

ELEMENT STEWARDSHIP ABSTRACT
for

Arundo donax

Giant Reed

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The Nature Conservancy
Element Stewardship Abstract
For *Arundo donax*

I. IDENTIFIERS

Common Name: GIANT REED

Global Rank: G5

General Description:

Arundo donax is a tall, erect, perennial cane- or reed-like grass, 2 to 8 meters high. It is one of the largest of the herbaceous grasses. The fleshy, almost bulbous, creeping root stocks form compact masses from which arise tough, fibrous roots that penetrate deeply into the soil. The culms reach a diameter of 1 to 4 cm and commonly branch during the second year of growth. These culms are hollow, with walls 2 to 7 mm thick and divided by partitions at the nodes. The nodes vary in length from 12 to 30 cm. The leaves are conspicuously two-ranked, 5 to 8 cm broad at the base and tapering to a fine point. The bases of the leaves are cordate and more or less hairy-tufted, persisting long after the blades have fallen (Perdue 1958).

The flowers are borne in large (3 to 6 dm long) plume-like terminal panicles between March and September. The spikelets are several-flowered, approximately 12 mm long with florets becoming successively smaller. The rachilla is glabrous and disarticulates above the glumes and between the florets. The more or less unequal glumes are membranaceous, narrow and 3-nerved. They are also slender, pointed and as long as the spikelet. Lemmas are thin, 3-nerved and pilose. These are narrowed upward with the nerves ending in slender teeth; the middle one becomes an awn.

II. STEWARDSHIP SUMMARY

Although arundo has been widely cultivated for a long time, little information on its biology or ecology has been published. Its rapid growth rate and strong vegetative competitive ability enables it to quickly invade new areas and dominate local vegetation. Very little has been published regarding effective ways of controlling arundo and it is difficult at this point to suggest the best strategy for managing the species.

III. NATURAL HISTORY

Range:

Arundo donax is a native to the countries surrounding the Mediterranean Sea. From this area it has become widely dispersed, mostly through intentional introduction by man, into all of the subtropical and warm temperate areas of the world.

Habitat:

Arundo donax has been widely planted throughout the warmer areas of the U.S. as an ornamental. It is especially popular in the Southwest where it is used along ditches for erosion control (Perdue 1958). In California, giant reed has escaped cultivation and has become established in moist places, such as ditches, streams, and seeps in arid and cismontane regions (Robbins et al. 1951). As early as 1820 it was so plentiful along the Los Angeles River that it was gathered for roofing materials (Robbins et al. 1951). *A. donax* tolerates a wide variety of ecological conditions. It is reported to flourish in all types of soils, from heavy clays to loose sands and gravelly soils.

Plants grow best in well-drained soils where abundant moisture is available (Perdue 1958). It can spread from the water's edge up the banks and far beyond the zone previously occupied by riparian woody vegetation (Wells et al. 1980). *Arundo donax* was observed to grow well where water tables were close to, or at, the soil surface (Rezk and Edany 1979). Individual plants can tolerate excessive salinity (Perdue 1958).

Giant reed can be seriously retarded by lack of moisture during its first year, but drought causes no great damage to patches two- to three-years old (Perdue 1958). Individuals will survive extended periods of severe drought accompanied by low-pressure humidity or periods of excessive moisture (Perdue 1958). *Arundo's* ability to tolerate or even grow well under conditions of extreme drought is due to the development of coarse, drought-resistant rhizomes and deeply penetrating roots that can reach moisture at depth. *A. donax* can survive very low temperatures when dormant but is subject to serious damage by frosts after the start of spring growth (Perdue 1958).

Giant reed has played an important role in the culture of the western world through its influence on the development of music, which can be traced back 5000 years. The basis for the origin of the most primitive pipe organ, the Pan pipe or syrinx, was made from *A. donax*. Reeds for woodwind musical instruments are still made from the culms and no satisfactory substitutes have been developed (Perdue 1958).

Even before its musical qualities were appreciated, Egyptians used giant reed as early as 5000 B.C. to line underground grain storage. Mummies of the Fourth Century A.D. were wrapped in arundo leaves. Other uses for giant reed include: basket-work, garden fences and trellises, chicken pens, crude shelters, fishing rods, arrows, erosion control, livestock fodder, pulp and ornamental plants. Medicinally, the rhizome has been used as a sudorific, a diuretic, as an antilactant and in the treatment of dropsy (Perdue 1958).

