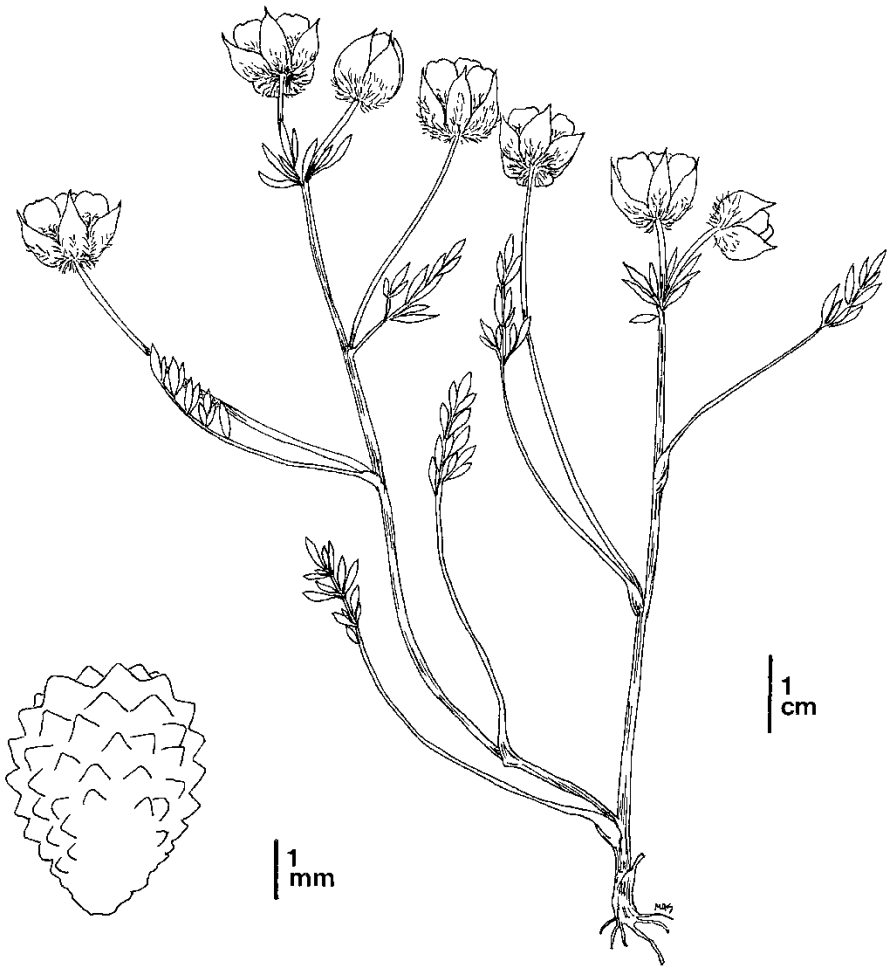
STONE RIDGE ECOLOGICAL RESERVE

BUTTE COUNTY MEADOWFOAM MONITORING PLAN
WITH
2015-2017 RESULTS & DISCUSSION



PREPARED BY THE
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NATIVE PLANT PROGRAM

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Part 2..... STONE RIDGE ECOLOGICAL RESERVE BUTTE COUNTY MEADOWFOAM MONITORING RESULTS AND DISCUSSION 2015-2017

EXECUTIVE SUMMARY

Butte County meadowfoam (*Limnanthes floccosa* ssp. *californic*a) is an annual plant that is designated as endangered under the California Endangered Species Act and federal Endangered Species Act. Butte County meadowfoam is only found in a narrow 28-mile strip along the eastern Sacramento Valley in Butte County, and there is a population of Butte County meadowfoam located at the California Department of Fish and Wildlife (CDFW) Stone Ridge Ecological Reserve (Reserve). Populations of Butte County meadowfoam have been subject to historic grazing practices. Grazing took place at the Reserve for many years prior to it becoming an ecological reserve, and CDFW has continued this practice to manage vegetation.

Residual dry matter (RDM) appears to have reduced on the Reserve every year since 2014. This reduction could be due to seasonal weather patterns that are less favorable for the accumulation of RDM (i.e. drought), trampling of vegetation due to saturated soils in the winter and spring of 2017, and removal of more RDM as a result of increased grazing pressures in 2017. Based on the information currently available, no change in the intensity of grazing from what was used in in the 2014-2015 and 2015-2016 grazing seasons appears to be needed at this time; however, CDFW should continue to evaluate monitoring results at the end of each monitoring year. CDFW should also consider restricting cow access to Pasture 1 of the Reserve when wet years occur.

The monitoring plan presented in this report was implemented from 2015 to 2017, and implementation is expected to continue into 2021 or later. Growth and reproduction of a considerable number of Butte County meadowfoam and woolly meadowfoam plants occurred on the Reserve every year from 2015 to 2017. 2016 was the “best” year for Butte County meadowfoam, with the highest number of plants in monitoring macroplots, and 2017 appears to have been the “worst” of the three monitoring years for Butte County meadowfoam, with 2015 somewhere in between. The high number of Butte County meadowfoam plants in 2016 may have been due to the relatively low impacts from grazing and trampling in the 2016 growing season due to relatively low water availability in Pasture 1 that supports the Butte County meadowfoam population, but still with sufficient rainfall in January and March to support growth and survival of plants. The most plausible explanation for the lower number of Butte County meadowfoam plants in 2017 is increased impacts from grazing and trampling in 2017 due to an increase in the number on animals on the Reserve, combined with very wet winter and spring conditions that left the ground susceptible to more hoof disturbance from cows.

The monitoring plan presented in this document should be implemented by CDFW staff at the Reserve to facilitate the adaptive management of Butte County meadowfoam. The monitoring consists of four primary parts: (1) monitoring spring density of the target species Butte County meadowfoam, and a closely related possible indicator species woolly meadowfoam (*Limnanthes floccosa* ssp. *floccosa*); (2) monitoring RDM in the fall; (3) taking photographs; and (4) describing the grazing that took place that year.

STONE RIDGE ECOLOGICAL RESERVE BUTTE COUNTY MEADOWFOAM MONITORING PLAN

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

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1. INTRODUCTION

Butte County meadowfoam (*Limnanthes floccosa* ssp. *californic*a) is an annual plant that is designated as endangered under the California Endangered Species Act and federal Endangered Species Act. Butte County meadowfoam is only found in a narrow 28-mile strip along the eastern Sacramento Valley in Butte County, including a population of Butte County meadowfoam located at the California Department of Fish and Wildlife (CDFW) Stone Ridge Ecological Reserve (Reserve) (Figure 1). Populations of Butte County meadowfoam have been subject to historic grazing practices. Grazing took place at the Reserve for many years prior to becoming an ecological reserve, and CDFW has continued this practice to manage vegetation.

This protocol should be implemented by CDFW staff at Stone Ridge Ecological Reserve (Reserve) in Butte County (Figure 2). The purpose of this monitoring protocol is to facilitate the adaptive management of the populations of Butte County meadowfoam at the Reserve. The monitoring consists of four parts:

1. Monitoring spring density of the target species Butte County meadowfoam, and a closely related possible indicator species woolly meadowfoam (*Limnanthes floccosa* ssp. *floccosa*);
2. Monitoring residual dry matter (RDM) in the fall;
3. Taking photographs; and
4. Describing the grazing that took place that year.

