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Executive Office of Human Services
Department of Public Health

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Center for Health Promotion and
Environmental Disease Prevention

TO: Chair, Pesticide Board Subcommittee

THRU: Elaine T. Krueger, M. P. H.

FROM: Elizabeth Anne Bourque, Ph.D.

RE: Review of Alternatives to Herbicide, Amitrole

DATE: May 9, 1985

Massachusetts has 36 active ingredients in 89 products registered for poison ivy control. The EPA listed the contact herbicide dicamba, 2,4-D, MCPP and glyphosate and the residual herbicides MSMA, simazine, picloram, duiron, bromacil, tebuthuiron and velpar as alternatives to Amitrole. There is a possibility of MSMA being a thyroid oncogen and the possibility of ground water problems with simazine and picloram. There are data gaps in the information on duiron, bromacil and velpar (1). Further these herbicides were not listed alternatives by the Department of Agriculture at the January 1985 meeting. Therefore of the remaining five EPA listed alternatives as well as ammate were reviewed: 2,4-D, Dicamba, Glyphosate, MCPP and Tebuthiuron. All six herbicides have gaps in the data base for which EPA has requested information (EPA, personal communication April 17, 1985). You will note that the gaps are in critical health areas. These herbicides are all general use herbicides.

An alternative method to herbicide control of weeds is Integrated Pest Management (IPM). As it appeared that one of amitrole's main uses was for poison ivy control the possibility of I.P.M. was reviewed. This approach would reduce the adverse health effect concerns or ground water contamination concerns associated with the use of herbicides. I.P.M. for poison ivy is clearly outlined in the enclosed review by Bio-Intergral Resource Center.

A final alternative method to consider is the complete elimination of spraying of herbicides. The successful No Spray policies in effect in Maine and Vermont are summarized. A Cost of Comparison of Right-of-Way Treatment Methods prepared for Empire State Electric Energy Research Corporation, June 1984 showed that on the basis of a single treatment hand cutting has a cost advantage over other types of treatment regardless of the density of the capable stems.

bj

REVIEW OF THE ALTERNATIVES TO AMITROLE

AMMATE

Action:	A post-emergent herbicide that kills plants on contact or after translocation within the plant.
Observation in Man:	ACGIH recommends a TLV of $10 mg/m^3$ (1a) while OSHA's permissible airborne exposure limit is $15 mg/m^3$ (OSHA, personal communication April 25, 1985).
Acute Effects:	LD_{50} oral rat 3900 mg/kg (2) LD_{50} oral mice 5760 mg/kg (2)
Mobility in Soil:	Ammate is highly soluble 216g/100 ml in water. Konnai _et al_. (1974) showed that ammate was very mobile in the soil. It moved 14 cm and 50 cm after application of 2 cm and 50cm of water (2). The EPA reviewed the data submitted for registration of ammonium sulfamate and determined that there was insufficient data to predict the fate of ammate in the environment (2).
Summary of Toxicological Literature:	Insufficient information is available to assess the carcinogenic, teratogenic or mutagenic potential of ammonium sulfamate (2). EPA has requested a large range of tests but few have been received by EPA (EPA, personal communication, April 12, 1985).
Mutagenicity:	Negative results were noted in an Ames/Salmonella Assay (2).

2,4-D

Action:	A post-emergent, selective herbicide which kills plants by causing them to grow too quickly.
Route of Exposure	inhalation and dermal absorption (2)
Observations in Man:	There have been a few cases reported of ingestion of 2,4-D. The lethal dose is estimated to be over 90mg/kg. The clinical picture indicative of 2,4-D poisoning includes fibrillary twitching and muscular paralysis.(3) During the field application of 2,4-D, several cases of illness were reported to the American Medical Association. Symptoms included burning sensations in the throat and chest, weakness, loss of appetite and weight, and slight albuminuria. This brings into question whether the ACGIH TLV of 10mg/m^3, based wholly on ingestion, is sufficiently low to prevent the effects by inhalation (1a). OSHA has a TLV of 10mg/m^3. (OSHA, personal communication April 25, 1985).
Metabolism:	Khanna and Fang (1966) found that the time necessary to eliminate 2,4-D from the body was dose-dependent. Rats eliminated 1-20mg within 24 whereas 100mg required 144 hours for 75% recovery. Fang <u>et al</u> (1973) reported that small amounts of phenoxy herbicides were passed through mother's milk to the young.(2)
Acute Effects	LD_{50} oral range from 100mg/kg dog to 541mg/kg chicks the salts and esters were less toxic (2)
Chronic Effects:	Rats fed 30 or 100mg/kg 5 times per week showed a depressed growth rate, liver pathology and gastrointestinal irritation. Rats fed 300 mg/kg died within a 4 week period. Khera and McKinley (1972) noted an increase in fetopathology and fetal skeletal anomalies in pregnant rats fed 100 Or 150 mg/kg/day. Bage <u>et al</u>.(1973) observed teratogenic and embryotoxic effects in NMRI mice that were injected with 50 or 110 mg/kg 2,4-D on days 6-14 of gestation (4)

Mobility in Soil:

The physical and chemical properties of 2,4-D are dependent on the form of the active ingredients (2) High mobility was shown in a study of 2,4-D amine and ester applied to a silty loam soil reached a depth of 40 cm after 5 days.(2) Low mobility was noted by Smith (1975) who found only negligible amounts of 2,4-D below 5 cm at the end of one growing season (2) Most 2,4-D residues breakdown in the soil in 6 weeks (4)

Summary of Toxicological Literature

The EPA has requested data under 3C2B of FIFRA (1) that agency required a fairly significant number of tests from the registrants as the data base was so deficient as to quality and presence of data. A neurotoxicity and subchronic feeding study are presently being reviewed by EPA. A reproductive study and a long term chronic study are due in the summer of 1985 and late 1986, respectively.(EPA, Personal Communication April 12, 1985) In 1981, a state advisory committee of DEQE and DPH said of 2,4-D: "The scientific data are sufficiently suggestive of a carcinogenic effect... that 2,4-D use should be restricted to areas in which human exposure can be kept to a minimum ... Broadcast methods of application that potentially expose the general population should be stopped."

