Cook's desert-parsley (*Lomatium cookii*) population monitoring and reintroduction in the Illinois Valley, Oregon: 2024 annual report

September 2024

Report for the Bureau of Land Management Medford District

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Institute for Applied Ecology

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PREFACE

IAE is a non-profit organization whose mission is the conservation of native ecosystems through restoration, research, and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations, and the private sector. IAE aims to link its community with native habitats through education and outreach.

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Cover photographs: 2024 crew monitoring at French Flat; photo by Denise Giles.

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EXECUTIVE SUMMARY

Cook's desert parsley (*Lomatium cookii*) is an endangered species found only in the Illinois and Rogue River valleys in Southern Oregon. For this project, we monitored the status of natural, augmented, and reintroduced populations on BLM managed properties: Rough and Ready, French Flat, Indian Hill, and Woodcock Bog. We also describe outplanting efforts at Rough and Ready, French Flat, Waldo-Takilma, and Woodcock Bog.

Long-term monitoring has occurred at French Flat since the mid 1990's. Data from these efforts are used to track population dynamics at all sites and create a population viability analysis for French Flat.

French Flat

Since monitoring began at this site, populations have declined. In 2024 at French Flat South there were 31,109 (±10,056) plants, down from 39,107 (±11,495) in 2023. At French Flat Middle in 2024 there were 58,067 (±15,556) plants up from 52,400 (±15,150) in 2023. Habitat maintenance at the site in the last six years has included shrub clearing which has expanded portions of the potentially populated area. Increases in introduced graminoid cover (medusa head) is of particular concern for this site.

Indian Hill

In 2024, we observed an estimated 7,102 (±6,279) plants. In the first years following shrub clearing we observed increases in the population, however the population has declined from 2019 to present. Additional transects may be added in 2025 at this site to narrow the confidence interval for the population estimate.

Rough and Ready

At Rough and Ready a complete census in 2024 counted 1,534 plants in the natural (not augmented) portion of the site (see below).

Reintroduction Efforts & Survival

French Flat/Waldo-Takilma – Seeded in January 2022 and February 2024, Seeded and Plugged in December 2022

These sites were seeded in January and December of 2022. Plugs were outplanted at two locations in December 2022. At French Flat South in 2024, survivorship of plugs was 26%, and seedling establishment ranged from 2.6-8.4%. Seeded blocks at French Flat contributed an additional 19,260 plants to the natural populations in this area. In February 2024 a new block was seeded at French Flat and will be monitored in 2025. In 2023, the survivorship of the block plugged and seeded at Waldo-Takilma was similar to that observed at French Flat; this block will be assessed in 2025.

Rough and Ready – Seeded in December 2022 and February 2024

Three blocks were seeded in December 2022. Initial establishment was low in all plots. One block (closest to 'Patch A') was re-seeded in February 2024. In May 2024 the re-seeded plot had 173 plants, equivalent to 0.4% establishment.

Woodcock Bog – Seeded in December 2022

One plot was seeded in December 2022. In 2024 there only 5 plants in the seeded plot.

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1. INTRODUCTION

1.1 Project Overview

Cook's desert-parsley (*Lomatium cookii*, Figure 1), is listed as endangered by the State of Oregon and the U.S. Fish and Wildlife Service (ORBIC 2023, USFWS 2023). It is closely related to Bradshaw's Lomatium (*Lomatium bradshawii* (Rose) Math. & Const.), an endangered species found in the Willamette Valley of western Oregon. Several significant populations of Cook's desert-parsley occur on land managed by the Bureau of Land Management (BLM) Medford District. This progress report documents monitoring on the BLM Medford District through 2023. Outplanting and seeding efforts conducted in 2019-2021 are summarized in a complementary report (Giles 2022).

Figure 1. Line drawing of Cook's desert parsley (*Lomatium cookii*) (Kagan 1986).

1.2 Review of Past Monitoring

The largest population of Cook's desert-parsley on federal land was recorded in 1992 at French Flat on the BLM Medford District. Areas around this population were placer-mined for many years. During the 1993 field season, staff from the BLM Medford District established long-term monitoring plots and transects in the three largest subpopulations of Cook's desert-parsley in this area (Tong 1993). Annual monitoring plots were established on BLM land near Rough and Ready Creek in 1994 and at Indian Hill in 1997. Monitoring between 1994 and 1999 was conducted by the Oregon Department of Agriculture Native Plant Conservation Program. Since 2000, populations have been monitored by the Institute for Applied Ecology.

1.3 Description

Cook's desert-parsley is a member of the Apiaceae (parsley) family. The plants are usually less than 30 cm tall and inconspicuous except when in flower. Ternately divided leaves featuring many narrow leaflets and creamy yellow flowers are produced in compound umbels on leafless stems (Figure 1). Fruits are flattened and oblong. The species was originally described by Kagan in 1986 from specimens collected in the Medford area.

1.4 Geographic Range

Cook's desert-parsley is endemic to southwestern Oregon. Two population centers are known, the Illinois Valley in Josephine County and the Agate Desert north of the Medford Plains in Jackson County (Kagan 1994). This report focuses on population monitoring on BLM land in the Illinois Valley at French Flat, Indian Hill, Rough and Ready Creek, and Woodcock Bog.

1.5 Habitat

The populations of Cook's desert parsley studied in the Illinois Valley are found in moist, grassy meadows dominated by California oatgrass (*Danthonia californica*) (Kaye and Blakeley-Smith 2002). Other associated species include tufted hairgrass (*Deschampsia cespitosa*), inland Roemer's fescue (*Festuca roemeri* var. *klamathensis*), Lemmon's needlegrass (Eriocoma lemmonii), common camas (*Camassia quamash*), western buttercup (*Ranunculus occidentalis*), dwarf Hesperochiron (*Hesperochiron pumilus*), Cascade Downingia (*Downingia yina*), carrotleaf Horkelia (*Horkelia daucifolia*), Nuttall's quillwort (*Isoetes nuttallii*), large-flowered star-tulip (*Calochortus uniflorus*), and Hall's violet (*Viola hallii*). Patches of Cook's desert-parsley individuals at the Rough and Ready Botanical Wayside and Indian Hill have been observed growing up through dense groundcover of poison oak (*Toxicodendron diversilobum*). Trees and shrubs, such as Ponderosa pine (*Pinus ponderosa*), Jeffery pine (*Pinus jeffreyi*), manzanita (*Arctostaphylos* spp.), and buckbrush (*Ceanothus cuneatus*) border these grassy meadows. Cook's desert parsley is found on both serpentine and non-serpentine substrates throughout the Rogue and Illinois Valleys. Plants that tolerate serpentine soils generally have developed traits which allow them to exist in the presence of heavy metals and low nutrient availability (Kruckeberg 1951, 2013). In this report, all sites discussed have serpentine influenced substrates with the exception of Reeves Creek. Other non-serpentine sites include the Agate Desert in the Rogue Valley.

1.6 Reproductive Biology

Flowering stems begin to emerge from a rosette of leaves in late February and flowers usually bloom around mid-March and continue into May. As with some other *Lomatium* species, the earliest umbels are predominately staminate, while later umbels have both staminate and hermaphroditic flowers. Plants that produce only one umbel produce very few, if any, fruits (Kaye and Kirkland 1994). Several pollinators have been observed visiting Cook's desert-parsley including a small bee in the Andrenidae (mining bee) family (Brock 1987) and a small black moth (Kagan 1986). In some years IAE staff have observed bumblebees (*Bombus* spp.) and small beetles visiting the flowers at French Flat in the Illinois Valley.

In natural populations monitored by IAE, ~30% of plants are reproductive in any one year. Annual mortality of individuals ranges from 15-30%; smaller, vegetative individuals are more likely to be absent in subsequent years than large vegetative or reproductive individuals (Kaye et al. 2018). Plants in introduced populations at Reeves Creek and French Flat took longer to transition from seedling (or transplant) to reproductive phase than their natural cohorts (Kaye et al. 2018). Because stable or increasing populations are required to meet recovery requirements, it is vital that introduced propagules reach reproductive phases, and that monitoring includes assessments of population structure in at least a sub-sample of the population.

1.7 Concerns

Mining activities continue to threaten Cook's desert-parsley. Placer gold mining has restricted the population at French Flat and permanently altered much of the natural hydrologic patterns through the meadows. Hydrology at the Rough and Ready Creek population is affected by a nearby irrigation ditch and by roads that pass through and divide the population. Some of the French Flat subpopulations monitored and discussed in this report are located on BLM managed lands adjacent to the "Hillside #2", "Hillside Association", and the Ophir Assn #1 and #2 active mine claims within the French Flat ACEC . Recently, mining plans associated with these claims would impact populations of Cook's desert parsley ("BLM Reporting Application, Mine Claims" 2024).

Cook's desert-parsley habitat in the Illinois Valley is threatened by development and recreational activity. Both the French Flat and Rough and Ready Creek sites continue to be severely damaged by off-road recreational vehicles (ORV) use, where we have observed fresh vehicle tracks on a near annual basis since monitoring was initiated. In some years damage has included disturbance of population monitoring plot markers. A trash pile, with old appliances and deep tire ruts, was found at the Rough and Ready Creek population in 2003, and burnt-out cars in 2020 and 2022.

2. GOALS AND OBJECTIVES

The purpose of this project is to assist in recovery efforts for Cook's desert-parsley (*Lomatium cookii*) through the following population monitoring tasks:

- Summarize monitoring data from 1993 through 2024.
    a. Sample populations of Cook's desert parsley on BLM land near French Flat to monitor changes in population size and/or density.
    b. Conduct a complete census at the Rough and Ready Creek Botanical Wayside to monitor changes in population size.
    c. Sub-sample the population at the Indian Hill to track population size.
- Assess survivorship and establishment of seeds and plugs from reintroduction efforts conducted in January 2022, December 2022, and February 2024 to support the recovery of the species by increasing knowledge regarding the success of seeding projects in suitable habitat for the species.
- Augment populations of Cook's desert parsley on BLM lands.

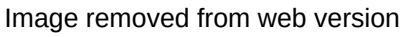

Figure 2. Locations of the Cook's desert-parsley (Lomatium cookii) study sites included in this report. Note: other Cook's desert-parsley L. cookii subpopulations occur in this general area but are not shown here.

3. METHODS

3.1 French Flat – Sub-sample

Long-term monitoring plots were established at the Middle and South subpopulations in 1993. Density monitoring plots (1 foot x 10 feet and 1 foot x 20 feet) were located randomly within the area of each subpopulation. These plots were monitored annually from 1993-2011. At some point between the 2011 and 2012 field season, plot markers were removed from the French Flat South subpopulation; only 3 of the 44 plot markers remained in place and the plots could not be re-established. New plots were established in 2012 at South and in 2013 at Middle (see below for details).

French Flat South Subpopulation

1993-2011

Forty-four 1 foot x 20 foot plots were monitored annually at French Flat South. These plots were established at random locations within the mapped population area in 1993. A numbered copper tag was attached to the northeast corner rebar post of each plot for identification. The count of plants in each vegetative stage and the presence of grazing were noted for each plant within each plot. Twenty-two of the plots had demography plots established within them. In each 0.5m x 0.5m demographic plot, each plant was mapped, and the count of leaves, count of umbels, the height of tallest leaf, and grazing were measured.

2012-2024

In 2012, new monitoring and demography plots were established at this site because of vandalism to the plots in 2011. In 2012, the boundary of the population in French Flat South was mapped using a handheld GPSmap 60CSx; a 157 m transect was laid at a bearing 180° due south to bisect the population to create a new monitoring macroplot. The head of the transect was marked with rebar, and additional rebar were placed at 50, 100 and 150m as well as at the end of the central baseline transect (157 m) (Appendix A). Thirty-three density plots were run perpendicular to the central baseline transect to the East or West at randomly selected intervals. For each monitoring transect a tape was run out 40m and a 10 cm strip on the South side of the tape was monitored for Cook's desert-parsley. Plants in the density plots were assigned to a life-history category and grazing was noted (Table 1). The location of the last plant along each transect was noted in order to evaluate changes in the occupied area of the habitat.

Middle Subpopulation

1993-2012

In 1993, forty plots were established at random locations within Cook's desert parsley population at French Flat Middle. A numbered copper tag was attached to the northeast corner rebar post of each plot for identification. Twenty of the plots also had associated demographic plots.

2013-2024

New density plots were established in 2013 to reflect the methods at French Flat South in 2012. The boundary of the population was mapped, and a 100 m baseline transect was laid at a bearing of 034° (northeast) to bisect the population. Thirty density plots were placed at random intervals perpendicular (either east or west) to the central baseline transect (Figure A-2.). A tape was run for 40 m and a 10 cm

strip on the south side of the tape was monitored for Cook's desert-parsley. Plants in the density plots were assigned to the life-history categories, and the location of the last plant encountered on each transect was noted (Table 1). After burning and meadow clearing at French Flat in 2017 the population has expanded such that some of our original sub-sample transects at French Flat Middle did not capture the whole population therefore, in each year, sub-sampling transects are extended to the maximum extent of the Cook's desert parsley population and the location of the 'last' or furthest plant from the baseline is recorded (Appendix B).