2. ECOLOGICAL MODEL

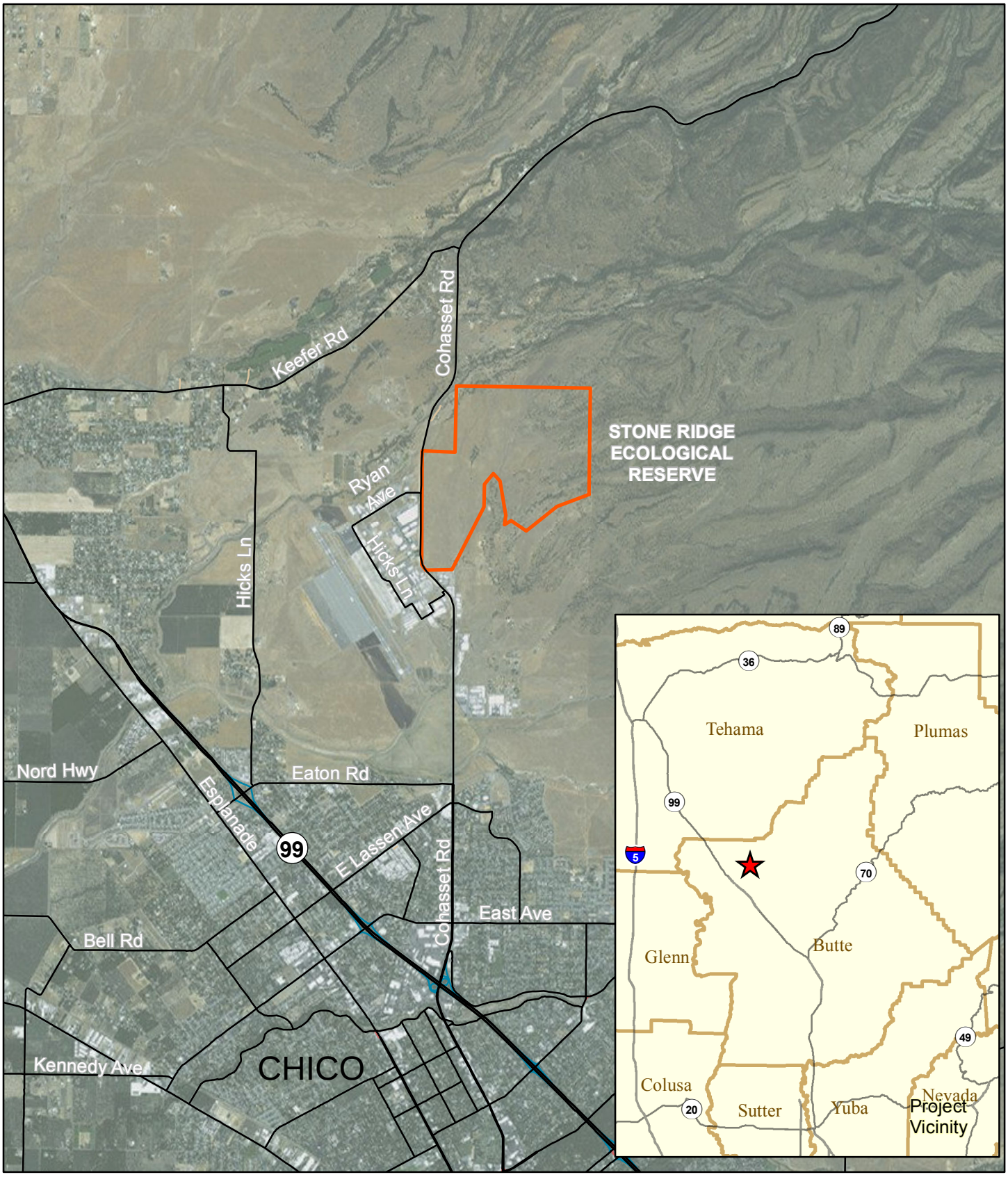
See Figure 3 for an ecological model of Butte County meadowfoam.

2.1. LIFE HISTORY

Butte County meadowfoam is a winter annual that germinates in the fall after the onset of the rainy season and begins to flower by mid to late February. Peak flowering typically occurs in early to mid-March. Flowering in Butte County meadowfoam seems indeterminate (i.e., flowering continues until the necessary environmental conditions, such as moisture availability, are no longer provided). Butte County meadowfoam plants can flower until early April when rainfall is sufficient. Regardless of the rainfall, flowering does not typically continue beyond early April. Fruit and seed production is staggered throughout the latter part of the flowering season into May, when plants begin to die. Dead plants disappear rapidly and are extremely difficult to find by late May or June. Butte County meadowfoam persists as dormant seed in the soil from April or May until the fall rains commence.

Water availability influences reproduction in the meadowfoam genus (Brown 1976, Brown and Jain 1979). Insufficient moisture limits seed production in the closely related woolly meadowfoam (Brown and Jain 1979) and is believed to have this effect on Butte County meadowfoam (Jokerst 1988). Butte County meadowfoam regularly produces five seeds per flower under ideal moisture conditions, but may produce fewer seeds under less ideal conditions (Arroyo 1973).

Studies of meadowfoam seed dispersal suggest that dispersal is short-range, and seed is distributed within vernal pools and swales (Jain 1976, Hauptli et al. 1978). Seed of rosy Douglas' meadowfoam (*Limnanthes douglasii* ssp. *rosea*) was found to be dispersed in close proximity to the mother plant, but some seed migrated up to 20 meters along ephemeral drainages, presumably having been carried by flowing water (Jokerst 1988). Similar dispersal



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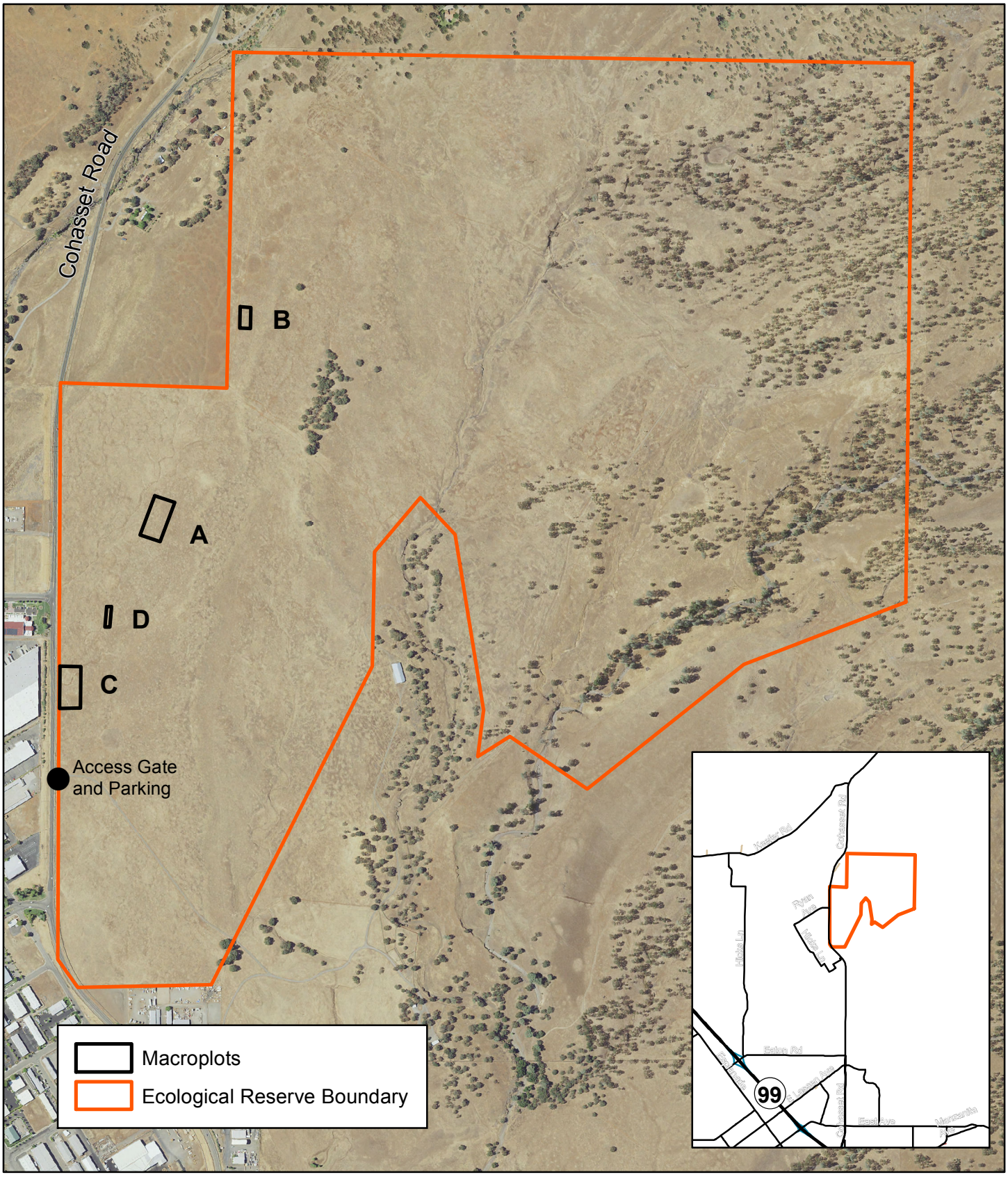
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

