MULTIFLORA ROSE CONTROL PROJECT

by

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Introduction

Multiflora rose (Rosa multiflora Thunb.) was introduced into the United States prior to 1811 from Japan (Rehder, 1936). It is characterized from other members of the genus Rosa by leaves which are pinnately compound and leaflets numbering 5 to 11 per leaf, usually 9. The mature leaflets seldom exceed 20 cm in length and are broadly ovate. The stipules are obvious and adnate to the petiole, pectinate-toothed and glandular-ciliate. The styles are united and rise well up from the hypanthium. The flowers are bisexual, white but may range to pinkish, and are 1.5 to 2.0 cm in diameter. They arise from the panicle in numbers ranging from 25 to 100. Flowering in southwest Virginia usually begins in the middle to later part of May and lasts several weeks. The fruit are globular and turn from green to bright red in the fall (Fawcett 1980). The plant is deciduous with bud break occurring in the early spring. The thorns are curved and flattened and often occur in pairs, however, thornless varieties are not unknown (Rosene, 1950).

Multiflora rose spreads vegetatively by root suckering and cane layering, however, the main method of propagation is by seed. The seeds (achenes) are encased in the fruit (hip) and may persist on the bush until displaced by the new buds the following spring. The number of achenes per hip may range from 5 to 15. They are about 4 mm long and there are 50-82,000 cleaned seeds per pound. The seeds are viable soon after the hip fades from green to red and germinate most readily at this time.

The species was originally introduced as an ornamental and its presence continued as such for over a hundred years. Two other uses for the species were later described. The first was its use as rootstock by the nursery industry. Because of its vigor and lack of natural enemies in this country

it was found to be a prime stock for grafting a vast array of hybrid ornamental roses. This function continues today. The other use involved its planting for conservation purposes.

Research was conducted during the 1930's to assess the possibility of using a number of species for various conservation functions. At that time it was found that multiflora rose would be a good species for erosion control, living fences, and game cover and food. Little consideration was given to its potential for spread for it was felt that any such spread would occur into waste areas and would be of little consequence. Incidental spread into crop lands would be controlled by tillage while spread into pastures could be alleviated by clipping (McAtee, 1941). Later publications described the use of 2,4,5-T as a control measure for unwanted plants (Anderson and Edminster, 1954). Planting recommendations continued to be made by the Soil Conservation Service and various wildlife organizations well into the 1950's. However, even as these recommendations were being made, a number of researchers were issuing warnings. In 1949, Durward Allen wrote: "Charles A. Damback... suggests that perhaps we are going forward too rapidly with this plant... if it becomes a nuisance, it will be difficult to sell farmers on other new ideas."

The spread of multiflora rose occurs in a number of ways. Wind will carry the seeds for short distances while water is capable of dispersing them along creek banks for miles. The bulk of seed spread, however, is carried out by birds. A number of species have been implicated as vectors. Their dispersal method naturally leads to multiflora rose infestations along fence rows, forest edges, and in fields which they fly over. The natural tendency of birds to congregate in brushy, weedy, or otherwise unmanaged areas contributes significantly to the establishment of multiflora rose on these sites. With this in mind, it easily follows that, when left unmolested, multiflora rose

is fully capable of taking over unimproved pastures, leading to an increase in the resident bird population. Hence, the spread of the species becomes exponential. Multiflora rose does not spread into wooded areas as it is not shade tolerant, however, it does spread into pine populations where an open canopy is in evidence.

Warnings about the potential spread of multiflora rose are legion. Some were issued over 30 years ago. Walter Rosene published a paper in 1950 in which he stated: "Control will be necessary if multiflora rose is to be kept from spreading in idle land and into unimproved pastures." W. D. Klimstra followed in 1956 by saying "In the regions where agriculture is less intense and natural succession of woody vegetation and idle land relatively common, planting of multiflora rose is believed not only unwise but in general unnecessary, for natural conditions probably offer much more for wildlife. The emphasis now being placed on multiflora rose ... might well result in the establishment of another nuisance plant." In 1957, O. H. Fletchall commented at the North Central Weed Control Conference that, "Multiflora rose is an increasing weed problem in Missouri". Despite such cautionary publications, the Soil Conservation Service, as well as the U.S. Fish and Wildlife Commission, advocated its planting well into the 1960's. Additionally, state highway departments installed large plantings throughout the eastern half of the U.S., often at the behest of the Federal Government. These plantings were made for both safety and aesthetics. Other plantings also followed with the funding of Federal beautification programs. In essence then, a monster was created, however unknowingly, by various state and federal agencies while the warnings were being issued by some still small voices in the wilderness.

The manner in which various states approach the multiflora rose problem is in direct proportion to the intensity of that problem within each state. West Virginia

has legislated an eradication program that is being actively pursued. Ohio forbids the importation into or planting of multiflora rose in the state, except for nursery rootstock. Numerous bills regarding the control of multiflora rose have been introduced in North Carolina's legislature and passage of such a law appears imminent. Various other states have, or have proposed, similar laws. In Virginia, public displeasure with the multiflora rose problem has led to the formation of a Senate subcommittee to investigate the complaints which, if found legitimate, could lead to their drafting legislation to confront it.

The bulk of the multiflora rose problems in Virginia are confined to the southwest portion of the state. This does not mean that there are no problems with the species in other portions of the commonwealth, but rather that the bulk of the landowner complaints come from this area. The topography of the Shenandoah Valley throughout this area is conducive to grazing of livestock and consequently, that industry is a real presence there. Unfortunately, the presence of the grazing industry and the topography it thrives on is also conducive to the spread of multiflora rose. Plantings of multiflora rose in Virginia date back to early conservation efforts and as such, the species has been present throughout the state for many years. Later plantings by the Department of Highways and Transportation, however, have been the sources of the most recent complaints. Their prominence on the highway rights-of-way makes them subject to constant perusal and attachment of blame. It is this problem that the following research report addresses.

