The Chewuch Weed Pilot Project

Sarah Masco
Pacific Biodiversity Institute
Summer 1998

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Introduction

The introduction of non-native species into our native ecosystems has a significant and often negative impact on those native ecosystems. In the plant kingdom, we broadly refer to these invaders as weeds.

Non-natives are introduced by a variety of mechanisms: they are introduced by humans as impurities in seeding activities, carried by vehicles and animals, and dispersed by the wind. Many weeds, such as the Knapweeds, need a large disturbance to become established in an area. (Figure 4) Other species (Dalmatian toadflax) spread using subterranean rhizomes, as well as seeds, and propagate easily without disturbance. (Figure 5)

Humans have been waging battles against weeds for thousands of years. Traditional methods included burning, cutting, and hand pulling. Within the last 30-40 years humans have turned to chemical solutions to the weed problem; currently herbicides are the standard for weed control in most areas. Unfortunately these herbicides are not always effective. Widespread usage of spray has caused weeds to become more tolerant to herbicides; in turn herbicide usage has selected for the hardiest, most resistant weeds. Recently there has been concern about the environmental and health consequences of widespread use of herbicides. These concerns have led to the current research in alternative weed management.

Our project centers on the weed problem in the Methow Valley, in North-Central Washington. (Figure 1) The project is a unique cooperative agreement between the US Environmental Protection Agency, the County Roads Department, and the citizens of the West Chewuch Road. Pacific Biodiversity Institute has provided technical support throughout the project.

The purpose of this study is to determine the species composition along the West Chewuch Road in the Methow Valley with respect to native vegetation and weeds, and to investigate the effectiveness of alternative management strategies. Specifically, the weed project aims to:

1. determine and document the current state of the vegetation, asphalt and shoulders of the West Chewuch road and right-of-way;
2. track changes in these conditions through the course of the project;
3. identify new weeds which are spreading into the area - **before** they become a major problem;
4. measure the effectiveness of non-chemical vegetation management;
5. assess the difficulty of re-establishing vegetation in an area recently treated with herbicides;
6. measure the effect of vegetation on properties adjacent to the roadside vegetation with regards to weed migration.

Background

The Methow Valley in North Central Washington is a glacially carved valley formed around 10,000 years ago from the Cordillearan and local ice sheets. The floor of the valley contains a thick deposit of glacial alluvial outwash deposited after the glacier receded. The Methow River flows through the valley depositing sediments and creating a fertile floodplain. Average mean annual precipitation varies throughout the valley, but is about 15-20 inches per year along the West Chewuch Road. The rolling hills above the valley are much drier and are described as shrub-steppe vegetation. These upland areas are particularly susceptible to invasion by weeds due to their xeric soils, previous extensive grazing, and recent development.

Methods

Our project concentrates on one such area above the Chewuch River (a tributary of the Methow River). The West Chewuch Road runs north-south along the Chewuch River drainage, the county road is approximately 8 miles long and has an elevation of 1700-2000 feet above sea level, the average slope of the road is minimal. We chose a five-mile section of the road, from its southernmost end to five miles north. We divided the road into quarter mile segments (20 segments total). (Figure 2) The first mile of the road was not surveyed because the roadside was sprayed immediately before the advent of our study.

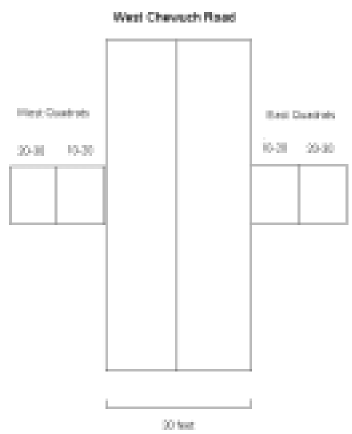
The survey consisted of four major components: 1) A survey of weed composition by quarter mile segment (surveyor walked five-mile stretch of road, noting every weed seen per quarter mile segment, both east and west side); 2) A survey for presence or absence of three select weeds: Dalmatian toadflax (*Linaria dalmatica*), Common Mullein (*Verbascum thapsus*), and Diffuse Knapweed (*Centaurea diffusa*) per quarter mile segment (both east and west side); 3) Quadrat study of percent cover by species at each quarter mile point: two quadrats on the east side of the road and two quadrats on the west. The first quadrat was measured 10-20 feet from the centerline of the road; the second quadrat was adjacent to the first, measured at 20-30 feet from the centerline. Each quadrat was ten feet on a side (Figure 3); 4) General description of same quadrats, with emphasis on asphalt and road condition, and approximate species composition of surrounding private property (weedy or native, etc.). (Appendix A)

