Forest Health Protection

Report 03-7 March 2003

EVALUATING RELEASE SITES OF *CYPHOCLEONUS ACHATES* AS POTENTIAL INSECTARIES IN MONTANA AND IDAHO

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Introduction

Cyphocleonus achates (Fahraeus) is currently the most promising introduced biological control agent of spotted knapweed, *Centaurea maculosa*. This large root-feeding weevil mines the center of the knapweed taproot often stunting growth and can even cause plant mortality (Corn et al. 2003). Hundreds of releases, consisting of 50 to 200 weevils, have been introduced across most of the knapweed range in Montana and in surrounding states. The Western Montana Agricultural Center has produced most of the weevils for these releases. There, the weevils are reared in corrals made from aluminum flashing. Large knapweed plants are transplanted into the corrals and weevils are introduced. The knapweed is widely spaced, clipped and irrigated to favor the growth and production of both the knapweed and weevils (Story et al. 1996).

The objectives of this project were to identify sites where weevils had been previously released that could be used to make future collections of weevils for redistribution and to evaluate the use of field corrals for collecting weevils. This project was funded through the National Fire Program. Weevils will be collected from insectary sites in future years and redistributed to sites that were burned and have mature knapweed plants or into other high priority areas identified by county or forest weed cooperators. We also verified the establishment of *C. achates*, collected information on site characteristics that might influence establishment, and impact data at most of the sites. The site information and impact data will be summarized in a later report.

Methods

In April and May of 2002, county and USDA Forest Service (Forest Service) weed specialists were contacted regarding *C. achates* releases within their counties or forests. Initially, 97 sites were evaluated for potential as field insectaries based on the following characteristics developed in 2001: 1) knapweed infestation > 3 acres or knapweed infestation with large plants, 2) good access, and 3) free from major disturbances (Sturdevant and Dewey 2002). Seventy-one of the 97 sites met the above criteria and were further evaluated for weevil establishment.

Each site was visited between May and July. At each site 20 of the largest rooted plants within approximately 50 feet of the original release point were excavated, examined, and number of larvae found were recorded. Adult weevils were sampled between August 5 and September 6 by sweeping with an insect net over 300 m of knapweed surrounding the original release point. Global Position System coordinates were recorded to ensure accuracy in relocating releases in subsequent years.

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During June, weevil corrals, similar to those at the Western Agricultural Research station, were constructed at six different locations, five in Montana and one in Idaho. However, we did not transplant, clip or irrigate plants; instead only existing field knapweed populations were used. Therefore, we do not expect to produce as high numbers of weevils as the Western Agricultural Research Center. At each of three of the six locations, two corrals were built measuring either 10 x 10 m or 25 x 25 m (fig. 1). Ten female-male pairs of weevils were introduced into one corral to augment the existing population. At the remaining three locations, only one corral was built. Mesh netting was placed over the tops of corrals to prevent bird predation. Between July 30 and August 28, weevils were sampled by searching within the corrals. Often, weevils were found congregated on the flashing inside corrals (fig. 2). To compare the efficacy of collecting in corrals with other methods, we also swept the knapweed surrounding the insectaries for adults. This comparison will be more meaningful when repeated in 2003 once weevils have had a chance to reproduce inside the corrals.

Figure 1. Weevil corral located in Lewis & Clark County.

Figure 2. Weevils often gather on metal flashing of corral making collection easy.

Results

Forty eight of the 97 releases were made by weed specialists from 12 counties. Forest Service weed specialists made the remaining 49 releases from 3 National Forests. Table 1 lists 26 sites that were not suitable for sampling either the weevil or knapweed populations because the size of the knapweed infestation was too small, plants were too scattered or the plants themselves were too small for colonization by *C. achates*. Only initials are used to represent site names to protect the location and integrity of the release. These sites were initially considered to have a knapweed infestation sufficient to justify introducing *C. achates* and in some case other biological control agents as well. Many of these infestations have become reduced in size, or no longer exist due to herbicide spraying, or possibly the effects of the biological control agents. Intensive livestock grazing excluded other sites from the survey.

