ALTERNATIVE CONTROL OF TANSY RAGWORT

ON A TRANSMISSION RIGHT-OF-WAY

SECOND ANNUAL PROGRESS REPORT

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Mr. Bob Brown of the Oregon Department of Agriculture visited the site with us and supplied the flea beetles for release on the study area. The staff of the Thurston County Noxious Weed Control Board assisted with the collection of cinnabar moth larvae.

Mr. A.T.S. Wilkinson, retired research scientist with Agriculture Canada, and Dr. Peter McEvoy of Oregon State University reviewed our report and provided helpful suggestions on study design. We gratefully acknowledge these people and the many other individuals who contributed to the study.

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SUMMARY

This report describes the second year of a multi-year experiment to control tansy ragwort (<u>Senecio jacobaea</u>) on a transmission right-of-way near Darrington, Snohomish County. Seattle City Light authorized the study in 1986 to compare the feasibility of biological control with traditional methods of ragwort control (i.e. handpulling and herbicide). Two insect species which feed on ragwort, the cinnabar moth (<u>Tyria jacobaeae</u>) and ragwort flea beetle (<u>Longitarsus jacobaeae</u>), have been introduced to the study area. Insect populations are being monitored along with ragwort densities in each of the three experimental treatment types. Depending on the success of biological control, the City may reduce the use of herbicides for controlling tansy ragwort on the right-of-way.

INTRODUCTION

Tansy ragwort (Senecio jacobaea) is a biennial or short-lived perennial member of the daisy family, introduced to North America from Europe (Figure 1). It is considered a major noxious weed in Oregon and Washington, causing economic losses by poisoning cattle, horses, and goats (Bedell et al. 1981, Macdonald 1983) and by displacing desirable forage (McEvoy 1985). Land owners in the state of Washington are required under RCW 17.10 to control and prevent the spread of ragwort and other noxious weeds to adjacent agricultural lands.

For several years Seattle City Light has been using the herbicide Banvel, combined with hand weeding near streams, to suppress tansy ragwort on a transmission right-of-way near Darrington, Snohomish County. In 1986 the City authorized a study of the feasibility of biological control of ragwort on the right-of-way. The purpose of the study is to establish populations of two insect species, the cinnabar moth (Tyria jacobaeae) and ragwort flea beetle (Longitarsus jacobaeae), and test their effectiveness, against herbicide and handpulling, in keeping ragwort at low densities. Ultimately, the City would like to eliminate the use of herbicide for tansy ragwort control on the right-of-way.

Successful biological control of ragwort may take several years, depending on how quickly the insect populations establish themselves. The City views this as a multi-year project, and has renewed the study annually since 1986. First-year results, and a literature review on the biology and control of tansy ragwort were reported by Parametrix, Inc. (1987). This report describes the results of the second year's study.

STUDY AREA

The tansy ragwort study area is located north of Darrington near the Snohomish-Skagit county line (Figure 2). The site is part of a 300-ft wide transmission right-of-way used to convey power from the Skagit Hydroelectric Project to Seattle.

Vegetation on the right-of-way consists of early successional forest communities (shrubs, grasses, and forbs), interspersed with pasture. The terrain on the study area is relatively flat, and is bisected by Beverly Creek, an intermittent stream which joins the Sauk River. The creek flows from approximately October through April, and has flooded during two of the last three winters.

Ragwort density is highest near the creek in the northeast part of the study area. Before the study, cattle from adjacent farmlands had access to the study area through coniferous forest bordering the right-of-way. To prevent the interference of cattle with this study, their use of the area has been eliminated.

