RESOURCES: BEST PRACTICES AND ALTERNATIVE APPROACHES TO PEST MANAGEMENT
RIGHTS-OF-WAY INTEGRATED VEGETATION MANAGEMENT

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BACKGROUND

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Rights-of-way (ROW) are the areas involved in common transport. They are essential for the proper functioning of a modern society and include:

- Federal, state, county, and township highways and roads;
- Public airports;
- Railroads;
- Electric utilities (including substations, switching stations, transmission lines, and distribution lines);
- Pipelines (including pumping stations);
- Public surface drainage ways;
- Public irrigation waterways;
- Banks of public barge ways and areas around locks and dams; and
- Bicycle, bridle and other public paths or trails (outside established recreational areas).

Reliability and public safety are of major concern across all rights-of-way with one specific issue of concern is the control of selected types of vegetation. Vegetation Management on rights-of-way is desirable and necessary for variety of reasons such as necessary to maintain a safe & clear sight distances, to clear signs and fixtures of vegetation for visibility and functionality, to provide adequate drainage in roadway ditches, to reduce fire hazard and provide snow or dust drift control. It is also necessary to protect the roadway surface from vegetation encroachment and to maintain drainage. Rights-of-way must also allow maintenance workers to perform their function without creating hazards to those that use and depend on the ROW. Managers of rights-of-way share common objectives, including user and worker safety, reduced fire hazard, and an assured ability to perform inspections.

Most ROW managers are also confronted with "noxious weeds." The Federal and State Executive orders require the Department to take steps to prevent the spread of invasive or noxious plants. Federal Executive Order 13112, signed by President Clinton on February 3, 1999 requires "authorities to (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species." Additionally, there are many issues unique to each type of right-of-way.

Management of ROW vegetation is a complex challenge and a formidable task that varies greatly from one location to another. Because no single practice or method is likely to give the desired long-term result, a primary goal of rights-of-way vegetation management is to design an appropriate combination of practices (integrated vegetation management (IVM)) that ensure the protection, operation, safety, stability, and longevity of the particular right-of-way in question. The term IVM means different things to different people. While an integrated program attempts to include all aspects of roadside vegetation control, the deployment of herbicides to achieve many of the goals and objectives of an authentic IVM program needs to be based upon the appropriate principles and practices of the much more

rigorously established ecological approach to IPM body of knowledge. It is also understood that vegetation management concepts and techniques need to address social and environmental issues such as, ***traffic safety***, ***water quality***, ***threatened and endangered species***, ***wetland protection***, ***native planting***, *and* ***noxious weed programs***. The management techniques utilized may include manual, mechanical, chemical, cultural, and biological methodologies. Those techniques, which will likely produce the least long-term disturbance to the natural and human community, should be practiced.

A problem, either actual or potential, must first be determined to exist and pose unacceptable risks; a cost benefit analysis of an array of ranges of cost-effective treatment alternatives should be given consideration; the timing of treatments should take into consideration the treatment window for optimum effectiveness and safety. Best management practices should be developed and records should be kept in a database (preferably GIS) for roadside maintenance, and the results of treatments should be monitored for effectiveness. Careful analysis of each situation is essential to reach this goal and to keep the costs at reasonable levels. Training of Rights of Way Vegetation Control Managers is essential to accomplish the same.

Laws & Regulations

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- California Laws related to Care of Vegetation
  - The Penal Code Section 384(a) – This section relates to the protection of native trees, shrubs, ferns, herbs, bulbs, cacti, flowers, huckleberry, or redwood greens. This law prohibits negligence including cutting and removing plants growing upon state or county highway right-of-ways, public land and land not owned by persons performing such acts without written permission from the owners
  - Streets and Highways Code, Section 730.5 – This code relates to the destruction of trees on state highways
  - Streets and Highways Code, Section 1495 – This code relates to injury to trees on highways
  - Streets and Highways Code, Section 670 – This section relates to removal or planting of trees and shrubs on State Highways
  - The California Environmental Quality Act (CEQA) – This law requires that any project that has a significant impact on the environment require an Environmental Impact Report (EIR). The annual vegetation control plan may be considered to be project under CEQA. In preparing an EIR, alternatives and mitigation measures must be considered. Once an EIR is prepared, the public reviews it and a decision is then made by the agency issuing the permit for the project as to whether or not to proceed with the project.
  - Laws – California Food & Agriculture Code 6,7 and 13; and California Code of Regulations Title 3 Division 6 – These sections relates to pesticide use.
- Public Agencies involved with cooperative enforcement vegetation control practices:

    - California Department of Health Services – develops regulations for worker safety and hazardous material disposal. They cooperate in pesticide illness investigations and monitor domestic water supplies.
    - Environmental Protection Agency – responsible for pesticide control. The EPA reviews state and county pest control programs for compliance with federal requirements.
    - State Water Resources Control Board and Regional Water Quality Control – The regional boards (RWQCB) regulate pesticide container disposal sites and water quality standards.
    - Air Resources Control Board and Regional Air Pollution Control Districts – The board and regional districts regulate dust control and buring.
    - Division of Occupational Safety and Health (Cal/OSHA) – is charged with protection of workers. It enforces laws and pesticide safety in formulations and manufacturing.
    - California Department of Fish & Game – cooperates in fish and wildlife loss investigations that may have been caused by pesticides
    - University of California – is charged with pest control research and providing technical education and awareness.
- Regulations regarding "Open Burn" - Bay Area Air Quality Management District (BAAQMD)
- Santa Clara County's Hillside Brush Abatement Program
- California Non Point Source (NPS) Pollution Control Program

Rights of Way Vegetation Management General Guides

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- denotes "Editor's Choice" recommendation.

- A Citizen's Guide to Maintaining Storm Water Best Management Practices – Lake County Storm Water Management Commission
- A Manual of California Vegetation – California Native Plant Society
- California Roadsides, A New Perspective Brochure – California Department of Transportation (Caltrans), also Vegetation Control Manual
- Environmental Concerns in Rights of Way Management – Key yourself refreshed on the research in the Pipeline
- Exploring Alternative Methods for Vegetation Control and Maintenance Along Roadsides – A final report by Hopland Research and Extension Center - UC Division of Agriculture and Natural Resources (Attach Internal PDF link)
- Forest and Right-of-Way Pest Control Pesticide Application Compendium, Volume 4 –UC Publication 3336 - 248 pages - $30.00This book, in an easy-to-read format, is the recommended study guide for preparing for the California Department of Pesticide Regulation's certificates and licenses that are needed by forest and right-of-way pesticide advisors, agents, pilots, dealers, and applicators.

- Frequently Asked Questions - These are some of our most frequently asked questions about our use of herbicides and their answers. – Western Massachusetts Electric
- Guidelines for Coordinated Management of Noxious Weeds: Development of Weed Management Areas – Western Weed Management Areas Organization (WMA)
- Model Certification Training Manual for Right of Way Pesticide Applicators – Produced by Purdue University, a comprehensive training manual, highly recommended for training right of way vegetation control personnel.
- Noxious and Nuisance Plant Management Information System (PMIS) available on CD free of charge from the US Army Corps of Engineers.
- Online invasive plant management course and textbook for land managers and products and information resources for all types of educators – Center for Invasive Plant Management
- Online invasive plant management course and textbook for land managers and products and information resources for all types of educators – Center for Invasive Plant Management
- Training Manual for Rights of Way Vegetation Management – University of Kentucky Cooperative Extension Service
- Understanding and Managing Invasive Plants in Wilderness and Other Natural Areas: An Annotated Reading List. USFS Rocky Mountain Research Station, General Technical Report RMRS-GTS-79-volume 4. September 2002. Order print copies via website.
- Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas - The Nature Conservancy, UC Davis
- The Weed Worker's Handbook: A Guide to Techniques for Removing Bay Area Invasive Plants – The Watershed Project, California Invasive Plant Council
- Weed Management Links from NAWMA (North American Weed Management Association)

