EFFECT OF HERBICIDE MAINTENANCE OF AN ELECTRIC TRANSMISSION LINE RIGHT-OF-WAY ON BUTTERFLY POPULATIONS

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Abstract. A study was carried out in 1997 of the butterfly populations on the right-of-way of a 230-kV transmission line of GPU Energy in the Allegheny Mountain Physiographic Province of central Pennsylvania. The objective was to determine if herbicide spray maintenance had produced an adverse impact on butterfly populations. Butterfly counts were made at 7 points in time during the growing season to coincide with flowering of important plant species. On the handcut control unit, there was a total of 14 butterfly species and 58 individuals present over the growing season. In contrast to this, there was a total of 20 butterfly species present on the high-volume basal spray unit, 19 species on the mowing plus herbicide spray unit MH-1, and 22 species on the mowing plus herbicide spray unit MH-3. The number of individual butterflies ranged from 172 to 186 on the 2 mowing plus herbicide spray units to 342 on the high-volume basal spray unit. These results indicate that herbicide spray maintenance had not produced an adverse effect on butterfly species and number of individuals compared to handcutting without herbicides.

Key Words. Butterfly population; ecosystem; right-of-way; tree control; biodiversity; target trees; herbicide sprays.

Butterfly populations are important components of the ecosystem of transmission line rights-of-way (ROWs) in that they pollinate flowers, provide food for wildlife, and add to natural beauty of the area.

In response to interest of the general public and several environmental organizations, studies were made of possible adverse effects of herbicide spray maintenance on butterfly populations of 2 electric transmission ROWs. The first study, made in 1995, was located in the Piedmont region of eastern Pennsylvania (Bramble et al. 1997). A second study, made in 1997, was located in the Allegheny Mountain region of central Pennsylvania, and is reported in this paper.

BACKGROUND

An extensive study of use of flowering plants by butterflies and skippers in forested and agricultural landscapes in central Pennsylvania was carried out from 1994 to 1996 (Yahner 1998). This study indicated that wildflower richness and abundance in herbaceous openings and wooded edges of forest areas were highly important to butterfly conservation and should be given special protection.

A study of butterfly populations of an electric utility ROW was carried out in 1995 and 1996 in the Piedmont region of Pennsylvania (Bramble et al. 1997). No discernible adverse effect of herbicide sprays on butterfly species and their abundance was found.

Occurrence of endangered species of butterflies on ROWs has been given special emphasis in recent years (Andow et al. 1994; Bidwell 1995). Consequently, a long-term study was initiated in 1994 of the rare Karner blue and its relationship with blue lupine on ROWs in the Pine Barrens of New York (Leopold and Smallidge 1994).

An increased interest by public utilities in butterflies on ROWs was indicated by a report in *UAA* (Utility Arborist Association) *Quarterly* (UAA 1997) that the group Butterfly Lovers International had been made a partner in the Project Habitat® Wildlife Enhancement Program formed to promote development of desirable wildlife habitat on utility ROWs.

CONTROL OF TARGET TREES

ROW Treatment Units

Four treatment units that represented typical cover types present on the ROW in 1997 were selected for the butterfly study (Table 1). These included 1) a handcutting unit (HC-1) with a tree-shrub cover type on both wire and border zones, 2) a high-volume basal spray unit (BHV-1) with a shrub-forb

cover type on both wire and border zones, 3) mowing plus herbicide unit Rep 1 (MH-1) with a grass-forb cover type on the wire zone and a shrub-forb cover type on border zones, and 4) mowing plus herbicide unit Rep 3 (MH-3) with a forb-grass cover type on the wire zone and a shrub-forb cover type on border zones. The dominant species of each cover type are shown in Table 1.

