

Weed Eradication: Realistic Goal or Pipedream?

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The concept of pest eradication in general and weed eradication in particular is somewhat controversial; many people believe that pest eradication is an impossible goal. However, the experience of the California Department of Food and Agriculture (CDFA) is that pest eradication is an achievable goal, given the right approach. The objective of this paper is to illustrate some of the principles of weed eradication and to outline some of the characteristics of a successful eradication program.

What exactly does eradication mean? It means that every plant or plant-part capable of reproduction is removed from a defined area. By tradition, the CDFA uses the county as the defined area. To contrast eradication with control: whereas eradication is the removal of all plants or plant-parts capable of reproduction, control means the temporary suppression of plant germination, emergence, or growth sufficiently so that crop, forest, or range production, or other goals such as highway safety or water movement, can be achieved for a season. Once eradication is achieved, treatments can stop; with control, treatments must continue year-after-year into the future, without end.

Weed eradication programs are most effective at the "pioneer" stage of weed invasion. Non-native weeds can be thought of as invaders. A new weed can move from an alien situation (outside California's borders) to be introduced into the state via various pathways. Pathways to introduction include man-made vectors such as car and truck traffic, aircraft, boats and ships, and pack animals and hikers; they also include natural vectors such as wind, rivers and streams, water fowl, and wild life. Once introduced, the new weed forms what I'll call "pioneer" populations: populations that are relatively small, and are not yet a permanent feature of the plant community. Many new weed infestations probably die out at this stage from natural causes such as competition from native vegetation. However, a small number of new weeds have the biological and agronomic ability to adapt and grow well in their new home, and they begin to proliferate and overcome the native vegetation. I'll call this the "colonization" stage. If nothing is done to stop the spread of the weed, it eventually becomes a part of the state's ecology; I'll call this the "establishment" stage. (See Figure 1).

The appropriate weed control strategy depends upon the stage of invasion on a new weed. While the weed is alien, outside California, prevention and exclusion strategies are appropriate and effective. These include the California CDFA Border Stations that intercept truck and trailer traffic, and in some locations passenger car traffic, to inspect for agricultural products that could

bring unwanted insects, diseases, and weeds into the state. Once a weed has entered the "pioneer" stage of invasion, the most appropriate control strategy is eradication. It is at this stage, and the beginnings of the "colonization" stage, that eradication techniques have a reasonable chance of being successful. Once well into the "colonization" stage, and into the "establishment" stage of invasion, weed populations are too large and extended for eradication to work, and control strategies must be adopted. (See Figure 1).

Weed eradication is most effective at the "pioneer" stage of invasion, but can also be effective at the beginning of the "colonization" stage, depending upon the nature of the weed and the resources available to eradicate it. In any case, the smaller the original population, the greater is the likelihood of eradication success. The World Conservation Union states in its guidelines "The best opportunities for eradicating or containing an invasive species are in the early stages of invasion, when populations are small and localized" (IUCN 2006). Rejmanek and Pitcairn studied the history of successful weed eradication projects by the CDFA (Table 1) and concluded "With the exception of *Cucumis* [dudaim melon] ..., all gross infestations were smaller than one hectare when they were detected" (Rejmanek and Pitcairn 2002).

In addition to the successfully completed eradication programs listed in Table 1, the CDFA also has many on-going weed eradication programs including hydrilla, alligatorweed, wormleaf salsola, Scotch thistle, and camelthorn. Based on this experience, I believe that weed eradication can be divided into three phases, as follow: the "discovery" phase, the "control" phase, and the "eradication" phase. The "discovery" phase starts with the first discovery of a new weed in California, and can usually be described by a population that is limited in area, but growing and spreading, with many "pioneer" populations around the main infestation. This phase usually requires treatment with a low cost weed control method that can be applied over a larger area. This usually means herbicide use, though some mechanical treatments may also be effective. The "control" phase starts after weed control treatments begin and the initial population begins to decline. Small "pioneer" populations are controlled or eradicated. As the number of plants declines, weed control treatments need to become more directed. Spot sprays of herbicides and hand removal may become effective treatments. In the "eradication" phase, only isolated plants or zero plants or plant-parts are found. This phase requires the use of highly directed treatments when these isolated plants are detected. At this stage, spot sprays of herbicides and hand removal of individual plants and underground plant-parts are the most commonly used weed control techniques. The "eradication" phase is also characterized by long-term survey and monitoring of previous infested sites to ensure that no new plants emerge. The level of total effort may not decrease in the eradication phase, but the bulk of the work shifts from treatment of existing populations to survey and search for surviving plants or plant-parts (seeds, tubers).

