MONITORING STUDY OF

CIRSIUM LONGISTYLUM (Long-styled thistle),

A CANDIDATE THREATENED SPECIES

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EXECUTIVE SUMMARY

Monitoring of Cirsium longistylum was initiated in 1990 at three sites with permanent circular plots. The trend data indicates that juvenile stage numbers are conditioned by disturbance episodes, and that flowering plant numbers vary in a non-parallel pattern, perhaps corresponding with climate. The 1993 work represents continuation, expansion and refinement of monitoring to get more accurate demographic data and provide baseline data for genetic studies, with the following changes:

1) Additional recording of bract morphology characteristics as tentative indication of hybridization. Concurrent genetics research was initiated in 1993 which will test this indicator, as well as the discreteness and persistence of the C. longistylum genome.

2) Incorporation of an additional monitoring study plot providing intra-population comparison, the Kings Hill - USFS plot established in 1991 for the Lewis and Clark National Forest.

3) Addition of a permanent belt transect to the original circular plot layout, representing greater accuracy in mapping locations and a more methodical approach to finding rosettes and seedlings.

5) Additional monitoring of weevil infestation impact.

6) Additional recording of relative groundcover and presence of soil surface disturbance.

The localized patterns of life history stage trends contrast between sample sets, with net increases found at the Kings Hills pair of sites, and significant decreases found at the other two sites. The latter two were also major sites of weevil infestation in 1993; the heavy weevil infestation at Kings Hill disappeared or was almost completely eliminated in 1993.

It is recommended that monitoring continue contingent on genetic research results corroborating taxonomic uniqueness of Cirsium longistylum, with a minimum of two more years of monitoring to characterize species life history and genetic trends.

Sample size numbers at Neihart and Russian Creek are low for stage-classified matrix population analysis, and it is recommended that an additional monitoring site be established at each of these sites for producing sound demographic data.

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INTRODUCTION

Passage of the Federal Endangered Species Act of 1973 has fostered compilation of herbarium collection records and baseline species surveys to determine the location and size of populations of rare plant species. Species' status and listing priority are initially based on range of distribution and habitat as determined by collection records and surveys. However, knowing the species' population locations and sizes at any given time is necessary but not sufficient for determining species status. Status is also conditioned by associated risks of destruction, modification, or curtailment of habitat and range; disease or predation; natural or manmade factors affecting its continued existence; the inadequacy of existing regulatory mechanisms; and overutilization for commercial, recreational, scientific or educational purposes, as identified in Section 4 of the Act. Demographic monitoring can document population dynamics and critical life history stages (Menges 1986), directly or indirectly providing insights into status questions.

Cirsium longistylum Nutt. (Long-styled thistle) is currently placed in Category 2 as a candidate for federal listing as threatened or endangered (58 FR 51144). It is a species endemic to four "island" mountain ranges with calcareous bedrock in Montana, spanning six counties (Lesica and Shelly 1991, Poole and Heidel 1993). Systematic survey of *Cirsium longistylum* was initiated in 1990 because it was initially known from few sites in the Little Belt Mountains. This also made it a priority for collecting baseline demographic information (Schassberger 1991). Three permanent monitoring plots were established to characterize life history of *Cirsium longistylum* (Schassberger 1991, Schassberger and Achuff 1991). They have been reread in the following three years (Roe 1992, Poole and Heidel 1993) including results represented in this report.

While *Cirsium longistylum* was once thought to be highly restricted in its numbers and distribution, it has now been found to recur throughout the Little Belt and Big Belt Mountain ranges, and in at least trace amounts in the Castle Mountains and Elkhorn Mountains. In the course of this baseline survey and monitoring work, taxonomic questions were raised, potential impact of weevil infestation by *Rhinocyllus conicus* in the flower head was identified as a concern, and major differences in disturbance regimes were observed across its range of habitats.

Taxonomic questions surrounding *Cirsium longistylum* underlie all other status questions.

The most recent 1993 monitoring work was incorporated the recommendations and study design considerations previously mentioned in order to interpret monitoring results and lead to status recommendations.

Demographic monitoring work at the three sites is confounded by presence of plants with bract characteristics deviating from the taxonomic circumscription of Moore and Frankton (1963), including both typical Cirsium longistylum and C. hookerianum Nutt. bract types as well as intermediates. One of the three monitoring sites (Neihart) was interpreted as made up primarily of Cirsium hookerianum, possibly with C. hookerianum x C. longistylum hybrids present (Cronquist pers. commun. as cited in Roe 1992). Monitoring work of the following year included a companion morphological investigation (Poole and Heidel 1993). Closer examination revealed a full range of bract characteristics which are diagnostic in species identification keys. It was concluded that, on morphological grounds alone, Cirsium longistylum appeared to be a distinct species which hybridizes freely with C. hookerianum to produce swarms of morphologically variable individuals. It was recommended that this provisional interpretation warranted genetic analysis, and that the discreteness and persistence of a recognizable Cirsium longistylum genome be tested.

