RESOURCES: BEST PRACTICES AND ALTERNATIVE APPROACHES TO PEST MANAGEMENT

IPM FOR INVASIVE SPECIES

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BACKGROUND

North America is home to many animals and plants that have been introduced since early European settlements. Many of the most damaging invasive animal species were originally introduced either for sport, as pets, or as livestock and pack animals. Invasive plants were introduced in a variety of ways, for example as crops, pasture and garden plants and to prevent erosion. Without their natural enemies, some non-native plants became invasive, reducing the diversity and quantity of native plants. Millions of acres of once healthy, productive rangelands, forestlands and riparian areas have been overrun by noxious or invasive weeds. They are invading recreation areas, public lands, National Parks, State Parks, roadsides, stream banks, federal, state, and private lands. Invasive weeds destroy wildlife habitat, reduce opportunities for hunting, fishing, camping and other recreational activities, displace many threatened and endangered species, reduce plant and animal diversity because of weed monocultures- single plant species that over run all others in an area, disrupt waterfowl and neo-tropical migratory bird flight patterns and nesting habitats, cost millions of dollars in treatment and loss of productivity to private land owners.

Invasive species also include disease-causing organisms such as fungi and viruses. These organisms can be a threat to a wide variety of native plants and animals. Some of these have become invasive — they have spread and multiplied to the point where they damage the environment, threaten the continued existence of native plants and animals, or create significant problems for agriculture.

What can we do about invasive species?

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It would be desirable to rid USA of the worst invasive species, but this is not achievable in most cases. Thus, management of invasive species conventional or biological, focuses on reducing their impacts as cost effectively as possible. Management may involve eradication of the pest particular area, repeated reductions of pest numbers for periods of time, lasting reductions of pest numbers, removal of the most destructive individuals or exclusion of the pest species from an area. This approach means that control can be targeted — for example, to protect a threatened native species. Interactions between native species and invasive species are often hard to measure and can complicate decisions about controlling the invaders.

Control methods for invasive plant species include use of herbicides, manual removal, controlled burn and ploughing in. Problems that may arise from the use of herbicides include the pollution of waterways and the killing of native insects and small invertebrates.

Conventional techniques for control of invasive animals include fencing, trapping, poisoning and shooting. There has been some community concern for the welfare of invasive animals and it is now generally accepted that any pest control program must be humane and must have minimal impact on non- target species.

Biological methods to control pests include the use natural enemies such as predators, parasites and disease-carrying bacteria or viruses. Biological controls are most effective if used in combination with conventional methods. In California, the Biological Control Program

is an integral component of the Plant Health and Pest Prevention Service's (PHPPS) Pest Prevention Program. The program helps to minimize the economic and environmental impact of noxious weed and insect species through the implementation of biological control programs throughout the state.

In 1999, President Clinton signed an Executive Order #13112 that legally defined an "invasive species" as a species that is

1. Non-native (or alien) to the ecosystem under consideration and
2. Whose introduction causes or is likely to cause economic or environmental harm, or harm to human health.

Invasive species can be plants, animals, and other organisms, such as microbes. Human actions are the **primary** means of invasive species introductions.

From the management perspective, invasive species can be categorized as follows:

Terrestrial Plants

Terrestrial Animals

Aquatic & Wetlands Plants

Aquatic & Wetlands Animals

Microbes

The Federal Government, working with the states and territories, is supporting research and developing management plans to reduce the impact of invasive species on USA's native plants and animals and on agriculture. Invasivespecies.gov is the gateway to Federal efforts concerning invasive species. On this site you can learn about the impacts of invasive species and the Federal government's response, as well as read select species profiles and find links to agencies and organizations dealing with invasive species issues. Invasivespecies.gov is also the Web site for the National Invasive Species Council, which coordinates Federal responses to the problem. The website also provides specific state information, for example Invasive Species: California.

The web site of the Animal and Plant Health Inspection Service (APHIS), a department within U.S.D.A., also includes a Hot Issues page and an Emerging Pests page that provides information, and updates on current problems. APHIS also maintains several pest lists containing species considered a threat or possible threat to American animals, plants, ecosystems, agriculture, and agricultural trade.