DICAMBA

Action:	A pre-and post emergent, selective herbicide. It kills plants by interfering with protein synthesis (2).
Route of Exposure:	Inhalation and dermal absorption.
Metabolism:	Studies on rats and a holstein cow fed radiolabeled dicamba showed 73-99% of the administered radioactivity was excreted in the urine in 3-7 days (4).
Acute Effects:	LD_{50} oral rat 757-2,900 mg/kg (4) LD_{50} oral mice 1,189 mg/kg (4) Signs of acute dicamba poisoning in animals include muscle spasms, bradycardia, and inhibited voluntary and involuntary reflexes. Death occurs in 3 days(4).
Chronic Effects:	Moderate necrosis and vacuolization of the liver were seen in rats fed dicamba at 413 ppm), slight liver pathology in rats fed (330 ppm dicamba) and no adverse effects were seen in rats fed 206 ppm(4).
Mobility in Soil and Water:	Dicamba is highly mobile in soil. It was found to be the most mobile of 40 pesticides tested. Friesan applied dicamba to a sandy loam and eluted it with 5 cm of water, the herbicide reached a depth of 15 cm in 1 hour (2). It is very soluble in water and persists in sods for 7-10 months.(4)
Summary of Toxicological literature:	Available tests are inadequate to assess carcinogenicity, teratogenicity and mutagenicity (2). A number of studies on dicamba were conducted by Industrial Bio-Test Laboratories (IBT). The following studies conducted by IBT were determined by the EPA to be invalid: mutagenicity, mouse; teratology, mouse; mutagenicity, bacteria; reproduction, men; and chronic carcinogen, mouse. All the tests listed above, except the reproduction test in men are in progress and results are due by September, 1987 (EPA, Personal Communication April 12, 1985). Thus, dicamba remains a herbicide with a large number of data gaps still imposed by the IBT scandal.
Observations in Man:	No available data (4).

GLYPHOSATE

Action:	A post-emergent, broad spectrum herbicide that blocks cell metabolism by inhibiting synthesis of aromatic amino acids(2)
Acute Effects	LD_{50} oral rat 1,568 mg/kg (6) LD_{50} oral mouse 4,873 mg/kg (2)
Mobility in Soil	Glyphosate binds tightly to soil particles. Half-lives in a variety of soils range from 8 to 19 weeks. Highly soluble in water. The half-lives in various water samples range from 7 to 10 weeks. (2)
Summary of Toxicological Literature:	There were 23 tests conducted by IBT that were invalid. Only two of these have been replaced and are presently being reviewed by the EPA. (EPA personal communication, April 12, 1985). More publicly available information is needed to allow a independent review of glyphosate(2)

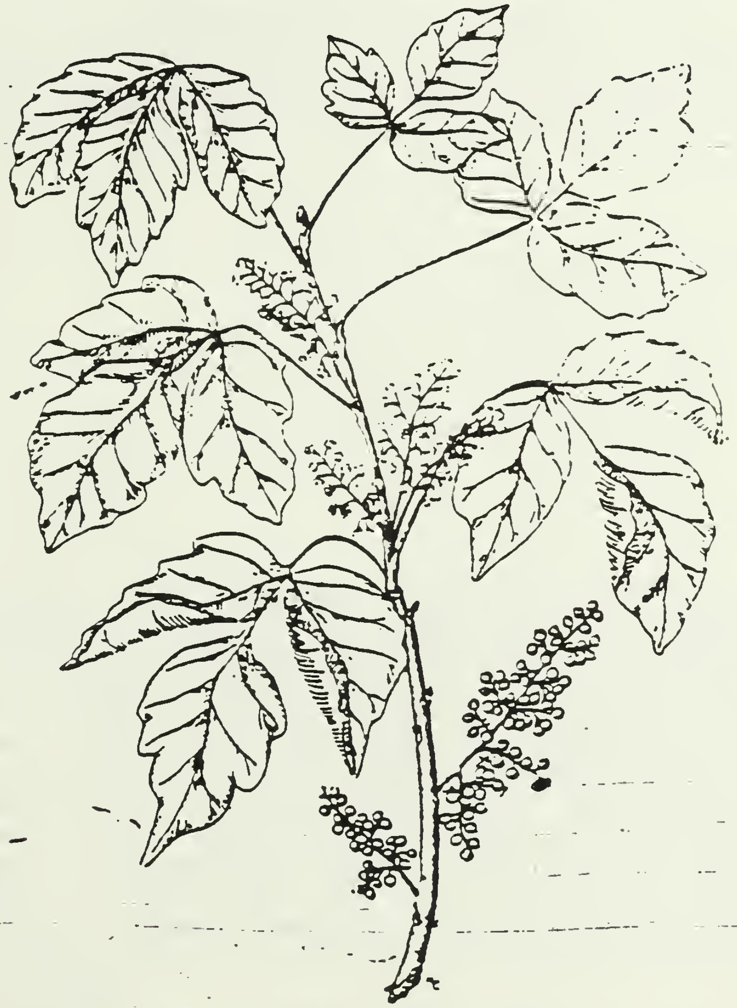
MECOPROP

Route of Exposure:	Toxic by ingestion and inhalation, irritant to skin and eyes (3)
Acute Effects	LD_{50} oral rats 650mg/kg (6) LD_{50} oral mice 650mg/kg (6)
Chronic Effects	Mecoprop given orally to mice at days 6-15 of gestation was embryotoxic and caused malformations of the skeleton (5)
Summary of Toxicological Literature:	The EPA requested in 1984, data to test the potential for contamination of groundwater. (EPA, Personal Communication, April 17, 1985).

TEBUTHIURON

Action:	A pre-emergent, non-selective herbicide, applied by as pellets, which must be washed into the soil by rain and taken up by the roots.
Metabolism:	More than 85% of a radiolabeled single oral dose was excreted in 96 hours according to Lilly Research Laboratories (2).
Acute Effects:	LD_{50} oral rat 579 mg/kg (2) LD_{50} oral mouse 644 mg/kg (2)
Mobility in Soil:	Soluble in water and appears to be very persistent. Three studies note a half-life of more than 1 year. Precautions on the label include the statement that "its presence in the soil may prevent growth of other desirable vegetation for some years to come"(2). Reed noted tebuthiuron moved to 26 cm in a silty clay and to 30 cm in a sandy loam after 6 weeks (2). Bauer (1978) found that 20 cm of rain distributed tebuthiuron throughout a 20 cm soil profile.
Summary of Toxicological Literature:	More publicly available information is needed on tebuthiuron. The EPA in 1983 requested a teratogenic study and in 1984 requested an array of studies on groundwater contamination (EPA, Personal Communication, April 12, 1985).

Integrated Pest Management for Poison Ivy



BY SHEILA DAAR, WILLIAM OLKOWSKI, HELGA OLKOWSKI

A B·I·R·C TECHNICAL REVIEW

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The Bio-Integral Resource Center (BIRC), a non-profit organization, provides practical information on the least toxic methods of managing pests and land resource problems. Since 1970 members of BIRC staff have designed Integrated Pest Management (IPM) programs for community groups, public agencies and private institutions throughout the U.S. and Canada.

IPM is a decision-making process. A key component is a monitoring program to determine the timing and placement of pest control treatments. A mix of biological, horticultural, mechanical and chemical strategies are integrated to suppress pest populations below levels causing economic, medical or aesthetic damage.