Preliminary results of the genetic analysis will be submitted in a separate document. The putative Cirsium longistylum, C. hookerianum and intermediates at C. longistylum sites were compared with Cirsium hookerianum and C. scariosum material outside the range of Cirsium longistylum using gel electrophoresis and RAPD analysis. Genetic analysis work will be extended and completed in 1994.

The introduced weevil (Rhinocyllus conicus) was identified as a recurring seed predator at the onset of monitoring (Schassberger 1991, Schassberger and Achuff 1991) and was interpreted to significantly affect seed output as indicated by the levels of potential seed destruction. In this year's monitoring, weevil infestation incidence was recorded inside the monitoring plots, and seed destruction levels were also estimated.

The particular study sites have natural and man-caused disturbance regimes which differ from one another. While the monitoring plots were set up for comparison between years and not between plots or their disturbance regimes, the collection of additional baseline data may aid in developing hypotheses to understand the differences and interpret the divergent trends between plots. Disparate disturbance factors were first recorded as very pronounced between the three sites in 1991, with the Neihart site having many plants (31%) that were grazed, affecting at least seed output; and the Kings Hills site having intense Columbian ground squirrel burrowing activity, a factor in both mortality and germination conditions. In this year's monitoring, groundcover estimates were taken along the belt transect for the first time as indication of burrowing activity.

METHODS

This study represents a revisit of three Cirsium longistylum monitoring plots established in July of 1990 (reported in Appendix B of Schassberger 1991; also reported in Section G of Schassberger and Achuff 1991.) and revisit of one Cirsium longistylum monitoring plot established in July of 1989 (Phillips 1989) with recording of monitoring data initiated in August of 1990 (Phillips 1990, Field and Lovelace 1991, Phillips 1992). This study is treated as though it were an initial establishment of a monitoring study because of the expanded monitoring purposes, the incorporation of the monitoring plot established by the U.S. Forest Service, additional baseline data collection and modifications in design.

Demographic monitoring

Circular plots had originally been established at three monitoring sites by Montana Natural Heritage Program in 1990 (Schassberger 1991). They served their purpose for characterizing demographic profile over time. However, accurate recording and relocation of juvenile stage plants in the circular plot had proven difficult in high density situations (Poole and Heidel 1992). The author discussed experimental design with previous authors and made advance site visits to compare circular with permanent belt transect plots as described by Lesica (1986). The latter provided both greater accuracy in mapping the locations of individuals, and a more methodical approach to locating seedlings and rosettes by training the eye across each square decimeter of the belt.

A belt transect of 69.3 ft (ca. 11 m) was established at Kings Hill by the Lewis and Clark National Forest in 1989 for monitoring Cirsium longistylum local trends as well as weevil impact; first read in 1991. Individuals were tallied along the belt in alternate eleven 1 x 1 m square subplots. This served for characterizing local trends in the juvenile class. However, it did not map individuals for determining life history, and may have been too small an area for tracking trends in flowering plant numbers.

The four permanent plots were read between August 9-11; individual plants were mapped in a continuous series of 1 m x 1 m plots within a gridded frame, placed along the belt transects. In addition, groundcover was estimated for each subplot consistent with ecodata sampling (classes: soil, gravel, litter, moss+lichen, basal vegetation).

The circular plots were originally marked at their center by a piece of rebar ca. 4 ft. long and painted bright orange, driven to a depth of 2 ft. Radii ranged from 15-37 ft. depending on density of Cirsium longistylum. These original circular plots were the ones for which flowering individuals were tallied in

1993. Across the circular plots were superimposed permanent belt transects measuring 1 m. x the circular plot diameter (20 m for all sites except 40 m at Russian Creek), oriented to cross the largest number of flowering plants within the circular plot. Paired endpoints were marked by rebar, with two metric tapes stretched between them, and a gridded 1m x 1 m frame laid directly over the tapes. All plants rooted within the plot were recorded.

Plants in the belt were recorded in the following categories:

S - Seedlings or small plants; having three or fewer basal leaves (Note: S = Rs of Schassberger 1991; and is encompassed by R of Phillips and Field 1989-92).

R - Rosettes, having more than three basal leaves but not flowering (Note: R = Rm + Rl of Schassberger 1991; R is not split from S by Phillips and Field (1989-92)

F/B - Flowering plants, recorded by the number of flower heads open in flower (F) and closed in bud (B). Some flowering plants had many tiny immature flowers recorded separately as aborted (A).

D - Dead flowering stem of previous year

Regarding the distinction between juvenile classes, there was observed to be every permutation between leaf length and leaf number above the three-leaf stage. Some plants had, e.g., four big leaves of over 15 cm. length, while other plants had eight small leaves of 5 cm. length. The "R" class as defined represents a merging of two size classes defined in the original MTNHP study (the medium and large rosette classes; Schassberger 1991); and a splitting of the single "rosette" class that encompassed seedlings in the USFS monitoring study (Field and Lovelace 1991). It is possible that some of the leaf size/leaf number proportion differences reflect the timing of fall vs. spring germination. Without any discrete break among rosettes, all rosettes were placed in a single rosette category.