I. Literature Search

A computerized search of scientific publications referring to multiflora rose, flower prevention, fruit abscission and other key words was initiated

during the summer of 1978. The U.S.D.A. Library, Beltsville, MD. and the Virginia Commonwealth Library were searched in this manner. The results of this search ranged from poor to good, depending on the subject area addressed. Publications referring to multiflora rose usually concerned either propogation or eradication. There was a multitude of information by horticulturists evaluating the species for its uses in the propagation of ornamental (hybrid) roses. There was also a significant amount of information concerning the conservation uses of the species. These were, of course, older publications. Additionally, there was a host of more recent literature referring to the control or eradication of the species with herbicides. Precious little, however, was found concerning the species and the control methods this research was geared toward.

On the other hand, publications concerning flower thinning or prevention, fruit abscission, and growth regulation on other species were numerous. These publications were invaluable in providing guidance for application techniques as well as providing information on potential chemicals to evaluate.

Inquiries regarding the original source and the degree of infestation of multiflora rose led to many dead ends. Attempts to locate original Soil Conservation records were to no avail. Older records of this nature have been stored for many years and were virtually inaccessable. Some farm records were available at local SCS offices, however, going through them would have taken a prohibitive amount of time and some of the information contained in them is confidential. The bulk of the information obtained concerning original plantings was by word of mouth with local residents. Unfortunately, specific information such as dates and precise locations could not be verified. In general, most landowners who had participated in earlier plantings of multiflora rose were of little help. Either they had eradicated the plantings, died or moved away, or were simply uncorporative.

Investigations into the major means of propagation and spread let to one course; seed, regardless of how it was dispersed.

Botanical characteristics of the species were considered in depth. Nothing was found that could be conceivably used for checking the spread of the species. No significant natural enemies appear to live in this country. (This is not surprising since the species is not a native of the Western Hemisphere). The only organism found that could potentially have an effect on multiflora rose is the European rose seed chalcid, Megastigmus aculcatus (Swederus). This insect is a member of the Hymenoptera, and of the parasitoid chalcid group which has contributed other species presently used in biological control activities. Unfortunately, the species does not disperse easily and is subject to death by winters of moderate severity (DeBach, 1964). Additionally, private conversations with Entomologists at VPI & SU suggest that the propagation and dispersal of such an organism, even if successful, would probably not be in the best interests of the rose industry.

To summarize the literature search, one could say that, while contributing few concrete items of interest, it sowed an abundance of seeds for thought. Fortunately, a few of the seeds germinated which led to some very positive results.

II. Seed Prevention

Over 30 compounds and countless formulations were screened initially to assess their growth regulator effects on multiflora rose. Some elicited no response, others gave undesired results, while still others virtually killed the plant. Efforts to cause abscission of the fruit after set were completely unsuccessful. Data gathered after applications made in the spring of 1979 reduced the number of compounds warranting further testing to six.

Research carried out with these compounds in the spring of 1980 further reduced this list to two and also allowed a seasonal application window to be defined. The two chemicals finally isolated were dikegulac (Atrinal®) and maleic hydrazide (Slo-gro® and various other trade names). The selection of these compounds was based on their efficacy and the length of their effective application window (Table I). It is felt that either of these products will give adequate seed control when applied at the proper rate at the right time. With this in mind, the choice of products should be made on a cost/acre basis as there is not significant difference in their efficacy. Further research will be carried out during the spring of 1982 to determine if tank-mixes of these two chemicals will allow the rates of either to be reduced thereby reducing the cost.

Atrinal® is manufactured by Hoffman LaRoche, Vero Beach, Florida and maleic hydrazide is produced by Uniroyal and various other companies. It should be noted that maleic hydrazide is already in the inventory of the Virginia Department of Highways and Transportation.

III. Seed Viability

Seeds of multiflora rose were gathered from various areas of Montgomery County, Virginia during the first week of November, 1978. They were cleaned and divided into three portions. Two portions of the seed were scarified in concentrated sulfuric acid for 15 and 30 minutes respectively. The third portion of the seed was not treated. Half of each sample was then placed dry into a plastic bag and kept in cold storage at $2^{o}C$. The remaining seed was also placed dry into a plastic bag which was placed inside of a plastic jar. This jar of samples was buried at a depth of six inches in the soil. Three subsequent experiments were carried out with these samples.

The first experiment involved planting 5 replications of 50 seeds each from the three samples held in cold storage. The seeds were planted in galvanized flats containing Spasoff mix and placed in the greenhouse. The seeds were planted at a depth of 1/4 inch and were bottom watered each afternoon. The temperature was kept at approximately 20^{o}C at all times and no supplemental lighting was used. A plant count was made after 14 days to determine percent germination. This experiment was conducted every six months beginning 1 December 1978.

Results of this work (Table II) indicate that the scarification process had little impact on the germination ability of the seed. It should be noted, however, that the overall germination rate of the seed began to decline after 18 months of storage.

In the second experiment, samples of the cold storage seed was planted in all-weather flats and placed in the ground such that the soil level in the flat was the same as that of the surrounding soil. Five replications of 50 seeds each from the three stored samples were planted. The seeds were planted 1/4 inch deep and no supplemental watering was performed. At the end of six months, the flats were removed and placed in the greenhouse. The greenhouse temperature was maintained at approximately 20^{o}C, the flats were bottom watered, and no supplemental lighting was provided. A plant count was made after 14 days to determine the percent germination. This experiment was performed once each year beginning 1 December 1978.

Data collected from this experiment is of interest because of the gap in germination rates between the two scarified groups (Table III). It is apparent that some scarification of the seed is desirable for relatively good germination, however, it appears that 30 minutes of acid treatment destroyed some mechanism in the seed coat which protects the embryo during its long winter exposure. Any number of factors could be involved in this, all of which are beyond the

scope of this experiment.

The seed that was buried was used for the third experiment. Samples of this seed were exhumed each year in March and used in a greenhouse experiment. The seed was sown in flats and placed in the greenhouse as described in the first experiment. Plant counts were made after 14 days.

