LONG-TERM MONITORING PLAN: *Lewisia longipetala*

(On-line plan: sensitive location information is not included)

USDA FOREST SERVICE, LAKE TAHOE BASIN MANAGEMENT UNIT

PREPARED BY:

BLAKE ENGELHARDT, BOTANICAL TECHNICIAN & SHANA GROSS, ECOLOGIST

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INTRODUCTION

Lewisia longipetala (Piper) Clay, commonly known as Long-Petaled Lewisia, is a low, deciduous perennial of the Portulaceae. The species is characterized by a basal rosette of linear fleshy leaves, distinct glandular-dentate purple sepals, and an inflorescence of several too many stems each bearing one to three pale pink flowers (Calflora 2010; Halford 1992; Halford & Nowak 1996).

Lewisia longipetala is endemic to alpine snowfield communities along the crest of the northern Sierra Nevada between elevations of 2400 and 3800 meters. It grows in moist, rocky habitats directly below persistent snowfields, typically on north-facing and leeward slopes where snow accumulations are greatest. Plants easily become water-stressed when snowmelt ceases to reach them. Populations usually occur on gentle gravelly or bouldery slopes but are also found in the crevices of large rock slabs. Soils are derived from granitic or basaltic parent materials (Halford 1992; Halford & Nowak 1996).

The distribution of *L. longipetala* is limited to the Sierra Nevada crest in El Dorado, Nevada, and Placer Counties, California. There are currently 14 extant populations (CNPS 2010). Three populations exist in the Lake Tahoe Basin Management Unit (consisting of 8 sub-element occurrences); all occur in Desolation Wilderness, in the vicinity of Dicks Lake, Azure Lake, and Triangle Lake. The species is currently designated as a United State Forest Service (USFS) Sensitive Species and a Tahoe Regional Planning Agency (TRPA) Special Interest Species, and has a California State Rank of S2.2 (imperiled) and a Global Rank of G2 (imperiled) (CDFG-CNDDB 2011). It is also included in the California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants on list 1B.3 (*rare, threatened, or endangered in CA; not very threatened in California*) and is therefore eligible for state listing (Calflora 2010).

Human activities that pose direct threats to *L. longipetala* include those that might uproot plants or disrupt the soil surface, such as recreational activities (e.g. camping, hiking, equestrian use, trail construction) and grazing. Given that the known LTBMU populations are located on relatively remote and off-trail ridges, and the activities listed above can be regulated by land management agencies, they may be of secondary concern compared to the potential threat of snowpack decline and altered hydrologic regimes related to climate change. Changes in the timing and amount of snowmelt would likely impact the viability of *L. longipetala* populations due to the species dependence on water supplied by persistent snowfields (Halford 1992; Halford & Nowak 1996). In addition, competitive exclusion of *L. longipetala* could occur if other plant species can expand into habitat where hydrologic regimes were previously more favorable for *L. longipetala* (Halford 1992).

Long-term monitoring transects were installed at two *L. longipetala* populations in 1991, at Basin Peak on the Tahoe National Forest and below Keith's Dome (Triangle Lake) within the LTBMU portion of Desolation Wilderness (Halford 1992). The transects at Keith's Dome have not been revisited since establishment and will be relocated in 2012. Monitoring at additional populations is necessary to document the variation in population trends and site characteristics across the range of the species. Populations on the LTBMU support the largest number of plants (Table 1, CNDDB 2010) and are crucial for maintaining the viability of the entire species. This monitoring plan addresses monitoring specific to LTBMU lands, however it is recommended that CNDDB 15 on the Eldorado NF be evaluated for long-term monitoring suitability.

Table 1. Summary of known *Lewisia longipetala* populations (CNDDB 2010).

CNDDB Occurrence	Land Owner/Manager	Date Last Visit	Number of Plants at Last Visit	1991 Halford Monitoring	LTBMU Long-Term Monitoring
1	Tahoe NF & SPRR	2009	26	X	
2	Tahoe NF	1992	Extirpated?		
3	LTBMU	2009	>1000	X	X
4	Eldorado NF	1990	100		
5	Eldorado NF	1990	0		
6	Eldorado NF	1990	0		
7	LTBMU	2009	7866		X
8	?	1990	Extirpated?		
9	LTBMU	2009	886		
10	Eldorado NF	1990	100		
11	Tahoe NF	1991	<100		
12	Tahoe NF	2009	3000		Recommended
13	Tahoe NF	2009	0		
14	Eldorado NF	1991	100		
15	Eldorado NF	1990	<500		Recommended

CNDDB= California Natural Diversity Database, **SPRR**= Southern Pacific Railroad

MANAGEMENT OBJECTIVES

Forest Service objectives for Sensitive Species are to 1) develop and implement management practices to ensure the species does not become threatened or endangered because of Forest Service actions, 2) maintain viable populations of all native plant species in habitats throughout their geographic range on National Forest System lands, and 3) develop and implement management objectives for populations and/or habitats of sensitive species (FSM 1995). In addition, both the USDA Strategic Plan – FY 2010-2015 and the USFS Strategic Framework for Responding to Climate Change set a goal of "…leading efforts to mitigate and adapt to climate change." The USFS Climate Change Performance Scorecard contains a "Monitoring" element, which tasks each National Forest with "conducting monitoring to track the impacts of climate change and the changing conditions of species, watershed condition, forest and grassland health, and other measures, and the effectiveness of treatment programs."