In 2013, 18 of the 20 previous demography plots were located; demography plots without plants for multiple years were abandoned and four new demographic plots were established in 2013. These plots are monitored annually.

Table 1. The life history codes used to represent the life history category for Cook's desert parsley (*Lomatium cookii*).

Life History Code	Life History Category
S	Seedling; signs of cotyledons present
V1	Vegetative plant with 1 leaf
V2	Vegetative plant with 2 leaves
V3	Vegetative plant with 3 or more leaves
R1	Reproductive plant with 1 umbel
R2	Reproductive plant with 2 umbels
R3	Reproductive plant with 3 or more umbels

Density Plot Data Analysis

In order to estimate the population size at French Flat South, French Flat Middle and Indian Hill, the average number of plants per square meter along each monitoring transect is multiplied by the number of potential plots within the mapped population boundary (Figure 3). From 1993-2012 for French Flat South and from 1993-2013 at French Flat Middle the area of each population was assigned a fixed value of 2,787m^2 (French Flat Middle) and 3,751m^2 at French Flat South.

In 2012 (FFS) and 2013 (FFM) population calculation methods were modified to reflect the updated plot set-up in both meadows. Population estimates are calculated by using the average length from the baseline to the last plant encountered on the monitoring transects (Appendix A). In each year the population area is evaluated based on the average length to the last plant multiplied by the length of the baseline and multiplied by two to reflect that the baseline bisects the population area.

Demographic Plots and Analysis

Demographic plots were established at the Middle and South subpopulations in 1994. Sampling was suspended from 2000 through 2007 at the Middle subpopulation because sufficient information on population dynamics could be obtained from long-term study of one subpopulation to understand the basic life-history of the species and prepare a transition matrix model. In 2008-2024, the Middle subpopulation was re-sampled. Demographic monitoring at the South subpopulation has been consistent through the 2023. In 2012 due to vandalism at French Flat South, new demographic plots were established. In 2013, additional plots were established at French Flat Middle because some of the older plots no longer had surviving Cook's desert parsley in them (and had been vacant for more than 5 years).

Figure 3. Map of three French Flat subpopulations of Lomatium cookii and reintroduction blocks from 2022. The Middle and South subpopulations include long-term monitoring demographic plots and transects. The smaller North subpopulation is sampled with radially-arranged transects only, and has not been monitored since 2007.

PLOT SAMPLING

At each subpopulation (Middle and South), 20 existing density plots were randomly selected as locations for 0.5 m x 0.5 m demographic plots (Appendix A, Appendix B). Within each demographic plot, all *Cook's desert-parsley* plants were mapped, given unique numbers (beginning with #1), assigned to a life history category (Table 1), and the presence or absence of grazing was recorded. To sample, a 0.5 meter x 0.5 meter frame was placed over the left rebar post, with the post positioned in the lower left corner of the frame. In 2012 at French Flat South the demographic plots were removed by vandals. We were not able to re-establish the plots, which had been monitored from 1993-2011, thus 30 new plots were monumented in 2012 (Appendix A). Location of the demographic plots were randomly selected along the randomly selected density transects. Two opposite corners of the 0.5 m x 0.5 m monitoring plot were marked with nails and the northeast corner is tagged Appendix A).

In previous years data from the demographic plots was utilized to conduct a population viability analysis (Pfingsten et al. 2019). Demographic analysis is planned to be repeated in 2025.

3.2 Rough and Ready Creek - Census

A complete census of the population at Rough and Ready has been conducted in each year from 1994 to 2024. The site is roughly divided into eight patches (A-H). Each plant is classified into life history stages and grazing is noted for each plant.

Counting of each patch is implemented by laying tapes around the boundaries of each patch and then further breaking up the patch into smaller segments with tapes and monitoring poles so that small sections of the patch can be counted systematically. In Patch A, one 4m x 15m transect is monitored each year to detect changes at a finer scale at the site (Appendix C).

3.3 Indian Hill – Sub-sample

The population of *L. cookii* at Indian Hill was first documented in 1996, and monitoring was initiated in 1997. The population occurs on BLM managed land, but access is through private land. The population occupies a long stringer of open vegetation surrounded by dense forest and extends to near the banks of the West Fork Illinois River.

There are 10 0.5m x 40m transects. Diagram of the plot set-up and distribution at the site are found in Appendix D, details on initial plot establishment can be found in previous reports (Kaye 2003) .

Monitoring Plots

All plots are 50 meters x 0.5 meters and are permanently marked at each end with rebar posts marked with flagging and copper tags with the plot number scratched onto the surface. Aluminum plot tags were added in 2015 (Appendix D.) To sample these plots, a 50 meter measuring tape was extended between rebar posts. The tape represented the west edge of the plot. Individual Cook's desert-parsley plants that occurred within the plots (between the tape and 0.5 meter east) were counted and assigned to the same stage categories used at French Flat. Poison oak is patchy in this area, especially along the forest edges, so care should be exercised to minimize exposure. Also, common lomatium (*Lomatium utriculatum*) and yampah (*Perideridia* sp.), which may resemble *Cook's desert-parsley*, occur in this area and were encountered in the sampling plots (Figure 4).

Data Analysis

The population estimate is calculated by multiplying the average number of plants per plot by the number of potential plots at the site.

Figure 4. *L. cookii* (left), *L. utriculatum* (middle), and *Perideridia gairdneri* (right). These species can co-occur in sampling plots.

3.4 Seeding and Outplantings (2022-2024)

Previous work by IAE has included introduction and seeding efforts at French Flat North, Reeves Creek and Agate Desert in 2006-2008 and results related to these efforts can be found in previous years reports and the Master's Thesis of Ian Silvernail (Silvernail 2008, Kaye et al. 2018) . Additional seeding efforts were conducted in the Fall of 2019 in the Waldo Takilma ACEC (Giles 2022). Included in this report are the seeding and outplanting efforts conducted in January 2022, December 2022, and February 2024.

January 2022, French Flat and Waldo-Takilma

In January of 2022, two larger blocks were seeded using belly seeders at the Waldo-Takilma and French Flat South sites. Each block was a total of 900m^2. At Waldo-Takilma the seeded block is 15m x 60m with the long-axis running North to South. At French Flat, the seeded block is 30m x 30m. Each block is marked with PVC markers at each corner. Seeds were spread using a belly seeder by Tom Kaye. Seeds were grown at the J. Herbert Stone Nursery, with a serpentine influenced seed source used for the production field.. For all calculations throughout this report, we assumed 77,000 seeds/lb as provided by J. Herbert Stone Nursery for the 2019 accession. A total of 4 lbs of seed was spread over the two blocks (2 lbs/900m^2 block); at an equivalent rate of 9 lbs/acre, or 171 seeds/m^2 (Table 2).

December 2022, French Flat, Rough and Ready, Woodcock Bog, Waldo-Takilma

In December 2022 a total of four sites were seeded and two received plugs (Appendix F). Maps of all seeded areas are included in Appendix F. A total of 6 lbs of seed was spread across the 4 sites.

Plugs were grown at J. Herbert Stone and were in 8" conetainers. Each conetainer had 1-3(4) plants. Plants were dormant at the time of outplanting with the 'top' of the plant 1-4" below the top of the soil surface. We used 8" dibbles to make holes every meter on the south side of the tape in the first 10 cm of each meter. Plants were not placed a the "0" or the final meter of the tape, to prevent the potential for future trampling of outplanted individuals.

February 2024, French Flat and Rough and Ready

In February 2024 two sites were seeded. One block at Rough and Ready was re-seeded with 0.25 lbs of seed at a rate of 20.2 lbs/acre. This block is closest to the existing population at the site, and shrub clearing at the site has improved the habitat quality in this area. This block was selected due to its proximity to the existing population and the quality of the habitat.

At French Flat, we extended the existing 'Block B' 5m to the north creating a 5m x 45m area. This area was seeded with 0.75 lbs of seed at a rate of 13. 5 lbs/acre.

Table 2. Seeded and plugged areas in 2022 and 2024.

Date	Site Name	Lbs. of Seed	# of Plugs	Plot size(s)	Plot notes	lbs/acre
Jan-22	Waldo-Takilma	2		15m x 60m	This plot re-seeded and plugged in Dec 22	9.0
	French Flat - A	2		30 x 30		9.0
Dec-22	Rough and Ready	0.75		10 x 15 (x3 plots)	3 plots spread across site	20.2
	Waldo-Takilma	2.25	280	15m x 60m	Same as Jan -22 plot . Overseeded and plugged into same area.	10.1
	French Flat - B	2.25	280	30 x 45	Between /Main FF South population and Jan. 2022 plot	6.7
	Woodcock Bog	0.6875		20 x 15		9.3
Feb-24	Rough and Ready	0.25		10 x 15	Reseeded one block (closest to Patch A)	20.2
	French Flat – C	.75		5m x 45m	Seeded on North side of French Flat Block B	13.5

4. RESULTS

4.1 French Flat

Population size and density

At both French Flat South and French Flat Middle, the populations have generally declined since monitoring began at the site in 1993. While there have been fluctuations between years, the long-term trends show a thirty-year downward trend (Figure 5). The population at French Flat Middle shows a slight increase since 2017 when management actions were initiated at the site including shrub clearing. In 2024 at French Flat South there were 31,019 (±10,056) plants. At French Flat Middle, there were 58,067 (±15,556) (Figure 7, Figure 8).

Population structure

In all years, vegetative plants are the dominant life-history stage in both French Flat Middle and French Flat South with vegetative plants making up 59-92% of the total population. Over the last ten years at both French Flat South (FFS) and French Flat Middle (FFM), the percentage of reproductive plants has increased (indicating that recruitment of seedlings and subsequent vegetative stages are lagging.)

It has been shown that reproductive plants with more than one umbel have higher seed set than plants with just one umbel (R1)(Kaye and Kirkland 1994). Figure 7 and Figure 8 show the proportion of reproductive plants in the R3 size class paired with population trends. There is a concomitant decrease in the population size with decreases in the proportion of R3 (seed producing) plants (Figure 6, Figure 7, Figure 8, Figure 9). The increase in plants in the R3 size class at FFS and FFM in 2024 may result in more seedlings in 2025.

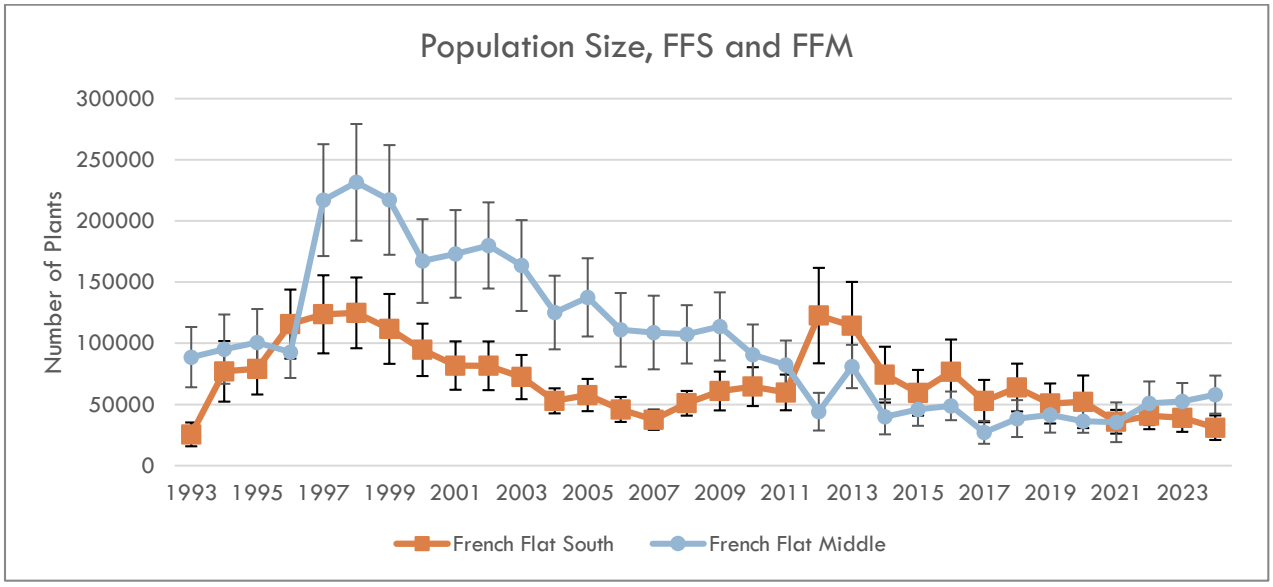

Figure 5. The total number of *Lomatium cookii* at Middle and South French Flat, 1993-2024. Error bars represent a 95% confidence interval.

