LOMATIUM ERYTHROCARPUM MONITORING

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Abstract: *Lomatium erythrocarpum* is a very narrow endemic perennial plant in the parsley family known from 11 sites over approximately 3 square mile in the Elkhorn Mountains of northeast Oregon. I visited 10 element occurrences of *Lomatium erythrocarpum* to assess the status of each site and better understand the status of the species across its range. I resumed quantitative census monitoring at two sites and completed R6 TES Plant Element Occurrence Field Forms at each of 9 EOs (EO 5 has yet to be relocated and EO 8 was not visited.) The census count at EO 1 was the highest recorded level since counting began, but more or less within a range of variation observed over a ten year period. I suspect the population at EO 1 is stable; however, the few years of widely varying counts at this EO did not reveal a statistically valid trend. Counts at EO 2 have dropped dramatically; only 3 plants were counted in 2006, the second consecutive year with a precipitously low count, with no apparent cause for this decline. With the exception of EO2, population counts or estimates at other sites are within ±50% of earlier tallies. These counts (estimates in some cases) appear to be within an emerging range of variation for *Lomatium erythrocarpum*. Qualitative monitoring showed some impacts from mountain goats trailing through two sites (EO 7, EO 3) but I estimated these goat trails impacted less than 5% of the habitat at each site. Aside from hiking trails that have been constructed through 4 sites (prior to discovery of *Lomatium erythrocarpum*) no additional impacts from recreational pursuits were observed. To increase accuracy of counts of future monitoring, I recommend visiting sites earlier in the year (flowering to early fruit) to ensure all plants have not senesced.

Introduction:

Lomatium erythrocarpum is a strict local endemic known from 11 occurrences dotted across 3 square miles in the Elkhorn Mountains of NE Oregon. This small perennial plant grows in subalpine and alpine habitats from sparsely vegetated scree communities to open subalpine fir – whitebark pine communities. Most *Lomatium erythrocarpum* sites are found on relatively steep slopes (>50%).

Threats to *Lomatium erythrocarpum* appear few. A draft conservation agreement for *Lomatium erythrocarpum* identified impacts from mountain goats and hiking trails as the two main threats to this species (USDA Forest Service 2000). Hiking trails have been constructed through 5 occurrences, although impacts to these sites appear related only to the construction and use of the trail: compacted soil of the trail has eliminated small portions of suitable habitat in four sites. Off-trail impacts from visitors are not apparent in these four sites, with the exception of one fire ring constructed near, but not within, one

site. Trampling damage, grazing, and dust-wallowing by mountain goats, which were reintroduced to the Elkhorn Mountains in the 1980's, were also identified in the draft conservation agreement as a threat to this species.

During a 2005 inventory for *Lomatium erythrocarpum*, I made a few observations that prompted the need to assess the status of this species range-wide and specifically to observe any impacts that may have been caused by mountain goats (Yates 2005). First, at element occurrence number 2 (EO 2), I counted very few plants in 2005 where hundreds were counted in prior years. Second, I noticed impacts from mountain goats digging wallows very near *Lomatium erythrocarpum* plants at EO 4.

In 2000, the completion of a conservation agreement for *Lomatium erythrocarpum* stalled over concerns raised by the Oregon Department of Fish and Wildlife (ODFW). The draft conservation agreement proposed removing any threats if evidence could show the source of a threat had caused the population to decline for two consecutive years and the total decline was greater than 10% (USDA Forest Service 2000). Census data collected between 1995 and 1998 at two sites had shown greatly fluctuating populations counts. ODFW questioned whether a 10% decline over two years might be within the natural range for this species. Following a joint field visit August 2005 with FS and ODFW staff to *Lomatium erythrocarpum* at element Occurrence (EO) 4 the ODFW repeated an earlier request that prior to establishing a trigger for management action in the conservation agreement the Forest Service first establish the natural range of fluctuation in population abundance. Reading the census monitoring plots again in 2006 will add another year of census data to better understand the natural variation in population of *Lomatium erythrocarpum*.