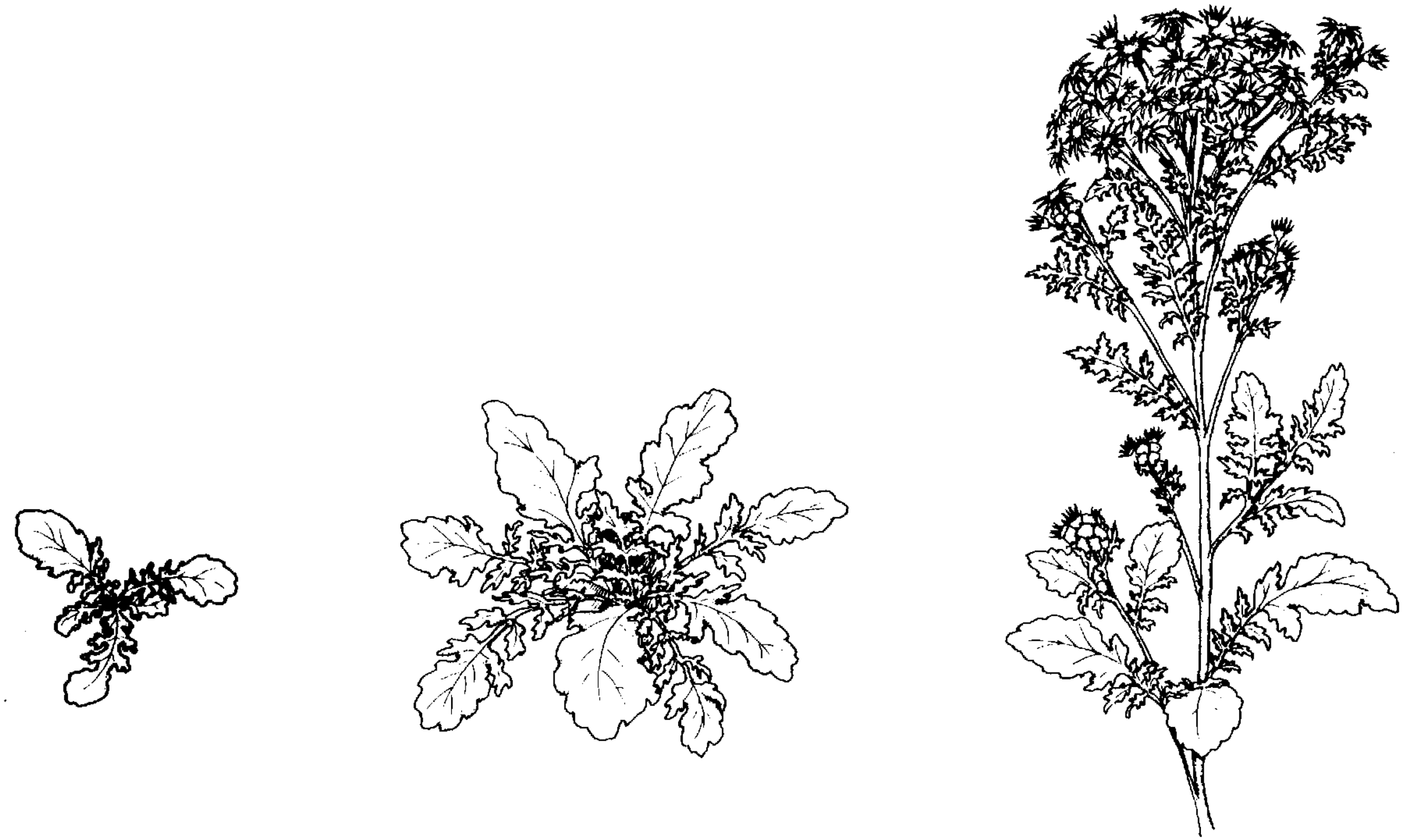

Figure 1.
Tansy Ragwort.

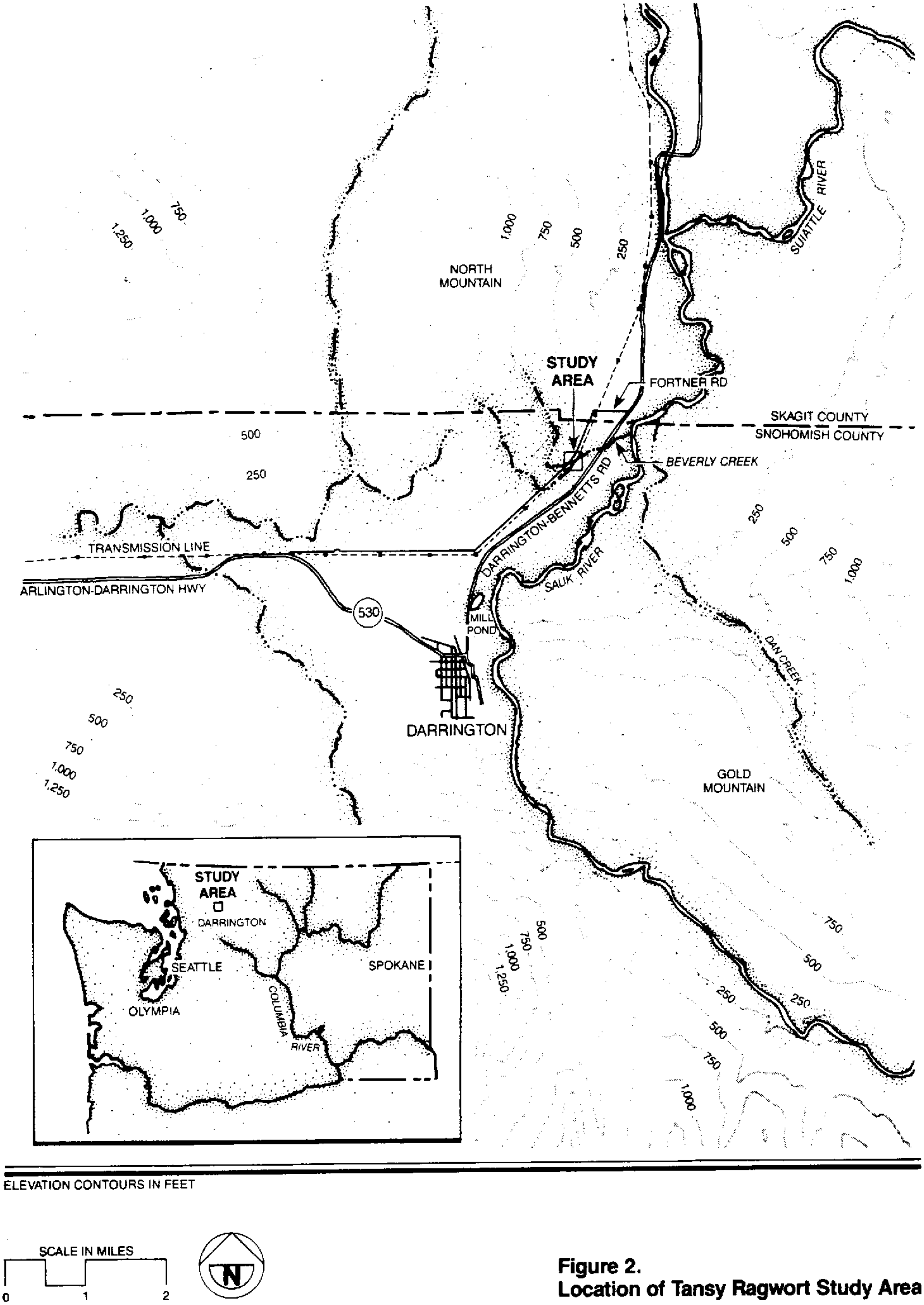

Figure 2.
Location of Tansy Ragwort Study Area

METHODS

This study is designed to evaluate the feasibility of biological control of tansy ragwort. Control of ragwort populations was evaluated in terms of success in eliminating the plant and dollar costs associated with removal. Three experimental treatments--insects, handpulling, and herbicide--are being compared on a 7.5-acre section of the right-of-way (Figure 3). The experimental design was influenced by the following factors:

1) The need to establish insects in the area of highest ragwort density.

2) A City ban on herbicide use within 50 ft of the streambed.

3) The need for easy interpretation by right-of-way maintenance crews which are responsible for handpulling and herbicide treatments.

4) A requirement of the Snohomish County Weed Control Board that some form of treatment be administered to tansy ragwort on all parts of the study area.

As a result of the latter requirement a control (no treatment) was not possible. We therefore established a reserve area on the site to accommodate expanding insect populations.