0 1 2 Miles

Figure 1
Regional Location of Stone Ridge Ecological Reserve



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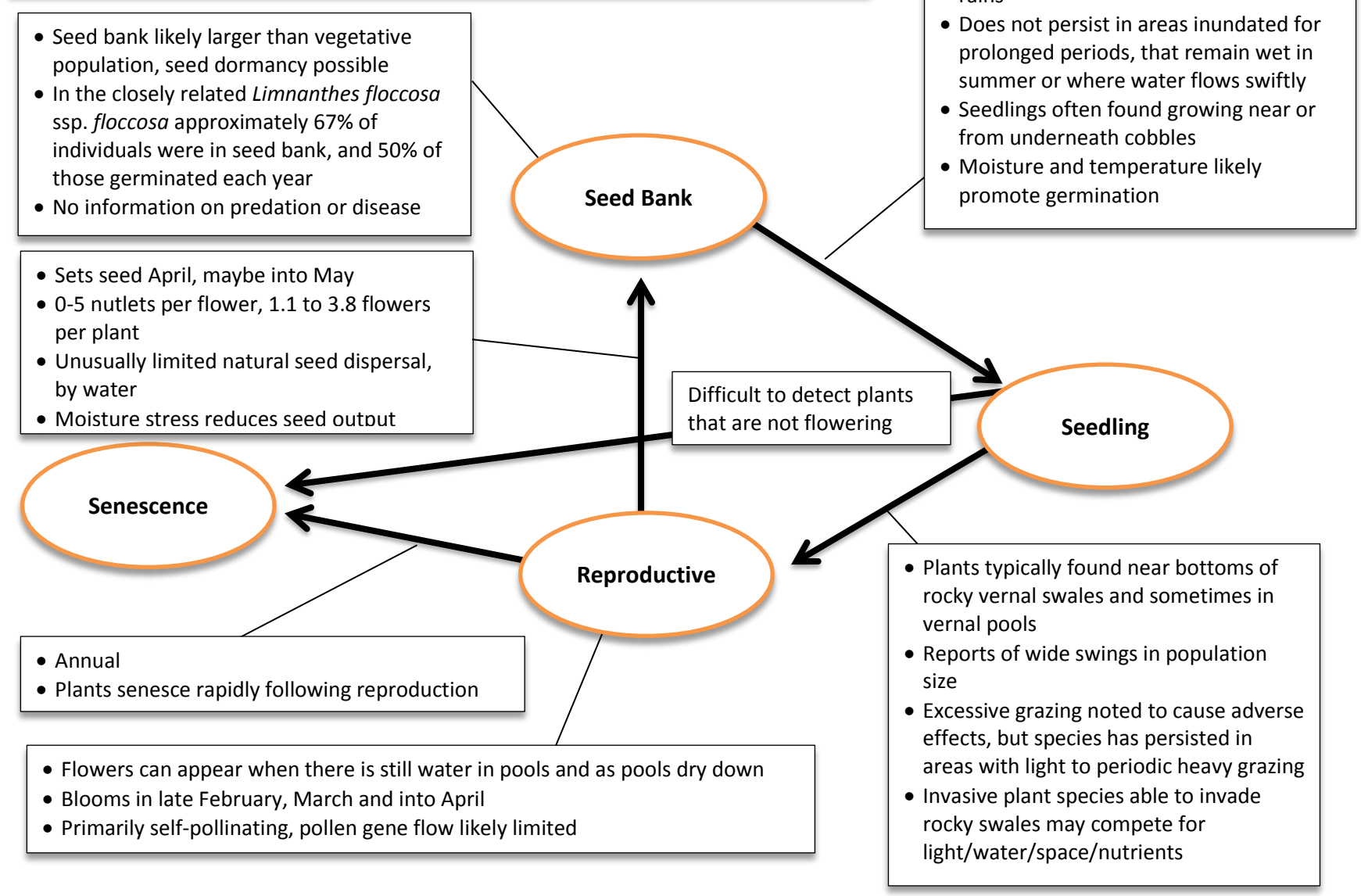
Base Image: NAIP 2014

N

0 0.1 0.2 0.4 Miles

Figure 2.
Boundaries of Stone Ridge Ecological Reserve and General Locations of *Limnanthes* Monitoring Macroplots

Figure 3. Ecology of Butte County Meadowfoam (*Limnanthes floccosa* ssp. *californica*)



could be expected for Butte County meadowfoam because most populations occur along ephemeral drainages and rocky swales.

Unlike some meadowfoam species, seed of Butte County meadowfoam is reported to germinate easily when properly wetted in petri dishes, with up to 100 percent germination in laboratory conditions (Jokerst 1988). Viable woolly meadowfoam seed, on the other hand, does not always germinate under the same treatment. The timing and percentage of seed germination in the meadowfoam genus is related to the length of exposure to water and patterns of temperature change (Jain 1976; Toy and Willingham 1966, 1967). Wide fluctuations of Butte County meadowfoam populations in the past, and populations that have been found in areas where plants were previously absent indicates that Butte County meadowfoam has some dormancy mechanism that activates the seed reserve during favorable conditions (Jokerst 1988).

Intensive livestock grazing likely has a significant negative effect on Butte County meadowfoam. The predominant use of intensive livestock grazing for many years may have eliminated Butte County meadowfoam from previously occupied suitable habitat in the past, and numbers of Butte County meadowfoam have been reported to increase when grazing has been reduced (Jokerst 1988). Butte County meadowfoam has persisted in areas that have received light to periodic heavy grazing, so grazing is not necessarily detrimental to the persistence of Butte County meadowfoam. Grazing may be beneficial for Butte County meadowfoam by preventing or reducing thatch.

2.2. WOOLLY MEADOWFOAM

Monitoring both Butte County meadowfoam and woolly meadowfoam is important for several reasons. The two species are easily confused and calling attention to both species will help ensure that plants are accurately identified and monitors are able to confidently differentiate between them in the field. Woolly meadowfoam is also included in CDFW's California Natural Diversity Database and has a California Rare Plant Rank of 4.2, indicating that the taxon is of limited distribution or infrequent throughout a broader area in California, and its vulnerability or susceptibility should be monitored. Butte County meadowfoam and woolly meadowfoam both have similar habitats and life histories; however, woolly meadowfoam is more widespread on the reserve than Butte County meadowfoam and therefore it may be easier to detect changes in woolly meadowfoam populations than changes in Butte County meadowfoam populations. Woolly meadowfoam may prove to be an appropriate indicator for habitat quality at the reserve and, in turn, an appropriate indicator species for Butte County meadowfoam.

3. MANAGEMENT OBJECTIVES

Measuring above-ground expression of annual plant species such as Butte County meadowfoam and woolly meadowfoam will provide a quantitative annual record of the populations that may allow important ecological insights into how grazing practices affect the species. However, population size/density of annual plant species may not be a good metric for making short term management decisions. Because of this, a management objective and response for adaptive management based on population size/density is not used.

Thatch accumulation may be a threat to Butte County meadowfoam at the Reserve. RDM is expected to be a habitat indicator that is correlated with the suitability of habitat for Butte County meadowfoam, and may therefore be one of the most appropriate metrics to use for making management decisions. A management objective for adaptive management based on fall RDM is therefore presented below. The management objective should be revisited and revised based

upon the results of the monitoring program described in this protocol. The term of the current land use agreement for the Reserve will end on May 31, 2018.

Grazing animals that are used for vegetation control may eat and trample Butte County meadowfoam and other rare plants and disturb their habitat, and are therefore a direct impact to Butte County meadowfoam. Photomonitoring in the spring is used to qualitatively evaluate the general condition of Butte County meadowfoam habitat and document the impacts of trampling.

The management objectives are:

- Management Objective #1: Prevent the RDM of all Stone Ridge Ecological Reserve macroplots that are known to contain Butte County meadowfoam from exceeding 1000 lbs/acre in two consecutive years.
- Management Objective #2: Prevent grazing-related disturbances from impacting the ability of Butte County meadowfoam and other rare plants to maintain healthy self-sustaining populations at Stone Ridge Ecological Reserve.

4. MONITORING DESIGN

4.1. SPRING DENSITY MONITORING

The following sections provide instruction on how to implement this monitoring protocol. As part of the protocol, you will monitor the density of Butte County meadowfoam and the related woolly meadowfoam within specific macroplots. Conduct the spring density monitoring when Butte County meadowfoam and woolly meadowfoam are evident and easily identifiable, likely in March.

4.1.1. SAMPLING OBJECTIVE

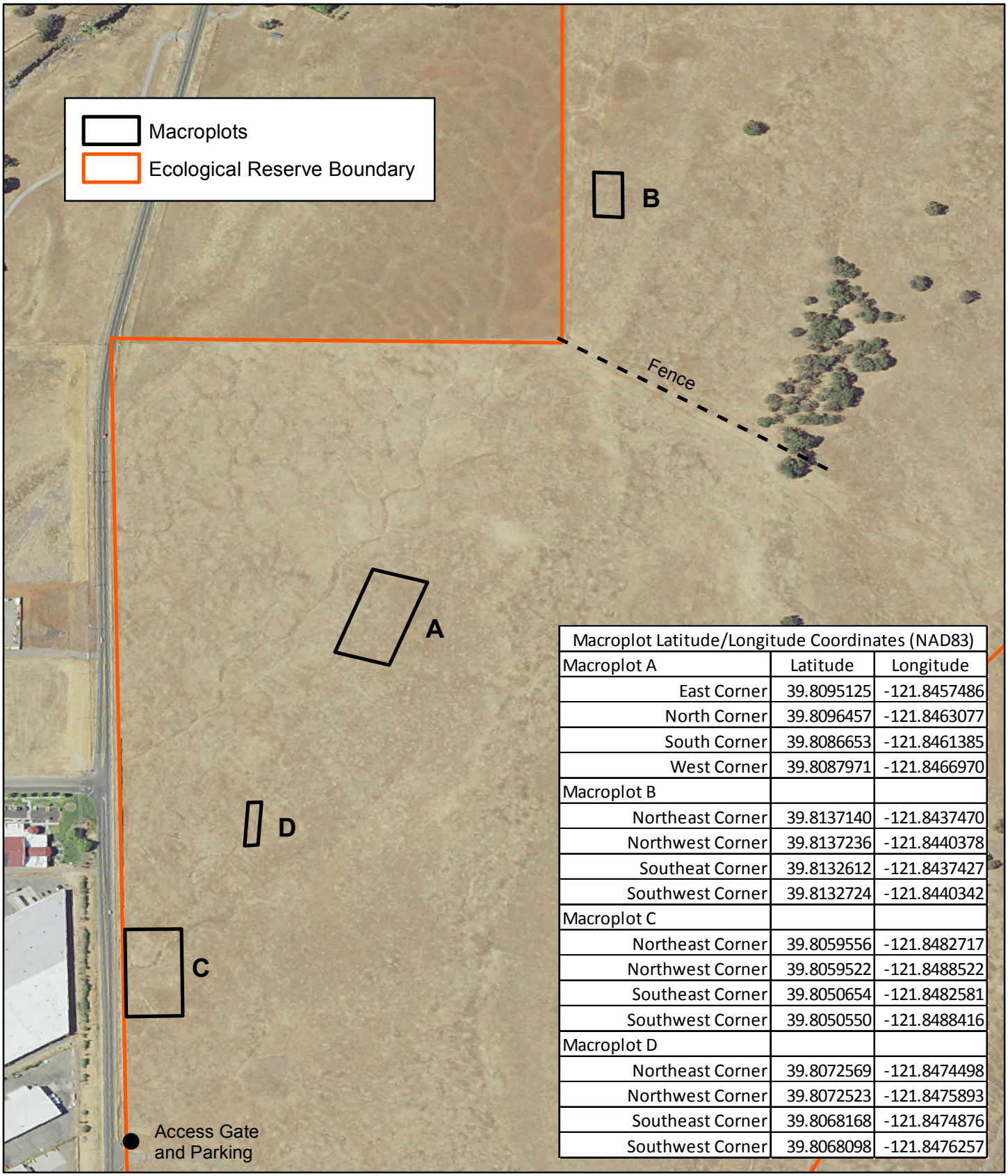
We want to be 90 percent confident that our population estimate for each macroplot is within 20 percent of the estimated true value.