Reduced Risk Controls

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Right-of-way vegetation management within the public agency varies from urban to rural settings. Rights of way vegetation maintenance activities are subdivided into the four basic control or management methods that cover the scope of integrated pest and vegetation management. These four areas of control are ***cultural***, ***physical/mechanical***, ***biological***, and ***chemical***. Specific actions within each area are considered Best Management Practices for rights-of-ways. The landscape architecture program of California Department of Transportation provides an extensive, including multi-modal transportation and facility design, visual impact assessments, aesthetics, mitigation, roadside management, resource conservation, regional planning, site planning and development, and sustainable design. At this website, the Highway Planting & Irrigation (Highway planting general policy, Native Grass database, Plant Spacing & Setback Guide) and Management Toolbox (for extended gore areas, guardrails & signs, medians, road edge, side slopes) are of particular interest

that describes various techniques in vegetation management on rights-of-way. The following links will also further your knowledge in this regard:

Cultural Control Methods

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- **Revegetation**: Can increase competition with weed species; can decrease reinvasion of weeds Establishing desired plants; can help meet land use objectives. Promote native plant in revegetation projects. Following links & information will further your understanding in this regard:
    - What is a Native Plant?
    - Why Grow Native Plants?
    - Where to find Native Plant Nurseries in California?
    - California Native Plant Society
    - Planting of Native non irrigated vegetation on Roadsides – California Department of Transportation
    - Planting of desirable irrigated ornamental vegetation to compete with undesirable vegetation – California Department of Transportation
    - Federal Guidance for Native Wildflower Planting Requirements on Roadsides – US Federal Highway Administration
    - Hydro-seeding & Hydromulching; Hydromulching is good for sites with limited access for machinery. It is particularly suited to revegetating steep banks such as road batters and the awkward slopes of creeks and drains. The special binders added to the slurry ensure the mixture adheres to the slope. Hydro-seeding & Hydromulching technology helps to control erosion on roadsides.
    - Restoration in the California Desert Vertical mulch for site protection and revegetation -Prepared for the California Department of Transportation as part of the Desert Plants Project
    - VegSpec is a tool for finding and selecting plant species appropriate to the climate, soils, and location of your revegetation projects. It incorporates a database of over 2500 plants and specific information for all U.S. climate zones and soils, and is available free through the USDA PLANTS website.
    - CIPM Restoration Database – Find hundreds of revegetation resources at Center for Invasive Plant Management
- **Use of Weed barriers** such as hardscape, poly pavements, weed mats, weed fabric etc. and seek road design improvements that prevent vegetation growth around signage, culverts, or where potential for surface run-off is high. Following links & information will further your understanding in this regard:
    - Use of Asphalt concrete pavement under guardrails – California Department of Transportation
    - Use of Aggregate base with emulsion to prohibit root growth – California Department of Transportation
    - Use of shorcrete as barrier under guardrails to prohibit root growth – California Department of Transportation
    - Use of patterned concrete on medians to prohibit vegetation growth – California Department of Transportation

    - Use of Rock Blanket a continuous hard surface to prohibit vegetation growth – California Department of Transportation
    - Use of Stamped asphalt concrete on medians to prohibit vegetation growth – California Department of Transportation
    - Use of Polyureas or elastomers on roadsides around signage and guardrails to prohibit root growth – California Department of Transportation
    - Use of Weed Control Mats (Fiber & Rubber) under signage and guardrails to prohibit root growth – California Department of Transportation
- **Use of Mulch & Compost**:
    - Use of Organic mulch on roadside –California Department of Transportation
    - Using Compost in Roadside Landscaping – RTA Australia
    - Use of Gravel Mulch –California Department of Transportation
    - Use of Compost and Shredded Wood on Rights of Way – Texas Department of Transportation
    - Compost Use on State Highway Applications – US EPA Wastes