Reproduction:

Very little information is available in the literature regarding the biology of *A. donax*.

Perdue (1958) reports that arundo does not produce viable seeds in most areas where it is apparently well-adapted, although plants have been grown in scattered locations from seed collected in Asia.

Wind dispersal of seeds is facilitated by having a dense seed head on the end of a tall, flexible culm, presumably catapulting the seeds a fair distance. The importance of sexual reproduction to the species, as well as seed viability, dormancy, germination and seedling establishment, have yet to be studied and published.

Much of the cultivation of arundo throughout the world is initiated by planting rhizomes which root and sprout readily. Wild stands in the U.S. have been reported to yield 8.3 tons of oven-dry cane per acre (Perdue 1958).

Giant reed grows rapidly. Growth rates up to 0.7 meters/week over a period of several months under favorable conditions is not unusual. Young culms develop the full diameter of mature canes; further growth involves thickening of the walls. The new growth is soft, very high in moisture and has little wind resistance (Perdue 1958).

IV. CONDITION

Threats:

Arundo can rapidly invade streambanks and roadside habitats from a few planted individuals. When established, it has a strong ability to outcompete and completely suppress native vegetation. Because it propagates vegetatively, it can form rather pure stands, often at the expense of other plants (Wells et al. 1980). In some areas it may so totally invade irrigation ditches as to reduce their water-carrying capacity (Robbins et al. 1951).

A survey of 48 public agencies listed arundo as one of the top 53 weed species of concern (Armer 1964). Arundo was nominated for Element Stewardship Abstract research by preserve managers from Santa Rosa Plateau and Creighton Ranch.

Restoration Potential:

With proper management, areas infested with arundo may be restored to more desirable vegetation. Since arundo may be spread primarily by dispersal of rhizome fragments along watercourses, removal of the entire rootstock may be adequate to eradicate the plant. Research is needed to determine the importance of sexual reproduction in this species.

V. MANAGEMENT/MONITORING

Management Requirements:

Weed control involves three fundamental objectives: prevention, eradication and control.

From a practical viewpoint, methods of weed management are commonly categorized under the following categories: physical, thermal, managerial, biological, and chemical (Watson 1977). Physical methods include both manual and mechanical methods. Thermal methods include both broadcast burning or spot treatment with a flame thrower. Managerial methods include the encouragement of competitive displacement by native plants and prescribed grazing. Biological control is usually interpreted as the introduction

of insects or pathogens which are highly selective for a particular weed species. Chemical control includes both broadcast and spot application.

The most desirable approach is that of an integrated pest management plan. This involves the optimum use of all control strategies to control weeds. This approach is generally accepted as the most effective, economical, and environmentally sound long-term pest control strategy (Watson 1977). In cases where more than one control technique is used, the various techniques should be compatible with one another. Broadcast herbicide application, for example, may not work well with certain managerial techniques (i.e., plant competition).

PHYSICAL CONTROL The two types of physical control methods discussed below, manual and mechanical, produce slash debris that can be disposed of by several techniques. If cut before seeds are produced, debris may be piled and left for enhancement of wildlife habitat (i.e., cover for small mammals). Debris may be fed through a mechanical chipper and used as mulch during revegetation procedures. Care should be taken to prevent vegetative reproduction from cuttings. Burning the slash piles is also effective in disposing of slash.

MANUAL CONTROL Manual methods use hand labor to remove undesirable vegetation. These methods are highly selective and permit weeds to be removed without damage to surrounding native vegetation.

The Bradley Method is one sensible approach to manual control of weeds (Fuller and Barbe 1985). This method consists of hand weeding selected small areas of infestation in a specific sequence, starting with the best stands of native vegetation (those with the least extent of weed infestation) and working towards those stands with the worst weed infestation. Initially, weeds that occur singly or in small groups should be eliminated from the extreme edges of the infestation. The next areas to work on are those with a ratio of at least two natives to every weed. As the native plant stabilizes in each cleared area, work deeper into the center of the most dense weed patches. This method has great promise on nature reserves with low budgets and with sensitive plant populations. More detailed information is contained in Fuller and Barbe (1985).

