

**Experimental Control of Tung Trees
at
Cumberland Island National Seashore
CPSU Technical Report 29**

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ISLAND NATIONAL SEASHORE**

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Authorship:

This report is the product of three projects. The first, a test of hand cutting of tung trees, began in 1985 under the supervision of **Susan Bratton**. **Elaine Furbish** accomplished part of the field work. The second and third were class projects for a Basic Vegetation Management Course taught for the US National Park Service by the University of Georgia in April 1986. One group worked on the Dungeness area and one group worked on the Stafford area. In addition, several class members assisted with the burn. Participants in the tung project included:

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Abstract

Tests of methods of removing exotic tung trees, *Aleurites fordii*, on Cumberland Island National Seashore indicate hand cutting can be effective but requires multiple repeated treatments. Prescribed fire, which burned into the duff, was very effective for removing smaller size classes. Three months after a burn only 1% of the stems ≤ 1 cm basal diameter had resprouted, and 13% of the stems ≤ 7 cm had resprouted. All plants greater than 7 cm resprouted, however. The most cost effective method for removing small plants was hand pulling. For plants greater than 1 cm basal diameter, removal with a pulaski is slightly more time consuming than painting the leaves with herbicide, but results in lower survivorship (2% to 4%) as opposed to up to 60% for herbicide. The most effective herbicide technique was gridling followed by painting with Roundup (9% survivorship). The least effective was painting the leaves, as leaves tended to abscise before the herbicide translocated to the stems. Use of a hypohatchet caused difficulties such as spattering and clogged equipment. Cutting and painting stumps of larger trees is moderately effective (20% survivorship) and like burning, prevents fruiting of individuals surviving treatment. These results suggest burning first, at least for larger stands. After survivors have resprouted, hand pulling or grubbing can be used on small stems and gridling or cutting followed by painting with Roundup on larger stems. On archaeological sites where digging is not a viable technique, gridling and painting with herbicide is probably the best, although use of any pesticides containing acids should be avoided around tabby walls.

Introduction

The tung tree, *Aleurites fordii*, is an exotic plant species, cultivated for the oil extracted from the nuts. Prior to the establishment of Cumberland Island National Seashore, island residents established, then abandoned two tung plantations. One of these was east of the Captain's House at Dungeness and the other was at Stafford or House Field. Resistant to grazing by deer and feral horses, tung trees have spread into the native forest understory. A survey by Bratton (1984) documented the spread of tung around the old plantations.

In early spring, 1985, test removal of tung began at Dungeness. Initially only hand cutting was used. This was continued, but proved to be slow. In April 1986, the US National Park Service established ten test control areas for testing herbicide application, hand pulling, grubbing root stocks and burning. The purpose of this report is to discuss the results of these experimental efforts at tung control.

Methods

The first experimental control areas were the entire tung population south of the road from Dungeness dock to the Main Road (Coleman Avenue) and the entire population around the tabby cemetery just west of the Captain's House (Fig. 3, areas G and C). The treatment schedule may be seen in Table 1. With the exception of an herbicide application in April, 1986, each treatment consisted of hand pulling all seedlings and small saplings and hand cutting all larger saplings (> 1 cm diameter at the base) with a machete. In summer of 1986, cutting all the branches off larger plants in the morning and then waiting until afternoon and cutting the main stem was also tested.

On April 23 and 24, 1986, one team established three 20 m x 20 m test plots at Dungeness (Fig. 1). The methods were:

Plot A) All trees < 2 m in height were either hand pulled (if possible) or the leaves were painted with a solution of 30% Roundup. A 2 cm square was painted on 50% of the leaves. All trees ≥ 2 m height were injected with 100% Roundup (glyphosphate) by use of a hypohatchet.

Plot B) All trees < 2 m were either hand pulled or leaves were sprayed with a 30% Roundup solution. All trees ≥ 2 m were injected with 100 % Weedar (a 2,4-D compound) by use of a hypohatchet.

Plot C) All trees < 2 m in height were painted as in Plot A. All trees ≥ 2 m in height were cut and the stumps were painted with 100% Roundup.

This team also treated the remaining Dungeness tung population using foliar painting; foliar spray; cutting and stump painting; and frilling (cutting notches into the cambium) and squirting with Roundup.