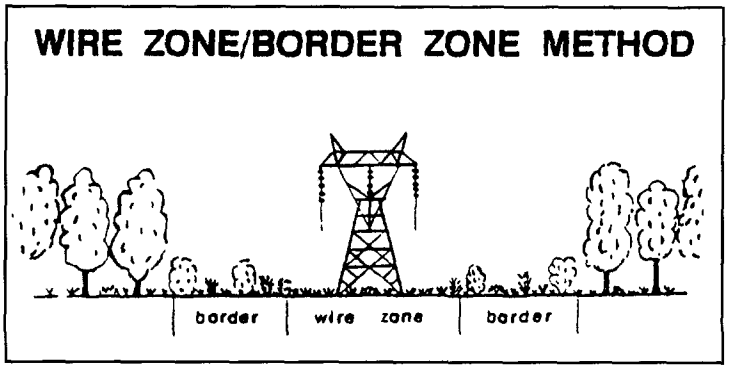

Figure 1. Diagram of a 230-kV line and ROW showing wire and border zones. A low shrub-forb-grass cover type is shown on the wire zone; a tall shrub-forb cover type is on the border zones.

ROW Treatments

Because the wire zone–border zone method was used for all ROW treatments (Figure 1), descriptions of treatments were divided into wire and border zones. All herbicides used are commercially available.

Wire zone treatments (1987). Woody vegetation in the wire zone of the handcutting unit was clearcut to a height of 4 in. (10 cm) in 1987 and 1993. On the mowing plus herbicide spray units (MH-1 and MH-3), the wire zone was mowed and a herbicide spray applied immediately to the cut stubble in 1987. The spray mix consisted of Tordon K (0.75 gal [2.8 L]) plus Garlon 4 (0.75 gal.) in water to make 100 gal (379 L) of mix. A blue dye, (Bullseye 0.21 gal [0.8 L]) was added to identify coverage. All trees and shrubs were sprayed on the high-volume basal spray unit in 1987 with a mix of Access (91.5%) in fuel oil (98.5%). The lower 18 in. (46 cm) of stems were sprayed on all sides to the point of runoff.

Table 1. Target tree control and cover type present on ROW treatment units in June 1997. Herbicide treatments were applied in 1987 and 1996; handcutting in 1987 and 1993.

	Trees per acre over 1 ft. ht.		Plant cover type and dominant species	
Treatment unit	Wire zone	Border zone	Wire zone	Border zone
Herbicide				
Mowing plus herbicide unit MH-1	0	150	**Grass-forb** Fescue Goldenrod	**Shrub-forb** Blackberry Witchhazel Blueberry Hayscented fern
Mowing plus herbicide unit MH-3	100	150	**Forb-grass** Goldenrod Hayscented fern Poverty grass	**Shrub-forb** Witchhazel Goldenrod Hayscented fern
High-volume basal spray unit BHV-1	150	200	**Shrub-forb** Blackberry Goldenrod Hayscented fern	**Shrub-forb** Bear oak Witchhazel Goldenrod Hayscented fern
Mechanical				
Handcutting unit HC-1	4450	5360	**Tree-shrub** Oak, red maple Dewberry Blueberry	**Tree-shrub** Oak, red maple Bear oak Blueberry

Border zone treatments (1987). Border zones on the handcut unit were selectively cut to remove only tall-growing trees species in 1987 and 1993. On the high-volume basal spray unit, the same basal spray used on the wire zone was applied to tall-growing tree species in 1987. The border zones of the mowing plus herbicide spray units were given a low-volume basal spray in 1987 using Weedone CB undiluted, applied to tall-growing tree species.

ROW Treatments (1996). A low-volume basal spray treatment was applied to both wire and border zones of the 2 mowing plus herbicide spray units in August 1996. At that time, a

sparse tree cover was present on those units (Table 1). The spray consisted of Access (Picloram plus Garlon herbicides) (20%) in basal oil (80%). A high volume basal spray was used on the high-volume basal unit to retain its integrity. The spray mix consisted of Access (1.5%) in kerosene (98.5%). All trees and tall shrub species were sprayed on the wire zone; only tall-growing trees were sprayed on the border zones.