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FLOW DIAGRAM SUMMARIZING RECOMMENDED IPM PROGRAM FOR POISON IVY

POISON IVY PRESENT?-----no------>NO PROBLEM

yes

PRESENCE TOLERABLE?-----yes------->
(e.g. not growing on structures or areas utilized by visitors/staff)

no

BEGIN MONITORING

- ID subspecies, review biology & ecology
- Map location & density of growth
- Determine locations where injury to people or structures likely to occur
- Decide frequency of monitoring needed
- ID maintenance/other activities at site
- Set injury level (variables include proximity of ivy to people and structures, density of growth, season, etc.)
- Set action point (e.g. in high-use areas action is needed early to limit spread of plant; in remote areas, action can be delayed or avoided as injury is less likely to occur)

-------------> ACTION POINT REACHED?---------------no--------->

yes

BEGIN MECHANICAL, BIOLOGICAL OR HORTICULTURAL CONTROLS

- Grub out seedlings
- Prune out vines
- Mow or cut/grub shrub forms
- Graze area with goats or sheep
- Mulch or replant cleared areas
- Minimize soil disturbance
- Eliminate bird perches

ADDITIONAL ACTION NEEDED?----------------no--------->

yes

USE CHEMICAL CONTROLS

- Ammonium sulphamate (Ammate®)
- Weed Oil
- Glyphosate (Roundup®)
- Mulch or replant cleared area

POISON IVY

By

Sheila Daar, Helga Olkowski and William Olkowski

1. TARGET PEST IDENTIFICATION AND BIOLOGY

1.1 Description of Target Pest and Related Species

Poison ivy (*Rhus radicans* L., or *Toxicodendron radicans* Kuntz) is a deciduous woody perennial plant which is native to North America. It takes several forms including a trailing vine, a subshrub to shrub from 2 inches to 4 feet high, or a vine up to 50 feet tall climbing rough surfaces.

Leaves are 1/2 to 2 inches long, and are always borne in groups of three leaflets. These leaflets, found alternately along the stem, may be glossy or dull-green, are usually smooth, but occasionally may be somewhat hairy. The edges of the leaves vary widely; some are smooth, others are toothed or even deeply lobed. Unfurling leaves are red, becoming green during summer and colored various shades of yellow, orange, red or bronze in autumn.

Leaves of poison ivy never occur in pairs along the stem. This "alternate" leaf characteristic distinguishes poison ivy from other, more benign plants such as Virginia Creeper, *Parthenocissus quinquefolia* L., which resemble poison ivy. See Table 1 for details which distinguish poison ivy from plants which resemble it.

TABLE 1.

DISTINGUISHING POISON IVY FROM PLANTS WHICH RESEMBLE IT

RELATED SPECIES	POISON IVY
Virginia Creeper (Parthenocissus quinquefolia) has leaves composed of five leaflets; leaf scars are circular with raised edge; fruits are juicy and purple; aerial roots contain suction disks.	Leaves are composed of three leaflets; leaf scars are triangular; fruits are hard and white; no suction disks on aerial roots.
Boston Ivy (Parthenocissus tricuspidata) has leaves with three lobes but rarely three leaflets; leaves are up to 8" wide; fruits are juicy and purple; aerial roots contain suction disks.	Leaves are composed of three distinct leaflets; leaflets are narrow, rarely exceeding 1/2 inch in width; fruits are hard and white; no suction disks on aerial roots.
Box Elder (Acer negundo) has leaves composed of three leaflets but are borne opposite each other on the stem; fruits are in flattened pairs with "wings"; young stems are bright green.	Leaves composed of three leaflets borne alternately on the stem; fruits have a round, berry-like shape; young stems brown or dull green.

Stems are woody, ranging from 1/2 to 6 inches in diameter. Slender, creeping rootstalks are produced from the base of the stem. These roots often travel horizontally on top of or through the soil, giving rise to short, slender leafy shoots several yards from the parent plant.

In early summer, small clusters of greenish-white flowers form where the leaf and stem join. Each flower develops into a white or cream-colored berry about 1/8 inch in diameter. The berries are especially helpful in identifying poison ivy during the winter.

Consistent variation in the appearance and growth habit of poison ivy is recognized by the designation of certain subspecies. See Table 2 for a description and geographical distribution of the major subspecies of poison ivy.

A substance known as urushiol, which is toxic to most humans, is found in the phloem cells of poison ivy, located just under the bark. The poison is not carried in the xylem vessels, however, so the inner wood of the plant is not poisonous (Gillis 1975).

Poison ivy is a member of the Sumac family, Anacardiaceae, which also contains such familiar plants as Poison oak (*Rhus diversiloba*) and Poison sumac (*R. vernix*), the cashew nut tree (*Anacardium occidentale*), and the lacquer tree of China and Japan (*Toxcicodendron vernicifluum*) from which oriental lacquerware is made. The sap in each of these species contains urushiol which can cause severe dermatitis in susceptible humans.

1.2 Life History

A. Reproduction

Poison ivy has male and female flowers on separate plants (dioecious). Pollen is distributed by insects and female flowers produce a high percentage of one-seeded mature fruit (Mulligan 1977). Seeds mature in late summer or early fall. They may remain viable for at least six years (Gillis 1971).

TABLE 2.

MAJOR SUBSPECIES OF POISON IVY FOUND IN THE UNITED STATES

Latin Name	Description	Distribution
Rhus radicans L. subsp. radicans (Toxicodendron radicans subsp. radicans Green, Mulligan.)	Shrub to vine form with aerial roots climbing rough surfaces; undersurface of leaflets with tufts of hairs toward bases of midribs; hairs ascending along lateral veins on undersurface of leaflets; usually 5 or more leaves on vertical stems; leaflets entire or mostly entire; surface of fruits pubescent.	A lowland subspecies which is essentially an Atlantic coastal dweller that occurs from southern Nova Scotia south to the Florida Keys and the western Bahama Islands and west to eastern Texas. It is separated from subsp. negundo to the west by the Allegheny Ridge in PA. and NY., and the Blue Ridge mountains to the south. In the north R. radicans is separated from R. rydbergii along the 44th parallel of latitude.
R. radicans L. subsp. negundo (T. radicans, subsp. negundo Greene).	Shrub to vine with aerial roots climbing rough surfaces; hairs along midrib on undersurface of leaflets not tufted; hairs along sideveins on undersurface of leaflets spreading; usually 5 or more leaves on vertical stems; leaflets toothed or mostly toothed.	Found in the central area of the U.S. (the midwestern states generally north of the Ohio River). Eastern boundary is Allegheny Ridge, most clearly delimited in the vicinity of Tuscarora Mountain in Pennsylvania. On the east flank of the Alleghenies is subsp. radicans.
R. radicans L. subsp. rydbergii (T. radicans, subsp rydbergii Greene)	A trailing vine, or a subshrub to shrub lacking aerial roots; hairs along midrib on undersurface of leaflets not tufted; hairs along sideveins on undersurface of leaflets spreading; usually fewer than 5 leaves on stems; leaflets toothed.	Most widespread and uniform of all the subspecies. Occurs from Central Arizona to the Gaspe Peninsula and to the Rockies in southern Canada.
R. radicans L. subsp. verrucosum (T. radicans subsp. verrucosum Greene)	Aerial roots; glabrous leaves and shoots except for an occasional population with small tufts of hairs in major vein axils on lower leaflet surface. Has become distinctive due to prominent sharp lobes on the leaflets.	Found only in Texas.