Hand Pulling: This method may be used to destroy seedlings or plants up to two meters tall. Plants or seedlings are best pulled after a rain when the soil is loose. This facilitates removal of the rooting system, which may resprout if left in the ground. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds.

Hand Digging: The removal of rootstocks by hand digging is a slow but sure way of destroying weeds which resprout from their roots. The work must be thorough to be effective. Every piece of root that breaks off and remains in the soil may produce a new plant. Such a technique is only suitable for small infestations or around trees and shrubs where other methods are not practical.

MECHANICAL CONTROL Mechanical methods use mechanized equipment to remove above ground vegetation. These methods are often non-selective in that all vegetation on a treated site is affected. Mechanical control is highly effective at controlling woody vegetation on gentle topography with few site obstacles. Most mechanical equipment is not safe to operate on slopes over 30 percent. It is also of limited use where soils are highly susceptible to compaction or erosion or where excessive soil moisture is present. Site obstacles such as rocks, stumps or logs also reduce efficiency.

Chopping, Cutting or Mowing: *Arundo donax* may be trimmed back by tractor-mounted mowers on even ground or by scythes on rough or stony ground. Unwanted vegetation can be removed faster and more economically in these ways than by manual means and with less soil disturbance than with scarification. However, these methods are non-selective weed eradication techniques. They reduce biological control potential (other plants outcompeting arundo) and may open up new niches for undesirable vegetation. In addition, wildlife forage is eliminated. Another disadvantage of chopping, cutting or mowing is that perennial weeds usually require several cuttings before the underground parts exhaust their reserve food supply. If only a single cutting can be made, the best time is when the plants begin to flower. At this stage the reserve food supply in the roots has been nearly exhausted, and new seeds have not yet been produced.

PRESCRIBED BURNING Flame Thrower: A flame thrower or weed burner device can be used as a spot treatment to heat-girdle the stems at the base of arundo plants. This technique has advantages of being less costly than basal and stem herbicide treatments and is suitable for use during wet weather; it cannot be used during periods of wildfire hazard. Its effectiveness is comparable to manual cutting. The timing of the treatment may affect resprouting behavior (Jones and Stokes Associates 1984).

Broadcast Burning: Large areas of weed infestation may be burned in order to remove the standing mature plants. This may be accomplished with or without a pre-spray of herbicides to kill and desiccate plants, Notably flammable plants usually do not require any pre-spray treatment. Used alone this method will not prevent resprouting from root crowns. Burning is best followed by 1) herbicide treatment of stumps, 2) subsequent burning to exhaust soil seed bank and underground food reserves, and/or 3) revegetation with fast growing native species. Other considerations for the use of prescribed burning include the time and cost of coordinating a burn, and the soil disturbance resulting from firebreak construction.

MANAGERIAL CONTROL Prescribed grazing: Giant reed is not very palatable to cattle, but during the drier seasons the animals do not hesitate to graze this species. The younger shoots are eaten first, followed by the upper parts of the older plants (Wynd et al. 1948).

In many areas of California the use of Angora and Spanish goats is showing promise as an effective control for *Arundo donax* (Daar 1983). In the Cleveland National Forest goats are herded for firebreak management of brush species on over 79,000 acres of land. Goats are less costly to utilize than mechanical and chemical control methods. They can

negotiate slopes too steep to manage with machines and do not pose the environmental dangers inherent with herbicides (Andres 1979).

A pioneer in the use of goats for weed control in urban settings is Richard Otterstad, owner of Otterstad's Brush Clearing Service (718 Adams St., Albany, CA 94706, (415) 524-4063). The primary weed control "tools" utilized by Otterstad's company are Angora goats and light-weight flexible fencing reinforced with electrified wire. Angora's are preferred over Spanish goats because their smaller size makes them easier to transport (Otterstad uses a pickup truck). Dairy goats were abandoned when Otterstad found them to be "goof-offs" when it came to eating (Daar 1983).

