4. INTEGRATED PEST MANAGEMENT (IPM)

4.1 INTRODUCTION

Integrated Pest Management (IPM) is the use of multiple treatment methods to control undesirable weeds and other pests. While IPM has a range of meanings and is subject to various interpretations, the Natural Areas Program defines IPM as the optimal integration of management methods to control pests with the least possible hazard to people, property, and the environment. The Natural Areas Program uses a least toxic decision-making model in its vegetation management (Figure 4-1). Although the IPM process has been formally adopted by many public and private organizations, it continues to evolve as management strategies are fined-tuned and innovative new pest control methods are found to be effective.

IPM is a multi-step, ecologically based approach that enables staff to make decisions regarding where, when, and how resources should be best allocated to control pests. Conventional pest control methods attempt to control the symptoms of a pest problem. IPM, however, is a proactive strategy that focuses on identifying and reducing, or eliminating, the root cause of a pest problem and implementing effective, long-term management solutions through the use of a broad range of expertise, a combination of treatment methods, and a comprehensive monitoring and evaluation process.

There are more opportunities for the introduction of foreign species into the United States due to the more frequent and wider-ranging transport of people and products. Foreign species may become established in this country with little or no competition from native species, and eventually displace some native species (APHIS 2000). There are several organizations devoted entirely or in part to the monitoring, control, and removal of invasive exotics (e.g., the California Exotic Pest Plant Council [CalEPPC] and the Center for Invasive Plant Management). The Nature Conservancy has an entire team devoted to this issue. In a policy memo, the Nature Conservancy discussed the impacts of invasive species. The memo stated that: (1) three-quarters of the operating units of the Nature Conservancy believe that invasive species are a threat to their conservation planning and that all their lands are at risk; (2) as many as 46 percent of the plants and animals in the United States that are Federally listed as endangered are adversely affected by invasive plants; and (3) invasive plants represent an annual cost to the people of the United States of about $137 billion (Bartuska 2002). The California Native Plant Society (CNPS) has established a policy on its approach to the issue of invasive species. Although lengthy, the essence of this policy is that the CNPS urges coordination of planting and management, education, control measures that do not affect the native habitats, and expansion of volunteer restoration efforts (CNPS 1996).

Some native plant species can coexist with exotics, and it is not uncommon for introduced species to become naturalized in native plant communities without altering natural ecosystem

functions. However, a handful of invasive plant species have the potential to overwhelm and displace native ecosystem biodiversity, reducing native plant populations and seriously changing the fundamental ecosystem processes (Mullin et al. 2000; USDA 1999). As the number of indigenous plants decreases, so too do the insects, birds, and other animal species that depend on the diversity of these plants for food, shelter, and reproduction.

In general, a pest is a weed that has no value in a particular landscape setting, either because it is undesirable or injurious to humans. Clearly, a plant species can be valued differently depending on its location. For example, English ivy (*Hedera helix*) is an invasive perennial vine in Natural Areas, but is valued for aesthetic reasons in many landscaped areas. For purposes of this report, an exotic pest plant is defined as a plant that originated in areas outside of the San Francisco Bay Region and competes with native plants in wildland situations. If left unchecked, it has high potential to eliminate diversity. Many of these species are considered wildland pest plants by the CNPS, CalEPPC, and U.S. Department of Agriculture (USDA). Only the most invasive and disruptive weeds require control in the Natural Areas.

4.2 IPM PROGRAMS

CITY IPM

In October 1996, the San Francisco Board of Supervisors passed Chapter 39 of the San Francisco Administrative Code, which mandates all City departments that perform or obtain pest management services to adopt IPM policies. San Francisco's IPM plan focuses on all aspects of pest plant and animal management, while promoting non-chemical control strategies and the elimination of all but exempted pesticides. The San Francisco Department of the Environment is responsible for oversight and implementation of IPM practices citywide. Additionally, all City departments are required to abide by the City's IPM ordinance. This ordinance requires that herbicide applicators are trained and required to follow the manufacturer's label when applying pesticides. Also, signs alerting the public of a scheduled spray must be posted in a prominent location four days before the spray and must remain up for three days after the application. All use of pesticides is recorded by the San Francisco Recreation and Park Department (SFRPD) and forwarded to the Department of the Environment.