4.1.2. BEFORE GOING INTO THE FIELD

Before going into the field read this protocol, identify random quadrats to sample, recruit field helpers (a total of 4 workers is ideal), and organize your field equipment

Identify random quadrats to sample

You will need to collect density data on Butte County meadowfoam and woolly meadowfoam from within four macroplots. This data can be collected by counting every Butte County meadowfoam and woolly meadowfoam plant within the macroplot, or by sampling random locations within the macroplot. Each macroplot is named with an uppercase letter (A-D). The locations of the four macroplots are presented in Figures 2 and 4, and the sizes of these macroplots are presented in Table 1, below.



Macroplot Latitude/Longitude Coordinates (NAD83)		
Macroplot A	Latitude	Longitude
East Corner	39.8095125	-121.8457486
North Corner	39.8096457	-121.8463077
South Corner	39.8086653	-121.8461385
West Corner	39.8087971	-121.8466970
Macroplot B		
Northeast Corner	39.8137140	-121.8437470
Northwest Corner	39.8137236	-121.8440378
Southeat Corner	39.8132612	-121.8437427
Southwest Corner	39.8132724	-121.8440342
Macroplot C		
Northeast Corner	39.8059556	-121.8482717
Northwest Corner	39.8059522	-121.8488522
Southeast Corner	39.8050654	-121.8482581
Southwest Corner	39.8050550	-121.8488416
Macroplot D		
Northeast Corner	39.8072569	-121.8474498
Northwest Corner	39.8072523	-121.8475893
Southeast Corner	39.8068168	-121.8474876
Southwest Corner	39.8068098	-121.8476257

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Base Image: NAIP 2014

N

0 0.05 0.1 0.2 Miles

Figure 4
Locations of *Limnanthes* Monitoring Macroplots at Stone Ridge Ecological Reserve

Macroplot	Size (m)	Orientation of long edge	Corner Locations (UTM) (Easting, Northing) (NAD83)	Subspecies of *Limnanthes floccosa* known to be present 2015-2017
A	100x50	20°-200°	North: 598752.95, 4407266.70 East: 598801.00, 4407252.53 South: 598768.84, 4407158.07 West: 598720.84, 4407172.07	ssp. floccosa ssp. californica
B	50x25	0°-180°	Northeast: 598966.32, 4407721.07 Southeast: 598967.33, 4407670.82 Southwest: 598942.36, 4407671.73 Northwest: 598941.41, 4407721.81	ssp. floccosa
C	100x50	0°-180°	Northeast: 598590.11, 4406854.97 Southeast: 598592.54, 4406756.18 Southwest: 598542.61, 4406754.38 Northwest: 598540.42, 4406853.95	ssp. californica ssp. floccosa
D	50x12	0°-180°	Northeast: 598658.6, 4407000.3 Southeast: 598655.99, 4406951.41 Southwest: 598644.18, 4406950.48 Northwest: 598646.67, 4406999.64	ssp. californica

Table 1. Locations of Stone Ridge Ecological Reserve *Limnanthes* Monitoring Macroplots

Macroplot A: The size of Macroplot A is 100 meters by 50 meters. The quadrat size is 50 meters by 0.25 meters (Figure 5). You need to select random locations for the quadrats within the macroplot using restricted random sampling. Divide the macroplot into equal-sized smaller segments that are perpendicular to the long (100 meter) edge of the macroplot. The edge could be divided into 20 segments so each segment represents 5 meters of the long edge of the macroplot, or the edge could be divided into 25 segments of 4 meters each or 40 segments of 2.5 meters each, etc. If you divide the macroplot edge into 20 segments there will be 20 (5/0.25= **20**) possible places for the quadrat to be located within each 5 meter segment. Therefore you need to generate a random number from 0-19 and multiply it by 0.25 meter to determine where the quadrat should be located in that 5 meter segment. For example, if you generate a random number from 0-19 for the first segment (let's say it is 13), you would multiply it by 0.25 (3.25 meters) so the first quadrat would start 3.25 meters from the origin of the macroplot. Generate random locations for the quadrat within each additional segment. For example, the position of the second segment's quadrat would be calculated in the same way as the position for the first segment, but you would need to add 5 meters to the result, because that segment would start at 5 meters from the origin (see example below from Figure 7.21 from Elzinga et al. 1998).

Macroplot B: The size of Macroplot B is 50 meters by 25 meters, and the quadrat size is 25 meters by 0.25 meters (Figure 5). You need to select random locations for the quadrats within this macroplot. Do this using restricted random sampling in much the same way that was done for Macroplot A. In 2015, the long edge of Macroplot B was divided into 20 segments with each segment representing 2.5 meters.

Macroplot C: The size of Macroplot C is 100 meters by 50 meters (Figure 5). Due to the low density of Butte County meadowfoam in Macroplot C, a quadrat size of 50 meters by 1 meter

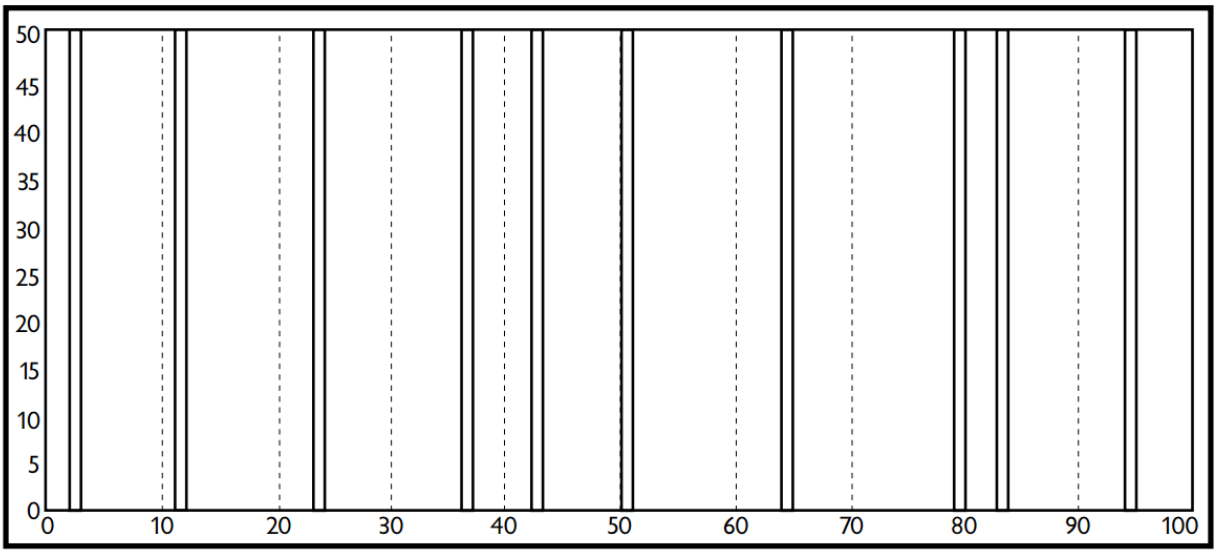


FIGURE 7.21. A restricted random sample of 10 1m x 50m quadrats in a 50m x 100m macroplot. One quadrat is randomly positioned within each 10m segment of the baseline (x-axis).

