban Runoff on the Coastal Environment of Long Beach, California.*

Clearly, a much more aggressive approach in terms of pollution prevention is needed to provide for the health and safety of humans and wildlife in the affected area. Generally speaking, solutions to water quality problems in the Los Angeles Basin will need to move more in the direction of integrated watershed management that sees all water issues as inter-related. But, perhaps, the most glaring omission of anything being done about marine debris is the situation concerning the infestation of *Arundo donax*. The need to bring about eradication programs on Arundo in the Los Angeles River Watershed is profound, especially, if you consider the statements made by an advisory panel of experts for the Office of Technology Assessment (U.S. Congress) that warn, "By the mid-21st Century, biological invasions become one of the most prominent ecological issues on Earth."

Based on my interviews with public officials with Los Angeles County, I have been told that there are no programs currently planned for in the future anywhere in the Los Angeles River Watershed to eradicate this pest plant. The reasons are numerous, but the main reluctance to proceed is the lack of funding. It goes without saying that eradicating Arundo is an expensive undertaking. It is my hope, with the example set by Team Arundo in undertaking an eradication program in the Santa Ana River Watersned, the same level of dedication can be brought about by other groups to begin an eradication program somewnere in the Los Angeles River Watershed. The need for implementing realistic mitigation's for marine debris from land-based sources is tremendous. Then, and only then, can our waterways be helped on the road to recovery.

THE IMPACT OF *ARUNDO DONAX* ON FLOOD CONTROL AND ENDANGERED SPECIES

BY

PAUL FRANDSEN AND NELROY JACKSON

RIVERSIDE COUNTY PARK DISTRICT AND MONSANTO COMPANY

INTRODUCTION

The Santa Ana River Watershed is the largest in Southern California and serves many, often conflicting, human needs. The needs of the more than four million people who live within the watershed include:- development along the banks, drinking water, flood control, water infiltration, release of treated sewage effluent, recreation and transportation. The river basin is also important habitat for wildlife, in particular as a nesting ground for the least Bell's vireo, a small songbird that is listed as endangered by both federal and state agencies.

IMPACT ON FLOOD CONTROL

One major use of the river is to move water from winter rains and snow melt from the San Bernardino mountains to the Pacific Ocean, without flooding lowland areas of San Bernardino, Riverside and Orange counties. All three counties that the Santa Ana river runs through have agencies that must protect the public from floods. Several decades ago, winter flows caused huge losses of life and property in the river basin. Structures were then built along the river to prevent a repeat of such enormous losses. Levies, dams, berms, and water retention facilities have been built to either move water swiftly down river, or keep it in check for measured release to infiltrate into the underground water table. The most notable structure is Prado Dam in Corona which holds water back for gradual release downstream into Orange County. A series of percolation ponds was built downstream of the dam. Orange County subsequently utilizes the water stored underground for domestic and industrial purposes.

Arundo donax growing in flood control channels necessitates constant removal tactics. It can form debris dams against flood control and transportation structures (bridges and culverts). Giant reed may also clog floodways and requires constant monitoring, cutting, mowing, spraying and removal of the biomass. Cutting wild cane by traditional methods may send small bits of cane down river to form new colonies. During storm events, entire clumps of Arundo looking like giant celery stalks float down the river and become lodged on sandy banks, only to begin new colonies.

Another problem with wild cane infesting a river is that it begins to 'channel', so that it gets 'stuck' and begins to build a side bank that forces it to rise above the main river channel. This happens to a larger degree when floods do not dislodge the giant reed and sand is deposited amongst the root mass. The root mass also may deepen and spread. The two actions, sand getting caught and the spreading root mass, elevate the river bottom so that during a 10, 20, or 50 year storm event, the river bottom is raised 2-4 feet. The water then has to spread with possible impacts on structures and habitat.

FLOOD CONTROL PRACTICES

Current maintenance systems include use of bulldozers, giant mowers (Hydro-Ax), and small machines that scrape the ground to keep at least the center of the river clear for water passage. Spraying of approved herbicides, like Rodeo herbicide, is used extensively to control *Arundo donax*. Another management system, used by San Bernardino and Orange counties, allows sections or patches of habitat to grow to a specific size, then removes the wild cane or cuts it. This action reduces the problem of larger trees becoming a hazard downstream or catching debris and eroding levees. The actual amount of stream flow and the degree of habitat that may be left has been factored into the plan, and removal becomes routine.

Bob Tate, manager of the Lower Tule Irrigation District in the San Joaquin Valley of California used Rodeo herbicide over a three-year period to control *Arundo donax* in his irrigation canals. The main delivery channel had become choked with giant reed and a number of other plant species. He sprayed the vegetation in late summer using hand equipment the first year and got good control. The second and third years he used progressively less material to treat growth from previously uncommitted rhizomes and resprouts of giant reed. After 3 years, he was on a maintenance program and his channel had become clear. When the heavy rains and snow melt came in the winter and spring of 1992/93, his channels were able to hold the water without flooding. This successful program allowed him to deliver water to his customers throughout 1993 without any flooding.

IMPACT ON ENDANGERED SPECIES HABITAT

Some sections of the Santa Ana River are strictly working sections, with virtually no habitat left. A good part of the river flowing through Orange County is channeled and used for either groundwater recharge or is covered with concrete. The middle and upper reaches of the river have more habitat and more options for habitat restoration. The large middle section or 'waist' of the river is very wide and can take flood events without much threat to public or private property, except where it is choked with *Arundo donax*.

In the Simi Valley area, *Arundo donax* has choked the habitat of the 3-spine stickleback, an endangered fish species. Giant reed, not only uses excess water and dries out streams, but its activities often change the temperature of the water. A project is in place to remove *Arundo donax* from the area and restore the habitat for this fish.

® Rodeo is a registered trademark of Monsanto Company.

IMPACT OF ENDANGERED SPECIES LAWS AND REGULATIONS

Endangered species laws and *Arundo donax* have changed a straightforward business of moving water to one of regulations and maintenance headaches. Endangered species laws protect creatures in the river from harm. Several birds will probably be listed in the next decade. After removal of giant reed, endangered species, either plant or animal, re-establish themselves in riparian areas unless the floodway channels are kept totally devoid of plants. Conflict in the river occurs repeatedly from the needs of growing plants, both native and exotic, and the desire to move the maximum amount of water down river. Fines, mitigation requirements, threats, and public concerns over their health and safety or environmental damage are additional factors.

A key need is to have an operational plan approved by the Resources agencies so that both 'sides' know the notification requirements, timing for cutting and access, dealing with emergency situations and, in general, do enough planning to protect both floodway capacity and habitat. The operational plan should include where the maintenance task will take place, exactly, with maps and photographs. The type of maintenance needed, shoring up a dike, re-building an access road or removing cane. It should include when the work is anticipated to be done and where any fill will come from. In addition, the agreed-upon window, or time for a particular task should be laid out. Anything outside of the agreed-upon maintenance plan must not be done without prior written approval. It is very important to set up a phone list and protocol for decisions. Keeping a log of the requests and approvals may save time and money later. Remember to brief the person operating the equipment, since one wrong move could cost money and cause delays.

The current state and federal regulations require expensive mitigation for even the removal of wild cane, let alone restoring the 'right' habitat. This is one of the key rules that must be changed to encourage flood agencies to remove exotic pest plants and save high value habitat for endangered and threatened species. Permits and consultation with the key Resource Agencies is vital for a smooth relationship between the flood Agencies and the agencies that regulate them. Surprises or errors are very expensive. One acre of restoration of riparian habitat costs about $100,000! One endangered bird can require many acres of mitigation.

THE SOLUTION

Some flood agencies are becoming "green", after years of conflict with Resource Agencies and a new breed of manager who understands that the little riparian habitat left will have to be saved. Floodways, where appropriate, can have some habitat and still do their main job of carrying water to the ocean or percolation ponds. Agencies are willing to remove *Arundo donax*, leave a percentage of habitat, and would like, of course, to receive credit for their efforts. Receiving credit for their work would be welcome.

Bill Tidwell, Supervisor with the Orange County Environmental Management Agency, has developed an elegant solution to the dilemma of balancing the need for flood control with the requirements of maintaining high quality bird habitat. He allows native vegetation, including grasses and forbs, to grow and set seed in the spring and early summer. This period coincides with the nesting and fledgling period for the least Bell's vireo, an endangered songbird. Then, after the birds have fledged and moved to a different area, he brings out the spray crews and equipment to treat unwanted vegetation with Rodeo herbicide in late summer and early fall. Thus, his channels are clear and open for the flow from winter rainfall.

Another aspect of controlling *Arundo donax* is to be opportunistic and prepared for wildfire events. A fire burned 250 acres of wild cane and other vegetation in Featherly Park that is in the streambed of the Santa Ana river in Orange County. Bill Tidwell seized the opportunity and applied Rodeo herbicide to the young resprouts. The first time, his crews treated all the Arundo. The second time he treated areas that were missed the first time or had resprouted. Rodeo herbicide was very effective at controlling precisely the wild cane and allowing the willows, mulefat and cottonwoods to recover. Since the seed source was in the soil, native grasses and forbs germinated the following winter and the area recovered without need for artificial re-vegetation.

SUMMARY

Laws and regulations to protect endangered species will get stronger as more people live and work in the watersheds of the Santa Ana and other rivers in Southern and Central California. There are few natural areas left for the remnants of many bird, fish, mammal and plant species. The need for flood control in riparian areas serving metropolitan communities will not diminish.

Arundo donax is a serious and severe threat to both endangered species and man, because it not only displaces beneficial plants, but consumes excessive amounts of water, as well as posing a wildfire threat. Giant reed is putting more pressure on the remaining natural areas. Floodways may well be used more in the future to balance the needs of moving floodwater, recharging underground storage basins, and providing vibrant habitat for wildlife to survive and flourish.

Flood Control Agencies are showing their willingness to change their maintenance practices in order to bring balance back toward restoration and protection of habitat, while providing flood protection for metropolitan and farming communities. They utilize a combination of tools and methods, including treatment with Rodeo herbicide to accomplish their goals. These agencies are an integral part of Team Arundo.

FIRE THREAT FROM ARUNDO DONAX

Gregory D. Scott
State Forest Ranger II
California Department of Forestry
and Fire Protection

Introduction

The Arundo Donax has spread throughout the Santa Ana River Basin from San Bernardino County into Orange County.

Historically, Santa Ana Basin wildfires have been small and easy to contain, or they have become large infernos which tax the ability of the fire manager to contain and control in a cost effective manner. With the introduction of the Giant Reed (Arundo Donax), the fuel available for wildfires doubled and in some areas even tripled, causing serious burning conditions given suitable weather conditions.

The encroachment of this reed and its potential exposure to fire increases the likelihood of costly damage. The recreational use of urban and suburban parks increases the chance of man-caused fires to occur. Fire and smoke will affect livestock grazing, dairy farming, oil field operations, an airport and local industry. Currently, a large portion of the Santa Ana Basin has been leased to support clubs which hunt water fowl, pheasant, and doves.

New environmental concerns impact the fire manager in addition to his responsibilities to suppress wildland fires and engage in pre-fire planning. Nesting sites and habitats for the endangered species, "Least Bell's Vireo," are located within the Prado Basin and along the Santa Ana River. Several other species designated by the California Department of Fish and Game as "bird species of special concern" can also be found in the Santa Ana River Basin. The Least Bittern, Burrowing Owl, and Cooper's Hawk are among other targeted species in this area.

Pre-fire Planning

Every fire department with jurisdictional responsibilities can relate problems due to exposures to wildland fires. Homes in subdivisions along the Santa Ana River cause exposure problems. Hot fire brands, which blow ahead of the fire, land in palm trees growing over roofs or the fire brands themselves land on the roofs resulting in structure fires. When burning conditions are favorable and high winds are present, fire equipment dispatched is greater to address this situation.

To address large damaging fires, the Santa Ana River Basin Pre-fire Plan was developed in June of 1991. This plan included maps of the area and identified Incident Command Posts, staging areas, drop points, fire hydrants, water sources, helicopter landing sites, established control lines and known hazardous conditions. These plans were distributed to all affected fire departments to provide for a common approach. The Pre-fire Plan will allow the fire manager to establish control points, tactics, operations,

communications, jurisdiction and environmental issues which will assist in developing a plan of action.

Pre-suppression Actions

In an effort to develop a method to kill the Arundo Donax plant, firefighting inmate crews from the Norco Conservation Camp have been clear cutting areas along the Santa Ana River. These handcrews are provided through an agreement between the California Department of Corrections and the California Department of Forestry and Fire Protection. After the crew has completed an area, that part is sprayed in an effort to kill the plant. The part of the plant which has been cut is burned.

A fuel break has twice been cut across the river next to the Van Buren Road Bridge. The first time a fuel break was constructed was prior to a large wildland fire. Firefighters used this fuel break to stop the fire's spread which resulted in the final control.

In September, 1993, the Norco Conservation Camp provided 752 inmate firefighter hours for cutting the Arundo Cane in the river bottom. In October 1993, this assignment received 1,080 inmate firefighter hours. The program has been in effect since January 1993. It should be noted that chainsaws, which are the primary tools used to cut this cane, require more maintenance and more periodic sharpening than when used on other types of fuels. Safety tailgate sessions are provided prior to beginning each day's work of cutting, to discuss chainsaw safety rules and hazards such as insects, snakes, skunks, shape stobs from the cut-off cane.

Conclusion

The fire manager addresses a number of challenges when dealing with the Arunda Donax. During favorable burning conditions, a wind-pushed fire spreads fast and burns very hot often resulting in spots from firebrands starting ahead of the main fire. Equipment access is limited in parts of the river because of muddy conditions. Pre-event planning and construction of fire breaks as a control line are coordinated efforts among a number of agencies. As you can see, the fire manager's concerns make up only a small part of the problems caused by Arundo Donax.

EFFECTS OF ARUNDO DONAX ON WATER RESOURCES

Mark E. Iverson, P.E.
City of Riverside
Water Reclamation Plant

Standing on the banks above the Santa Ana River looking across a sea of Arundo, it is easy to understand how arundo effects the riparian habitat of the river. The thick, high growing cane chokes out all other plant life. The growth is so dense that neither man nor small animal can pass through. And anyone who has seen television coverage or witnessed first hand the arundo when it burns understands the danger it presents to people and animals who live near the river. But what is not as easy to understand is how arundo effects water resources.

Every year the arundo along the Santa Ana River evaporates an estimated 56,200 acre-feet of water--enough water to serve a population of about 280,000 people. If this amount of untreated water was purchased from the Metropolitan Water District (MWD), it would cost approximately $18,000,000 at the current cost for untreated drinking water. There is, therefore, a cost that can be easily associated with arundo and its effects on water resources. A successful arundo removal program could ultimately cut the evapotranspiration by two thirds. This would save an estimated 37,500 acre-feet per year of water worth approximately $12,000,000.