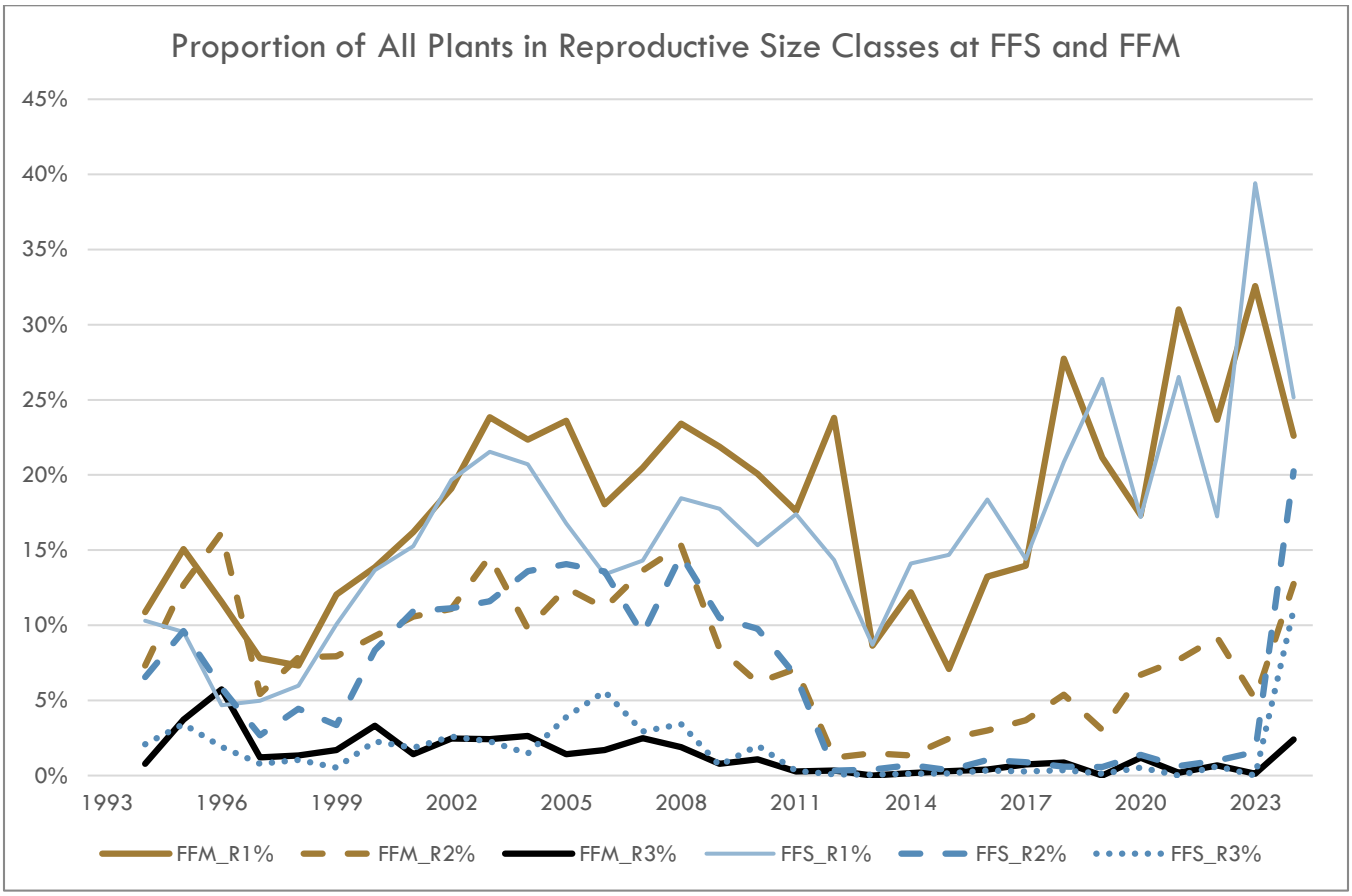

Figure 6. The proportion of reproductive *Lomatium cookii* relative to the total number of plants in all size classes at Middle and South French Flat, 1993-2024.

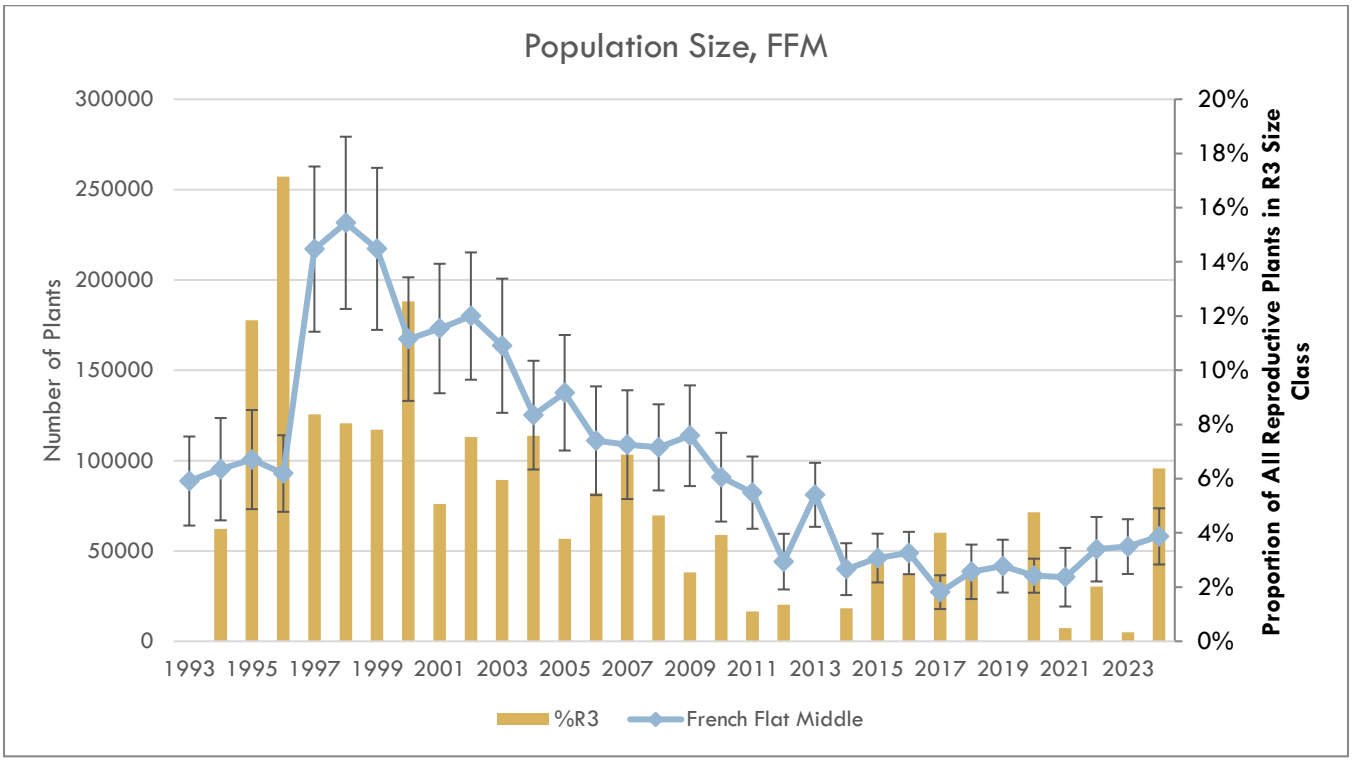

Figure 7. Population size at French Flat Middle from 1993 to present paired with the proportion of all reproductive plants in the R3 size class. Error bars represent 95% confidence intervals.

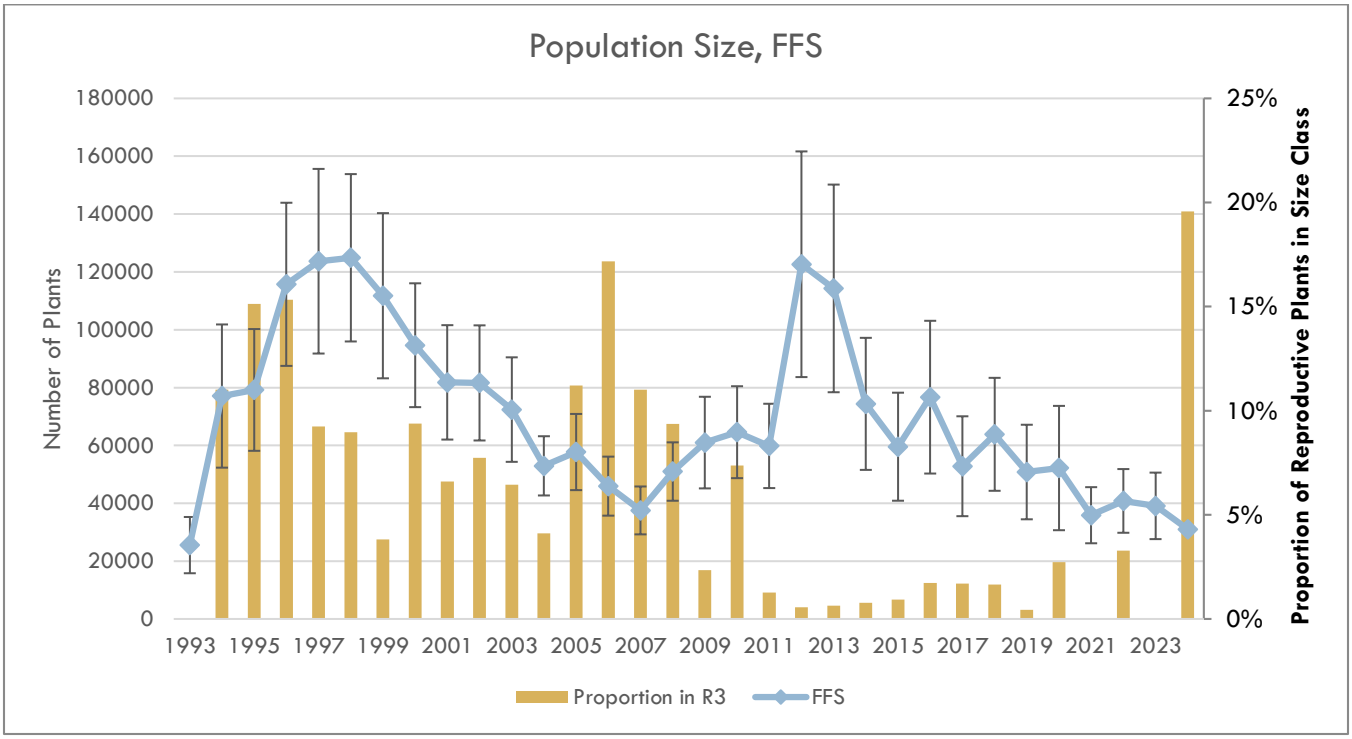

Figure 8. Population size at French Flat South from 1993 to present paired with the proportion of all reproductive plants in the R3 size class. Error bars represent 95% confidence intervals.

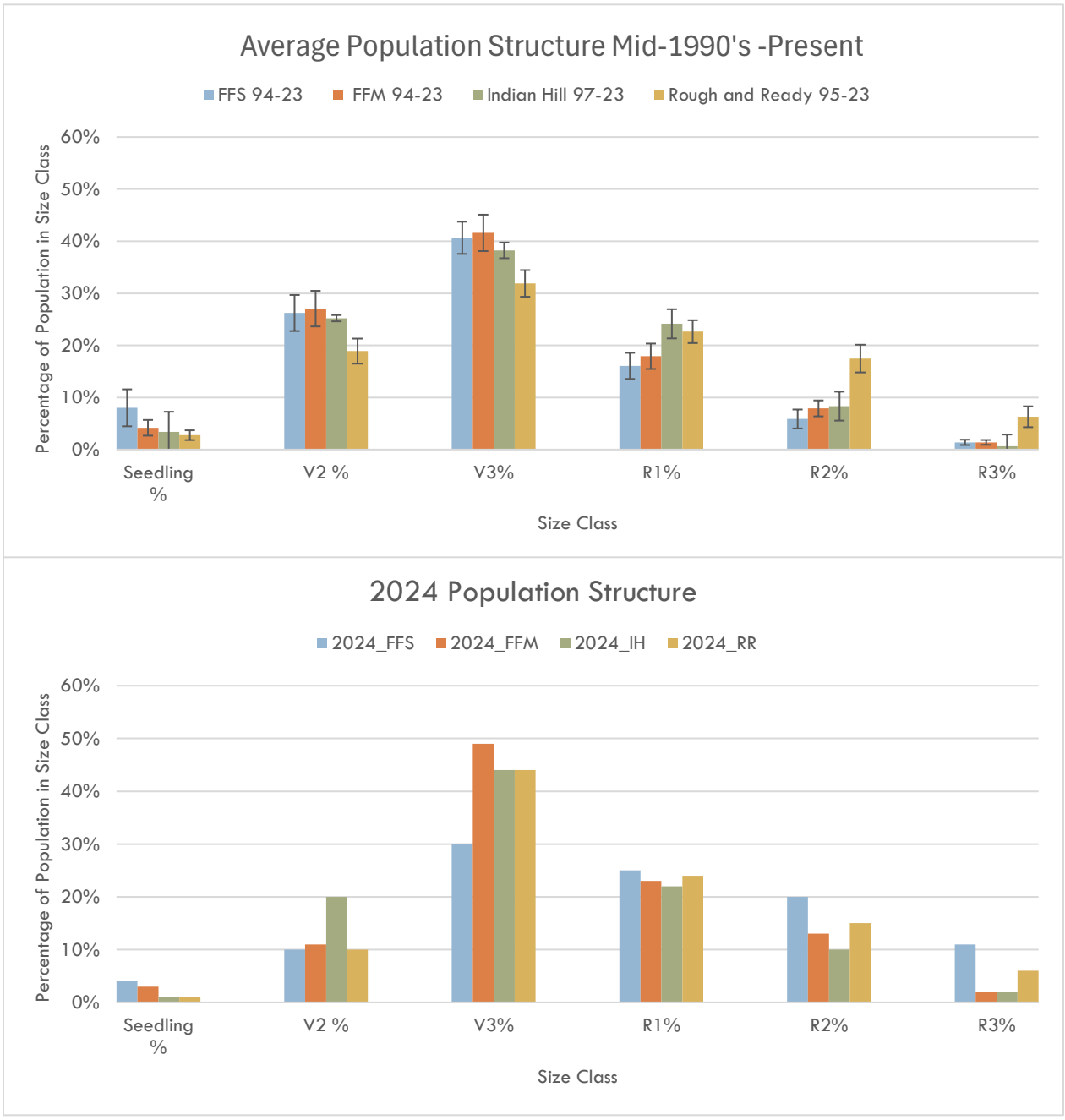

Figure 9. *Lomatium cookii* population structure in 2024 (bottom) and averaged over the course of the study (top) for French Flat Middle (FFM) subpopulation, French Flat South (FFS) subpopulation, Rough and Ready Creek, and Indian Hill. Bars indicate the mean percentage of plants in each stage. Error bars in the upper graph represent 95 % confidence intervals. See text for explanation of life-history stages.