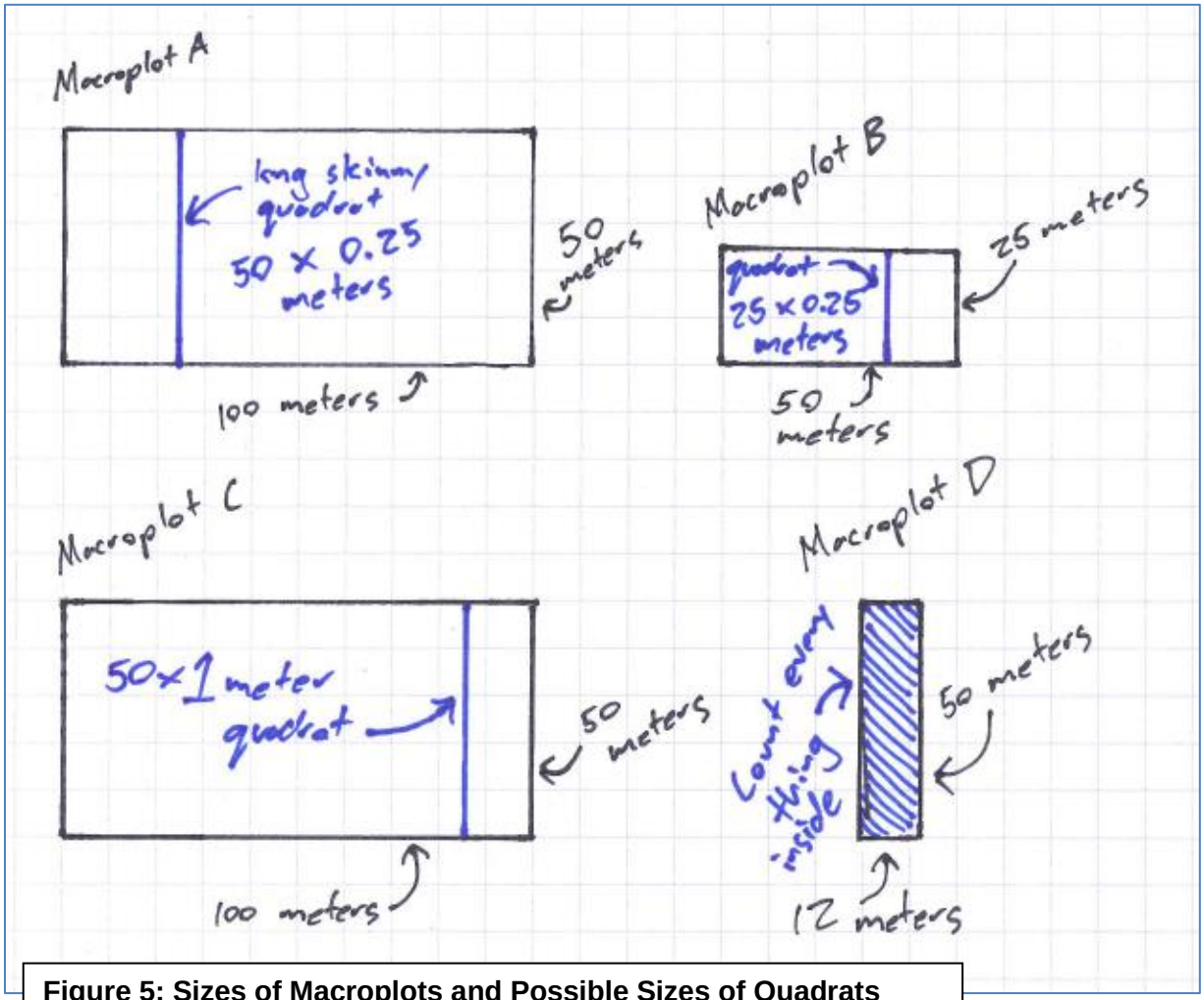


Figure 5: Sizes of Macroplots and Possible Sizes of Quadrats

was used in 2015, and random locations for the quadrats was selected using restricted random sampling in much the same way that was done for Macroplots A and B. In 2016 and 2017 all

Butte County meadowfoam and woolly meadowfoam plants within the macroplot were censused (i.e. we counted every plant) and therefore no sampling within Macroplot C was necessary. To aid in counting we used meter tapes to divide Macroplot C into smaller segments and counted all of the meadowfoam plants within each segment. A 1-meter wide segment was found to be ideal for efficiency and ease of counting.

Macroplot D: The size of Macroplot D is 50 meters by 12 meters (Figure 5). Due to the relatively small size of Macroplot D, all of Butte County meadowfoam plants in the plot were censused in 2015, 2016 and 2017, and therefore no sampling of Macroplot D was necessary.

Calculate the locations of the quadrats in macroplots in the office before fieldwork, and type all of the locations in the blank datasheets saved on the shared drive so you don't have to do this in the field. Save and print the datasheets with the randomly-selected quadrat locations for later use in the field.

Organize Field Equipment
(Figure 6):

Figure 6: Spring Field Equipment

a) (2+) 100 meter tapes
b) (2+) 50 meter tapes
c) Screwdrivers or other tools for pinning meter tapes to the ground
d) (many) Pin Flags
e) (2+) Lengths of PVC (0.25 meter)
f) (2+) Lengths of PVC (1 meter)
g) (3+) Hand tally counters
h) Data sheets, clipboards, pencils
i) Replacement field markers (aluminum conduit and/or rebar with caps and lengths of pvc)
j) PVC cutter
k) Tape measure
l) Small sledgehammer
m) GPS for relocating field markers and documenting plant locations
n) Tripod and camera
o) Compass
p) Zip-lock bags and/or plant press
q) Metal detector for relocating missing field monument locations (not pictured)

4.1.3. In the Field

Locate Macroplots

Contact the reserve manager prior to your visit (Henry Lomeli in 2017). Drive to and park at the access gate on Cohasset Road:

- Lat/Long: 39°48'13.00"N, 121°50'55.96"W
- Google Maps: https://www.google.com/maps/@39.8035763,-121.8488831,65m/data=!3m1!1e3?hl=en
- See Figure 2

All macroplots can be reached on foot from the parking area/access point. Climb over the gate.

Macroplot A is in Pasture 1 and can be reached from immediately inside the main gate by following the tire track use-road that goes to the northeast. After walking along this track for about ½ mile, Macroplot A will be to the left. Be sure to have the coordinates of each of the four Macroplot A corners and a handheld GPS receiver with you before going into the field, because GPS may be necessary to relocate the field markers. In the spring of 2015 each corner of Macroplot A was marked with an approximately 50 cm-long rebar stake, hammered into the ground, surrounded by white PVC pipe and capped with a red plastic rebar cap.

Macroplot B can be reached from inside the main gate by following the tire track use-road that goes to the northeast towards Pasture 2. The tire track use-road will lead to a gate between pastures 1 and 2. Macroplot B is approximately 200 meters past the gate on the right side of the road. In the spring of 2015 each corner of Macroplot B was marked with an approximately 50 cm-long rebar stake, hammered into the ground, surrounded by white PVC pipe and capped with a red plastic rebar cap.

Macroplot C is the closest macroplot to the parking area and can be reached by walking approximately 150 meters north of the parking area along the rock wall. The northwest and southwest markers for this macroplot are hammered flush to the ground, and backup markers have been placed 2 meters west of the corner of Macroplot C, directly under the barbed wire fence. It will likely be easier to find the backup markers and measure 2 meters east from them to identify the macroplot corners.

Macroplot D is between Macroplots C and A, and straddles a vernal swale.

Some markers may be missing due to cows or vandalism, and relocating the markers may be difficult. In addition to the rebar/pvc markers, two 20 cm-long magnetic nails were hammered flush to the ground approximately 10 cm to the north, south, east and west of each macroplot field marker. These nails are backup markers, and will likely be difficult to relocate without the aid of a metal detector.

If any markers are missing, use GPS, a metal detector, distance from other markers, or other means to relocate and replace them.

Identify Meadowfoam Subspecies

Butte County meadownfoam and woolly meadowfoam look very similar, but there are some ways to tell them apart.

The best ways:

- Pull apart the flower petals to examine the nutlets. The nutlets of Butte County meadowfoam are bumpy (papillate) (Figure 7, Photo 1), whereas the nutlets of woolly meadowfoam have awl-shaped projections (tubercles) on them (Figure 7, Photo 2).
- Remove one of the petals and use a hand lens to look for tiny hairs on the inner (adaxial) surface of the petal near the base: Butte County meadowfoam has hairs (Figure 8, Photo 3), woolly meadowfoam does not have hairs.

Photo 1: Bumpy (papillate) nutlets of *Limnanthes floccosa* ssp. *californica*

Photo 2: Awl-shaped projections (tubercles) on nutlets of *Limnanthes floccosa* ssp. *floccosa*

Figure 5
Photos of *Limnanthes floccosa* Nutlets

Photo 3: Petal hairs of *Limnanthes floccosa* ssp. *californica*

Photo 4: *Limnanthes floccosa* ssp. *californica*

Figure 6
Photos of *Limnanthes floccosa* Petals

Other, more subjective ways:

- The flowers of woolly meadowfoam are generally grouped closer together on the plant, are on generally shorter pedicels of roughly equal lengths, mostly from the uppermost portions of the stem, and flowers are generally clustered into groups of 3-6 during flowering. The flowers of Butte County meadowfoam are on longer pedicels of variable lengths, some from the lower portion of stem, and flowers are generally not clustered into bunches during flowering (Figure 9).
- The sepals of Butte County meadowfoam are generally hairier near the base, and less hairy near the tip. The sepals of woolly meadowfoam are hairier than Butte County meadowfoam in general, and this is most easily observed near the tips of the sepals (Figure 9).