Laws & Regulations

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Federal

- Executive Order 13112 established the National Invasive Species Council
- Invasive Species Bills - 108th Congress
- Invasive Species Bills - 107th Congress
- Congressional Hearings and Testimony
- Federal Acts, Agencies, and Authorities pertaining to invasive species
- Federal Laws & Regulations

State

- California Laws & Regulations
- California Weed Laws

International

- International Legal Instruments with Programs / Activities pertaining to invasive species
- Codes of Conduct / Guidelines pertaining to invasive species
- International Conventions
- DECLARATIONS & REPORTS

Invasive & Noxious Plant Species

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Native plants evolved over millions of years to fill unique ecological niches. What we know as weeds today (non-native, ecologically damaging plants) did not exist in the wilderness then. These plants developed in and are native to other countries. Like our native plants, they are kept in check in their native environment by insects or diseases and by competition with other species. In order to survive in their native ecosystems, many plants develop characteristics that make them especially hardy.

The term "weed" means different things to different people. In the broadest sense, it is any plant growing where it is not wanted. Weeds can be native or non-native, invasive or non-invasive, and noxious or not noxious. Legally, a noxious weed is any plant designated by a Federal, State or county government as injurious to public health, agriculture, recreation, wildlife or property. A noxious weed is also commonly defined as a plant that grows out of place (e.g., a rose can be a weed in a wheat field) and is "competitive, persistent, and pernicious.

Invasive plants include not only noxious weeds, but also other plants that are not native to this country. Plants are invasive if they have been introduced into an environment where they did not evolve. As a result, they usually have no natural enemies to limit their reproduction and spread. Some invasive plants can produce significant changes to vegetation, composition, structure, or ecosystem function. California's pest prevention program addresses pests that are not native to the state.

Noxious weeds are non-native plants that are highly destructive, competitive or difficult to control. California State law requires both private and public landowners to eradicate certain plants, prevent seed production and prevent the spread of state listed noxious weeds. Noxious weeds are designated in several classes. Biologists of the California Department of Food and Agriculture (CDFA) recommend plants for listing, after consultation with outside experts and the Agricultural Commissioners of California's counties (CACs). If a plant is found to probably be "troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species, and difficult to control or eradicate", the Department will designate the plant as a noxious weed. At the time that CDFA lists a species, it also receives a rating of A, B, C, D, or Q. For example Class A weeds have a limited distribution in California. Control and eventual eradication of these species is required in California. Class B weeds are currently limited to portions of California. Class B weed lists will differ from county to county based on a weed's distribution, and each county weed board's policy. Control of certain Class B weeds may be required. Class C weeds are common throughout California. Counties can select priority weeds off the Class C list for mandatory control.

Encycloweedia web site provides list of CDFA defined noxious weeds and management programs. The California state noxious weed list is updated annually. The county weed control boards also adopt a weed list annually. Contact your county weed management area (Santa Clara Weed Management Area) for a full noxious weed list for your county. Contact the county noxious weed control program for educational and technical assistance on identifying, controlling, and preventing noxious weed infestations. In order to take assistance in identification, please remember that plant specimens in plastic bags or bottles always run the risk of arriving at the laboratory decomposed or "cooked" beyond recognition. To learn how to collect and submit the botanical sample for identification, follow the directions as described at the Encycloweedia web.

Reduced Risk Strategies to Control Invasive & Noxious Plant Species

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The primary emphasis of the Noxious Weed Control IPM Project is prevention, education, and technical assistance. Within it county agriculture departments inspect seed and plant shipments to intercept and exclude exotic weeds.

Follow these Integrated Pest Management techniques when dealing with noxious weeds:

- Prevent noxious weed problems. Learn how to identify noxious weeds, and employ strategies for controlling or eliminating them.
- Monitor for the presence of noxious weeds and weed damage.

- Treat noxious weed problems to reduce populations by using strategies such as **biological**, cultural, mechanical, and chemical control methods. Always consider human health, ecological impact, feasibility, and cost-effectiveness.
- Minimize the use of chemical pesticides by using alternative control methods and chemical controls correctly.
- Evaluate the effects and efficacy of noxious weed control treatments. The methods of control include pulling, repeated mowing, digging to eliminate all roots and rhizomes, cutting and bagging to remove seeds, use of landscape fabric, replanting with appropriate species, and in some cases herbicide applications. It is usually necessary to recheck the site for newly emerging seedlings and plants missed in previous control efforts.