A second team at Stafford established and treated seven plots (Fig. 2). All plots except the burned area had all seedlings ≤ 1 cm diameter at the base hand pulled. The treatments for the larger plants were:

Plot 1) Trees ≤ 7 cm basal diameter were cut and the stumps were painted with 41% Roundup. Trees > 7 cm were injected with 100% Roundup by use of a hypohatchet.

Plot 2) Trees > 1 cm basal diameter were frilled and the cuts were squirted with 30% Roundup.

Plot 3) Trees ≤ 7 cm were hand grubbed with pulaskis. Trees > 7 cm were injected with 46% Weedar by use of a hypohatchet.

Plot 4) All trees were ≤ 7 cm, and these had leaves painted with 30% Roundup.

Plot 5) All trees > 1 cm were girdled and painted with 30% Roundup.

Plot 6) All trees were ≤ 7 cm and were hand grubbed with pulaskis.

Plot 7) On April 24, a 2 ha area was burned by strip head fire. Flame length averaged .5 m. Relative humidity varied from 33 to 37%, averaging 34%. Dry bulb temperature varied between 68 and 70 ° F. Average wind speed was 2 miles per hour. Almost all of the litter and most of the duff were removed.

The plots were inspected June 10-13, 1986, and all of the new seedlings were removed with any remaining plants that could be hand pulled. In addition, larger shoots were grubbed in Plot 6 (all of these had been missed on the first treatment). Plots were inspected again Aug. 8-10, 1986. All new seedlings were pulled. The plots at Dungeness were retreated by:

Plot A) Cutting and painting stumps with 30% Roundup. Trees < 2 m in height were grubbed with a pulaski.

Plot B) All trees were girdled and painted with 30% Roundup.

Plot C) All trees were grubbed with a pulaski or an ax.

In addition, all living stems from Plots 7 and 6 were grubbed with an ax, and the seedlings were removed from Plots 1 through 5.

During both inspections all living shoots were counted by size class and any fruiting was noted.