Few seeds fall directly to the ground, remaining instead encapsulated in the fruits which are eaten by birds and other wildlife.

Poison ivy also reproduces from alternate buds on horizontal rootstalks. However, horizontal spread of poison ivy is slow, rarely more than 4 inches/year and frequently less (Mulligan 1977). Vertical growth of vining stems is rapid, however. Despite its ability to propagate vegetatively, poison ivy rarely becomes established by plant fragments (Gillis 1971).

B. Growth and Development

Colonization of new sites is primarily by seed dispersed by birds and animals during autumn, winter and early spring. The hard seeds pass through the digestive tracts of birds and animals in a viable condition.

Seeds germinate when the soil warms up in the spring. They produce a primary vertical stem and basal roots. Horizontal rootstalks (rhizomes) are produced from the base of the primary vertical shoot in the first or second growing season, and grow horizontally on or beneath the surface of the ground. Rhizomes have buds which produce new vertical stems as well as adventitious roots just below each bud. Each new vertical stem in turn produces additional horizontal rhizomes, resulting in a large interconnected clone with many vertical stems and horizontal rootstalks, both above and below ground.

Flower and leaf buds are formed on new growth on vertical stems in late summer and early autumn, and are carried overwinter on the stems. Leaves appear on the year-old stems as soon as the soil warms up in the spring. Flower buds formed the previous year open in late spring through mid-summer, depending on location. Maximum flowering occurs in June and July in most areas with some additional flowering occuring sporadically until early autumn.

Poison ivy often grows intertwined with ornamental plants and may be mistaken for a desirable landscape plant due to its attractive foliage and striking reddish-bronze fall color.

When growing in full sunlight poison ivy usually takes the form of a shrub, assuming a vine form when growing in more filtered sunlight. The vine form of poison ivy is most common. Vines grow for many years, becoming several inches in diameter and quite woody. Slender vines may run along the ground, grow with shrubbery, or take support from a tree.

The vine forms roots readily when in contact with the ground or with any object that will support it. Aerial roots attach the vine securely to the tree or post supporting the vine. According to Crooks and Klingman (1967), the vines and roots apparently do not cause injury to trees except where growth may cover the supporting plant and exclude sunlight. The vining nature of the plant makes it well adapted to climbing over stone walls or on brick and stone houses. See Section 3.1, Determinining Injury Levels, for a discussion of the impact of poison ivy vines on buildings and other structures.

C. Benefits of Poison Ivy

Despite the toxicity it poses to humans, poison ivy plays a number of beneficial roles in the natural environment. For example, poison ivy is of considerable wildlife value. Fruits are eaten by many birds. Martin et al. (1951) report that poison ivy fruits make up a quarter of the diet of some flickers and wrentits. Fruits, stems and leaves are eaten by bears, muskrats, rabbits, small rodents and deer, and a number of small mammals use it for cover. Bees can make a nontoxic honey from its nectar (Rostenburg 1955).

As a colonizer of disturbed soils, poison ivy appears to play a significant role in erosion control and soil stabilization. In the Friesland Province of Holland, poison ivy is used to stabilize dykes (Gillis 1975). In park settings, poison ivy (properly posted with signs) could be used to discourage human trampling of sensitive areas.

1.3 Natural Enemy Information

Mulligan (1977) lists arthropods in the following orders as feeding on poison ivy: Lepidoptera, Hymenoptera, Diptera, Coleoptera, Homoptera (Aphididae) and Acarina (Harrison 1904; Tissot 1928, 1933; Steyskal 1951; Gillis 1971; Richards 1972). Criddle (1927) considered the larvae of *Epipaschia zelleri* Grote (*Lepidoptera*) the most destructive of all insects to poison ivy.

Conners (1967) lists the following fungi as infesting poison ivy in Canada: *Cercospora rhoina* Cke. & Ell. Man., *Cylindrosporium irregulare* (Pk.) Dearn., *Cylindrosporium toxicodendri* (Ell. & Mart.), *Phyllosticta rhoicola* Ell. & Ev., and *Pileolaria brevipes* Berk. & Rav. Parmelee and Elliott (1974) also list *Pileolaria brevipes* from British Columbia and Arthur (1934) states that this rust infects poison ivy throughout its range.

1.4 Host/Site Information

Poison ivy is usually found where soils have been repeatedly disturbed in connection with construction projects, forest clearing operations, etc. It does not grow where repeated agricultural cultivation occurs, since these operations remove seedlings before they can become well-established. Poison ivy grows in association with many other native and introduced plant communities and is most often found growing at woodland edges or openings, along roadsides and fenceposts, and adjacent to watercourses. Because poison ivy fruits are eaten by a wide variety of birds, the plant is common around trees, fencerows, under telephone wires, and wherever birds are likely to perch.

Its wide distribution throughout the north-and south-eastern U.S. and extensions into Canada and south into Central America indicates that poison ivy is adapted to a wide variety of climatic conditions.

Poison ivy grows on a variety of soils. According to Gillis (1971), calcium is the most important element in the soil for the growth of poison ivy. The maximum root development is in the A horizon of the soil and poison ivy is virtually absent from soils that are highly leached of minerals, especially calcium and magnesium.

2. MONITORING

2.1 Target Pest Monitoring Techniques

In park settings where poison ivy is or has been present, begin monitoring in mid-to-late spring when new seedlings have germinated and the leaves have opened on older, established clumps. Use the distinctive 3-part leaves to identify the plant. To decide on levels of effort needed for monitoring, determine which growth form (sub-species) of poison ivy is present at the site. With the relatively low shrub forms which tend to spread horizonally only very slowly -- approximately 4" per year (Mulligan 1977), monitoring can be kept to a minimum.

2.2 Monitoring Timing and Frequency

The most important thing is to time the first monitoring visit(s) early enough in the season that both seedling and established poison ivy stands are visible and can be accurately noted on a map. This is usually mid-to-late May in most parts of its range.

For the vining forms of poison ivy which are capable of rapid and extensive vertical growth (six to twenty feet in one season is not unusual), more frequent monitoring might be desirable in order to determine the need for treatment before growth is excessive. Since most vertical growth of poison ivy occurs prior to flowering, it is desirable to monitor poison ivy vines once per month between foliation in the spring (April-May), and onset of flowering (June-July in most areas) and again at the end of the growing season.

If monitoring indicates that no treatment is required, subsequent visits should be necessary only at the end of the summer before plants lose their leaves. At this time any changes in park use patterns near the poison ivy, as well as the height and width of the clump can be recorded. By reviewing this data over time, park managers can determine relative growth rates of poison ivy in their area as well as the likelihood of park visitors or workers coming in contact with it. Decisions about injury (tolerance) levels and treatments can be based on this data.