The TRPA has also established specific vegetation thresholds to provide for the conservation of uncommon plant communities and sensitive plant species in the Lake Tahoe Basin. For sensitive plants, the indicator of threshold attainment is "the number of population sites that are maintained as suitable

habitat (as determined by a qualified expert)." For *L. longipetala*, the goal is to maintain a minimum of two population sites for the species (TRPA 2007).

In order to meet these objectives, all LTBMU *L. longipetala* populations are censused every five years by LTBMU plant ecology/botany staff. As of 2010 no consistent trends in *L. longipetala* population change have been detected (Table 2). Some populations appear relatively stable while others have declined. LELO1a is the only sub-population at the Dicks Lake site that appears to be stable. LELO1b and LELO1c have both declined substantially since the initial census in 2004. A new sub-population (LELO2b) was identified near Azure Lake in 2008, boosting the overall size of that occurrence. The population near Triangle Lake/Keith's Dome (LELO3) appears relatively stable.

Table 2. LTBMU census results for *Lewisia longipetela* sub-element occurrences.

	Census Year				
LTBMU EO	**2002**	**2004**	**2006**	**2009**	**2010**
LELO1a	6000	4450	-	7860,*	*
LELO1b	-	360	-	4	2
LELO1c	-	124	-	1	33
LELO1d	-	1	-	1	12
LELO2	9	472	-	86	331
LELO2b	-	-	-	800	1450
LELO3a	-	1067	-	750	*
LELO3b	-	-	150	201	-

* Monitoring plots established/revisited.

Permanent long-term monitoring plots were established at two LTBMU *L. longipetala* populations in 2009 and 2010. The intent of the long-term monitoring is to more quantitatively and consistently determine the status and trend of the populations. Both populations are comprised of large numbers of plants, making it difficult to accurately count individuals or determine population trends. Monitoring in permanent plots will allow for more repeatable and efficient surveys in order to determine population status. In addition, information on demographic structure and reproductive success, local snowfield patterns, annual climate patterns, and the associated plant community can be combined to better interpret population changes.

STUDY DESIGN

Monitoring Questions

1. What is the status and trend of *Lewisia longipetala* density within the Lake Tahoe Basin?

2. What is the status and trend of *L. longipetala* demographic structure within the Lake Tahoe Basin?

3. Are changes in climate (snowpack persistence, total snowfall, timing of spring runoff) influencing the density or demography of *L. longipetala* populations?

4. Are changes in inter-specific competition (associated species, total vegetative cover) influencing the density or demography of *L. longipetala* populations?

Monitoring Objectives

1. Density: The number of *L. longipetala* plants in plots will be counted in order to detect recruitment or loss of individuals. The information from this sample of plants will be used to approximate the general trend in the size of the population (increasing, decreasing, or stable).

2. Demographic Structure: The number of *L. longipetala* plants in each of six life stages (seedling, vegetative, budding, flowering, fruiting, and withered) will be counted in order to better understand changes in the demographic structure (e.g. a decline in recruitment or a decline in all life stages). Demographic structure monitoring can often detect population changes earlier than simple density monitoring (Elzinga et al. 1998).

3. Climate Change: Density and/or demographic structure at the time of monitoring may vary with the snow and climatic conditions of that particular year. Distance from *L. longipetala* plots to the nearest snowfield along with data on date of greatest Snow-Water-Equivalent (SWE) and date of SWE=0 will be used to better understand the relationship between population trends and climate change variables. The source for the SWE data is the Echo Peak SNOTEL Site (Site Number 463; NRCS-SNOTEL 2011).

4. Inter-specific Competition: The plant species that co-occur with *L. longipetala* as well as their cover in the sampling plots will be recorded in order to characterize *L. longipetala* habitat and associated plant communities. Changes in the percent cover of co-occurring species and the total vegetative cover within the monitoring plots will identify inter-specific competition pressure on *L. longipetala* populations.

Monitoring Design & Protocol

This study's monitoring design is based on the methods of Halford (1992) with additional demographic data collection. This will allow for comparison with data collected from the long-term monitoring plots established at the Basin Peak (Tahoe NF) and Keith's Dome (LTBMU; if relocated) populations in 1991.

Long-term monitoring plots were established at LELO 1a above Dicks Lake in 2009 and at LELO3a above Triangle Lake in 2010 (Appendix 1). Monitoring could not be established at LELO2b (Azure Lake) due to extensive granite slabs that prevented the installation of permanent plot markers. All three populations are located in Desolation Wilderness. At each population, three permanent transects were established within the boundaries of the population. Transects were systematically placed such that at least one *L. longipetala* plant occurred in each plot. Because complete randomization was not employed to locate transects and plots, the data is only representative of the measured sample of the population. Transect location diagrams and details on layout (length, bearing, endpoint UTMs and photographs) are found in Appendix 2.

Plant data was collected in plots placed along one side of the transect at regularly-spaced intervals. Plot ID numbers, locations along transects, and notes are summarized in Appendix 3. Site elevation, slope, and aspect as well as transect slope and bearing were collected at the time of plot establishment. Distance and bearing to the nearest uphill snowfield will be collected for each transect during each monitoring visit.