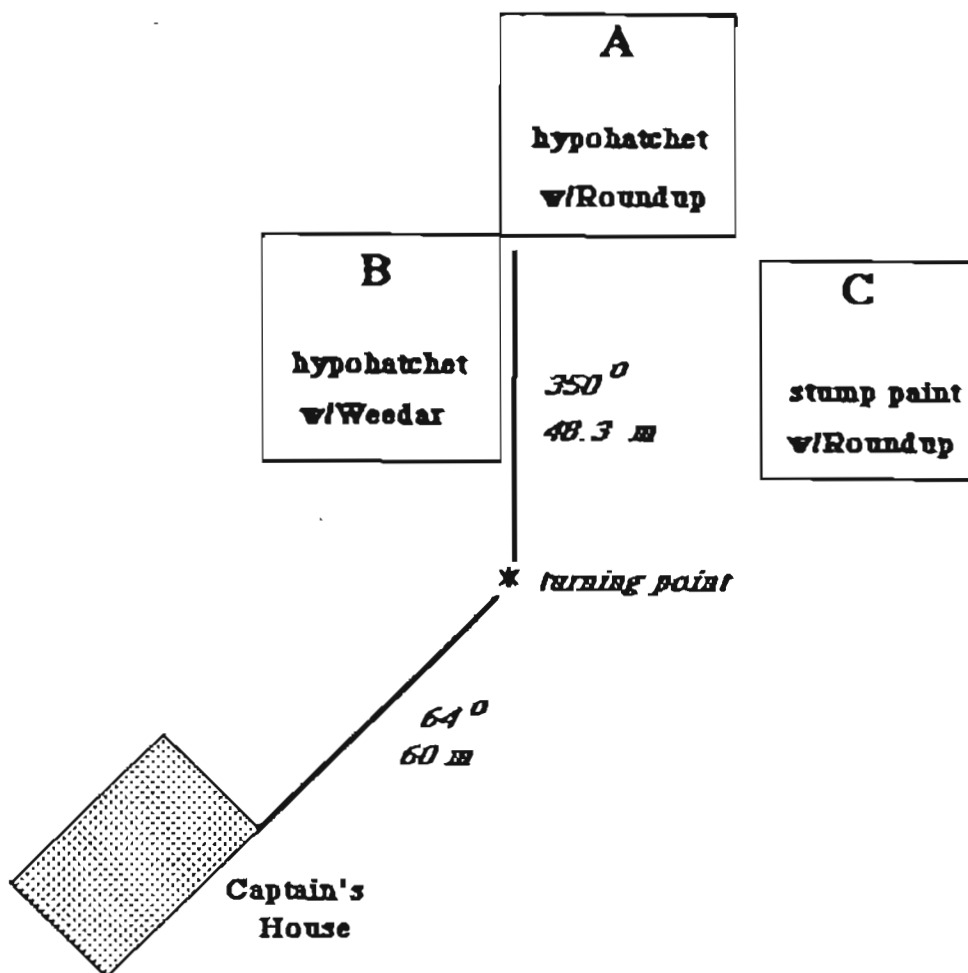


Figure 1. Dungeness tung control research plots.

Each plot is $20\text{ m} \times 20\text{ m}$. Plot boundaries were set on cardinal directions.

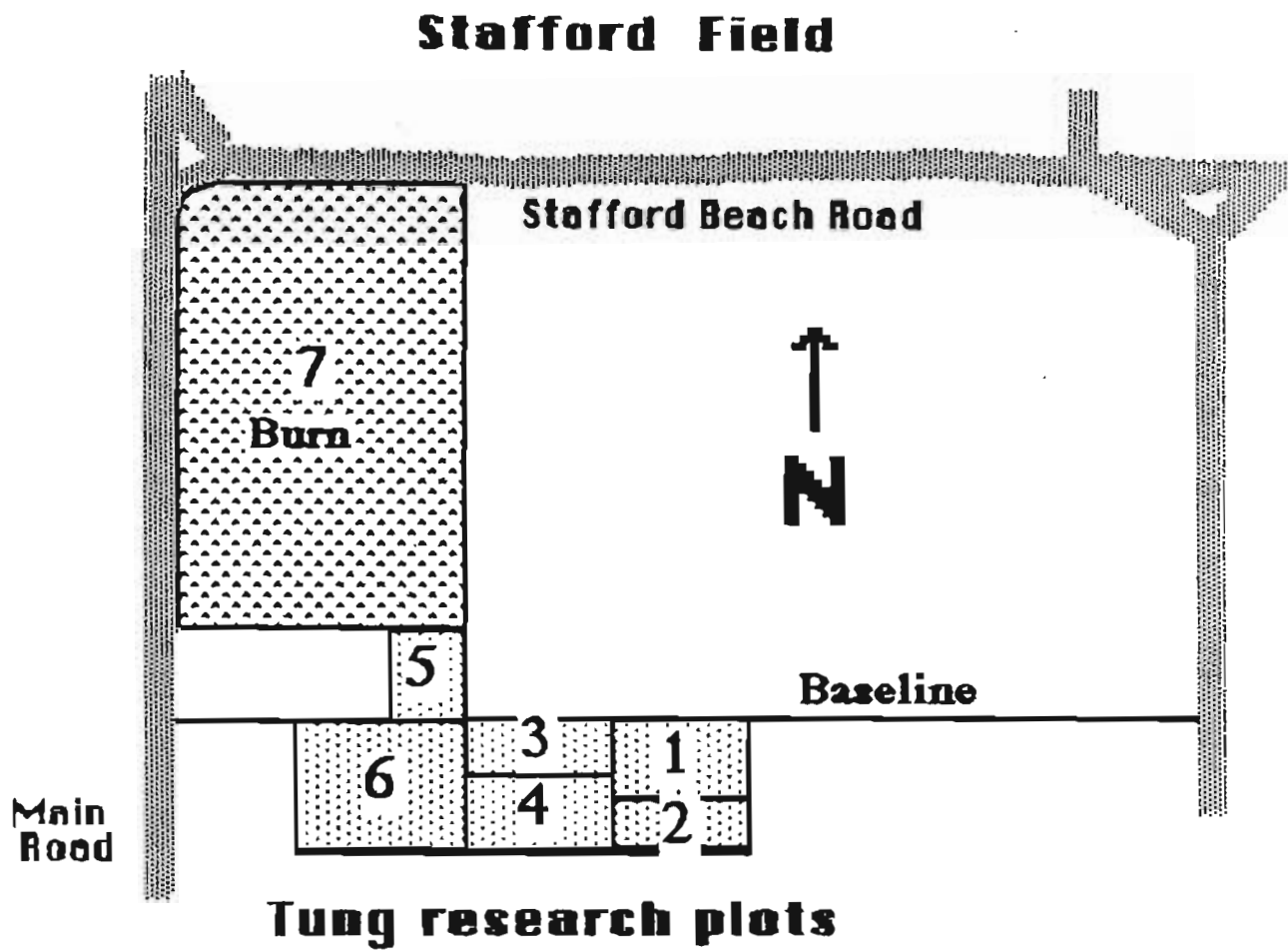


Figure 2. Stafford tung research plots.