RAGWORT POPULATION ESTIMATES

Tansy ragwort densities were sampled on May 24, 1988 using a stratified random design as in previous years (Parametrix 1987). Plants were classified as seedlings (<7.5-cm diameter), rosettes (>7.5-cm diameter), and flowering plants (McEvoy 1985). Each treatment area was staked in a rectangular grid pattern, with individual grid cells measuring 30 x 30 ft (Figure 3). Ragwort plants were randomly sampled within grid cells using a 1/4-m^2 quadrat. There were 51-68 samples per treatment.

We analyzed our data for statistical differences in ragwort densities. We compared mean ragwort densities among treatment areas using the Kruskall-Wallis test. This nonparametric statistic is designed for use with data which are not normally distributed, such as ours.

We also made stem counts of flowering ragwort plants on June 21 and 23, 1988. These counts of flowering plants were necessary because their densities were generally too low to estimate reliably by sampling, although we did sample two areas where plants were too crowded to count accurately. Counts of stems were transformed to numbers of individual plants by dividing by 1.69, the mean number of stems per plant from counts made during 1987. Ragwort population data were gathered before application of our treatments.

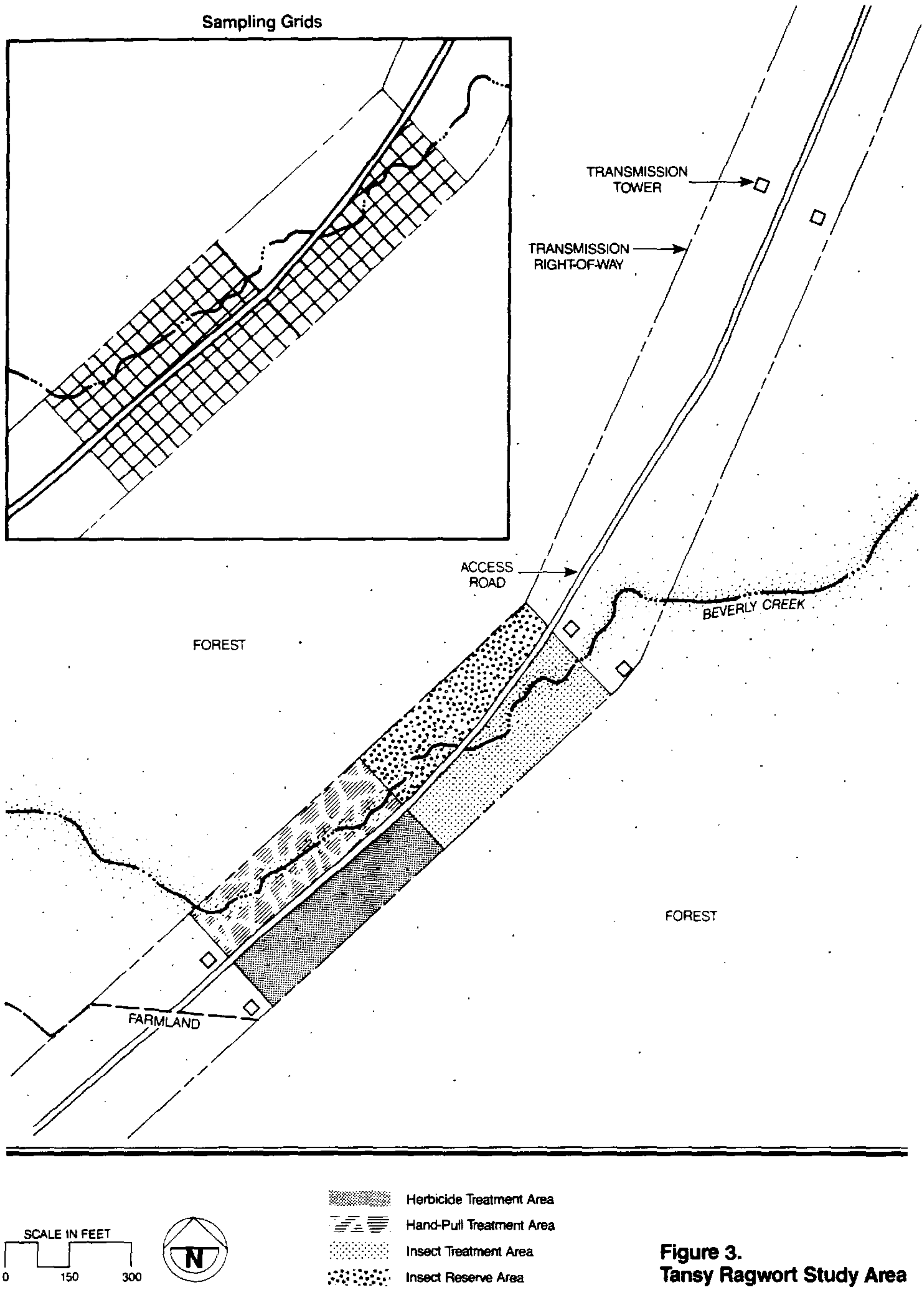

Figure 3.
Tansy Ragwort Study Area

INSECT RELEASES AND POPULATION ASSESSMENTS

Annual insect releases have averaged 4,500 cinnabar moth larvae and 4,500 adult flea beetles (Table 1). Cinnabar moth larvae were collected on clearcut commercial forest land near Olympia, with help from the Thurston County Weed Control Board. Larvae were released on flowering plants in the insect treatment and reserve areas within 24 hours of collection. In 1988, we also released flea beetles along the right-of-way near Fortner Road, about 3/4 mile north of the study area (Figure 2). The preferred release sites were slightly elevated and had logs or stumps nearby to provide dry habitat for overwintering pupae.

Table 1. Insect releases on tansy ragwort study area, July 1986-October 1988.