If a treatment is warranted, monitoring must occur frequently enough to determine when the plants are at the optimal stage for treatment. For example pruning treatments on poison ivy are most effective if applied just before the plant blooms; herbicide treatments on mature plants should be applied during or just after flowering (see section 4.2). Since chemical and mechanical treatment methods prescribed for poison ivy usually require more than one application, it is important that monitoring occur frequently enough after the first treatment to detect if and when a second treatment is needed.

This usually means that treated plants should be visited again a minimum of two-to-four weeks after initial control efforts. If a second treatment appears to be needed, another post-treatment monitoring visit should be scheduled, with a final visit at the end of the growing season to determine the overall effectiveness of the treatment program. Plants believed to be dead sometimes resume growth after many months; thus an area under treatment must be watched fairly closely for at least a year to determine if retreatment is necessary (Crooks and Klingman 1967).

2.3 Monitoring Natural Enemies and the Environment

As a native plant, poison ivy tends to enjoy a stable relationship with the herbivores and pathogens that feed on it. Thus, suppression of its growth by native natural enemies is not likely to be significant. However, livestock, particularly penned goats and sheep can severely reduce and sometimes eliminate stands of poison ivy by their browsing and trampling activities. Thus,

These variables may differ from site to site depending on the location, overall maintenance objectives, role or value of the plants in the environment, opinions and experience of managers, level of complaints by visitors or staff, etc. In the case of poison ivy, the adverse health effects that contact with the plant pose to humans usually render tolerance levels very low.

Similarly, the potential damage to buildings posed by poison ivy may also justify low tolerance levels. Like Boston Ivy (*Parthenocissus tricuspidata*) and English Ivy (*Hedera helix*) (Warnock et al. 1983), Poison Ivy attaches itself to stone masonry, wood and other building materials by means of aerial rootlets which are capable of penetrating and enlarging small cracks in the structure. This habit can result in water damage and general weakening of the building. The dense foliage and thicket of roots produced by poison ivy also can visually obscure the building surface so that damage goes undetected.

Tolerance for poison ivy growing on trees, however, may be high due to the fact that vines and roots apparently do not cause injury to trees except where growth may cover the supporting plant and exclude sunlight (Crooks 1967).

In summary, in areas of high use near buildings, within campgrounds, and on major trails, tolerance levels would be *low* since the likelihood of human contact or damage to buildings is high. In low use and remote areas of the park, tolerance levels for poison ivy could be quite *high*, since human contact is less likely. *In general, poison ivy should only be controlled in developed sites where the plant is likely to come in contact with humans or damage structures.*

3.2 Action Point

The action point is that point in time when weed suppression must take place to prevent the injury level from being reached (or the tolerance level from being exceeded).

where livestock are corralled in the vicinity of poison ivy, early and late season monitoring visits should be made to document levels of control achieved by the livestock.

The environmental conditions conducive to poison ivy growth (e.g., sites where soils have undergone severe disturbance) should be monitored several times per season in order to spot new infestations of the plant. Examples of such areas include construction sites, trenching operations, heavily used trails, eroding streamsides, and even rodent mounds. Monitoring of these areas can consist of casual observation until poison ivy is found to be present, at which point written records should be initiated.

3. DECISION-MAKING

3.1 Determining Injury (Tolerance) Levels

Injury level refers to the point in the growth of the pest population when the numbers of pest organisms are sufficient to cause some unacceptable kind or degree of structural, economic, aesthetic or medical damage (injury). When applying the injury level concept to weed problems, it is useful to substitute the phrase "tolerance" levels as a synonym for "injury" levels. In other words, to determine how much weed growth can be tolerated before action is required to prevent aesthetic or other injury (damage) from taking place.

Several variables should be considered in establishing any weed tolerance level. These include:

a. species and growth habit;
b. location of weed problem;
c. weed population size;
d. type of actual or potential damage caused by weed;
e. degree of invasiveness of growth;
f. costs of managing the weed problem (including lost work time, responding to complaints, education of staff and visitors, etc.).

Like injury/tolerance levels, weed action points are based upon an understanding of how fast the plant is likely to spread in a given period of time and the need to treat early enough in the plant's growth to prevent injury to people, structures, ornamentals, etc.

With poison ivy, the point when action is needed primarily depends on whether it is the shrub or vine form to be dealt with, and whether it is the young seedling stage or established perennial rootstalks that are to be treated.

If it is the shrub form, growth is slow enough that several seasons may pass before action is required to keep the plants from exceeding tolerance levels. The only interim action required may be monitoring and the posting of warning signs to keep humans away from the plants. With the vining form, however, its rampant growth habit may indicate the need to treat as soon as it is observed growing in order to prevent the tolerance level from being exceeded.

3.3 Timing Treatments

Seedling: The timing of treatments is a function of the growth stage of the plant to be treated and the technique to be used. Poison ivy is most easily removed when in the seedling stage in early spring (Crooks and Klingman 1967). Such timing permits the use of mechanical methods--primarily grubbing out the plants--and occurs at a time when the soil is still wet and all parts of the plant including the roots can be removed by cultivation. Careful workers with proper protective clothing can dig out small plants with minimal hazard to themselves.

Clumps: If the plants to be removed are established clumps supported by mature rootstalks, treatments by mowing should be applied just before the plants bloom, usually in early to mid-June. Herbicides are most effective when applied at the full-bloom stage when poison ivy plants are translocating sugars (and the herbicide) down to the roots. Subsequent treatments should be delayed until the resprouts are in full leaf. Treatment of mature plants by physical means (hand removal) or pruning, might best be done in late fall when plants have lost their leaves, thus reducing the potential exposure of workers

to the poisonous resins. At this point in the season fall rains have again soaked the soil, making physical or mechanical removal of rootstalks easier to achieve. Herbicide use can be kept to a minimum by first pruning off the leaves and stems with a weed eater or lopping shears followed by spot-treating the stumps with a hand-sprayer, wick applicator or injection device.

During the early part of the growing season, the leaves of poisonous plants usually tend to stand conspicuously apart from those of adjacent plants, and treatments can be targeted to poison ivy alone if done carefully. Later the leaves become intermingled, and injury to adjacent species is unavoidable.

3.4 Spot Treatment

The purpose of spot treatments is to confine the material or activity to the target plant. Spot treatments when plants are small can solve problems early and avoid more extensive control efforts later on. When treatments are applied, unnecessary soil disturbance should be avoided as it provides habitat for new infestations of poison ivy.

4.0 TREATMENTS

4.1 Indirect suppression

Indirect suppression strategies and tactics are those that change the conditions that create or define the pest problem. Examples are:

a) design or redesign of the landscape or the plant care system for the purpose of reducing or eliminating weed growth;

b) modifying the habitat in some major way to discourage growth of a particular weed species;

c) human behavior changes including the alteration of use patterns or maintenance practices contributing to weed growth, or education to increase tolerance levels for the "weed" species.