SFRPD NATURAL AREAS PROGRAM IPM

In accordance with Chapter 39, SFRPD's Natural Areas Program employs IPM as its strategy for preventing new and managing existing pest infestations. The Natural Areas IPM program has:

- identified management goals such as preserving biodiversity;
- identified pests and the environmental conditions favoring their spread;
- identified gaps in the knowledge of species biology and habitats and made efforts to increase understanding and fill these gaps;

- established a monitoring program to determine pest population, size, occurrence, and rate of change in each ecosystem;
- set injury levels and treatment thresholds;
- employed effective, least-toxic pest control methods if feasible, using combinations of methods as necessary; and
- implemented pilot programs to experiment with alternative pest control methods.

Management goals and IPM program elements for Natural Areas have been provided in the 1995 Significant Natural Resource Areas Management Plan and have been further refined (see Section 2). Twenty-one wildland pest plants have been identified as those of highest priority for management within this plan (Table 4-1). Multiple environmental and life history factors contribute to the spread of these species. This plan, through its identification of Management Areas, prioritizes weed removal areas and describes monitoring activities (Section 7).

Weed Management Strategies

Four general weed management strategies exist: prevention, containment, reduction, and eradication. Each results in a different level of weed control and reflects available resources. In Natural Areas, new invasions are prevented by routine monitoring activities (Section 7). Containment strategies, or the isolation of weed infestations from further spread, are typically used when large, aggressive infestations that cannot be eradicated threaten adjacent habitats. Implementation of this strategy often takes the form of a "weed break" created at the leading edge of the invasion. Within the weed break, exotics are reduced or eliminated, thus preventing further invasion by vegetative spread and seed to intact areas. This is seen as a short-term strategy to buy time until more resources are made available. Reduction strategies are the most commonly used strategy. They are typically used in high-value habitat areas that can greatly benefit from the reduction in the number of weedy competitors. While eradication may be the goal for some species, the likelihood of system-wide eradication of any particular pest plant species is low. Eradication may be possible in smaller areas and is the most effective goal and strategy for small infestations of particularly aggressive specie (e.g., Cape ivy (*Delairea odorata*) and ehrharta grass (*ehrharta erecta*)).

Injury level is synonymous with damage or infestation level. Closely tied to the concept of injury level is the treatment threshold. Treatment thresholds are the infestation level at which treatment should begin and are established to minimize harmful impacts to desired vegetation. Some species (e.g., Cape ivy, yellow star thistle (*Centaurea solstitialis*), etc.) are very aggressive colonizers and difficult to control. These should not be tolerated except in small numbers (low treatment threshold) unless they are providing some other important function (erosion control or wildlife habitat). For these species, aggressive prevention containment and reduction strategies should be employed. Other species (e.g., radish (*Raphanus sativus*), cotoneaster (*Cotoneaster sp.*), English ivy (*Hedera helix*), etc.) can be tolerated at moderate levels (moderate treatment

threshold) because they are easier to control or are limited by on-site environmental factors. For these species, containment and reduction are the most frequently used strategies.

Natural Areas Program Control Methods and Herbicide Usage

The type of control method employed for plant pests in natural areas is under the discretion of the SFRPD Natural Areas Program (Tables 4-2 and 4-3). The Natural Areas Program's policy is to use the least-toxic control methods whenever feasible and practical. Recently, the Natural Areas Program formalized restoration guidelines in *Native Habitat Restoration: A guide for citizen involvement in San Francisco Natural Areas* (SFRPD NAP 2000). This document covers preferred removal techniques for 15 invasive species and is intended primarily for use by community groups. The Natural Areas Program relies heavily on volunteer and contract labor for weed management. For example, in 2003 over 13,000 volunteer hours were spent restoring natural areas. The majority of these restoration activities involved invasive weed management. In 2001-2002, Natural Areas Program staff spent approximately 2 percent of their weed control time applying herbicide (exclusively Roundup Pro™). The remainder of the time (98 percent) involved manual and mechanical control methods (i.e., hand weeding, power tools, etc.). Ultimately, human resources, site conditions, and level of infestation will determine the type of method used.

Factors that make manual and/or mechanical methods impractical include:

- direct threats to human health and safety (e.g., steep, inaccessible, unstable slopes, significant poison oak infestations, etc.);
- large infestations requiring ongoing repeated strenuous physical labor, such as picking and lifting, that may cause injury to staff, contract field crews, or volunteers; and
- areas where access, human trampling, or soil disturbance may directly or indirectly damage native plant communities or cause soil erosion.