Demography and Population Viability Analysis

While demographic analysis was not conducted in 2023, a brief summary of results from 2019 is included here. For more detailed information and a in depth description of analytical methods see (Pfingsten et al. 2019).

In stochastic simulations incorporating environmental variability from 1994-2011 and 2012-19, ***French Flat South was projected to decline at an overall rate of 0.856 without any management intervention.*** This reflects the overall poor annual growth rates at this site since monitoring began in 1994. ***At Middle, the stochastic growth rate was lower, 0.840.*** The risk of sharp decline (50% loss) in 20 years was 99.9% at South and 99.7% at Middle. The risk of 99% decline in 20 years was 1.9% at the South subpopulation and 13.5% at the Middle subpopulation. Thus***, both deterministic and stochastic growth rates project that both South and Middle subpopulations will decline rapidly and substantially in the next two decades.***

Table 3. Average transition matrices used in the stochastic analyses for *L. cookii* at French Flat. The top row of each matrix represents the number of seedlings produced per reproductive plant (fecundity). Lower rows represent the probability of an individual in a given stage changing to another stage the following year. Stage-specific mortality is provided in the bottom row. The elements in the matrices are averaged from the transition data collected in 1994-2011 and 2012-19 for the South subpopulation and 1994-99 and 2008-19 for the Middle subpopulation.

South, average matrix (1994-2011 & 2012-19), lambda = 0.871						
	S	V2	V3	R1	R2	R3
S	0	0	0	0	0.456	2.839
V2	0.418	0.295	0.134	0.066	0.062	0.037
V3	0.258	0.379	0.460	0.236	0.162	0.078
R1	0.023	0.035	0.123	0.252	0.234	0.197
R2	0.018	0.008	0.056	0.175	0.224	0.156
R3	0	0.004	0.008	0.020	0.095	0.322
Mortality	*0.284*	*0.278*	*0.220*	*0.251*	*0.223*	*0.210*
Middle, average matrix (1994-99 & 2008-19), lambda = 0.863						
	S	V2	V3	R1	R2	R3
S	0	0	0	0	0.630	1.828
V2	0.469	0.354	0.135	0.056	0.067	0
V3	0.177	0.288	0.509	0.312	0.119	0.218
R1	0.004	0.041	0.128	0.320	0.321	0.278
R2	0.005	0.019	0.033	0.140	0.198	0.163
R3	0	0.006	0.009	0.026	0.079	0.205
Mortality	*0.345*	*0.292*	*0.187*	*0.147*	*0.216*	*0.137*

4.2 Rough and Ready Creek

Due to its relatively small size we censused the entire Cook's desert parsley population at Rough and Ready Creek. In 2024 we counted 1,534 Cook's desert parsley plants (905 reproductive) in eight patches at Rough and Ready Creek (Figure 9, Figure 10).

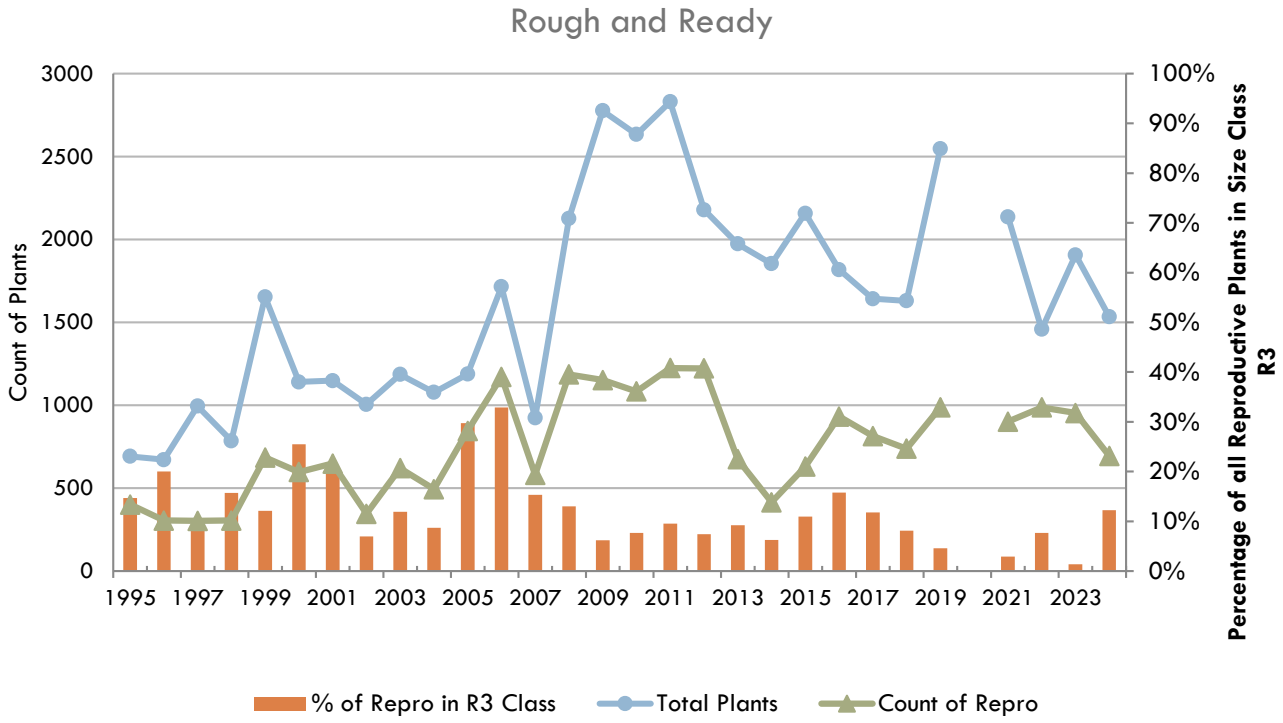

Figure 10. Total number of Cook's desert parsley and number of reproductive plants at Rough and Ready from 1995-present. Bar graph represents the proportion of reproductive plants in the "R3" size class. In 2020 only Patch G was monitored.

4.3 Indian Hill

The total population size of Cook's desert parsley at Indian Hill has generally decreased since monitoring was initiated in 1997. Following management treatment in the fall of 2015 the population briefly rebounded then began to decline again after 2019. In 2024 an estimated 7,102 ±6,279 95% CI plants were observed. Only two of these plants were seedlings. In 2023, seven seedlings were observed (Figure 11).

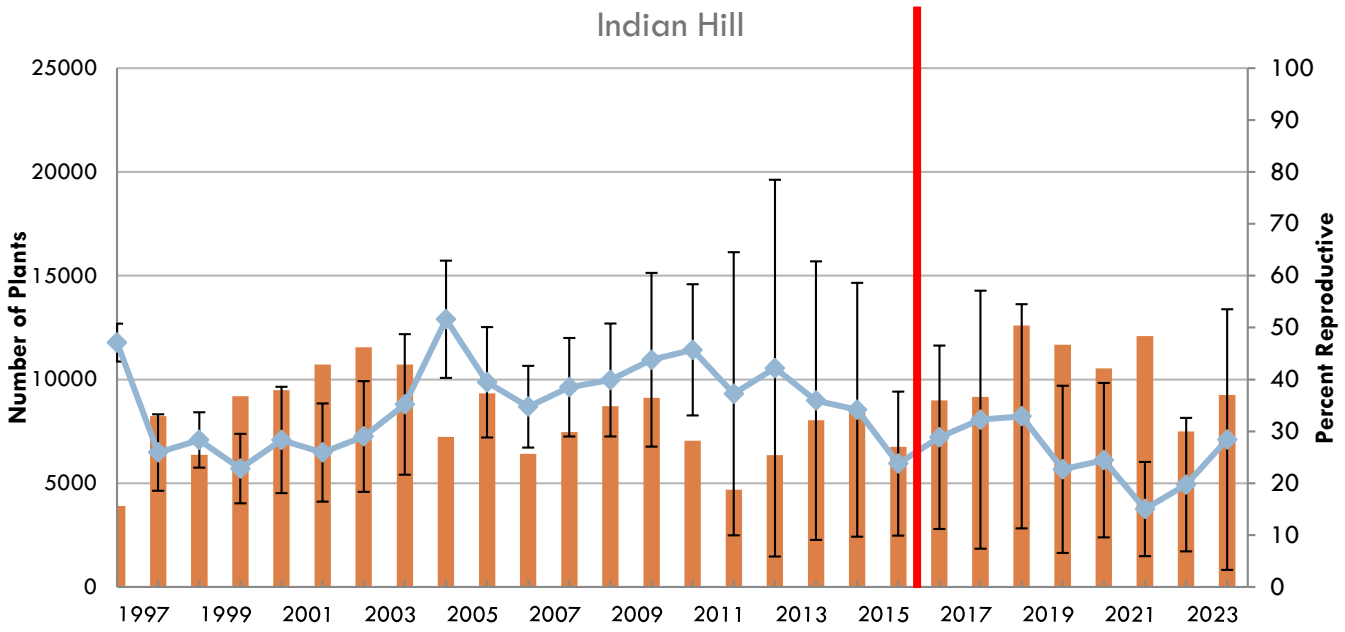

Figure 11. Estimated number of plants at Indian Hill from 1997 to present. Error bars represent 95 % confidence interval. Red bar indicates the timing of shrub removal in the fall of 2015. Bar graph indicates the percentage of plants that are reproductive.

4.4 Herbivory on *Lomatium cookii*

Herbivory by voles is relatively frequent on *L. cookii*, but the frequency of damage to the plants has varied substantially among sites and years (Figure 13). Typically, damage to the plants ranges from consumption of leaf tips and inflorescences, to removal of nearly all aboveground plant material. Consumption of the flower clusters results in little damage to the individual plant, but eliminates seed production and, therefore, recruitment of seedlings in the following year. The long-term impact of herbivory on *L. cookii* plants may play an important role in population growth and seedling dynamics. Environmental parameters (e.g., rainfall, average maximum daily temperature, and average minimum daily temperature) may influence vole populations similarly across the region and in turn affect the number of *L. cookii* that are grazed.

Herbivory on *L. cookii* has fluctuated between years, and the patterns are not always synchronous among the sites (Figure 13). In our observations since 1993, the highest recorded average herbivory was 57% detected at Indian Hill in 2019, while the lowest was 1% at French Flat Middle in 1994.

4.5 Outplanting and Seeding

In January 2022, French Flat Block A was seeded with 2 lbs of seed. In May 2024 (after three growing seasons), this block had an estimated 4,560 plants; which is equivalent to 5.1 plants/m^2 (95% CI: 1.9-7.0 plants/m^2) and an establishment rate of 2.6% (95% CI: 1.6-3.6%) (Table 2, Table 4). At French Flat Block B (seeded December 2022), May 2024 monitoring estimated 14,700 plants (95% CI: 8,901 – 20,499) with an establishment of 8.5%.

At Waldo-Takilma, the block was seeded twice; once in January 2022 (9lbs/acre) and again in December 2022 (10.1 lbs/acre)(Table 2). In 2023, this block had an estimated 33,480 (95% CI: 18,573 – 48,387) plants with a density of 36.7 plants/m^2. This block will be re-assessed in spring 2025.

At Woodcock Bog, although the seeding rate was similar to those at French Flat or Waldo-Takilma (Table 2), establishment was much lower with only an estimated 160 plants in the entire plot in 2023 and only 5 plants in 2024 (Table 4).

