

# THE BIOLOGY AND ECOLOGY OF GIANT REED (*ARUNDO DONAX*)

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## Introduction

Invasive plants are receiving increasing attention because of the impacts of human activities on native vegetation and the continual introduction of exotic species into disturbed habitats. Riparian habitats are particularly susceptible to invasion by exotics because water acts as a dispersal agent and flooding creates openings in vegetation cover. *Arundo donax*, giant reed, is a vigorous, invasive perennial grass that has established and spread rapidly in California's riparian habitats. The presence of giant reed in these areas impacts water conservation efforts and causes a severe fire hazard during the dry season. Giant reed appears to replace native vegetation, which may impact endangered species such as the least Bell's vireo (*Vireo bellii pusillus*) in southern California. Although giant reed was introduced into California as an ornamental plant and for erosion control, it easily escapes cultivation and spreads rapidly along irrigation and drainage canals as well as in riparian habitats. Giant reed is thought to have originated in Asia, and is now widespread in Europe, North Africa, the Middle East, Australia, and North and South America.

In California, numerous state and private agencies are actively working towards removing giant reed from riparian habitats. Some of the issues complicating these efforts are regulations regarding use of heavy machinery and herbicides in riparian habitats, the need in some areas for restoration for mitigation purposes, and the lack of biological information on giant reed with which to design effective management. The lack of biological information is surprising given the many real and potential uses of giant reed described in the literature, such as for reeds in woodwind instruments, for biomass as an energy source, and for production of allelochemicals for deterring pests. Despite these uses, giant reed currently has little commercial value in North America and its presence in riparian habitats is a serious problem.

## Biology of Giant Reed

Giant reed is a large-statured perennial species in the grass family (Poaceae) and is the most common of the six species in the *Arundo* genus. This plant has many common names including giant reed, bamboo reed, giant cane, donax cane, and reed grass. It can grow up to 25 feet in height with stems up to 1.5 inches in diameter that root at the nodes. In southern California, emergence of primary shoots begins in spring and peaks in early summer. Plants grow vigorously during summer, flower in fall, and go dormant in winter. During the following year secondary branching occurs. Giant reed possesses a deep, fibrous root system and large creeping rhizomes. It is a hydrophyte, growing best near water, which has facilitated its establishment and spread in riparian habitats throughout warm, mostly coastal freshwaters of North America, including the southwestern United States. While flowers are often seen, seed production is apparently absent in North American populations and vegetative reproduction

predominates, similar to many other clonal species. Dispersal of vegetative propagules (fragmented stem and rhizome pieces) of giant reed typically occurs during winter floods. The rapid spread of giant reed, a C<sub>3</sub> species, is likely due to high rates of photosynthesis and productivity, which are comparable to those of some C<sub>4</sub> species. Its occurrence in habitats from the Pacific coast inland to the Mojave Desert in California is indicative of plasticity in adaptation to a wide variety of growing conditions; in addition, propagules will sprout under a range of environmental conditions. It is not surprising that this species has become a serious riparian invader; however, little is known about its development, phenology, and rate of spread or its response to environmental factors.

### **Research Findings at UCR**

Management of giant reed often results in severed pieces of stems and rhizomes, which can easily reinfest a site. We conducted controlled experiments on sprouting potential of vegetative propagules, effects of propagule storage duration and conditions on sprouting, and survival and growth of propagules in various soil types and moisture regimes. In all experiments, over 90% of stem and rhizome pieces with at least one node sprouted. Stem sprouting was affected by prior storage duration, temperature, and moisture, while only storage duration and moisture affected rhizome sprouting. Sprouting was reduced by drying propagules at 30°C for one week and by storage in a soil slurry. After 16 weeks, even propagules maintained optimally in moist soil showed reduced sprouting. Rhizome pieces sprouted readily from 25 cm, while stem pieces sprouted from less than 10 cm. Responsiveness of giant reed asexual reproduction to environmental cues suggests that mechanical control can be achieved by careful timing and treatment of cut biomass pieces to minimize or inhibit resprouting.