Current management methods employed by the Natural Areas Program include:

- physical control methods, which range from hand-pulling weeds to the use of hand and mechanical tools to uproot, girdle, or cut plants;
- biological control, which involves revegetating cleared areas and introducing native plants in an area to encourage competition with weeds;
- chemical control, which involves the use of herbicides to suppress wildland weeds; and
- public education and outreach.

Alternative methods such as grazing, burning, and solarization[1] are experimental at this time.

Despite the emphasis on hand, mechanical and alternative methods of removal, herbicides are used to control invasive weeds in Natural Areas, especially when other methods are not feasible.

[1] Solarization: To cause injury by exposure to light.

In 2004, the Natural Areas Program used less than 10 percent of the overall SFRPD usage (P. Rossi, pers. comm. 2005). Natural Areas account for approximately 25 percent of the land managed by SFRPD. Therefore, on a per-acre basis, pesticide usage in the Natural Areas is significantly less than usage rates in other park maintenance programs. In addition, of the over 40 approved pesticides used department-wide, the Natural Areas Program uses only three types of pesticides and most of the product used is the least-toxic category. Usage for the SFRPD and for Natural Areas Program in 2004 is provided below.

Product	**NAP use**	**SFRPD use**
Roundup Pro Dry™	22 lbs.	178 lbs.
Round Up Pro™	Less than 1 gal	16 gal.
Garlon™	1.5 gal	2 gal.

Table 4-1. Priority Pest Plants

SCIENTIFIC NAME	COMMON NAME	TYPE	REPRODUCTION	MANAGEMENT STRATEGY
Arctotheca calendula	Cape weed	evergreen perennial	seed and vegetative	Eradicate
Brassica spp.	Black/Field mustard	annual/perennial herb	seed	Reduce
Carpobrotus edulis	Iceplant	perennial sub-shrub	seed and vegetative	Reduce
Centaurea solstitialis	Yellow starthistle	annual herb	seed	Eradicate
Conium maculatum	Poison hemlock	biennial herb	seed	Reduce - Eradicate
Cortaderia selloana	Pampas grass/	perennial grass	seed - without pollen	Reduce - Eradicate
Cortaderia jubata	Jubata grass	(apomictic)		Reduce - Eradicate
Cotoneaster spp.	Cotoneaster	evergreen shrub	seed	Contain
Delairea odorata (formerly *Senecio mikanioides)*	Cape ivy	perennial vine	seed and vegetative	Contain - Reduce - Eradicate
Ehrharta erecta	Ehrharta	perennial grass	seed	Contain - Reduce
Eucalyptus globulus	Tasmanian blue gum	tree	seed	Contain - Reduce
Foeniculum vulgare	Wild fennel	perennial herb	seed	Contain - Reduce
Festuca anundonacea	Tall fescue	perennial herb	seed	Reduce - Eradicate
Genista monspessulana	French broom	perennial shrub	seed	Reduce
Hedera helix	English ivy	perennial vine	seed and vegetative	Reduce - Eradicate
Hirschfeldia incana	Field mustard	perennial shrub	seed	Contain - Reduce
Lathyrus latifolius	Everlasting pea	perennial vine	seed	Reduce - Eradicate
Oxalis pes-caprae	Sourgrass, Bermuda buttercup	perennial herb	vegetative	Contain - Reduce
Raphanus sativa	Wild radish	annual/perennial herb	seed	Reduce
Rubus discolor	Himalayan blackberry	perennial shrub	seed and vegetative	Contain - Reduce
Rumex acetosella	Sheep sorrel	perennial herb	seed and rhizome	Reduce

Table 4-2: Summary of Control Methods for Weeds (Alphabetical by species name).