It is easy to attach a dollar amount to how arundo affects the quantity of water resources, but it is difficult to do so for how it affects the quality of water resources. Being a giant grass, arundo provides little shade along the river. This causes the water temperatures to increase which in turn changes the water chemistry of the river. The net result is water quality that is less suited for fish and other aquatic life. Arundo therefore affects the water resources of the Santa Ana River in ways that are both tangible and intangible to man.

Effects on the Quantity of Water Resources

Arundo is a non-native plant that was imported to southern California from the Mediterranean by the early Spanish settlers. Over the years, the arundo population has increased to the point where it out competes all other native plant species in riparian habitats. You can visit almost any stream or river in southern or northern California and find arundo growing in abundance. This is particularly true along the Santa Ana River.

Not only does arundo out compete native plants, it uses about three times as much water as they do. There are no specific studies on the evapotranspiration rates of arundo. Horticulture experts, however, estimate arundo evaporates water at approximately the same rate as rice. This means that every acre of arundo uses about 5.62 acre-feet of water per year. Native species use only about two thirds this amount, 1.87 acre-feet per year. The water lost to evapotranspiration is water that would otherwise be available for groundwater recharge and ultimately drinking water supplies.

The Santa Ana River and the other streams and rivers in southern California are natural groundwater recharge basins. Water in the rivers migrate down through the river beds and into the groundwater aquifers. Were it not for the numerous wastewater discharges along the Santa Ana River, it would be almost, if not completely, dry except during the short rainy season. Only a small portion of the runoff from the heavy winter rains reaches the groundwater aquifers. Most of it runs off quickly and is ultimately discharged to the ocean. But nearly all of the water that flows in the river during the dry season either percolates into the groundwater or is lost to evaporation.

There are an estimated 10,000 acres of arundo along the Santa Ana River. Using the estimated evapotranspiration rate of 5.62 acre-feet per acre per year, a total of 56,200 acre-feet per year of water is being consumed by the arundo. If the arundo was completely replaced with native vegetation, the annual water consumption of the plants would be only about 18,700 acre-feet per year. To put this in perspective of beneficial use, one acre-foot of water is enough to serve a family of five for one year. The savings in water consumption would therefore be enough to serve a population of around 190,000 people. The water saved by reducing evapotranspiration will naturally recharge the groundwater aquifers and be available for drinking water supplies.

Chart 1 presents a simple scenario of how an arundo removal program could ultimately reduce evapotranspiration losses and increase the amount of water resources available. If the arundo is systematically removed at 200 acres per year, the loss from evapotranspiration will decrease at about 1,124 acre-feet per year. If at the same time native vegetation is replanted, evapotranspiration of the native plants will increase at an average rate of about 312 acre-feet per year. This translates into a net decrease in water loss of about 812 acre-feet per year. In the long run, the water loss will decrease from 56,200 to 18,700 acre-feet per year. It is interesting to note that if only 200 acres per year of arundo is removed, it will take 50 years to remove it all. And this assumes no additional growth in the existing arundo population. In reality, more than 200 acres per year would have to be removed to keep pace with the rapidly expanding arundo population and complete the project within 50 years.

Chart 2 shows the estimated value of the water saved based on the net decrease in evapotranspiration presented in Chart 1. Ultimately, $12,000,000 worth of water could be saved per year. This value is based on $320 per acre-foot which is approximately the rate MWD is charging for untreated drinking water. The cost of MWD water will increase in the future, and as it increases, so will the value of the water saved from arundo removal.

Charts 3 and 4 are similar to Charts 1 and 2 except they are based on 500 acres per year of arundo removal. In this case the arundo removal program will take only 20 years to complete and the benefits of the program will be realized sooner. The net result in water savings is, however, the same.

Some assumptions have been made in the charts to simplify the presentation. First, it is assumed that the arundo will be systematically removed at the given rate until it is all removed. It also assumes that the remaining arundo population will not increase. Second, it is assumed that the areas cleared will be replanted with native vegetation, the native vegetation will take 10 years

to fully mature, and there will be 100 percent cover once the vegetation is fully matured. The water use of the native plants is considered to increase linearly over the 10-year period from zero to 1.87 acre-feet per acre per year. The lags in the increase of evapotranspiration from replanting native vegetation are the result of the 10-year maturity period. Based on these assumptions, the net decrease in evapotranspiration was determined.

Much more research and refinement is needed to accurately predict the benefits of implementing an arundo removal program. More accurate estimates of the arundo evapotranspiration need to be determined. And a complete economic analysis that considers the cost of removing the arundo, increasing water costs, and other factors is needed to fully understand the benefits in water savings. Charts 1 through 4 do, however, give us an idea of the order of magnitude in water savings and time needed to implement an arundo removal program.

Effects on the Quality of Water Resources

Being a giant reed grass, arundo provides little shade along the banks of the river. Native vegetation normally overhangs the river, providing shade that keeps the temperature of the banks and the water down. Arundo provides no significant amount of shade; consequently, the water in the river is exposed to more sunlight. This increases the water temperature and changes the chemistry of the water.

With increased sunlight comes increased photosynthesis activity. Warmer water in conjunction with more sunlight promotes algae growth which tends to raise the pH of the water. The Santa Ana River, being an wastewater effluent dominated stream, is high in ammonia nitrogen concentration. The high pH of the water shifts the equilibrium of ammonia from the ionized to the un-ionized form. Un-ionized ammonia is more toxic to fish and other aquatic life. The increase in algae growth also reduces the clarity of the water. Arundo therefore degrades the quality of water resources as well as the quantity. And while it is easy to attach a dollar value to show the effects on water quantity, it is more difficult to do so for the effects on water quality.

People benefit either directly or indirectly from a healthy river habitat. Those people who fish, swim, and otherwise visit the river for recreation benefit directly from better water quality. But those who don't visit the river are also affected. How and to what monetary extent is difficult to determine. Suffice it to say that ultimately we are all affected by our natural environment and water resources are a key factor in environmental quality. Removal of the arundo is therefore important from the standpoint of both the quality and quantity of water resources.