ROW tree control (1997). Excellent tree control by the herbicide treatments met the basic requirements for a valid comparison of the effect of herbicide maintenance on ROW butterfly populations, i.e., herbicides had been thoroughly applied on the ROWs.

Figure 2. Mowing plus herbicide spray unit MH-3, June 2, 1998. A forb-grass cover type was being invaded by sweet fern. A shrub-forb type occupied the border zones.

The mowing plus herbicide treatments and the high-volume basal spray treatment reduced tree density in 1997 to 200 trees per acre, or less, on both the wire and border zones (Table 1). In contrast, clearcutting of the handcutting unit resulted in a tree density of 4,450 trees per acre on the wire zone and 5,360 trees per acre on border zones, which is typical of handcutting.

Cover Type Development

Development of plant cover types with a highly diverse plant species composition, typical of herbicide maintenance, played an important role in determining the abundance and diversity of butterfly populations on the various treatment units. For example, the mowing plus herbicide spray unit MH-3 wire zone was dominated by a dense forb-grass cover type composed of goldenrod, hayscented fern, and poverty grass (Figure 2). In contrast, the wire and border zones of the handcut unit were covered with a tree-shrub cover type dominated by dense tree saplings. Herbaceous plants were flowering only in a few small openings (Figure 3).

EFFECT OF ROW MAINTENANCE ON BUTTERFLY POPULATIONS

The effect of ROW maintenance with herbicides to control target trees on the ROW butterfly population was studied on 3 ROW treatment units for comparison with the effect on a handcutting treatment unit. These treatments are described in the section on target tree control.

Butterfly Census Procedure

Butterfly census counts were made at 7 points in time over the growing season, distributed so as to cover important plant flowering periods. Each census included a handcut unit 1.25 ha (3.1 ac) and 3 herbicide spray units were each 0.81 to 1.01 ha (2 to 2.5 ac).

Each census was taken after 9 A.M. on warm sunny days with no wind. Particular care was taken to avoid duplicate counts of butterflies. A total of 45 minutes was spent on each treatment unit and consisted of a 15-minute stop in each of 3 equal divisions of the unit. The census counts taken in the adjoining forest consisted of 15-minute periods taken at about 150 ft (45 m) from the forest edge. Location on the unit, activity, and plant species used were recorded for each butterfly counted.

Effect of ROW Maintenance on Butterfly Species Diversity and Abundance

Two major characteristics of ROW butterfly populations were used to measure the effects of ROW treatments, namely, species diversity (number of species

Figure 3. Handcutting unit HC-1, August 1, 1995. A tree-shrub cover type was on the wire zone. A patch of goldenrod and hay-scented fern occupied a small opening.

per unit) and species abundance (number of individuals per acre in each unit). Data were collected from 7 census counts distributed over the 1997 growing season to cover major flowering periods.

Effect on Butterfly Species Diversity

A total of 29 butterfly species were counted on the 4 ROW treatment units combined (Table 2*). This was similar to the 27 species found in woodland edges in central Pennsylvania (Yahner 1998), and to the 32 species counted on an electric utility transmission line in eastern Pennsylvania (Bramble et al. 1997).

The number of butterfly species present on specific treatment units for the 7 census counts ranged from a low of 21 species on the handcutting unit to 63 species on the high-volume basal unit (Table 3). Butterfly species abundance on the 2 mowing plus herbicide spray units was 41 and 48, respectively.

Effect on Butterfly Abundance

A total of 758 individual butterflies was counted on the entire research segment of the ROWs by the 7 censuses combined (Table 2). The lowest number was counted on the handcutting unit (18.8 per acre), and the highest number on the high-volume basal spray unit (121.1 per acre) (Table 3). On the 2 mowing plus herbicide spray units, 78.8 butterflies per acre were counted on MH-1 and 94.5 butterflies per acre on MH-3.