Results of this experiment tend to initially reinforce the data taken in the second experiment. It is, however, interesting to note the yearly decrease in the germination rate of both the scarified samples. It would appear that the extremes in temperature around the seed over the course of the year was instrumental in reducing the viability of the seeds.

In summation, these experiments demonstrate the various conditions which can have effects on the viability of multiflora rose seed over the course of a year. Scarification approximates the effects that gastric acids might have on seeds as they pass through the digestive system of an animal. These effects can be either beneficial or detrimental, depending on the environment the seed is ultimately exposed to. It appears that little can be done by man to appreciably alter the conditions the seed is ultimately exposed to during and after dispersal.

VIa. Seed Germination

Work in this area is directly related to the experiments performed above. As stated earlier, there appears to be little that man can do to alter the germination potential of multiflora rose seed grown in the wild. Attempts at altering the temperature that germinating seeds were subjected to were unsuccessful. This work was carried out in a growth chamber, however, even when the temperature approximated those the seed would be exposed to under natural conditions, germination could not be obtained. Variations in diurnal light supplies were of no help. In most instances, the seed molded after a

few days. Data gathered from the viability study better describe the best conditions for germination.

VIb. Seed Dissemination

Two major routes of seed dissemination were identified for multiflora rose. The first of these, water, is only as important as its flow rate and relative proximity to multiflora rose infestations. Seeds entering slow moving streams result in dense localized infestations along banks for a short distance. Fast moving water, on the other hand, is capable of transporting seeds for miles. Infestations along streams of this nature are intermittent and concentrated along curves in the creek channel. In both cases, movement of seeds in this manner provide for infestations to occur in previously clean land. Once the species is established along stream banks, birds feeding on the fruit facilitates movement out into the surrounding fields.

Birds are the second major means of seed dispersal. Scott reported in 1965 that hedge plantings of multiflora rose constituted a unique attraction as later winter food for seasonally-flocking, fruit-eating birds -- either wintering or in spring migration. Less abundant resident species such as the mockingbird (Mimus polyglottos) made considerable use of the plantings. F. C. Schmid (1958) reported that mockingbirds subsisted almost entirely on multiflora rose hips throughout the winter. He further pointed out that winter flocks of cedar waxwings (Bombycilla cedrorum) were constantly in the hedges feeding on the rose hips. Welty (1974) observed that food injested by young cedar waxwings could move through the digestive system of the bird in 16 minutes. It should be noted that this amount of time (16 minutes) corresponds well with the ideal scarification time observed in the seed germination and viability experiments (15 minutes). The seasonal movement of robins (Turdus migratorius) also contributes to the dispersal of multiflora rose seed (Taylor, 1949; Davison and Grizzell 1961). Robins appear to be facultative consumers of multiflora hips, subsisting on them in the absence of insects.

Observations and specimen collections made in southwest Virginia during the winters of 1978-79 and 1979-80 tend to reinforce articles in the literature (Table V). Casual observations were made during the late fall, winter, and early spring and specimens were taken in the months of January and February when the ground was snow covered. Specimen evaluations were made by dissection of the gizzard and posterior intestinal tracts.

From the data, it appears that mockingbirds and robins are quite active in the dispersal of multiflora rose seed, at least in this area. Additionally, while no specimens were taken, localized feeding by cedar waxwings probably also contributes significantly to the total volume of multiflora rose seed dispersed.

Conversely, it would appear that Cardinals and Evening Grosbeaks do more good than harm by virtue of their destruction of the seed in their consumption process. The Cardinal is a year-round resident of Virginia, while the Evening Grosbeak is an irregular (though not rare) visitor. Other small birds, such as sparrows and warblers probably reduce the number of dispersed seed by consuming them as they forage for food. Schmid (1958) observed Fox Sparrows (Paserella iliaca) and Song Sparrows (Melospiza melodia) feeding on the multiflora rose seed in the droppings of Cedar waxwings. When specimens of these species were collected, it was found that the contents of the gizzards of the Fox Sparrows consisted of from 60-100% multiflora rose seed. It can be concluded that, while there are species of birds which tend to disperse multiflora rose seed, there are also concomitant species which scavenge up this dispersed seed when found. The degree that this scavenging reduces the number of seeds that could potentially germinate is unknown.

Incidental to this is a report by L. W. Krefting and E. I. Roe (1949) that the injestion of rose seeds by pheasants and grouse reduced total germinability but increased germination of those seeds which passed through the birds without harm.

Various reports (Martin et al., 1951; Krefting and Roe, 1949) indicate that several mammalian species also forage on multiflora rose in the winter months. Attempts to trap and, or observe mammals feeding on multiflora rose fruit were unsuccessful. Deer mice (perimyscus sp.) which were subsequently trapped and fed rose hips and cleaned seed, utilized it only as a starvation food. When the seed was consumed, none could be isolated from fecal pellets. This insinuates that if mice of voles do consume any significant amounts of multiflora rose seed, they destroy it in the process.

V. Survey of Multiflora Rose Populations

A survey to determine the degree of multiflora rose infestations in southwest Virginia was begun in the fall of 1978. Originally, this survey was to be state wide, however, the logistics of such a survey soon proved untenable. After discussion with members of the Virginia Highway Research Council and the Vegetation Management Task Group this portion of the project was abbreviated to include only those counties in southwest Virginia directly adjacent to Interstate 81 and a few adjoining counties. Twenty randomly selected samples were taken in each county (2 replications, 10 samples each). The data gathered is attached as Appendix A. Additional data was also gathered concerning other woody weed species so that a comparison could be made to determine the overall significance of the multiflora rose infestations. An attempt was also made to correlated multiflora rose infestations with respect to their distance from I-81.