The start and end of each transect were permanently marked with rebar. After a meter-tape was stretched between the two rebar, plots were placed along the left side (when viewed from 0m or unless otherwise noted) of the transect tape so that the bottom of the plot was parallel to the tape. Plot locations were permanently marked with a large nail, tag, and blue stake chaser at the lower left corner of the plot (see Appendix 4 for an example photograph). Adjustments to plot or marker location were made if a nail could not be put in the ground due to a rock or other obstacle. The plot frame used was 0.5m by 0.5m ($0.25m^2$).

All plants that occurred completely within the plot were counted. Each rosette was counted as one individual. If a plant occurred on the edge of the plot and was only partially within the plot, it was counted if it was on the top or bottom side of the plot (sides parallel to the tape) but not if it was on the left or right side of the plot (perpendicular to the tape). Counts of the number of individual plants were made by life stage: seedling, vegetative, budding, flowering, fruiting, and withered. Canopy cover was recorded for all other plant species (including moss and lichen) that occurred in each plot. Each plot was photographed from directly above. An example blank datasheet and instructions for filling out the datasheet are attached at the end of this monitoring plan (Appendix 5).

The monitoring protocol was designed with the goal of minimizing impacts to the populations (*sensu* Farnsworth 2005). The permanent markers do not affect snow accumulation or hydrology and they do not attract undue attention to the populations. Monitoring was only set up at two of eight sites (both of which are comprised of greater than 1000 individuals), the sites are only visited every three to five years, and the protocol does not require any destructive sampling. Trampling and soil compaction during visits are minimized by traveling on durable substrates (e.g. rocks and slabs) as much as possible.

Monitoring data and plot photographs will be stored at:
O:\NFS\LTBMU\Project\Monitoring\StatusTrend\Lewisia_longipetala LongTermMonitoring

The GIS shapefile consisting of transect start and end points will be stored at:
T:\FS\NFS\LTBMU\Project\Monitoring\StatusTrend\Lewisia_longipetala

These points also will be included in the larger *LTBMU Monitoring Projects* shapefile at:
T:\FS\NFS\LTBMU\Project\Monitoring

Timing of Monitoring

Monitoring should occur in late summer (August-September) when plants are flowering, within one week of the date of the initial plot establishment and sampling, when possible. During late season snow years, monitoring may occur later in the year so that plots are not under snow during monitoring. Monitoring will occur for two years after plot establishment in order to collect baseline data and then every three to five years until a decision is made to no longer monitor this species (i.e. this species is no longer considered sensitive, rare, imperiled, etc.). The monitoring schedule is detailed in Table 3. This schedule assumes a revisit every four years; however the actual years of revisits may change given the three to five year range.

Table 3. Schedule for *Lewisia longipetala* monitoring at two populations within the Lake Tahoe Basin.

	Monitoring Year							
LTBMU EO	**2009**	**2010**	**2012**	**2015**	**2019**	**2023**	**2027**	**2031**
LELO1a	Established	x	x	x	x	x	x	x
LELO3a		Established	x	x	x	x	x	x

DATA ANALYSIS & MANAGEMENT IMPLICATIONS

1. Density: Temporal changes in LELO density will be explored graphically. Density will be represented by both the sum of plants at each transect and each site, and also by the average ± standard error at each transect and each site. These graphs will also be compared to trends in the ongoing census counts of LELO populations. A paired t-test will be used to test for a significant difference in average density between years at each site individually and at the two sites combined. For this analysis, LELO density in each plot will be averaged over the entire site, ignoring the blocking effect of transect. After three years of data have been collected, a repeated-measures ANOVA will be used to test for any significant differences in average density between years, followed by paired t-tests with a Bonferroni correction for multiple comparisons to identify which years were significantly different.

2. Demographic Structure: Temporal change in the demographic structure of sampled LELO plants at each population will be displayed graphically using stacked column charts. A paired t-test will be used to test for a significant difference between years in the number and percentage of plants in each life stage at each site. After three years of data have been collected, a repeated-measures ANOVA will be used to test for any significant differences in the percentage of each life stage between years, followed by paired t-tests with a Bonferroni correction for multiple comparisons to identify which years were significantly different. A decrease of 20% in the number of seedlings or flowering plants, or an increase of 20% in the number of withered plants, would be deemed undesirable for population viability. There is no scientific data available that would aid in determining such a threshold; 20% was selected based on BLM guidelines for maintaining population viability when making seed collections (SOS-BLM 2011). If such a decline was observed, the site would be revisited the following year. If two years of similar decline are observed, a management strategy might be to consider experiments to establish *L. longipetala* from seed.

3. Climate Change: The distance from each transect to the nearest snowfield in each year will be displayed graphically. Plant density and the number of withered plants at each transect will be plotted against distance to the nearest snowpack. After three years of data collection, date of greatest Snow-Water-Equivalent (SWE) and date of SWE=0 will also be plotted against transect density and/or the number of withered plants. When a sufficient number of data points have been collected, a regression analysis may be used to characterize the relationship between plant density/number of withered plants and these climate variables. If a receding snowpack appears to be causing a population decline, management strategy might consider experiments to establish *L. longipetala* from seed closer to more persistent snow in the vicinity of the population.