The study took place over approximately two weeks in early to mid July; the surveying was done by the same botanist throughout the project. After data collection, the species data were tabulated into a list and categorized as native, alien, or noxious weeds. In addition, we entered the species composition/percent cover quadrat data into an Excel spreadsheet. Using a two-sample t-test we compared the inner and outer quadrats for percent area vegetated, native, alien, noxious, bare, rocks, and litter[*].

- Total Area = % Vegetated + % Bare + % Rocks + % Litter
- % Vegetated = % alien + % native
- % Alien = % non-noxious + % noxious.

[*] At this time, this was one of the only statistically powerful comparisons to make with our limited data. Further analyses will be done in the future with a more extensive data set.

Figure 3. Diagram of quadrats on West Chewuch Road, Methow Valley Washington. July 1998.



Results

In our survey of the West Chewuch Road, we found a total of 50 alien and 54 native plant species. (Appendix B) Some were rare while others were present in nearly all segments of the road. (Table 1)

Table 1. Widespread alien plant species of the West Chewuch Road Pilot Project, July 1998. Noxious weeds noted with a *.

Common Mullein (*Verbascum thapsus*)
Diffuse Knapweed (*Centaurea diffusa*)*
Prickly Lettuce (*Lactuca serriola*)
Goat's Beard (*Tragopogon dubius*)
Tumblemustard (*Sisymbrium altimissimum*)
Lambsquarter (*Chenopodium album*)
Russian Thistle (*Salsola kali*)
Corregated-seed Spurge (*Euphorbia glyptosperma*)
White Sweet Clover (*Trifolium repens*)
Yellow Sweet Clover (*Trifolium pratense*)
Wheatgrass (*Agropyron intermedium, cristatum, repens*)
Downy Cheat (*Bromus tectorum*)
Green Bristlegrass (*Setaria viridis*)
Dalmatian Toadflax (*Linaria dalmatica*)*

Table 2. Results of two sample t-test comparing percent cover for inner (10-20) and outer (20-30) quadrats on the West Chewuch Road, Methow Valley,Washington. N= 32, alpha = 0.05. July 1998.

t-Test: Two-Sample Assuming Equal Variances

% Vegetated	*10--20*	*20--30*
Mean	20.5	65.4411765
Standard Deviation.	14.0723577	18.8454921
Variance	198.03125	355.152574
Observations	17	17
Pooled Variance	276.591912	
Hypothesized Mean Difference	0	
df	32	
t Stat	-7.8783299	
P(T<=t) one-tail	2.7301E-09	
t Critical one-tail	1.69388841	
P(T<=t) two-tail	5.4603E-09	
t Critical two-tail	2.03693162	

% Native	*10--20*	*20--30*
Mean	29.7573773	43.3032703
Standard Deviation	21.6382189	26.0866407
Variance	468.212516	680.512822
Observations	17	17
Pooled Variance	574.362669	
Hypothesized Mean Difference	0	
df	32	
t Stat	-1.64787399	
P(T<=t) one-tail	0.05458223	
t Critical one-tail	1.69388841	
P(T<=t) two-tail	0.10916447	
t Critical two-tail	2.03693162	

% Alien	*10--20*	*20--30*
Mean	71.8419788	56.6967297
Standard Deviation	22.4443161	26.0866407
Variance	503.747326	680.512822
Observations	17	17
Pooled Variance	592.130074	
Hypothesized Mean Difference	0	
df	32	
t Stat	1.81458503	
P(T<=t) one-tail	0.03948624	
t Critical one-tail	1.69388841	
P(T<=t) two-tail	0.07897248	
t Critical two-tail	2.03693162	

% Noxious	*10--20*	*20--30*
Mean	28.8923129	24.2967655
Standard Deviation	22.9997677	28.3230196
Variance	528.989314	802.193441
Observations	17	17
Pooled Variance	665.591377	
Hypothesized Mean Difference	0	
df	32	
t Stat	0.51932935	
P(T<=t) one-tail	0.30355238	
t Critical one-tail	1.69388841	
P(T<=t) two-tail	0.60710476	
t Critical two-tail	2.03693162	