Plots were of variable size. The prescribed burn was in the northwest corner of the pine plantation south of Stafford (House) Field.

Results

The cutting treatments have almost no adverse impacts on other plant species or on the archaeological resources of the sites, but are very slow. Almost all plants cut, rather than pulled up by the roots, resprout. Once the larger trees have been cut, chopping away new shoots with a machete is a relatively easy task. Much of the time is expended searching for shoots. Cutting requires at least eight treatments to obtain better than 90% reduction in the number of stems present (Table 1). Sprouts remained after ten treatments. Removing branches, waiting for the sap to rise, and then cutting the main stem was time consuming and ineffective in preventing sprouting. About 40 to 60% of the cut stems resprouted after the first treatment. It should be noted in these tests that cut stems do always resprout immediately. In 1985, a dry year, it took over two months for most of the plants to respond.

The effectiveness of the techniques tested in 1986, varied widely (Table 2). Use of the hypohatchet and frilling did not produce outstanding rates of mortality, although exact method of application may have made some difference. Inspection in August indicated that the cambium of trees treated with a hypohatchet tended to die above and below the injection area but not beside it. Thus cuts around the base of the tree are superior to several cuts in the same area. Frilling and squirting, frilling and painting or use of the hypohatchet were all poor to moderately effective techniques. Weedar was not superior to Roundup in any noticeable way.

Gridling and painting with Roundup was effective for ≤ 7 cm size class (9% survivorship). Leaf painting and spraying leaves were both poor techniques, although the concentrations of herbicide may have influenced these results. In June many of the painted areas had died but there was little evidence of translocation. In some cases leaves abscised but the plants managed to produce new foliage. Lower concentrations of herbicides might have produced better translocation by avoiding immediate kill of the tissue around the point of application. 1986 was a drought year, which may have influenced translocation. Since spring on Cumberland tends to be dry, any technique which does not work well under low soil moisture should probably be avoided. For small plants, hand pulling is not only faster than herbicide application, it leaves no survivors.

Cutting and grubbing is slightly more time consuming than herbicide application, but it is very effective with plants ≤ 7 cm basal diameter (Table 3). Survivorship was as low as 2% (Table 2). Burning worked very well with plants ≤ 1 cm (1% survivorship), and worked well with plants ≤ 7 cm basal diameter (13% survivorship). All the root stocks of trees > 7 cm survived the fire, however, and resprouted.

Of the techniques tested in 1986, the hypohatchet proved to be one of the most difficult to

use consistently. The hatchets jammed and on one occasion sprayed herbicide on the person using the hatchet (who was wearing gloves and goggles and washed immediately, so there was no resultant injury). Techniques employing squirting and spraying provide less confinement of herbicide to target areas. Brushes are as easy to use and more accurate.

No injuries to non-target species were noted. Oaks and pines growing near the tung trees did not show any evidence of herbicide damage.

Table 1: Schedule and results of hand cutting experiments

<i>Date</i>	<i>Sprouts</i>	<i>Seedlings</i>	<i>Total stems</i>
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Area south of Coleman Avenue

4-2-85	55	343	398
7-2-85	168	155	323
7-23-85	45	31	76
8-13-85	48	31	79
9-6-85	87	30	117
9-27-85	30	23	53
10-7-85	43	6	49
6-12-86	13	3	16
8-8-86	15	8	23

Area around cemetery near Captain's House

4-2-85	237	323	560
7-2-85	305	81	386
7-23-85	132	26	158
8-13-85	148	9	157
9-6-85	154	7	161
9-27-85	116	8	124
10-7-85	57	2	59
4-27-86	-	-	38
6-12-86	16	3	19
8-8-86	5	5	10

Table 2: Survivorship of tung trees by size class and treatment.