Four questions are fundamental to the conservation of *Lomatium erythrocarpum*:

1. What is the natural range of variation in population for *Lomatium erythrocarpum*?

2. What constitutes a biologically significant change in the population (i.e. census) of *Lomatium erythrocarpum*?

3. If a biologically significant change is detected, what phenomenon is responsible for this change?

4. Is management capable of addressing the phenomenon responsible for the detected change?

This project's primary objective is to gain more information to help answer question 1, and if successful, then qualitatively answer the remaining questions. A secondary objective is to assess the "status" of all sites with an emphasis on qualitative observations of impacts or imminent threats to *Lomatium erythrocarpum.*

Study Area:

The study area is located in the Elkhorn Mountains of northeast Oregon. The study area is approximately 3 square miles along and east of the Elkhorn Mountains crest, west of Baker City, Oregon (see Appendix A – Vicinity Map). The center of the study area is T 9 S, R 38 E, section 31. This subalpine-alpine area consists of open stands of whitebark pine (*Pinus albicaulis*) and subalpine fir (*Abies lasiocarpa*) surrounded by sparsely vegetated scree communities. Two *Lomatium erythrocarpum* sites are within a glacial cirque landform, but most sit on ridge shoulders or upper slopes. Elevations range from 7700 ft. to 8500 ft.

Methods:

I reestablished and read the census monitoring plots at *Lomatium erythrocarpum* EO numbers 1 and 2. I counted all individuals, both vegetative and reproductive, within each macroplot. The macroplots measure 50' x 30' (EO 1) and 75' x 33' (EO 2). To increase the accuracy of counts, I divided the macroplot into manageable grids (in this instance 3' x 3') as recommended by Elzinga et al. (1998). I established the 3-ft. grids using a measure tape and yellow cord. I counted each stem emerging from the soil as one genet, regardless of the distance separating stems. Meinke and Constance (1984) report that *Lomatium erythrocarpum* stems arise "from a simple or very rarely 2-3-branched caudex." By counting each stem arising from the soil some genets may have been "very rarely" double or triple counted. Total counts (the sum of reproductive and vegetative counts) were plotted over time to discern trend. Regression analysis was performed using NCSS to test the significance of the trend.

In addition to revisiting and reading the census monitoring plots, I visited each *Lomatium erythrocarpum* element occurrence and completed an NRIS Terra R6 TES Plant Element Occurrence Field Form. One site, EO 8, was not visited because of hazardous conditions I encountered en route to this site (rock fall prevented safe passage below the headwall en route to EO 8. I was not able to relocate EO 5, a very small site that has not been relocated despite many attempts the past 15 years. When completing the NRIS field form, I counted, when practical, individual plants or estimated the population size. At EO 4 I established a photomonitoring point.

Results:

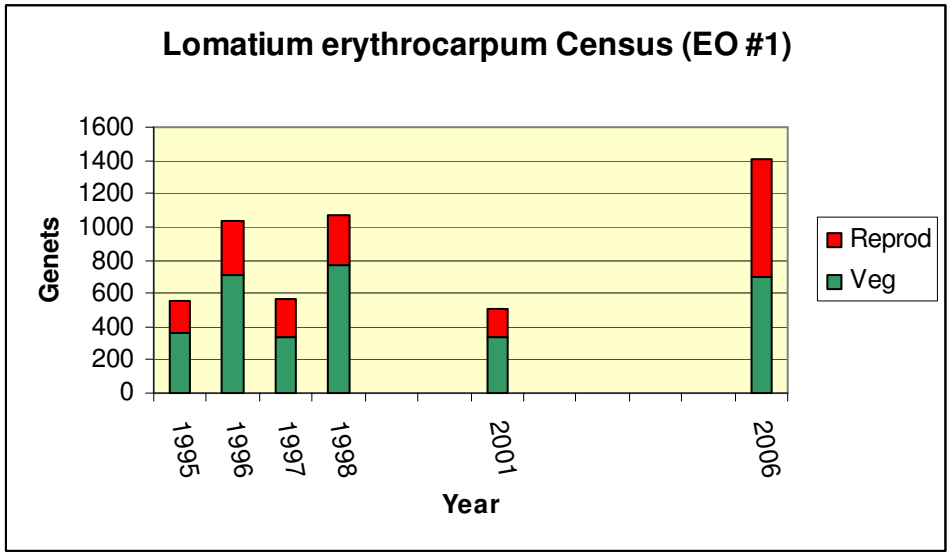
1a. Census monitoring results, *Lomatium erythrocarpum* Element Occurrence Nos. 1 and 2.