The number of butterflies varied considerably among the 7 census counts (Table 3). The highest number was counted in June and July (Census 2 and 3), and the lowest in late May and early June (Census 1). An important increase in butterfly abundance took place in September on the herbicide spray units (Table 3). At that time, goldenrods were in full flower and were frequently used by the migrating monarch butterfly. This was in sharp contrast to the sparseness of goldenrods on the handcut unit and absence of butterflies.

When tested by the Mann-Whitney U test, the number of individual butterflies per acre on both the basal spray unit and the mowing plus herbicide units were significantly greater than on the handcut unit. Thus, it was apparent that use of herbicides for ROW maintenance did not adversely affect abundance of individual butterflies.

OCCURRENCE OF FLOWERING PLANT SPECIES USED BY BUTTERFLIES ON ROW TREATMENT UNITS

Occurrence of flowering plant species used by butterflies at various points over the growing season on herbicide sprayed and handcut treatment units was a highly important factor in evaluation of the effect of treatments on butterfly populations (Tables 4 and 5).

For example, a total of 40 flowering plant species and 21 butterfly species were counted on the handcut unit in 1997 (Table 4). In contrast, 63 butterfly species and 139 plant species were counted on the basal spray unit. On the 2 mowing plus herbicide units in 1997, a total of 41 and 48 butterfly species and 55 and 96 flowering plant species were counted. Consequently, it was clearly evident that herbicide sprays had not adversely affected butterfly species richness.

*Tables 2 through 5 begin on page 308.

An important sequence in the occurrence of flowering plant species over the growing season took place that affected butterfly species abundance (Table 5). In late May and early June, an abundant flowering of blueberry and blackberry on the basal spray unit was accompanied by a high butterfly count that exceeded the counts on the other 3 units (Table 5). Mountain laurel also flowered in abundance on the basal spray unit and was heavily used by butterflies in early July.

In late July and early August, flowering of spotted knapweed, Indian hemp, and spreading dogbane on the herbicide spray units was accompanied by high butterfly counts. Narrowleaf spirea in flower was heavily used on the mowing plus herbicide units. This was in contrast with the lower butterfly counts in July on the handcut unit from which these plant species were absent.

In late August, flowering of a number of herbaceous species and spirea on the herbicide spray units was accompanied by high butterfly species counts (Table 5). Butterfly species were absent on the handcut unit on which these plant species were absent.

Goldenrods were of special importance on the ROWs in September when they were dominant species on the herbicide spray units (Table 5 and Figure 4). At that time, butterfly species, including the migrating monarchs, were relatively abundant on the herbicide spray units. However, butterflies were notably absent on the handcut unit where goldenrods were sparsely present in small openings of a dense tree thicket.