Additional guidelines regarding noxious weeds include:

- Learn to recognize and eliminate noxious and invasive weeds before they establish.
- Choose non-invasive species for landscapes and gardens.
- Prevent noxious weed infestations by checking vehicles, clothing and equipment for weeds and seeds.
- Remove or control weeds safely and appropriately. The most important step is to control seed production by cutting down and bagging noxious plants.
- Protect yourself when working with noxious weeds, some such as hogweed and leafy spurge contain toxins that can damage skin on contact.
- Replant with appropriate species to prevent weeds from returning.
- Dispose of noxious weeds and weed seeds properly. Consult with the county program for specific recommendations. Do not compost any noxious weed debris that may contain seeds or plant parts that might take root.
- In cases where noxious weeds may impact habitat (aquatic or terrestrial), control measures may need to be taken to restore the habitat functions.

Biological control is a term used when living organisms are used to control weeds. Beetles or weevils are used as bio-controls, but so are moth larvae, goats and even fungi or rusts. Biological controls can control the target weed directly or indirectly, but they will not eradicate the plant population from a site. Weeds are directly impacted when the bio-controls destroy plant parts that prevent growth, or prevent seed production. Bio-controls also impact a weed indirectly when the stressed plants are no longer able to out compete native or beneficial plants on a site. It can take 4 to 5 years for any visible signs of weed control, making this an effective tool in a long-term control plan. Releasing biological control agents is an option on sites with large stands of weeds, when immediate control is not possible. Under the Biological Control Program at CDFA, several projects are underway, for example, biological control of Yellow Star Thistle, Purple Loosestrife, Bull Thistle, Mediterranean Sage and Leafy spurge, For more information follow the link Biological Control in the Weed Control Method Handbook, published by The Nature Conservancy.

Details on other reduced risk strategies are also discussed in the Weed Control Methods Handbook. Sections found within the handbook include Manual & Mechanical Techniques,

Grazing, Prescribed Fire, and Guidelines for Herbicide Use, Adjuvant, Cut Stump Herbicide Applicator, and Spot Burning. All sections of the handbook are downloadable.

The *Weed Workers' Handbook* published by the Watershed Project and the California Invasive Plant Council **(Cal-IPC)**, also explains how to remove more than 35 of the San Francisco Bay Area's most invasive plants. The *Handbook* provides a simple, strategic approach to dealing with wild land weeds, guidelines for how to plan and lead volunteer control projects, descriptions of the techniques used to control wild land weeds, tool illustrations and a chart explaining how each tool can be used, color illustrations, detailed descriptions, and thorough explanations of the best ways to control the Bay Area's worst weeds.

Invasive plants of California (also available in Online version), a book provides specific information about the biology and control of the 78 nonnative plant species that are listed by the California Exotic Pest Plant Council (CalEPPC) as being of greatest ecological concern in California. The book consists of species accounts, each description illustrated with a close-up photo, a habitat photo, and line drawings showing details to aid identification. The text addresses the following questions about each species: How do I recognize it? Where would I find it? Where did it come from and how does it spread? What problems does it cause? How does it grow and reproduce? How can I get rid of it?

The following databases will further your understanding of invasive plant species management in California:

Database: CalWeed Database
Host: California State Department of Food & Agriculture; California Interagency Noxious Weed Coordinating Committee; U.S. Bureau of Land Management; University of California-Davis
Scope: This database contains weed eradication project profiles, including many invasive weeds, in California. Profile data include: targeted invasive name(s); targeted species for (re) introduction; project location; lead and participating agencies; controls used; time frame for project; resource issues; and project contact information. Users can view the data by project, by targeted invasive, by county, or by control method.

Database: CalFlora Database
Host: CalFlora Database Project is a collaborative project of the USDA Forest Service, UC Berkeley Digital Library Project, United States Geological Survey (USGS), UC Davis Information Center for the Environment, Santa Barbara Botanic Garden, and others.
Scope: CalFlora provides information on California plant biodiversity for conservation, research, and education. This database contains summary geographic and ecological distribution information for 8,363 California vascular plant taxa, as well as additional habitat information for rare taxa and species of the Sierra Nevada.