Goats prefer woody vegetation over most grasses or forbs; Angoras have a higher tolerance for non-woody species than do Spanish goats. Since goats will trample or browse virtually any vegetation within a fenced area, any desirable trees or shrubs must be protected.

Sheep are more selective than goats in their food choices but function well in grazing down a variety of plants. Sheep in feeding experiments may survive for extended periods on a strict diet of *Arundo donax* (Fratteglani-Bianchi 1963), thus sheep may be another practical alternative to mowing.

It is important to properly manage sheep grazing to prevent soil compaction problems which may occur when sheep are allowed to graze an overly damp area. Sheep are valuable not only for weed control but also for additional income from the sale of their wool and their contribution of fertilizer to the soil. However, it is possible that seed re-introduction may occur from the sheep droppings.

Geese, especially the more wild breeds, are known to be very active and effective weeders of grass and sedges (Andres 1979). This suggests that making an area attractive to waterfowl might contribute to arundo control efforts.

BIOLOGICAL CONTROL The term "biological control" is used here to refer to the use of insects or pathogens to control weeds. The introduction of exotic natural enemies to control plants is a complex process and must be thoroughly researched before implementation to prevent biological disasters. Such tools are not normally suitable for preserve managers to implement.

Little is known about the actual effects of various pathogens and insects on the growth and reproduction of *A. donax*. However, numerous insects are known to feed on this species. The green bug (*SCHIZAPHIZ GRAMINUM*) has been observed to feed on arundo during the winter (Zuniga et al. 1983). In France *PHOTHEDES DULCIS* caterpillars may feed on it (Dufay 1979). *ZYGINIDIA GUYUMI* uses *A. donax* as an important food source in Pakistan (Ahmed et al. 1977). A moth borer (*DIATRAEA SACCHARALIS*) has been reported to attack it in Barbados (Tucker 1940). Although these insects may eventually prove to be effective in controlling arundo, it is unlikely that

insects or pathogens will be introduced as controlling agents because arundo is widely cultivated as a commercial crop.

Please notify the California Field Office of The Nature Conservancy of any field observations in which a native insect or pathogen is seen to have detrimental effects on arundo. These reports will be used to update this Element Stewardship Abstract. Management techniques which may encourage the spread of such species-specific agents may be desirable in controlling arundo.

CHEMICAL CONTROL Detailed information on herbicides are available in such publications as Weed Science Society of America (1983) or USDA (1984), and will not be comprehensively covered here. The Weed Science Society publication gives specific information on nomenclature, chemical and physical properties of the pure chemical, use recommendations and precautions, physiological and biochemical behavior, behavior in or on soils and toxicological properties for several hundred chemicals. In applying herbicides it is recommended that a dye be used in the chemical mixture to mark the treated plants and thus minimize waste.

Dowpon-C-grass-killer, based on sodium salts of dalapon and TCA, is applied as a full coverage foliar spray to control deep rooted perennial grasses. Arnold and Warren (1966) used it at a rate of 15 pounds per 100 gallons (plus 2 quarts of surfactant) in late spring and summer on *A. donax*. This rate gave good top growth kill in 2 to 4 weeks. A small amount of regrowth was evident in 6 months. Fall applications at the same rates resulted in no regrowth the following spring. Horng and Leu (1979) studied the effects of several herbicides on arundo in Taiwan. Glyphosate at 2-3 kg/ha showed slow control, effecting over 95% kill 3 months after application. 2,2 DPA at 6-8 kg/ha gave 80% kill within 25 days. Following either glyphosate or 2,2 DPA application with doses of paraquat showed much faster and more complete control. Paraquat alone at 0.72 kg/ha effectively controlled arundo. Two applications of paraquat was just as effective as a single application. Asulam did not adequately control *A. donax*.

Monitoring Requirements:

Monitoring is needed to determine the effectiveness of management practices.

Detailed observations focused on the vegetational change of the affected area over time will help to determine what method of control would be most efficient.

Monitoring Programs:

No quantitative monitoring studies of arundo were discovered in this research.

VI. RESEARCH

Research Needs (General):

Much more information on seed biology, seedling establishment, growth patterns, and synecology needs to be gathered about arundo. ^Of great interest is the importance of

sexual reproduction over vegetative propagation in the establishment of the plant in new locations. Does arundo produce viable seed in California?