Collect Data

For Macroplots A-C, string out meter tapes along both of the long edges of the macroplot, with the 0 meter mark placed farthest to the north. Make sure that the meter tapes are straight and taught, and it is very helpful if the side of the tape with the meter marks is facing up. String another meter tape perpendicular with and between the two parallel meter tapes, and align zero edge with the distance associated with the first quadrat (e.g. 1.25 meters). Make sure that the meter tape is taught and straight. Use an appropriate length of PVC pipe (0.25 meter or 1 meter), and walk along the meter tape using the length of the PVC as your guide to determine what is inside the quadrat and what is not. Count the number of Butte County meadowfoam and woolly meadowfoam plants within the quadrat using a hand tally counter. Two people may count plants in one quadrat simultaneously if they start at opposite ends and work towards the center. Follow the counting rules in the box below:

- If the rooted portion of a plant is within the quadrat, then the plant is counted as being in the quadrat. If the rooted portion of a plant is outside of the quadrat, then the plant is not counted as being in the quadrat.
- If the rooted portion of a plant is underneath a meter tape, then the plant is not counted as being in the quadrat.
- If the rooted portion of a plant is right on the outside edge of the PVC (farthest from the perpendicular meter tape), then the plant is counted as being in the quadrat. If the rooted portion of a plant is right on the edge of the perpendicular meter tape, then the plant is not counted as being in the quadrat.
- If two flower stems are coming out of the ground from the same hole, but they cannot be seen as being joined, they count as two different plants.
- It is very difficult to detect plants that are not flowering; however, if a plant that is not flowering is detected, it should be identified to subspecies if possible, and counted.

Record the number of Butte County meadowfoam and woolly meadowfoam plants counted in each quadrat on the appropriate datsheet, and be sure to fill out all fields on the datasheet and take any other necessary field notes.

For Macroplot D, you will need to count all of the Butte County meadowfoam and woolly meadowfoam plants that are present. It is likely easiest to do this by dividing the macroplot into 1 meter wide segments, and counting all of the plants in each segment separately. Make sure that plants near the edges of segments are not double counted. Record the number of Butte County meadowfoam and woolly meadowfoam plants counted on the datasheet.

Photo 5: Immature *Limnanthes floccosa* ssp. *californica* plant

Photo 6: Immature *Limnanthes floccosa* ssp. *floccosa* plant

Figure 9
Photos of Immature *Limnanthes floccosa* Plants

Before you leave the field site complete a qualitative monitoring datasheet and take monitoring photos for each macroplot that you collected data from (see Section 4).

4.1.4. Back in the Office

- Scan, save and re-name all field data sheets. The current project folder is: U:\groups\HCPB\Shared Folders\NPP\Section 6\2014\Project Files\BCM Files\Stone Ridge. The project folder may change in the future.
- Enter the field data into Excel spreadsheets, analyze the data and make sure that the sample statistics are being calculated correctly. Record results and sample statistics in the Excel spreadsheet located on the shared drive in the following location: U:\groups\HCPB\Shared Folders\NPP\Section 6\2014\Priority Plant Surveys\Project Files\BCM Files\Stone Ridge\Monitoring Data. The Project folder may change in the future.
- Compare the results with previous years and make graphs of the data. Make conclusions. Think. Talk to the reserve manager about adaptive management of the site. **This is the most important part of adaptive management!**
- Download and rename field photos (see Section 4) and compare them with monitoring photos from previous years.

4.2. Annual Monitoring for Adaptive Management of Residual Dry Matter

As part of the monitoring protocol, the weight of residual dry matter (RDM) will be monitored within specific macroplots. The fall RDM monitoring should be conducted after most annual plants except summer-flowering annuals have dried up and died, but prior to any significant fall or winter rains, likely in September or October. The material should be dry when it is collected.

4.2.1. Sampling Objective

We want to be 90 percent confident that our RDM estimate for each macroplot is within 20 percent of the estimated true value.

4.2.2. Before Going into the Field

Before going into the field you should read this protocol, identify random quadrats to sample, recruit field helpers (a total of 4 people is ideal), and organize your field equipment

Identify random quadrats to sample

RDM will be sampled within four macroplots. Each macroplot is named with an uppercase letter (A-D). The locations of the macroplots are presented in Figures 2 and 4, and more information on these macroplots is presented in Section 1, above. Within each macroplot RDM will be clipped from several 1 square foot quadrats using the University of California Guidelines for Residual Dry Matter on Coastal and Foothill Rangelands in California (Bartolome *et al*. 2006).

Use systematic sampling to identify the quadrats to sample within each macroplot. An example of systematic sampling can be seen in Figure 7.18, below, from Elzinga et al. 1998.

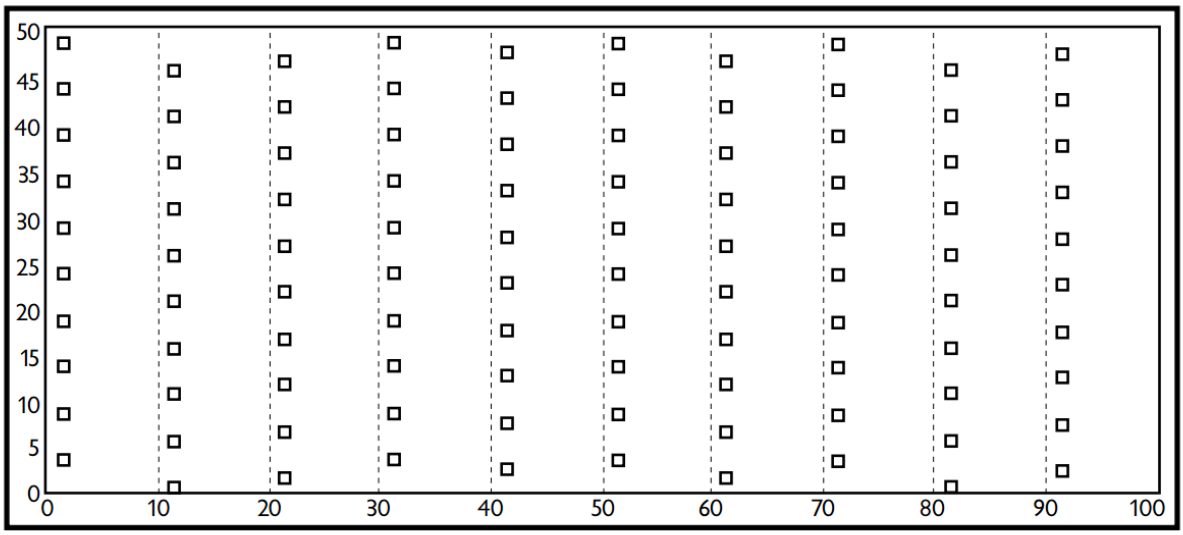


FIGURE 7.18. A 50m x 100m macroplot, sampled by 100 1m x 1m frequency quadrats. The quadrats are aligned along transects. Both the transects and the quadrats are systematically positioned with a random start. A random starting point is selected for the transects along the baseline, while separate random starting points are selected for the quadrats along each transect.

Because the quadrat size is 1 square foot, the edges of the macroplots must be converted from meters to feet (Table 2)

Macroplot	Dimensions in Meters	Dimensions in Feet
A	100 x 50	328 x 164
B	50 x 25	164 x 82
C	100 x 50	328 x 164
D	50 x 12	164 x 39

Table 2: Unit Conversion of Macroplot Dimensions

In 2015 the long edges of Macroplots A and C were divided into 8 segments (41 feet in each segment), the long edge of Macroplot B was divided into 4 segments (41 feet in each segment), and the long edge of Macroplot D was divided into 8 segments (20 feet in each segment). For each macroplot generate a systematic random start for the transects, which will allow you to identify the locations of each transect in the macroplot. Then for each transect, generate a systematic random start for the first quadrat along the transect, which will allow you to identify the locations of each subsequent quadrat along that transect, similar to the example in Figure 7.18 from Elzinga et al. 1998.

After you have identified the locations of all of the quadrats you will be clipping, create data sheets in the office so that you have all of the information you need in the field.

Organize Field Equipment

- (2+) 100 meter tapes (the tape must also have feet markings)
- (2+) 50 meter tapes (the tape must also have feet markings)
- Screwdrivers or other tools for pinning meter tapes to the ground

- (many) Pin Flags
- (2+) 1 square foot PVC or metal wire quadrat (1' x 1')
- (2+) Good scissors for clipping material
- (100+) paper lunch bags
- (5+) Large grocery bags or garbage bags for collecting the filled lunch bags
- (2) staplers with replacement staples for stapling bags closed
- (3+) Sharpie Pens
- Data sheets, clipboards, pencils
- Replacement field markers (aluminum conduit and/or rebar with caps and lengths of pvc)
- PVC cutter
- Sledgehammer
- GPS for relocating field markers and documenting plant locations
- Tripod and camera
- Compass set to the correct declination for the site (14 degrees east)
- Zip-lock bags and/or plant press

4.2.3. IN THE FIELD

Locate Macroplots

Contact the reserve manager prior to your visit (Henry Lomeli in 2017). Drive to and park at the access gate on Cohasset Road:

- Lat/Long: 39°48'13.00"N, 121°50'55.96"W
- Google Maps: https://www.google.com/maps/@39.8035763,-121.8488831,65m/data=!3m1!1e3?hl=en
- See Figure 2, and the description of "Relocating the macroplots" in Section 1 of this document, above.