CHART 1
CHANGE IN ANNUAL EVAPOTRANSPIRATION WITH IMPLEMENTATION OF AN ARUNDO REMOVAL PROGRAM

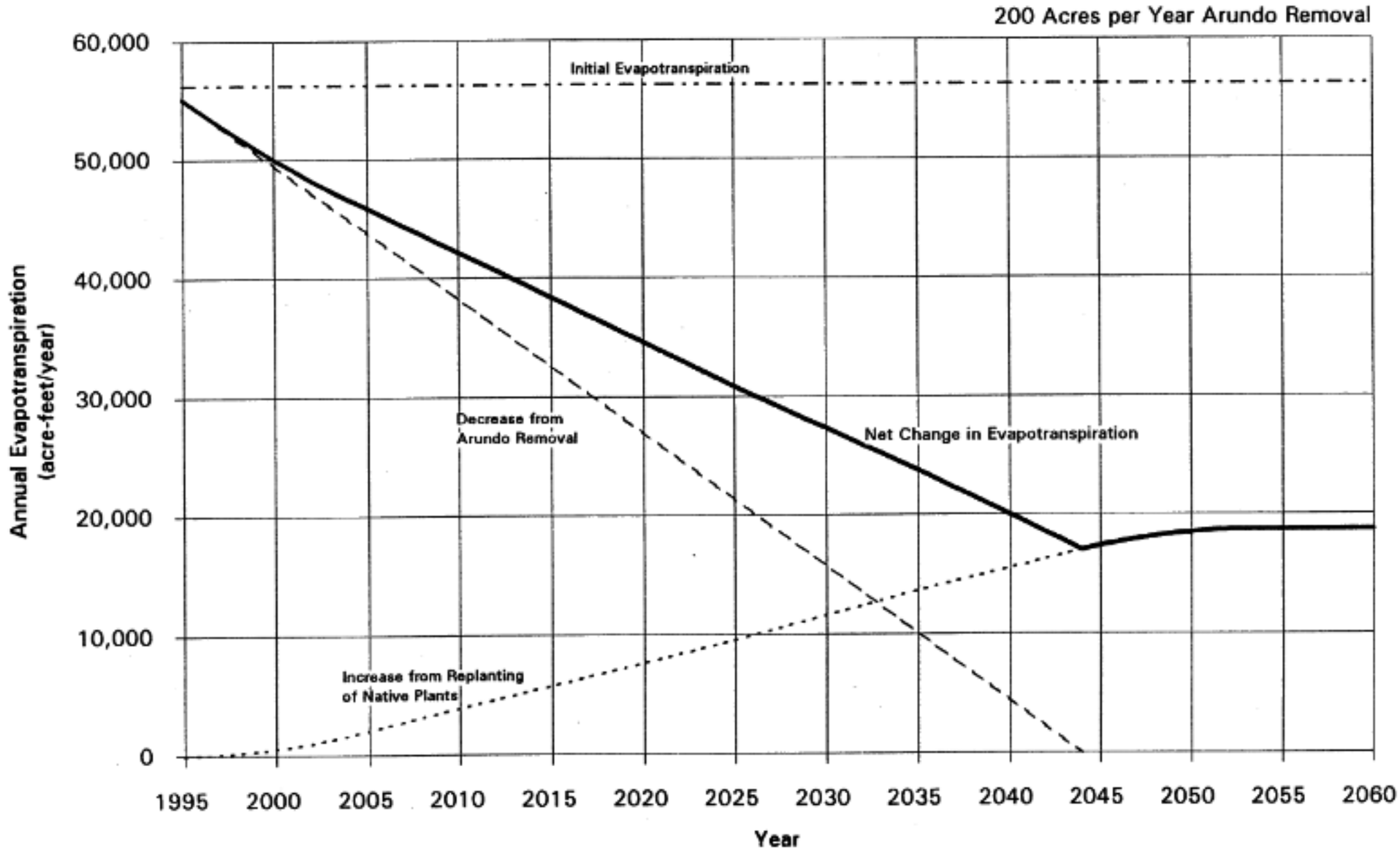


CHART 2
ESTIMATED ANNUAL VALUE OF WATER SAVED
FROM ARUNDO REMOVAL PROGRAM

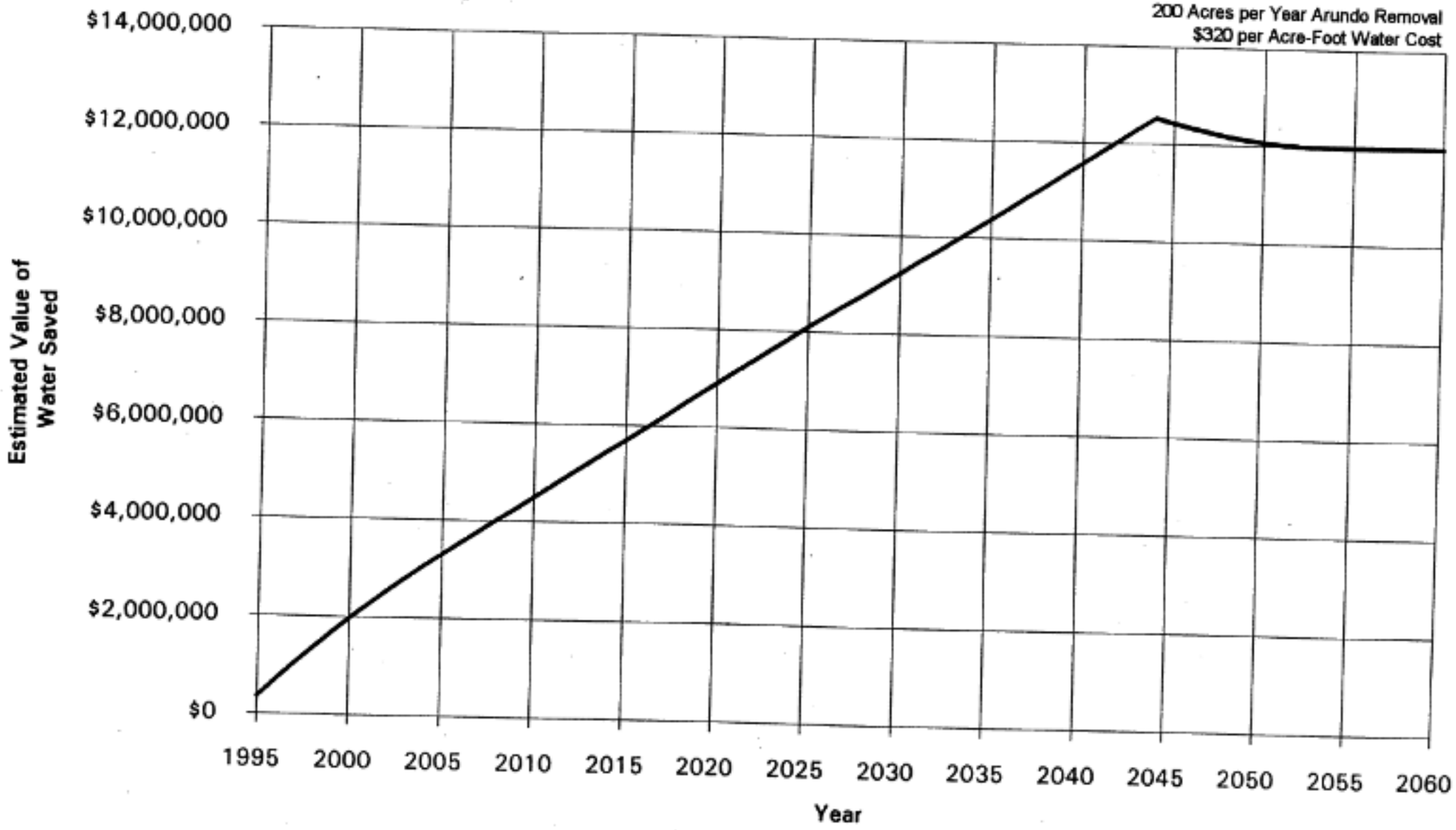


CHART 3
CHANGE IN ANNUAL EVAPOTRANSPIRATION WITH IMPLEMENTATION OF AN ARUNDO REMOVAL PROGRAM

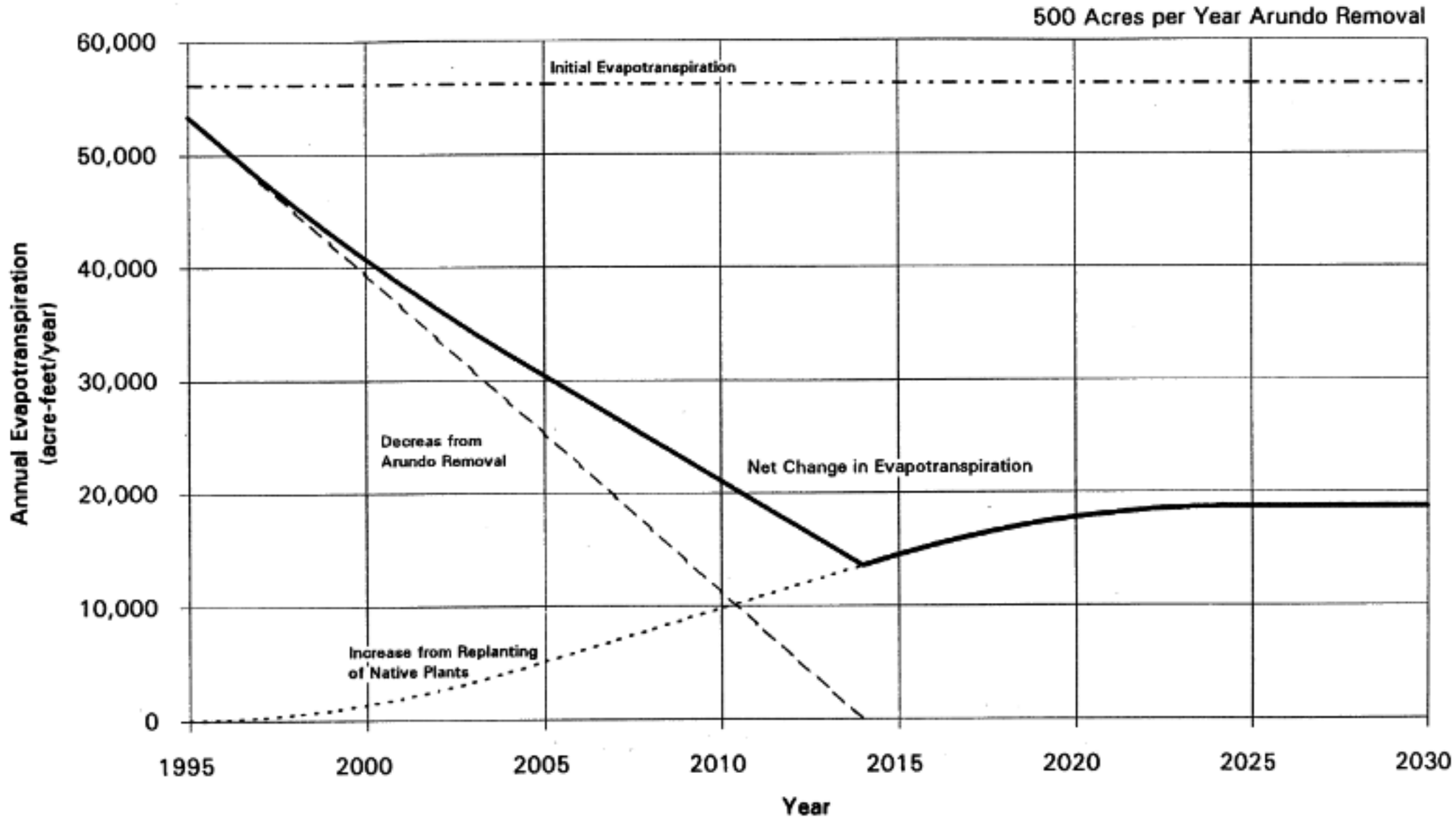
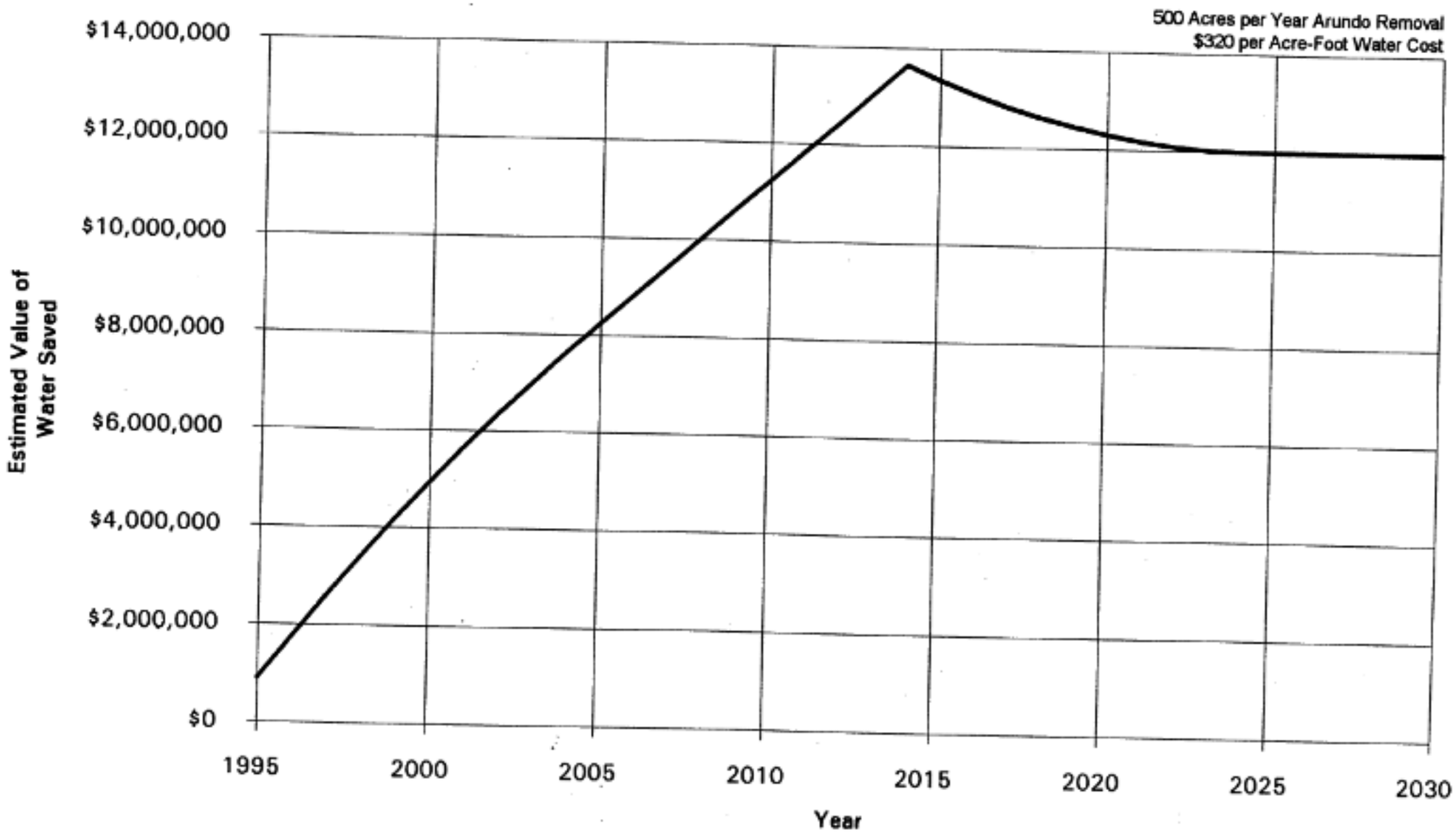


CHART 4
ESTIMATED ANNUAL VALUE OF WATER SAVED
FROM ARUNDO REMOVAL PROGRAM



CONTROL OF *ARUNDO DONAX*: TECHNIQUES AND PILOT PROJECT

BY

NELROY E. JACKSON

THE AGRICULTURAL GROUP, MONSANTO COMPANY

INTRODUCTION

Many exotic plants were introduced into California, with very admirable goals. Unfortunately, several of them that succeeded too well as colonizing species crowded out native species and degraded wildlife habitat. These exotic plants have become obstacles in native habitat restoration work. *Arundo donax*, also called giant reed or wild cane, is the exotic plant species discussed in this paper.

Arundo donax is estimated to infest up to 2,000 acres of the Santa Ana river basin in Southern California. This species introduced from the Mediterranean area, has become one of the most destructive exotic plants found in many of the riparian areas of central and southern California. In the last 20 years, *Arundo donax* has exploded to the point of adversely affecting many rivers and tributaries, and it has gained the attention and concern of those people who live in and enjoy California's native habitat.

The initial requirement for good weed management is to identify and classify the weeds to be controlled. Are they annuals or perennials? Or grasses, forbs, brush or trees? Or are they sprouters or re-sprouters? Do they grow primarily from seed?

Arundo donax is an exotic perennial grass species from the Gramineae family. It is a very rapidly spreading plant reaching upward of 25 - 30 feet tall often growing as much as 10 inches per day under ideal conditions. Because of its aggressive nature, Arundo produces large amounts of biomass. One single plant can have a root span of up to 40 feet in diameter. *Arundo donax* reproduces vegetatively from underground stem structures (rhizomes) and by stems rooting at the nodes along the stalk. It produces large, whitish plumes as flowers, 2 or more feet in length, in late summer and early fall; but, reproduction by seed is limited by low seed viability.

Details of the Pilot Project at the Van Buren Bridge in Riverside, California are given in a separate report.

METHODS OF WEED MANAGEMENT

There are essentially four methods of weed management -- mechanical, biological, competition, and chemical.

Mechanical weed control includes hand-pulling, digging, use of weed eaters, axes, machetes, bulldozers, and fire. These methods give effective control of annual grasses and forbs, but may not be efficient for removal of perennial weeds, brush, and trees. For example, after giant reed is cut, the plant simply regrows from corms and rhizomes. Hand labor is not always available and is costly unless it is volunteered.

When heavy equipment is used, soil is often disturbed with consequences such as bringing weed seed closer to the surface and disturbing invertebrates and other denizens of the ecosystem. In addition, some mechanical weed control methods do not give long-term weed control, are not cost-effective, and pose a substantial accident risk to humans.

Biological weed control is part of the ecosystem under climax natural stands of vegetation. However, it is rarely efficient or effective as a tool in destroying introduced exotic species. Because species were not introduced with their natural pests, specific agents have to be imported from the country of origin for each species. Biological pests tend to be more active on maturing rather than seedling plants; above all, what happens to this introduced agent after the exotic plant is controlled? It may seek alternate hosts that are desirable native species, rather than calmly enter a demise.

Good growth of desirable native species, once they are re-established, may compete effectively and crowd out exotic species. Unfortunately, at the start of a restoration project, the reverse situation exists -- where exotic and/or undesirable species have outgrown and out-competed desirable native species. Therefore, alternative methods of weed control have to be used to give the re-introduced or existing native species a chance to grow and prosper. After re-establishment, competition as a means of weed control achieves a high degree of success.

In most situations, weed control with herbicides is the most efficient and effective method of weed control for removal of exotic plants at the beginning of and during the restoration process. The chemical method allows regeneration and/or re-population of natives or re-vegetation with native species. The use of herbicides can be specific, selective and fast. The best method for removal of Arundo from infested areas is by utilizing all four methods in combination with each other.

WEED MANAGEMENT WITH HERBICIDES

The most critical step is the selection of an appropriate herbicide. Specific factors to be considered in a herbicide program are: efficacy, environmental safety, soil residual activity, operator safety, application timing, and cost-effectiveness. In most situations, the initial treatment in removal of exotic plants is post emergence to the weeds. Since pre-emergence herbicides may control seedlings of desirable species, post emergence treatment of seedlings is preferable in situations where growth from a seed source in the soil is a problem.

Roundup® and Rodeo® are efficacious broad spectrum post emergence herbicides that have no soil residual activity. Because of these properties and a favorable environmental profile, these herbicides are chosen most often for use by managers of native habitat restoration projects. Rodeo® is registered for use in aquatic sites, including estuaries and riparian areas, and may be applied to emerged weeds growing in water. These are critical factors in many native habitat restoration projects.

APPLICATION METHODS

Versatility of application methods is also important in the choice of herbicide. In the case of Roundup® and Rodeo®, these choices include: broadcast and spot treatment foliar sprays by ground equipment, cut stump treatments, wiper treatments, and aerial application where appropriate.

Roundup® and Rodeo® are trademarks of Monsanto Company. Always read and follow the label for each herbicide.

Chemical control has been found to be the most effective means of controlling Arundo. When herbicides are applied at the correct rates, control of the cane will be achieved. Sequential application will be necessary, but, in the long run, both the environmental and economical aspects of the project win in the end.

There are several conditions that have to be addressed when implementing an *Arundo donax* control program. First, the level of infestation at the site must be considered. A control program should be based upon whether the level of infestation is sparse, in isolated clumps, light, heavy, or in pure stands. A program directed at light infestations will be a failure if used for combating pure stands. A successful program will use the appropriate methods and tools for the appropriate level of infestation. Second, the correct method of treatment must be chosen for *Arundo donax* control. Several methods are available including foliar application by backpack, handgun or hand wand or by aerial application (fixed or rotor wing). Additionally, there is a cut-stump application. Many factors determine the method chosen including the infestation level, site geography, desirable non-target vegetation and wildlife, habitat of surrounding areas and general ease of the chosen control method.

APPLICATION RATES

The herbicides that are labeled for control of *Arundo donax* are in the glyphosate family: Roundup® Herbicide for terrestrial locations and Rodeo® Aquatic Herbicide for aquatic, riparian, estuarine and terrestrial areas where water may occur. Most often, Rodeo® herbicide will be used because *Arundo donax* is usually located near water.

Recommended application rates for Rodeo® and Roundup® herbicides are given below:

Rodeo® Aquatic Herbicide:

Spot Treatment: 1½% v/v Solution plus ½% v/v Nonionic Surfactant
Broadcast Treatment: 7½ Pts/Acre plus ½% v/v Nonionic Surfactant
Cut Stump Treatment: 100% v/v Solution (Full Strength)

Roundup® Herbicide:

Spot Treatment: 2% v/v solution
Broadcast Treatment: 5 Quarts/Acre
Cut Stump Treatment: 100% v/v Solution (Full Strength)

Some of the symptoms associated with glyphosate applications to Arundo are yellowing and browning of the leaves, death of the meristem (growing point), "abnormal" regrowth, multiple budding (grass-like shoots) and white leaves in new shoots. Any of these symptoms indicates that the herbicide has had an effect upon the plant.

Timing of application for optimal control is important. Best results from foliar applications of Rodeo® or Roundup® are obtained when the herbicides are applied in late summer to early fall, when the rate of downward translocation of glyphosate would be greatest. This is shown in the accompanying chart.

POST-SPRAY MANAGEMENT

When sufficient time has elapsed for the herbicide to kill the plant, there is a need to remove the large amount of biomass left on the site. Several alternatives are available. Burning may be possible when no danger of spreading fires will occur and when the necessary permits have been acquired. Chipping can be used, but needs to be properly disposed of or composted, due to rooting of pieces of nodes. Dead cane can be left to decompose on site, but large amounts of cane and low moisture and humidity may limit this alternative. Finally, removal of the cane from the site can be done. This is somewhat costly, and locations for disposal may not be available.

