Integrated Weed Management Plan

1. Purpose

The purpose of this integrated weed management plan (IWMP) is to provide weed management guidelines that will:

- Implement the mandates of the Colorado Noxious Weed Act (Appendix A) by creating a plan for the control of noxious weeds using integrated control methods.
- Adhere to the Colorado Department of Agriculture's Rules Pertaining to the Administration and Enforcement of the Colorado Noxious Weed Act (Appendix B).
- Adhere to City Code (Appendix C).
- Adhere to the Colorado Pesticide Applicator's Act (Appendix D) and the Rules and Regulations Pertaining to the Administration and Enforcement of the Pesticide Applicators' Act (Appendix E).
- Consider the environmental, economic, and social impacts of different control methods.

This IWMP is intended to be a dynamic document. It will be reviewed and updated to reflect advancements in professional weed control management and changes in noxious weed infestation locations, sizes, and densities on City owned property.

2. Goals

- Protect visitor and applicator safety, water quality, non-target vegetation, federally protected endangered or threatened species, and local species of concern.
- Reduce the spread of weeds from City of Longmont properties to adjacent or downstream/downwind properties.
- Utilize the best available science to guide control techniques.
- Eradicate all known populations of List A species and List B species designated by the State for eradication.
- Survey and map all City properties for noxious weeds on a five year cycle.

3. Scope

This integrated weed management plan covers properties in which the City of Longmont is actively engaged in land management (Appendix F). Control of noxious weeds on private property within City limits is covered by the City of Longmont Municipal Code (Appendix C). All contractors hired by the City will be provided with and will be required to follow this IWMP. Furthermore, specific standard operating procedures will be required for different control methods, such as mowing and reseeding native vegetation.

The City manages approximately 2500 acres of Open Space, 1654 acres of district parks, 253 acres of community and 192 acres of neighborhood parks.

Latest monitoring efforts conducted in 2014 indicate that there are at least 37 different species of noxious weeds found on City lands ranging from State categories A, B, and C list species as well as various other nuisance weed species (Appendix G).

4. Overview

Noxious weeds are a concern when managing land. Noxious weeds out compete native vegetation for resources such as sunlight, water, growing space, and soil nutrients. They are able to do so because they have few natural predators or diseases, are not as palatable to wildlife and livestock as native vegetation, have deep and extensive root systems that more easily sequester water and nutrients, and produce thousands of seeds per plant. Additionally, some weeds have allelopathic capabilities which inhibit the growth of surrounding native plants.

Once established, noxious weeds cause severe ecological, agricultural, and recreational impacts by decreasing biodiversity, diminishing habitat and forage for wildlife, decreasing crop yield, and interfering with outdoor recreation. Additionally, management of weed control efforts requires a considerable amount of funding and time for planning and implementation.

5. Definitions

Noxious Weed - As written in the Colorado Noxious Weed Act, a noxious weed "means an alien plant or parts of an alien plant that have been designated by rule as being noxious or has been declared a noxious weed by a local advisory board, and meets one or more of the following criteria:

(i) Aggressively invades or is detrimental to economic crops or native plant communities;
(ii) Is poisonous to livestock;
(iii) (iii) Is a carrier of detrimental insects, diseases, or parasites;

(iv) The direct or indirect effect of the presence of this plant is detrimental to the environmentally sound management of natural or agricultural ecosystems" (Colorado Noxious Weed Act, 35-5.5)

Integrated Weed Management - According to the Colorado Noxious Weed Act, integrated weed management (IWM) is "the planning and implementation of a coordinated program utilizing a variety of methods for managing noxious weeds, the purpose of which is to achieve desirable plant communities" (Colorado Noxious Weed Act, 35-5.5). Methods used in integrated weed management include but are not limited to preventative measures, education, monitoring, mechanical control, cultural control, biological control and chemical control. The process of integrated weed management takes into account each method's potential hazard to people, the environment, and property, while also taking into consideration limitations of budgetary and human resources.

List A Species - List A species are uncommon noxious weeds that are found in Colorado in small populations or are not yet found in Colorado but are in surrounding states and threaten to become established. These weeds are mandated for eradication by the Colorado Noxious Weed Act.

List B Species – List B species are so well established and common throughout Colorado that their total eradication in the State is not feasible. However, isolated populations are recommended for eradication. Suppression and containment are the goals for all other populations.