	Date	Number	Origin
Cinnabar Moth (larvae)			
	7/10/86	2,500	Thurston County, Washington
	7/15/86	1,500	"
	7/01/87	4,500	"
	7/21/88	5,000	"
Ragwort Flea Beetle (adults)			
	10/09/86	5,000	Tillamook County, Oregon
	10/14/87	5,000	"
	10/13/88	3,500	"

Flea beetles were supplied by the Oregon Department of Agriculture from a collection site near Tillamook. We released the beetles within 24-36 hours of collection, in areas of high rosette densities in the insect treatment and reserve areas. Concentrating the beetles in optimal habitat facilitates fall mating.

We evaluated flea beetle establishment and damage during September 1987 and October 1988, and cinnabar moth establishment and damage from May through July 1988. The evaluation was semi-quantitative, consisting of observations on the number and location of adult moths, the presence and abundance of caterpillars and defoliation of flowering plants, and the number of flea beetle adults in a timed vacuum net (D-Vac) sample. We also recorded the level of damage to ragwort flowering heads caused by seedhead flies, which colonized the study area through natural dispersal (Parametrix, Inc. 1987).

ALTERNATIVE TREATMENTS

Alternative treatments (handpulling and herbicide application) were administered by right-of-way maintenance crews on July 11 and 19, 1988. Banvel herbicide (diluted 1:100 with water) was applied with a backpack sprayer to flowering plants in the herbicide treatment area. Flower heads were clipped and bagged to reduce the spread of seeds. In the handpull area, flowering plants were pulled and bagged. All plant residues were buried offsite in a landfill. To compare the costs of treatments, labor and travel time were recorded and multiplied by the hourly rate.

A supplemental task during 1987-88 was to analyze mechanical alternatives for controlling tansy ragwort. This was done to identify manual removal techniques which are effective, and at the same time, minimize the risk of worker back injury. B-Twelve Associates completed this analysis by reviewing literature and talking to people involved in tansy ragwort control throughout the Pacific Northwest. Their report is contained in Appendix A.

RESULTS

Results of the two years of study are preliminary, given that insect populations generally need several years to establish themselves at high enough levels to control their host plants. Thus comparative successes and costs of treatments can only be measured over the long term.

RAGWORT POPULATIONS

At the outset of the study in 1986 there were no statistically significant differences in ragwort sampling densities among the treatment areas. However, in 1987 and 1988 the insect treatment area had significantly greater densities of vegetative plants (seedlings and rosettes) than either the handpull or herbicide treatment areas (Table 2).

Flowering plant populations have generally been highest in the insect treatment area, lowest in the herbicide treatment area, and intermediate in the handpull area (Table 3). In the insect treatment area, flowering plants declined from 1986 to 1987, and then increased markedly in 1988. In the handpull area the 1986 count was made after pulling, but numbers have remained relatively steady since 1987. The flowering plant population in the herbicide treatment area was steady in 1986 and 1987, and then declined sharply in 1988.

Table 2. Tansy ragwort seedling and rosette sampling densities, 1986-88.

Treatment		1986		1987		1988	
		n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
Insect	seedlings	69	0.346	68	44.000	68	0.956
	rosettes	69	0.200	68	0.882	68	1.235
Handpull	seedlings	(*)	(*)	68	2.000	68	0.162
	rosettes	71	0.152	68	0.765	68	0.529
Spray	seedlings	(*)	(*)	51	1.020	51	0.039
	rosettes	54	0.016	51	0.471	51	0.000

(*) Seedlings were not distinguished from rosettes in these samples.
n = Number of plots sampled
$\bar{x}$ = Mean number of plants/m^2

Table 3. Tansy ragwort flowering plant counts, 1986-88.

		Plant Numbers	Plant Density per m^2
1986	insect	767	0.076
	handpull	89(*)	0.009
	spray	84(*)	0.008
1987	insect	294	0.029
	handpull	366	0.036
	spray	88	0.009
1988	insect	4,000	0.395
	handpull	412	0.041
	spray	5	0.000

(*) In 1986, counts were made after treatments in the handpull and herbicide treatment areas.

INSECT POPULATIONS

Results of the insect introductions (Table 1) are encouraging. Cinnabar moth larvae released in Summer 1986 apparently survived poorly through the following winter (Parametrix, Inc. 1987). However, the larvae released in

1987 did much better. Although we saw only 1 moth during 16 hours on the site in June, we observed many caterpillars in late July when we released another batch. We estimated that larvae were present on about 2 to 5 percent of the ragwort flowering plants in the insect treatment and insect reserve areas. None were observed outside these areas. Numbers of caterpillars varied from about 1 to 20 per plant. A few plants were completely defoliated, but generally there was little damage to most plants.

Seedhead fly damage was also evident throughout the study area in Summer 1988. Though our study design did not include quantitative estimates, we observed that the center flowers of most plants were affected. Future studies should include damage estimates for this potentially useful insect.

Sampling for flea beetles during September 1987 revealed that a small population had become established from the first release in 1986. We collected 25 adult beetles in 25 minutes of vacuum net sampling in the insect treatment area, or about 1 beetle per minute sampled.

By October 1988, the flea beetle population increased by about 12 times (232 beetles captured in 19 minutes of sampling)! Beetle densities were greatest in the insect treatment and insect reserve areas, but the population had also spread along the right-of-way to the south end of the handpull area (Figure 3). We also found them just north of the study area where Beverly Creek leaves the right-of-way. A visual search for flea beetles resulted in 30 beetles counted during 180 minutes of searching. Leaf damage caused by feeding of the adult beetles was evident in many areas.

ALTERNATIVE TREATMENTS

Preliminary cost comparisons for 1986-88 suggest that insect application and hand pulling were more expensive than herbicide use (Table 4). The higher initial cost of biological control reflects the expense of establishing insect populations, a cost that will decline markedly if control is effective.

Monitoring costs for insects and ragwort populations are not included in the estimates, but are expected to be about the same for any of the treatments. Hidden costs for herbicide use, including employee training and potential liability to the City, are difficult to quantify but must be acknowledged.

The study of mechanical alternatives for controlling tansy ragwort (Appendix A) concluded that manual removal can be effective on small, scattered populations. Larger infestations of ragwort require an integrated approach, such as a combination of biological and manual control. All methods require yearly monitoring for plant outbreaks, due to the resilient nature of ragwort and the longevity of its seeds.