After initial application of either herbicide to *Arundo donax*, re-treatment of newly emerged giant reed and "escapes" that were missed during the first application will likely be necessary. This is due, in part, to the density of the viable root mass and the germination of non-committed rhizomes. The amount of re-treatment necessary in the second and third years will be drastically reduced, provided there is no re-invasion of giant reed.

Re-vegetation of the site may be done by either natural means or by planting native species.

ENVIRONMENTAL PROPERTIES OF ROUNDUP® AND RODEO® HERBICIDES

The active ingredient in both herbicides is the isopropylamine salt of glyphosate. Members of the glyphosate family of herbicides are probably the most widely tested, researched, and used herbicides throughout the world. The list of toxicological and environmental studies on glyphosate completed by agencies around the world is extensive.

The acute toxicity of glyphosate is relatively low, with an LD50 of greater than 5000 mg/kg. Long-term tests on laboratory animals show that glyphosate is not a teratogen (does not cause birth defects), is not a reproductive toxin, causes no effects to nerves or nerve functions, does not cause genetic effects, and is not a carcinogen. The Environmental Protection Agency (EPA) has classified glyphosate in Category E (evidence of non-carcinogenicity for humans), which is the most favorable rating possible.

After application of Roundup® or Rodeo® herbicides, glyphosate is bound by soil and organic matter. This binding makes glyphosate unavailable for herbicidal activity. Thus, subsequent germination of desirable native grasses, forbs, brush, and trees are not affected adversely.

SAFETY TO WILDLIFE

Of particular concern is the safety of a herbicide to wildlife, even when ingested, glyphosate is poorly absorbed through animal guts or intestines. Any product that is absorbed is rapidly eliminated. Furthermore, the metabolic pathway by which glyphosate affects plants, does not exist in animals.

The use of glyphosate for weed control has had positive effects on wildlife populations in native habitat restoration areas. Removal of exotic plants in flood control canals throughout California has led to increased water flow, reduction in rodents, increases in fish spawn, and increases in migratory birds. In Orange County, herbicide treatments are not made during the nesting season for endangered bird species such as the least Bell's vireo. Cover is provided; grasses allowed to mature and birds to fledge, before

herbicide applications are made. Thus, the channels are cleaned before the rainy season in the fall, allowing for flood control protection of residents along river basins, and still providing enhanced habitat.

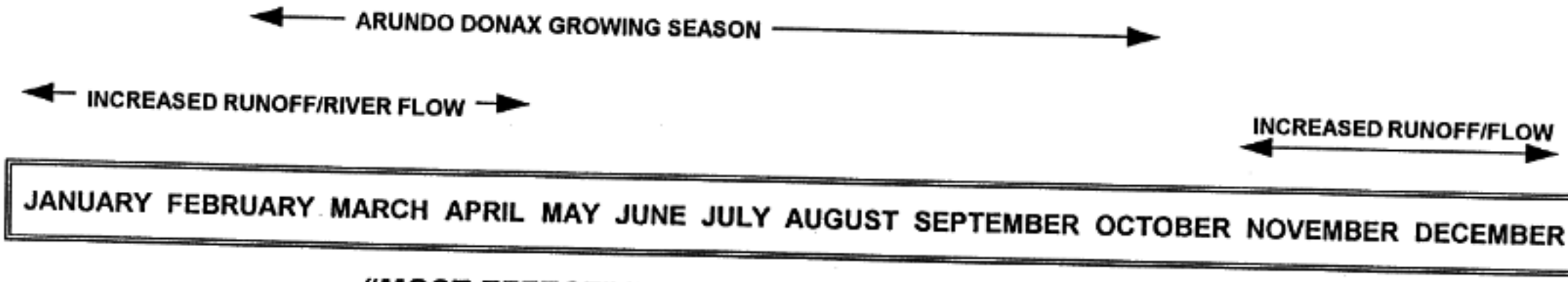
SUMMARY

Chemical weed control is the optimal method for control and removal of exotic plant species during the establishment and improvement of most native habitat restoration projects. Roundup® and Rodeo® herbicides are the products most often chosen by managers of native habitat restoration projects because these herbicides are efficacious and cost-effective, with favorable environmental and toxicological properties.

Rodeo® and Roundup® herbicides may be used effectively to control infestations of *Arundo donax*, within a defined management plan. The products may be applied by hand or aerial, as a foliar or as a Cut-Stump treatment. Post-spray management includes re-treatment of escapes and new growth in subsequent years, while saving desirable plants, protecting animal life, enhancing wildlife habitat and protecting water quality in riparian, estuarine and terrestrial areas.

The most desirable weed management in native habitat restoration projects may utilize a combination of chemical, mechanical, biological, and competitive methods. Long-term, healthy competition from the desired species, coupled with chemical control of any re-invading exotic plants may be the optimal program. Good growth of desirable native species, once they are re-established, will crowd out exotic species. In any given project, the best combination of tools should be selected and molded into a viable weed management program.

"ARUNDO DONAX REMOVAL TIMELINES"



TEAM ARUNDO: AN INTERGENCY SUCCESS STORY

by Paul Frandsen
Team Arundo

Arundo donax, or giant cane, does not seem to appreciate political or ownership boundaries along the Santa Ana River, and in fact, in many of the rivers in the State of California. Team Arundo arose out of the need to match a very aggressive plant spread in one river basin--the Santa Ana River.

Efforts had been made to come to grips with the effects of the plant but nothing had "jelled" until the concept of bringing together many of the "stakeholders." The Nature Conservancy (TNC) and the California Department of Forestry and Fire Protection (CDF) had independently begun work on a program to remove cane from the river for different reasons--The Nature Conservancy to save habitat and CDF to reduce wildfires in the river bottom. These two agencies were not able to make progress since they did not include the key owners, users or controllers of the river. Without a broader base, little action could take place.

From telephone conversations between TNC and CDF, a meeting took place with many organizations involved in some way with the river. Organizations at all levels of government, city, county, state and federal were approached to discuss this one plant in the river. From this early scoping meeting, seventeen agencies (nonprofits, special districts, a joint-powers authority, a citizen conservation organization and one private company) formed the TEAM. As the meetings progressed, other agencies or potential partners were invited.

For those who were not at the Workshop, some additional background might help. The Santa Ana River is infected with cane mostly in mid river and on parkland down to Prado Basin. But, the problem had grown to such proportions that other parts were also infected. Since the plant spread by vegetative cuttings, as long as cane existed upstream, the downstream agencies would forever have had an impossible task to clear the river, even if they wanted to.

After finding that many agencies and others had a stake in the river being filled with cane, information was shared about the plant, where it came from, how it spread and what effects it had on different agencies. It became apparent that attempts to remove cane had been expensive failures, and costly restoration projects failed.

The TEAM had to be based on a series of needs: flood control, therefore all three Flood Control Districts were invited; wildfire, so CDF was invited; and later the city of Riverside Fire Department. The other obvious need was protection of habitat for endangered species living in the remaining natural parts of the river. It took time to understand that the plant had other impacts that might turn out to be vital to the success of the program; i.e., water conservation and mitigation needs of various agencies. So the main reasons for inviting agency representatives were based on wildfires, flood damage, impact to key riparian habitat and water conservation. Each "theme" had a constituency and set of needs and problems to solve. Each agency brought a need that had to be addressed.

The four themes had to be formed around the ownership of the river, the regulatory agencies and users. Each theme in some way touched one or more of the members but not all shared the entire set of problems. The meetings became a trading ground for concerns and opportunities. In fact, some members feel the meeting had made important inroads in key areas like acceptance of herbicide, use of hand crews, use of machinery and new rules for removal of exotic plants and others.

It took months of information exchange and getting to know each other before a true team started to form. A target was needed that would bring the members together and get something done. Planning was not enough for a goal. A pilot site was suggested that would give us a chance to practice removal techniques, get to know each other and show the community that something was about to happen.

The site picked was at the Van Buren Bridge in Riverside. It was surrounded by cane and had periodic fires. Other problems also had to be addressed. Thousands of people saw the river, or a slim part of it, each day. Some members provided staff, time, funding, machinery, trucks, Rodeo and tools. It was enough to break down more barriers and agency representatives became real people to each other.

Another target was selected, a large Urban Streams Grant. This again forced members to do something to keep the TEAM alive. Since money was going to be a major factor in the success of removing cane, we had to find a source. The grant gave us a focus of what we were proposing and the cost to remove the cane.

A major problem was unfolding. The environmental regulations prevented us from using large machinery to clear the river of cane. Also, the regulatory agencies had traditionally used fixed acres for restoration for mitigation from impacts to riparian habitat loss. We heard examples of expensive restoration sites washed out or not properly maintained and soon returned to cane. After a series of meetings, the rules were discussed and a new approach was developing by the regulators to allow for some kinds of mitigation to come to the TEAM. Also, the TEAM began work on necessary permits to use machinery to remove cane.

Mitigation was the first avenue for funds. Once the resource agencies saw a viable alternative to fixed restoration projects and a willingness of the TEAM to maximize dollars, funds began to line up. But, a major problem still exists in that some rules need to be changed and new agreements forged. All parties had to look beyond their own position to see how the entire watershed works and its effect on others.

Mitigation was not the only game in town. When a wildfire roared down the river on a cold November evening, it was the pilot project at the Van Buren Bridge that allowed CDF to stop the fire from moving down the entire river. CDF increased its support and made the removal of cane a higher priority than it had been.

Water conservation became another key to solve the problem of funds. I called an agronomist, formerly with the UC system, and asked him to develop the water use of the plant. He reported that cane takes up to three times as much as the native plants do . . . This was a major breakthrough for the project. With this new information, a presentation was made to the Santa Ana River Watershed Project Authority and senior management at the Orange County Water District. Calls were also made to staff at The Metropolitan Water District for help to understand the value of water.

The TEAM needed some special talents that all, in some way, brought to the table. Whether it was biological, use of machinery, water knowledge, herbicide use, expertise for spraying, access to some important information or one of literally scores of needs, someone on the TEAM had it or could go back to his or her organization and find it.

Several efforts are currently underway. An agreement to bind us together is being developed. A "Menu" was developed to explain the best way to remove cane and keep it out, and a larger project area was selected and sprayed using a helicopter. TEAM members began speaking at professional conferences and contacts were made with local and regional press. Currently, we are beginning the permit process to remove on an additional 100 acres of cane. Additionally, other projects along the river have a component that removes cane.

We then added another target for ourselves, we hosted a workshop on killing cane. Members were asked to organize and be speakers. This proceeding is one product of that effort. The goal was to spread the news about this one plant and provide a model for solving a very complex problem.

The TEAM is a forum for solving, trading and supporting each other. It is not always so since new people appear, some members come and go, but a strength has developed. An entire network has been created to stop one plant. Ways of doing maintenance are changing, new agreements have been made, recognition that a serious problem exists and that only through a cooperative approach can a solution be found.

If you are interested in forming a team to solve a similar problem, keep in mind who has a stake, who controls which parts of the problem, whose land it is on, what are the missions of the core agencies. Think of how to get wider involvement, how to work with the press and the community and, of course, define the problem and do your homework. Find someone who understands the limitations and opportunities of major problems and find and advocate within the agency.

Cane in the Santa Ana River is a huge problem. Time will tell whether TEAM ARUNDO will control ***the plant from Hell*** or just be another bureaucratic attempt to solve an impossible problem. The format of the meetings is one of the tradeoffs and openings with the hope to make things happen. Support is evident, and daily examples of shared interest or negotiations are taking place. The problem of removing cane is not very difficult. Getting so many stakeholders to work together and find individual or organization benefit is.

Restoring some or all of the river is a people-caused problem, and people have to have some reason to follow it. Most reasons will include self-interest, many levels of agendas, changing of old ways and may include painful decisions. While our group may serve as a model, it really points to the fact that our society has such fragmented power over the biological world that it is almost impossible to change the course we are now on.

Regional and national rules may have to change to find watershed-wide solutions. Single species protection and mitigation has not been successful, but a wider approach may. Powerful forces have brought our one river to its present condition, and often the same one must change course to make corrections.

TEAM ARUNDO is still a young group finding its way. It is being recognized as the only such group in the watershed and evidently in the state. While the TEAM is successful in many ways, it has a long way to go. The proof will be in clearing hundreds of acres of cane each year. But, this is the beginning of a new approach that has to work if we are going to save and protect our waterways in California.

SECTION 404 PERMITS: NEEDS AND PROCESSES

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Introduction. The U.S. Army Corps of Engineers operates under a number of regulatory authorities. The most likely ones for the public to encounter are the following:

- Section 10 of the Rivers and Harbors Act of 1899.
- Section 103 of the Ocean Marine Protection and Sanctuaries Act of 1972 ("Ocean Dumping Act").
- Section 404 of the Clean Water Act.

In southern California, if your project does not involve tidal waters or the Colorado River, Corps regulatory involvement normally is through Section 404 of the Clean Water Act (404).

The following pages will describe the 404 regulatory permit program in general, the various types of permits and permitting processes, and recent and proposed future changes to the Corps' program as a result of the Clinton Administration's wetland initiatives. The relevance of these issues to *Arundo* control will be highlighted.

Section 404 and *Arundo* Control. Section 404 of the Clean Water Act authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits for the discharge of dredged or fill material into the waters of the United States. To understand this permit program in terms of *Arundo* control, a few definitions would probably be helpful:

- **"Fill material"** means any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a waterbody. It does not include pollutants discharged into the water primarily to dispose of waste.

- **"Discharge of fill material"** means the addition of fill material into waters of the United States. Examples of such discharges are site-development fills for houses or other structures in waters of the United States; causeways or road fills; levees; bank protection structures such as riprap; and concrete channel liners.

- **"Waters of the United States"** means all waters which are currently used, or were used in the past, or may be susceptible to use in the future in interstate or foreign commerce. This includes all waters which are subject to the ebb and flow of the tide; all interstate waters, including interstate wetlands; all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce, including any such waters associated with interstate commerce; tributaries of the aforementioned; the territorial seas; and wetlands adjacent to waters of the United States.

Since a channel does not have to flow year-round or have vegetation to be a "water of the United States", desert washes are within jurisdiction as a type of intermittent stream. The lateral limit of jurisdiction in non-tidal waters is the limit of wetlands, if wetlands are present; in the absence of wetlands, the limit is the ordinary high water mark. There is no upstream limit.

- **"Ordinary high water mark"** is defined as that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means.

- **"Wetlands"** means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Under the 404 program, to be a wetland under the jurisdiction of the Corps a site must exhibit evidence of hydric soils, hydrophytic vegetation and hydrology as prescribed in the 1987 Corps Wetlands Delineation Manual.

To translate the above to the context of *Arundo* control, measures used to control *Arundo* can involve a discharge of fill material into waters of the United States, and therefore require authorization from the Corps of Engineers. If the *Arundo* is in wetlands or within the ordinary high water mark of a channel, it is in a water of the United States, and therefore in an area under the jurisdiction of the Corps of Engineers. Use of heavy mechanized equipment within a water of the United States is considered to cause a discharge of fill. This discharge and any associated excavation activity within waters of the United States would be regulated by the Corps of Engineers.