Regarding distinctions between genets and ramets, Cirsium longistylum is said to reproduce both sexually and asexually by biennial offsets from a perennial "underground stem" (Moore and Frankton 1963). Paired seedlings and rosettes were present at low numbers at Kings Hill, and digging outside the plots indicated that plants within less than ca. 2 cm were attached below ground. Paired flowering stems were very rare. Some showed different bract characteristics. Digging of flowering plants outside of the plots indicated that any offshoots came off at near-vertical angles from a perennial rootstock did not have offshoot development except at the apex. Plants growing within ca. 2 cm of one another were recorded as single individuals.

Paired plants were absent from Neihart and Russian Creek, at significantly lower elevations than Kings Hill. It is possible that multiple rosettes found at Kings Hill sites originated with underground frost heaving injury, or that multiple rosettes are normal in the sparser vegetation at Kings Hill compared to the other two sites.

Regarding the infloresence, infloresence branching pattern varied widely between individuals. Racemose infloresences with about seven flower heads were frequent. Panicle infloresences with many axillary branches and over 50 flowering heads, were present at the opposite extreme. Every intermediate condition was also present. The number of flowering heads tallied in 1993 compares directly with previous year's results. Distinction were made between mature flowers and unopened buds; F = Ph, and B = Pb of Schassberger 1991. However, these distinctions were not made by Phillips and Field (1991-92) because their monitoring work was conducted near the end of the growing season when any unopened buds were not expected to mature.

Written note was also made of grazing or trampling damage and impact to flowering plants; damaged plants were not included in the tallies determining mean number of flowers per infloresence.

As a followup to previous demographic monitoring, flowering stems were also counted but not mapped within the original 15 ft/37 ft. circular plots to provide direct comparison with data on the flowering plants recorded in previous years. The revised monitoring does not try to replicate previous seedling and rosette counts.

Photographs taken from respective endpoints are filed in the species' monitoring folder. Within each plot, an ecodata form was completed, also on file.

<u>Kings Hill #1 MTNHP</u>

This is the plot established by Schassberger and Achuff in 1990 (Montana Natural Heritage Program).

Location: Meagher County, T.12N R.8E Sec. 2 near the section center at ca. SE1/4SE1/4NW1/4. Located on southeast side of Kings Hill above head of Petty Creek. From Kings Hill Pass on Hwy 89, ca. 1 mile southeast along Forest Service road #487. Plot center is located ca. 40 m. downslope and south (158 degrees - no declination) of west-facing USFS sign reading "Memorial Hwy, Dry Wolf Rd" posted within a triangular-shaped piece of meadow cut off by roads converging from three directions directly east of (below) the Kings Hill summit. View of the plot center rod from the roadside sign is partially obscured by two clumps of pine (diagrammed in project file). It is ungrazed. Quad: Kings Hill (4610076).

General description: This site is on an exposed ridge crest, an ecotonal setting between forest and dry meadow along the south-facing ridge extending east of Kings Hill. The north half of plot contains both meadow and parkland species with dominants including pine and Potentilla fruticosa. The south half contains dry meadow species with dominants including Festuca idahonis and intensive disturbance caused by burrowing animals. Elevation: 7880 ft, Slope: 15%; Aspect: S.

Line Bearing: From the west end, 92 degrees (no declination), nearly parallel to the slope for 20 m. Originally set up as 15 ft. radius circular plot.

Instructions: Read from west to east facing uphill (north), the X-Y axis read from the lower left.

Kings Hill #2 USFS

This is the plot established by Phillips in mid July of 1989, and subsequently read in late August of 1990, 1991 and 1992 (Phillips 1990, Field and Lovelace 1991, Phillips 1992). It lies close to the former plot and has similar high densities of Cirsium longistylum plants, but differs in having a more level slope, less direct exposure to the sun, and lower apparent intensity of burrowing activity compared with plot #1. View of the marker cairn and plot center rod are apparent from the road. These plot pairs signify the only intrapopulation comparison set.

Location: Meagher County, T.12N R.8E Sec. 2 near the section center at ca. SW1/4SW1/4NE1/4. Located on southeast side of Kings Hill. From Kings Hill Pass on Hwy 89, ca. 1 mile southeast along Forest Service road #487. North end is marked by cairn 240 degrees from east-facing USFS sign, near a whitebark pine tree, just south of (downslope) from the road. A copy of the original USFS plot map is in Lewis and Clark NF files; copied in monitoring project file. Quad: Kings Hill (4611076).

General description: This site is on an open ridgetop, part of continuous meadow on a ridge extending east of Kings Hill. It has thin turf buildup. It lies immediately above slopes covered by whitebark pine parkland. Elevation: 7890 ft; Slope: 5%; Aspect: SW.

Line Bearing: The line bearing had been permanently marked at the plot endpoints 74 ft apart, running at 274 degrees (18 degrees declination). Originally, subplots were taken at alternate 1 m. intervals to tally individuals in each size class, beginning with the 0-3.3 ft interval, with no mapping of individuals. Comparison of belt transect data started in 1993 with previous year's data can be made only by excluding even numbered subplots, and by comparing just the tallies.

Instructions: Read from east to west (facing north), the X-Y axis read from the lower left. The "extra" 2.2 meters at the end are not read except for frame #22 to compare previous data.