List C Species – List C species are widespread and well established within Colorado. The State's goals are to provide education, research, and biological controls to local governments. List C species are the lowest priority for control for the City of Longmont. As resources of time, budget, and staff permit, controls will be conducted to help suppress and contain their spread.

Broadcast Spray – A method of applying pesticides indiscriminately over a non-localized area typically more than 1/10 of an acre in size and often utilizing a boom or boomless nozzles.

Spot Spray – A method of applying pesticides to isolated areas of 1/10 of an acre or less limiting the amount of pesticide that is applied to non-target vegetation and often utilizing hand gun or backpack sprayers.

6. **Methods**

Using a combination of methods for weed control increases the effectiveness and efficiency of control. This is accomplished by continually depleting nutrient reserves and reducing the ability of the weed to reproduce. Being able to use a variety of methods also allows for the flexibility required to control different species of weed

infestations in varying locations under varying and unpredictable environmental conditions. The following list of control methods is not exhaustive. Alternative methods that are not listed below will be evaluated for appropriateness and effectiveness by City staff.

6.1 Prevention

The most effective way to control noxious weeds is to prevent their initial establishment. Once noxious weeds become established, their control is costly and time consuming.

Prevention methods include:

- Limit disturbance to landscapes, especially those that create bare ground.
- Clean boots, clothing, and equipment of seed before entering and leaving City properties.
- Monitor and amend soil where appropriate.
- Require dogs to be leashed.
- Require users to remain on trails.
- Eliminate social trails.
- Require contractors and utility maintenance personnel to reseed or plant native vegetation after creating a disturbance to the soil.
- Require weed free restoration materials.
- Ongoing property monitoring.

6.2 Education

Weed management education is an important step in integrated weed management (IWM) for both City staff and the public. Weed management is a complex and evolving field of study that requires staff to continually increase their knowledge and understanding so that weed control methods can be used in the most effective means possible. Also, it is important to educate the public about weeds so that they understand the necessity of their control and will support the City's efforts. Furthermore, a more educated public will be able to more effectively control weeds on their own property.

Methods to educate City staff:

- All pesticide applicators will be licensed by the Colorado Department of Agriculture as a Qualified Supervisor or Certified Operator in the categories that they apply pesticide to.
    - Categories include rangeland, industrial/right-of-way, aquatic, turf, and ornamental.
    - Licensed staff will obtain continuing education credits as required by the Colorado Department of Agriculture.
- Staff will attend noxious weed workshops, presentations, and conferences.

- Staff will network and communicate with other Colorado weed managers.
- The City will form collaborative partnerships with stakeholders involved with noxious weed management.

Methods to educate the public:

- Presentations given by staff and other weed control professionals.
- Contacts made by Code Enforcement.
- Interpretive signage.
- Hosting volunteer weed pull events.
- Contacts made by City staff while working in the field.
- Pamphlets.
- Submitting articles to the local newsletter and newspapers.
- Information provided through the City's website.

6.3 Collaboration

Collaboration with others is essential to effectively control weeds as weeds are not bound by political boundaries.

Collaboration methods include:

- Communicating with other Colorado weed managers the presence and location of noxious weeds.
- Partnering with neighboring counties, municipalities, and weed managers on regional weed control plans and projects.
- Sharing equipment and knowledge with weed managers.
- Leveraging funding sources with other weed managers to solicit grants for regional weed control projects.

6.4 Monitoring

Monitoring is a critical tool in integrated weed management as it helps to detect initial weed infestations before they get out of control and also helps to determine if the current methods of control are effective.

Beneficial Uses:

- Monitoring restoration sites or newly disturbed sites for weed encroachment and restoration progress.
- Monitoring locally uncommon weed species populations.
- Monitoring vectors of seed dispersal for weed establishment.
- Monitoring pastures for overgrazing and weed encroachment.
- Monitoring high priority weed infestations.

Limitations:

- Difficulty in determining cause and effect of weed control actions due to variable weather conditions.
- Can become time consuming.

Methods:

- Photo points set up on City properties at key locations and revisited on a two (2) year rotation.
- City properties will be mapped by hand or GPS unit on a five (5) year rotation.
- Vegetation monitoring transects and/or plots will be set up and monitored as needed and as resources allow.
- Visual observations made by staff in the field.