Permit Decisions and Processes.

Decision Factors. In order for the Corps to issue a 404 permit, the activity requiring authorization must meet two important tests. It must (1) comply with the 404(b)(1) Guidelines and (2) be determined not contrary to the public interest. No permit can be issued if either of these tests is not met.

The 404(b)(1) Guidelines describe a set of procedures which the Corps must use to evaluate whether a particular discharge (fill) site can be authorized. There are four basic sets of evaluation criteria:

1) Alternatives analysis. The guidelines require that the Corps permit only the least-environmentally-damaging practicable alternative that meets the overall project purpose.

2) Water quality, endangered species and sanctuaries. State water quality certification or waiver must be obtained; endangered species considerations must be resolved; and limitations on activities in sanctuaries and refuges must be met.

3) Significance of degradation. The project, including all proposed mitigation measures, must not significantly degrade waters of the United States.

4) Minimizing adverse effects. The project must include all appropriate mitigation. In addition, as clarified in a 1990 Memorandum of Agreement (MOA) between the U.S. Environmental Protection Agency (EPA) and the Corps, mitigation measures are to be

considered in the order of avoidance of impacts, minimization of impacts and, last, compensation for unavoidable impacts.

The Corps' decision to issue or deny a permit, in addition to compliance with the 404(b)(1) Guidelines, is based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest. The benefits which reasonably may be expected to accrue from an applicants's proposal are balanced against its reasonably foreseeable adverse impacts. All factors, environmental or otherwise, which may be relevant to a particular proposal and the needs and welfare of the public, are considered. If a project satisfies the 404(b)(1) Guidelines, a permit may still be denied if the district engineer determines that the proposed project would be contrary to the public interest.

Forms of Authorization. There are two basic types of Corps authorizations, with several subsets of each type:

General Permits are issued for a category of similar activities, rather than for individual projects. General Permits include nationwide permits (NWPs), regional permits and state programmatic general permits. Currently in the Los Angeles District we have no state programmatic general permits and only two regional permits. However, hundreds of projects are authorized under NWPs. In fact, by far the majority of authorizations issued in the Los Angeles District are through the nationwide permit program.

NWPs are designed to regulate with little, if any, delay or paperwork certain activities having minimal impacts. There are 36 nationwide permits in effect now, authorizing fills in waters of the United States required for such activities as the installation of scientific measurement devices, construction of minor road crossings, certain bank stabilization activities, installation of utility lines and limited fills in certain wetlands. All nationwide permits, in addition to requiring that the activity in question fit within particular limits of work, require compliance with a number of standard terms and conditions; activity-specific conditions are required in some cases as well. All terms and conditions must be met for the authorization to be valid. Some nationwide permits require the Corps to coordinate with other agencies, such as the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service and California Fish and Game, before deciding whether the work qualifies for authorization under the NWP program. Others do not even require the applicant to contact the Corps before beginning work. None of the NWPs require general public review or public notice of individual projects. However, in all cases the impacts of work proposed for authorization under a NWP must be minimal. If an activity meets fits within the description of an activity covered under a NWP, but the impacts of the activity are not minimal, it cannot be authorized under this program.

By far the most controversial NWP is #26, which authorizes discharges of dredged or fill material into up to 10 acres of headwaters and isolated waters of the United States, including wetlands. Headwaters are defined as non-tidal rivers, streams, and their lakes and impoundments, including adjacent wetlands, that are part of a surface tributary system to an interstate or navigable water of the United States upstream of the point on the river or stream at which the average annual flow is less than five cubic feet per second. Because of the hydrological nature of our southern California systems, the majority of a water in a channel or

other watercourse typically lies above headwaters. This gives a tremendous number of projects the possibility of being authorized without general public review.

Individual Permits consist of Letters of Permission and Standard Permits and are issued for particular projects, rather than for categories of activities. The Letter of Permission is issued after an abbreviated evaluation procedure that involves coordination with State and Federal fish and wildlife agencies, a public interest evaluation, but no public notice. At this time Los Angeles District does not issue Letters of Permission for Section 404 activities.

Standard permits are issued after individual project review and documentation. They require issuance of a public notice (usually circulated for 30 days), preparation of an Environmental Assessment or Environmental Impact Statement, a 404(b)(1) Guidelines compliance evaluation and a Statement of Findings or Record of Decision.

Recent Changes in the Corps' Regulatory Program and Their Implications to *Arundo* Control. On August 24, 1993 the Clinton Administration announced a comprehensive package of improvements intended to improve the efficiency and effectiveness of Federal wetlands protection programs. The Administration's announcement included the following Five Principles for Wetlands Policy:

1) **No net loss/long-term wetlands gain.** The Administration supports the interim goal of no overall net loss of the Nation's remaining wetlands, and the long-term goal of increasing the quality and quantity of the nation's wetlands resource base.

2) **Fair, flexible, effective, efficient and predictable regulatory programs.** Regulatory programs must be efficient, fair, flexible and predictable and must be administered in a manner that avoids unnecessary impacts upon private property and the regulated public, and minimizes those effects that cannot be avoided, while providing effective protection for wetlands. Duplication among regulatory agencies must be avoided and the public must have a clear understanding of regulatory requirements and various agency roles.

3) **Encourage protection of wetlands through non-regulatory means.** Non-regulatory programs, such as advance planning, wetlands restoration, inventory and research and public/private cooperative efforts must be encouraged to reduce the Federal government's reliance upon regulatory programs as the primary means to protect wetlands resources and to accomplish long-term wetlands gains.

4) **Partnering and ecosystem/watershed approach.** The Federal government should expand partnerships with State, Tribal and local governments, the private sector and individual citizens and approach wetlands protection and restoration in an ecosystem/watershed context;

5) **Base policy on science.** Federal wetlands policy should be based upon the best scientific information available.

Approximately forty changes to the existing wetlands program were proposed. Some of these initiatives have already been implemented or are in the process of being implemented; others will

require rulemaking or legislative action before they can take effect. Many of them are not relevant or are perhaps only marginally relevant to the *Arundo* problem. However, some clearly have potential applications to *Arundo* control programs. Chief among these are

• So-Called "Excavation Rule". This change in Corps regulations, effective September 24, 1993, contains three clarifications of the term "discharge of dredged material": 1) the discharge of dredged material subject to Section 404 regulation includes discharges incidental to mechanized landclearing, ditching, channelization, or other excavation activities that destroy or degrade waters of the United States; 2) the discharge of fill material subject to Section 404 regulation includes activities that involve non-traditional use of pilings; and 3) prior converted croplands are not waters of the United States.

Probably only the first clarification is pertinent to *Arundo* control. When *Arundo* is cut by hand-held equipment, no authorization from the Corps is required, because the surface of the soil is not disturbed. However, when heavy equipment is used to remove the *Arundo* by excavating it from a channel or wetland, a permit almost always will be required. The only time a permit will not be required for this kind of work will be if the person preparing to undertake this kind of excavation activity can demonstrate to the satisfaction of the Corps, or EPA as appropriate, that the activity would not have the effect of destroying or degrading a water of the United States. An activity associated with a discharge of dredged material degrades an area of waters of the United States if it has more than a *de minimis* (i.e., inconsequential) effect on the area, causing an identifiable individual or cumulative adverse impact on any aquatic function. At this time the phrase "identifiable adverse impacts" has not been defined; it will be determined on a case-by-case basis. However, we have been told that the standard of identifiable adverse impacts is intended to be very low, i.e., very minor adverse impacts will trigger regulation. Examples of adverse impacts would include an adverse alternation of an area's hydrologic regime or alteration of the type, distribution or diversity of aquatic vegetation.

The "excavation rule" formally creates new categories of regulated activities for the Corps and the general public, and therefore potentially more paperwork for both. The Corps is taking at least two measures to ease this burden. First, there is a "grandfathering provision" in the regulation. This says that anyone who had underway a discharge of fill associated with ditching, channelization or other excavation activity in waters of the United States for which 404 authorization was not previously required or who was under contract for such excavation on August 25, 1993 is exempt from the need to obtain Corps authorization, provided that the excavation activity is completed by August 25, 1994. This "grandfathering" does not apply, however, to discharges associated with mechanized landclearing. Second, the Corps intends to develop general permits for discharges associated with excavation activities that have minimal impacts on the aquatic environment. *Arundo* removal would probably be a good candidate for a general permit.

• Deadlines for wetlands permitting decisions. To ensure that permit decisions are made without unnecessary delay, the Corps is to establish deadlines for wetlands permitting decisions under the Clean Water Act. The initial Corps proposal is that a permit decision will be made within 90 days, unless a longer period is required by other laws, such as the National Environmental Policy Act or the Endangered Species Act. For *Arundo* work that requires a

permit, it appears then that there will be definite time frames that the public can rely upon to have a permit decision. This should facilitate planning efforts.

• Guidance to Corps/EPA field staff on flexibility. The Corps and the EPA issued joint guidance to their field staffs in August 1993 affirming that flexibility exists to apply less rigorous permit review to small projects with minor environmental impacts.

• Endorsement of mitigation banks. The Administration has endorsed its use as a means to increase the predictability and environmental effectiveness of the Clean Water Act regulatory program and to help attain the goal of no overall net loss of wetlands.

• Incentives for state and local watershed planning. The Administration supports incentives for States and localities to engage in watershed planning, to reduce the conflict that can result between wetlands protection and development when permit land use decisions are made on a permit-by-permit basis.

• Promote restoration of damaged wetland areas through voluntary, non-regulatory programs. This is intended to help attain the Administration's long-term goal of increasing the quantity and quality of the nation's wetlands. Perhaps there may be ways to effect *Arundo* removal through this initiative, since surely an *Arundo*-infested wetland is a "damaged wetland".

• Administrative appeals process. Regulations will be proposed to allow individuals to appeal wetlands jurisdictional determinations, permit denials and administrative penalty enforcement actions. Currently, the only recourse available to members of the public who wish to challenge regulatory decisions is the expensive route of a lawsuit.

• Revisions to NWP 26. Regional conditions will be developed with which all activities authorized under this NWP must then comply. The intent of these conditions will be to increase protection of valuable aquatic resources.

Conclusion. *Arundo* removal and control can require a permit from the Corps of Engineers under Section 404 of the Clean Water Act. Depending on the location and scale of the activity and sometimes other site-specific factors, the authorization required may be in the form of a nationwide general permit or the longer process of a standard individual permit. Recent and proposed changes to the program should bring a more efficient and effective permitting program that facilitates the permitting process for the public while providing increased protection for the nation's wetland resources. Programs to control *Arundo* may benefit from several of these changes.

WETLAND MITIGATION BANKING IN THE U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

by

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1. EXECUTIVE SUMMARY

Extensive loss of wetlands in the United States have led to enactment of federal and state legislation for protection of wetlands. The Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1972 (CWA), are the two main legislation for regulation of activities involving wetlands. Regulation of activities within wetlands under Section 404 of the CWA follows a sequencing procedure of avoidance, minimization of impacts, and compensatory mitigation in cases where the loss can not be avoided.

Wetland mitigation banking is an innovative resource management tool which provides an alternative to the project-by-project compensatory mitigation. A wetland mitigation bank is a mitigation area, where, various projects fulfill their mitigation requirement by purchasing credits from an established mitigation site. Theoretical benefits of this concept include improved planning and efforts of the restoration projects, restoration and creation of a larger more contiguous wetland, and a more cost-effective approach to the mitigation requirement.

The U.S. Army Corps of Engineers (Corps), Los Angeles District, is currently evaluating this management policy for applicability to its the regional regulatory program. The Corps is working with the Team Arundo to assist them in establishing the Santa Ana River restoration projects as a fee-based compensatory mitigation. As the restoration continues in advance of impacts, the goal is to establish a wetland mitigation bank. The overall goal of this project is to achieve restoration of a significant habitat through an innovative resource management concept.

2. INTRODUCTION

The term "wetland" encompasses a variety of complex ecosystems which are intermediate between terrestrial and aquatic habitats, where the water level is above the surface of the land for sufficient duration to result in development of hydric soils and hydrophytic vegetation (Mitsch & Gosselink, 1986; Etherington, 1983). Wetlands include freshwater and saltwater marshes, estuaries, freshwater riparian woodlands, prairie potholes, and vernal pools.

Regulatory definition of wetlands used by the EPA and the Corps for Section 404 permits:

> Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swaps, marshes, bogs, and similar areas (33 CFR Part 328.3 and 40 CFR Part 230.3).

Although there are many definitions of wetlands they all point to wetlands as an important ecosystems in terms of their ecological functions, and their human-use values. The functions and values of wetlands include the following:

- provide habitat for numerous animal and plant species including one third of the listed endangered and threatened species in the United States, roosting and foraging for migratory birds, spawning areas for fish, therefore helping to maintain a viable population size;
- improve water quality by retaining sediments, processing organic matter, and removing toxins;
- groundwater recharge and discharge;
- provide flood protection, by providing a buffer zone to retain the runoff water and vegetation to store floodwater water;
- provide erosion control, by reducing the impact of high energy waves; and
- provide recreational, aesthetic and psychological values for human beings.

3.0 REGULATIONS FOR PROTECTION OF WETLANDS

- The River and Harbor Act of 1899: Section 10 of this Act prohibits structures, such as any work to change the course, capacity, and condition of navigable waters of the U.S., including excavation and deposition of material into navigable waters , without obtaining a permit from the Corps. Navigable waters is defined as "...those waters of the United States that are subject to the ebb and flow of the tide shoreward to the mean high water mark and/or are presently used, or have been used in the past, or may be susceptible to use to transport interstate or foreign commerce" (33 CFR Part 322.2(a)). Although this is the oldest legislation regulating activities in wetlands, until the late 1960's the Corps restricted its regulatory authority to navigation issues.

- U.S. Fish and Wildlife Coordination Act of 1958: Recognizing the wildlife contribution as a national resource, this act had a significant effect on wetland protection. In 1967 a Memorandum of Understanding (MOU) between the Secretary of the Army and the Secretary of Interior developed procedures for the Corps to obtain and consider recommendations from the U.S. Fish and Wildlife Service for projects under the Corps permitting (Section 10 of the River and Harbor Act and

subsequently Section 404 of the Clean Water Act). This is the first act that requires the Corps to consider mitigation recommendations for loss of fish and wildlife in their permit decision making process.