B. Competitive Planting

Where significant soil disturbance has occured due to construction projects, acts of nature, or physical removal of poison ivy plants, it is important to seed in or plant fast-growing soil colonizing plants such as grasses or groundcovers in a effort to limit the soil space and nutrient reserve otherwise available to poison ivy. Although this tactic has not been documented specifically for poison ivy in the weed literature, it is a well-established weed control tactic for similar species (Daar, 1983b) and is worth testing on poison ivy.

To be most effective, the planting should occur as soon as possible after the soil disturbance has occured. Native plant species are most desirable for such areas as they are best adapted to existing soil conditions and weather patterns and best able to establish themselves with minimum maintenance. Consult local soil conservation and native plant organizations for recommended plant species.

4.1.3.2 Education

In a park setting, it is important to educate visitors and staff on methods of identifying poison ivy so they can avoid contact with the plant. To the degree human contact with the plants can be avoided, treatments of the pest will be unnecessary. Signs, pamphlets and displays can be located at trailheads, campgrounds, visitor centers and similar areas where visitors are frequent.

4.2 Direct Suppression

4.2.1 Physical controls

A. Grubbing Out

Seedling: Physical removal with digging and cutting tools is often the most effective means of thorough removal of poison ivy. Seedling plants can be dug out most easily in early spring after leaves have unfurled, but while the soil

4.1.1 Design or Redesign

Poison Ivy is primarily a problem in landscapes that have not been designed by humans originally, or that have been left to revert to a more "natural" state after previous human management. Redesigning the area is rarely a desirable strategy because of the basic objective of keeping the area as "natural" as possible.

However, in developed park areas designers of latrines, visitor centers, campgrounds, fencelines, etc. should be encouraged to avoid creating bare areas beneath likely bird perches as these conditions optimize the establishment of poison ivy.

4.1.2 Habitat Modification

No examples of using habitat modification to manage poison ivy could be found in the literature. However, ecological information on the pest suggests that application of deep mulches to bare soil could restrict germination of poison ivy seeds (see "Mulching", Section 4.1.3.1C).

4.1.3 Human Behavior Changes

4.1.3.1 Horticultural Controls and Maintenance Activities

A. Minimizing Soil Disturbance

Poison Ivy is opportunistic, taking advantage of areas where the soil has been disturbed and laid bare, and there is less competition. Where the pest plant and the wildlife that feeds upon and spreads it are common, every effort should be made to minimize soil disturbance as a part of construction projects or staff and visitor traffic.

is still wet. By summer or fall of the first year, seedlings usually have a well-developed vertical and horizontal root system and are more difficult to remove.

Mature: Late fall, after poison ivy has dropped its leaves and rains have saturated the soil, is usually the best time to dig out mature poison ivy. Since root systems may travel horizontally for 20 feet, extensive digging may be necessary. However, the roots do not appear to grow more than a foot or so deep, so extensive vertical digging is usually not required. After the initial grubbing has occured, treated areas should be monitored on a monthly basis to check for resprouts from rootstock inadvertently left in the soil.

In addition to shovels and mattocks, other tools useful when grubbing out poison ivy include brush hooks, McLeods (a double-edged digging tool), Pulaski's (a forester's axe), and gas-powered weedeaters with blade attachments. Hydraulic winches mounted on pick-up trucks are often useful in removing stems and roots of poison ivy growing in dense thickets. These tools can be found in most forest equipment supply catalogues.

B. Mowing

Seedling and young plants can be kept within an inch or two in height by frequent mowing (probably twice per month during the growing season). This regular removal of leaves and stems will restrict (but not eliminate) the development of horizontal roots. If a mowing program is adopted, it is important to collect clippings and dispose of them in a plastic bag or bury them to prevent the clippings from being spread over large areas and inadvertently contaminting park workers or visitors. Mowing is not recommended for poison ivy control in a lawn area used for picnicing or other recreational activities.

C. Repeated Cultivation

Poison ivy can be removed by repeated cultivation with a hoe, disk, spring-toothed harrow, or duck-foot cultivator. To be effective, cultivation has to occur frequently enough to remove new seedlings or young plants before they are able to form extensive perennial roots. The actual cultivation frequency required is a function of several factors including extent of growth of poison ivy, soil conditions, type of adjacent vegetation, etc.

D. Pruning and Girdling

It may be possible to kill poison ivy by girdling stems or trunks. To do this, cut an incision through the bark into the sapwood in a continuous line around the circumference of the stem. The incision cuts the sap transport vessels thus halting the movement of nutrients and water up and down the plant, causing eventual death.

Poison ivy growing as long vines on trees can be killed by severing their stems near the soil line with an axe or saw (Grant 1929). Care should be taken to chop completely through the viney stem which is often found fitting in a groove of the bark of the tree. To minimize damage to the tree bark, the final cut should be made with a knife.

The severed vine can be pulled from the tree at the time the cut is made, or it can be left to dry on the tree over the summer and be removed in the fall when the dried leaves have dropped off and the remaining wood is less toxic to handle. After a month or six weeks, the new tops that spring from the lower portion of the vine may be pulled up (Grant 1929), injected or painted with an herbicide, or cut off repeatedly in hopes of starving the root system and achieving the eventual death of the plant.

E. Mulching

Once poison ivy has been removed from an area, it is desirable to cover the soil with a temporary groundcover, to reduce the ability of poison ivy

seedlings to recolonize the open ground. A deep mulch (6 - 12 inches) of hardwood chips is most likely to provide protection against poison ivy seedling emergence. Hardwood chips in the 1" x 2" size range are more effective than mulches made from bark. The small particles size of bark mulches and their easy decomposition by soil microbes limits their effect.

NOTE: Never burn any part of the poison ivy plant. Tiny droplets of the oil will be carried on ashes in the smoke and can be breathed into the lungs. The throat may swell up and the whole body can break out in an extreme rash. Whenever possible, dispose of treated poison ivy by burying. Plant pieces should be covered with at least 12" of soil to prevent sprouts from developing. If burying is not feasible, enclose plants in plastic bags for disposal in a landfill.

4.2.2 Biological controls

A. Arthropods and Pathogens

A number of arthropods, micro-organisms and viruses are reported to feed on poison ivy (See Section 1.4). However, researchers are reluctant to pursue biocontrol programs on poison ivy because so little is understood about the beneficial roles played by poison ivy and other native plants in the ecosystem. The unknown risks to the environment caused by non-selective suppression of native plant species by biological control organisms could outweigh the benefits.