SPECIES	PRIOR.	MANUAL CONTROL	MECHANICAL CONTROL	CHEMICAL CONTROL*	ALTERNATIVES**
Arctotheca calendula Cape weed	Low	- Manual removal of small patches with hand tools	None known	- Apply 2% Roundup Pro or 2% Garlon 4 solution	- Do not brush blade, weed wack, string trim or mow
Brassica spp. Mustard	High	- Hand-pull making sure to remove root system	- Brush blade flower heads over consecutive springs	None known	- Grazing - Repeated flaming
Carpobrotus edulis Iceplant, Hottentot fig	High	- Hand-pull making sure to remove root system	None known	- Apply 1.0%-1.5% Roundup Pro solution	None known
Centaurea solstitialis Yellow starthistle	Low	- Monitor for new populations - Manually removal small patches using hand tools	None known	- Apply 1% Garlon 4 or 1% Roundup Pro on young plants - Apply 2% Garlon 4/Roundup Pro mixture on adult plants	- Flaming - Burning
Conium maculatum Poison hemlock	High	- Hand-pull making sure to remove root system	- Repeatedly brush blade when flowering	- Apply 2% Garlon 4 solution (repeat every two months)	None known
Cortaderia selloana/jubata Pampas grass	High	- Uproot plants with hand tools	- Brush blade large plants to remove flowering plumes and leaf mass prior to herbicide treatment or root mass removal	- Foliar or stump application of 1.5%-2% Roundup Pro	None known
Cotoneaster spp. Cotoneaster	High	- Hand-pull small plants	- Cut plants with power equipment and follow up with herbicide treatment on resprouts	- Inject Roundup Pro into stems with EZ-Ject Foliar application of 2% Garlon 4 - Paint freshly cut stumps with Garlon 4 solution	None known

Table 4-2: Summary of Control Methods for Weeds (Alphabetical by species name) (Continued)

SPECIES	PRIOR.	MANUAL CONTROL	MECHANICAL CONTROL	CHEMICAL CONTROL*	ALTERNATIVES**
Delairea odorata (formerly Senecio mikanioides) Cape/German ivy	High	- Hand pull in small areas and remove all fragments of stems and roots	- Brush blade large infestations - Follow-up with manual or herbicide treatment	- Apply 0.5% Garlon 4/0.5% Roundup Pro/0.1 Sylgard surfactant mixture to root system - Repeat application - Most practical where roots are not accessible	- Flaming
Ehrharta erecta Ehrharta	High	- Hand-pull in small areas	None known	- Apply 2% Roundup Pro and repeat application in three months - Most pracitcal where roots are not accessible.	- Solarization in areas where potential for vandalism is low.
Eucalyptus globulus Tasmanian blue gum	High	- Hand-pull or use weed wrench or hand saw on saplings - Remove resprouts once they have reached 8-10 feet using hand saw	- Remove adults with chain saw and follow-up with manual removal or chemical treatment	- Inject cut stumps of trees with Roundup Pro - Paint freshly cut stumps with Roundup Pro	None known
Foeniculum vulgare Wild fennel	High	- Hand-pull or cut above-ground portions using hand tools (small or diffuse populations only).	- Brush blade large areas and follow-up with herbicide treatment	- Apply 2% Garlon 4 or 2% Roundup Pro in late spring/ summer - Most practical on steep erodable slopes.	None known
Genista monspessulana French broom	High	- Hand-pull seedlings when soil is moist and infestation is small - Manual removal using weed wrench or loppers on adult plants	- Brush blade or chain saw above-ground portions of large adult plants (3 inches dbh or greater)	- Apply 2% Roundup Pro in winter to early summer - Apply 2% Garlon 4 in summer to fall	- Burning seedlings - Flaming seedlings

Table 4-2: Summary of Control Methods for Weeds (Alphabetical by species name) (Continued)

SPECIES	PRIOR.	MANUAL CONTROL	MECHANICAL CONTROL	CHEMICAL CONTROL*	ALTERNATIVES**
Hedera helix English ivy	High	- Hand-pull and remove root system	- Brush blade prior to herbicide treatment	- Apply 2% Roundup Pro or 2% Garlon 4 repeat application as necessary	- Flaming - Solarization in areas where potential vandalism is low.
Lathyrus latifolius Everlasting pea	High	- Hand pull in small areas	None known	- Apply 2% Garlon 4 - Most practical on steep erodable slopes.	- Flaming
Oxalis pes-caprae Sourgrass, Bermuda buttercup	High	- Hand pull in small areas	- Repeatedly brush blade above-ground portions of plant as close to the ground as possible to exhaust energy reserves	- Apply 2% Roundup Pro immediately after foliage has emerged (early spring) - Repeat application	- Flaming
Raphanus sativa Wild radish	High	- Hand-pull before plants go to seed making sure to remove root system - Repeat as required	- Brush blade only as a stop gap - does not remove roots	None known	None known
Rubus discolor Himalayan blackberry	High	- Hand-pull seedlings making sure to remove root system - Cut larger canes and remove root crown	- Mow or brush blade prior to hand removal	- Apply 2% Garlon 4 after plant has resprouted - Repeat application	None known
Rumex acetosella Sheep sorrel	High	- Hand-pull small patches before plants go to seed making sure to remove all runners	None known	- Apply 2% Roundup Pro or 2% Garlon 4 solution	None known

* Rodeo may be substituted for Rroundup Pro when water is present.