To be successful, weed eradication requires adequate government authority and support of the local community. In general, government authority is required to establish quarantine zones and support eradication programs. Quarantine zones are needed to prevent movement of a new weed

into non-infested areas, but also to ensure that new introductions are not being made into an area with an active eradication program. Government support of eradication programs is generally necessary for two reasons: first, the complete removal of all plants or plant-parts from even a small area often requires considerable costs, which individual landowners are usually not willing or able to make; and second because all infested properties in given area must cooperate with the eradication effort if it is going to succeed. It makes no sense to eradicate a given weed from one property only to allow it to grow and spread unimpeded across the fence.

The California Legislature has given the CDFA authority and responsibility to eradicate noxious weeds from California. The Legislature has specifically named two weeds in the Food and Agriculture Code to be eradicated, hydrilla and camelthorn (Food and Agriculture Code Sections 7303 and 6048, respectively.) The Legislature has given the CDFA authority to control or eradicate other weeds (Food and Agriculture Code Sections 403, 5004, 5021-5027) and those weeds are named by regulation (California Code of Regulations Title 3 Section 4500.) In addition, the CDFA acts on behalf of the United States Department of Agriculture in the control and eradication of federally listed noxious weeds within the state.

To carry out the responsibility to control and eradicate noxious weeds, the CDFA classifies weeds according to the actions it intends to take (CDFA 2006). Based on the results of an ecological and economic risk analysis, the CDFA rates weeds in four classes: A, B, C, or Q. For A-rated weeds, the CDFA rates them as an ecological or economic a threat to California's agriculture or environment, and limited in extent of infestation. A-rated weeds are subject to statewide eradication and cannot be sold by plant nurseries or in other channels of trade. B-rated weeds are also considered a threat to agriculture or the environment, but are more widespread in distribution. B-rated weeds are subject to local eradication, at the discretion of the county Agricultural Commissioner, and cannot be sold by plant nurseries. C-rated weeds are also considered a threat to the state, but are generally widespread and subject to local control activities. The Q rating is a temporary rating and the CDFA treats these weeds as A-rated weeds until a full risk analysis can be completed. This rating system may be refined in the near future, but the essential goal of rating weeds according to the size of the infestation and potential risk/impacts to agriculture and the environment will be maintained.

The CDFA has found that local community support is also vital to the success of an eradication program. Local community groups include, but are not limited to, Native American tribes, environmental groups, fishing, hunting, and boating and other outdoor recreational enthusiasts, and local city and county governments. The CDFA conducts extensive public education and outreach to explain the actions that it is taking and the reasons for those actions, including the consequences of inaction. The CDFA has found that local communities can be very supportive of eradication programs once they understand the rationale behind them.

In addition to authority and local community support, a successful eradication effort needs an on-the-ground program. Based on the CDFA experience, I can define four components to such a program: early detection, rapid response, environmental compliance and monitoring, and long-term commitment. Early detection means finding an introduction of a new weed as early in the "pioneer" stage of invasion as possible. It requires constant survey of high risk areas (highways, airports, marinas, campgrounds) by as many "eyes" as possible. In addition, it requires help from the public to see and report a new weed. Early detection also requires that the CDFA maintain a Botany Laboratory to correctly identify any suspect new weed. Rapid response means that the CDFA and landowners bring all appropriate resources to bear against the new introduction in a timely manner. This can mean that plans, required permits, and funding sources be identified ahead of time. It also means that appropriate control strategies be implemented, usually including, but not limited to, herbicides and mechanical control. Environmental compliance means that the treatment program must be in compliance with all environmental laws, including the California Environmental Quality Act, and the federal Endangered Species Act. In addition the CDFA has a policy of conducting an environmental monitoring program for all of its eradication programs, including monitoring foliage, soil, air, and water, depending upon the nature of the treatment program. Long-term commitment means that funds and manpower be dedicated to follow up survey and treatment for several years after the last plants are detected to ensure that hidden seeds or tubers don't germinate, become established, and start a new introduction.

In conclusion, I believe that pest eradication in general and weed eradication in particular is an achievable goal. The CDFA has been conducting weed eradication projects for decades, with an impressive track record. The key is to detect new weed introductions as early as possible, especially in the "pioneer" phase, respond rapidly with appropriate weed control techniques, maintain environmental compliance, and stay the course with follow up survey and treatments for the long term.

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Figure 1. Stages of Invasion for Weed Pests and Appropriate Control Strategies.

Stages of Invasion

Alien Introduction Pioneer Colonization Establishment



Appropriate Control Strategies

Prevention/Exclusion Eradication Control

Table 1. Weeds Eradicated by the CDFA in California.

Whitestem distaff thistle	Heartleaf nightshade
Dudaim melon	Torrey's nightshade
Giant dodder	Austrian peaweed
Serrate spurge	Wild marigold
Russian salttree	Syrian beancaper
Blueweed	Meadowsage
Tanglehead	Creeping mesquite