If any markers are missing, use GPS, a metal detector, distance from other markers, or other means to relocate and replace them

Collect Data

String out measuring tapes along both of the long edges of each macroplot, with the 0 mark always placed farthest to the north. Make sure that the tapes are straight and taught, and it is very helpful if the side of the tape with the feet marks is facing up. String another measuring tape perpendicular to the other two measuring tapes with the 0 mark always placed farthest to the West, and align the edge with the distance associated with the first transect (e.g. 25 feet). Make sure that the measuring tape is taught and straight. Place pin flags at the appropriate locations along the measuring tape, representing the northwestern corners of the quadrats to be clipped. It is efficient if two field helpers are responsible for laying measuring tapes, placing pin flags, marking the flags with the quadrate coordinates, while two other field helpers are responsible for clipping the quadrats, bagging RDM, and labeling the bags. Before you leave the field site, take monitoring photos for each macroplot that you collected data from (see Section 4).

Clip Quadrats

Once you have located a quadrat to be clipped clip plots according to the following instructions, adapted from Bartolome et al. 2006:

1. Place the quadrat (1 square foot) on the ground surface.
2. Remove from the area within the quadrat all summer-flowering annuals such as tarweed, yellow starthistle, and turkey mullein and other live plants.
3. Remove tree leaves.
4. Clip the remaining RDM within the quadrat as close to the ground surface as you can without disturbing the soil.
5. Rapidly collect as much of the RDM as is practical without inadvertently including bits of soil.
6. Place the RDM in a paper lunch bag, staple the bag closed, and use a permanent marker to write the macroplot letter and sampling location coordinates on the bag (e.g. “A: 25, 59”). Collect all filled lunch bags in large grocery bags for ease of transportation.
7. Complete a qualitative monitoring datasheet and take monitoring photos for each macroplot that you collected data from (see Section 4).
8. Take the garbage bags filed with the labeled paper bags back to the office for weighing.

4.2.4. Back In the Office

Download and rename field photos (see Section 4).

Systematically weigh the RDM from each bag (do not include the weight of the bag). Use a scale that is sensitive to at most 0.1 or 0.01 gram. Write the weight of the RDM from each quadrat (to the nearest 0.1 or 0.01 gram) in the appropriate location on the data sheets. Scan the completed data sheets and save them in the project folder. Enter the data into a spreadsheet to calculate the average RDM and sample statistics. Check to make sure that the Excel spreadsheet is working correctly and double check your work. Spreadsheets from past years of monitoring can be found in the project folder on the shared drive (U:\groups\HCPB\Shared Folders\NPP\Section 6\2014\Project Files\BCM Files\Stone Ridge\Monitoring Data\2015\RDM Monitoring 2015 October).

Compare the results with previous years, with spring density data and grazing regimes. Make conclusions. Think. Make graphs. Talk to the reserve manager about the management of the site. **This is the most important part of adaptive management!**

4.3. Annual Photomonitoring for Adaptive Management

Photomonitoring should be conducted for a macroplot whenever density data (Section 1) or RDM data (Section 2) is collected for that macroplot.

4.3.1. Before Going into the Field

The monitor conducting the photomonitoring should be trained and familiar with the proper use of a field compass and whatever digital camera and tripod will be used. The following equipment is required:

- Clipboard with photomonitoring log sheets (Section 5)
- Pencil
- Digital camera with fully-charged batteries and available memory
- Tripod
- Tape measure or meter tape
- Compass set to the correct declination for the site (14 degrees east)

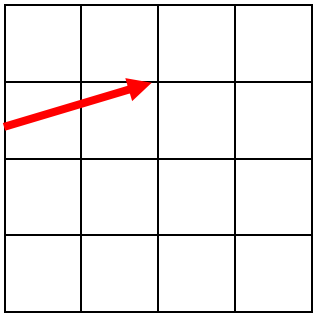
To duplicate approximately the same field of view from year to year, the camera should be set to a focal length that is equivalent to a focal length of approximately 27mm on a “full frame”

camera such as a 35mm film camera or a Nikon “FX” camera and lens. Monitoring photographs for the initial 2014 photomonitoring were taken using a Nikon “DX” camera and lens, set to a focal length of 18mm, which is equivalent to 27 mm on a “full frame” camera and lens. Before visiting the site, check the specifications for digital cameras that may be used for the monitoring to see if photographs can be taken with the correct field of view. If the camera equipment to be used cannot duplicate this field of view, the closest field of view possible should be used.

4.3.2. In the Field

Photographs should be taken from the four corner markers of each macroplot. Three photographs should be taken from each macroplot corner, each one directed at one of the other corners of the macroplot.

- **Set up the tripod and camera** so that the center of the camera lens is 5 feet (152cm) from the ground (the maximum height for many tripods).
- **Populate Each Page of the Photomonitoring Log** with the date, photographer name, focal length, camera, lens and camera settings.
- **Take a “Slate” Photo** of the first page of the Photomonitoring Log sheet itself before taking all of the monitoring photos on that page. Take a photo of the next page of the Photomonitoring Log before taking all of the photos that are listed on that page, and so on, until all monitoring photos have been taken.
- **Take monitoring photos** in the order that they are listed on the Photomonitoring Log and move between the photomonitoring locations. Follow these rules:
    - Use the field compass to ensure that all photos are taken in the direction indicated in the Photomonitoring Log.
    - Make sure that the camera focuses properly before taking each picture, and use the preview function of the camera to make sure that the photos are being taken correctly.
    - Take each of the photographs so that the subject of the photo or the horizon is approximately 1/4 of the way down from the top of the frame, so that more of the ground is incorporated into the photo.
    - Ensure that the horizon as is level as possible in the viewfinder.



Center the photo subject or horizon in the camera viewfinder at area shown with red arrow.

4.3.3. Back In the Office

Save all monitoring photos in the in the project folder on the shared drive in the folder for that date’s field visit, for example: “U:\groups\HCPB\Shared Folders\NPP\Section 6\2014\Priority Plant Surveys\Project Files\BCM Files\Stone Ridge\Monitoring Data\2016\031816 (Macroplot C)”

Carefully change the file names for the monitoring photos using the following convention: [uppercase letter of macroplot][lowercase letter of the photopoint][last two digits of year][two digit month][two digit day of the month]. For example if a photo is taken at photopoint j of Macroplot A, on March 12, 2015 the file should be named “Aj20150312”.

All properly named monitoring photos should be saved in the following folder on the shared drive: U:\groups\HCPB\Shared Folders\NPP\Section 6\2014\Priority Plant Surveys\Project Files\BCM Files\Stone Ridge\All renamed photos here for comparison. The location of this folder may change in the future.

With the monitoring photos saved, use the Windows Photo Viewer program and the left and right arrow keys on the keyboard to compare monitoring photos with those taken during previous site visits and look for signs of excessive impacts from grazing and other differences. Think. Talk to the reserve manager about the management of the site. **This is the most important part of adaptive management!**

4.4. DOCUMENTATION OF GRAZING

CDFW has a land use agreement with a grazing operator for the removal of vegetation from the Reserve. The land use agreement expires on May 31, 2018. The agreement allows cattle to be on the site from December 1 through May 31 (6 months). Grazing is limited to no more than 360 animal unit months (AUMs) per year (60 AUMs/month multiplied by 6 months = 360 AUMs/year). Weaned calves and light steers between 350-600 pound weight class are each counted as 0.7 animal unit and bulls, cows, cows with calves, and steers over 600 pounds are counted as 1.0 animal unit.

If CDFW staff are able to hike around the reserve, they should conduct a rough count of animals present on the site.

At the end of each grazing period, the following information should be recorded and saved in the project folder:

- The actual number and size classes of animals present on the site.
- The dates that animals were actually added to and removed from the Reserve, including dates for any animals that were added late or removed early.
- The dates that pasture gates were opened and closed and the purposes for opening and closing them.
- The dates that supplemental water was brought to the site (if any), and the locations where it was placed.
- The dates of any efforts to herd animals to specific portions of the site, the locations where animals were herded from and herded to, and the reason for herding them.
- Any other information on grazing-related activities that took place.

The Reserve manager may decide to change the management of the Reserve based on the results of the monitoring described in this document. The Reserve manager could change the timing or intensity of grazing, or implement supplemental measures such as providing supplemental water for animals, herding animals to specific locations, or fencing areas to exclude grazing. The end of a grazing lease period may be the most appropriate time to adjust the timing and/or intensity of grazing.

5. RESPONSIBLE PARTIES

CDFW staff in the Native Plant Program or North Central Region (Region 2) should implement this monitoring protocol and report results and recommended actions annually to the Reserve manager. The Reserve manager should make decisions on how to adaptively manage the Reserve.