4. Inter-specific Competition: Average percent cover of co-occurring species and the number of plots in which they occur will be summarized by *Site X Year*. The change in percent cover for each species will also be summarized following successive monitoring visits. Total vegetative cover in plots will be derived by summing the individual percent covers of plant species in each plot; thus total vegetative cover may

exceed 100 percent. Nonmetric Multidimensional Scaling (NMS), a type of multivariate statistical analysis, will be used to examine relationships between species composition and LELO density/seedling density. Species percent covers will be used to ordinate plots while LELO density, LELO seedling density, and total vegetative cover in the plots will be overlaid as directional vectors. Plots will be grouped using the categorical variable *Site X Year X Transect*. These results will be used to interpret whether there is a relationship between LELO density and total vegetative cover, and whether particular species are driving the changes in total vegetative cover and LELO density. If it is determined that increasing vegetative cover or expansion of a certain species is correlated with decreasing LELO density, a possible management response could be experimental removal of that species.

Microsoft Excel will be used to calculate descriptive statistics and to produce basic graphs and tables. SigmaStat will be used for t-tests, ANOVAs, and regression analyses. PC-ORD will be used for multivariate analyses (NMS). Analysis of monitoring data will be completed following baseline data collection and then following each year of monitoring revisits. Management recommendations will be identified in the monitoring reports. If immediate action needs to be taken to maintain population viability, project suggestions will be brought forth to the forest leadership team.

Monitoring reports will be stored at:
O:\NFS\LTBMU\Project\Monitoring\StatusTrend\Lewisia_longipetala LongTermMonitoring

Reports will also be posted to the external LTBMU website under "Publications" at:
http://www.fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gjAwhwtDDw9_AI8zPyhQoY6BdkOyoCAGixyPg!/?ss=110519&navtype=BROWSEBYSUBJECT&cid=FSM9_046480&navid=360000000000000&position=Feature*&ttype=detail&pname=Lake Tahoe Basin Mgt Unit- Maps & Publications

ASSESSMENT

The monitoring protocol will be assessed after initial data analysis is complete to weigh the information gained against time and resource requirements, and to determine the efficiency of the methods. Changes to the protocol, inclusion of additional sites, and/or suggestions for improvement will be considered.

PLANNING

Activity	Time	Notes
Monitoring visits*		
LELO 1a (August 16-17)	1.5 days	Overnight backpack; could be combined with other surveys. Day 1: Hike to Dicks Lake in afternoon. Day 2: Survey plants in morning & hike out in afternoon.
LELO 3a (August 10)	1 day	Utilize boat taxi across Echo Lakes.
Data entry	1.5 days	
Data analysis & Reporting	8 days	

*Based on 10-hour days and two people when conducting field work, one person when completing office work.

REFERENCES

Calflora: Information on California plants for education, research and conservation. [web application]. 2010. Berkeley, California: The Calflora Database [a non-profit organization]. Available: www.calflora.org (Accessed: December 10, 2010).

California Department of Fish and Game, California Natural Diversity Database. 2011. Special vascular plants, bryophytes, and lichens list. Available: www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPPlants.pdf. Quarterly publication, January 2011.

California Native Plant Society (CNPS). 2010. Inventory of Rare and Endangered Plants (online edition, v8-01a). California Native Plant Society. Sacramento, CA. (Accessed: December 30, 2010).

Elzinga, C. L., Salzer, D. W., and Willoughby, J. W. 1998. *Measuring & monitoring plant populations.* BLM Technical Reference 1730-1. USDI Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO.

Farnsworth, E.J. 2005. Guidelines for ethical field research on rare plant species. New England Wildflower Society, Framingham, MA.

Forest Service Manual (FSM). 1995. Title 2600 – Wildlife, Fish, and Sensitive Plant Habitat Management, Section 2670.22, Amendment No. 2600-95-7, Effective June 23, 1995. USDA Forest Service, Washington, D.C.

Halford, A. S. 1992. Interim Management Guide for *Lewisia longipetala* Tahoe and Eldorado National Forests and the Lake Tahoe Basin Management Unit. USDA Forest Service, Tahoe National Forest, Nevada City, California.

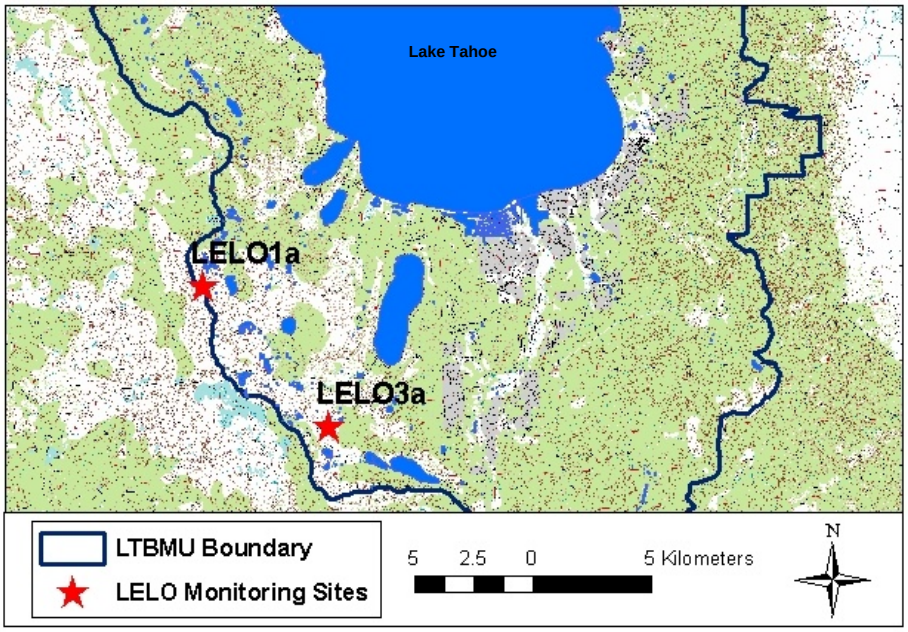
Halford, A. S. and R. S. Nowak. 1996. Distribution and ecological characteristics of *Lewisia longipetala* (Piper) Clay, a high-altitude endemic plant *Great Basin Naturalist* 56:3 225-36.