On analysis, the data indicates that multiflora rose is a problem throughout the counties surveyed. However, other species such as black locust (Robinia pseudoacacia L.), blackberry (Rubus allegheniensis Porter), and wild cherry (Prunus serotina Ehrk.) were also significant problems. The presence of any of

the above named species or species of similar nature can significantly reduce the presence of more desirable forage species. Additionally, each of the above mentioned species is capable of spreading in much the same manner as multiflora rose.

The correlation analysis attempted to establish a relationship between multiflora rose infestations and their proximity to I-81. No linear correlation was found when the counties of Washington, Wythe, and Smyth were analyzed together, however, when Smyth County was analyzed alone the data indicates that a positive correlation may exist. Additional data would have to be gathered in order to verify this possibility. (See Appendix A).

VI. Cost/Benefit of Control of Multiflora Rose

An analysis of this portion of the project was performed during the winter of 1979. (See Appendix B). In summary it shows that one cannot consider multiflora rose alone when calculating the agricultural losses experienced due to brush infestations. Multiflora rose is usually accompanied by companion species which enhance the problem. THey must be considered collectively. Brush infestions are basically the result of poor land management. In most instances this is demonstrated by the presence of various herbaceous species as well, such as thistles, milkweed, and pigweed. Observations made on well managed land show the absence of both woody and herbaceous weeds. This does not preclude the fact that undesirable species will not move onto well managed land, rather that they do not become established. This is the crux of the problem and the solution. A farmer who cares for his land properly will always be at the mercy of a neighbor who does not.

VII Use of Multiflora Rose by the Nursery Industry in Virginia

There appears to be very little ornamental rose propagation done by nurseries in Virginia. Results gathered by telephone conversations indicate that most nurseries purchase their roses from large scale rose producers out-of-state.

Legislation that would outlaw the use of multiflora rose as rootstock in Virginia would have little impact on the propagation of roses in the Commonwealth, but would also have little impact on preventing the spread of the species. The main result of such legislation would be the limitation of rose importation into the state.

Correspondence with several rose producers in various states more accurately provides an indication of the impact that such legislation might have. Dr. Eldon W. Lyle of the Texas Rose Research Foundation responded: "If Rosa multiflora type root stock were outlawed in Virginia, Texas and probably other states would cancel all shipments of roses for distribution in Virginia. There would be no suitable alternative, so many kinds of rose understocks having been tested and not proven superior to multiflora... When used as rootstocks, there is little or no rootsprouting such as can occur with other rose rootstocks. For this reason, there should be no reason to condemn multiflora as a rootstock." Mr. L. E. Sjulin of Inter-State Nurseries, Hamburg, Iowa responded in much the same way. He noted that 90% of the roses they ship to Virginia are on Multiflora rose. Additionally, he pointed out that Iowa has much the same multiflora rose problem that we have in Virginia, however, all legislation in Iowa regarding Multiflora rose has exempted the nursery use of the species (for rootstock) from regulation. These and other correspondences indicate that the burden of such legislation would fall on those businesses involved in the resale of ornamental roses rather than propagators.

In conclusion, I would like to point out that, after three years of travel in the state of Virginia, I have never found a rose infestation whose source could be identified as the rootstock of an ornamental rose. Any legislation which would limit the use of this rootstock would have little impact on the spread of the species while placing an unfair burden on the retailers who market ornamental roses.

VIII. Chemical Control

A large number of herbicides have been evaluated over the last three years including both foliar and soil applied compounds. Most gave some margin of control while a few failed miserably. Those which gave acceptable control are recommended in the Vegetation Management Guide. This list includes, picloram (Tordon®), dicamba (Banvel®), triclopyr (Garlon®), fosamine (Krenite®), and several combinations of 2,4-D and 2,4-DP. As with their use on other brush, the response elicited by each is a measure of its proper usage. Past experience in other areas of brush control has shown that herbicides that have been applied at the wrong time or without the proper coverage inevitably gave poor control.

Table 1. Evaluation of Dikegulac and Maleic Hydrazide on Multiflora Rose.

Date of Application	Rate (ppm)	% Hip Reduction	% Growth Reduction	Visual[1/] Injury
Dikegulac				
3/28	1000	5	61	1
	2000	3	71	1
4/11	1000	87	60	1
	2000	91	72	1
4/23	1000	99	64	1
	2000	99	81	1
5/2	1000	98	78	1
	2000	99	85	1
5/9	1000	98	74	1
	2000	99	80	1
5/30	1000	3	8	0
	2000	4	11	0
Maleic Hydrazide				
3/28	1000	0	24	0
	2000	0	24	0
4/11	1000	15	36	1
	2000	21	48	1
4/23	1000	90	61	1
	2000	93	64	1
5/2	1000	92	61	1
	2000	90	65	1
5/9	1000	88	42	1
	2000	94	48	1
5/30	1000	3	21	0
	2000	3	20	0

[1/] Visual rating based on a subjective visual estimate; 0 = no injury, 10 = death.

Table II. Experimental Data from Greenhouse Plantings.

Planting Date	Seed Treatment	$\bar{X}$ % Germination after 14 days
1 December 1978	Unscarified	37.6
	15 min. scarification	29.2
	30 min. scarification	28.8
1 June 1979	Unscarified	31.2
	15 min. scarification	27.4
	30 min. scarification	27.8
1 December 1979	Unscarified	34.5
	15 min. scarification	30.0
	30 min. scarification	28.0
1 June 1980	Unscarified	27.0
	15 min. scarification	27.0
	30 min. scarification	22.3
1 December 1980	Unscarified	20.2
	15 min. scarification	22.1
	30 min. scarification	16.3

Table III. Experimental data from Outside Plantings

Planting Date	Seed Treatment	$\bar{X}$ % germination after 14
1 December 1978	Unscarified	21.4
	15 min. scarification	30.1
	30 min. scarification	11.4
2 December 1979	Unscarified	20.6
	15 min. scarification	26.7
	30 min. scarification	9.6
29 November 1980	Unscarified	18.7
	15 min. scarification	31.6
	30 min. scarification	10.0

Table IV. Experimental Data from Buried Seed

Planting Date	Seed Treatment	$\bar{X}$ % Germination after 14 days
15 March 1979	Unscarified	20.6
	15 min. scarification	30.6
	30 min. scarification	14.7
22 March 1980	Unscarified	14.1
	15 min. scarification	12.7
	30 min. scarification	11.9
17 March 1981	Unscarified	15.2
	15 min. scarification	5.9
	30 min. scarification	4.8

Table V. Evaluation of Various Bird Species collected in or Around Multiflora Rose Bushes.