- The National Environmental Policy Act of 1969 (NEPA): Section 102(2)(C) of NEPA requires the federal agencies to prepare a detailed document for projects requiring any federal action which includes issuance of federal permit, to describe the environmental impacts of an activity and the alternatives of the proposed project. The effect of NEPA is to consider environmental impacts of a project in addition to economic and technical issues. NEPA requires coordination of activities between federal agencies with jurisdictional authority over the proposed project and its impacts. The Environmental Impact Statement (EIS) is subject to review and comment by the general public and public interest groups in addition to the government agencies. Consequently, activities involving wetlands that require a permit are subject to an environmental assessment and coordination with other government agencies, public review and comments. All permit actions issued by the Corps must perform an environmental assessment that consider alternatives to the proposed project and go through public review and comment consideration.

- The Federal Water Pollution Control Act of 1972 (The Clean Water Act): Section 404 of this Act requires a Department of the Army permit for discharge of dredged or fill material into the waters of the U.S. that include all surface tributaries, isolated waters, adjacent wetlands, and territorial seas. The Environmental Protection Agency (EPA) in cooperation with the Corps developed guidelines that establish specific criteria to be met prior to permitting under Section 404 of the Clean Water Act. The guidelines require selection of the least environmentally damaging, practicable alternative. Practicability is determined based on the available technology, cost and logistics. Determination of logistics of a project is based on whether a project is water dependent. If a project is determined to be water dependent, the impacts must by minimized prior to consideration of compensatory mitigation. The 404(b)(1) Guidelines for the first time provided the basis for requiring compensatory mitigation, however, the steps were not clear until the 1990 MOA. In 1988, a Memorandum of Agreement between the EPA and the Corps established a sequencing procedure to be followed before issuance of a permit. The sequence of steps in any permit decision is 1) a determination that the loss of wetland can not be avoided, 2) the loss can not be minimized, and 3) the loss must be mitigated. Currently, the regulatory procedure for protection of wetlands is based on the three tier step of avoidance, minimization, or compensatory mitigation. Section 401 of the Clean Water Act requires obtaining a water quality certificate prior to issuance of a Department of Army permit to discharge dredged or fill material into waters of the U.S. The water quality certificate is issued by the state water quality board to ensure the proposed activity does not interfere with the beneficial uses of waters. Therefore, in California this is one of the two ways by which the state is involved in wetland regulation.

- The Executive Order 11988 - Floodplain Management: This directive issued in 1977 discourages filling of wetlands that are subject to flooding and requires agencies with authority to provide guidance to applicants prior to submittal of the application.

- Executive Order 11990 - Protection of Wetlands: In 1977 this directive issued by the president directed all federal agencies to minimize loss of wetlands and to preserve and enhance the beneficial values of wetlands.

These executive orders add additional power to the regulatory authorities of the existing regulations.

4.0 Mitigation

The Council on Environmental Quality (CEQ) defines mitigation as avoidance, minimization, rectifying, reducing, or compensating for the impact by providing substitute resources or environments. In evaluating permit applications under Section 404 of the Clean Water Act, the Corps follows the sequencing procedure as established by the 404 (b)(1) Guidelines and the 1990 MOA between the Corps and the EPA. Traditionally, project-by-project compensatory mitigation has been the means of achieving "no net loss" of wetlands when impacts are determined to be unavoidable, and minimized. Technical and regulatory limitations of project-by-project mitigation has prompted attention to other resource management options such as wetland mitigation banking.

5.0 Wetland Mitigation Banking

The concept of wetland mitigation banking is creation, restoration, enhancement, or preservation of a large wetland, offsite, with equivalent functions and values, prior to loss of the wetland (Reppert, 1992). The functions and values of the wetland, called credits, which are typically in form of acres of restored habitat, can then be withdrawn or debited to compensate for unavoidable wetland losses. Wetland mitigation banks are considered to be beneficial for replacement of small wetland losses by creating a larger, more successful wetlands.

The major objectives of the wetland mitigation banks are:

- To replace the same range of functions and values as the wetlands impacted and provide no net loss.
- Improve the effectiveness of off-site mitigation by creating larger, contiguous, sustainable wetlands.
- To meet the national goal of "no net loss" of wetlands.
- To reduce the technical, logistic, and administrative difficulties for the developers and the regulators.

In 1991 the EPA's Region IX developed guidelines for the creation and operation of wetland mitigation banks to assist the Corps in the establishment of mitigation banks

while meeting the goals of the Clean Water Act. The EPA's mitigation banking guidelines accept mitigation banking as compensatory mitigation and emphasize compliance with the pertinent environmental regulations, the 404(b)(1), and the 1990 MOA sequencing procedure to avoid, minimize and provide compensatory mitigation. The EPA Guidance also stresses that wetland mitigation banks may be considered as acceptable compensatory mitigation when on-site mitigation is determined not to be practicable. A minimum of 1:1 replacement of wetlands is recommended and depending on the likelihood of habitat loss, the functions and values of the impacted wetlands, and time delay factors a higher compensatory requirement may be used.

5.1 Types of Mitigation Banks

Mitigation banks are classified mainly on the basis of sponsorship or funding to create the banks. There are three major categories of mitigation banks.

a. Dedicated or private banks: This type of mitigation bank is sponsored by a public agency or private sponsors for a specific type of activity. This type includes the transportation mitigation banks, Port authority sponsored mitigation banks, and Industrial banks. For example, the transportation banks are established by Highway authorities for compensation of wetland losses that occur as a result of highway construction activities. The Transportation agencies provide funds and the land title to a natural resource agency to create, enhance, or restore a wetland to compensate for wetland losses incurred by highway projects. This type of bank can only be used for compensation of the sponsoring company.

b. Commercial Banks: The privately sponsored commercial banks are established by private developers to compensate for mitigation requirements of projects with different sponsors and various activities. The banks are created with cooperation and involvement of resource agencies that establish a crediting system to fulfill the mitigation requirements of permittees.

5.2 Wetland Mitigation Trusts

Wetland mitigation trusts are also referred to as fee-based-compensatory mitigation, where there is after-the-fact creation of wetlands. Therefore, it is not considered a mitigation bank. Wetlands are established by funds collected from permittees to fulfill various compensatory requirements.

5.3 Establishment of Wetland Mitigation Banks

Establishment of a wetland mitigation bank generally is by a memorandum of agreement between the sponsor, U.S. Army Corps of Engineers, and other resource agencies having a role in the establishment of the bank. The memorandum of agreement identifies the bank sponsor, specifies the roles of the participating parties, the geographic area of the

bank, method of restoration and creation, monitoring requirements, success criteria for the site, and requirements for protection of the wetland mitigation bank in perpetuity.

The Corps in consultation with the resource agencies determines the requirements for the credits to be withdrawn from the bank. The mitigation ratio is determined by the Corps depending on the restored functions of the wetland. The Corps also establishes the accounting procedure for keeping track of credits and debits in the bank. The following represent a general procedures for establishment of a wetland mitigation bank:

- Informal Discussions
- Submission of Preliminary Plans
- Detailed Planning and Baseline Information
  - Size, Type, Location
  - Description of Physical and Biological Improvements
  - Scheduling
  - Real Estate Acquisition
  - Crediting and Debiting Procedure
  - Operational Guidelines
  - Success Criteria
  - Monitoring Requirements
- Permit Issuance and/or MOA Between Responsible Agencies and the Sponsor
- Implementation
- Credit Certification By the Corps
- Sale of Credits (Approved by the Corps)
  - Generally Higher Compensation Ratio for Earlier Stages
- Bank Monitoring

5.4 General Guidelines for Appropriate Projects

The following are general criteria used to determine appropriate projects to fulfill their mitigation requirements for unavoidable losses in a wetland mitigation bank, however, these criteria may vary depending on the specific bank:

- The 404 (b)(1) Guidelines and the 1990, Corps and EPA MOA sequencing procedure for evaluating applications.
- Use of mitigation banks will be considered if on-site and in-kind mitigation are not practicable.
- The impacts to be mitigated at a site must occur in the same watershed as the mitigation bank.
- Mitigation requirements depend on the functions and values being impacted and the success stage of the mitigation bank.
- A 1:1 mitigation ratio is the minimum accepted to obtain the national policy of "no net loss".

6.0 Santa Ana River Restoration Project

The Corps is currently working with the Riverside County Park and Open Space District to establish a fee-based-compensatory mitigation. Various projects with unavoidable, minimal impacts, as determined by the Corps, will be able to compensate for their impacts at this site. Ecological benefit of this project will be in restoration of the Santa Ana River riparian wetlands which are a significant resource for the region, and valuable habitat for various endangered and sensitive species in the region. This project will have the benefit of cooperation and expertise of regulatory, resource agencies and conservation groups, to restore valuable resource in the region. As the Arundo removal and habitat restoration takes place in advance of impacts we will continue to work with The Team Arundo to establish a mitigation bank.

7.0 Conclusion

The Corps is currently evaluating the success and operation of existing mitigation banks in the Los Angeles region. A result of this evaluation will be development of regional guidelines for establishment of wetland mitigation banks which would assist the regulatory personnel and the regulated public with the regional requirements for establishment and operation of wetland mitigation banks. The success of the Santa Ana River fee-based compensatory mitigation is critical in terms of restoration success, and evaluation of the wetland mitigation banking with cooperation of federal, state and local agencies.

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[1] The material presented are views of the author and are not approved by the U.S. Army Corps of Engineers.

8.0 References

Etherington, John R. (1983) "Wetland Ecology, The Institute of Biology's Studies in Biology." Edward Arnold Publishers, London, England, **154:**1-65.

Memorandum of Agreement. Determination of Mitigation Under 404 (b)(1) Guidelines. Environmental Protection Agency and U.S. Army Corps of Engineers. Effective Date: February 2, 1990.

Federal Register 33 CFR Part 330.1 et seq. "General Regulatory Policies."

Federal Register 33 CFR Part 323.1 et seq. "Permits for Discharge of Dredged or Fill Material into Waters of the United States."

Federal Register 33 CFR Part 325.1 et seq. "Processing of Department of the Army Permits."

Mitsch, W., and J.G. Gosselink (1986) "Wetlands." Van Nostrand Reinhold, New York, New York. pp. 1-87.

Reppert, Richard (1992) "Wetlands Mitigation Banking Concepts." IWR Report 92-WMB-1, Water Resources Support Center, Institute for Water Resources, U.S. Army Corps of Engineers, Ft. Belvoir, VA, pp 1-25.

The Nature Conservancy (1993) "Habitat Mitigation and Monitoring Proposal: Giant Reed Eradiction and Riparian Management, Van Buren Bridge Unit, Santa Ana River." Murrieta, California pp 1-20.

U.S. Army Corps of Engineers (1992) "Draft Plan of Study For Wetlands Mitigation Banking Demonstration Study." Water Resources Support Center, Institute for Water Resources, Ft. Belvoir, VA, pp. 1-54.

U.S. Army Corps of Engineers (1993) "Alternative Mechanisms for Compensatory Mitigation: Case Studies and Lessons about Fee-Based Compensatory Wetland Mitigation." Institute for Water Resources, Ft. Belvoir, VA, pp. 1-81.

U.S. Army Corps of Engineers (1993) "Procedures for Development and Use of Mitigation Banks (Draft)." Unpublished Study. Washington D.C. pp. 1-12.

U.S. Environmental Protection Agency, Region IX (1991) "Mitigation Banking Guidance" San Francisco, CA, pp. 1-7.

Re-vegetation of riparian habitat: hauling coals to Newcastle?

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Introduction:

By far the greatest threat to the dwindling riparian resources of southern California is the alien weed species known as giant reed (*Arundo donax*). Over the last 25 years the riparian forests of coastal southern California have become infested with giant reed. Reed dramatically alters the ecological/successional processes in riparian systems, making them essentially fire-driven communities, and ultimately move most riparian habitats towards pure stands of reed.

By current estimates there are tens of thousands of acres of giant reed along the major coastal drainage systems of southern California, including the Santa Ana, Santa Margarita, Ventura, Santa Clara, San Diego, and San Luis Rey Rivers. The removal of giant reed from these systems provides numerous downstream benefits in terms of native species habitat, wildfire protection, water quantity and water quality.

Riparian management:

One of the prime incentives for riparian habitat management has been endangered species legislation, including the federal Endangered Species Act (ESA) and the state California Environmental Quality Act (CEQA). The ESA and CEQA have both focussed attention on declining species and sought to protect those species in greatest risk by provisions against take. In each case the focus of the legislation has been on the species with little attention given to the dynamics the natural systems of which these species are only a part. There are important historical and legislative reasons for this focus. In the 1970's ecologists were still highly focussed on single species. System-oriented approaches had not been widely applied. In addition, it is far easier to attach legal definition to something tangible, like an individual animal, than it is to the more vague concept of ecological processes.

The concept of habitat restoration developed in response to the take provisions of the ESA and CEQA as a means of mitigating site-specific damage. While re-vegetation has been carried out in a wide variety of natural community types, its earliest successes and its greatest application has been in mitigation of losses of riparian forests. In southern California riparian re-vegetation has been pursued as an ever-evolving artform in response to the perceived need for replacement of habitat for the federally and state endangered least Bell's vireo (*Vireo bellii pusillus*) and a suit of other endangered or candidate species including the western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), and the willow flycatcher (*Empidonax traillii*).

It may be argued that the main reason why riparian re-vegetation has received so much attention is because it is so relatively easy to achieve. This ease is a result of the very dynamics of riparian systems - they are high-disturbance systems composed of flood-adapted species. Willows, cottonwoods, mulefat, and other riparian plant species establish easily by fragmentation in flood events in addition to seeding in flood-washed sediment beds. As a result riparian re-vegetation essentially requires only plant material (cuttings or rooted stock) and water (irrigation). However, such re-vegetation projects are extremely expensive.

An important distinction to make is that re-vegetation does not necessarily equate with habitat restoration. While riparian species are relatively easy to establish, the dynamics of native riparian communities are poorly understood or appreciated. While some re-vegetation programs have been successful in terms of establishing a matrix of riparian habitat which is used by native species, we need to steer clear of the notion that re-vegetating is the way to create habitat.

Managing for processes, not for products:

I argue here that the best way to address habitat loss in southern California riparian systems is through a comprehensive program of eradication of giant reed, tamarisk, brown-headed cowbird, and other invasive aliens, and relying on natural physical processes, especially flood dynamics, for the recovery of native natural communities and species. This approach might be just as easily argued for other high disturbance-adapted communities.

This strategy is based upon two of important factors. First, riparian habitats are flood-dynamic communities, dependent upon natural cycles of flood scouring and sediment deposition to create the proper conditions for community establishment. The Santa Ana, Santa Margarita, and many other southern California streams lack none of the factors necessary for the recovery and maintenance of healthy riparian communities and riparian species. The natural flood regime is largely unaltered and there remain extensive sources of seed and vegetative propagules for willows and other native riparian plants throughout these watersheds. Second, the only real threats to the integrity of the system are (1) habitat fragmentation by development and (2) introduced exotic species which have altered the successional dynamics and stability of the natural communities. In other words, the native riparian communities of the Santa Ana and other major riparian corridors (and thus riparian-dependent species such as least Bell's vireo) are limited, not by the capacity of the community to regenerate, or the available area of riparian zones, but by the capacity of native species to compete with aggressive invasive exotic species, chiefly giant reed.