The study also concluded that a wide array of tools have proven effective for manual removal, including shovels, planting bars, and hoes. Workers involved in manual control of ragwort should be given a choice of tools that allow the task to be done with comfort.

Table 4. Preliminary cost comparisons of treatments on tansy ragwort study area during 1986-88. (1)

HANDPULL	Hours	Rate	Cost
Labor	17	$28.00 (2)	$476.00
Travel	8.5	28.00	238.00
TOTAL			**$714.00**
HERBICIDE			
Labor (3)	2	$28.00	$ 56.00
Travel	5.5	28.00	154.00
Chemical			2.00
TOTAL			**$212.00**
INSECTS			
Cinnabar Moth:			
Caterpillars			$0.00
Labor	6	$28.00	168.00
Travel	6	28.00	168.00
Subtotal			$336.00
Flea Beetle:			
Beetles			$275.00
Labor	3	$28.00	84.00
Travel	3	28.00	84.00
Subtotal			$443.00
TOTAL			**$779.00**

(1) Higher set-up costs for biological control reflect the experimental nature of the project and the initial expense of establishing insect populations. Long-term maintenance costs of biological control are expected to be lower.

(2) Hourly rates used to estimate treatment costs were those of City right-of-way maintenance crews.

(3) Does not include cost of annual employee training.

DISCUSSION

We believe that differences in ragwort abundance among the treatment areas reflect both environmental differences and the effects of treatments.

Environmental differences are most pronounced in the herbicide treatment area. This area lacks the influence of Beverly Creek, and has sandier soils and sparser vegetation than the rest of the study area. Ragwort density has been low in the herbicide treatment area since the beginning of the study, and dropped to almost nil during 1988. The lack of water, aggravated by the recent drought, has probably contributed to poor recruitment and survival of ragwort plants. Suppression and control of ragwort under these conditions is relatively easy and inexpensive.

Treatment effects appear to play a larger role in the relative populations of ragwort on the rest of the study area. Both the handpull and insect treatment areas are influenced by the creek, and they are more alike vegetatively than the herbicide treatment area. Ongoing control efforts in the handpull area have maintained ragwort density at a moderate, relatively stable level. In contrast, ragwort density in the insect treatment area has increased substantially. This is at least partly due to a lack of any effective control by insect populations, which are just now becoming established. We expect that the cinnabar moth and flea beetle will begin to exert a noticeable impact on the ragwort population in the next 2-3 years.

Preliminary cost comparisons among treatments reflect the higher initial expense of establishing insect populations, and the relative scarcity of ragwort in the herbicide treatment area. Assuming that biological control proves feasible, the only expected long-term cost would result from monitoring, and, if necessary, periodic reintroductions of insects if their populations decline to very low levels. In contrast, manual and chemical control methods require continued, annual maintenance costs. All control methods will require yearly monitoring of ragwort populations. Reliable cost comparisons can be more accurately assessed over the long term.

CONCLUSIONS AND RECOMMENDATIONS

Results of the study to date show that the cinnabar moth and ragwort flea beetle are beginning to establish populations from releases made on the right-of-way, and that the seedhead fly is well established from natural dispersal. Populations are still too small to impact the tansy ragwort population. We expect this to change within the next 2-3 years. The spread of insects on the right-of-way may reduce or eliminate the need for other methods of ragwort control.

Continued monitoring of insect, handpulling, and herbicide treatments will permit a better comparison of the costs and effectiveness of these control methods. Insect populations will continue to expand throughout the study area, so the study will measure the influence biological control, with and without, the other treatments. As long as this is acknowledged, valid comparisons among control methods can still be made. To enhance the long-term survival of the insects, introductions should be considered in other problem areas where they are not already established.

We recommend that the study be continued to provide better estimates of the costs and effectiveness of ragwort control. A proposed scope of work and budget for the next 2 years (November 1988 through October 1990) will be submitted at a later date.

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APPENDIX A

MECHANICAL ALTERNATIVES FOR CONTROL OF TANSY RAGWORT

B-twelve Associates
Land Consulting

MECHANICAL ALTERNATIVES FOR CONTROL OF TANSY RAGWORT
(*Senecio jacobaea*)

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MECHANICAL ALTERNATIVES FOR CONTROL OF TANSY RAGWORT
(*Senecio jacobaea*)

INTRODUCTION

Manual or mechanical means of tansy ragwort control can be an effective management tool. Much of the information contained in this report comes not from the literature, which focuses on the more commonly used biological control, but from personal communications. Various alternatives and combinations of methods have been suggested by those working directly with control of this weedy biennial herbaceous species and are discussed in detail below. All experts contacted and literature sources reviewed emphasized the absolute necessity of yearly inventory and monitoring. It is stressed by all sources that mechanical or manual control success relies on preventing tansy populations from getting out of control. Any of the recommendations made at the end must therefore be understood to include allocation of manpower to inventory sites and make corrections as necessary.

ALTERNATIVES

A. Mowing

Mowing as a tool is not generally recommended by the experts contacted or in the literature. However, Dave Humphrey of Oregon State Department of Agriculture (OSDA) recommends that in some sites it may be preferable to remove the seed producers by using a motorized mowing machine. The next best alternative would be an annual mowing one or two times a year if it is a heavy stand (Humphrey, pers. comm.)

Bill Rogers, Lincoln County (Oregon) Extension Agent, feels that mowing can help in emergency situations (Rogers, pers. comm.). This might be applied to roadside situations where mowing machines can reach to control the spread of stands from the roadside to pasture areas. However, Larry Burrill, Oregon State Extension Agent, disagrees. Burrill has observed that mowing turns tansy essentially into a perennial. In good growing conditions, tansy generally completes its life cycle within two years. However, if damaged, for example by mowing, or in poor growing conditions, tansy can adopt a perennial habit. Once mowing is started it must be done constantly "like turf management" (Burrill, pers. comm.).