Species	# Specimens	# Seed in Digestive Tract	Condition of See
Mockingbird	1	25	intact
Sparrow (sp.)	3	1	intact
Warbler (sp.)	1	0	----
Robin	3	>20/bird	intact
Blue jay	2	0	----
Cardinal	2	>5/bird	crushed
Evening Grosbeak	1	>5	crushed
Cedar Waxwing	0	observed feeding on m. rose	

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Appendix A

Multiflora Rose Survey of Southwest Virginia

These results reflect data collected in the counties of Carroll, Grayson, Russell, Smyth, Tazewell, Washington, and Wythe. In the sampling selection process, those areas which appeared to be predominately wooded were disregarded and new sites selected. In those sites which contained some wooded area, only the cleared area was evaluated. All data was gathered by physically visiting each site. All figures referring to actual acreage were calculated from initial data obtained from the Virginia Extension Service.

Carroll County

Degree of infestation of open lands by various pest type woody species similar to multiflora rose in size and encroachment patterns, (including multiflora rose) in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	0	0
> 0 to 5	30	44,482
> 5 to 10	20	29,655
> 10 to 50	50	74,138
> 50	0	0
		148,275

Degree of infestation of open lands by multiflora rose in plots surveyed.

Plants/Acre	% of Open Land	Actual Acreage
0	40	59,310
>0 to 5	20	29,655
>5 to 10	30	44,482
>10 to 50	10	14,828
> 50	0	0
		148,275

Various pest type woody species and the percent times their population was found to be the predominant invader of open land in each plot.

Multiflora rose	5%
Blackberry	25%
Wild Cherry	5%
Black locust	35%
Other[2/]	30%

[1/] All percentage figures must be considered to range ± 5% except for zero, it must be considered to range up to 5% in a positive direction only.

[2/] Other indicates minor species which only occurred on rare occasions or, plots where the desired information could not be obtained due to extremely low population counts.

Various pest type woody species and the percent times their population was found to be the secondary invader of open land in each plot.

Multiflora rose	5%
Blackberry	25%
Wild Cherry	5%
Black locust	35%
Other[2/]	30%

Grayson County

Degree of infestation of open lands by various pest type woody species similar to multiflora rose in size and encroachment patterns, (including Multiflora rose) in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	10	17,734
>0 to 5	30	53,200
>5 to 10	30	53,200
>10 to 50	20	35,466
>50	10	17,734
		177,336

Degree of infestation of open lands by multiflora rose in plots surveyed.

Plants/Acre	% of Open Land[1/]	Acutual Acreage
0	55	97,535
>0 to 5	30	53,200
>5 to 10	10	17,734
>10 to 50	5	8,867
>50	0	0
		177,336

Various pest type woody species and the percent times their population was found to be the predominant invader of open land in each plot.

Multiflora rose	5%
Blackberry	15%
Wild cherry	10%
Black locust	25%
Hawthorn	5%
Other[1/]	35%

[1/] All percentage figures must be considered to range ± 5¢ except for zero, it must be considered to range up to 5% in a positive direction only.

[2/] Other indicates minor species which only occurred on rare occasions or, plots where the desired information could not be obtained due to the extremely low population counts.

Grayson County (Cont'd)

Various pest type woody species and the percent times their population was found to be the predominant invader of open land in each plot.

Multiflora rose	30%
Blackberry	20%
Wild cherry	10%
Black locust	0%
Hawthorn	10%
Other[2/]	30%

Russell County

Degree of infestation of open lands by various pest type woody species similar to multiflora rose in size and encroachment patterns, (including Multiflora rose) in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	10	19,318
0 to 5	25	48,294
5 to 10	40	77,270
10 to 50	20	38,634
50	5	9,659
		193,175

Degree of infestation of open lands by multiflora rose in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	80	154,539
0 to 5	10	19,318
5 to 10	5	9,659
10 to 50	5	9,659
50	0	0
		193,175

Various pest type woody species and the percent times their population was found to be the predominant invador of cleared land.

Multiflora rose	5%
Blackberry	20%
Wild cherry	25%
Black locust	0%
Hawthorn	15%
Other[2/]	35%

[1/] All percentage figures must be considered to range ± 5¢ except for zero, it must be considered to range up to 5% in a positive direction.

[2/] Other indicates minor species which only occurred on rare occasions or, plots where the desired information could not be obtained due to the extremely low population counts.

Russell County (Cont'd)

Various pest type woody species and the percent times their population was found to be the secondary invader of open land in each plot.

Multiflora Rose	0%
Blackberry	0%
Wild Cherry	20%
Black locust	35%
Cedar	20%
Other	25%

Smyth County

Degree of infestation of open lands by various pest type woody species similar to multiflora rose in size and encroachment patterns, (including multiflora rose) in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	0	0
> 0 to 5	55	79,345
> 5 to 10	10	14,426
> 10 to 50	35	50,493
> 50	0	0
		144,264

Degree of infestation of open lands by multiflora rose in plots surveyed.

Plants/Acre	% of Open Land	Actual Acreage
0	55	79,345
> 0 to 5	30	43,279
> 5 to 10	10	14,426
> 10 to 50	5	7,214
> 50	0	0
		144,264

Various pest type woody species and the percent times their population was found to be the predominant invader of open land in each plot.

Black locust	30%
Red Cedar	20%
Multiflora rose	15%
Blackberry	10%
Other[2/]	25%

[1/] All percent figures must be considered to range ± 5% except for zero, it must be considered to range up to 5% in a positive direction only.