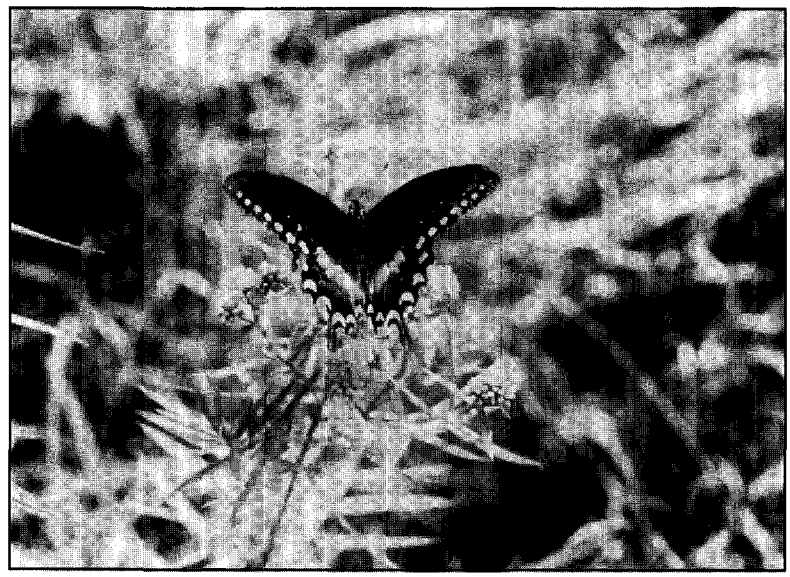

Figure 4. A spicebush swallowtail on narrowleaf goldenrod on a mowing plus herbicide spray unit, September 3, 1996. This butterfly species was present on the ROWs at all of the 7 census dates in 1997.

CONCLUSIONS

Use of herbicides to control tall-growing tree species on an electric transmission line right-of-way, located in the Allegheny Mountain Physiographic Region in central Pennsylvania, did not adversely affect butterfly species diversity and abundance in comparison with handcutting without herbicides. These conclusions confirmed earlier results from similar research in the Piedmont Physiographic Region in eastern Pennsylvania. The wire zone–border zone method that was used for all treatments on both ROWs over a period of 10 years produced a diverse vegetation on the herbicide-sprayed units composed of forbs and grasses on the wire zone and desirable shrubs on border zones. Under those conditions, diverse and abundant butterfly populations developed

LITERATURE CITED

Andow, D.A., R.J. Baker, and C.P. Lane. 1994. Karner blue butterfly: A symbol of a vanishing landscape. Minn. Agric. Exp. Sta. Misc. Pub. 84. 232 pp.

Bidwell, A.D. 1995. Karner blue butterfly dispersal and habitat disturbance at Fort McCoy. Mil. Res. Wis. M.S. Thesis, Univ. Wisc. Stevens Point. 124 pp.

Bramble, W.C., R.H. Yahner, and W.R. Byrnes. 1997. Effect of herbicides on butterfly populations of an electric transmission right-of-way. J. Arboric. 23:196–206.

Leopold, D.J., and P.J. Smallidge. 1994. Transmission lines and biodiversity. Esf Quarterly, State Univ. NY. p. 9.

Utility Arborist Association (UAA). 1997. Butterfly Lovers International becomes Project Habitat partner. UAA Q. Spring:12–13.

Yahner, R.H. 1998. Butterfly and skipper use of nectar sources in forested and agricultural landscapes of Pennsylvania. J. Penn. Acad. Sci. 71:104–108.

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Résumé. Une comparaison en regard des papillons présents a été faite entre trois sections vaporisées avec de l'herbicide et une autre coupée manuellement d'une emprise de ligne électrique de transport dans le centre de la Pennsylvanie. Le décompte des papillons a été mené à sept points en même temps au cours de la période végétative qui coïncidait avec la floraison des espèces de plantes les plus fréquentées par les papillons. À la fois le nombre d'espèces ainsi que le nombre total d'individus étaient plus élevés dans les sections traitées à l'herbicide que celle traitée par une coupe manuelle.

Zusammenfassung. An einer elektrischen Überlandleitug in Zentral-Pennsylvania wurde ein Vergleich an Schmetterlingen auf drei herbizidkontrollierten und einem handgeschnittenen Kontrollstreifen durchgeführt. An 7 tellen wurden die Schmetterlinge während der Wachstumsperiode, die zufällig auch mit der Hauptblütezeit der bevorzugten Arten übereinstimmte, gezählt. Sowohl die Anzahl der Schmetterlingsarten als auch die totale Individuenzahl war auf den herbizidkontrollierten Einheiten größer als auf den handgeschnittenen ohne Herbizideinsatz.

Resumen. Se realizó una comparación acerca de las mariposas, en el derecho de vía de una central de transmisión eléctrica en Pennsylvania, usando aspersión de herbicidas en tres sitios contra uno de control manual. La contabilidad de mariposas fue hecha en 7 puntos durante la estación de crecimiento, que coincidieron con la floración de las especies de plantas más importantes utilizadas por las mariposas. Tanto el número de especies de mariposas como el número total de individuos fueron más altos en los tres sitios de aspersión de herbicidas que en los de control manual sin herbicidas.