Table 1 and Figure 1 below displays the results of census monitoring at *Lomatium erythrocarpum* EO 1 between 1995 and 2006. Gaps in time indicate years where monitoring was not conducted. Census data for years 1995 – 2001 were reported by Murray (2001).

Table 1. *Lomatium erythrocarpum* EO 1 census monitoring results 1995 - 2006

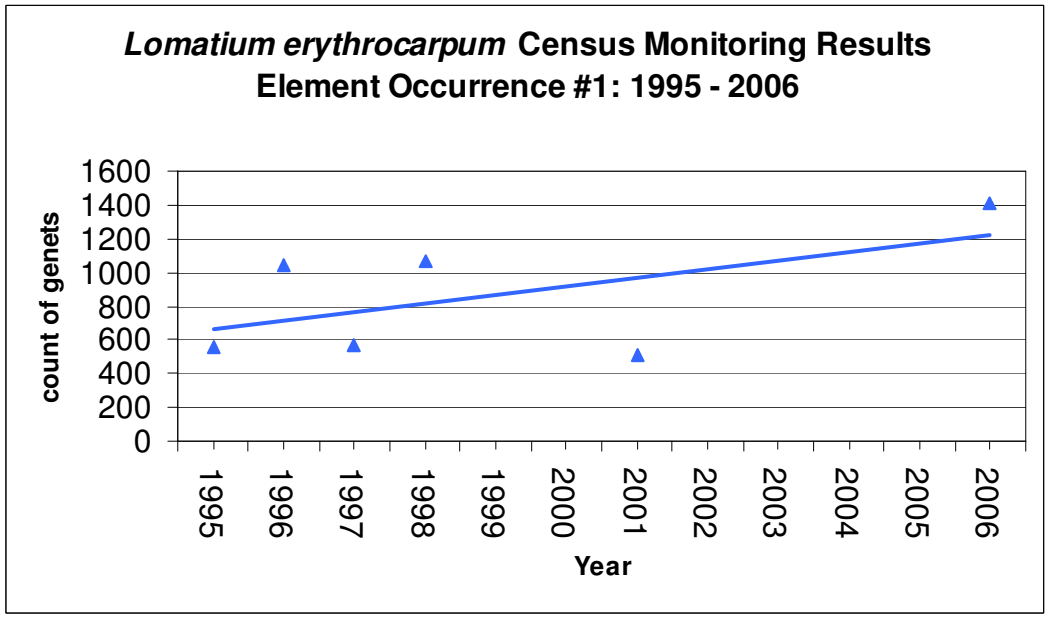
	8/5/1995	8/26/1995	8/13/1997	7/29/1998	7/16/2001	**7/23/2006**
Veg	359	707	341	775	340	**695**
Reprod	194	332	225	295	165	**711**
Total	553	1039	566	1070	505	**1406**

Figure 1. Bar graph depicting vegetative, reproductive and total census counts for *Lomatium erythrocarpum* EO 1: 1995-2006.



Gaps indicate years census not taken.

Figure 2. Line graph of total genet counts at EO 1: 1995-2006



The slope of the linear trendline in Figure 2 is 50.4 (genets/year). A significance test that the slope is zero resulted in a t-value of 1.3387. The significance level of this t-test is P = 0.2517, which is greater than P = 0.05.