Physical/Mechanical Control Methods

Following links & information will further your understanding in this regard:
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- **Mowing**: is effective if done at the correct time of the weed's growth cycle, but may stimulate growth. It requires multiple field entries over years to kill all weeds and generally requires reseeding. It is best as an element of a long-term plan. Incorrect timing may damage native plants. Mowing will not eliminate perennial weeds. Mow grass and brush at heights that avoid "scalping" of soil. Controlled disking to avoid “scalping” of soil. Mow native vegetation at heights that promote its growth.
- **Manual & Mechanical Techniques**
    - (Weed pulling, Mowing, Brush cutting, Weed eating, Stabbing, Girdling, Mulching, Tilling, Soil solarization, Flooding) - TNC Weed Control Methods Handbook
    - **Hand Pulling**: is labor-intensive. It is effective for small infestations. It may stimulate growth of rhizomatous or other perennial species. Promote volunteer programs to remove weed manually See the Organic Weed Management
    - **Mechanical Weed Control** using The Kimco 9300 - In-Row Vineyard & Orchard Tiller – A good piece of equipment to be considered for Right of Way Vegetation management in park trails, along roadsides, airports, etc.
- **Thermal Weed Control**:
    - Fire as a Tool for Controlling Nonnative Invasive Plants a comprehensive literature review of prescribed burning and weeds
    - Prescribed Fire - Best used to control invasive plants in the spring before flower or seed set, or at the sapling stage. It may stimulate increased reproduction by invasive species. It may burn too hot and damage soil. Controlled Fire should be followed by native plant vegetation.
    - Consult The Nature Conservancy's Fire Management Manual for Prescribed Fire Guidelines

- Spot Burning using propane torches - from TNC Weed Control Methods Handbook
- Weed Burners Optimal combustion with the aid of aimed direct flame burners, combined with infra-red radiation results in more effective weed burning, which makes a higher driving speed of the tractor possible. That cost to run the machine are drastically kept to a minimum, speaks for itself. Because there is less gas used in the "vapor phase", savings on maintenance will be at a maximum. Heat-sensitive components are not exposed to the heat of the burners because they are placed outside the burner compartment.
- Thermal Weed Control -Another example of commercial weed burner
- Organic Hot Foam Weed Control System – Waipuna: This technology needs to be demonstrated for large-scale adoption in Non-Crop production agriculture pest management such as right of ways total vegetation control.

Biological Control Methods

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Biological Control is the use of insects or other natural predators to control the growth or reproduction of a specific weed species. Predators usually come from the invasive plant's native habitat and are available commercially. Once established, they may support their own growth and expansion. They may attack different parts of plants at different times, but eventually may decrease seed production and growth rate. One or more biological control agents can be used at a time on a weed species. Following links & information will further your understanding in this regard:

- **Beneficial Predators:** Incorporate **biological controls,** such as use of beneficial predators, into the rights of way IPM practices wherever appropriate.
  - USDA APHIS Technical Advisory Group for Biological Control Agents of Weeds — TAG reviews petitions for biological control of weeds and provide an exchange of views, information and advice to researchers and those in APHIS responsible for issuing permits for importation, testing, and field release of biological control agents of weeds.
  - Biological control of invasive plants in eastern United States – Invasive.org
  - Biological control of invasive plants in United States – by Eric M. Coombs, Janet K. Clark, Gary L. Piper, and Alfred F. Cofrancesco, Jr. published by Oregon State University Press; An invaluable reference for land managers, natural resource and weed control specialists, and students of natural resource management, the book provides practical, science-based information needed for understanding and using biological control as part of an integrated invasive-plant management strategy. Illustrated with more than 300 photographs, this comprehensive, 450-page guide covers 39 target plants and 94 agents, as well as the theory and practice of classical biological control.
  - Biological control of invasive aquatic plants in lakes, rivers, springs, marshes, swamps and canals – An online guide by Center for Aquatic and Invasive Plants, University of Florida, and the Bureau of Invasive Plant Management, Florida Department of Environmental Protection