<u>Neihart</u>
This plot was established by Schassberger and Achuff in 1990 (Montana Natural Heritage Program).

Location: Cascade County, in T.14N R.7E Sec. 27 NE 1/4NE1/4NE1/4. Located south of USFS Belt Park Road, along road segment with scattered trees to north, located by backtracking 0.15 mile east of cattleguard and gate; 19 m from road edge to plot center. Plot center visible from road, partially obscured by tall grass. Quad: Belt Park Butte (44611087).

General description: The plot is located in a small, gently-sloping meadow opening surrounded by parkland and forest, with a shallow water table and located downslope from a spring. It represents a diverse <u>Festuca idahonis</u> association that may be ecotonal to mesic meadow associations. A small ephemeral rivulet runs across the southern side. It is lightly grazed, and grazing appeared to have begun in late July shortly before the time of monitoring. Elevation: 6960 ft; Slope 5%; Aspect: NE.

Line Bearing: From the south end, magnetic north (0 degrees; no declination); trending oblique to the slight slope. Originally set up as 15 ft. radius circular plot.

Instructions: Read from south to north (facing west), the X-Y axis read from the lower left.

<u>Russian Creek</u>
This plot was established by Schassberger and Achuff in 1990 (Montana Natural Heritage Program).

Location: Judith Basin County, in T.11N R.10E Sec. 11 SE1/4NW1/4NW1/4. Located south of USFS road #2013 and west of Russian Creek. Plot center is 82 m north (3 degrees - no declination) from first road culvert. It is partially visible from road; partially obscured by <u>Potentilla fruticosa</u>. Quad: Russian Flat (4611076).

General description: The plot is located in a large, nearly-level meadow opening. Its vegetation shows the greatest influence of grazing among the study sites as indicated by abundance of exotic grasses and forbs, as well as by the abundance of grazing increaser species. Grazing had taken place before the time of monitoring. It is believed to represent the <u>Potentilla fruticosa</u> - <u>Festuca idahonis</u> h.t., but <u>Poa pratensis</u>

currently dominates. Elevation: 6520 ft; Slope: nearly level; Aspect: ENE.

Line Bearing: From the west end, ca. 80 degress (this needs to be measured); trend parallel to slope. Originally set up as 37 ft. radius circular plot.

Instructions: Read from west to east (facing north), the X-Y axis read from the lower left.

Hybridization monitoring

Preliminary work has already been done in taking a chromosome count for Cirsium longistylum, with 2n=34 (Mathews 1980), agreeing with results of Moore and Frankton (1963). This is the same as for Cirsium hookerianum (Ownbey and Hsi 1963) and Cirsium scariosum (Gardner 1974), reflecting a base level for New World Cirsium which exhibit a prevalent reduction in numbers. It has been noted that specimens of Cirsium hookerianum from the southern limits of its range in the United States have been seen only from northwestern Montana and north central Washington (Moore and Frankton 1965).

Flowering stems were recorded as to their bract category, in the five categories described by Poole and Heidel (1993). Leaf materials from all flowering stems were concurrently sampled for genetic analysis, and bract characteristic compared against results (report in progress). If bract morphology characteristics correspond with genetics, then monitoring of bract characteristics will indirectly monitor putative hybridization levels.

Flowering stem bract categories were assigned and leaf material sampled at the time of monitoring (August 9-11). To get an adequate sample size (min. 20 flowering plants), the sampling was not confined to the original circular plots of 15 or 37 ft radius. It was considered appropriate to keep sampling centralized and relocatable from year-to-year, so hybridization monitoring took place throughout a circular plot area having a diameter corresponding to permanent plot length (20/40 m.).

Hybridization monitoring took place at each of the four permanent plots, in addition to three sites that had been characterized as to their bract category composition by Poole and Heidel (1992), and which also augmented the first four sites. A table was prepared which compiled information from previous work, to aid in site selection (Appendix 1). At these three additional sites, a rebar stake was placed in the center marking a 10 m radius circular plot sample area. The three additional site locations are described in the following text, and documented in ecodata plots. All of the sample sites except the previously mentioned

Kings Hill pair represent discrete sample areas, with discontinuities in *Cirsium longistylum* distribution, and airmile distance between them of at least 2 miles (3.2 km).

Moose Park

Location: Cascade Co., T.13N R.8E Sec. 19 NE1/4SE1/4SW1/4, ca 82 m. southwest of USFS Road #839, from the point on the road where the meadow opening on the east side ends in forest (mapped in Poole and Heidel 1993). The site is not visible from road because of the distance. Quad: Kings Hill (4611064).

General Description: Extensive, gently rolling meadow opening. Sample site lies ca. 1/2 mile northwest of abandoned homestead. The meadow vegetation is vigorous, but its composition indicates past heavy grazing. It is low on forbs, particularly the grazing-sensitive species. Co-dominants include: *Poa pratensis*, *Phleum pratense*, and *Festuca idahonis*.

South Fork of Deadman's Creek

Location: Meagher County, T. 11N R.8E Sec. 25 NW1/4SE1/4NE1/4, first small meadow opening on the south after the first creek crossing along USFS Road #837 (mapped in Poole and Heidel 1993). The site is not visible from the road because of the dip and the tall grass. Quad: Kings Hill (4610064).