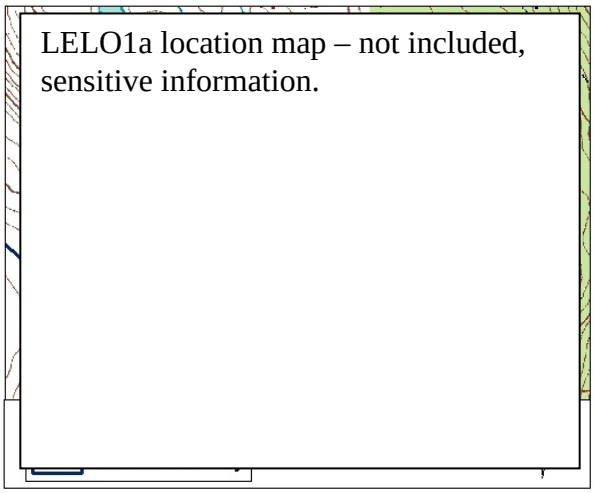
Natural Resources Conservation Service (NRCS) - SNOwpack TELemetry (SNOTEL). 2011. Snowpack and related climatic data collection system. Available: www.wcc.nrcs.usda.gov/snow/.

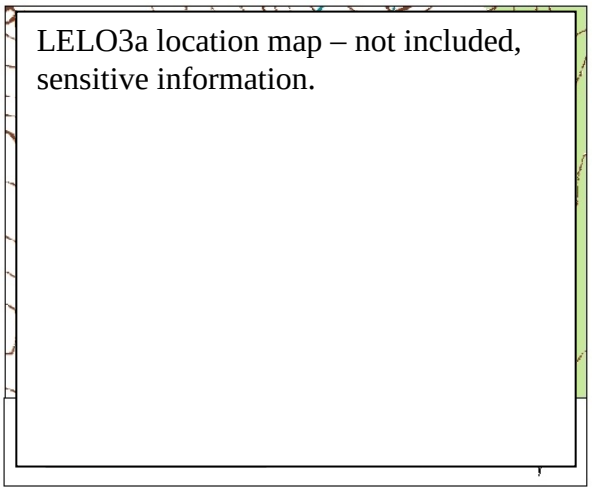
Seeds of Success (SOS) - USDI Bureau of Land Management (BLM). 2011. Partnership to collect, conserve, and develop native plant materials for stabilizing, rehabilitating and restoring lands in the United States. Available: www.nps.gov/plants/sos/index.htm.

Tahoe Regional Planning Authority (TRPA). 2007. 2006 Threshold Evaluation Report. Tahoe Regional Planning Agency, Zephyr Cove, Nevada.

APPENDIX 1. Location maps of populations selected for long-term monitoring.







APPENDIX 2. Transect descriptions including length, bearing (taken from 0m), side of transect for plots, endpoint UTMs (NAD83, Zone 10) and photographs taken from both transect endpoints. Diagram of transect locations at each site. Pages 12-15.

<u>LELO 1A, Transect 1</u>: 25m long, Bearing=354°, Plots on left side of transect

UTM data not included: sensitive information

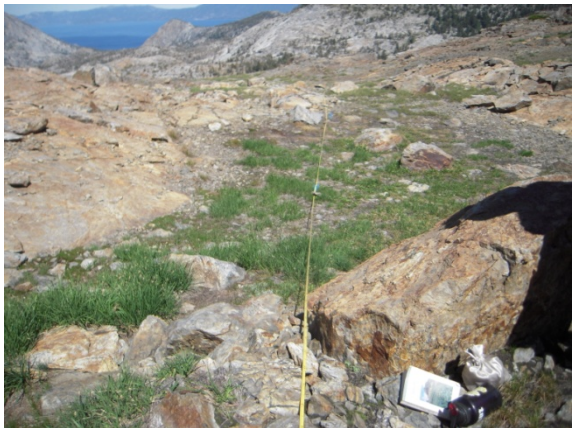
0m → 25m

25m → 0m

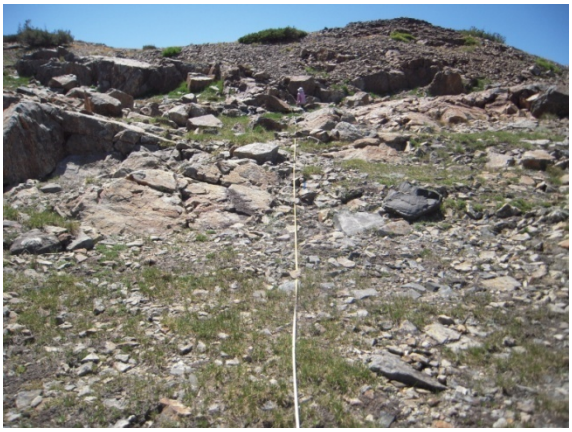
<u>LELO 1A, Transect 2</u>: 25m long, Bearing=62°, Plots on left side of transect