% Bare	*10--20*	*20--30*
Mean	39.6176471	9.67647059
Standard Deviation	36.0713396	13.3743472
Variance	1301.14154	178.873162
Observations	17	17
Pooled Variance	740.007353	
Hypothesized Mean Difference	0	
df	32	
t Stat	3.20893046	
P(T<=t) one-tail	0.00151244	
t Critical one-tail	1.69388841	
P(T<=t) two-tail	0.00302488	
t Critical two-tail	2.03693162	

% Rocks	*10—20*	*20—30*
Mean	5.73529412	2.08823529
Standard Deviation	6.29513117	2.41890532
Variance	39.6286765	5.85110294
Observations	17	17
Pooled Variance	22.7398897	
Hypothesized Mean Difference	0	
df	32	
t Stat	2.22975966	
P(T<=t) one-tail	0.01645283	
t Critical one-tail	1.69388841	
P(T<=t) two-tail	0.03290565	
t Critical two-tail	2.03693162	

% Litter	*10--20*	*20--30*
Mean	5.23529412	11.8823529
Standard Deviation	4.71075116	10.2736456
Variance	22.1911765	105.547794
Observations	17	17
Pooled Variance	63.8694853	
Hypothesized Mean Difference	0	
df	32	
t Stat	-2.4248913	
P(T<=t) one-tail	0.01056774	
t Critical one-tail	1.69388841	
P(T<=t) two-tail	0.02113547	
t Critical two-tail	2.03693162	

General Comments

Weeds observed growing on or near the side of the road appeared to be different than weeds growing on adjacent property. Within ten feet of the road, we were likely to find *Salsola kali* (Russian Thistle)*, Setaria viridis* (Green Bristlegrass)*, Euphorbia glyptosperma, Lactuca serriola* (Prickly-leaved lettuce)*,* and *Chenopodium album* (Lamb's Quarters), as well as the occasional clover. From ten to twenty feet from the road edge, we were likely to find *Sisymbrium altimissimum* (Tumble Mustard)*, Verbascum thapsus* (Mullein)*, Centaurea diffusa* (Diffuse Knapweed)*, Linaria dalmatica* (Dalmatian Toadflax) and many species of native and non-native grasses (if the plot had bare ground we found many of the same weeds as along the road's edge). On adjacent property, the vegetation appeared to be less diverse. We often observed large monocultures of non-native grasses*, Centaurea diffusa*, dotted occasionally with native *Purshia tridentata* (Bitterbrush)*.* Further analyses should be done to test the statistical significance of these assumptions.

Statistics

We found a significant difference between the inner and outer quadrats in four areas: percent vegetated, bare, rocks, and litter. (Table 2)

Conclusions

Roadsides in the Methow Valley are generally sprayed every one to two years. The areas nearest to the road (inner quadrats) experience the heaviest application of herbicides, while the areas further from the road (outer quadrats) receive a lighter application. This may be responsible for the differential distribution of vegetation in the inner and outer quadrats. The statistical difference in bare ground also reflects this difference. Another contributing factor is that adjacent provate lands may provide a seed source for the roadside weed communities; as a result the outer quadrats are reseeded more extensively than the inner quadrats.

The differences in rocks may be the result of the large rocks used in the building of the roadbed. The inner quadrats are closer and thus contain more large rocks. Another possible cause is that the dense vegetation of the outer quadrats conceals large rocks just under the surface. The amount of litter in the quadrats is related to the amount of vegetation present, as biomass is produced and released by the plants. As the outer quadrats have more vegetation, it follows that they have more litter than the inner quadrats.

We did not see a difference in percent native, noxious, or alien vegetation, possibly due to the large standard deviation we experienced in most of our statistical analyses. The analyses was somewhat insensitive, thus only picking up very strong differences between the inner and outer quadrats. The standard deviation might be improved with a larger sample size, and by repetition of the study on a yearly basis. We may have erred in our estimates of percent cover, in which case the standard deviation could be improved by better methods. The large standard deviation may also reflect the heterogeneity of the plant communities (weed communities) along the roadsides. Perhaps there is not a significant difference in species composition between the inner and outer quadrats.

The weed counts may also be subject to some bias due to the fact that some weeding occurred along the road previous to the start of the weed survey. This is especially pertinent around segments 8-11, where a large amount of *Linaria dalmatica* and other alien species were pulled.