B. Livestock

Suppression and even eradication of shrubby stands of poison ivy can be achieved by intensive grazing of livestock in areas where the plant is growing (Grant and Hansen 1929). While few studies exist on using livestock specifically for poison ivy control, there is extensive experience with goats controlling similar brush species such as poison oak (*Rhus diversiloba* L.) in the western U.S., and useful extrapolations to poison ivy are probably in order (Daar 1983a; Green and Newell 1982).

Where appropriate, Angora, Spanish or other non-dairy goat breeds or sheep can be concentrated in an area containing poison ivy by use of lightweight, portable, electrified plastic fencing called Flexinet®, powered by a 12 volt car battery or solar cell which generates sufficient current to keep livestock in and predators out. Fencing fabric is supported on non-conductive fiberglass fence posts. Flexinet® is available from the Waterford Corporation, Fort Collins, CO and costs approximately $100 for 150 feet in 1983.

The degree to which poison ivy is suppressed or eradicated by goats or sheep depends on a number of factors including herd size, duration of penning, state of succulence of vegetation, etc. Goats and sheep will graze or trample most of the vegetation in the area in which they are penned, so valuable vegetation such as specimen trees and shrubs should be protected by fencing or other barriers to keep the livestock at a distance. Goats eat both foliage and stems of poison ivy.

4.2.3 Chemical controls

A. Herbicide Application Timing and Techniques

Typically, at least two herbicide applications are needed to kill all parts of the plant (Grant and Hansen 1929; Crooks and Klingman 1967). Seedlings should be treated in the spring as soon as new leaves are fully opened (Daar 1983b). Translocated herbicides such as ammonium sulphamate (=Ammate®) or glyphosate (=Roundup®) should be applied on mature plants during or just after the bloom stage as that is the point when sugars are being translocated to the roots and will carry the herbicide throughout the plant system. If monitoring indicates retreatment is needed, a second application is best made as soon as resprouted leaves are fully expanded (Crooks and Klingman 1967). See Table 3 for a list of herbicides registered for use against poison ivy.

B. Protection of Workers

Poison ivy is toxic at all stages of growth--and even when dead from severed roots or herbicide spray (Crooks and Klingman 1967). Thus protective

TABLE 3.

A COMPARISON OF EFFICACY, TOXICITY, MOBILITY & PERSISTENCE OF COMMON HERBICIDES USED AGAINST POISON IVY*

HERBICIDE	EFFICACY	TOXICITY (LD_{50})†	MOBILITY	PERSISTENCE SOIL/WATER††	COMMENTS
Ammonium Sulphamate (Ammate®)	H	L	L	S= 4-12 wks W= nd	Degrades to nitrogen and sulfur in soil
Aminotriazole (Amitrol-T®)	H	M	M	S= 7 weeks W= 201 days	Potentially carcinogenic in humans¶
Glyphosate (Roundup®)	H	L	L	S= >8 wks§ W= nd	
Sodium Chlorate (Chlorate/Borate mix is fire-retardant)	H	L	L-H	S= 12-52 wks W= nd	

*Herbicides from Herbicide Handbook. 1979. Weed Science Society of America.

†Ibid, Herbicide Handbook.

††Pimentel, D. 1971. Ecological Effects of Pesticides on Non-Target Species. Office of Science and Technology. USGPO. NOTE: This data is dependent on many variables including soil type, available moisture, rates of application, etc. Figures presented here should be considered approximations.

¶IARC monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Supplement I, 1979. IARC, Lyon, France, p. 22.

§Herbicide Handbook, op.cit., p. 226.

KEY:
- Efficacy: H = High; M = Medium; L = Low
- Toxicity: H = LD_{50}'s of 1-99 mg/kg; M = 100-1000; L = >1000.*
- Mobility: H = High; M = Medium; L = Low
- Persistence: S = soil; W = water; nd = no data

clothing should be worn no matter which treatment is selected. Workers should cover as much of the body as possible. Canvas or leather leggings over work-pants provide extra protection when working in dense stands of the plants. Hands should be protected with thick canvas, rubber or leather gloves. A beekeeper hat with veil can be used to protect the face when clearing dense stands of poison ivy. An industrial respirator mask should be worn when chopping or sawing plants to prevent breathing in sawdust particles, or when in the vicinity of burning poison ivy (burning is not a recommended method of control or disposal.)

Poison ivy sap can adhere to clothing, tools, and the coats of pets and livestock for very long periods of time, and therefore serve as reservoirs for recontamination. For example, Shelmire (1941) reports that gloves stored at room temperature for 16 months still can cause poison ivy dermatitis. Thus it is important that clothing worn while working in or near poison ivy be carefully removed (use gloves), washed in hot, soapy water, and hung in the air to dry for several days in order to insure that all sap is deactivated (Gillis 1975). Repeated washing may be needed. Do not wash with other clothing. Using rubber gloves, clean tools used on poison ivy after each use with a rag containing an oil solvent such as gasoline, alcohol, or turpentine. Rags and gloves should be enclosed in a plastic bag and discarded after use to prevent recontamination.

Contaminated skin should be washed several times with water and a strong soap. The soap dissolves the oily sap and enables it to be removed from the skin. If soap is not available, cotton balls soaked in vinegar (2 tablespoons in 1 cup water) or alcohol (1/2 cup alcohol to 1/2 cup water) can be dabbed on the contaminated skin to dissolve the sap. Calamine lotion or a paste of baking soda can be topically applied to the dermatitis to relieve itching.

C. Protecting Adjacent Vegetation

Since both shrub and vining forms of poison ivy usually grow in association with desired ornamental or native plant species, great care must be taken not to permanently damage such plants when using herbicides on poison ivy.

To keep damage to desirable plants to a minimum, use injection, frill or basal spray techniques where possible. Herbicide injection tools are available from forestry supply catalogues or other equipment sources. Frill methods consist of making shallow axe cuts around the circumference of the stem and applying herbicides into the cuts. Basal sprays involve coating the bark on the lower 12" to 24" of trunk or stem with herbicide.

When foliage sprays are required, spray nozzles which produce fairly large herbicide droplets should be used to limit drift of the herbicide. It may be useful to include an anti-drift product in the spray tank. Drift also can be minimized by using moderate pressure thus producing relatively large spray droplets, rather than high pressure which produces a driving mist (Crooks and Klingman, 1967).

Another application tool useful in confining herbicides to the target weed (spot-treatment) is a wick applicator. These tools absorb the herbicide on a rope, sponge or carpet wick and permit the applicator to wipe the herbicide directly onto the poison ivy. The applicators are made from common PVC plastic pipe and commercial rope, sponges or carpet pieces. They can be custom designed (or easily retrofitted) with long handles allowing the worker to stand some distance from the poison ivy yet still apply the herbicide. Manufactured, hand-held or machine-mounted wick applicators can be purchased from commercial sources.

The "jar method" is another technique of limiting drift. To implement this method, cut the tip off a trailing stem of the poison ivy plant. Discard the severed tip and place the cut end into a quart jar containing an herbicide solution for at least one hour. Jars (or other containers) should be stabilized so they don't tip over. It also may be necessary to use a wedge or fastener to hold the immersed shoot in position. The herbicide will be translocated throughout the plant's vascular system and the plant (or substantial portions) will die.