Invasive Animal Invaders and Pathogens

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Common vertebrate invasive species in the continental United States include nutria, house sparrows, European starlings, and commensal rodents (roof rat, Norway rat, and house mouse). In Hawaii and in some continental U.S. States, feral pigs (wild boar), goats, and cats have severely impacted natural and environmental resources. Additionally, numerous invertebrate invasive species have become established in the United States, including zebra mussels, Red imported fire ants, Africanized honey bees, Asian long horned beetles, Mediterranean Fruit Fly, and Glassy-winged sharpshooter, Palm Leaf Skeletonizer, to name a few. The Nature Conservancy, UC Davis website has image database that provides images of various invasive animal invaders and pathogens.

There are many harmful insect pests and plant diseases that put California's environment and economy at risk. The website of Pest Detection/Emergency Projects Branch of CDFA provides the list of significant invertebrate pests and diseases of plants. Under the Biological Control Program at CDFA, several projects are underway, for example, biological control of Ash Whitefly, Cotton Aphid, Giant Whitefly, Silver leaf Whitefly, Olive Fruitfly, Red Gum Lurp Pysllid, and Pink Hibiscus Mealy bug.

Invasive Diseases, Fungi and Parasites

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Invasive diseases, fungi and parasites in USA affect many native plants and animals and agricultural crops. Quite often when plants and animals have come into contact with introduced diseases, fungi or parasites they do not respond well to treatment. Vaccines are often very expensive to produce and, in the case of animals in the wild, it would be very difficult to catch and treat each one. Some diseases have been blamed for causing mass die-offs of species leading to some species becoming endangered or even extinct. For example, *Phytophthora ramorum* is a fungus-like organism that causes Sudden Oak Death occurs in the environment in 13 counties in California (Alameda, Contra Costa, Humboldt, Lake, Marin, Mendocino, Monterey, Napa, San Mateo, Santa Clara, Santa Cruz, Sonoma, Solano). Pitch canker is another fungal disease of Monterey, Bishop and other native and ornamental pines.

Invasive Species Management

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Databases

Invasive species are usually widespread across USA and eradication is either currently not achievable or is impractical. Effective diagnosis, monitoring and managing these species, through activities such as quarantining or enforcing existing quarantine measures can help reduce the spread of invasive species into high conservation areas. Invasive species management information in available at the following web based databases:

General Guides

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The following links will also assist you to further your knowledge about Invasive Pest (Weeds, Insects & Diseases) management in parks, rangelands, and unincorporated areas: Resources marked with ● denotes "Editor's Choice" recommendation.

- ● Guide to Poisonous Plants- Colorado State University
- ● Integrated Vegetation Management Guide for Noxious Weeds
- ● Manager's Tool Kit
- ● Bug Mobile versus The Invasive Species Lesson Plan & Video for Grade 7-12 – An award-winning project of Pennsylvania IPM Program
- APHIS Federal Noxious Weed Program
- APHIS Pest List
- Arundo Project
- Asian Longhorned Beetle Web Site - All you ever wanted to know about the invasive pest - photos, in the news, biology, identification, research, locations of infestations, etc from Univ. of Vermont.
- Biological Control of Bull Thistle
- Biological Control of Knapweeds
- Biological Control of Non-Indigenous Plant Species (Cornell Univ.)- Background, research projects, resources.
- Biological Control of Purple Loosestrife
- Biological Control of Weeds - Resources
- Biological Control of Yellow Star Thistle
- Bureau of Land Management's Weed Website- Weed Wanted posters, publications, weed management info, national strategy.
- California Native Plant Society (CNPS)
- California Plant Identification Services
- California Weed Mapping Handbook
- California Weed Science Society
- Database of IPM Resources (DIR) Internet Resources in Weeds and Their Control
- Ecology & Management of Invasive Weeds Program – Cornell University