Implications

Although we cannot say that weeds occupy more area close to the road, we can say that weeds are a problem along this road. The differences in bare ground between the inner and outer quadrats indicate the source of the weed problem along the West Chewuch Road. The adjacent property serves as a seed-source for the roadsides, and the periodic spraying of the right-of-way leaves the ground bare and open for colonization by spray tolerant weeds. If the roadsides are planted with a hardy but non-invasive grass or native plant species, the weeds might be out-competed. Annual rye grass has been used for this purpose at other sites with satisfactory results. The addition of vegetation to the edge of the road might also help reduce flooding and stream load during storm events, as the vegetation would slow down run off. This reduction in overall flow and in flow rate would help to curb erosion of the road and surrounding area.

Hand-pulling, mowing and disking have also been used to control weeds in other places , especially the Knapweeds. Used in combination, these traditional methods control the weed population more effectively than herbicides, with less cost to the ecosystem and inhabitants. In order for these methods to become widespread, the public must be informed of their existence and effectiveness.

To educate the public on the weed problem in the Methow Valley, I would recommend:

- Publicity: publish article in the newspaper about the alternatives to spray
- Publicity: publish article about the hazards and problems involved with spray
- Publicity: publish article about this pilot project
- Publicity: radio ads (free ads on NPR?) discussing the above issues (2 or 3 minute sound byte)
- Education: flyers discussing the above issues, with easy to digest, easy to implement information for the average county resident, make these widely available (feed stores, hardware stores, county weed board, etc.)
- Education: flyers with information regarding the native species endangered and threatened by invasive species, make the citizens of the Methow proud of their native species
- Involvement: volunteer work parties for weed pulling, mowing and replanting of native vegetation
- Get the county involved with the alternative weed campaign, push them to try these methods, if only for a trial period.

Project Direction and Future

We will repeat a portion of this survey in mid-September 1998, to guage the effectiveness of the weed pulling campaign. There will be no further statistical analysis until Summer 1999, when the survey will be repeated. The power of this study lies in its longevity: the yearly repetition of the survey will lead to a large and powerful dataset. After 4 or 5 years of data have been collected, an extensive statistical analysis may be performed.

This project would certainly benefit from the addition of control plots. A comparable road that hasn't been sprayed in the recent past would help control local variation. The control road would need to be of similar elevation, slope, aspect, soil type and climate. It should also be a similar grade of road (two lane, paved, well maintained, etc.) It may be difficult to find a road fitting this description, but cooperation between our research team, the county and the Forest Service may produce acceptable results.

Further statistical analyses may be done comparing the number and percent cover of specific plants in the inner and outer quadrats. Mean number of species in the quadrats may also be analyzed. Differences between the east and west sides of the road could be examined.

This project is an excellent example of how different levels of government and the general public can work together for the common good. The widespread applications involve relations between citizens and government, local, state, and federal weed control, and the study of non-native plants in general.

Appendix A
Plant Lists

Native Plant List for Chewuch Weed Pilot Project

<u>Asteraceae</u>
Achillea millefolium: Common Yarrow

Artemisia tridentata or *ludoviciana*: Big Sagebrush or Prairie Sage

Balsamorhiza sagittata: Arrowleaf Balsamroot

Chaenactis douglasii: Hoary Chaenactis

Conyza canadensis: Horseweed, Canadian Fleabane?

Erigeron filifolius: Threadleaf Fleabane

Iva xanthifolia: Tall Marsh-elder

Matricaria matricarioides: Pineapple Weed

Solidago canadensis: Canada Goldenrod

<u>Beriberidaceae</u>
Berberis aquifolium or *repens*: Tall Oregon Grape or Creeping Oregon Grape

<u>Boraginaceae</u>
Amsinckia spp: Fiddleneck spp

Cryptantha torreyana: Torrey's Crypthantha

Lithospermum ruderale: Western Gromwell, Columbia puccoon

<u>Caprifoliaceae</u>
Symphroricarpos albus

<u>Equisetaceae</u>
Equisetem arvense: Common Horsetail

<u>Fabaceae</u>
Lupinus latifolia

Vicia villosa: Wooly Vetch

<u>Graminae</u>

Agropyron spicatum: Blue-bunch Wheatgrass

Agrostis stolonifera: Fiorin, Creeping Bent, Red Top

Bromus carinatus: California Brome

Calamagrostis canadensis: Blue Joint Weed Grass

Festuca idahoensis: Idaho Fescue

Sporobolus cryptandrus: Sand Dropseed

Stipa comata: Needle-and-Thread
Stipa thurberiana: Thurber's Needlegrass

<u>Hydrophyllaceae</u>
Phacelia hastata: Silverleaf Phacelia
Phacelia linearis: Threadleaf Phacelia