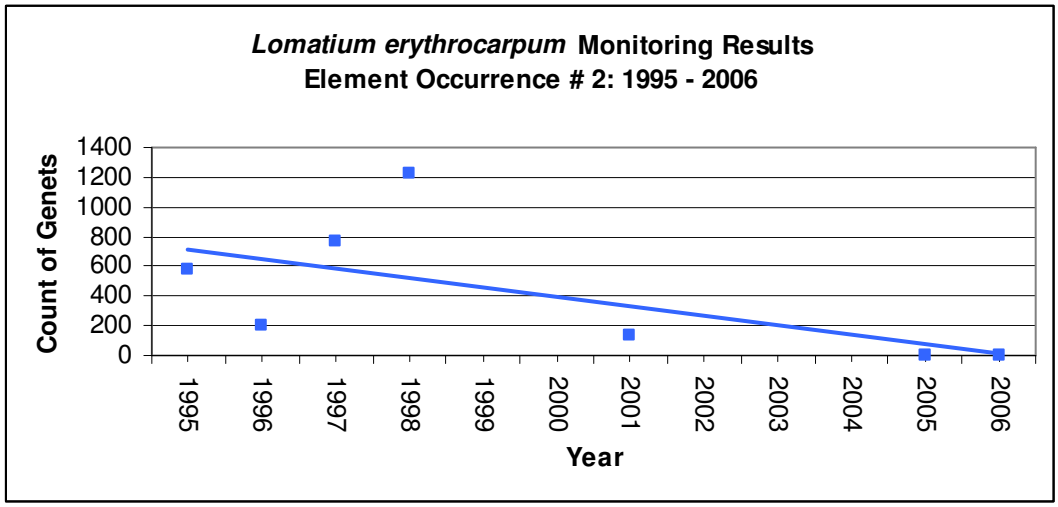
EO 2:

Table 3 displays census data from 1995 -2005 at element occurrence #2. Census data for years 1995 – 2005 were reported by Murray (2001).

Table 3. *Lomatium erythrocarpum* EO 2 Census monitoring results: 1995 - 2006

	1995	1996	1997	1998	2001	2005	2006
Veg	443	88	298	468	112	3	2
Reprod	130	108	464	752	18	3	1
Total	573	196	762	1220	130	6	3

Figure 3. Lomatium erythrocarpum Monitoring Results, Element Occurrence # 2: 1995 - 2006



The slope of the linear trendline is -65 (genets/year). A significance test that the slope is zero resulted in a t-value of -1.8565. The significance level of this t-test is 0.1128. Since 0.1128 > 0.0500, the hypothesis that the slope is zero is not rejected.

Running Mean Results

Table 3. EO #1: 2-yr., 3-yr and 5-yr. running means with % change over 2 consecutive counts.

Year	1995	1996	1997	1998	2001	2006
Count	553	1039	566	1070	505	1406
2-yr mean		796	802.5	818	787.5	955.5
% change			**0.8%**	**1.9%**	**-3.9%**	**17.6%**
3-yr mean			719	892	714	994
% change				**19.3%**	**-24.9%**	**28.2%**
5-yr mean*		796 [a]	719 [b]	807 [c]	747	917
% change			**(-10.7%)**	**(10.9%)**	**-8.1%**	**18.6%**

* - a: 2 years data; b: 3 years data; c: 4 years

Table 4. EO #2: 2-yr., 3-yr. and 5-yr. running means with % change over 2 consecutive counts

Year	1995	1996	1997	1998	2001	2005	2006
Count	573	196	762	1220	130	6	3
2-yr mean		385	479	991	675	68	4.5
% change			**19.7%**	**51.7%**	**-46.8%**	**-892.6%**	**-1411.1%**
3-yr mean			510	726	704	452	46
% change				**29.7%**	**-3.1%**	**-55.8%**	**-875.5%**
5-yr mean*		385[a]	510[b]	688[c]	576	463	424
% change			**(24.7%)**	**(25.8%)**	**(-19.4%)**	**-24.5%**	**-9.1%**

* - a: 2 years data; b: 3 years data; c: 4 years data

1b. Population Counts or Estimates for *Lomatium erythrocarpum* Element Occurrence Numbers 3 - 11.