Table 2. Number of butterfly individuals and species counted on treatment units in 1997. Data are totals of 7 census counts taken over the growing season.

	Treatment				
Species	Handcutting	High-volume basal	Mowing plus herbicide Rep 1	Mowing plus herbicide Rep 3	Total
Common species (15)					
European skipper (*Thymelicus lineola*)	11	110	38	38	197
Aphrodite fritillary (*Speyeria aphrodite*)	1	19	11	45	76
Little wood satyr (*Megisto cymela*)	1	24	24	19	68
Hobomok skipper (*Poanes hobomok*)	7	31	27	2	67
Monarch (*Danaus plexippus*)	0	17	8	31	56
Orange sulphur (*Colias eurytheme*)	1	21	15	15	52
Juvenal's duskywing (*Erynnis Juvenalis*	21	13	8	4	46
Silver-spotted skipper (*Epargyreus clarus*)	3	23	1	7	34
Spicebush swallowtail (*Papilio troilus*)	1	19	6	6	32
Eastern tiger swallowtail (*Papilio glaucus*)	3	11	4	3	21
Cabbage white (*Pieris rapae*)	2	9	4	3	18
Horace's duskywing (*Erynnis horatius*)	0	9	4	2	15
Common wood nymph (*Cercyonis pegala*)	2	0	8	3	13
Pearl crescent (*Phyciodes tharos*)	0	9	1	1	11
Common sootywing (*Pholisora catullus*)	2	7	1	0	10
Number of common individuals	***55***	***322***	***160***	***179***	***716***
Number of common species	***12***	***14***	***15***	***14***	***15***
Infrequent species (14)					
Sleepy duskywing (*Erynnis brizo*)	2	4	3	0	9
Indian skipper (*Hesperia sassacus*)	0	1	6	0	7
Eastern tailed blue (*Everes comyntas*)	0	4	1	1	6
Peck's skipper (*Polites coras*)	0	4	0	0	4
Northern brokendash (*Wallengrenia egeremet*)	0	3	0	1	4
Spring azure (*Celastrina ladon*)	0	1	1	0	2
Banded hairstreak (*Satyrium calanus*)	1	0	0	1	2
Morning cloak (*Nymphalis antiopa*)	0	1	0	1	2
Coral cairstreak (*Harkenclenus titus*)	0	0	0	1	1
Great spangled fritillary (*Euptoieta claudia*)	0	0	0	1	1
Northern pearly-eye (*Enodia anthedon*)	0	1	0	0	1
Redspotted purple (*Limenitis arthemis*)	0	0	0	1	1
Red admiral (*Vanessa atalanta*)	0	1	0	0	1
Meadow fritillary (*Boloria bellona*)	0	0	1	0	1
Number of infrequent individuals	***3***	***20***	***12***	***7***	***42***
Number of infrequent species	***2***	***9***	***5***	***7***	***14***
Total number of individuals	***58***	***342***	***172***	***186***	***758***
Total number of species	***14***	***23***	***20***	***21***	***29***

Table 3. Total number of butterfly species and individuals per acre counted on 4 treatment units at 7 censuses in 1997.