<i>Plot</i>	<i>Treatment</i>	<i>Survivorship</i>
<i>Size > 7 cm basal diameter</i>		
1	Hypohatchet/ Roundup 41%	14%
2	Frill/ Roundup 30%	100%
3	Hypohatchet/Weedar 46%	46 %*
5	Gridle/Roundup 30%	25%
7	Burn	100%
<i>Size > 2 m height</i>		
A	Hypohatchet/Roundup 100%	57%
B	Hypohatchet/Weedar 100%	91%
C	Cut and paint/Roundup 100%	20%
<i>Size < 7 cm basal diameter</i>		
1	Cut and paint/Roundup 30%	22%
2	Frill and squirt/Roundup 30%	27%
3	Cut and grub	4%
4	Paint leaves/Roundup 30%	30%
5	Gridle and paint/Roundup 30%	9%
6	Cut and grub	2%
7	Burn	13%
<i>Size ≤ 2 m height</i>		
A	Paint leaves/Roundup 30%	44%+
B	Spray leaves/Roundup 30%	60%+
C	Paint leaves/Roundup 30%	23%+

Notes

* About half the individuals in this sample were in very poor condition in August, and will probably die leaving 23% survivorship.

+ All of these are low estimates since many small plants that were not seedlings were pulled with the seedlings in June.

Table 3: Cost estimates for the techniques used at Stafford pine plantation. All times and costs are per 100 stems treated and all cost figures are in dollars (assuming labor to cost \$5.00/ hour). All herbicide costs are for Roundup. Note that the plants pulled by hand were smaller than those treated by other methods, and that the hypohatchet technique was only used with plants greater than 7 cm basal diameter.

<i>Treatment</i>	<i>Person hours</i>	<i>Herbicide costs</i>	<i>Total costs</i>
Hand pulling	.3	.0	1.50
Cutting and grubbing	3.1	.0	15.50
Painting leaves	3.9	2.68	22.18
Frill and squirt	2.3	1.68	13.18
Gridle and paint	2.2	2.06	13.06
Cut and paint stump	5.4	2.27	29.27
Hypohatchet	5.9	2.27	31.77

Discussion

By far the best technique for handling seedlings and very small plants is hand pulling. This technique is cheap (5-10% of the cost of other techniques), leaves no chemical residues and does not require cutting tools. It is much better than leaf painting, both in terms of the time required and in terms of effectiveness.

The best technique for medium sized plants (> 1 cm but ≤ 7 cm basal area) is cutting and grubbing. This technique is slightly more expensive than girdling and painting, but is easier to inspect for sprouts (one does not have to wait for the herbicide to act) and produces greater mortality on the first application. It should be noted, the greater the size of the plant, the more difficult cutting and grubbing becomes. There is probably an optimal point for switching from grubbing to use of herbicide. (Experience of the senior author suggests this is about 4 cm basal diameter).

For larger trees, girdling and painting, cutting and stump painting, or careful use of the hypohatchet to ring the tree are probably the best methods. Roundup is as effective as Weedar, and has a very short half life; therefore is the better compound to use. Lower concentrations of herbicide work as well, if not better than, higher concentrations. A 30% to 40% solution is probably adequate for hypohatchet, or painting girdled trees. It should be noted that some larger trees surviving herbicide treatment did produce fruit in 1986. Follow up treatments to remove survivors should therefore consider cutting and stump painting as it can produce 80% kill, and removes unsightly damaged trees that might also fruit.

Burning is cost effective for a first treatment if a large enough area is burned. Considering a prescribed burn requires several workers for the afternoon and may require overtime pay for those monitoring the burned area for the next 24 hours, burning a small area is much less cost effective than use of pulaskis to grub tung. Burning the entire pine plantation (about 10 ha) is probably cost effective, however. For fire to be effective there must also be adequate fuel to sorch the top of the root stock. The experimental burn for this project was hot enough, even though a strip firing technique had to be used to move the fire through the plantation, to consume all the tung crowns and to kill most of the smaller root stocks. Burning should be followed by grubbing and perhaps herbicide treatment for large stumps. It is very easy to locate sprouting tung after a fire.