** Alternatives include other possible methods and experiments. Alternatives are only limited by typical site conditions (i.e., it is not feasible to use power mowers on steep slopes).

Table 4-3: Weed Management Calendar

Alphabetical by species name

SPECIES	TASK	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Arctotheca calendula	Manual	■	■	■	■	■	■	■	■	■	■	■	■
Cape weed	Mechanical												
	Herbicide			■	■	■	■	■	■	■	■		
	Monitor	■	■	■	■	■	■	■	■	■	■	■	■
Brassica spp.	Manual	■	■	■	■	■							
Mustard	Mechanical		■	■									
	Herbicide												
	Monitor	■	■	■	■	■							
Carpobrotus edulis	Manual	■	■	■	■	■	■	■	■	■	■	■	■
Iceplant, Hottentot fig	Mechanical												
	Herbicide			▒	▒	▒	▒	▒	▒	■	■	■	
	Monitor			■	■	■	■						
Centaurea solstitialis	Manual	■	■	■	■	■	■	■					
Yellow starthistle	Mechanical												
	Herbicide			■	■	■	■						
	Monitor												
Conium maculatum	Manual		■	■	■	■	■						
Poison hemlock	Mechanical												
	Herbicide				■	■							
	Monitor				■	■	■	■	■				

KEY

■ Optimal Time

▒ Appropriate Time

Table 4-3: Weed Management Calendar (continued)

SPECIES	TASK	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Cortaderia	Manual												
selloana/jubata	Mechanical												
Pampas grass	Herbicide												
	Monitor												
Cotoneaster spp.	Manual												
Cotoneaster	Mechanical												
	Herbicide												
	Monitor												
Delairea odorata	Manual												
(formerly S. *mikanioide*	Mechanical												
Cape/German ivy	Herbicide												
	Monitor												
Ehrharta erecta	Manual												
Ehrharta	Mechanical												
	Herbicide												
	Monitor												
Eucalyptus globulus	Manual												
Tasmanian blue gum	Mechanical												
	Herbicide												
	Monitor												

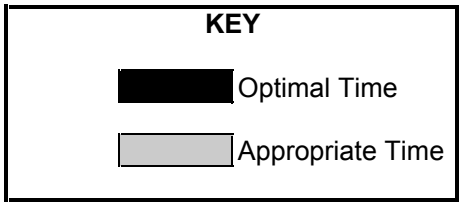


Table 4-3: Weed Management Calendar (continued)

SPECIES	TASK	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Foeniculum vulgare	Manual												
Wild fennel	Mechanical												
	Herbicide												
	Monitor												
Genista	Manual												
monspessulana	Mechanical												
French broom	Herbicide												
	Monitor												
Hedera Helix	Manual												
English ivy	Mechanical												
	Herbicide												
	Monitor												
Lathyrus latifolius	Manual												
Everlasting pea	Mechanical												
	Herbicide												
	Monitor												
Oxalis pes-caprae	Manual												
Sourgrass, Bermuda	Mechanical												
buttercup	Herbicide												
	Monitor												

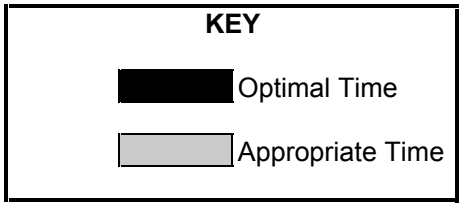
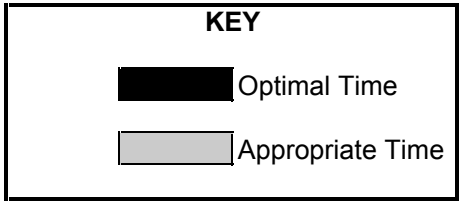


Table 4-3: Weed Management Calendar, (continued)