Mowing is reported as not effective in reducing tansy populations (Beddell 1981) since it is virtually impossible to achieve perfect timing on clipping the seed heads. Mowing can actually increase rosette density, although it may prevent flowering (MacDonald 1983). One of the drawbacks of mowing is that it is necessary to repeat mowings in order to prevent flowering. It is also ineffective for control of germination of plants from the seed bank and those moving in from other areas.

A combination of mowing and hand pulling might be appropriate in certain situations where the mowing would reduce seed set and early reproduction, and the more time intensive hand removal could take place once a year for actual plant removal.

B. Grazing

Several workers recommended grazing of goats and sheep as an alternative control method. Beddell reports that continuous sheep grazing will remove tansy and keep it out (Beddell 1981). Sharrow reports that "sheep can reduce tansy to acceptable levels" (Sharrow 1980). Sheep worked quite well to control tansy on Forest Service land in the Oregon Coast Range. Dave Humphrey, OSDA, also reports good results with sheep and goat grazing tansy in his area (Humphrey, pers. comm.). The sheep apparently do not respond to the toxicity of the alkaloids in the plants in the same manner as horses and cows.

Grazing by sheep must be continued for at least three years to keep third year plants from flowering. Both sheep and goats could be used to rid pastureland of tansy before reintroduction of horses and cows into a pasture, however, this must be done carefully as increased disturbance brought about by overgrazing of sheep and goats may provide additional disturbed areas where tansy can reinvade.

C. Seed Head Clipping

Some experts preferred the alternative of clipping tansy seed heads for short term control of reproduction. Dave Pickering, an organic farmer in Lincoln County, Oregon, suggests that each seed head be clipped and placed in a garbage bag. These should be disposed of in a land fill or burned. Whatever method of disposal is used, it is of tantamount importance especially to the small landowner, to destroy the flowering head (Pickering, pers. comm.).

Phil Mooney, Biologist with the Range Management Team, U.S. Forest Service, suggests that optimum timing for clipping seed heads is critical--so the plant will not reflower later in the season. In his experience the first week of July is a critical time for priority areas. Clipping must be accomplished by July 20th (Mooney, pers. comm.). Depending on site characteristics, exposure, and local microclimate conditions, critical clipping time for sites in Washington may differ.

D. Manual Removal

Results are mixed on the effectiveness of hand removal. One of the problems with hand removal is enabling those participating in removal to identify the plant before it flowers. Because some of the manual removal programs depend on convict or untrained manual laborers, it is difficult to ensure proper identification without the presence of the flowering stalk. This leads to conflicting recommendations from the experts. Those working with trained personnel recommend removal before the plant flowers. Those working with untrained workers must depend heavily on the easy identification of the flowering stalks for effective removal efforts. Removal of the plant before it flowers obviously prevents any sexual reproduction from occurring, however, effectiveness of the removal program is impaired if tansy plants are not identifiable to workers, and are left to flower after crews move to other areas.

Cathy MacDonald, Ecologist with The Nature Conservancy advises hand pulling only after populations have been controlled. However, she does recommend hand pulling for spot control. Effectiveness of hand removal can be increased if soils are moist at the time of removal. The moisture allows plants to be removed with minimal breakage, reducing the possibility of resprouting from root fragments (MacDonald 1983).

Work done by Beddell, Whitesides and Hawkes shows that hand pulling can be effective. However, they stress that hand pulling "requires persistence and intensive effort and it is most applicable to spot infestations." Regrowth, however, frequently occurs from root fragments left in the soil (Beddell et al 1981).

Mark Musick in an article in "Tilth", echoes other researchers in recommending that the entire tansy plant must be dug up before it can set seed to control reproduction, and to extirpate that particular population. He reports that this is being done in the localized infestations along mountain passes to eastern Oregon to stop the spread of tansy eastward. (Musick 1980)

Craft, in an OSDA Bulletin on the control of tansy, reports that hand pulling is not the most acceptable or effective method of ragwort control. He does say, however, that if chemicals cannot be used, "hand pulling can be used to prevent the plants from going to seed and spreading to nearby uninfested areas" (Craft 1979). He does not comment on whether hand pulling activities induce the perennial habit in tansy.

Elton Moffitt, Weed Control Agent for Lincoln County, Oregon feels that "pulling is not effective for large stands but will help for scattered plants." He stresses that the plants must be removed before they start to bloom and that infested areas must be checked two or three times during the summer season.

Moffitt's recommendations included the July 1st start time for hand pulling. Workers should wear heavy gloves and pull tansy when it is three to four feet tall. Larry Burrill, OSU Extension Service, reports that pulling is good "in theory" if it can be done when the soil is damp and one can get the roots. He also stresses that timing is critical and pulling should be done before it flowers. (Burrill, pers. comm.)

School of Agriculture (OSU) researcher and weed scientist, Bill Brewster comments that, "the problem is that if you pull it, you must keep repeating it. Tansy can come back in into the area you have hoed or pulled." He adds, "the question is, is it a reinvasion or resprouting or what? Pulling works for one year but you must repeat it." (Brewster, pers. comm.)

Phil Mooney, (USFS) relates that in the past, Youth Conservation Corps or prison crews were used to manually pull tansy. He also reinforces that the July 1st date is critical for pulling. Crews work as teams in which one clips and bags the heads and another person follows and pulls the plant. He also recommends the use of a shovel or planting bar (3-4 foot long bar used to plant trees; see Figure 1) as the tool to use if it is necessary to dig the plant.

Mooney emphasizes that it is absolutely mandatory to check the site two times during the summer season. He recommends that workers pin flags on the perimeter of known infestation areas and come back to recheck for later germinating and flowering plants.

Dave Humphrey (OSDA) was most specific that manual control could be effective. Humphrey recommends use of a regular garden hoe to chop the tansy plant out if the ground is too hard to easily pull the roots out. If the ground is still moist, he said that the plant can be pulled. The recommended method of removal depends on the requirements of the site and time of pulling. It is his recommendation to use 5 people per 10 foot wide area to remove the plants. He also emphasizes that you "must remove it just before it sets seed" to prevent reproduction.