Management Research Needs:

What are the most appropriate means of controlling arundo in riparian areas with minimal disturbance to the surrounding native vegetation?

VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

Bibliography:

Ahmed, M., A. Jabbar, and K. Samad. 1977. Ecology and behavior of *Zyginidia guyumi* (Typholocycloinae:Cicadellidae) in Pakistan. *Pak. J. Zool.* 9(1): 79-85.

Andres, L. 1979. Untitled. Unpublished manuscript. Copy on file at the Nature Conservancy, California Field Office, 785 Market Street, 3rd Floor, San Francisco, CA 94103.

Armer, A. 1964. Report by the statewide control committee of the California State Chamber of Commerce.

Arnold, W. J. and L. E. Warren. 1966. Dowpon C. Grass Killer - a new product for controlling perennial grasses such as Johnson grass and Bermuda grass. *Down to Earth* 21(4):14-16.

Cozzo, D. 1972. [Initial behavior of *Ailanthus altissima* in experimental plantation]. *Revista Forestal Argentina* 16(2):47-52 (in Spanish).

Daar, S. 1983. Using goats for brush control. *The IPM Practitioner* 5(4):4-6.

Dufay, C. 1979. [*Phothedes dulcis*, new record for the French fauna (Lepidoptera: Noctuidae)]. *Alexandria* 11(2):82-84 (in French).

Fratteggiani-Bianchi, R. 1963. [Possibilities of using the leaves of the common cane (*A. donax*) in animal feeding]. *Riv. Zootec.*, Milano 36(6):343-353.

Fuller, T. C. and G. D. Barbe. 1985. The Bradley method of eliminating exotic plants from natural reserves. *Fremontia* 13(2): 24-26.

Horng, L. C. and L. S. Leu. 1979. Control of five upland perennial weeds with herbicides. Pp. 165-167 in *Proc. 7th Asian-Pacific Weed Sci. Soc. Conference*.

Jones and Stokes Associates. 1984. Transmission right-of-way vegetation management program: analysis and recommendations. Prepared for Seattle City Light, Seattle, Washington. Copy on file at The Nature Conservancy, California Field Office, 785 Market Street, 3rd Floor, San Francisco, CA 94103.

Perdue, R. E. 1958. *Arundo donax* - source of musical reeds and industrial cellulose. *Econ. Bot.* 12(4):368-404.

Rezk, M. R. and T. Edany. 1979. Comparative responses of two reed species to water table levels. *Egypt. J. Bot.* 22(2):157-172.

Robbins, W. W., M. K. Bellue, and W. S. Ball. 1951. *Weeds of California*. California Dept. Agric., Sacramento.

Tucker, R. W. E. 1940. An account of *Dicraea saccharalis* with special reference to its occurrence in Barbados. *Trop. Agric., Trinidad* 17:133-138.

United States Department of Agriculture. 1984. Pesticide background statements. Vol. I: Herbicides. Agric. Handbook No. 633, U.S. Government Printing Office, Washington, D.C.

Veselack, M. S. and J. J. Nisbet. 1981. The distribution and uses of *Arundo donax* (abstract). *Proc. Indiana Acad. Sci.* 90:92.

Watson, H. K. 1977. Present weed control projections for the year 2001. Unpublished manuscript. Copy on file at The Nature Conservancy, California Field Office, 785 Market Street, 3rd Floor, San Francisco, CA 94103.

Weed Science Society of America. 1983. *Herbicide handbook*.

Wells, M. J., K. Duggan, and L. Henderson. 1980. Woody plant invaders of the central Transvaal. Pp. 11-23 in *Proc. 3rd National Weeds Conf.* South Africa.

Wynd, F. L., G. P. Steinbauer, and N. R. Diaz. 1948. *Arundo donax* as a forage grass in sandy soils. *Lloydia* 11(3):181-184

Zuniga, G.E., V. H. Argandona, H. M. Niemeyer, and L. J. Corcuera. 1983. Hydroxamic content in wild and cultivated Gramineae. *Phytochemistry* 22(12):2665-2668.

IX. DOCUMENT PREPARATION & MAINTENANCE

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