<u>Juncaceae</u>
Juncus ensifolius: Dagger-leaf Rush

<u>Liliaceae</u>
Smilacina stellata: False Solomon's Seal

Loasaceae
Mentzelia dispersa: Bush Mentzelia

Onagraceae
Epilobium angustifolium: Fireweed
Epilobium paniculatum: Autumn Willow-weed

Orchidaceae
Habenaria spp: Bog Orchid

Pinaceae
Pinus ponderosa

Plantaginaceae
Plantago major: Common Plantain

Polemoniaceae
Collomia grandiflora: Large-flowered Collomia

Salicaceae
Populus trichocarpa: Black Cottonwood

Collomia linearis: Narrow-leaf Collomia

Polygonaceae
Eriogonum elatum: Tall Buckwheat
Eriogonum heracloides: Wyeth Buckwheat
Eriogonum niveum: Snow Buckwheat

Polygonum minimum: Dwarf Knotweed
Polygonum douglasii: Douglas' Knotweed

Ranunculaceae
Clematis ligusticifolia: Western Clematis

Rosaceae
Prunus virginiana: Common Chokecherry

Purshia tridentata: Bitterbrush

Non-native Plant List for Chewuch Weed Pilot Project

Amaranthaceae
Amaranthus retroflexus: Red Root Pigweed

Asteraceae
Centaurea diffusa: Diffuse Knapweed

Chrysanthemum leucanthemum: Oxeye Daisy

Cirsium arvense: Canadian Thistle

Conyza canadensis: Horseweed, Canadian Fleabane

Lactuca serriola: Prickly Lettuce

Tragopogon dubius: Goat's Beard

Boraginaceae
Lithospermum arvense: Corn Gromwell

Brassicaceae
Capsella bursa-pastoris: Shepard's Purse

Cardaria draba: White Top, Hoary Pepperwort
Cardaria pubescens: Globepodded Hoarycress

Sisymbrium loeselii: Loesel Tumblemustard
Sisymbrium altissimum: Tumble Mustard

Thlapsi arvense: Field Pennycress

Caryophyllaceae
Lychnis alba: White Campion

Chenopodiaceae
Chenopodium album: Lambsquarter
Chenopodium botrys: Jerusalem Oak

Salsola kali: Russian Thistle, Tumbleweed

Euphorbiaceae
Euphorbia glyptosperma: Corregated-seeded Spurge

Fabaceae
Astralagus miser: Weedy Milkvetch

Medicago sativa: Alfalfa

Melilotus alba: White Sweet-clover
Melilotus officianalis: Yellow Sweet-clover

Trifolium dubium: Yellow Hop Clover
Trifolium repens: White Clover, Dutch Clover
Trifolium pratense: Red Clover

Graminae
Agropyron cristatum: Crested Wheatgrass
Agropyron dasytachyum: Downy Wheatgrass
Agropyron intermedium: Intermediate Wheatgrass
Agropyron repens: Quack Grass

Agrostis stolonifera: Fiorin

Avena fatua: Wild Oats

Bromus inermis: Hungarian Brome, Smooth Brome
Bromus japonicus: Japanese Cheat
Bromus tectorum: Downy Cheat, Cheatgrass

Dactylis glomerata: Orchard Grass

Festuca ovina: Sheep Fescue
Festuca rubra: Red Fescue

Poa bulbosa: Bulbous Bluegrass
Poa pratensis: Kentucky Bluegrass

Secale cereale: Cereal Rye

Setaria viridis: Green Bristlegrass

Malvaceae
Malva neglecta: Dwarf Mallow

Plantaginaceae
Plantago lanceolata: Lance Leaf Plantain

Polygonaceae
Polygonum convolvulus: Knot Bindweed

Ranunculaceae
Ranunculus repens: Creeping Buttercup

Scrophulariaceae
Linaria dalmatica: Dalmatian Toadflax

Verbascum thapsus: Common Mullein

Solanaceae
Solanum dulcamara: Climbing Nightshade

Appendix B
Study Forms

The current state of the roadway will be determined using Form A - Roadway Condition, Form B - Presence/Absence of Selected Weeds, Form C - Survey of All Weeds along Road and Form D - Detailed Quadrat

Form A - Roadway Condition
This data will be include the condition of the road and shoulder and the type of vegetation beside the road for rectangles 10 feet wide and extending a distance 30 feet from the centerline of the road. The rectangles will be located every 1/4 mile along the 5 mile length of the road.