General Description: Small meadow opening along valley bottom. Appears used for camping. Elevation: 6990 ft; Slope: nearly level; Aspect: (NA; exposed to light from west).

Duck Creek Pass

Location: Broadwater County, Helena National Forest, T.9N R.4E Sec. 31 SW1/4SE1/4NE1/4, on south side of USFS Rd. crossing Duck Creek Pass, 0.6 miles west of Pass, near isolated pine where road trends east-west. The site directly parallels road and adjoins it. Quad: Gurnett Creek (4611143).

General Description: Open ridgecrest west of Duck Creek Pass, dry meadow, shallow soil. Elevation: 7505 ft; Slope: less than 5%; Aspect: N.

Weevil impact monitoring

At all permanent monitoring sites, the presence/absence of weevil infestation was noted on all flowering stems sampled for hybridization monitoring (min. sample size: 20) for determining the rate of infestation. Next, ten whole flowering plants were collected a minimum of 10 m. beyond (generally downwind) of the plot periphery in a destructive sampling procedure. All heads on the plants were quartered and categorized as to degree of infestation (0%, 1-25%, 26-50%, 51-75%, 75-100%). Infestation data was recorded in sequence from top to bottom of the plant. The number of infested heads per plant, and the very approximate degree of infestation per infested head, were calculated. This method is based on the USFS weevil impact method that was begun in 1991 (Phillips and Field (1989-92), but incorporates a doubling of the sample size (N=10).

In addition, a preliminary assessment of the density dependence of infestation was made at the Russian Creek site, which had plants in two different areas that differed in their densities by orders of magnitude. It has been reported that Rhinocyllus conicus are effective in drastically reducing the density of musk thistle Carduus nutans), a noxious weed and intended host plant for this introduced biocontrol agent (Kok and Surles 1975, reported in Rees 1977).

RESULTS AND DISCUSSION

Demographic monitoring

Flowering of this monocarpic perennial is tentatively characterized as a pattern of short-term oscillation conditioned by climate. Flowering plant numbers increased at all sites in 1993 compared to the previous year, but have not returned to numbers at the original time of plot establishment in 1990 (Table 1). Both 1991 and 1992 were drought years.

Table 1. Trends in Cirsium longistylum flowering plant numbers

Site	1990	1991	1992	1993*
Kings Hill #1	32	0	12	26
Russian Creek	38	4	8	10
Neihart	24	0	2	8

*Note: Only the 15/37 ft circular plots identical to those sampled in the original MTNHP study are used for basis of comparison

Overall plant numbers did not show parallel trends between sites. It was difficult to determine with certainty whether any of the flowering plants in 1993 belt transects corresponded with rosettes or seedlings in the three previous years. Sample sizes at Neihart and Russian Creek are low for stage-classified matrix population analysis, and it is recommended that an additional monitoring site be established at each of these sites for producing sound demographic data.

It is suggested that the size variation of the 3-leaflet stage may depend on whether the seed germinates in fall or spring. Flower heads are observed to release seeds throughout late summer into winter. Investigations into seed germination requirements and seedbank development have not been conducted.

Juvenile stage numbers superficially appear to correlate with rodent burrow density. This is supported by the escalation of juvenile stage numbers with an episode of intense burrowing activity which occurred at Kings Hill #1 in 1991 (Roe 1992). If this is the case, then relative groundcover within 1 x 1 m plots should correlate with juvenile stage numbers over time, as will be tested in future years. There is conspicuously less burrowing activity at Neihart and Russian Creek sites, but it is unknown whether this is due to intrinsic suitability differences for rodent, or the vegetation change prompted by land use that has favored sod-building exotic grasses.

Changes in methodology were instituted in 1993 that increase demographic monitoring accuracy. It is suggested that the relative demographic profile of the populations over time can be roughly compared between years though the original circular plots do not encompass the same individuals as the belt transects.

Demographic profiles are secondary at this point to determining rates of life history stage transitions. The data from 1993, summarized below and detailed in Appendices X-X, will provide the basis for stage-based population matrix modelling through at least 1995.

Table 2. Summary of life history monitoring data for Cirsium longistylum, 1993

Site\ Date	Kings Hill #1 8-10-93	Kings Hill #2 8-10-93	Russian Creek 8-11-93	Neihart 8-9-93
# Seedlings	27	49	3	0
# Rosettes	44	110	28	42
# Flowering plants	3	2	2	7
# Plants total	74	161	33	49
% Seedling	36	30	9	0
% Rosette	60	68	85	86
% Flowering plants	4	2	6	16
Mean # flower heads/plant	12.3	15.5	7.5	10.2 (excludes grazed plants)

This monitoring was not established for determining population trends or developing population viability analysis. If the population segments in the Russian Creek and Neihart continue to drop, then further expansions in study design to monitor the latter may be appropriate.