Table 2 lists 47 sites that were suitable for weevil establishment but did not meet all of the criteria for a field insectary. *C. achates* larvae and adults were sampled at these sites to give land managers information on weevil establishment (Table 2).

Table 3 displays *C. achates* population data from 19 sites that have potential as field insectaries. The potential field insectary sites are located in nine counties and on one National Forest. The percent of roots infested with *C. achates* across sites ranged between 0% and 95% (mean. 45%). Number of adults found per minute of sweeping ranged between 0 and 2.5. It typically took about 10 minutes to sweep 300 meters of knapweed.

This survey also found that at many sites *C. achates* became established after only 1 year following the release. Also, there were many releases of only 50 weevils that became successfully established. This is probably in part due to site characteristics and weather conditions at the time of release and following the release.

Table 1. Sites Unsuitable for Sampling *C. achates* or for Use as Field Insectaries

COUNTY/FOREST	SITE (Initials Used)
Beaverhead County	C.C.
Glacier County	AMS R.
	S.B.
Granite County	A.N.R.
	I.R.
Lewis & Clark County	F. #1
	F. #2
	W.C./O. B. R.
Madison County	V.C.
Powell County	McQ. P.
Sanders County	B.P.
	McG. P.
Silver Bow County	S.P.
Stillwater County	F.P.
Bitterroot National Forest	L.C.#1
	L.C.#2
	S.#6
	S.#7
	S.#28
	S.#13
Kootenai National Forest	R.C.
Lolo National Forest	B.C.C.
	McC.F.
	M.
	M.C.
	S.L.#5

Table 2. Sites Suitable for Weevil Establishment but not Suitable for an Insectary.

County/Forest	Site	Release Date(s)	Number Released	No. Larvae /20 plants	No. Adults /300 m swept
Broadwater Co.	S.C.	1999	100	12	4
	Y.I.	1998/99	100/100	13	1
Beaverhead Co.	B.H.	2001	250	12	0
Cascade Co.	A.R.(Ulm)	1998	100	0	0
	H.P.	1999	75	0	0
Glacier Co.	O.A.	1995	100	0	0
Granite Co.	B.R.	1999	100	2	0
Lake Co.	W.of P.	1993	100	0	3
Mineral Co.	D.C.E.	1999	50	0	0
	R.O.	1997	100	0	0
Powell Co.	D.A.#2	1995	100	0	0
	D.A.#3	1995	75	4	0
	H.C.	2001	200	0	0
Sanders Co.	R.G.	1999	50	8	3
	R.P.	1999	100	3	3
Silver Bow Co.	H.S.	1999	150	0	0
	1-90	1995	100	0	0
	R.R.	1995	100	17	5
Stillwater Co.	Park	1995	50	3	1
	P.C.	1995	50	0	0
	Y.D.	1997	100	2	0
Bitterroot NF	B.H.R#16	1999	100	0	0
	B.H.R.#23	1999	100	0	0
	B.G.	1999	100	3	0
	G.D.	1999	100	0	0
	S.G.R.#1	2001	100	8	2
	S.G.R.#20	1999	100	5	0
	S.G.R.#21	1999	100	8	3
	T.C.#10	2000	50	0	0
	T.C.#10A	2000	50	2	0
	T.C.#11	2000	50	2	0
Kootenai NF	E.C.	1995-96	300	3	0
	P.C.	1995	100	0	0
	W.P.C.#1	1999	50	9	9
	W.P.C.#2	1999	50	0	0
	W.P.C.#3	1999	50	0	0
	W.P.C.#4	1999	50	0	0
	C.C.	1997	75	4	2
	S.C.	1997	75	14	3
	2.6.M.L.R.	1999	100	7	0
	K.C.	1999	100	3	2
	S.T.M.Y	1997	50	4	0
Lolo NF	P.C.	1999	200	2	0
	F.G.	1998	150	3	0
	K.C.	1999	200	1	0
	S.L.#1	1999	50	0	0
	S.F.L.J.C.	1999	200	0	0

Table 3. Sites Considered as Potential Field Insectaries for Collections of *C. achates*.