There are several drawbacks to the use of manual methods exclusively for tansy control. One is the level of effort and the number of people required to do the field work. Another is that this must be repeated annually until the infestations are controlled, and subsequently monitored for a long period of time.

The third drawback concerns the potential for workers involved in control efforts to injure their backs due to the nature of the work. This can be minimized through proper use of the tools available, and through screening participants that are assigned to this type of work (Anderson 1980).

Because the epidemiology of back pain is "an embarrassing array of possibly significant associations" (Wood and Bradley 1980), it is impossible to design a tool for the specific task of digging tansy to avoid back injuries. Back injuries are so various as to prevent a specific design from addressing all possible problems that could be encountered.

However, Roy Lebsack, Training Coordinator in the Loss Control Services with the Workmen's Compensation System, Washington Department of Labor and Industries, makes some general recommendations regarding this type of problem (Lebsack, pers. comm.).

* Keep manual materials handling at a minimum, and for those tasks that need manual work, make the work convenient for people.

* Organize the work site for convenience. Provide workers with tools they prefer and that are appropriate for the site and task to be performed.

* Provide a type of tool, or way of manual removal that minimizes the time a worker is bent over. This could include long handled tools included in Figures 1 and 2 and avoidance of pulling the plant without the aid of a tool.

* Give the worker a chance to vary movement patterns; for example, a team of tansy controllers could revolve jobs through the day in order introduce variety of movements.

* Provide a warm-up at the beginning of the day, after break times, and a cool-down at the end of the day before sitting in the truck.

* Provide supervisors with training for recognition of early back distress while on the site.

There is already available a wide array of tools such as shovels, planting bars, tile spades, garden and planting hoes, and one-pronged weeding hoes that one can chose from to work with the specific body needs and field conditions. Sufferers of back pain are advised to use tools that allow the task to be done with comfort. It appears that there is sufficient choice and successful use of these various tools proven for this task, and that restriction to a new tool design would not take advantage of the variety of tools already proven appropriate. Line drawings of several types of tools are included at the end of this report in Figures 1 and 2. Lebsack also recommends the retention of a kinesiologist to analyze the tasks being performed to make specific recommendations for avoidance of back injury (Lebsack, pers. comm.).

COMBINATION EFFORTS

Mooney's experience is that with a combination of biological and manual techniques, tansy can be controlled in approximately six years. But he stressed that even with 95% control, yearly checks and inventories are vital (Mooney, pers. comm.). The Lincoln County (Oregon) program stresses a combination of methods that include pulling and introduction of the flea beetle. This integrated approach, he feels, has resulted in a 90% containment of tansy in Lincoln County. Moffitt also states that, in his opinion, this was the most economical way of controlling tansy (Moffitt, pers. comm.).

Carolyn Cox, a researcher working on tansy control in the Department of Entomology at Oregon State University reports that "joint effects are dramatic." She states that since biological controls take two to three years to show an effect, combining manual reduction (pulling) with biological controls can speed up the control time. However, "the agency must examine the cost of shortening the lag period. The decision must be made -- is the time period worth the extra dollars?" (Cox, pers. comm.)

Cox also states that long term research has not been done on manual control of tansy. In her article in the Journal of Pesticide Reform she argues for a minimum two year trial period for manual control. Costs might be higher for the annual control efforts needed for manual control of tansy, but in small acreage areas it may be the preferred alternative (Cox 1986). She also stresses the necessity of getting competitive plants established (Cox, pers. comm.)

Humphrey suggests that rototilling the area or scarifying the area might help if grass seed is broadcast on the area to gain competitive planting. Humphrey stated that native grasses or other introduced species would be best. Humphrey added, "Tansy is not a strong competitor. You must get other ground covers established." He also stressed that for long term controls having biological agents present was important. But he emphasized that establishing competitive plantings was also vital. He recommends that until the area is controlled, it should be checked and individual plants removed manually. "It's also important to train the employees so they recognize it and can get rid of it. The lineman, maintenance workers--everyone should know tansy and help remove it" (Humphrey, pers. comm.)

Humphrey also feels the absolute necessity for a written management program. He has come to the conclusion from his experience with the problem, that removal by rototilling or grubbing (digging), introducing biological controls and planting a competitive ground cover should solve any tansy problem (Humphrey, pers. comm.).

CONCLUSIONS/RECOMMENDATIONS

Most experts feel that a combination approach is the best procedure to control tansy. Manual/mechanical means are definitely one of the methods that can be effectively utilized in a combination approach. There are, however, drawbacks to some of the means for mechanically removing tansy.

Mowing is not generally recommended for control, except as an emergency measure. Grazing of sheep and goats has been used successfully, but it is very important to avoid overgrazing an area and disturbing the soil to prevent reinvasion of tansy. Seed head clipping is viewed as a short term control of reproduction, but provides no long term eradication benefits. Finally, a program of manual removal has been shown to be very effective in a program of control and eradication.

There are serious drawbacks, however, to use of manual control exclusively. One of the more serious problems of manual control is the necessity to constantly monitor and repeat the treatment. Also, the cost of hand labor and the potential for on-the-job injury is high.

It appears that manual removal could be an effective method in the control program for tansy along Seattle City Light Utility Corridors. Manual removal, however, is most effective in conjunction with insect infestation and competitive planting methods. A combination program appears to provide a viable alternative to the use of herbicides along Seattle City Light corridors.

As all of those active in the field emphasized, the program, no matter what it includes, requires serious commitment to extensive monitoring of infestations over the summer period, and on an annual basis. An annual budget that enables the program director to treat new infestations and reinvasions of tansy is also very important to an effective control and eradication program.