6.5 Mechanical Control

Mechanical controls are those methods that physically remove all or part of a weed, often using hand tools or machinery.

Beneficial Uses:

- Digging or hand pulling can be effective at controlling some annual and biennial weed species.
- Controls smaller infestations of some annual and biennial weed species.
- Mowing can suppress seed production of some species if timed properly.
- Mowing or hand pulling can weaken some perennial plants by forcing the plant to regrow and reduce nutrient root reserves. Excellent control may be achieved if followed by a fall herbicide application.
- Can be used on infestations where the use of chemicals may be undesirable.
- Provides excellent opportunities for volunteer events and work for the Boulder County Youth Corps.
- Can be used in tree wells where the use of pesticides may be detrimental to tree health.

Limitations:

- Can cause soil disturbances and leave bare areas where new weeds can invade.
- Often ineffective at controlling rhizomatous perennials (Colorado Natural Areas Program, 2000).
- Can be counterproductive and cause some perennials to increase in density.
- Mowing can spread weed seeds if timed improperly.
- Is labor intensive.

- Is not cost effective for larger infestations of weeds.
- Topography may limit access or be unsafe for the use of machinery.
- Does not eliminate thatch that can impede pesticide efficacy or create a fire hazard.

Methods (See Appendix H for species specific control methods):

- Hand pulling.
- Clipping seed heads.
- Using shovels and similar bladed hand tools to sever tap roots below ground.
- Mowing.
- Using weed whips.
- Tillage.
- Using chainsaws.
- Using a propane torch.

6.6 Cultural Control

Cultural controls involve the re-establishment and promotion of desirable, competitive vegetation through re-vegetation, mimicking natural disturbances by conducting prescribed burns and grazing, and utilizing vegetation best management practices (BMP).

Re-vegetation of degraded lands through reseeding and planting a diverse mix of grasses, forbs, shrubs, and trees may be a long term goal. Many City properties were acquired in degraded states that are susceptible to weed infestations. Healthy plant communities are more able to resist and compete against invasions of weeds, ultimately reducing the costs of weed control.

Beneficial Uses:

- Controls weeds in the long term.
- Changes degraded sites into ecologically healthy lands.
- Increases native plant diversity.
- Increases plant competition against weeds.
- Increases structural value of habitat.
- Increases nutrient value of forage.
- Increases habitat for pollinators such as bees and butterflies.

Limitations:

- Difficulty and length of time necessary to establish native and/or desirable vegetation.
- Risk of seed mixes or hay/straw mulches containing weed seed.
- Difficult environmental conditions to seed in.

- Cost of seeding can be expensive.
- Cost of seeding and soil bed preparation equipment.

Methods:

- Whenever possible, drill seeding is the preferred method as it has the highest success rate of establishing plants from seed.
- When incapable of drill seeding, broadcast seeding is the next preferred method of establishing plants from seed.
- Hydro-seeding will be completed by qualified contractors and only in areas where drill or broadcast seeding is not possible. Hand raking after hydro-seeding is preferred to ensure soil-to-seed contact.
- Direct planting of trees and shrubs.
- Direct planting of wetland vegetation plugs.

Prescribed burns mimic the natural process of fire that native grasslands and forests have adapted to over thousands of years on the Colorado Front Range and Foothills. Prescribed burns are used as a tool by land managers to reduce weeds and promote healthy communities of native vegetation.

Beneficial Uses:

- Creates species and stand structure diversity in plant communities.
- Invigorates growth of some perennial grasses.
- Reduces overly dense forest stands creating habitat diversity and reducing the risk of catastrophic wildfires.
- Reduces infestation of certain weeds.
- Increases soil nutrients.
- Eliminates thatch layer to allow for pesticide applications to reach the soil and underlying weeds, improving weed control.
- Can be used at sites where topography may limit access to mechanical control equipment.

Limitations:

- Difficulty burning in areas surrounded by development.
- Availability of experienced fire crews to conduct prescribed burns.
- Time it takes to properly plan a prescribed burn that will meet resource objectives.
- Short windows of time to conduct prescribed burns due to the need for specific weather conditions.
- Some weeds are favored by fire and may increase in density following a prescribed burn.