The majority of the limited resources available for riparian management on these rivers should therefore be directed at managing for the process of riparian systems: removing the key perturbation from the system, thereby allowing natural flood dynamics to operate and the natural communities to recover. It is my contention that extensive efforts made attempting to re-vegetate riparian species in floodplain that have natural flood regimes are redundant, and resources spent to this end are largely wasted. This is not to imply that riparian (and other habitat) re-vegetation efforts should not be applied; however, they should be applied judiciously and only in situations where specific management goals are achieved by carrying out a re-vegetation project (e.g. closing up an important corridor or re-establishing native species in a depauperate watershed). Relying on natural processes for the recovery of the riparian communities has the following major benefits:

a. Cost-effectiveness. Riparian forest restoration is extremely expensive, often on the order of tens of thousands of dollars per acre. This necessarily limits the size, and therefore the biological value, of any funded restoration project. Giant reed can be removed from most areas of a river for a fraction of the cost of revegetation, opening up areas for natural re-colonization by native riparian species.

b. Biological value. As indicated above, the high cost of re-vegetation limits the size of restoration projects. Additionally, artificially-produced riparian habitat lacks the high stem densities characteristic of natural least Bell's vireo nesting habitat, making the actual biological value of re-vegetated sites questionable. Much higher value may be achieved by removing invasive exotics such as giant reed from the system. Areas opened up for recolonization which are subsequently flood-scoured and naturally seeded or "planted" with vegetative propagules spread by the flood are more likely to recover in high stem density habitat.

c. Natural vulnerability. Riparian systems are, by nature, dynamic. The natural flood process that produces the conditions for natural riparian establishment also puts artificially (and naturally) created habitat areas in flood jeopardy. This makes riparian revegetation a high-risk investment of limited resources. Numerous high-cost revegetation projects on the Santa Margarita and Santa Ana Rivers were damaged or lost to the January 1993 floods.

Summary:

Past practices of riparian species management have focussed on re-vegetation of small sites without consideration of natural riparian processes. Limited resources should be spent on managing for the natural dynamic processes of these systems on a watershed-wide scale. Re-vegetation in riparian areas should only be considered in special cases.

Recommended Management Strategies:

1. Remove giant reed beginning at the 'top' of the river to stop the downstream infestation.

2. Integrate watershed planning with understanding of key species needs (e.g. giant reed washing downstream from flood channel maintenance and other upstream sources is major threat to habitat of least Bell's vireo downstream).

3. Remove and keep riparian areas clear of giant reed near infrastructure and key habitat areas.

4. Be prepared to take advantage of wildfire or floods that clear stretches of the river of stands of giant reed.

5. Maximize the use of fire, heavy equipment, and aerial application of herbicides to remove reed to minimize per-acre costs and maximize habitat improvement.

6. Rely mainly upon natural flood processes,such as occurred in January 1993, for revegetation of riparian areas with native species.

7. In some cases it may be required or desired to 'jump-start' the process by revegetating particular sites with cottonwood-willow riparian forest species. Riparian re-vegetation will add greatly to the time, effort, and expense of this project and should be considered only in special circumstances.

BIBLIOGRAPHY

Anderson, B. W. and E. Miller. 1991.Analysis of revegetation on the Kern River Preserve 1986-1990, Prepared for The Nature Conservancy San Francisco, Ca.

Anderson, B. W. and V. Vasquez.1991. Tree growth on revegetation projects: Kern River Preserve, 1991. Prepared for The Nature Conservancy San Francisco, Ca.

Baird, K. and J. Rieger. 1989. A Restoration design for Least Bell's Vireo habitat in San Diego County. USDA Forest Service Gen. Tech. Rep. PSW-110.

Cooper, W.S. 1922. The broad-sclerophyll vegetation of California. Carnegie Inst., Publi. 319, Washington, D.C., 124 pp.

Cooper, W.S. 1926. Vegetational development upon alluvial fans in the vicinity of Palo Alto, California. Ecology 7:1-30.

Finn, M. and D. Minnesang. 1990. Control of giant reed grass in a southern California riparian habitat. Restoration & Management Notes 8:53-54.

Franzreb, K. 1989. Ecology and conservation of the endangered least Bell's vireo. U.S. Fish and Wildlife Service, Biological Report 89(1). 17 pp.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41:540-551.

Hawk, G.M. and D.B. Zobel. 1974. Forest succession on alluvial landforms of the McKenzie River valley, Oregon. Northwest Sci. 48: 245-265.

Hendricks, B. and J. Rieger. 1989. Description of nesting habitat for the Least Bell's Vireo. USDA Forest Service Gen. Tech. Rep. PSW-110.

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. Non-game Heritage Division, California Department of Fish and Game, Sacramento, CA. 156 pp.

Hoshovsky, M. 1988. *Arundo donax*. Element Stewardship Abstract. The Nature Conservancy, San Francisco, CA. 10 pp.

Kondolf, G. M. 1988. Hydrologic and channel stability considerations in stream habitat restoration. Environmental Restoration; Science and strategies for restoring the earth: Selected papers from Restoring the earth conference: ed. by John Berger. Island Press., pp. 214-227.

Parra-Sjizz, E. A. 1989. Revegetation in the Sepulveda Wildlife Reserve: A seven year summary. Proceedings of the SER conference.

Schoenherr, A.A. 1992. A natural history of California. California Natural History Guides, No. 56. University of California Press, Berkeley, CA. 772 pp.

Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Ann. Assoc. Amer. Geogr. 51:294-315.

TNC, 1992. Ecosystem models: a template for conservation actions. The Nature Conservancy, Arlington, VA. 10 pp.

Weaver, J.E. and F.E. Clements. 1938. Plant ecology. McGraw-Hill, New York, 601 pp.

Zembal, R. 1990. Riparian habitat and breeding birds along the Santa Margarita and Santa Ana Rivers of southern California. Pp. 98-114 In: A.A.Schoenherr [ed.] Endangered plant communities of southern California. Southern California Botanists, Special Publ. No. 3.

Other invasive non-native plants in California's wildlands and natural areas.

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INTRODUCTION

Arundo donax is one of 1023 non-native plant species that has become established in California in the past two centuries (Hickman 1993; Rejmanek and Randall in review). Roughly 17.5% of the state's flora is now composed of non-native species. The majority do not invade the state's wildlands and natural areas, however, a draft list of non-native plants troublesome in natural areas produced by the California Exotic Pest Plant Council (CalEPPC) includes 70 species (Howald and Sigg 1994). Arundo is among 20 species on this list designated as the state's most important widespread wildland pest plants. It was also among the 43 species cited as problems on at least one California preserve managed by The Nature Conservancy (Randall in prep.).

I will present a brief overview of some of these other wildland and natural area pests. They include herbaceous annuals and perennials, shrubs, vines and trees and they infest habitats ranging from desert to Great Basin sagebrush steppe to chaparral to grassland to coastal forest. In some natural areas such as Santa Cruz Island weed infestations are the worst problem that stewards and resource managers face (Randall in prep.).

GENERAL CHARACTERISTICS OF PEST SPECIES

There are two characteristics common to species considered weeds in natural areas: **1.** The great majority are not native to the areas they infest although they may be native to other parts of the continent (Randall in prep.). Such species may be referred to as non-native, non-indigenous, alien or exotic. There are, however, a few exceptions, including species native to one region of the country or state but newly introduced to other areas. **2.** The great majority of natural area weed are also invasive. This means that they move into and can dominate or disrupt natural communities.

Some natural area weeds have been declared noxious by the federal government, or by certain states or counties. In almost all cases they were designated noxious because they are also detrimental to agriculture, ranching and/or forestry.

PEST PLANT PROBLEMS IN CALIFORNIA

The pest species that cause the greatest damage are those that can dominate and change the plant community or alter ecosystem processes (Vitousek et al. 1987). Unfortunately, examples of this type abound. Cheat grass (Bromus tectorum) invaded millions of acres of rangeland in the Great Basin which in turn lead to an increase in frequency of fires from once very 60-110 years to once every 3-5 years (Mack 1981). Native shrubs, which do not recover well from the more frequent fires, have been eliminated or reduced to minor components in many of these areas.

The nitrogen-fixing plant bush lupine (Lupinus albus) was introduced to coastal areas north of Bodega Bay areas where it may sharply increase rates of nitrogen accumulation in the soil altering patterns of succession and allowing other weedy species with high nutrient requirements to invade (Pickart, personal communication, Vitousek et al. 1987).

Another invader, European beachgrass (Ammophila arenaria) has invaded many Pacific coast dune systems from central California to Washington. It traps sediments differently than do native species and so interferes with the natural dynamics of dune systems . In northern California it alters the geomorphology of the foredune community from gentle, sloping dunes formed at angles to the shore to vertical, wall-like dunes parallel to the shore (Barbour and Johnson 1977). This, in turn, prevents adequate sand movement from beach to interior dunes altering the entire community. Further north, in Oregon, Ammophila infestations have severely reduced the sand supply from beach to large inland dunes.

Tamarisks have invaded wetlands and riparian areas throughout the southwestern U.S. and are a severe problem in California. These trees, especially Tamarix ramosissima and T. chinensis, are notorious for their ability to reach supplies of groundwater up to 6 m below the surface (Kerpez and Smith, 1987). They use this water inefficiently relative to native species like the willows and cottonwoods that they displace and may cause precipitous declines in groundwater levels and the cessation of surface seeps and flows (Gary and Campbell 1965; Kerpez and Smith, 1987). These effects may in turn lead to the elimination of other native plants that can no longer reach the water table and of fish and other organisms dependant on surface flows (Howe and Knopf, 1991; Kerpez and Smith, 1987). A single tamarisk can produce thousands of tiny, wind dispersed seeds and the seedlings mature rapidly, often producing seed of their own by the end of their first year. Thus, an area that contains only a few tamarisks can be converted to an impenetrable thicket in less than a decade (Neill 1983). Native species usually fail to regenerate in these areas because their seedlings cannot tolerate the shade cast by tamarisks nor the deep layers of litter that they produce (Neill 1983). These thickets are also very poor habitat for native animals, most notably birds and insects (Anderson and Ohmart, 1976; 1984; Anderson et al., 1977; Cohan et al., 1978).

California's grasslands are believed to have been originally dominated by native perennial bunchgrasses such as Stipa pulchra, Poa scabrella and Melica californica (Barry, 1972; Burcham, 1981; Jackson, 1985). The vast majority of these areas have been invaded and taken over by annual grasses and forbs native to the Mediterranean region including Avena barbata, A. fatua, Lolium perenne, Bromus mollis, B. diandrus, Erodium botrys, E. cicutarium and Hypochaeris glabra (Barbour, unpublished data). Many theories have been advanced to explain this remarkable replacement, which has taken place over the last two centuries. Several center on the role of grazing by cattle introduced first by Spanish settlers and expanded greatly in the years following the Gold Rush and statehood (Burcham, 1981). Alteration of the natural fire regime is believed to have been important as well (Daubenmire, 1968).

Yellow star thistle (Centaurea solstitialis) has expanded its range in California at a roughly exponential rate since the late 1950s, increasing from 1.2 to 7.9 million acres between 1958 and 1991 (Thompson et al., 1991). It is an extremely prolific seeder and its long-lived seeds allow it to quickly re-establish after herbicidal control dissipates (Prather and Callihan, 1991). Its conspicuous yellow flowerheads and sharp spines make this species one of the best known rangeland, recreational area and natural area pests in the state.

Outlines of problems caused by a few more California wildland and natural area pest plants are presented below.

Eastern saltmarsh cordgrass (Spartina alterniflora) in coastal estuaries form San Francisco Bay north (Callaway and Josselyn 1992).

- Introduced to the Pacific coast from the Atlantic coast in the 1800s.
- Expanded rapidly since World War II and now infests many western estuaries.
- Control methods will likely include repeated mowing in accessible areas and application of glyphosate in less accessible sites.

Fennel (Foeniculum vulgare) on Santa Cruz Island, California.

- Infestations expanded rapidly in the past 3 years and now cover thousands of acres, up to 10% of the preserves 90,000 acres (Beatty and Licari 1992; Brenton and Klinger in prep.).
- The preserve ecologist is currently experimenting with the use of prescribed burns followed by treatment with the herbicide triclopyr to control it.

Pampas grass and jubata grass (Cortaderia selloana and C. jubata)

- Pampas grass is invading coastal scrub communities along the state's north and central coast. It will completely change these habitats in our state parks and elsewhere if not controlled.

Bull thistle (Cirsium vulgare)

- Bull thistle is one of the three worst weed in Yosemite National Park (Randall 1991).
- In 1993 workers put in 900 hours to control thistles and mullein in Yosemite's meadows and forests (Waldo, personal communication).

PEST PLANT PROBLEMS IN OTHER PARTS OF THE U.S.

Unfortunately, non-native pest plants are troublesome throughout the nation and, indeed around the world. When I surveyed The Nature Cosnervancy stewards around the country weed problems were reported from all 46 states that responded (Randall in prep.). Stewards from California, Florida and Hawaii reported the most pests. Ten percent of the respondants listed pest plants as their worst management problem and a total of 60% ranked pest plants among their top-10 concerns. Loope (1992) noted that weed problems in the nation's National Parks and biosphere reserves are most severe in south Florida, Hawaii and other islands such as the Channel Islands. He reported problems from many other regions of the nation, however, and a quick review of articles in the Natural Areas Journal or Restoration and Management Notes makes it clear that managers in the east, midwest and northern Plains states face daunting pest problems too.

EFFORTS TO CONTROL PEST PLANTS

Fortunately, there are examples of successful efforts to control pest plants in wildlands and natural areas and this work continues. For example, a tamarisk removal program that was sustained for nearly a decade finally resulted in the elimination of tamarisk as an ecological factor at the Coachella Valley Preserve in 1991 (Barrows, personal communication). This effort was a cooperative venture involving The Nature Conservancy (TNC), the Bureau of Land Management (BLM), the US Fish and Wildlife Service and the California Department of Fish and Game. Strategies for eradicating tamarisk were developed in consultation with Bill Neill who has organized volunteer tamarisk removal projects on private, state, federal and tribal lands throughout the southwest for over 10 years. Volunteers and staff continue to visit previously cleared areas to eliminate any resprouting or newly appearing tamarisk. A tamarisk control program has also been initiated at the Dos Palmas preserve, southeast of Coachella Valley. The BLM, which owns much of the land in this area, prepared an environmental assessment for a project to eradicate tamarisk from this area in concert with efforts on TNC property. Due to the scale of the project, BLM plans to complete the work in phases and will proceed from west-to-east and north-to-south within the drainage in order to take advantage of the area's prevailing winds.