To examine seasonality of giant reed sprouting, vegetative propagules were collected monthly from two southern California sites and planted in a greenhouse over one year. Rooting and emergence frequency of planted pieces, and time to emergence, growth rate and number of developing shoots were recorded; soluble carbohydrates were analyzed. Response variables were regressed against climatic, seasonal and site effects using a stepwise model. Rhizomes established much more frequently than stems in all months. Time of year of collection was found to be the most important factor determining establishment of all propagule types. The interaction of maximum daily temperature and precipitation at the field sites had a lesser, but significant effect on rooting frequency. The lack of a consistent correlation between any of the response variables and climate or site may indicate broad environmental tolerance. Seasonal patterns in emergence, growth, and soluble carbohydrates suggest that control by shoot removal would be most effective in fall when rhizome carbohydrate reserves are the lowest, resulting in the greatest reduction in regrowth. Chemical control with phloem-mobile herbicides would be most effective in late summer or early fall, when carbohydrates are moving from leaves to below-ground structures, but prior to natural leaf senescence.

We also conducted field research to evaluate demography of giant reed populations in two California riparian communities. Sites differed in the seasonal pattern of precipitation and in resource availability, as effluent from a water treatment plant enriched nitrogen in surface waters

at one site. Quadrats were established along 100 m transects at each site and oriented across the advancing fronts of established populations. Morphology and phenology were assessed monthly over one year for calculation of demographic parameters and rhizomes were excavated and mapped at the end of the experiment. No shoots in any of the quadrats flowered during the experimental period, supporting the observation that giant reed is obligately asexual in California. Seasonality affected the number of sprouts, spreading rate, and shoot deaths at both sites. Plant factors related to rate of spread included spatial advance of populations from buds on rhizomes and shoots as well as age and maturity of the populations. Giant reed at the nutrient-enriched inland site appeared to be spreading more rapidly than at the coastal site as evidenced by greater production of new shoots and higher linear and areal additions to clumps. At the coastal site, most clumps were dense at the beginning of the research and giant reed spread more slowly there than inland. However, several recently established clumps were found in gaps at the coastal site suggesting a greater frequency of flood-mediated dispersal of giant reed propagules. Inferences about local population invasiveness and hence, development of local management strategies for giant reed, could be made from the condition of the populations and their habitats.

### **Management of Giant Reed**

It has been estimated that 90% of the riparian habitat in southern California has been lost to agriculture, urban development, and other human impacts. Giant reed and other exotic invasive species threaten the remaining 10%, thus, management of this weed is critically important. Eradication of giant reed is impossible due to the depth of viable rhizomes and ease of movement of propagules in water. Therefore, prevention is particularly important, especially of infestations upstream of any area under active management. Unfortunately, no natural enemies have been found that would be potential biocontrol agents and in fact, giant reed is known for possessing an array of secondary chemicals that appear to deter insects. Management techniques available for giant reed include mechanical and chemical methods, as well as cultural control through restoration of competitive native species. The specific approach used must be tailored to the habitat, including the presence of native species and wildlife, terrain, season, etc. In all cases, the key to effective management of this weed is destruction of the belowground biomass.

Mechanical control of giant reed is commonly attempted using bulldozers, chainsaws, brushcutters, and hydroaxes, which, although effective at removing stems, are very destructive to fragile ecosystems. However, they are often the preferred means of control in solid monoculture stands of giant reed with little remaining native vegetation. Even after these methods are used, the problem remains of how to dispose of giant reed biomass. Cut stems may be left to dry with little threat of sprouting unless they are cut up, which separates the nodes and encourages sprouting from axillary buds. Stems chipped into pieces so small that nodes are damaged do not sprout and may be left on the site. Following stem removal, some means of killing the rhizome biomass is necessary to prevent resprouting.

The most common herbicidal treatment against giant reed is glyphosate, primarily in the form of Rodeo®, which is registered for use in wetlands. The most effective applications are made after flowering but before the winter dormant period, when plants translocate carbohydrates to belowground roots and rhizomes. Methods that have been used include foliar applications in late summer followed by removal of dead stems several weeks later, direct applications by painting or spraying herbicide on cut stems, and cutting of stems in spring followed by foliar application to shoot regrowth. Aerial spraying in some areas has also been used to control giant reed. All treatments require vigilant follow-up care.

## Conclusions

In spite of some attractive ornamental qualities of giant reed, it is a serious invasive weed in California and other coastal parts of the US. Its vigorous growth, prolific vegetative reproduction, adaptation to disturbance and fire, lack of herbivores and competitors, and unsuitability for food or habitat for wildlife make it one of the major threats to native riparian habitats in the western US. Management of giant reed requires a whole watershed approach since it moves and establishes readily downstream. To date the best control is achieved by a combination of mechanical and chemical means in combination with replanting of native species. However, greater understanding of the biology of this weed is desperately needed to improve its control.

## References on Giant Reed

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