County/Forest	Site	Release Dates	Total Number Released	#Larvae/ 20 Plants	#Adults/300 m swept
Broadwater Co.	W.	1999	100	16	14
Cascade Co.	S.C.	1994-98	500	17	8
Glacier Co.	L.P.	1995	100	18	15
L&C Co.	S.C.M.	1996	100	16	18
Mineral Co.	C.C.	1999-2000	150	12	15
	S.A.	1999-2000	300	16	6
Powell Co.	D.A.#1	1995	75	0	5
	M.M.	2001	50	12	12
Sanders Co.	P.G.P.#1	1996	50	2	25
	P.G.P.#2	1996	50	6	6
Silver Bow Co.	H.#1	2000	60	11	2
	H.#2	2000	60	19	15
Stillwater Co.	E.P.	1994-95	80	9	22
Bitterroot NF	B.C.#14	2000	100	3	18
	B.H.R.#24	1999	100	2	2
	B.H.R.#25	1999	100	3	6
	R.R.#1	1999	100	3	3
	S.G.R.#2	2001	100	3	4
	S.G.R.#22	1999	100	3	0

Preliminary results of weevil surveys at six sites where corrals were built are shown in Table 4. Weevils were detected in or near corrals July 30 but the majorities were found in mid to late August. Numbers of weevils found by searching corrals and sweeping around corrals varied considerably. At the most productive site (Silver Bow Co.), 120 weevils were found by searching one corral for 30 minutes. In 2003, we will evaluate the efficacy of both collection methods after the weevils have had a chance to reproduce in corrals.

Discussion/Conclusions

In 2002, we identified 19 sites that will serve as field insectaries in 2003 and possibly beyond. These sites had high populations of *C. achates* with an average root infestation of 45% and a range between 0 and 95%, greater than 3 acres of knapweed, easily accessible and were free from major disturbances. We also collected an average of one adult per minute, with a range between 0 and 2.5 adults per minute, by sweeping knapweed across the release sites. During 2003, we will coordinate with county and forest weed specialists that manage the 19 sites to redistribute the weevils. Late larval populations or early emerging adults will be sampled to determine if the weevil population overwintered successfully. Weevils collected from field insectaries can be released into knapweed infestations or directly into corrals. Releasing weevils into corrals would probably increase the number of weevils produced for at least the first few years following the collections as well as protect the weevils from natural mortality factors such as predation.

Collecting *C. achates* larvae and/or adults at release sites verifies establishment of populations of insects at these locations. However, finding no *C. achates* is not definitive evidence that the insect is not present. Many

variables can influence the probability of finding this insect in samples. These variables include number of insects released, years since release was made, condition of plants and weather conditions at the time of adult sampling. At some sites we found fewer number of adults than our larval sampling would have suggested. One plausible hypothesis is that the summer of 2002 was unusually hot and dry throughout much of Montana. At many sample sites the knapweed bloom was completed and the plants appeared dried out by mid-August, prior to sampling the adults. Knapweed in this condition does not provide a suitable host plant for the weevils therefore our adult sampling via sweeping plants may have been compromised at some sites. Also, some sites had thrifty knapweed and larval populations in spring and early summer but had few mature plants and stems at the time of adult sampling due to heavy grazing and herbicide applications.

Although this survey concentrated on *C. achates*, other introduced biological control agents were observed at many sites. These insects included the root-feeding moth *Agapeta zoegana* Haw., seedhead feeding weevils *Larinus* spp., and the seedhead flies *Urophora* spp. Some of these insects were released at the sites surveyed, but the presence of agents at other sites can only be attributed to migration, and in some instances from long distances.

The need for the biological control agents of knapweed, especially *C. achates*, often exceeds what is available. The weevils are flightless and therefore natural dispersal is limited and perhaps slower than other insect species. Efforts should be continued on the local level to redistribute this insect from sites where they are prolific.

During 2003, we will compare the efficacy of collecting weevils from field corrals versus sweeping. The comparison will include the time required for building and maintaining corrals. We will work with local managers to take over maintenance of these corrals for future collections if they prove to be effective.

References Cited

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