Weevil monitoring

A comparison of 1993 weevil monitoring impact with previous year's monitoring by the U.S. Forest Service (Field and Lovelace 1991, Phillips 1992) documented an apparent localized eradication of Rhinocyllus conicus from the Kings Hills #2 sample area between 1992-1993 (Tables 3 and 4). The 1992 growing season ended early with a heavy Little Belt Mountains snowstorm on 23 August, and it the weevil may not have had time to complete its life cycle at the high elevation site represented by Kings Hill. The weevil requires 39-62 days after eggs are laid on the bolting plants for hatching of eggs, feeding, and pupal stage development prior to emergence of adults (Rees 1982). It is not known where they overwinter.

Alternatively, weevil numbers may have plummeted in the wake of two consecutive low-flowering years. This is supported by the marked difference in infestation levels in population segments of different density (see paired Russian Creek sample results, Tables 3 and 4). Even at sites that had nearly all plants infested in 1993 (Russian Creek, Duck Creek Pass), over half of the flowers lacked infestation.

Table 3. Weevil infestation among all flowers

Sites	1991 (%)	1992 (%)	1993 (%)
Kings Hills #1			0
Kings Hills #2	80	72	0
Russian Creek (high density set)			66
Russian Creek (low density set)			6
Neihart			45
Moose Park			0
S. Fk Deadman Cr.			0

Table 4. Weevil infestation intensity per infested flower

Sites	1991 (%)	1992 (%)	1993 (%)
Kings Hills #1			0
Kings Hills #2	76	64	0
Russian Creek (high density set)			53
Russian Creek (low density set)			25
Neihart			60
Moose Park			0
S. Fk Deadman Cr.			0

Infestation was consistently most intense on the terminal (oldest) flower heads.

Weevil invasion in 1993 was localized among the monitored Cirsium longistylum sites (Table 5). The three sites with heavy invasion are the farthest removed from one another. Under continuous host availability, Rhinocyllus conicus might be expected to expand its range 5-15 miles per year (Rees pers. commun.). It is noted that two of the three infestation sites are close to major U.S. Forest Service road thoroughfares (Duck Creek Pass, Russian Creek).

Table 5. Weevil infestation on flowering plants per plot

Sites	1993 (%)
Kings Hills #1	0
Kings Hills #2	0
Russian Creek	53
Neihart	97
Moose Park	0
S. Fk Deadman Cr.	0
Duck Creek Pass	75

Heaviest infestation levels are in populations with opposite bract character profiles (Table 5). If bract character is a valid indication of taxonomic status and hybridization, then preliminary evidence indicates that the weevil does not show a strong taxonomic preference. This inference could be invalidated by the development of Rhinocyllus conicus strains with different host preferences (Rees pers. commun.). It was noted that musk thistle (Carduus nutans), an alternative weevil host, is common below the Duck Creek Pass site in the Big Belt Mountains, while it is limited or absent in the vicinity of Little Belt Mountains sites (USDA Forest Service 1993).

Using data in Tables 3 and 4, the net seed predation among Neihart plants is crudely estimated at least 27%, and the net seed predation among high- and low-density Russian Creek plants is at least 35% and 15%, respectively. This contrasts with results from Kings Hill #2 where predations levels may have been as high as 61% and 46% in 1991 and 1992, respectively. These are conservative estimates because it has been noted that Rhinocyllus conicus also reduces the viability of unconsumed seeds in the flowering head (Rees 1977).

It is recommended that weevil infestation monitoring be continued throughout demographic monitoring, and seed predation levels compared against seedling numbers in successive years.

Hybridization monitoring

Morphological results differ from 1992 results in that the collective hybrid category is larger compared to any of the categories for "pure" taxa (Table 6). This is believed to reflect on the more stringent distinctions between the hybrids and parent taxa made in the 1993 field season compared to the 1992 field season rather than a hybridization trend. The need for tighter definitions of these distinctions is to be met by a set of illustrations that place flower heads in appropriate categories.

Hybridization monitoring results hinge on genetic analysis (Brunsfeld in progress). Preliminary results corroborate the absence of "pure" Cirsium longistylum sample sets, and indicate that there may have even less of the "pure" component than previously suspected. This interpretation is based on morphological analysis of a single correlated set of bract features, ambiguous by the standards of Wilson (1992). If hybridization is documented and a discrete Cirsium longistylum genome exists, then this taxonomic resolution thrusts us into the conservation biology realm involving hybrids (Riesberg 1991). If, however, Cirsium longistylum is not taxonomically unique, then monitoring research is to be discontinued. It is premature to make status recommendations to either the U.S. Fish and Wildlife Service or the U.S. Forest Service Region 1 Office at this time.