In 2023, survivorship of the planted plugs was 49% in both blocks, and 26% at French Flat in 2024. Because each plug had more than one plant, the total number of plants as a result of this outplanting is greater (Table 5). The outplanted block at Waldo-Takilma was not assessed for plug survivorship. Plants will be monitored again in 2025 to assess longer term survivorship and reproductive status of these plants.

Table 4. Seed establishment for plots seeded in January and December 2022.

Plot		**Estimated Number of Plants**	***95% C.I. (range)***	**Average Plants/m^2**	***95%C.I. (range)***	**% Establishment**	***95%C.I. (range)***
French Flat A (Jan 22)	2023	6,030	2,839 - 9,221	6.7	3.2 – 10.2	3.9	1.8-6.0
	2024	4,560	2,856-6,264	5.1	3.2-7.0	2.6	1.7-3.6
French Flat B (Dec 22)	2023	12,990	6,610 - 19,370	9.6	4.9 – 14.3	7.5	3.8-11.2
	2024	14,700	8,901-20,499	10.9	6.6-15.2	8.5	5.1-11.8
Waldo-Takilma *(Jan and Dec 22)	2023	33,480	18,573 - 48,387	36.7	20.0 – 53.3	10.2	5.7-14.8
	2024	Plot will be monitored in 2025					
Woodcock Bog (Dec 22) Census**	2023	160	49-271	0.5	0.2-0.9	0.3	0.1-0.5
	2024	5	N/A	0.01	N/A	0.01	N/A
Rough and Ready, Patch 1 (Dec 22, Feb 24)* Census **	2024	173	N/A	1.2	N/A	0.4	N/A
*Plot was seeded twice, both seeding events considered in establishment rate ** A census was conducted in 2024 at Woodcock Bog and Rough and Ready							

Table 5. Survivorship of plugs planted in December 2022. The block at Waldo-Takilma will be assessed in 2025. (and not was measured in 2024).

Site	Number of plugs outplanted	Number of "Plugs" survived		Number of Plants survived		% survivorship of each plug	
		2023	2024	2023	2024	2023	2024
French Flat B (Dec 22)	280	137	73	195	103	49%	26%
Waldo-Takilma (Dec 22)	280	138	N/D	228	N/D	49%	N/D

Figure 12. Seedlings observed at Waldo-Takilma in 2023.

5. DISCUSSION

5.1 Current population status

In 2023, populations of *L. cookii* at each of the four sites continued to decline, including a decrease in the number of large reproductive plants. In 2024, two of the four populations showed increases (French Flat Middle and Indian Hill), however all sites remained well below historic averages for the sites. In 2024, the number of large reproductive plants (size class R3) increased; these plants are critical to recruitment and stability (or increases) of population size.

Outplanting efforts with seed and plugs show promising results. Efforts for seeding and outplanting should be continued to augment populations on all existing populations in serpentine and non-serpentine substrate.

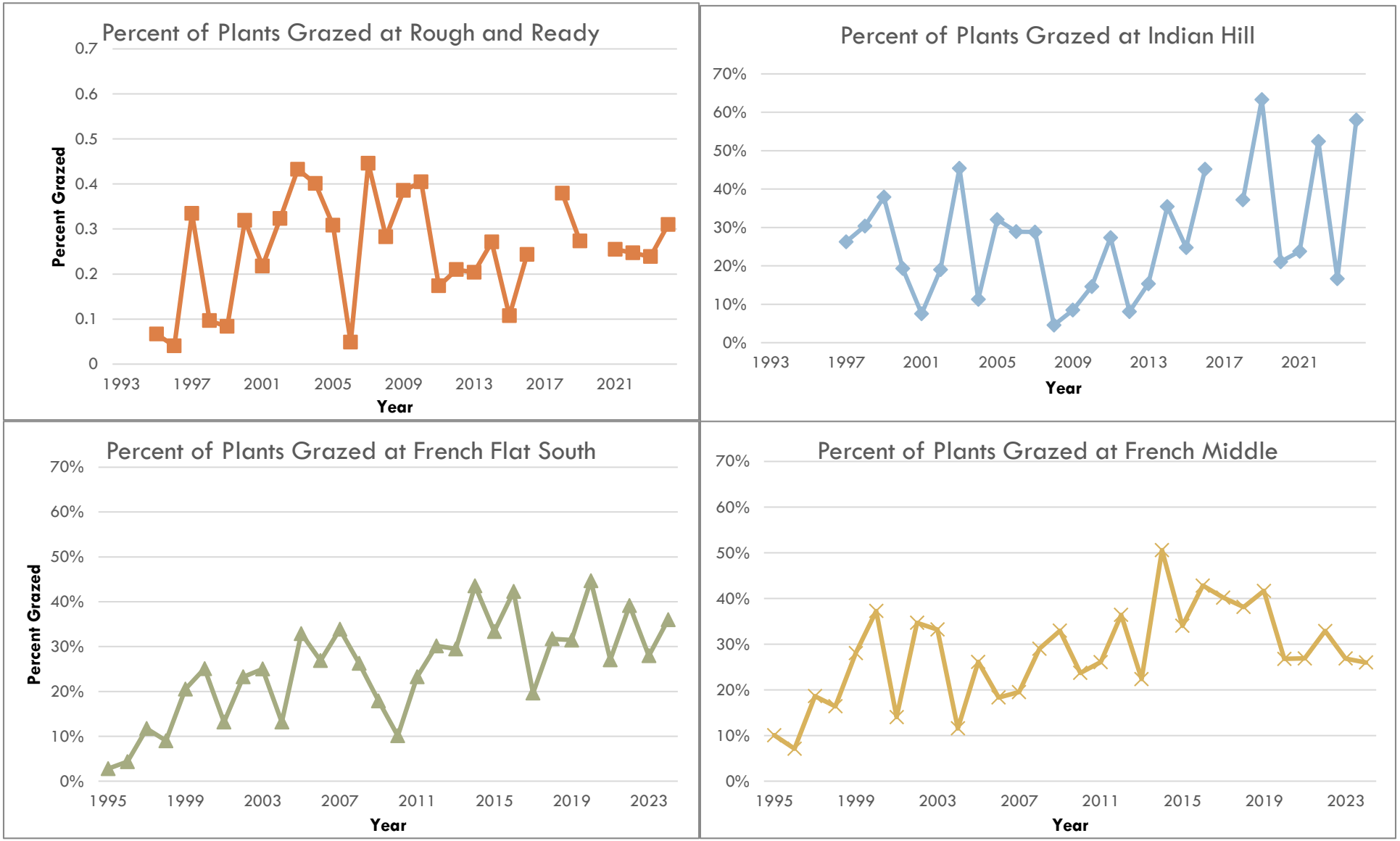

Figure 13. Frequency of herbivory of Cook's desert parsley at four populations from the mid 1990's to present.

French Flat

Current population estimates at this site are approximately 58,067 plants at the Middle subpopulation and 31,019 at the South subpopulation. The population viability analysis suggests that the South and Middle subpopulations may be at risk of long term decline if current conditions persist and without active management (Pfingsten et al. 2019). Increases in the cover of introduced annual graminoids is of concern as well as disturbance from ORV use. Recent work (based on a study at other sites) has shown that cover of annual invasive grasses is on the rise in response to climate change (Reed 2021).

The observed peak of the Middle subpopulation was an estimated 231,600 individuals in 1998'; nearly five times the current estimate. The population has generally been declining (with some variability) since 2000. The South subpopulation has followed a similar pattern, peaking in 1998, with a total of 124,890 individuals and subsequently declining.

Rough and Ready Creek

We counted 1,534 plants at Rough and Ready Creek in 2024. The Rough and Ready Creek population occurs in grassy patches and roadways on gentle to moderate slopes among shrubs and trees (*Pinus jeffreyi*). This patchy, less extensive habitat pattern is probably responsible for the large difference in population size between this site and French Flat. While road use can reduce the number of plants in this population, we observed recruitment along the roadbeds in 1995-2006, likely due to the reduced competition in these areas. Boulders placed to block vehicle traffic on some roads and grassland patches has resulted in effective protection of this habitat, and grasses are now colonizing the protected road beds. Shrub clearing conducted in the winter of 2022 may help to expand the habitat. One of the seeded plots adjacent to Patch A added an additional 173 plants to the population, increasing this natural population by more than 10%.

Indian Hill

The Indian Hill population, which is intermediate in size between the Rough and Ready and French Flat populations, declined in total numbers from 1997 (when monitoring began) to 1998, then remained relatively stable from 1998 to 2005. Since 2005, the population has been in decline. Following shrub clearing in the winter of 2015, there was a short rebound that appeared to last through 2019. However, the population has declined since that time, and in 2023 the lowest number were recorded for the site. Similar to the populations at French Flat South, the number of large reproductive plants has decreased, and NO seedlings have been noted at the site in the last three years.

The error around our population estimates at Indian Hill have increased since monitoring began. This is due to high variability among transects in 2023 and 2024. Additional plots may be added in 2025 as time allows to decrease sampling error.

5.2 Management Recommendations

French Flat

We recommend that population monitoring at the French Flat subpopulations be conducted once per year for all plots. If insufficient time is available for these activities, sampling of the density plots should be conducted at least once every three years for data collection and plot maintenance. Additional data from the demographic plots will allow improved population viability analyses, including enhancement of

environmental stochasticity estimates and greater certainty in evaluations of the importance of environmental variables such as precipitation and herbivory.

Maintaining the motorized vehicle closure should be a priority for management of this site. Off Road Vehicles still use this area, despite official closure of the roads, making this important population extremely vulnerable to damage. Also, horse-back riders that use French Flat should be warned of the presence of rebar posts interspersed throughout the habitat in order to avoid injury.

Burning could also be implemented as a management tool to decrease cover of introduced graminiods, and should be followed with seeding of native forb and graminoid species.

Rough and Ready Creek

The road leading through the Rough and Ready population is un-gated but some sensitive portions of habitat at this site have been blocked off from vehicle traffic with boulders. These obstacles appear to be having the desired effect of blocking vehicle access, which was a significant concern at this site in recent years. However, vegetation competition following exclusion may now be an issue. Vehicle access should be monitored at this site to confirm that the boulders remain in place and that habitat protection is succeeding.

Monitoring at Rough and Ready Creek should be repeated each year to detect changes in population size and density. However, if insufficient resources are available for this activity, sampling should be conducted at least once every three years. Seeding efforts should be focused in areas of appropriate habitat to augment this natural population.

Indian Hill

The habitat at Indian Hill is restricted by forest that surrounds a long strip of meadow habitat. These meadows are being invaded by shrubs that may be having detrimental impacts on the *L. cookii* population through competition for light, water, and nutrients. In the winter of 2015 a shrub and woody encroachment treatment was executed reducing the cover of woody species into the meadow. Material was piled and burned expanding the potential habitat at the site. No seeding of Cook's desert parsley occurred into the newly created habitat, and seeding is recommended to boost the existing (and declining) population at this site. Monitoring at Indian Hill should be repeated annually to detect changes in population size and density.

6. CONCLUSIONS

Populations monitored as a part of this study have shown a general 30-year decline, but seeding and outplanting efforts appear to help sustain populations.. In order to recover this species, augmentation through seeding and outplanting is recommended as detailed in the 2019 Reintroduction plan (Kaye et al. 2019). Population viability analysis indicates that populations at French Flat are in decline; declines have been observed at Rough and Ready and Indian Hill.

In order to increase plant material availability two production fields should be established from serpentine and non-serpentine sources. Plant materials from these production fields should then be utilized in augmentation efforts in suitable habitat across the range. Work by BLM, IAE and others have shown that seeding and transplanting are suitable methods for increasing populations of this federally listed endangered species.

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APPENDIX A. FRENCH FLAT SOUTH – PLOT DESIGN

Table A-1. Plot information for density and demography plots established in 2012 at French Flat South.