NRIS Terra EO forms were completed for each EO. Table 3 below summarizes population counts at EO's 3-11.

Table 5: Summary of *Lomatium erythrocarpum* Element Occurrence population counts or estimates over time

	***Lomatium erythrocarpum* Genets counted or estimated by year**								
	1986	**1992**	**1995**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
EO 3			145						342
EO 4	1900-e				100-e				300-e
EO 5	30				NR*				NR*
EO 6			100-e						750-e
EO 7		500-e							1000-e
EO 8			85						NV*
EO 9			118		NC*				60
EO 10				125					60-e
EO 11				100					NC*

NV: Not Visited, NC: Visited but Not Counted; e: estimated count

Discussion: Explain the significance of the results. Also discuss lessons learned about any aspect of the study.

Census Monitoring at EO 1: Census monitoring at Element Occurrence 1 reveals that this *Lomatium erythrocarpum* population fluctuates considerably from year to year. In 1995, the first year of the census, 553 total genets (the sum of reproductive and vegetative individuals) were counted. The next year, 1996, 1039 genets were counted. The following year, 1997, the total genet count dropped to 556, and then in 1998 the genet count again climbed up to 1070 individuals. The census was not taken in 1999 or 2000. In 2001, 505 genets were counted, and then following a 4-year hiatus, the census was taken in 2006 with 1406 genets counted. At a glance, this population, although fluctuating considerably, appears stable; however, statistical analysis of these data cannot show a statistically significant trend. Though the plot of these limited data has a positive slope (increasing by approximately 50 genets per year), a linear regression was run with the

following results. A significance test that the slope is zero resulted in a t-value of 1.3387. The significance level of this t-test is 0.2517. Since 0.2517 > 0.0500, the hypothesis that the slope is zero is not rejected. We cannot state with 95% certainty whether the population is increasing, decreasing or stable.

An analysis of the running means at EO 1 is displayed in Table 3 above. The running mean was calculated for a 2-year, 3-year and 5-year period. Because monitoring was not conducted some years, the mean series or span is the 2, 3, or 5 previous counting episodes, which do not always represent consecutive years. This fact may cast some doubt as to the utility of these data. The 2-year running mean varies the least, a likely artifact of the counts at this EO doubling from the prior year then halving the next. The longer periods of the 3-year and 5-year running means, which should smooth out the bumps, instead show greater percent changes from one year (count) to the next.

Census Monitoring at EO 2: This site, despite intensive search effort, held very few plants in 2006. Where hundreds were counted in past years (see table 2 above) only three were counted in 2006, similar to the 2005 count of 6. The population counts at EO #2 have varied considerably over time here just as in EO 1, and a regression analysis of the census counts plotted versus year shows no statistically downward trend, even though a decline appears real although. One interesting observation is that the pattern of population ups and downs (high counts versus low counts) at EO 2 does not follow the pattern found at EO 1. At EO 1, high population counts were made consistently on even-numbered years (see table 1 above, years 1996, 1998, 2006). At EO #2, high or low counts fall on either even or odd-numbered years. In other words, when looking at these two element occurrences, the fluctuation of census counts at EO #1 is not in sync with the fluctuation of counts at EO #2. This might argue against an environmental factor accounting for annual population fluctuations in the populations of *Lomatium erythrocarp*um at these two sites.

An examination of the running mean using 2, 3, and 5-year periods shows at this site, the 5-year mean smoothes the fluctuations most and the 2-year period the least (Table 4 above).

It is troubling that so few plants have been recorded at this EO in both 2005 and 2006. There appear to be no apparent impacts; there is no evidence of off-trail impacts from hikers and use by mountain goats is among the lightest of all the occurrences visited in 2006. The relatively late phenology of *Lomatium erythrocarpum* at the time of monitoring at this in 2006, may account for the few observed plants: some individuals may have senesced by this time and gone uncounted. Past years counts also reveal this site to be apparently more variable in population counts than EO 1.