Table 6. Bract types among flowering plants

Site	1	lx	x	hx	h	1992 l:hyb:h (%)[3]	1993 l:hyb:h (%)
	Bract category[1]					Relative %[2]	
Kings Hill #1	9	10	11	5	1	50:50:0	24:73:3
Kings Hill #2	8	10	4	1	1		33:63:4
Russian Creek	25	4	1	-	-	80:15:5	66:33:0
Neihart	-	4	5	12	10	0:20:80	0:68:32
Moose Park	1	12	16	6	3		3:89:8
S. Fk. Deadman Cr.	30	11	5	-	-		65:24:1
Duck Cr. Pass	23	8	1	-	-		71:29:0

[1] The symbols are taken to represent the following bract categories, as described in Poole and Heidel (1993):

l - _C. longistylum_
lx - _C. longistylum_ _C. hookerianum_
x - _C. longistylum_ _C. hookerianum_
hx - _C. longistylum_ _C. hookerianum_
h - _C. hookerianum_

[2]"hyb" is taken to represent the total of all hybrid categories "lx + x + hx"

[3]See Methods (p.) and Discussion (p.) for validity of comparing between 1992 and 1993 data

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Appendix 1. *Cirsium longistylum* population features, environmental features

EO No.	Site Name	Pop. Size (1992)	% bract types l/hy/h*	Size (ac.)	Elev.
001	Monarch SE	?	?	?	4740?
002	Kings Hill	1500	50:50:1	500	7289
003	Forest Green	100	15:75:10	15	6028-6040
004	Monarch	0	?	1	4680
005	Bender Creek Trail	23	17:6:78	5	5360
006	Duck Creek Pass	1000-5000	?	20	6320-7600
007	Jumping Creek Camp	75	75:15:10	5	5920
008	Neihart	1000	1:20:80	160	5440-7040
009	Long Baldy	?	?	?	8000?
010	O'Brien Cr =Moose Park	3000+	0:50:50	800	7200
011	South Fork Deadman Cr	700	90:10:1	600	6520-8170
012	Hay Coulee	5000+	70:10:20	60	5440-6180
013	Belt Creek	50	?	1	6080
014	Paine Gulch	11-50	?	2	5200
015	Servoss Mt	?	?	?	6400?
016	Lake Sutherlin	?	?	?	5500
017	Upper Bear Gulch =Bear Gulch Spring	100	?	10	6280
018	Skunk Gulch	100's	80:10:10	60	6280
019	Thornquist Gulch	50	?	30	5800

020	Russian Flat = Russian Cr	1000's	80:15:5	86	6350-6640
021	Pasture Gulch	50	40:40:20	5	5560-5640
022	Carl Creek	7	?	?	5440-5480
023	Atlanta Ridge	350	?	40	6400-7440
024	Cement Gulch	?	?	?	6000?
025	Hogback Mt	?	?	?	7800
026	Bear Gulch Spring	100	?	1	6920
027	Confederate Gulch	?	?	?	5220
028	Boulder Creek	30	?	?	6920-7020
029	Spring Gulch	50	10:70:20	10	6640-6840
030	Long Gulch	500	?	100	6440-6700
031	Brooks Cr.	?	?	?	5960-6040
032	West Fork Flagstaff Cr.	?	?	?	5400
033	Brooks Cr.	?	?	?	5680
034	West Fork Checkerboar d Cr.	?	?	?	6350-6440
035	West Fork Checkerboar d Cr.	?	?	?	6000-6440
036	East Fork Checkerboar d Cr.	?	?	?	6800-6840
037	West Fork Cottonwood Cr.	?	?	?	6280-6600
038	Newlan Cr.	?	?	?	6200-6240

039	Sheep Cr.	?	?	?	6200-6440
040	O'Brien Cr.	?	?	?	6600
041	Oka Butte	?	?	?	5640-5760

Appendix 2. Bract types definitions

1 - *Cirsium longistylum* form, recorded as "l", with apically widened, flared, lacerate-margined, tapering bracts, often with a sharp bend and overall curvature

hy - Intermediate *Cirsium longistylum* x *C. hookerianum* forms, tentatively categorized as hybrids, and recorded as "lx", "x", or "hx", with one of the following sets of features:

> lx - *Cirsium longistylum* *C. hookerianum*. Apically slightly widened involucral bracts with highly lacerate or erose margins.
>
> x - *Cirsium longistylum* *C. hookerianum*. Apically non-widened involucral bracts with lacerate or erose margins. Variable in conspicuousness of midvein.
>
> hx - *Cirsium hookerianum* *C. longistylum*. Apically non-widened bracts with slightly lacerate or erose margins.

h - *Cirsium hookerianum* form, recorded as "h", with narrow width, straight-edged outline and no apical widening, with entire non-hyaline margin

Variables:

Geniculate curvature of bract; most often associated with *C. longistylum* form

Conspicuousness of bract midvein; most often associated with *C. hookerianum* form

Variable bract forms on the same flower head: the *C longistylum* form bracts are lowermost on the involucre when not found throughout.