Methods:

- The City Fire Department's Wildland Fire Team will be relied upon to lead prescribed burns by providing burn plans, equipment, staff, and oversight of firing operations.
- The Land Management Program staff will collaborate with the Wildland Fire Team to develop objectives for burn plans, obtain necessary permits, and provide staff during burns.
- All staff members participating on a prescribed burn must have a Firefighter Type II Wildland firefighting certification.
- The City may collaborate with other agencies that perform prescribed burns.

Grazing by ungulates has historically been a part of the Front Range ecosystem which invigorated root growth and created diverse grassland communities. Grazing by cattle, sheep, or goats helps to simulate this process that was once performed by buffalo, deer, pronghorn antelope and other native grazing animals. Mowing can also be used to serve as a substitute for grazing but does not mimic the effects of reducing thatch. Beneficial uses, limitations, and methods are discussed in section 6.6. Biological Control.

Vegetation best management practices are those methods utilized by land managers to ensure healthy vegetation and limit detrimental impacts to City properties. They are accepted industry practices that are developed through research and experience.

Methods:

- The City's Vegetation Management – Dryland Mowing Standard Operating Procedure outlines proper mowing heights for vegetation in different areas of the City (Appendix I).
- The City's Vegetation Management – Dryland Irrigation Standard Operating Procedure outlines proper watering regimes for vegetation in different areas of the City (Appendix J).
- City staff shall clean vegetation management equipment such as mowers, tractors, and ATVs between uses to prevent spreading weed seeds.

6.7 Biological Control

Biological controls involve using a weed's natural insect predators or grazing animals to control the weed.

Biocontrol insects for specific noxious weeds are reared by the Colorado Department of Agriculture's Insectary. Most are available free-of-charge or for a small fee.

Beneficial Uses:

- May control infestations that are not easily accessible to people or equipment.
- May control very large and dense infestations where other control methods would not be cost effective.
- May control low priority List C species in which budget and time may not be available for other control methods.

Limitations:

- May reduce but not eradicate a weed infestation (Colorado Natural Areas Program, 2000).
- Limited availability.
- Lack of biological control insects for all noxious weed species.
- Variable successes (Colorado Natural Areas Program, 2000).
- Difficulty and length of time to establish.
- Although low risk, insects may attack native vegetation.
- Difficult to integrate with some other control methods.

Methods:

- There are dozens of different insects that specialize in controlling different species of noxious weeds.
- Species for which biocontrol insects have been shown to be effective include field bindweed, Dalmatian toadflax, diffuse knapweed, and leafy spurge.

Livestock can be used to help control weeds by limiting seed production and depleting nutrient root reserves. The use of livestock requires the supervision of a knowledgeable herder who can manage the duration and intensity of the grazing so as not to damage the landscape and native vegetation. Associated costs can vary widely depending on the person contracted to manage the grazing and the infrastructure required.

Beneficial Uses:

- May control infestations that are inaccessible to people or equipment.
- May control very large and dense infestations where other control methods would not be cost effective.
- Invigorates growth of some perennial grass species by eliminating dead and mature plant material.
- Creates diverse grassland communities.
- Can increase public awareness of weed control.

Limitations:

- Limited availability of experienced and knowledgeable herders.

- Need for infrastructure such as fencing and a water source.
- Predation of livestock by wild carnivores.
- Some weeds are poisonous to certain livestock.
- Some weeds are only palatable to certain livestock.
- Palatability of weeds varies throughout the season.
- Risk of spreading weed seed through manure or fur.
- Risk of overgrazing or trampling desirable vegetation.
- Will not eradicate a weed infestation (Tu et al., 2001).
- Risk of spreading livestock diseases to wild ungulates and vice versa.

Methods:

- Goats
- Sheep
- Cattle

6.8 Chemical Control

Chemical Control involves the use of pesticides to kill weeds. When used by trained professionals in accordance with the accompanying labels, pesticides are effective and the risk of use limited. The City will reduce the amount of pesticides used through the use of integrated weed management.

Beneficial Uses:

- Controls large infestations in which other methods would be time consuming or cost prohibitive.
- Controls infestations of rhizomatous weed species (Colorado Natural Areas Program, 2000).
- Eradicates high priority List A species that require a fast response as required by the Colorado Noxious Weed Act (Appendix A).
- Controls weeds in preparation for re-vegetation.
- Prevents weed establishment following a prescribed burn or wildland fire.