SPECIES	TASK	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Raphanus sativa	Manual	■	■	■	■	■	■	■					
Wild radish	Mechanical		■	■	■	■	■						
	Herbicide												
	Monitor	■	■	■	■	■	■	■					
Rubus discolor	Manual	■	■	■	■	■	■	▒	▒	▒	▒	▒	▒
Himalayan blackberry	Mechanical	■	■	■	■	■	■	■	■				
	Herbicide					■	■	■					
	Monitor	■	■	■	■	■	■	■					
Rumex acetosella	Manual	■	■	■	▒	▒	▒						
Sheep sorrel	Mechanical												
	Herbicide			■	■	■	■	■	■	■			
	Monitor	■	■	■	■	▒	▒	▒	▒	▒	▒	▒	▒



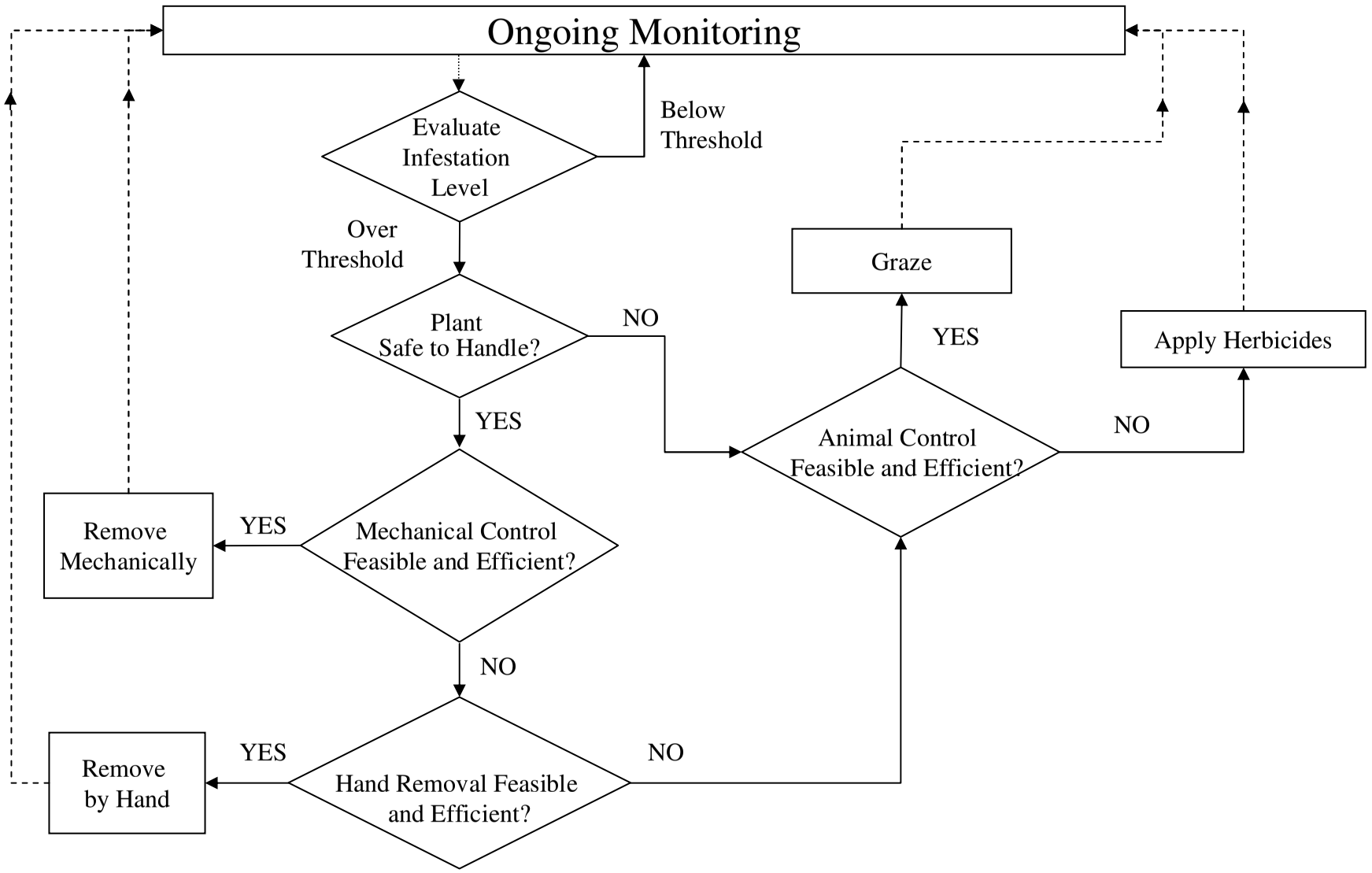


Figure 4.1: Schematic representation of vegetation management decision process.