[2/] Other indicates minor species which only occurred on rare occasions or plots where the desired information could not be obtained due to extremely low population counts.

Various pest type woody species and the percent times their population was found to be the secondary invader of open land in each plot.

Black locust	10%
Red Cedar	15%
Multiflora rose	5%
Blackberry	35%
White thorn	10%
Other	25%

Wythe County

Degree of infestation of open lands by various pest type woody species similar to multiflora rose in size and encroachment patterns, (including Multiflora rose) in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	10	16,760
>0 to 5	45	75,418
>5 to 10	15	25,140
>10 to 50	25	41,899
>50	5	8,380
		167,597

Degree of infestation of open lands by multiflora rose in plots surveyed.

Plants/Acre	% of Open Land	Actual Acreage
0	65	108,938
>0 to 5	25	41,899
>5 to 10	10	16,760
>10 to 50	0	0
>50	0	0
		167,597

Various pest type woody species and the percent times their population was found to be the predominant invader of open land in each plot.

Black locust	30%
Blackberry	20%
Red Cedar	20%
Multiflora rose	10%
Other[2/]	20%

[1/] All percentage firgures must be considered to range ± 5¢ except for zero, it must be considered to range up to 5% in a positive direction only.

[2/] Other indicates minor species which only occurred on rare occasions or, plots where the desired inforamtion could not be obtained due to the extremely low population counts.

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Various pest type woody species and the percent times their population was found to be the secondary invader of open land in each plot.

Black locust	35%
Blackberry	25%
Wild Cherry	10%
Multiflora rose	5%
Red Cedar	0%
Other	25%

Tazewell County

Degree of infestation of open lands by various pest type woody species similar to multiflora rose in size and encroachment patterns, (including Multiflora rose) in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	10	15,979
>0 to 5	20	31,958
>5 to 10	15	23,969
>10 to 50	35	55,926
>50	20	31,958
		159,790

Degree of infestation of open lands by multiflora rose in plots surveyed.

Plants/Acre	% of Open Land[1/]	Actual Acreage
0	70	111,853
>0 to 5	25	39,948
>5 to 10	5	7,989
>10 to 50	0	0
>50	0	0
		159,790

Various pest type woody species and the percent times their population was found to be the predominant invader of open land in each plot.

Multiflora rose	5%
Blackberry	20%
Wild cherry	25%
Black locust	0%
Hawthorn	15%
Other[2/]	35%

[1/] All percentage figures must be considered to range ± 5¢ except for zero, it must be considered to range up to 5% in a positive direction only.

[2/] Other indicates minor species which only occurred on rare occasions or, plots where the desired information could not be obtained due to the extremely low population counts.

Tazewell County (Cont'd)

Various pest type woody species and the percent times their population was found to be the secondary invader of open land in each plot.

Multiflora Rose	5%
Blackberry	0%
Wild Cherry	10%
Black locust	30%
Hawthorn	15%
Other[2/]	40%

Washington County

Degree of infestation of open lands by various pest type woody species similar to multiflora rose in size and encroachment patterns (including multiflora rose) in plots surveyed.

Plants/Acre	% of Open Land [1/]	Actual Acreage
0	0	0
> 0 to 5	35	79,282
> 5 to 10	25	56,630
> 10 to 50	30	67,956
> 50	10	22,652
		226,520

Degree of infestation of open lands by multiflora rose in plots surveyed.

Plants/Acre	% of Open Land	Actual Acreage
0	15	33,978
>0 to 5	60	135,912
>5 to 10	15	33,978
>10 to 50	10	22,652
>50	0	0
		226,520

Various pest type woody species and the percent times their population was found to be the predominant invader of open land in each plot.

Black locust	25%
Blackberry	15%
Red Cedar	35%
Multiflora rose	25%
Other [2/]	0%

[1/] All percentage figures must be considered to range ± 5% except for zero, it must be considered to range up to 5% in a positive direction only.

[2/] Other indicates minor species which only occurred on rare occasions or, plots where the desired inforamtion could not be obtained due to extremely low population counts.

Various pest type woody species and the percent times their population was found to be the secondary invader of open land in each plot.

Black locust	35%
Blackberry	20%
Red Cedar	10%
Multiflora rose	15%
Other	20%

CORRELATION OF THE DENSITY OF MULTIFLORA ROSE INFESTATIONS WITH RESPECT TO THEIR DISTANCE FROM I-81

An attempt was made to correlate the density of Multiflora rose infestations and the proximity of these infestations to Interstate 81. No linear correlation was found. A table follows to show the data accumulated.

ROSE POPULATIONS IN RELATION
TO DISTANCE FROM INTERSTATE 81.

WASHINGTON COUNTY		SMYTH COUNTY		WYTHE COUNTY	
*DIST.	ROSES/A	DIST.	ROSES/A	DIST.	ROSES/A
0.19	1	0.19	>1	0.09	0
0.38	0	0.28	>0	0.19	0
0.38	>7	0.47	>2	0.28	0
0.57	<1	0.57	6	0.47	5
0.85	6	0.57	<1	1.04	<1
1.52	>35	0.95	>22	1.14	0
1.89	>5	1.14	0	1.32	0
3.41	<1	1.52	0	1.52	>9
3.50	>2	2.46	7	2.27	9
3.79	2	3.03	1	2.84	0
4.17	1	4.36	1	2.84	1
4.17	<1	4.36	3	3.60	>3
4.36	3	4.92	2	4.36	0
4.92	1	5.11	<1	4.54	0
6.44	0	5.87	0	4.64	0
7.20	<1	5.96	0	5.54	0
7.20	<1	6.25	0	5.68	0
8.33	0	6.63	0	6.82	0
9.09	25	8.14	0	7.20	<1
10.04	1	9.28	0	8.14	0

*Miles from I 81.