2012 New Plot #	Side of Tape	Location on Baseline (m)	End Rebar at (m)	End Rebar Tag	2012 Last Plant Found at (m)	Demog. Tag	Demog. Plot Location (NE Corner)	Demog. Plot Location (End)
362	E	13	23	363	9.3	-	-	-
364	W	27	30	365	10.4	-	-	-
366	W	30	33	367	6.9	-	-	-
707	W	36	21	708	15.9	329	10.5	11
709	W	38	21	710	15.8	330	6.5	7
711	W	42	21	712	12.7	331	4	4.5
749	E	45	40	750	23.6	353	15.5	15
713	E	52	37	714	25.8	332	17.5	17
741	E	57	35	742	27.1	352	20.5	20
743	E	59	40	744	30.1	354	21.5	21
753	E	61	36	754	31.8	357	23	22.5
745	W	65	39	746	23.9	361	13.5	14
747	E	70	40	748	32.1	360	8.5	8
751	E	72	40	752	22.8	355	5.5	5
725	W	79	40	726	11.8	338	3	3.5
715	E	81	40	716	30.4	333	11.5	11
717	W	94	40	718	28.7	334	13.5	14
719	E	95	40	720	30.9	335	19	18.5
721	E	97	40	722	30.6	336	15.5	15
723	W	99	32	724	31.0	337	16	16.5
727	W	107	28	728	24.6	339	13	13.5
701	E	109	40	702	27.2	326	24.5	24
703	E	111	40	704	28.3	546	23	22.5
705	W	116	32	706	23.0	328	19	19.5
729	W	119	33	730	22.8	340	24	24.5
755	E	125	40	756	27	356	16.5	16
731	E	126	40	732	19.1	341	5.5	5
733	W	128	35.5	734	29.2	342	20	20.5
735	E	129	40	736	23.6	343	9	8.5
737	W	136	40	738	31.5	344	15	15.5
757	W	142	33	758	32.8	358	5	5.5
759	W	144	34	760	32.6	359	9.5	10
739	W	154	40	740	32.8	345	18	18.5

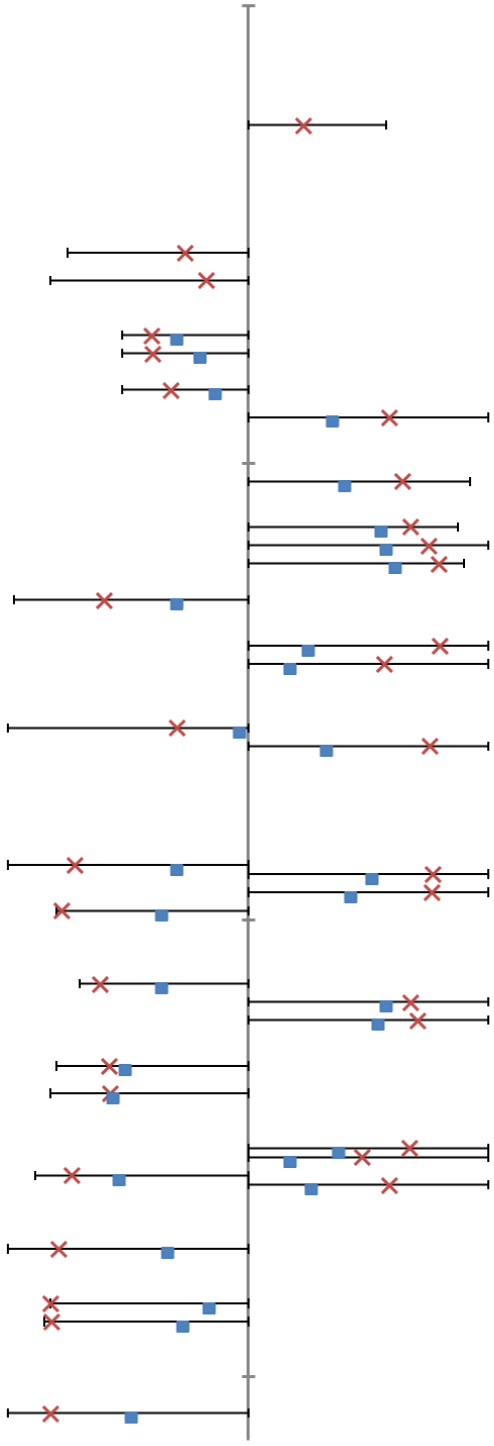

Figure A-1. Location of French Flat South demographic and density plots established in 2012. Baseline transect is 157 m with a bearing due south. Last plants located on density plots are indicated by red crosses. Demography plots are indicated by blue squares. See Table 2 for exact locations of all density and demography plots.

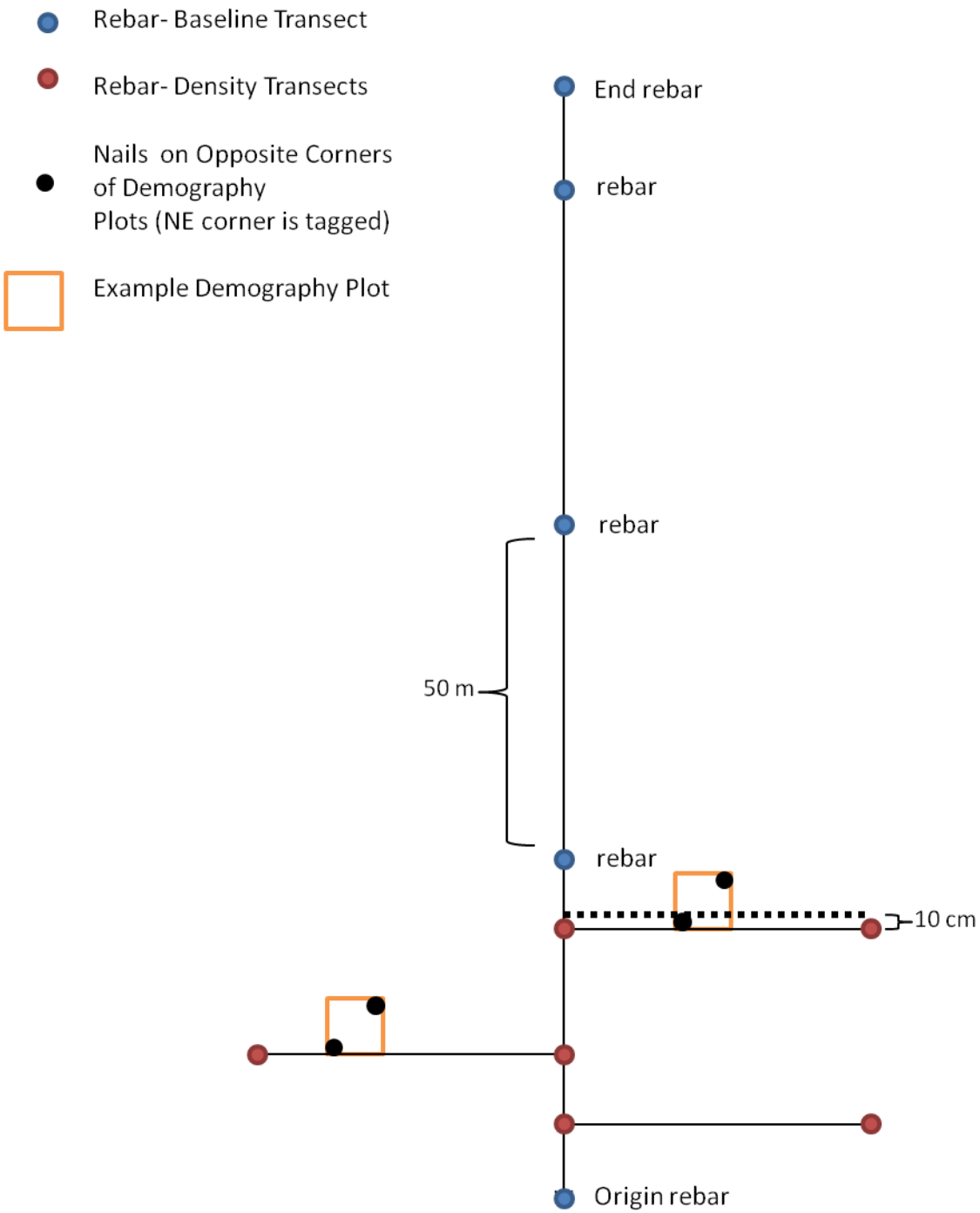

Figure A-2. Schematic layout of density and demography plots established in 2012 at French Flat South and in 2013 at French Flat Middle. Density plots run perpendicular to the baseline to the east or west and are monitored in 10cm strips on the south side of the transect line. Demography plots (0.5m x 0.5m) are marked in the northeast and southwest corners (NE is tagged).

Table A-2. Values utilized when calculating population size at French Flat South, French Flat Middle and Indian Hill. Plot set-up was modified in 2012 (French Flat South) and 2013 (French Flat Middle).

Area	Year	Mapped Population Area (m2)	Size of monitoring Macroplot	size of montioring plots	potential plots	Avg length to last plant	Population area by last plant	Potential plots by last plant
Indian Hill	1994-present					N/A	N/A	N/A
French Flat South	1993-2011	3751	157*2*40m 2	1 ft x 20 ft	2019	N/A	N/A	N/A
	2012	7990		40m x 0.1m		24.4	7668	3143
	2013					23.7	7433	3136
	2014					23.1	7240	3134
	2015					23.7	7453	3145
	2016					22.8	7155	3138
	2017					22.8	7165	3143
	2018					23.6	7407	3139
	2019					23.1	7260	3143
	2020					18.4	5764	3133
	2021					20.2	6350	3144
	2022					20.6	6472	3142
	2023					21.5	6752	3140
	2024					20.7	6496	3140
French Flat Middle	1993-2012	2787		1 ft x 10 ft	3000	N/A	N/A	
	2013	4676	100*2*40m 2	40m x 0.1m	1169	24.2	4830	1996
	2014					20.4	4078	1999
	2015					23.5	4694	1997
	2016					23.7	4733	1997
	2017					19.1	3820	2000
	2018					30	5999	2000
	2019					21.5	4305	2002
	2020					17.2	3439	1999
	2021					27	5407	2003
	2022					25.4	5072	1997
	2023					31.8	6361	2000
	2024					30.4	6074	2000

APPENDIX B. FRENCH FLAT MIDDLE – PLOT DESIGN

Table A1. Plot information for density and demography plots established in 2013 and 2019 at French Flat Middle.

2013 New Plot #	Side of Tape	Location on Baseline (m)	End Rebar at (m)	End Rebar Tag	2013 Last Plant Found at (m)	Demog. Tag	Demog. Plot Location (NE Corner)	Demog. Plot Location (End)
165	W	2.8	30	166	25.95	33	11.43	10.90
154	W	6.5	37	153	34	1	11.2	10.75
155	E	6.5	60	156	26.5	3	18.55	18.05
161	E	9.1	60	162	35.2	8	23.25	23.75
163	E	9.7	60	164	38.05	7,10	7: 15.5; 10: 33.25	7: 16; 8: 33.75
28	W	15	37	29	35.7	876	18.55	19.05
167	E	17.5	60	168	38.05	-	-	-
30	E	19	60	31	35.1	-	-	-
33	W	22	40	34	28.1	877	23.45	23.95
169	W	25	40	170	38.7	37	22.24	21.71
171	E	27.1	60	172	33	38	2.4	2.9
199	W	31	30	200	29.3	-	-	-
35	E	35	60	36	38.6	-	-	-
173	E	36.6	60	174	36.6	874,875	874: 20.5; 875: 11.2	874: 30; 875: 11.7
175	W	40.2	35	176	31.85	167	23.45	23.95
158	W	43.1	30	157	20.6	18	13.2	12.7
159	E	43.5	60	160	28.25	28	5.2	5.7
177	E	46.6	60	178	33.9	29	5.1	5.6
179	E	55.1	60	180	13.7	31	4.75	5.25
181	W	56	20.4	182	19	-	-	-
183	E	60	11.3	184	11.05	-	-	-
185	E	62	10.8	186	9.7	-	-	-
187	W	67	9.9	188	6.7	-	-	-
189	E	72	15	190	14.9	168	6.5	7
37	W	74	16	38	6.9	-	-	-
191	W	82	15.5	192	11.4	169	2.5	2
193	W	86	10.5	194	3.5	-	-	-
195	E	89	33.3	196	19.5	170	15.6	15.1
197	W	95	15	198	10.5	-	-	-
39	W	98	15	40	8.7	-	-	-