Limitations:

- Inability to spray certain pesticides near water.
- Public sensitivity to pesticide use.
- Possible formation of pesticide resistance.
- Possible damage to non-target vegetation.

Methods (See Appendix H for species specific control methods):

- Backpack sprayer.
- Spray bottles.
- Wicks/wipers.

- Paintbrushes.
- ATV or truck mounted boomless nozzles.
- ATV or truck mounted hand guns/wands.
- ATV or truck mounted booms.
- Tractor pulled spray systems.
- Boat mounted spray systems.
- Aerial applications.

Guidelines for Use:

- The City and all contractors working for the City will comply with the Colorado Pesticide Applicators Act (Appendix D) and the Rules and Regulations Pertaining to the Administration and Enforcement of the Pesticide Applicators' Act (Appendix E).

- City Staff
    - All City staff members that apply pesticides will be licensed by the Colorado Department of Agriculture as a Qualified Supervisor or Certified Operator in the categories that they apply pesticides.
    - Categories include rangeland, industrial/right-of-way, aquatic, turf, and ornamental.
    - During the first year of licensing, new applicators shall meet minimum field experience requirements under the supervision of an experienced licensed applicator until determined to be competent.
    - City staff will comply with all Federal, State, and local regulations pertaining to the purchase, possession and application of all pesticides.

- Contractors
    - All contractors will be registered with the Colorado Department of Agriculture.
    - All applicators will be licensed by the Colorado Department of Agriculture in the categories that they apply pesticide to or meet the State requirements for technician training.
    - All contractors will comply with all Federal, State and local regulations pertaining to the purchase, possession, and application of all pesticides.

- Pesticide Application
    - The City of Longmont will only use pesticides that are legally registered with the Environmental Protection Agency and the Colorado Department of Agriculture.

- All pesticide labels will be followed precisely and kept with the applicator in the field.
- Material Safety Data Sheets of all pesticides being applied will be kept with the applicator in the field.
- Pesticides used will be in the Environmental Protection Agency's Toxicity Category III or IV, indicating low toxicity levels.
- Pesticides in a Toxicity Category of I or II will only be considered when other methods have been determined to be ineffective, cost prohibitive, unsafe, or necessary to prevent pesticide resistance.
    - Having the ability to use various pesticides in higher toxicity categories with different modes of action is critical to prevent the buildup of pesticide resistance by populations of weeds.
- Pesticides will be applied at the lowest recommended rates that are effective to control the targeted weed species.
    - Sometimes using the lowest rate may not control the targeted weed and result in the need for a second pesticide application. Also using low rates that are ineffective may create pesticide resistance in the targeted weed species. For these reasons, the use of higher rates may be recommended.
- Weeds will be spot sprayed whenever possible. Broadcast spraying will only be used on large infestations where spot spraying would be ineffective or too time consuming and costly.
- Pesticide applications beneath tree canopy drip lines will be limited.
- All application equipment will be property calibrated and documented before the first applications of the year are conducted and again in September in order to detect changes in application rates or faulty equipment.

- Spill Prevention and Clean Up
    - Application equipment will be monitored for leaks and fixed as quickly as reasonably possible.
    - All applicators will have a spill kit with them in the field.
    - All spills will be responded to immediately, following the procedure of control the spill to prevent more pesticide from being released, contain the spill to keep the pesticide from spreading, and then clean up the spill and the remove as much of the pesticide as possible and properly dispose of it.

- Public Notification and Protection
    - The City will refer to the Colorado Pesticide Sensitive Registry and follow the rules and regulations for public notification of persons

on the registry according to the Rules and Regulations Pertaining to the Administration and Enforcement of the Pesticide Applicators' Act (Appendix E). This registry does not pertain to mosquito control applications of pesticides.