UTM data not included: sensitive information

0m → 25m



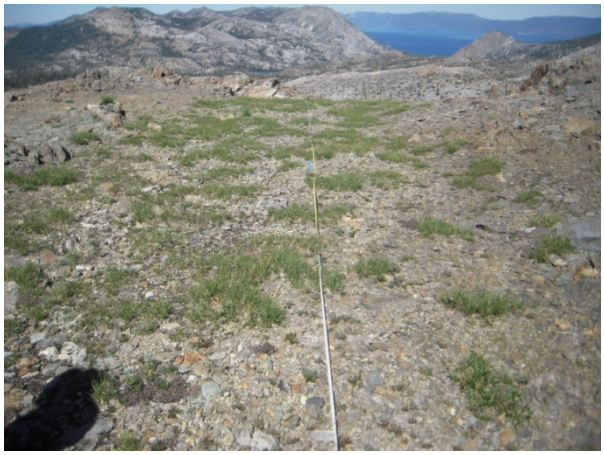
25m → 0m



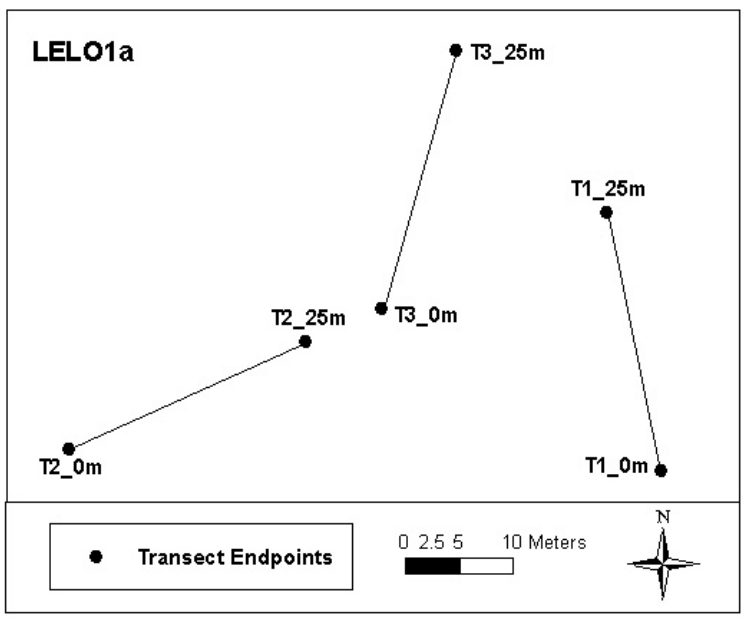
<u>LELO 1A, Transect 3</u>: 25m long, Bearing=28°, Plots on left side of transect

UTM data not included: sensitive information

0m → 25m



25m → 0m



LELO 3A, Transect 1: 20m long, Bearing=11°, Plots on left (west) side of transect

UTM data not included: sensitive information

0m → 20m

20m → 0m

LELO 3A, Transect 2: 14m long, Bearing=39°, Plots on right (southeast) side of transect

UTM data not included: sensitive information

0m → 14m

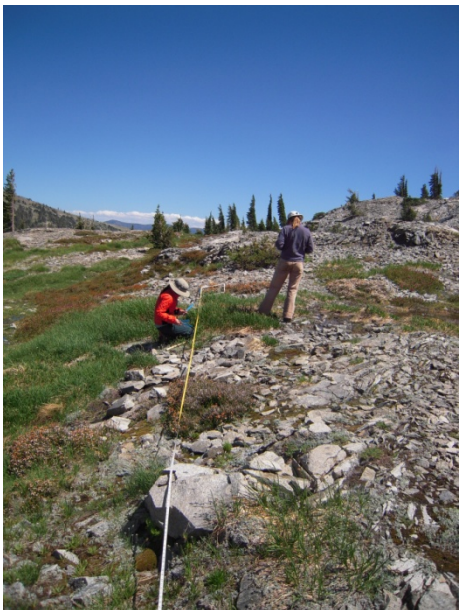
14m → 0m

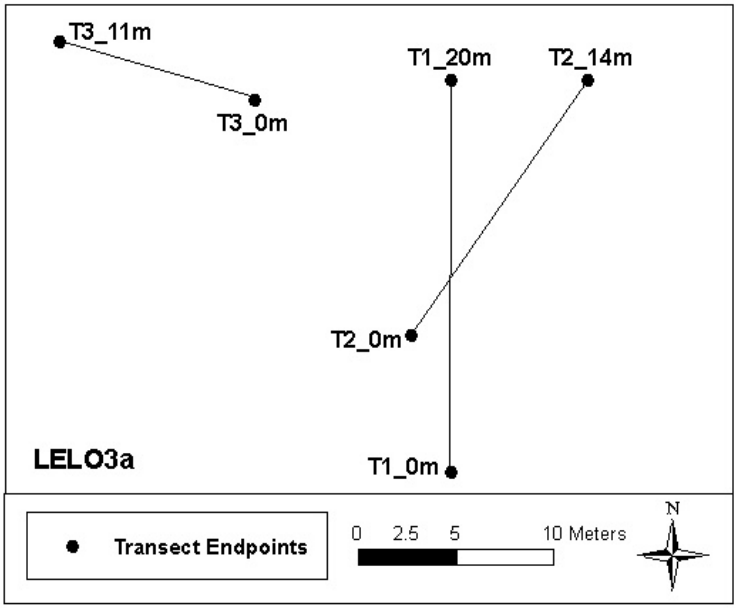
<u>LELO 3A, Transect 3</u>: 11m long, Bearing=286°, Plots on left (uphill) side of transect