The Nature Conservancy supported research to determine how seasonal grazing and prescribed fires influence competition between native bunchgrasses and introduced annuals at the Jepson Prairie

preserve in Solano County. A number of other groups, including the California Native Grass Association, are working to develop methods to restore perennial bunchgrasses to large areas.

Because of yellow star thistle's alarmingly rapid spread significant resources have been dedicated to efforts to control it. For example, Dr. Charles Turner of the USDA-ARS biocontrol laboratory in Albany, California has focused on establishing a biocontrol program for yellow star thistle for the last several years. As a result of this work, six insect species have now been approved for release.

The California Exotic Pest Plant Council (CalEPPC) was formed in 1992 to help find solutions to problems caused by non-native plant invasions of the state's natural areas. In addition to directing attention to the problem it is proposing and facilitating solutions. Since its formation CalEPPC:

1. Developed and continues to update and improve a modem-accessible database on pest plant biology and control methods.
2. Initiated and continues to conduct experiments on methods to control French Broom at Jackson State Demonstration Forest in Mendocino County.
3. Held annual Symposia attended by over 120 people in 1992 and 1993 and sponsored a Symposium focusing on pest plant problems in San Diego County.
4. Developed a draft list of the state's worst non-native pest plants.
5. CalEPPC is now co-sponsoring (with the CA Native Plant Society) a proposal to create a state Exotic Species Coordinator position to help state agencies combat infestations efficiently.

LITERATURE CITED

Anderson, B.W., A.E. Higgins and R.D. Ohmart. 1977. Avian use of saltcedar communities along the lower Colorado River Valley. pp. 128-136 IN R.R. Johnson and D.A. Jones (eds.) Importance, preservation and management of riparian habitat: a symposium. U.S. Forest Service General Technical Report RM-43. 217 pp.

Anderson, B.W. and R.D. Ohmart. 1976. A vegetation management study for the enhancement of wildlife along the lower Colorado River, annual report. In Fulfillment of Bureau of Reclamation Contract #7-07-30-V0D09. Arizona State University, Tempe, AZ.

Anderson, B.W. and R.D. Ohmart. 1984. Vegetation management study for the enhancement of wildlife along the lower Colorado River. Comprehensive Final Report to the U.S. Bureau of Reclamation, Boulder City, Nevada. 529 pp.

Barbour, M. and A.F. Johnson. 1977. Beach and dune. Pp. 223-260 in Barbour, M. and J. Major (eds.), Terrestrial vegetation of California. John Wiley and Sons, NY.

Barrows, C. 1992. Southern California Area Manager, The Nature Conservancy, personal communication.

Barry, W.J. 1972. The central valley prairie. California prairie ecosystem, Vol. 1. California Department of Parks and Recreation Report, Sacramento. 82 pp.

Beatty, S.W. and D.L. Licari. 1992. Invasion of fennel into shrub communities on Santa Cruz Island, California. Madrono 39:54-66

Brenton, R. and R. Klinger. in prep. Modeling the expansion and control of fennel (Foeniculum vulgare) on the Channel Islands.

Burcham, L.T. 1981. California rangelands in historical perspective. Rangelands 3:95-104.

Callaway, J.C. and M.N. Josselyn. 1992. The introduction and spread of smooth cordgrass (Spartina alterniflora) in south San Francisco Bay. Estuaries 15(2):218-226.

Cohan, D.R., B.W. Anderson and R.D. Ohmart. 1978. Avian population responses to saltcedar along the lower Colorado River. pp. 371-381 IN R.R. Johnson and J.F. McCormick (eds.) Strategies for protection and management of floodplain wetlands and other riparian ecosystems. U.S. Forest Service General Technical Report WO-120. 410 pp.

Daubenmire, R. 1968. Ecology of fire in grasslands. Advanced Ecological Research 5:209-266.

Gary, H.L. and C.J. Campbell. 1965. Water table characteristics under tamarisk in Arizona. U.S. Forest Service Research Note RM 58. 7 pp.

Hickman, J.C. (ed.) 1993. The Jepson Manual - higher plants of California. University of California Press, Berkeley.

Howald, A. and J. Sigg. 1994. Draft list, Exotic pest plant species of greatest concern in California. Report presented to California Exotic Pest Plant Board.

Howe, W.H. and F.L. Knopf. 1991. On the imminent decline of Rio Grande cottonwoods in central New Mexico. Southwestern Naturalist 36:218-224.

Jackson, L.E. 1985. Ecological origins of California's Mediterranean grasses. Journal of Biogeography 12: 349-361.

Kerpez, T.A. and N.S. Smith. 1987. Saltcedar control for wildlife habitat improvement in the southwestern United States.U.S. Fish and Wildlife Service / Resource publication 169. 16 pp.

Loope, L.L. 1992. An overview of problems with introduced plant species in national parks and biosphere reserves of the United States. pp. 1-28 In C.P. Stone, C.W. Smith and J.T. Tunison (eds.) Alien plant invasions in native ecosystems of Hawaii: management and research. University of Hawaii Cooperative Park Studies Unit, Honolulu.

Mack, R.N. 1981. Invasion of Bromus tectorum L. into western North America: an ecological chronicle. Agroecosystems 7:145-165.

Neill, W. 1983. The tamarisk invasion of desert riparian areas. Education Bulletin #83-84. Publication of the Education Foundation of the Desert Protective Council.

Pickart, A. 1992. Northern California Area Ecologist, The Nature Conservancy, personal communication.

Prather, T.S. and R.H. Callihan. 1991. Interference between yellow starthistle and pubescent wheatgrass during grass establishment. Journal of Range Management 44:443-447.

Randall, J.M. 1991. Ecology of an invasive biennial, Cirsium vulgare, in California. Ph.D. dissertation, University of California, Davis. 187 pp.

Randall, J.M. in prep. Assessment of pest plant problems on The Nature Conservancy preserves. for submission to Natural Areas Journal.

Rejmanek, M. and J.M. Randall. in review. Invasive plants in California: 1993 summary and comparison with other areas in North America. submitted to Madrono.

Thompson, C.D., M.E. Robbins and S. Larson. 1991. Yellow star thistle control. Range Science Report No. 30. Department of Agronomy and Range Science, University of California, Davis. 6 pp.

Waldo, E. 1993. Resources Management, Yosemite National Park, personal communication.

Vitousek, P.M., L.R. Walker, L.D. Whiteaker, D. Mueller-Dumbois & P.A. Matson. 1987. Biological invasion by Myrica faya alters ecosystem development in Hawaii. Science 238:802-80.

TEAM ARUNDO

Santa Ana River Interagency Habitat Recovery Project

Van Buren Unit#1
Summary of Pilot Project

SITE DESCRIPTION

Location: Township 2 South, Range 6 West, Section 25, Riverside West U.S.G.S. Quadrangle. Santa Ana River directly beneath and North of the Van Buren Bridge.

City: Riverside County and portions of the City of Riverside

Size: 20 +/- acres

ACTIVITY DESCRIPTION

Activity Description: This project involves the testing of manual techniques for the removal of Arundo (Arundo donax), and the recovery of the site to a more natural condition. Habitat recovery activities have involved the following:

1. Broadcast application of herbicide for the purpose of killing live standing Arundo using aircraft.
2. Manual removal of dead Arundo employing trained hand-crews using chainsaws and other associated brush cutting hand-tools.
3. Spot treatment of resprouting Arundo with herbicide(either by backpack sprayer or vehicle mounted equipment).
4. Replanting of the site with locally collected cuttings of native species.
5. Monitoring and maintenance (removal of weeds, spot application of herbicide when needed, etc.) of the site for at least five years or when the threat of reinfection by Arundo has been eliminated.

Purpose: The purpose of this project is the recovery of 20 acres of highly impacted willow-Cottonwood forest and associated habitat.

Project History: The need for this project was great. As of the Summer of 1992, this site was almost entirely dominated by Arundo and had been burned twice in the past three years. Invasion of the Santa Ana River by Arundo and the increased threat of devastating wildfire associated with it, brought about a call for action by public agencies and concerned citizens.

The pilot site provided a unique opportunity to test Arundo removal techniques at a location visible by the general public (the site is visible from Van Buren Bridge) and was easily accessed by hand crews.

Project Timeline:

March 1993:	Initial aerial broadcast treatment of Arundo with herbicide.
May 1993:	Begin removal of "standing dead" Arundo using hand crews.
July 1993:	Second aerial broadcast application herbicide
September 1993:	Follow-up "spot treatment" application of herbicide.
November 1993:	Burn piles and/or slash sub-units.
December 1993:	Conduct site analysis in preparation for revegetation.
January 1993:	Revegetate unit using locally collected Cottonwood and willow cuttings.
May 1994 (and annually thereafter):	Follow-up application of herbicide to giant reed resprouts.
Ongoing:	Monitoring and maintenance of unit.

Methods of Treatment: Giant reed was controlled by two aerial applications of herbicide and two follow-up applications using vehicle mounted spray equipment. Dead stalks were removed by hand and placed in burn piles for disposal. The recovery of the native plant communities will be encouraged by continued "spot" applications of herbicide and the planting of 2,000 willow and mulefate cuttings during the Winter of 1993.

Herbicide Use and Applications:

Name of Pesticide(s)	Rate Per Acre	Volume Per Acre
Rodeo	7 1/2 pt./AC	10 Gallons/Ac H2O
Non-Ionic Surfactant	1 qt/AC	10 Gallons/Ac H20

Application Date	Method	Total Product Used
March 1993	Helicopter	57 1/2 gallons
*April 1993	Vehicle	22 1/2 pints
July 1993	Helicopter	58 gallons
**September 1993	Vehicle	2 1/2 gallons

Notes

* Treatment of areas unable to be reached by helicopter (underneath bridge and adjacent to structures and native vegetation.

** Treatment of resprouts.

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1993 ARUNDO DONAX WORKSHOP

EVALUATION FORM RESULTS

1. City of Residence: From San Francisco Bay Area to San Diego

2. Please indicate employment/volunteer affiliation Federal, State, County and City Depts., Private Citizens, Commercial (Chemical companies and Suppliers), Consultants, Applicators, University, Sierra Culb, California Native Plant Society and the Audubon Society

3. Overall impression of workshop: 30 Outstanding 21 Good 0 Average 0 Poor

4. What did you especially like about the workshop? See Comments

5. Should we hold another workshop? Yes = 45 No = 2

   If yes, when? Within 6 mo. = 5 Within 1 yr. = 29 Within 2 yrs. = 1
   When more information is available (Team Arundo Project complete) = 8

6. Please indicate below your preference for information at future workshops by entering one (1) number of your choice for each category.

1 = MORE 2 = SAME 3 = LESS	1	2	3		1	2	3	
	19	23	4	Biology/Growth Habits	25	14	2	Revegetation
	32	15	0	Control Techniques	22	14	6	Mitigation
	18	22	4	Effects on Native Habitat	11	24	9	Environmental Permits
	19	22	5	Impaired Flood Control	13	23	3	Legislation
	21	15	5	Education	11	17	9	Publicity
	19	20	5	Inter-Agency Success	39	7	0	Successful Programs
	7	22	15	Fire Threat	18	21	3	Water Resources impact

   Other: See Comments # 4

7. Would you attend another workshop about other specific weeds? Yes = 42 No = 6

   If yes, which weeds would be of most importance? Saltcedar/Tamarisk = 24 Artichoke Thistle = 7 Pampas Grass and Yellow Starthistle - 5 Russian thistle, Casterbean = 3 Broom, Mustard = 2 Tree tobacco, Ailanthus and Iceplant = 1

8. Are you a member of Cal EPPC? Yes = 6 No = 44

   If no, did you join Cal EPPC today? Yes = 1 No = 42

   Will you join Cal EPPC in the future? Yes = 9 Maybe = 21 N0 = 11

COMMENTS:

#4: What did you especially like about the workshop?

1 The subject of the Meeting
5 Gave answers and not just outlined the problem
4 The involvement of diverse agencies
3 Mitigation banking
18 Presentations were practical and relevant
5 Workshop was highly motivating
11 Speakers were qualified and had diverse backgrounds
3 Biological aspects of the talks
1 Legal constrains
4 Networking
1 1 day format
3 Eradication methods given
1 Water resource information
1 Workshop was fast moving

#9: Comments

Should give imput with respect to agriculture
Get someone from the Ag Commission to outline laws
Information on how to get contracts for treating Arundo donax
More info on currently used techniques
What are some wildlife impacts
Give other watershed planning activities
Give more actual figures, ie. cost, acreage etc.
How to plan and implement a large scale program
Expand programs into other areas

JOIN. . . .

CALIFORNIA EXOTIC PEST PLANT COUNCIL

"The insidious invasion of ecosystems by plants and animals from around the world has become a major environmental threat." -- Carla D'Antonio and Tom L.Dudley (Pacific Discoveries, Summer 1993, California Academy of Sciences)

A Brief History of CalEPPC

The California Exotic Pest Plant Council (CalEPPC) was organized in 1992 to address the major environmental threat of invasive exotic vegetation in natural areas of the state. At its first symposium at Morro Bay in October 1992, over 150 land managers, scientists and concerned citizens reflected strong agreement that the time for action is now if many of the state's natural systems are to survive the onslaught of invasive plant species.

Since October 1992, CalEPPC has lived up to the energetic spirit of the Morro Bay symposium. An excellent newsletter, *CalEPPC News*, keeps members abreast of the latest developments and the people and agencies who are making news. CalEPPC members focus energy and action through volunteer "Working Groups." In 1993, working groups formed an electronic bulletin board service through EcoNet, organized a scientific experiment on control of French broom, helped generate publicity on invasive species, organized regional workshops on problem species, and contributed valuable information for members through the newsletter. Through the common ground of CalEPPC, members are meeting each other, sharing information and taking action on a wide variety of projects and issues.

Why You Should Join CalEPPC

CalEPPC is only as strong as its membership, and the challenge we face is great. Please join the state's only organization devoted to the management and control of exotic pest plants that threaten California's natural ecosystems. In addition to helping the cause you will:

- Receive *CalEPPC News* quarterly with late breaking information on pest plants
- Be invited to CalEPPC's annual symposium where the best minds meet
- Receive a listing of all symposium attendees
- Participate in regional workshops sponsored by CalEPPC
- Network with researchers, land managers and local activists
- Participate in CalEPPC working groups to achieve tangible results

Memberships are for the calendar year. If you join before the annual symposium is held each fall, you will receive free back issues of *CalEPPC News* for the year you join. (Other back issues are available for $2.00 each, including postage.)

PLEASE JOIN CalEPPC NOW using a membership application form distributed with this information sheet, or write CalEPPC; c/o Sally Davis; 448 Bello Street; Pismo Beach, CA 93449. Regular individual membership $25; Regular institutional membership $100. Make checks payable to CalEPPC.