Appendix 3. Monitoring data - KINGS HILL #1

Plot		1993
1-4		
5	a	R
	b	R-2
	c	R
6	a	S
	b	S
	c	F-3,B-7
7	a	S
	b	R
	c	S-2
	d	S
	e	S
	f	S
8	a	R
	b	R
	c	R-2
	d	S
	e	S
	f	R
	g	R
	h	S-2
	i	R
	J	S
	k	S
	l	S
	m	S
	n	R
	o	R
	p	S
	q	S
	r	R-2
	s	R
	t	R
	u	R
	v	R
	w	R
	r	Y
9	a	R
	b	R
	c	R
	d	R

e R
f R
g R
h B-10
i R
j S
k R
l S
m R
n S
o S
p R
q R-2
r R
s R
t R
u R-2

10 a S
b S
c R
d R
e R

11 a R
b F-1,B-16
c R
d S

12 a R
b R
c R-2

13 a S

14 a S
b S
c S

15
16
17

18 a R

19
20

Appendix 4. Monitoring data - KINGS HILLS #2

1990	1991	1992	1993	
1			(12 juv., 0 fl.)	
			a	R
			b	R
4 juv.	6 juv.	9 juv.	c	R
1 fl.	0 fl.	1 fl.	d	R
			e	S
			f	S
			g	R
			h	R
			i	S
			j	S
			k	R
2			a	R
			b	R
			c	R
			d	S
			e	R
			f	R
			g	R
3			(8 juv., 0 fl.)	
			a	R
			b	S-2
3 juv.	4 juv.	4 juv.	c	R
0 fl.	0 fl.	0 fl.	d	S
			e	S
			f	R
			g	S
			h	R
4			a	R
			b	S
			c	R
5			(4 juv., 0 fl.)	
			a	S
1 juv.	1 juv.	5 juv.	b	S
0 fl.	0 fl.	0 fl.	c	S
			d	R
6			a	R
			b	R
7			(14 juv., 1 fl.)	
			a	R
2 juv.	6 juv.	10 juv.	b	F-1,B-6
0 fl.	0 fl.	0 fl.	c	R
			d	S-2

				e	S
				f	R-2
				g	S
				h	S
				i	R
				j	R
				k	R
				l	R
				m	R
				n	R
				o	S
8				a	R
				b	R
				c	S-2
				d	R
				e	R
				f	R
				g	S-2
				h	R
9				(11 juv., 0 fl.)	
				a	S
	1 juv.	8 juv.	9 juv.	b	S
	1 fl.	0 fl.	0 fl.	c	S
				d	S
				e	R
				f	R-2
				g	R
				h	R,S
				i	R
				j	R
				k	R
10				a	R
				b	R
				c	R
				d	R
				e	S
				f	S
11				(3 juv.,0 fl.)	
				a	R
	1 juv.	3 juv.	5 juv.	b	R
	0 fl.	0 fl.	0 fl.	c	S
12				a	F-3, B-21
				b	S
				c	S
				d	R
				e	R

13				(14 juv.,0 fl.)
				a R
2 juv. 3 fl.	10 juv. 0 fl.	17 juv. 1 fl.		b R
				c R-1,S-3
				d S
				e R
				f R
				g R
				h R
				i R
				j R
				k S
				l R
				m R
				n S
14				a S
				b R
				c S
				d R
				e S
				f S
				g S
				h S
				i R
				j R
				k R
				l R
				m R
				n R
				o R
15				(19 juv., fl.)
				a R
3 juv. 0 fl.	5 juv. 0 fl.	18 juv. 0 fl.		b R-3
				c R
				d R
				e R-1,S-1
				f R
				g R
				h R
				i R
				j R
				k R
				l R
				m R-2
				n R
				o S
				p S
				q R
				r R
				s S

16				a	R
				b	R
				c	R
17				(7 juv.,0 fl.)	
				a	R
	4 juv.	4 juv.	8 juv.	b	R-1,S-1
	0 fl.	0 fl.	0 fl.	c	R
				d	R
				e	R-3
				f	R-3
				g	R
18				a	R
				b	S
				c	R
				d	R
				e	R
				f	R
				g	R
				h	R-2
19				(8 juv.,0 fl.)	
				a	R-3
	4 juv.	7 juv.	7 juv.	b	R
	0 fl.	0 fl.	0 fl.	c	R-2
				d	S
				e	S
				f	R
				g	S-2
				h	S
20				a	S-4
				b	S-2
				c	S
21				(3 juv., 0 fl.)	
				a	S
	5 juv.	2 juv.	5 juv.	b	S-2
	0 fl.	0 fl.	0 fl.	c	R
			d R		

Appendix 5. Monitoring data - RUSSIAN CREEK

1

2 a S
b F-4,B-3
c R

3 a R
b R
c R
d R

4 a R

5-13

14 a R
b R
c R
d F-5,B-3
e R
f R

15 a R
b R
c R
d S
e R
f S

16 a R
b R

17 a ?
b R
c R
d R
e R

18 a R

19
20

21 a R

22
23
24

25 a R

26

27 a R

28
29
30

31 a R
b R

32-40

Appendix 6. Monitoring data - NEIHART

1 a F-8,B-5
b R
c D
d B-5,F-0 broken top
e R
f F-6,B-5
g R
h R

2 a R
b D
c F-4,B-3
d R
e R
f R
g R
h R
i R
j R
k R

3 a R
b R
c R
d R
e B-4,F-0 (almost dead)

4 a R

5 a R
b D
c R

6 a R
b R
c R

7 a R

8 a R

9 a R

10 a D

11

12 a R
b R
c R

d R

13 a R
b R
c F-7,B-5
d R

14 a R
b R

15 a R
b R
c R
d R

16 a R

17 a F-6,B-15 damaged

18 a R
b R

19
20