Form B - Presence/Absence of Selected Weeds
This form will be used to record high or low presence or absence of toadflax, knapweed and mullen in the road easement and adjacent property along the entire 5 mile length of road. One page of this form will be used for each of the 3 weeds and the locations will be indicated as distances from the start of the road where the weed is present or absent.

Form C - Survey of All Weeds along Road
This survey will identify all noxious weeds present along the 5 mile length of road.

Form D - Detailed Quadrat
This form will quantify the vegetation in the Roadway Condition rectangles. All vegetation will be surveyed for percent cover and frequency of occurrence. Vegetation on adjacent private property will be noted. Not all Roadway Condition rectangles will be detailed in Quadrant Forms. Number to be determined by time constraints

Form A - Roadway Condition

This form is to be taken every quarter mile along roadway to give a general measure of the condition. This data will be include the condition of the road and shoulder and the type of vegetation beside the road for rectangles 10 feet wide and extending a distance 30 feet from the centerline of the road.

Date________________________

Survey Person________________

Road Segment________________Measured from Start of West Chewuch Road at Highway 20

	East Side	West Side	
Asphalt Condition	___________	__________	1-unbroken, 2-broken, 3-severely broken
Road Shoulder	___________	__________	1-uneroded, 2-broken, 3-severely broken
General cover 10-20 feet frrm cntrline	___________	__________	1-bare ground, 2-weedy, 3-grass 4-native vegetation
Primary Veg	___________	__________	
Weeds	___________	__________	
General cover 20-30 feet from cntrline	___________	__________	1-bare ground, 2-weedy, 3-grass 4-native vegetation
Primary Veg	___________	__________	
Weeds	___________	__________	
Vegetation on Adjacent Property		1-bare ground, 2-weedy, 3-grass	
Primary Veg	___________	__________	
Weeds	___________	__________	

Comments and follow-up
activities____

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____

Form B - Presence/Absence of Selected Weeds

This form is to be taken along roadway to give a general measure of the percent cover or absence of selected weeds. Use the code 1 - High (100-10%), 2 - Medium (10 - 1%), 3 - Low (1-0%), 4 - Absent

Date_________________________

Survey Person_________________

Weed ________________________

Road Segment Start	Stop	East Side	West Side
________	________	____________________	_______________________
________	________	____________________	_______________________
________	________	____________________	_______________________
________	________	____________________	_______________________
________	________	____________________	_______________________
________	________	____________________	_______________________
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________	________	____________________	_______________________
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________	________	____________________	_______________________
________	________	____________________	_______________________

Form - C Survey for Weeds

Date________________________

Survey Person________________

The following list of weeds were identified along the Project roadway

Weed Name	Location if weed is of very low occurrence

Form D **Vegetation Quadrat**

The following vegetation quadrat was made to quantitatively record vegetation at the same locations as the Road Condition Survey along the roadway. A pair of flags is placed at the outside edge of the easement on each side of the quadrat and lines one foot long are marked on the asphalt. at the sides of the quadrat.. The quadrat is to be 10 feet wide and will extend from the edge of the asphalt a nominal 10 feet from centerline to a distance of 30 feet. The 20 foot distance will be broken into two parts, each 10 feet long. Within each section the spp code will be recorded with the % cover and frequency of occurrence.

Date________________________

Survey Person________________

Location of Quadrat____
East ______________ West_____________ (check one)

First Part - 10 - 20 feet from centerline			Second Part 20 - 30 feet from centerline		
ssp Code	% Cover	Frequency	ssp Code	% Cover	Frequency
_________	__________	__________	_________	__________	__________
_________	__________	__________	_________	__________	__________
_________	__________	__________	_________	__________	__________
_________	__________	__________	_________	__________	__________
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