		Handcutting (3.1 ac)		High-volume basal (2.8 ac)		Mowing plus herbicide Rep 1 (2.2 ac)		Mowing plus herbicide Rep 3 (2.0 ac)	
Census #	Census dates	# species counted	# per ac	# species counted	# per ac	# species counted	# per ac	# species counted	# per ac
1	5/31 & 6/5	3	5.2	6	5.7	4	3.6	3	3.5
2	6/19 & 6/20	5	5.8	13	30.0	11	33.2	6	15.0
3	7/5 & 7/9	6	5.5	10	46.8	6	20.0	9	25.5
4	7/21 & 7/26	6	2.3	10	15.7	5	6.4	7	11.5
5	8/7 & 8/9	6	2.3	10	15.7	5	6.4	7	11.5
6	8/24 & 8/26	0	0	8	7.5	5	4.6	7	9.5
7	9/12 & 9/14	0	0	7	9.3	4	6.4	8	15.5
Total # species present		**21**	**18.8**	**63**	**121.1**	**41**	**78.8**	**48**	**94.5**
#/census		**3.0**		**9.0**		**5.9**		**6.9**	

Table 4. Number of plant species flowering on treatment units at 7 censuses in 1997; and their use by butterflies.

		Number of flowering plant and butterfly species on treatment units							
		Handcutting unit		High-volume basal unit		Mowing plus herbicide unit MH-1		Mowing plus herbicide unit MH-3	
		# species		# species		# species		# species	
Census #	Census dates	Plants	Butterflies	Plants	Butterflies	Plants	Butterflies	Plants	Butterflies
1	5/31 & 6/6	11	4	17	6	8	4	14	3
2	6/19 & 6/20	12	5	26	13	13	11	14	6
3	7/6 & 7/7	7	6	25	10	8	6	11	9
4	7/21 & 7/26	3	0	19	9	8	6	16	8
5	8/17 & 8/19	1	6	14	10	4	5	13	7
6	8/24 & 8/26	2	0	20	8	7	5	15	7
7	9/12 & 9/14	4	0	18	7	7	4	13	8
Total, 7 censuses		**40**	**21**	**139**	**63**	**55**	**41**	**96**	**48**
#/census		**5.7**	**3.0**	**19.9**	**9.0**	**7.9**	**5.9**	**13.7**	**6.9**

Table 5. Number of butterfly species observed using plants flowering on treatment units during each of 7 censuses in 1997 (X = sparse, C = common, A = abundant).

			Treatment				
			Handcut	High-volume basal	Rep 1	Rep 3	Total butterfly species
No.	Dates	Flowering plant species	Number of butterfly species				
1	5/31 & 6/5		4	6	4	3	6
		Blueberry	X	A	X	X	
2	6/19 & 6/20		5	13	11	6	13
		Blackberry	X	A	A	X	
		Blueberry	X	X	X	X	
3	7/5 & 7/7		6	10	6	9	11
		Mountain laurel	X	A			
		Dewberry	X	C	C		
		Oxeye daisy		X	X	X	
		Milkweed				X	
		Daisy fleabane				X	
		Crown vetch		X	X	X	
4	7/21 & 7/26		0	9	6	8	13
		Spotted knapweed		X			
		Spreading dogbane			X	C	
		Crown vetch		X	X	A	
5	8/7 & 8/9		6	10	5	7	13
		Spotted knapweed		X		A	
		Spreading dogbane		X	X	X	
		Indian hemp		C		X	
		Crown vetch		X	X		
		Teasel	X	X		X	
		Narrowleaf spirea			X	X	
6	8/24 & 8/26		0	8	5	7	12
		Spotted knapweed		C			
		Crown vetch	X	C			
		Teasel		X			
		Narrowleaf spirea			X	X	
		Indian hemp				C	
		Joe Pyeweed				X	
		Thistle		X		X	
		Narrowleaf goldenrod	X	A		C	
		Rough goldenrod		X		X	
7	9/12 & 9/14		0	7	4	8	8
		Rough goldenrod	X	A	A	A	
		Narrowleaf goldenrod	X	A	A	A	
		Narrowleaf spirea				X	
		Thistle		X	X	X	
		Spotted knapweed		C			
		Crown vetch		A	X		
		Daisy fleabane		C	X		
		Joe Pyeweed				X	
		Oxeye daisy		X		X	
		Queen Anne's lace		A		X	