- The City will refer the Colorado Pesticide Sensitive Crops and Habitats Registry to be able to notify registered persons adjacent to City owned properties to which a pesticide will be applied. This registry does not pertain to mosquito control applications of pesticides.
- Labeled re-entry intervals will be followed to keep the public out of areas where pesticides have been applied.
- Depending on the size and location of the application area(s), properties may be closed to the public in the event that a broadcast application is necessary until the labeled re-entry interval has been met.
- Areas adjacent to schools or trails used a routes to schools will not be sprayed when children are present or may be present during the labeled re-entry interval.
- Pesticide applications in areas accessible to the public must be flagged and posted prior to application. Flags shall have the City Division's phone number, date of application, and trade name of all chemicals applied. The flags will be posted at trailheads and along trails or access routes immediately adjacent to and at a 100 ft. distance from the area of application in both directions along the trail. If applications are made along a trail right-of-way, flags shall be spaced at 100 foot intervals along the edge of the trail that has been sprayed. Flags shall be removed once the labeled re-entry interval has been met.
- Post all pesticide applications with an 11 inch by 17 inch sign a minimum of 48 hours prior to applications to irrigated turf in Park areas. These postings will be displayed at kiosks and all designed entry ways into the park. Signs shall have the City Division's phone number, date of application, and trade name of all chemicals applied. Signs shall be removed once the labeled re-entry interval has been met.
- Locations of pesticide applications in public areas, targeted species, and trade name of the pesticide(s) being used will posted on the City website a minimum of 48 hours before the application is to take place.

- Record Keeping
  - All record keeping requirements of the Colorado Department of Agriculture and the Environmental Protection Agency will be followed (See Appendix K for sample application record form).

- City staff will complete all application records by the end of the day that a pesticide application was completed. Application records will then be reviewed and stored by the licensed qualified supervisor responsible for the application.

- Pesticide Storage
  - All storage requirements of the Colorado Department of Agriculture as stated in the Rules and Regulations Pertaining to the Administration and Enforcement of the Pesticide Applicators' Act (Appendix E) and the City of Longmont Fire Department will be followed.
  - Provide an emergency eye wash and shower station near storage locations and mixing/cleaning stations.
  - A binder containing the MSDS of each pesticide stored at a location must be kept at the storage location, in the office of supervisors, and in a binder accessible to the Fire Department in case of emergencies. Replace MSDS when they are updated or when new pesticides are stored or no longer used.
    - The Parks Operations and Forestry emergency accessible binder will be stored at the front desk of the Sunset Campus
    - The Land Management emergency accessible binder will be stored at the Sandstone Ranch Visitors and Learning Center.
  - Inform the Fire Department of storage locations.
    - Hazardous Materials Inspector – 303-651-8833
  - Group similar types of pesticides together and separated from fertilizers. Herbicides, fungicides, insecticides, etc. shall be grouped together.
  - Do not store pesticides with flammable materials such as gasoline or spray paint.
  - Store dry pesticides so that they will not come in contact with liquids if there is a leak or spill.
  - Do not store pesticides in containers that were originally labeled for some other use such as bleach bottles, food containers, pesticide containers labeled for different pesticides, etc.
  - Purchase pesticides as needed to avoid a large stockpile.
  - Label pesticides with date purchased and use the oldest pesticides first.
  - Maintain an inventory of pesticides and their amounts stored. Update inventory in March and September.

6.9 Priority Weed Infestations

The City recognizes that it has limited resources in terms of staff and budget, which prevents all weed infestations from being controlled. Thus, it is important to prioritize which populations of weeds will be controlled so that these resources can be used efficiently and where they will be most cost effective.

Priority will be placed on populations of weeds that fulfill one or more of the following criteria:

- Is a List A or B noxious weed designated for eradication by the County or State.
- Control is mandated by City Code.
- Located in an environmentally sensitive area such as riparian areas, wetlands, or within populations of rare or imperiled native plant species.
- Is small enough where eradication is possible.
- Is a locally rare weed.
- Located along movement corridors such as trails, riparian areas, and roads.
- Located within a restoration area.
- Located within an area where ground disturbance will occur in coordination with Capital Improvement Projects (CIP), other City development, or large activity or event.
- Located in areas highly visible to the public.
- Weed infestations that cause a profit loss that is greater than the cost of control, such as infestations at golf courses or other revenue driven properties.

References

Colorado Natural Areas Program. 2000. Creating an Integrated Weed Management Plan: A Handbook for Owners and Managers of Lands with Natural Values. Caring for the Land Series, Volume IV, http://cpw.state.co.us/Documents/CNAP/IntegratedWeedManagement/IWMhandbooktext.pdf, version: March 2000

Colorado Noxious Weed Act, 35-5.5 C.R.S. 1996

Tu, M., Hurd, C. & J.M. Randall. 2001. Weed Control Methods Handbook, The Nature Conservancy, http://tncweeds.ucdavis.edu/handbook.html, version: April 2001