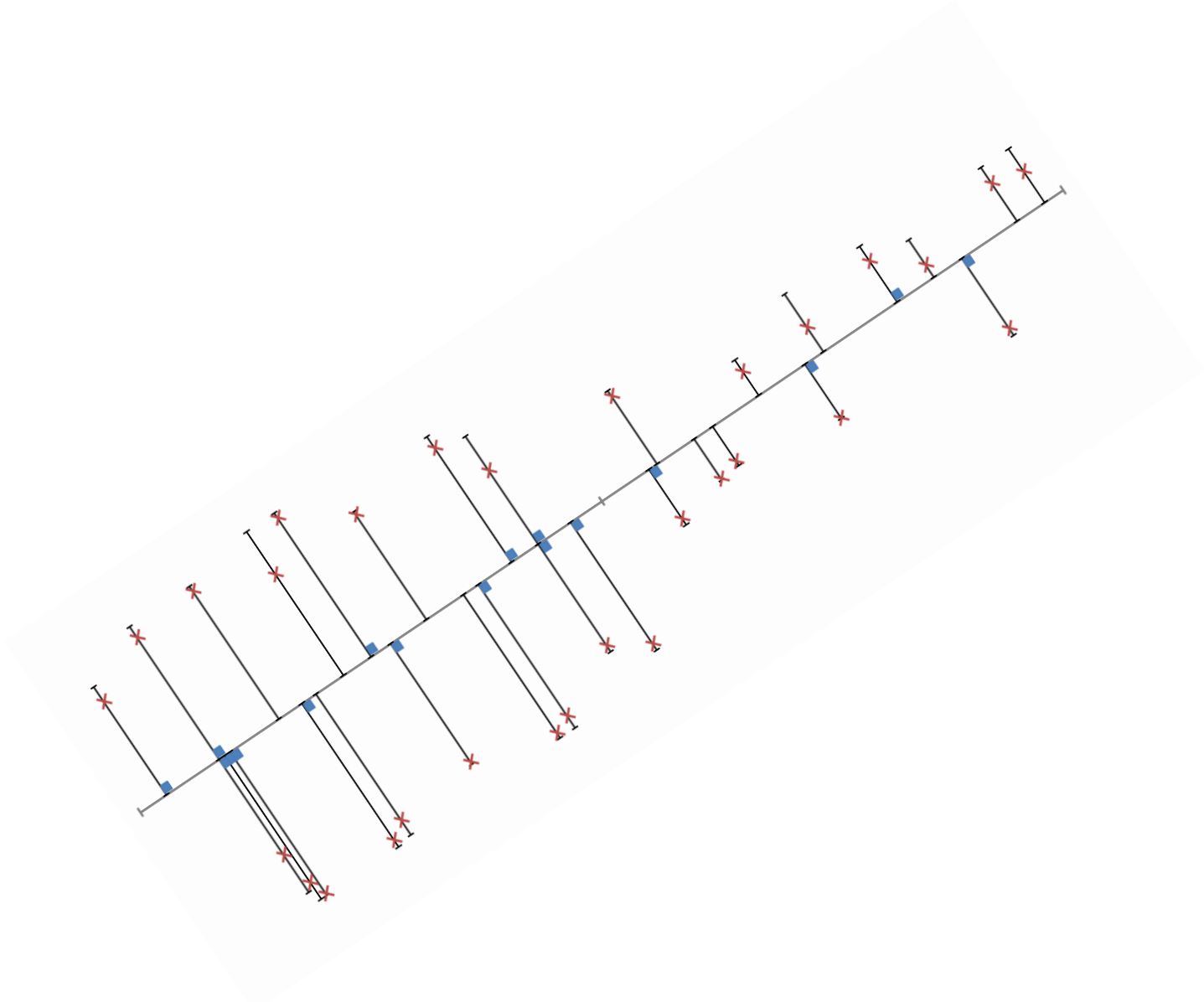

Figure B1. Location of French Flat Middle demographic and density plots established in 2013. Baseline transect is 100 m with a bearing of 034° (northeast). Last plants located on density plots are indicated by red crosses. Demography plots are indicated by blue squares and are not located along the baseline transect as shown here. See Table 1 for exact locations of all density and demography plots. Note that this figure does not reflect the transects on the east side of the baseline were extended in 2018.

APPENDIX C. ROUGH AND READY

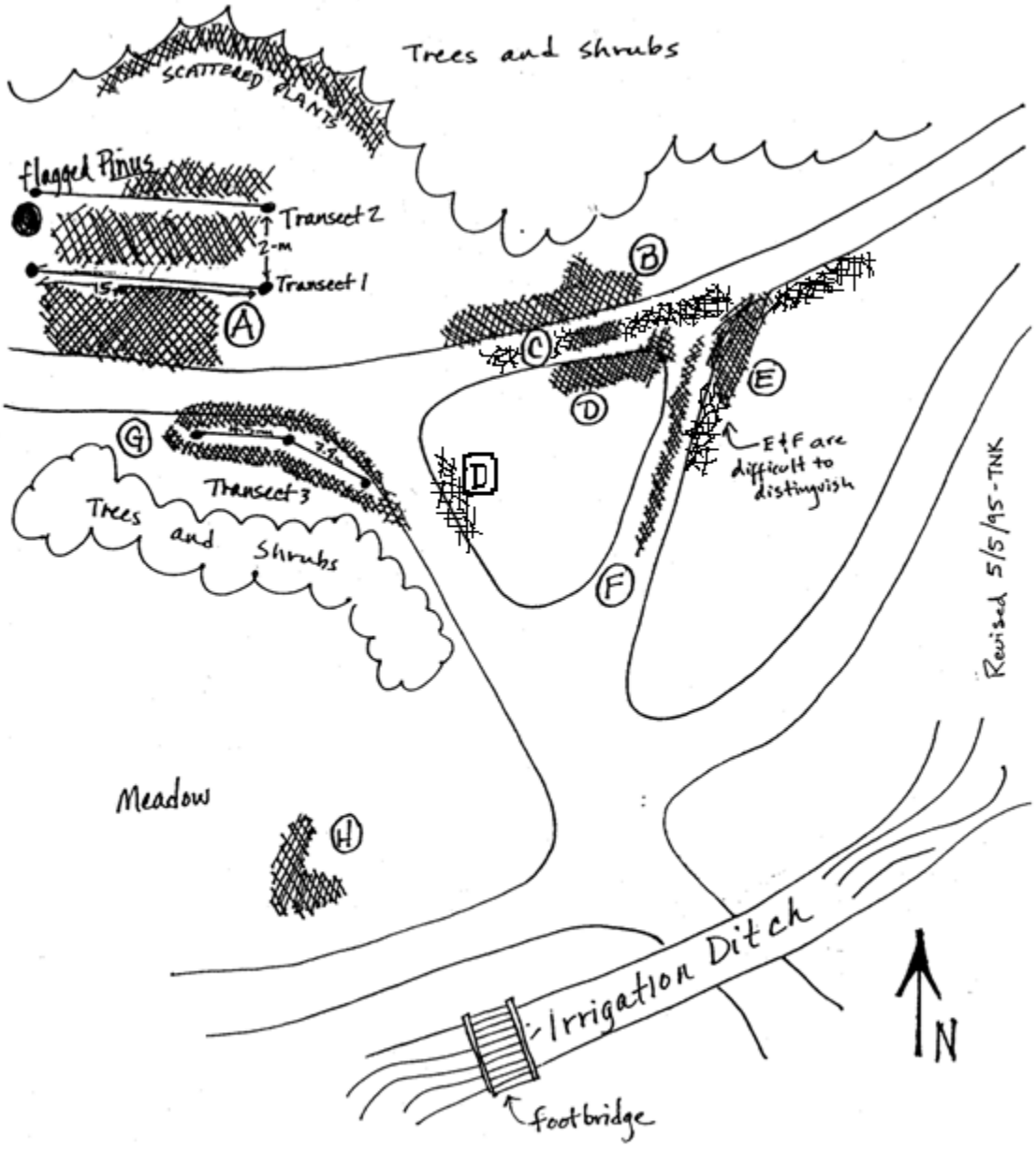

Figure C1. Sketch map of the L. cookii patches located at Rough and Ready Botanical Wayside. Cross-hatching indicates patches of plants. The long-term monitoring transects are also indicated in the drawing. Note that the patches are distinguished by the letters A-H.

Transects 1 and 2:

Transect line; plots oriented to either side of tape.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

Transect 3:

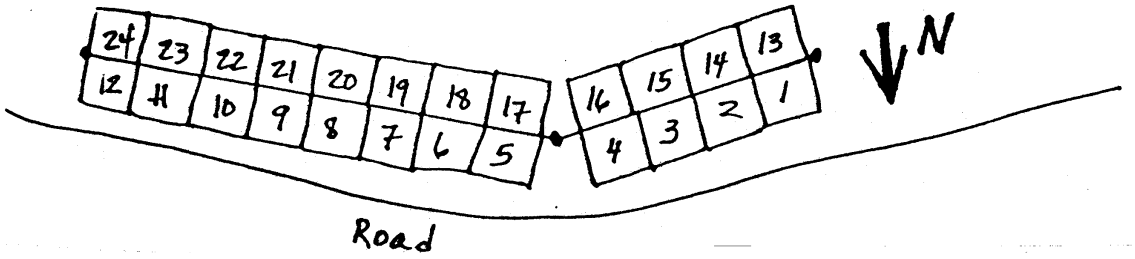

Figure C2. Orientation of the sampling plots around transects 1, 2, and 3 at the Rough and Ready Botanical Wayside population.

APPENDIX D. INDIAN HILL – PLOT DESIGN

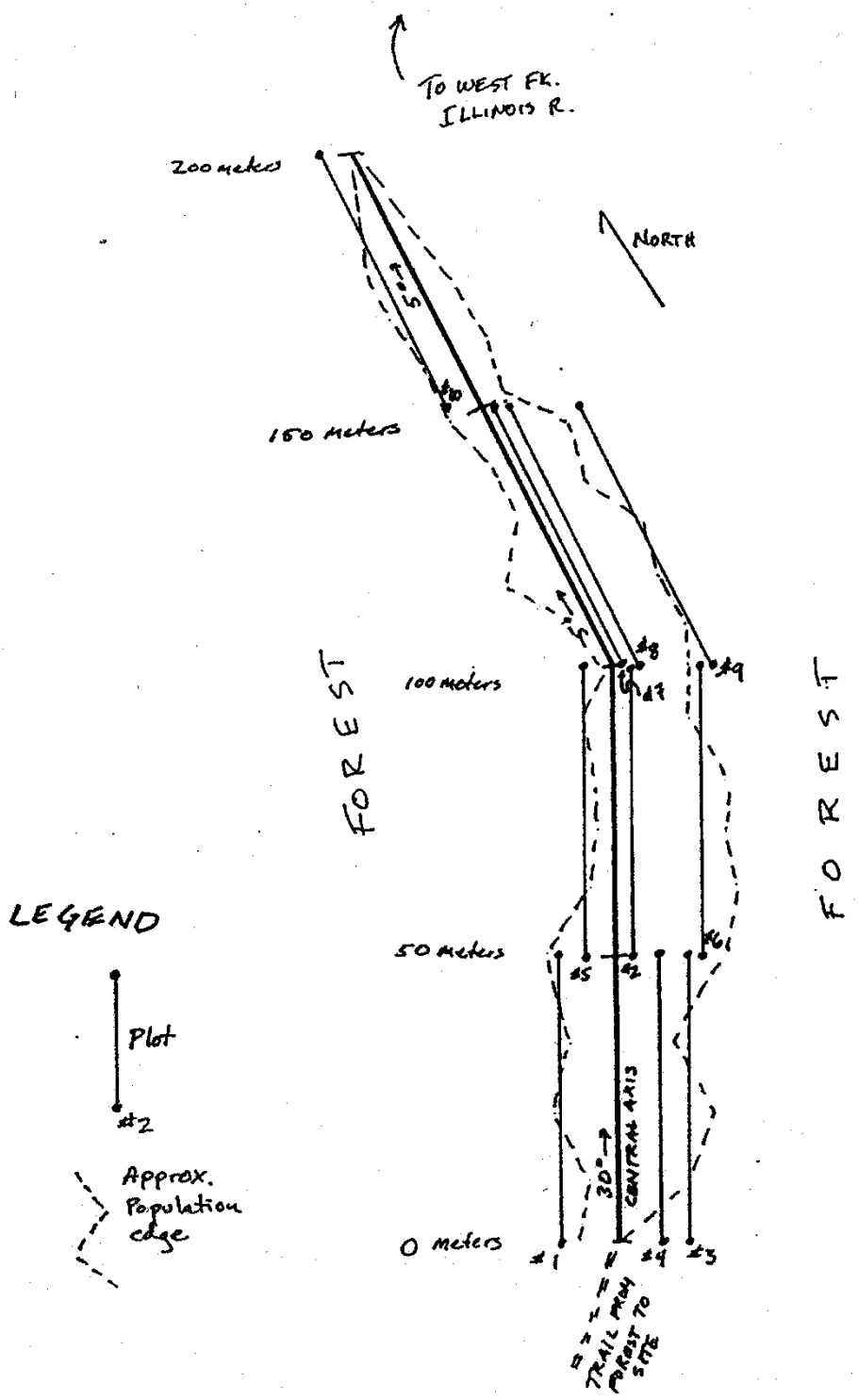

Figure D1. Plot layout of the Lomatium cookii population at Indian Hill. Sample plots are 50 meters x 0.5 meters, marked at either end by a rebar post (with a copper tag and flagging). The plots are monitored on the east side of the tape.

APPENDIX E. GEAR LIST

Field Gear

Last year's report
Last year's datasheets
Density plot datasheets
French Flat South and Middle demographic datasheets
Rite-in-the-rain paper
Jepson guide
Clipboards/pencils
Plot maps/checklists
6 100+ feet tapes, 8 smaller (50ft) tapes (+more for Rough and Ready – broken are fine)
candy canes x MANY
rulers
large binder clips
Bundle of pin flags (at least 2 colors)
Sharpies (for writing on flags) x 2
Quadrat frames: 1x1m for Rough and Ready, .5x.5m for French Flat
Extra rebar, hammer, wire, tags and flagging to replace lost/bent
Compass x 2
First Aid Kit/Tecnu
Water jug *2
Pruning tool
Health and Safety box

Note for planning:

- Indian Hill – 10 transects took about 4-5 hours. Park at/near Samarkand Road (off of Waldo Rd.) Cross through private fence, past pond, turn left and follow old road to site. Final 100m through flagged trail in forest.
- Woodcock Bog- contact landowner prior to visit (contact info in project notes)
- "Waldo-Talkilma" – need BLM gate key to access site.

APPENDIX F. MAPS OF 2022 AUGMENTATION EFFORTS

French Flat

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Appendix F. Figure 1. Map of plots seeded at French Flat in January (southern block) and December (northern block) in December 2022. Nortern block also received 280 plugs.