- Encycloweedia - Notes on Identification, Biology, and Management of Plants Defined as Noxious Weeds by California Law
- English Ivy
- Environmental Impact Statement for Freshwater Aquatic Weed Management
- Exotic Forest Pest Information System for North America - Searchable database that identifies exotic insects, mites and pathogens with potential to cause significant damage to North American forest resources. The database contains background information for each identified pest and is intended to serve as a resource for regulatory and forest protection agencies in North America.
- Federal Noxious Weed Program - USDA/APHIS site for legislation, fact sheets, links.
- Giant Hogweed Control
- Global Invasive Species Database - A searchable database by the Invasive Species Specialist Group (ISSG) for ecology, distribution, habitat, etc. on many global exotic invasive species.
- Global Invasive Species Program (GISP) - Ecology, current status, legal issues, and international meetings.
- Gorse Control
- Harmful Non-Indigenous Species in the United States - A link to the Office of Technology Assessment Publication (PDF files).
- Hawkweed Control
- Insect Parasite Nematodes – Tools for Successful Insect Control – Department of Entomology, University of Ohio
- Insect Parasitic Nematodes – Tools for Successful Insect Control – Department of Entomology, University of Ohio
- International Survey of Herbicide Resistant Weeds - Searchable database of resistant weed species along with other resources.
- Invasive Aquatic & Wetland Plants of the San Francisco Bay - Delta Region
- Invasive on the Web – The Nature Conservancy
- Invasive Pest Species: Impacts on Agricultural Production, Natural Resources, and the Environment - Issue paper by CAST to "provide policymakers and others with a nine-step guide to curtail the impact of non-native pests, including diseases, insects and animals." Includes links to illustrations of pests.
- Invasive Plants of California's Wildlands
- Invasive Plants, Changing the Landscape of America: Weed Fact Book - A comprehensive non-technical overview of invasive plants.
- Invasive Species Control
- Invasive Species Resources – A Gateway to Federal & State activities & programs
- Invasivespecies.gov - Federal web site detailing government efforts and providing detailed background information.
- Knapweed Control
- List of California Noxious Weeds
- National Arboretum Invasive Plants Page - Defines invasive plants and what can be done for control.
- North American Non-Indigenous Arthropod Database - Database of over 2,000 non-indigenous insects and arachnids.

- Noxious Weed Control in Santa Clara County
- Plants Database - From USDA NRCS, gives federal and state noxious plant lists.
- Poisonous Plant Informational Database
- Poisonous Plants to Animals in USA
- Policemen's Helmet Control
- Purple Loosestrife Mapping Project
- Scotch Broom & Spanish Broom
- Spartina Project – San Francisco Estuary Institute
- Sulfur Cinquefoil Control
- Suppliers of Beneficial Organism in North America - California Department of Pesticide Regulations
- Tansy Ragwort
- The Amazing Story of Kudzu - History of the invasive weed that has taken over the southern U.S., from University of Alabama.
- The Bugwood Network: Weeds - Images, information, and control for invasive forest weed species, from the Univ. of Georgia.
- The Nature Conservancy - Wildland Invasive Species Program - Weed management, control methods, success stories, FAQs, and more.
- Training Courses for Professionals
- U.S. Fish & Wildlife Service
- U.S. Fish and Wildlife Service Invasive Species Program - Covers federal mandates and legislation, Presidential Executive Order on Invasive Species, and publications.
- USDA Emergency Program Manual
- USDA Vegetation Management & Protection Research
- USDA, APHIS, PPQ Invasive Species and Pest Management
- USDA-Natural Resources Conservation Service
- USDA-NRCS, CA State-listed Noxious Weeds
- Weed Education Clearing House
- Weed Research and Information Center (WeedRIC)
- Weed Science Society of America
- Weeds Gone Wild - Alien Plant Invaders of Natural Areas - Compiled national list of invasive plants, illustrated fact sheets, control strategies, by Plant Conservation Alliance.
- Western Society of Weed Science
- What is a Noxious Weed
- What You Can Do to Prevent Species Invasion - How citizens can prevent invasive species through their actions regarding gardening, travel, buying pets and boating/fishing, from the Union of Concerned Scientists.
- Wildflowers & Weeds Home Page - Noxious weed profiles, weed links, weed control by sheep grazing and horse trampling, by Thomas Elpel.
- Yellow Star Thistle Mapping Project

Pest ID

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- California Plant Pest Diagnostic Laboratory
- Invasive Plant Species Images: Grouped by Genus name – The Nature Conservancy
- Purdue Plant & Pest Diagnostic Laboratory
- Weed ID FMC
- Weed ID Oregon State
- Weed ID Turfgrass UC
- Weed ID UCWRIC
- Weed ID Virginia Tech
- Weed ID WSSA
- Weed Identification Resources
- Weed Seedling ID IOWA State Cooperative Extension
- Weed Identification Online Interactive Quiz – Ministry of Agriculture & Food, Ontario

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