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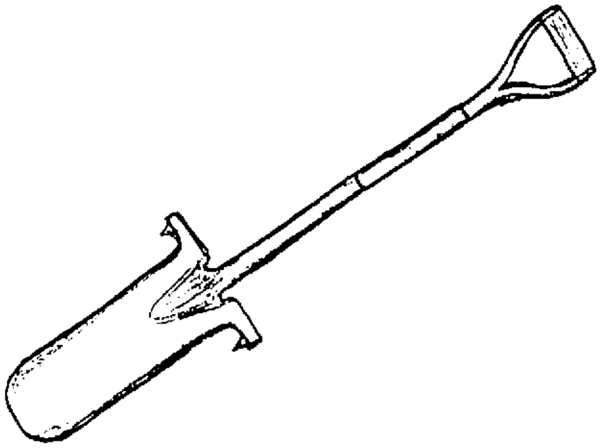
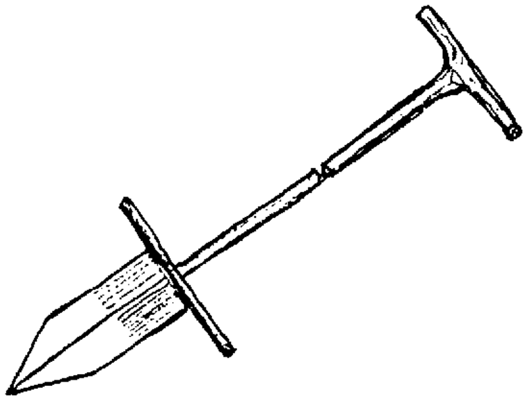
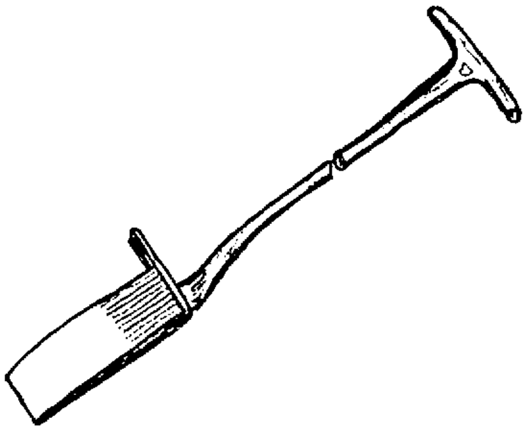


TILE SPADE PLANTING SHOVEL



PLANTING BAR (KCB BAR)



DIBBLE BAR

FIGURE 1

Spade-type tools

SCALE:
DATE:
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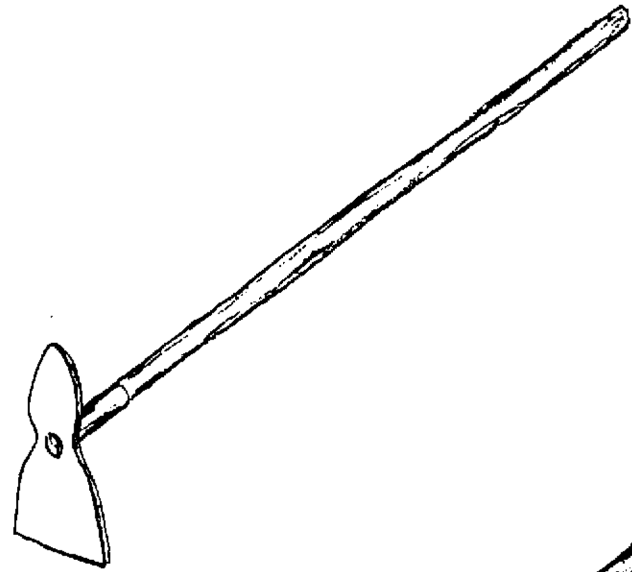
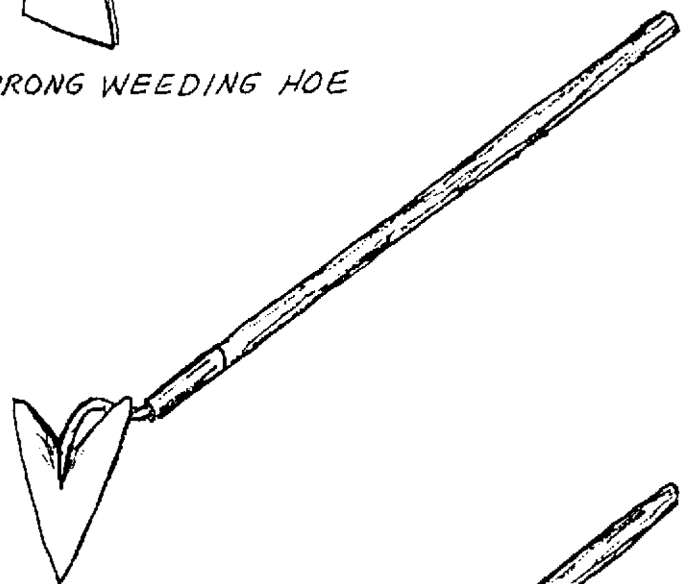
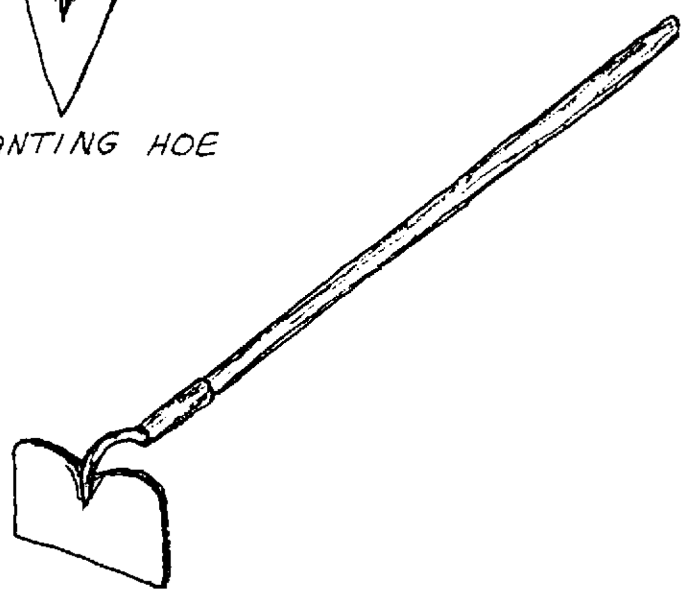


1-PRONG WEEDING HOE



PLANTING HOE



GARDEN HOE

FIGURE 2

Hoe-type tools

SCALE:
DATE:
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