Three modes of tung treatment could therefore be used on Cumberland Island. Where there is a large block that can be burned, prescribed fire should be employed first, followed by hand pulling of seedlings, grubbing of medium sized stems, and herbicide treatment of larger stems. Where

populations are localized or a fire hot enough to burn duff is unlikely, hand pulling of seedlings, grubbing of medium sized stems and girdling and painting or cutting and painting of larger stems should serve as the repeated method of treatment. Around archaeological sites, grubbing is an unacceptable technique. This should be replaced by girdling and painting. If there are tabby walls present, or other objects that may be affected by acids or chemicals, hand cutting should be used. Note that reliance on burning and grubbing greatly reduces the amount of herbicide used. A tung control program can, in fact, use very low quantities of Roundup per acre if the program is properly organized.

Seeds will continue to sprout for several years after mature tung are removed, so follow up must continue for at least three to four years following the initial clearing of tung. A majority of the seedlings should be gone at the end of the first two years, however.

Appendix: Past treatment history and potential management for tung stands on Cumberland Island

Dungeness area (Fig. 3)

Each separate tung stand is marked with a letter on the map in Figure 3.

Stand A. This stand has been used for both cutting experiments in 1985 and herbicide experiments in 1986. The test plots shown in Fig. 1 are in this stand. The eastern corner of this stand could possibly be treated by grubbing, but the western half of the area is over an old dump and a midden. Treatment as an archaeological site is recommended for the western portion, with girdling and painting with Roundup preferred.

Stand B. This area is small and is best handled by grubbing/herbicide.

Stand C. This stand includes a tabby walled cemetery and was one of the test areas for continued cutting. It is, as of summer 1986, almost clear of tung. Because of its archaeological nature continued hand cutting is the best method.

Stand D. This area is part of the original plantation and has been burned in 1985 and treated with herbicide in 1986. Low fuels and larger plants make fire of limited use. Continued herbicide use via gridling and painting is recommended.

Stand E. This small area was treated with herbicide in 1986. Use of grubbing and herbicide should be continued.

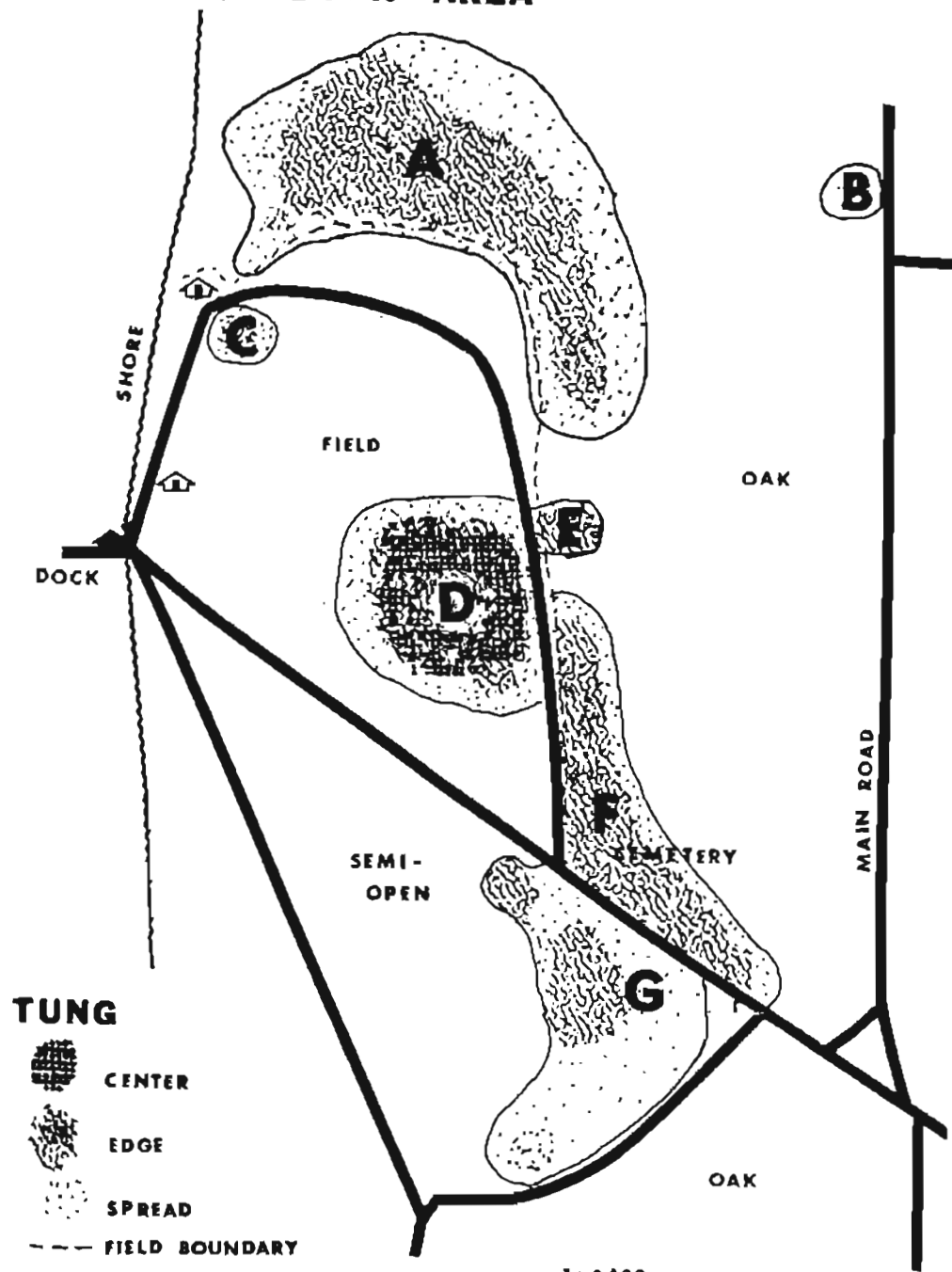
Stand F. This area was treated with herbicide in April 1986 and was treated with grubbing and herbicide applied through a mixture of girdling and stump painting in August 1986. The fenced cemetery was skipped on both occasions, however, due to lack of access. This area was partially clear of tung in August 1986 and treatment should be continued using grubbing and herbicide.