UTM data not included: sensitive information

0m → 11m

11m → 0m





APPENDIX 3. Number of plots at each transect, side of transect for plots (when viewed from 0m), and plot descriptions including plot ID#, distance along transect, and notes on exact plot placement. "Distance" is the point on the transect tape where the lower left corner of the plot should be placed, unless otherwise noted (e.g. Transect 2 at LEL03a). Pages 16-17.

LELO 1a (18 plots)

Transect 1 (6 plots, Left Side)

Plot ID#	Distance (m)	Notes
1	0	-
2	5	-
3	10	-
4	15	-
5	20	-
6	25	-

Transect 2 (6 plots, Left Side)

Plot ID#	Distance (m)	Notes
7	0	-
8	5	-
9	10	-
10	15	-
11	20	-
12	25	-

Transect 3 (6 plots, Left Side)

Plot ID#	Distance (m)	Notes
13	0	-
14	5	-
15	10	-
16	15	-
17	20	-
18	25	-

LELO3a (19 plots)

Transect 1 (8 plots, Left Side)

Plot ID#	Distance (m)	Notes
112	0	-
113	2.5	Nail at 2.5m, in upper left corner (off tape)
114	7.5	-
115	10	-
116	12.5	-
117	15	-
118	17.5	-
119	20	Nail at 20.5m, in lower right corner

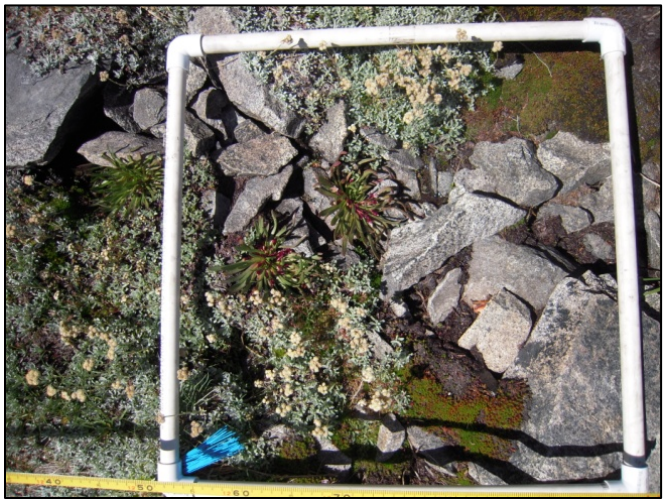
Transect 2 (5 plots, RIGHT Side)

Plot ID#	Distance (m)	Notes
120	0	Nail at 0m, in lower right corner
121	2.5	Nail at 2.5m, in lower right corner
122	4	Nail at 4.5m, in upper left corner (off tape)
123	12	Nail at 12m, in lower right corner
124	14	Nail at 14m, in lower right corner

Transect 3 (6 plots, Left Side)

Plot ID#	Distance (m)	Notes
125	0	Nail at 0.2m, but place lower left corner at 0m
126	2	-
127	4.5	-
128	6.5	-
129	8	-
130	10	Nail at 10.5m, in upper right corner (off tape)

APPENDIX 4. Example photograph of standard plot layout with nail, tag, and blue stake chaser marking the lower left corner of the plot.



APPENDIX 5. Instructions and example datasheet for *Lewisia longipetala* monitoring. Pages 18-22.

1. Fields at the top of the first page of the datasheet identify the population and describe environmental characteristics of the entire site:

Population EO: The assigned LTBMU EO that identifies the population (e.g. LELO1a).

Population Location: The location name used informally to identify the population (e.g. Dick's Lake).

Datum: The UTM datum used when recording UTM coordinates (should always be NAD83).

Zone: The UTM zone used when recording UTM coordinates (should always be Zone 10 based on current location of LTBMU LELO populations).

Easting & **Northing:** UTM coordinates to be used to locate the population.

Date: Month/day/year that the fieldwork was conducted.

Observers: Last name or initials of all people that participated in data collection.

Elevation: The average elevation in meters of the population (could also give a range of elevations).

Slope: The average percent slope of the population (could also give a range of slope).

Aspect: The average aspect in degrees of the population (could also give a range of aspect).

Site Description/Plant Community/Disturbance: A narrative description of the site including local topography, substrates, moisture regimes, habitat type, and significant or unique features. Describe in detail any disturbances to the population or area above the population, as well as species interactions (e.g. herbivory).

2. The table in the middle of page one is for recording information about the transects at each site. This information is primarily recorded at the time of monitoring establishment, but some fields (especially photo #s and distance to snow) are important to collect during each visit.

Transect: Transect number (1, 2, 3, etc).

Length: Transect length in meters. This is the distance between the rebar marking the two endpoints of each transect.

Bearing: Transect bearing in degrees. Bearing is recorded with a compass while standing at 0-meters and looking toward the end of the meter tape.