Appendix B

Cost/Benefit of Control of Brush in Pastures

Cost/Benefit of Control of Brush in Pastures

Introduction:

In southwest Virginia, large portions of the cleared land are devoted to grazing livestock and occasional hay production. In a recent survey of a number of counties in this area of the state, it was found that a significant amount of this land was being lost to brush infestations. In one county, as much as 20% of the otherwise usable land had brush infestations of >50 stems/acre. Further evaluation of infestations of this degree revealed that servicability of this land was reduced by a factor approaching 60%. With this in mind, it is not hard to imagine the economic loss caused by brush encroachments of this nature.

Originally, this report was to be designed to assess the economic impact of land loss due to infestations by Multiflora rose (M. rose). After evaluating the data from the infestation survey, it was found that such an assessment dealing with this species alone would be virtually impossible as well as meaningless. There is no practical way with which to eradicate M. rose infestations without gaining the side benefit of killing its companion woody speices (other brush). Additionally, in most instances, M. rose was found to be a smaller problem than several of the other species. Therefore, this report is written with respect to all species which have the ability to encroach on cleared land and of these, M. rose is only one.

Expense Involved in clearing land of Brush Infestations:

There are a number of ways in which brush infestations can be eradicated and cleaned up. Heavy infestations, as in fields that have long been neglected, would of course be the most time consuming and expensive. In these instances, the only herbicide which is cleared in Virginia for brush in pastures and non-crop lands is Tordon 10K®. Depending on the density of infestation, this compound is applied at a rate of 20-40 lb of product/acre (2-4 lb ai). The cost of Tordon

10K at this time is about $1.88/lb of product, with application costs ranging from $3.40 to $3.60/acre. After brush kill has occurred, a small amount of touch-up work might be necessary, but the cost of chemical and labor should be negligible. The total cost of eradication should range from $41.00 to $78.80/acre, with labor costs additional. At this time it should be noted that this is assuming the entire acre is infested. If, for instance, only 60% of the acre is covered, these figures would be adjusted down by a factor of 40%.

Following brush kill, it is often necessary to remove the undesirable remnants of the vegetation. There are two main techniques used for this. The first method, grubbing, is the process of physically pulling the brush, roots included, from the ground. This method is most time consuming, but is often necessary if the stem diameters are large. If the stem diameters are relatively small, a second method, bushhogging, would be the most desirable. This technique is less expensive and less time consuming. While it is quite difficult to put a dollar value on the labor involved in these processes, some information is available.

Hired part time as well as full time farm labor in the state of Virginia averages about $2.75/hr, with slight variations in certain areas. Farm machinery operators make somewhat more, on the average about $3.25/hr. With this in mind, labor computations in this report will be based on an average of $3.00/hr.

Grubbing, as mentioned earlier, is a time consuming affair, but with the exception of a tractor, involves no other powered implements. (The only exception to this might be the use of a chain saw in a few instances). The estimated hourly expense for a 90 hp. (Diesel) tractor averages $3.71/hr. Estimated labor hours for this work range from 3 to 10 hrs/acre. Again, the range of labor hours involved is a function of the degree of brush infestation. A summation of the expenses involved are shown in Table 1.

Table I. Range of expenses to be anticipated in eradicating and grubbing out vegetation remnants on land moderately to heavily infested with brush (land to be used for grazing). Expressed in $/acre.

	Moderate	Heavy
Herbicide(Tordon 10K®)	$37.60	$ 78.80
Application Labor	3.40	3.60
Machinery	11.13	37.10
Labor	9.00	30.00
Total	$61.13	$149.50

The alternative to grubbing, bushhogging, can be more readily cost evaluated. As noted earlier, labor should cost about $3.00/hr, equipment costs should run about $3.71/hr for a 90 hp. diesel tractor and about $0.88/hr for the bushhog. Depending on the density and size of the brush, the time involved can run from 1.5 to 3 hr/acre. A summation of the expenses involved are shown in Table II.

Table II. Range of expenses to be anticipated in eradicating and brush hoggi out vegetation remnants on land moderately to heavily infested with brush (land to be used for grazing). Expressed in $/acre.

	Moderate	Heavy
Herbicide(Tordon 10K®)	$37.60	$ 78.80
Appl. labor	3.40	3.60
Machinery	6.88	13.76
Labor	4.50	9.00
Total	$52.38	$105.16

Expenses involved in re-establishing vegetation on land cleared of undesirable brush:

Following brush eradication and removal, it is usually necessary to establish desirable vegetation. This operation should begin with disking followed by fertilizing, liming, and seeding and end with harrowing with a spike toothed harrow for coverage. The cost of operation for a 90 hp. diesel tractor and a tandem disk harrow is about $5.32/acre, while the cost of the spiked toothed harrow and tractor is about $4.47/acre. The average cost of spreading bulk (dry)

fertilizer is about $3.39/acre (this is an average based on custom rates that may vary to over $10.00/acre is some areas of the state). Lime application, again based on custom rates is about $14.72/ton/acre including material (this rate will vary with soil pH tests). The seed, if broadcast seeding is done, would cost about $4.30/acre plus the cost of the seed (see Table III). The following table outlines the cost of establishing a workable pasture.

Table III. Cost/acre to establish a productive stand of forage.

Operation	$/acre
disk harrowing	$ 5.32
spreading fertilizer	3.39
Nitrogen @ 50 lb/acre	10.00
Phosphate @ 60 lb/acre	12.00
Potash @ 60 lb/acre	7.20
Spreading lime (incl. material)	14.72
Broadcasting seed	4.30
Tall Fescue (Ky-31) @ 12 lb/acre	4.80[z/]
Red clover @ 5 lb/acre	9.50
Ladino @ 2 lb/acre	5.00
	$76.23[y/]

z/ Orchardgrass may be substituted for Tall Fescue but it is not a good cold weather forage and is not recommended for winter grazing.
y/ This cost will of course vary with various soil and plant regime demands.

A summary of expenses involved in establishing a productive pasture ranges from 128.61 to 225.73 dollars/acre, according to the manner used in eradication and clearing as well as the density of the infestation.