Stand G. This area was used for test hand cutting starting in 1984, and by August 1986 was almost clear of tung. Grubbing could be used to remove the last few viable root stocks. A few seedlings are still sprouting.

Figure 3. The stands of tung in the Dungeness dock area in 1983-84.

Each letter designates a stand discussed in the appendix.

DUNGENESS DOCK AREA



Stafford area (Fig. 4)

Stand A. The small trees from the northern part of the pine plantation were hand cleared by digging in 1983. This included shoots in the triangle at the intersection of Stafford Beach Road and the road to the east of Stafford Field. In 1986 the test plots shown in Fig. 2 were established within this block of pine plantation and the northwestern corner was burned. The rest of this stand may be easily burned and that might be the most effective initial treatment. This should be followed by grubbing and/or herbicide application.

Stand B. This stand contains a few scattered trees under an oak canopy. Grubbing and herbicide application to large trees would probably be most effective.

Stand C. This area was hand cleared in 1983. Grubbing would probably be most effective.

Stand D. This stand could be burned first, or grubbing with herbicide could be used.

Stand E. This stand has low fuels and many large trees. Although burning could be tried, but other forms of treatment are more likely to be effective. This is an area where cutting and painting stumps may work well. Note, if not near the road, it would be better not to flush the stumps, so if they resprout, they may be more easily treated by recutting or by girdling.

An additional stand of tung has been located in the dump area, northeast of the old servants' quarters at Dungeness. This stand should be treated with herbicide to avoid soil disturbance.

Figure 4. The stands of tung in the Stafford Field area, 1983-84.

TUNG DISTRIBUTION

STAFFORD FIELD

STAFFORD
HOUSE

OAK

E

OPEN
FIELD

AIR STRIP

MAIN ROAD

TRAIL

OAK



CENTER



EDGE



SPREAD

1:6000 SCALE

OAK

B

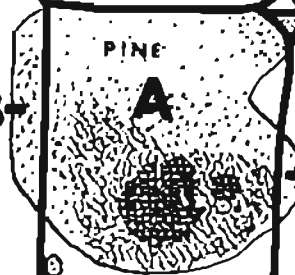
PINE

A

PINE

C

OAK



References

Bratton, Susan P. 1984. The distribution of tung and tamarisk on Cumberland Island National Seashore. Institute of Ecology, University of Georgia, CPSU Technical Report, No. 11, 26 pp.