Rough and Ready

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Appendix F. Figure 2. Map of three plots seeded at Rough and Ready in December 2022.

Waldo-Takilma

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Appendix F. Figure 3. Map of plot seeded at 'Waldo-Takilma' in January and December 2022. In December 2022 280 plants were also outplanted into this block.

Woodcock Bog

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Appendix F. Figure 4. Map of plot seeded in December 2022 at Woodcock Bog.

APPENDIX G POPULATION AND STRUCTURE DATA

French Flat South

Appendix G Table 1. Summary of *Lomatium cookii* population data for the French Flat South subpopulations, 1993-2023. Population size and density estimates include all life-history stages from seedlings to large reproductive plants.

Year	Population Size (95% CI)	Density (plant m^{-2}) ± 1 SE
1993	54,612 (33,698 - 75,526)	6.8 ± 1.3
1994	164,837 (111,579 - 218,095)	20.6 ± 3.4
1995	169,350 (124,073 - 214,628)	21.2 ± 2.9
1996	247,452 (186,779 - 308,125)	31.0 ± 3.9
1997	264,524 (195,852 - 333,196)	33.1 ± 4.4
1998	267,075 (204,835 - 329,316)	33.4 ± 4.0
1999	239,014 (177,581 - 300,446)	29.9 ± 3.9
2000	202,416 (156,353 - 248,479)	25.3 ± 3.0
2001	174,943 (132,398 - 217,488)	21.9 ± 2.7
2002	174,551 (131,737 - 217,365)	21.8 ± 2.7
2003	154,829 (115,968 - 193,690)	19.4 ± 2.5
2004	113,227 (91,201 - 135,253)	14.2 ± 1.4
2005	123,432 (95,095 - 151,768)	15.4 ± 1.8
2006	98,215 (76,262 - 120,168)	12.3 ± 1.4
2007	80,260 (62,441 - 98,079)	10.0 ± 1.1
2008	109,008 (87,290 - 130,726)	13.6 ± 1.4
2009	60,989 (44,971-77,007)	16.3 ± 2.2
2010	64,582 (48,516-80,648)	17.2 ± 2.2
2011	59,837 (45,099-74,576)	16.0± 2.0
2012	122,650 (83,635-161,665)	16.0± 2.6
2013	114,296 (78,393-150,199)	15.4± 2.5
2014	74,379 (51,549-97,209)	10.3± 1.6
2015	59,565 (40,890-78,240)	8.0± 1.3
2016	76,692 (50,285-103,099)	10.7± 1.9
2017	52,809 (35,537-70,081)	7.4± 1.2
2018	63,847 (44,315-83,378)	8.6± 1.3
2019	50,811 (34,461-67,161)	7.0± 1.1
2020	52,184 (30,694-73,674)	9.1± 1.9
2021	35,872 (26,174-45,570)	5.6± 0.8
2022	40,820 (29,809-51,831)	6.3± 0.9
2023	39,107 (27,612-50,603)	5.8± 0.9
2024	31,109 (20,963-41,075)	4.8± 1.5

French Flat Middle

Appendix G Table 2. Summary of *Lomatium cookii* population data for French Flat Middle subpopulations, 1993-2023. Population size and density estimates include all life-history stages from seedlings to large reproductive plants.

	French Flat Middle	
Year	**Population Size (95% CI)**	**Density (plant m^{-2}) ± 1 SE**
1993	74,694 (53,954 - 95,433)	16.0 ± 2.3
1994	80,221 (56,402 - 104,040)	17.2 ± 2.6
1995	84,706 (61,621 - 107,790)	18.1 ± 2.5
1996	78,200 (60,376 - 96,023)	16.7 ± 2.0
1997	182,802 (144,335 - 221,269)	39.1 ± 4.2
1998	195,057 (154,956 - 235,157)	41.7 ± 4.4
1999	182,929 (145,214 - 220,643)	39.1 ± 4.1
2000	140,860 (112,090 - 169,631)	30.1 ± 3.2
2001	145,787 (115,652 - 175,922)	31.2 ± 3.3
2002	151,598 (121,965 - 181,232)	32.4 ± 3.3
2003	137,765 (106,531 - 168,999)	29.5 ± 3.4
2004	105,424 (80,107 - 130,741)	22.6 ± 2.8
2005	115,846 (88,950 - 142,743)	24.8 ± 3.0
2006	93,486 (68,163 - 118,809)	20.0 ± 2.8
2007	91,654 (66,336 - 116,971)	19.6 ± 2.8
2008	90,391 (70,338 - 110,443)	19.3 ± 2.2
2009	113,775 (85,715-141,835)	40.8± 9.9
2010	90,825 (66,095-115,555)	32.6± 8.7
2011	82,275 (62,149-102,401)	29.5± 7.1
2012	44,100 (28,588-59,612)	15.8± 5.5
2013	81,067 (63,355-98,779)	16.8± 1.9
2014	39,933 (25,581-54,286)	9.8± 1.8
2015	46,067 (32,564-59,570)	9.8± 1.5
2016	48,867 (37,155-60,578)	10.3± 1.3
2017	27,200 (17,847-36,553)	7.1± 1.2
2018	38,467 (23,397-53,536)	6.4± 1.3
2019	41,600 (26,980-56,220)	9.7± 1.7
2020	36,286 (26,862-45,709)	10.6± 1.4
2021	35,467 (19,234-51,699)	6.6± 1.5
2022	50,966 (33,107-68,824)	10.0± 1.8
2023	52,400 (37,250-67,550)	8.2± 1.2
2024	58,067 (42,510-73,623)	9.6± 2.6

Indian Hill

Appendix G Table 3. Summary of population density (mean ± 1 S.E.) and size (mean ± 95% CI) for the Indian Hill population, 1997-present.

	density (m^{-2})		population size	
year	reproductive	total	reproductive	total
1997	0.40 ± 0.10	2.56 ± 0.65	1,840 ± 913	11,776 ± 5,738
1998	0.46 ± 0.21	1.41 ± 0.51	2,134 ± 1,842	6,477 ± 4,466
1999	0.39 ± 0.15	1.54 ± 0.49	1,803 ± 1,335	7,084 ± 4,279
2000	0.46 ± 0.19	1.24 ± 0.45	2,098 ± 1,674	5,704 ± 3,904
2001	0.58 ± 0.29	1.54 ± 0.64	2,686 ± 2,562	7,084 ± 5,599
2002	0.60 ± 0.27	1.41 ± 0.54	2,778 ± 2,367	6,477 ± 4,698
2003	0.73 ± 0.30	1.58 ± 0.75	3,349 ± 2,668	7,250 ± 6,556
2004	0.82 ± 0.39	1.91± 0.83	3,772 ± 3,387	8,795 ± 7,259
2005	0.81 ± 0.32	2.80 ± 1.35	3,735 ± 2,826	12,898 ±
2006	0.80 ± 0.30	2.14 ± 0.90	3,680 ± 2,660	9,862 ± 7,849
2007	0.48 ± 0.22	1.89 ± 1.13	2,226 ± 1,969	8,685 ± 9,942
2008	0.60 ± 0.27	2.04 ± 1.04	2,870 ± 2,374	9,623 ± 9,018
2009	0.76 ± 0.31	2.17 ± 0.99	3,478 ± 2,721	9,973 ± 8,640
2010	0.87 ± 0.48	2.38 ± 1.28	3,993 ± 4,186	10,948 ±
2011	0.70 ± 0.36	2.48 ± 1.23	3,220 ± 3,161	11,426 ±
2012	0.36 ± 0.15	2.02 ± 0.78	1,638 ± 1,281	9,310 ± 6,822
2013	0.54 ± 0.26	2.29 ± 1.04	2,502 ± 2,306	10,543 ± 9,077
2014	0.56 ± 0.25	1.95 ± 0.77	2,558 ± 2,156	8,979 ± 6,711
2015	0.48 ± 0.23	1.86 ± 0.68	2,190 ± 1,999	8,538 ± 5,949
2016	0.36 ± 0.10	1.29 ± 0.38	1,974 ± 912	5,943 ± 3,374
2017	0.56 ± 0.35	1.57 ± 0.96	2,558 ± 1,545	7,213 ± 4,298
2018	0.60 ± 0.25	1.75 ± 0.69	2,778 ± 2,215	8,059 ± 6,046
2019	0.78 ± 0.30	1.79 ± 0.60	3,588 ± 2,647	8,225 ± 5,253
2020	0.43 ±0.21	1.23 ±0.45	1,969 ± 1,882	5,667 ± 4,029
2021	0.55 ± 0.17	1.33 ± 0.81	2,539 ± 1,567	6,109 ± 3,720
2022	0.34± 0.12	0.82 ±0.49	1,564 ± 1,097	3,753 ± 2,269
2023	0.33 ± 0.21	1.07±0.70	1,527 ± 980	4,931 ± 3,216
2024	0.52 ± 0.25	1.54 ± 1.37	2,410 ±2,324	7,102 ±6,280

Rough and Ready

Appendix G Table 4. Number of *Cook's desert parsley* individuals in each patch at Rough and Ready Creek. In 2015, patches C, D, E, and F were lumped into patch B; in 2018, patch E was lumped into F; in 2024, Patches E and F were included in D.

	Number of plants per patch								Total		
Year	A	B	C	D	E	F	G	H		%	% in R3
1994	144	6	3	15	13	10	80	7	278	67%	-
1995	177	79	22	85	127	53	135	14	692	58%	15%
1996	259	82	44	82	30	42	119	14	670	46%	20%
1997	167	56	104	315	91	131	119	12	990	31%	9%
1998	141	82	93	180	128	48	106	7	785	39%	16%
1999	223	237	201	308	393	197	81	14	1,654	41%	12%
2000	228	167	105	171	102	296	61	11	1,141	52%	25%
2001	292	113	102	189	245	119	64	24	1,148	56%	20%
2002	88	153	104	135	274	217	16	18	1,005	34%	7%
2003	298	93	217	64	34	382	73	25	1,186	52%	12%
2004	251	114	123	46	271	174	74	25	1,078	46%	9%
2005	248	146	124	56	148	369	72	25	1,188	71%	30%
2006	98	271	235	69	424	540	50	28	1,715	68%	33%
2007	127	141	67	132	217	197	23	20	924	63%	15%
2008	397	250	477	157	433	325	79	9	2,127	56%	13%
2009	567	363	430	424	347	526	102	17	2,776	41%	6%
2010	346	567	758	300	133	382	60	11	2,557	40%	8%
2011	480	394	389	404	406	671	71	15	2,830	43%	10%
2012	292	349	486	146	336	489	65	16	2,179	56%	7%
2013	360	432	393	188	141	392	58	9	1,973	34%	9%
2014	300	450	377	238	263	175	15	9	1,827	23%	6%
2015	497	1,522	-	-	-	-	126	13	2,158	29%	10%
2016	405	300	383	142	198	261	114	15	1,818	51%	16%
2017	233	69	636	61	69	440	117	17	1,642	50%	12%
2018	131	107	724	76	-	452	127	13	1,630	45%	8%
2019	360	342	1,164	46	12	384	130	6	2,444	39%	4%
2020[1]							93		N/A		
2021	398	434	923	15	0	177	95	2	2,044	43%	3%
2022	232	191	631	234	5	29	83	0	1,405	48%	11%
2023	195	54	954	73	14	388	131	2	1,811	50%	1%
2024	134	327	714	292	-	-	64	3			

[1] Due to staffing restrictions in 2020 related to Covid-19 only Patch G was monitored.

Population Growth and Mortality Rates

Appendix G Table 4. Population growth and mortality rates at the French Flat Middle and South sub-populations from 1994-2019. [Note: Demographic data was not collected at the Middle subpopulation from 2000 through 2007, and plants mapped prior to 2012 were not relocated at the South subpopulation.]

	Lambda		Mortality (%)	
year	Middle	South	Middle	South
1994-95	1.103	1.142	18%	39%
1995-96	1.554	1.522	17%	15%
1996-97	1.016	0.811	11%	32%
1997-98	1.135	0.931	10%	25%
1998-99	0.900	0.692	12%	30%
1999-00	N/A	0.789	N/A	18%
2000-01	N/A	0.771	N/A	26%
2001-02	N/A	1.114	N/A	24%
2002-03	N/A	0.687	N/A	35%
2003-04	N/A	0.837	N/A	23%
2004-05	N/A	0.830	N/A	33%
2005-06	N/A	0.933	N/A	20%
2006-07	N/A	1.011	N/A	32%
2007-08	N/A	0.906	N/A	18%
2008-09	0.873	0.855	21%	28%
2009-10	0.844	0.993	25%	22%
2010-11	0.816	0.846	27%	22%
2011-12	0.617	N/A	36%	N/A
2012-13	0.681	0.803	34%	24%
2013-14	0.719	0.838	29%	17%
2014-15	0.617	0.724	43%	32%
2015-16	0.821	0.816	20%	17%
2016-17	0.587	0.667	37%	36%
2017-18	0.986	0.990	9%	17%
2018-19	0.877	0.795	16%	23%