Once the pasture has been established, the landowner must assume the responsibility of maintaining his investment. Proper land management, which would have precluded much of the above mentioned expenses, is of the essence. Periodic clipping of the forage, judicious use of herbicides, prevention of overgrazing, and the application of fertilizer, lime, and seed when necessary will assure a productive pasture. Costs in this area are estimated to be about $29.40/acre/year.

An improved pasture of this nature should yield 4.13 AUM (animal unit months) of grazing for beef. In other words, one beef cow/calf per 2.5 acres per

year, assuming some supplemental feeding in winter. This is a land investment cost of $73.50 per cow/calf per year. Based on a 100 cow herd calving in November and December with a 90% calf crop (calves weaned in July and sold in October), a production value of about $307/2.5 acres should be appreciated. This value, less the cost of land maintenance, $73.50, and the cost of general operating expenses, $52.84, (hay, corn, salt and minerals, veterinarian, machinery costs, etc.) yields a net value of $180.66 or $72.26/acre return. These values, of course, will fluctuate with the economy. Accepting these returns and assuming that the land was originally moderately to heavily infested with brush, a landowner would have to expect a 1.8 to 3.1 year lag in showing a profit for his endeavors.

Cash Crop Establishment:

An alternative to livestock prduction is the establishment of a cash crop such as alfalfa. In this case, an alternative to Tordon 10K® may be necessary due to the residual affects of the compound. One herbicide that should give excellent results and allow the planting of broadleaf species is Roundup® (this compound is labeled for treatment in pre-crop establishment but not for pasture renovation). The cost of Roundup® varies slightly, but generally runs about $70/gal. Rates of application run from 3 to 4 quarts/acre with custom application costs of $8 to $14/acre. Table IV summarizes the costs involved with this operatio Again it should be noted that the costs involved vary according to the degree of infestation.

Table IV. Range of expenses to be anticipated in eradicating brush and removing vegetation remnants on land moderately to heavily infested (land to be utilized for crop production). Expenses in $/acre.

	Moderate	Heavy
Herbicide (Roundup®)	$ 52.50	$ 70.00
Application (custom)	8.00	14.00
Grubbing*		
Machinery	11.13	37.10
Labor	9.00	30.00
Total	$ 80.63	$ 151.10
Herbicide (Roundup®)	52.50	70.00
Application (custom)	8.00	14.00
Brush hogging*		
Machinery	6.88	13.76
Labor	4.50	9.00
Total	71.88	106.76

*These expenses taken from Tables I & II

Expenses involved in establishing an alfalfa stand on land cleared of undesirable brush:

After eradicating and removing the brush, a process which should occur during the summer months, the land should be prepared such that planting can occur 30-60 days before the first anticipated frost (if spring plating is desired, planting should occur about 30 days before the last anticipated frost). Table V outlines the cost of alfalfa establishment. Since alfalfa is a perennial, maintenance of an established crop will be discussed later.

Table V. Alfalfa establishment costs.

Operation	$/acre
Land preparation	$ 11.99
Seed @ 20 lb/acre	51.00 x/
Spreading fertilizer	3.39
Phosphate @ 125 lb/acre	25.00
Potash @ 125 lb/acre	15.00
Boron @ 3 lb/acre	0.66
Lime spreading (incl. material)	44.16
Inoculant	0.30
Total	$ 151.50 w/

x/ 3-5 lb of orchardgrass may be added if desired.
w/ This cost will of course vary with various soil and plant regime demands.

An established alfalfa stand of this nature should yield from 3-6 tons of hay per year. Cuttings should be spaced at 35 to 40 day intervals (depending on the location in the state and average rainfall) with the last cutting occurring 3 to 4 weeks before the first killing frost. The estimated crop value, at $70.00/t (based on 3.5 tons/acre) before operating inputs involved with harvesting are considered is $245.00/acre. Table VI outlines the expenses and returns of an alfalfa stand after one crop year.

Table VI. Cost and returns of an alfalfa crop at the end of our crop year after brush removal.

Expenses	$/acre Low	High
Brush removal	$ 71.88	$ 151.10
Alfalfa establishment	151.50	151.50
Harvest expenses	40.28	40.28
Total	$ 263.66	342.88
Return @ $70/ton	245.00	245.00
	$ (18.66)	$ (97.88)

As is shown by Table VI, a farmer can expect an operating loss ranging from $18.66 to $97.88 per acre depending on the amount of money expended in reclaiming the land (the loss/acre could be somewhat offset or considerably more depending on the crop success). The financial gain should be realized the second year if the stand is properly maintained. Table VII outlines the cost of maintaining a stand of alfalfa from year to year.

Table VII. Maintenance of an existing alfalfa stand.

	$/acre
Fertilizer	
Phosphate @ 60 lb/acre	$ 12.00
Potash @ 125 lb/acre	15.00
Boron @ 20 lb/acre	4.00
Herbicide	4.25
Insecticide	3.00
Total	$ 38.25

The crop maintenance cost along with the equipment and harvest costs yield an annual expense of $78.53/acre. With an annual crop value of $245/acre, the second harvest should yield a profit of $166.47/acre. When the balance of expenses (Table VI) for the initial cleanup and establishment are considered, the realized income (for two years) ranges from $68.59 to $147.81/acre. If the alfalfa stand is considered to have a 4 year effective life, the annual income averages $148.16/acre/year.

Summary:

This report has been designed to show the income potential of farm land that has been surrendered to undesirable brush encroachment. As has been shown, the expected return from an acre of farm land is a direct function of what is put into it. The basic problem which leads to land loss to brush is neither multiflora rose nor any other brush (weed) species, it is a lack of proper management. One could eradicate every multiflora rose plant in the commonwealth and still not avoid the problem. In order to reap the benefits of the land, the landowner must accept the responsibility that goes hand in hand. The expenses involved in maintaining the source of a farmers income is a pittance when compared to the potential gain the land holds for him.

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