Slope: The average percent slope of the transect.

GPS (0m) & **GPS (end):** The UTM coordinates that correspond to each of the endpoints of the transect. These should be recorded in the same datum and zone as recorded at the top of the datasheet (should be NAD83 – Zone 10).

Photo# (0m) & **Photo# (end):** At each revisit, take a digital photo of the length of the transect as viewed while standing at each endpoint. Record the file number of the corresponding photo (i.e. **Photo# (0m)** is taken standing at 0m looking toward the end of the meter tape at 25m for example).

Plot Side: The side of the tape (when viewed from 0m) that the plots are laid down on. Make notes if the plots are not laid on the left side of the tape.

Distance/Bearing to Snow: At each revisit, identify the nearest uphill snowfield that is providing water to the population. If there is no snow above the site, identify the nearest snowfield. Record the shortest distance and the corresponding bearing from the transect 0m endpoint to the snowfield. Use a meter tape and compass if the snow is nearby. If the snow is further away, a GPS can be used to determine distance and bearing. Mark the transect endpoint, walk to the nearest point on the edge of the snowfield, and then "find" the transect using the GPS. The GPS will give a distance and bearing to the transect; that distance is correct, but add 180° to the bearing to get bearing from the transect to the snowfield (and not vice versa). When feasible, use a GPS to map the relevant boundary of the nearest snowfield (lower boundary if snow is uphill, or nearest boundary if snow is adjacent or below). If no snow is to be found than make notes to that effect.

3. The second table on page one is for recording information about the plots at each transect. Transect, Plot, and Distance shouldn't change after the initial transect installation, but photos should be taken and photo# recorded during each visit.

Transect: Transect number (1, 2, 3, etc).

Plot: Plot ID number, which corresponds to the number on the tag affixed to the nail and stake chaser at the lower left corner of the plot.

Distance (m): The distance along the meter tape where the lower left corner of the plot is placed. The bottom of the plot should be placed against the meter tape. This is also the location of the nail with ID tag and blue stake chaser attached. In some cases a nail could not be driven into the ground at this exact location; in that case there are notes describing the adjustments. If a plot has a distance of 4m, but the note says "nail at 4.5m," the lower left corner of the plot should be at 4m, the lower right corner will be at 4.5m, and the nail will mark the lower right corner in this case.

Notes: Note any departures from the standard plot/nail positioning, as well as observations regarding unique features or disturbances in a specific plot.

4. The table at the top of the second page is for recording measurements of *Lewisia* density in each plot. All fields in this table must be filled out during every revisit. All plants that occur completely within the plot are counted. Each rosette is counted as one individual. If a plant occurs on the edge of the plot and is only partially within the plot, it is counted if along the top or bottom side of the plot (sides parallel to the tape) but not if along the left or right side of the plot (perpendicular to the tape). Plants are counted according to life stage and each plant should only be counted once (it is assigned to only one life stage). The number of plants in each life stage will be summed to derive the total number of plants in the plot.

Transect: Transect number (1, 2, 3, etc).

Plot: Plot ID number, which corresponds to the number on the tag affixed to the nail and stake chaser at the lower left corner of the plot.

Seedling: Count and record the total number of seedlings in the plot. Seedlings can be difficult to distinguish from small vegetative plants, but the determination should be based on their very small size, the presence of cotyledons, and/or only a few very small true leaves. Do your best!

Vegetative: Count and record the total number of vegetative plants (of any size but excluding seedlings) in the plot.

Budding: Count and record the total number of plants in the plot with developing inflorescences and/or buds but without mature, open flowers.

Flowering: Count and record the total number of plants in the plot with mature, open flowers in the inflorescence.

Fruiting: Count and record the total number of plants in the plot with capsules and/or seeds present. May have flowers as well as fruits, but include under the later phenological stage- fruiting.

Withered: Count and record the total number of plants in the plot with withered leaves (i.e. plant appears to be dying back for the season or senescing).

5. The lower table on the second page is for recording measurements of percent cover of plant species other than *L. longipetala* that occur in each plot (include moss and lichens). Identify all plants to species if possible. All fields in this table must be filled out during every revisit. Transect and plot are entered in the top two rows of the table, while species names are entered once in the left hand column.

Transect: Transect number (1, 2, 3, etc).

Plot: Plot ID number, which corresponds to the number on the tag affixed to the nail and stake chaser at the lower left corner of the plot.

Genus/Species: The name of each plant species found in the plots is recorded once in the left hand column of the table. Values of percent cover (to the nearest one percent; can also use <1) are entered into the table for each plot.

USFS Lake Tahoe Basin Management Unit - Lewisia Monitoring

Population EO: **Datum:** **Easting:**
Population Location: **Zone:** **Northing:**

Date: **Observers:**

Elevation: **Slope:** **Aspect:**

Site Description/Plant Community/Disturbance:

Transect	Length	Bearing (from 0m)	Slope	GPS (0m)	GPS (end)	Photo# (0m)	Photo# (end)	Plot Side	Distance/Bearing to Snow

Transect	Plot	Distance (m)	Photo #	Notes

Population EO:	**Population Location:**
Date:	**Observers:**

Lewisia Density Measurements

Transect #	Plot #	Seedling	Vegetative	Budding	Flowering	Fruiting	Withered

Cover - Visual Estimation in Plots

Transect																							
												Plot #											
Genus/Species																							