Conclusions from Census Monitoring: If anything can be concluded, since the population attribute measured consists of a complete count of genets within the macroplot (that is, the entire statistical population was counted, not sampled) it is that population numbers vary considerably from year to year. With six years of counts done over an 11-year period, population fluctuations of ±50% may be normal for this *Lomatium*

erythrocarpum, at least at the two censussed element occurrences. A running mean calculated over a ten-year period may better capture the natural fluctuations in population counts. Even so, population size may not be the best measure to assess the trend of this species. Frequency, which may not fluctuate so greatly from year to year, may provide a more statistically reliable attribute for monitoring of this species. In my experience, frequency plots are require less effort to read

Given less than ten years of data, I am hesitant to postulate what would constitute a biologically significant change for this plant over time. Given the observed fluctuations in population, a one year decline is not appear cause concern, because census counts at both EO 1 and 2 have been able to increase substantially the following year. Even with these fluctuations, a sustained decline over a 3 years (or counts) would be cause for alarm, and although I'm not certain, we may be observing this at EO 2.

Population counts/estimates/and habitat integrity observations at EO #'s 3-11:

A comparison of population counts from earlier years to 2006 shows in most instances widely fluctuating numbers similar to the fluctuating counts observed during census monitoring at EO #'s 1-2. (See table 5 above.) At EO #3, the 2006 count of 345 plants is approximately double that of the count of 145 plants in 1995. Population estimates at EO #'s 6, 7 are twice or more that of earlier estimates, while the count at EO #9 and the estimate at EO #10 are half that of earlier counts.

At Element Occurrence #4, where trampling from mountain goats was noted as a concern in 2005, the habitat quality observations (per the NRIS Terra R6 TES Plant Element Occurrence Field Form) made this year show no additional trampling than observed in 2005. A small trail, apparently created by mountain goats runs uphill to the left of where plants are found at EO #4.

The amount of trampling impacts from mountain goats varied among the other element occurrences. Many sites showed little or no evidence of trampling (EO #'s 1, 2, 6, 9, 10, 11) while two sites had a discernable trail or evident trampling (post-holing) that occurred during wet soil conditions (EO #'s 3, 7). For the latter, I estimated the amount of impacted habitat to be much less than 5% of the habitat used by *Lomatium erythrocarpum* at these two sites.

Recommendations:

The census monitoring scheme for *Lomatium erythrocarpum* was designed in 1995. The draft conservation agreement included a monitoring objective, but not a clearly articulated management objective (address the cause of a 10% decline in the running mean from one year to the next). If formal quantitative monitoring is to continue, both a management and monitoring objective should be clearly articulated. Because the known range of this plant is small we have an opportunity to monitor more sites and be able to assess the trend of this species range-wide. Frequency may be a more appropriate population attribute to measure, because this attribute may not fluctuate to the degree

census counts have from year to year. If census counts are to continue, we should consider using the 10-year running mean, which would smooth out the large variation in counts from year to year. To minimize effort, sample the macroplots rather than count every individual. This would be particularly helpful at EO 1, where frequently over 1000 plants have been counted. Lastly, establish clear rules for counting individuals, (count every stem regardless of proximity) so that different readers on different years know exactly what to do.

Monitoring visits should be scheduled while most plants are blooming or beginning to fruit, rather than fully fruiting, because by a later date, small, juvenile individuals may have senesced and not be observable. Sites on southerly aspects (generally west of the NE-SW trending Elkhorn crest) should be visited sooner in the year than has occurred during this and past years, probably late June. It is especially important to visit EO 2 earlier in 2007 to determine if this population is present and to record the abundance of plants.

If the impacts such, as trampling from hikers or wildlife, can be easily observed, formal quantitative monitoring may not be necessary. Qualitative assessments, conducted by completing NRIS Terra R6 TES Plant Element Occurrence Field forms may be all that is necessary to document any declines in the status of *Lomatium erythrocarpum* that would, in turn, prompt changes in management to address the causes of any declines.

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Appendix

Lomatium erythrocarpum Monitoring - 2006 **Appendix A**
Vicinity Map