The herbicides ammonium sulphamate, sodium chlorate or glyphosate can be used in the jar method. Use at the highest concentration permitted on the label.

Bates (1955) found that a 40 percent concentration of sodium chlorate was more effective at killing woody plants than were weaker solutions of 5 to 10 percent. Note that sodium chlorate is highly combustible and should be used with extreme caution.

The "jar" method works on the principle of negative root pressure and, according to Bates (1955), the best results are obtained in hot dry weather and at the height of summer. Treatment with the "jar" method in mid-winter and early spring seem to be the least effective and treatment of certain plants was without effect in late March, but rapidly effective in July. Once the plant is dead, the sodium chlorate, "does not appear to cause any injury when the weed decays. Whether this is due to the small amount present or whether it is due to the decomposition of the chemical, is not known (Bates, 1955). Ammonium sulphamate degrades to the fertilizers nitrogen and sulphur. If the "jar" method is used, workers must remain near the jars to insure that visitors, pets or wildlife do not come in contact with the poisons.

----end----

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ADVANTAGES OF HAND CUTTING

1. Cost: The basis of a single treatment, hand cutting has a cost advantage over other types of treatment regardless of the density of capable stems. In the long-term program of treatment over several treatment cycles, hand cutting may not be the least expensive since this type of treatment eventually leads to prolific sprouting and increased density. All costs are based on utility billing rates for labor, equipment and materials. Labor rates include the wages paid to the worker plus overhead and profit (1b).

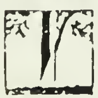
2. Maintenance of Desirable Non-target vegetation: Aerial herbicide treatment caused a net decrease (-6. percent of shrubs. Selective ground foliar spraying produced a low net increase (+3 percent) of shrubs. The effect of hand cutting and the other four treatments (listed on page 31) on ground cover were similar. An increase in total herbaceous cover was recorded for all treatments (1b).

3. Visual Effects: Undesirable brownout and more accumulation of dead stems was seen with herbicide treatments than with hand cutting (1b).

4. Health Affects: The adverse health effects of handling pesticides was studied in the Maine Department of Transportation and Pesticide Control Board. Of the 38 persons tested 27 may possibly be responding to occupational exposures. In some cases, liver enzyme levels were slightly above normal, while in others the cholinesterase values were somewhat depressed. Maine is one of a handful of states that has started such programs (Feb. 1985). It has begun focusing on long-term toxicity of chemicals used, instead of merely considering the acute effects. It should be noted that there have been some reports of accidents due to the use of chain saws in hand cutting.

EVALUATION MATRIX SUMMARY (1B)

KEY
- \+ Desirable Change
- \- Undesirable Change
- 0 No Change
- NA Not Applicable

		See Section: III	II	VI-A		VI-C				VI-E					VI-D		
						Visual				Wildlife Habitat					Soils		
	Density	Initial Average Cost per Acre ($)	Initial Percent Stem Kill	Shrub Species	Herbaceous Species	Brownout	Dead Stems	Formative Effect	Slash Concentrations	White-tailed Deer	Ruffed Grouse	Rufus-sided Towhee	Gray Catbird	Meadow Vole	Compaction	Erosion	Area Impacted by Vehicles
Hand Cutting 	High	159	-11	+	+	0	0	0	-	NA	NA	NA	NA	NA	NA	NA	NA
	Med.	118	-3	+	+	0	-	0	-	+	-	+	+	+	NA	NA	NA
	Low	91	+43	+	+	0	0	0	-	NA	NA	NA	NA	NA	NA	NA	NA
Mowing 	High	193	-44	+	+	0	-	0	-	NA	NA	NA	NA	NA	NA	NA	31.9
	Med	174	-19	+	+	0	-	0	0	-	-	+	+	+	-	-	21.2
	Low	162	+57	+	+	-	-	0	-	NA	NA	NA	NA	NA	NA	NA	14.3
Cut and Stump 	High	309	-61	+	+	0	0	0	-	NA	NA	NA	NA	NA	NA	NA	NA
	Med.	192	-49	+	+	0	-	0	-	-	-	+	+	+	NA	NA	NA
	Low	113	-13	+	+	0	0	0	-	NA	NA	NA	NA	NA	NA	NA	NA
Dormant Basal 	High	463	-78	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	3.8
	Med.	378	-80	+	+	-	-	0	0	-	-	+	+	0	-	-	3.5
	Low	322	-42	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	2.8
Summer Basal 	High	405	-86	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	3.1
	Med.	299	-80	+	+	-	-	0	0	-	-	+	+	-	-	0	2.9
	Low	227	-61	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	3.2
Selective Ground Foliar 	High	232	-59	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	NA
	Med	222	-71	+	+	-	-	0	0	-	-	-	-	+	-	0	4.1
	Low	214	-100	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	NA
Aerial 	High	285	-80	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	NA
	Med.	295	-73	+	+	-	-	0	-	-	-	+	-	+	NA	NA	NA
	Low	285	-54	+	+	-	-	0	0	NA	NA	NA	NA	NA	NA	NA	NA

Estimate Cost per acre for Single Treatment
(Based on 1981 Dollars) (1b)

Density stems per acre	4 ft 2,000	4 ft 6,000	4 ft 12,000	10 ft 2,000	10 ft 6,000	10 ft 12,000
Hand Cutting	$82	$159	$274	$124	$201	$317
Mowing	$93	$128	$181	$210	$245	$298
Cut & Stump	$88	$312	$648	$210	$434	$770
Dormant Basal Treatment	$184	$345	$586	$452	$613	$855
Summer Basal Treatment	$206	$408	$713	$314	$517	$821
Selective Ground Foliar Treatment	$104	$125	$155	$277	$297	$327

SUMMARY OF NO SPRAY PROGRAMS

STATE	RESPONSIBLE AGENCY OR COMPANY		
	Dept. of Trans.(DOT)	Utility Company	Agreement
Maine*	1. Town of Lebanon signed agreement 2 years ago. 2. Town of Southport presently discussing an agreement. 3. About 500 landowners have agreements. 75% of the landowners have successfully complied with the program. 4. DOT places metallic, reflective, No Spray signs on appropriate property.	Maine Central Power sent notification of No Spray option to all customers with March bill. To date about 75 people have requested information and about 20 have signed agreements.	Landowner or landowner of abutting property maintains land to specifications set by the Department of Transportation or Utility Company
Vermont**		Public Service Board (includes all utility companies)	1. Limited spraying, i.e. cutting and stump treatment free to landowner OR 2. Landowner pays the difference in cost between mechanical clearing and spraying. This cost is based upon a brush acre, i.e. 500 stems per acre. The cost has not been set yet as there are discrepancies in the cost estimation among the various companies.