- Biological Control Agents – Images – Invasive.org
- Biological Agents by Target Weeds – Oregon Department of Agriculture
- BioControl Agent Matrix - BC Ministry of Forests. Search by weed common name to find bioagent and description.
- Biological Control – Copyright © 2005 Elsevier Inc.: Online Journal provides articles on Bio Control research.
- Biological Control – A Guide to Natural Enemies in North America: Cornell University - It is also a tutorial on the concept and practice of biological control and integrated pest management (IPM).
- Biological Control Virtual Information Center, maintained by the NSF Center for Integrated Pest Management at NCSU. Includes links to federal, state, university, nonprofit, and commercial biocontrol resources.
- Internet Resources on Biological Control – Database of IPM Resources from IPMNet
- An alternative to Chemical Herbicide Brush Control: *Chondrostereum purpureum*, the fungus provides an attractive alternate to chemical herbicide use in industrial vegetation management.

- **Living Systems**: Grazing by sheep, goats, cattle, or horses can control weed growth Sheep and goats most commonly used because they consume more weed forbs and shrubs than other animals. Effectiveness varies throughout season, depending on what stage of plant growth is the preferred food. Efficient management techniques and expertise have made planned goat grazing the most effective method for Fire Mitigation, Noxious weed abatement and safe Land Management. Animals must move to prevent over-grazing on desired vegetation. Following links & information will further your understanding in this regard:
  - Grazing from TNC Weed Control Methods Handbook
  - Recent Perspectives in Using Goats for Vegetation Management in the USA Published in J. Dairy Sci. 84(E. Suppl.): E170-E176. © The American Dairy Science Association, 2001.
  - Manipulating Diet Selection to Control Weeds, by Bret Olson, Range Science, Animal and Range Sciences Dept., Montana State University. In "Grazing Behavior of Livestock and Wildlife," Idaho Forest, Wildlife and Range Experiment Station Bulletin 70, University of Idaho
  - Livestock Grazing: A Useful Tool for Managing Noxious Weeds - Dept. of Rangeland Ecology and Management, University of Idaho. It also provides Links to several articles on the subject.
  - Controlling weeds with sheep & goat grazing - sheepandgoat.com has many resources from universities and agencies in the U.S., Australia, and New Zealand
  - Noxious Weed Grazing By Goats Demonstration Project - University of Idaho Extension, 2002. Describes reduction in knapweed seed head production in Lemhi County.
  - Controlling Leafy Spurge using Goats and Sheep - NDSU Extension Service, May 1995: describes management plan & formula to calculate lease value of goats and sheep

- "Rent-a-goat or sheep" services (Santa Clara County does not endorse any of these businesses. This list is to help you find grazing services in your area.)
  - Caprine Restoration Services, Bend, Oregon 1-800-898-4628
  - Ewe4ic Ecological Services, Alpine, Wyoming
  - Southern Oregon Goat Producers, Lakeview, Oregon, 541-947-269, hbsb@ptinet.net
  - Goats R Us - livestock are utilized primarily for fuel mitigation and star thistle eradication, although they have also gained quite a reputation for brush reduction projects.
  - Sheep Sites - University of Missouri Extension. Links to dozens of universities, agencies, and organizations.
- King Conservation District - launched an environmental grazing demonstration project.
- Controlling Leafy Spurge Using Goats and Sheep – North Dakota State University Extension Service
- San Francisco International Airport – Using goats to control weeds
- City of Menlo Park - has found some inexpensive but effective firefighters in the form of several hundred goats.
- San Francisco Public Utilities Commission – Using goats for Total Vegetation Control

Chemical Control Methods

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Chemical control methods are effective for rapid, short-term management; May require multiple applications; May work best if used in conjunction with other control methods; Choice of herbicide depends on type of weeds, proximity to water, and season; Certified herbicide applicator may be required; there may be herbicide-resistant weeds. Following links & information will further your understanding in this regard:

- **Seek softer chemical chemistries** (Bio-pesticides) like vinegar, clove oil, thyme oil, corn gluten meal etc., investigate their efficacy, cost life cycle, and adopt their use.
  - Bio-Pesticides Products & Ingredients – US EPA
  - Bio-Pesticides Active Ingredients Fact Sheets – US EPA
  - Plant Incorporated Protectants – US EPA
  - Corn Gluten Meal – A good invention, here you will find information regarding the use of corn gluten meal as a natural herbicide for use on turf and organic crop production. Corn gluten meal, has potential as a natural pre-emergence herbicide.
  - Organic Herbicides – Evaluation: Horticultural Sciences Department, University of Florida
  - Herbicide Effects of Essential Oils - Appalachian Fruit Research Station, USDA, ARS, 45 Wiltshire Road, Kearneysville, WV 25430; E-mail: ttworkos@afrs.ars.usda.gov
  - Alternatives to Pre-Emergent Herbicides - USDA-ARS, Department of Plant Pathology, University of California/ UC-SAREP, Department of Plant Pathology, University of California

- Vinegar as an Herbicide – Sustainable Agricultural System USDA : Contact Contact: Dr. Ben Coffman
- Organic Pre Emergent Herbicide Trails at Santa Clara County: For more information contact Craig Crawford, Parks Program Coordinator at 408-355-2200, Craig.Crawford@prk.sccgov.org
- Generic Materials List - Organic Materials Review Institute
- Exploring alternative methods of vegetation control along roadsides – Hopland Research & Extension Center, University of California

- **Use chemical option only as part of an integrated approach** to pest and vegetation management and seek use of low volume precision pesticide application tools to minimize pesticide use, surface run-off, drift hazard etc. Following links & information will further your understanding in this regard:
  - Guidelines for Herbicide Use – Chapter 5 from TNC Weed Control Methods Handbook
  - Herbicides, Chapter 7 from TNC Weed Control Methods Handbook – provides information on most commonly used herbicides
  - Adjuvant , Chapter 8 from TNC Weed Control Methods Handbook – Know about adjuvant to increase herbicide effectiveness and reduce overall spray volume
  - Pacific North West (PNW) Weed Management Handbook : published by Oregon State University - useful to company field representatives, commercial spray applicators and consultants, herbicide dealers, teachers, and some producers.
  - Low Volume Herbicide Applicators
    - Weedseeker Technology by N Tech Industries
  - Cut Stump Herbicide Applicator
  - Use of Herbicidal Geofabrics: Precision application to reduce herbicide use - California Department of Transportation
  - Herbicide resistant weeds and their management - Publication 18, chapter 5, “Weed Control Strategies,” in the Pacific Northwest Conservation Tillage
  - International Survey of Herbicide Resistant Weeds - WeedScience.com. Funded and Supported by the Herbicide Resistance Action Committee (HRAC), the North American Herbicide Resistance Action Committee (NAHRAC), and the Weed Science Society of America (WSSA).
  - Managing Herbicide-Resistant Weeds in Texas —View tables on herbicide-resistant weeds in Texas and adjacent states, as well as a list of articles about herbicide resistant weeds in other regions.
  - Promote Field scouting to identify area of concern; and make target specific control treatments
  - Follow all California State Department of Pesticide Regulation pertaining to pesticide application
  - Follow the waterways or buffer zone, riparian corridor protection guidelines as applicable
  - Follow Storm Water Pollution Prevention guidelines as applicable
  - Use only California State registered pesticides. Follow all label directions.
  - Do not spray in windy or wet conditions.

- Do not spray within eroded areas where vegetation would be beneficial.
- Carry spill kit appropriate for equipment and pesticide used.

Pest Identification

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- California Plant Pest Diagnostic Laboratory
- Purdue Plant & Pest Diagnostic Laboratory
- Weed ID Turfgrass UC
- Weed ID FMC
- Weed Identification Resources
- Weed Seedling ID IOWA State Cooperative Extension
- Weed ID Oregon State
- Weed ID Virginia Tech
- Weed ID WSSA
- Weed ID UCWRIC
- Weed Identification Online Interactive Quiz – Ministry of Agriculture & Food, Ontario

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