6. FUNDING

CDFW staff in the Native Plant Program used grant funding to prepare this protocol and collect monitoring data from 2015 to 2017. Continuation of this monitoring protocol is likely dependent on the ability of staff in the Native Plant Program to use staff time funded by the endangered species tax check off fund, general fund, and other programs to do so. Field helpers can often be borrowed from other CDFW programs if the appropriate program managers approve the work as cross training for their staff. Implementation of this monitoring protocol could also be implemented by staff in CDFW's North Central Region or by CDFW volunteers. It is estimated that annual implementation of this protocol will require the following:

Spring Field Work: **112 hours**

In-office preparations: 16 hours by one environmental scientist or senior environmental scientist (specialist) = **16 hours**

Field visit to check phenology: 8 hours by one environmental scientist or senior environmental scientist (specialist) and one other field helper = **16 hours**

Field visits to collect data: 16 hours by one environmental scientist or senior environmental scientist (specialist) and three other field helpers = **64 hours**

In-office data analysis and reporting: 16 hours by one environmental scientist or senior environmental scientist (specialist) = **16 hours**

Fall Field Work: **104 hours**

In-office preparations: 16 hours by one environmental scientist or senior environmental scientist (specialist) = **16 hours**

Field visits to collect data: 16 hours by one environmental scientist or senior environmental scientist (specialist) and three other field helpers = **64 hours**

In-office data analysis and reporting: 8 hours by one environmental scientist or senior environmental scientist (specialist), 16 hours by scientific aid = **24 hours**

TOTAL STAFF TIME NEEDED: Approximately **216 hours per year**

7. MANAGEMENT IMPLICATIONS OF POTENTIAL RESULTS

Management Implication #1: If any part of the 80 percent confident interval for our RDM estimate for Stone Ridge Ecological Reserve macroplots A or C exceeds 1000 lbs/acre in two consecutive years, the grazing intensity shall be increased by increasing the number of grazing animals on Stone Ridge Ecological Reserve in the following year.

Management Implication #2: If a qualitative assessment of photomonitoring and Butte County meadowfoam density indicates that grazing-related disturbances in any year are impacting the ability of Butte County meadowfoam to maintain a healthy self-sustaining population at Stone Ridge Ecological Reserve, the grazing intensity at Stone Ridge Ecological Reserve Pasture 1 shall be reduced by decreasing the number of grazing animals on Stone Ridge Ecological Reserve Pasture 1 in the following year, or beginning with implementation of the next grazing lease. This conclusion may be supported by a statistically significant reduction in the density of Butte County meadowfoam in Stone Ridge Ecological Reserve macroplots C and/or D or other information.

Management Implication #3: If a there has been more than six inches of precipitation in February of any year as indicated by weather modeling in the vicinity of Stone Ridge Ecological Reserve, cows shall be excluded from Pasture 1 as early as possible in March of that same year. The gates to Pasture 1 shall remain closed until the ground in Pasture 1 has become considerably less saturated, or a majority of Butte County meadowfoam plants have set seed.

8. REFERENCES

Arroyo, M.T.K. 1973. A taximetric study of infraspecific variation in autogamous *Limnanthes floccosa* (Limnanthaceae). Brittonia 25:177-191.

Bartolome, J.W., W. Frost, and N. McDougald. 2006 Residual Dry Matter Management on Coastal and Foothill Annual Rangelands in California. Division of Agriculture and Natural Resources, California Rangelands Research and Information Center California Guidelines for Volume 8092 of Publication (University of California (System). Division of Agriculture and Natural Resources))

Brown, C.R. and S.K. Jain. 1979. Reproductive system and pattern of genetic variation in two Limnanthes species. Theoretical and Applied Genetics 54:181-190.

Elzinga, C.L., D.W. Salzer, and J. Willoughby. 1998. Measuring and Monitoring Plant Populations. BLM Technical Reference 1730-1. U.S. Dept. of the Interior, Bureau of Land Management, Denver, CO. 492 pp.

Hauptli, H., B.D. Webster, and S.Jain. 1978. Variation in nutlet morphology in Limnanthes. American Journal of Botany 65:615-624.

Jain, S.K. 1976. Local dispersal of Limnanthes nutlets: an experiment with artificial vernal pools. Canadian Journal of Botany 56:1995-1997.

Toy, J. and B.C. Willingham. 1966. Effect of temperature on seed germination of ten species and varieties of Limnanthes. Economic Botany 20:71-75.

Toy, J. and B.C. Willingham. 1967. Some studies of secondary dormancy in Limnanthes seed. Economic Botany 21:363-366.

9. DATA SHEET EXAMPLES

The following pages are examples of field data sheets that may be used or modified for monitoring.

Field Data Sheet

Density of *Limnanthes floccosa* ssp. *californica* and *Limanthes floccosa* ssp *floccosa*

Location: Stone Ridge Ecological Reserve	**Date:**
Field Personnel:	**Macroplot dimensions:**
	Quadrat dimensions:
Photo monitoring completed? ☐ YES ☐ NO	
Position of Macroplot: (GPS coordinates, bearing, corner of origin)	
Methods and Notes:	

Date	Macroplot	Segment	Quadrat Distance from Origin (m)*	# ssp. californica	# ssp. floccossa

*__Quadrat distance from origin (meters)__ is the distance along the origin edge of the macroplot

Stone Ridge Ecological Reserve Butte County Meadowfoam Monitoring Project **Date** _____
Residual Dry Matter Data Sheet

Field Observers: _____

Site Info: _____ **Weather:**_____

Macroplot A

Size: 164 ft. x 328.1 ft.

Transect Start (feet)	X,Y Coordinates (feet)	Weight of RDM (grams)	X,Y Coordinates (feet)	Weight of RDM (grams)	X,Y Coordinates (feet)	Weight of RDM (grams)	X,Y Coordinates (feet)	Weight of RDM (grams)
A								
B								
C								
D								
E								
F								
G								
H								

Plot Notes: _____
_____
_____

Macroplot C

Size: 164 ft. x 328.1 ft.

Transect Start (feet)	X,Y Coordinates (feet)	Weight of RDM (grams)	X,Y Coordinates (feet)	Weight of RDM (grams)	X,Y Coordinates (feet)	Weight of RDM (grams)	X,Y Coordinates (feet)	Weight of RDM (grams)
A								
B								
C								
D								
E								
F								
G								
H								

Plot Notes:
_____
_____
_____

Macroplot B

Size: 82 ft. x 164 ft.

Transect Start (feet)	X,Y Coordinates (feet)	Weight of RDM (grams)	X,Y Coordinates (feet)	Weight of RDM (grams)
A				
B				
C				
D				

Plot Notes:
_____
_____
_____

Photomonitoring Log: Stone Ridge Macroplot A

Shoot all with a focal length equivalent to 27mm on a full frame camera (e.g. 18mm on a Nikon dx lens which is what Jeb uses). All photos should be shot from 5 feet above the ground, or with the tripod extended to maximum height. Take a photo of this monitoring sheet before you begin the monitoring photos.

Date of observation: _____ **Camera and Lens:** _____

Observer(s): _____ **Focal Length:**_____ **Camera Setting:** _____

Photo point	From	Toward	Description/Notes	Photo file name in camera
a	S Marker	E Marker (horizon ¼ of the way down from top of frame)		
b	S Marker	E Marker (~45° angle down at ground)		
c	S Marker	N Marker (horizon ¼ of the way down from top of frame)		
d	S Marker	N Marker (~45° angle down at ground)		
e	S Marker	W Marker (horizon ¼ of the way down from top of frame)		
f	S Marker	W Marker (~45° angle down at ground)		
g	W Marker	S Marker (horizon ¼ of the way down from top of frame)		
h	W Marker	S Marker (~45° angle down at ground)		
i	W Marker	E Marker (horizon ¼ of the way down from top of frame)		
j	W Marker	E Marker (~45° angle down at ground)		

k	W Marker	N Marker (horizon ¼ of the way down from top of frame)		
l	W Marker	N Marker (~45° angle down at ground)		
m	N Marker	W Marker (horizon ¼ of the way down from top of frame)		
n	N Marker	W Marker (~45° angle down at ground)		
o	N Marker	S Marker (horizon ¼ of the way down from top of frame)		
p	N Marker	S Marker (~45° angle down at ground)		
q	N Marker	E Marker (horizon ¼ of the way down from top of frame)		
r	N Marker	E Marker (~45° angle down at ground)		
s	E Marker	N Marker (horizon ¼ of the way down from top of frame)		
t	E Marker	N Marker (~45° angle down at ground)		
u	E Marker	W Marker (horizon ¼ of the way down from top of frame)		
v	E Marker	W Marker (~45° angle down at ground)		
w	E Marker	S Marker (horizon ¼ of the way down from top of frame)		
x	E Marker	S Marker (~45° angle down at ground)		

Photomonitoring Log: Stone Ridge Macroplot B

Shoot all with a focal length equivalent to 27mm on a full frame camera (e.g. 18mm on a Nikon dx lens which is what Jeb uses). All photos should be shot from 5 feet above the ground, or with the tripod extended to maximum height. Take a photo of this monitoring sheet before you begin the monitoring photos.

Date of observation: _____ **Camera and Lens:** _____

Observer(s): _____ **Focal Length:**_____ **Camera Setting:** _____

Photo point	From	Toward	Description/Notes	Photo file name in camera
a	SE Marker	NE Marker (horizon ¼ of the way down from top of frame)		
b	SE Marker	NE Marker (~45° angle down at ground)		
c	SE Marker	NW Marker (horizon ¼ of the way down from top of frame)		
d	SE Marker	NW Marker (~45° angle down at ground)		
e	SE Marker	SW Marker (horizon ¼ of the way down from top of frame)		
f	SE Marker	SW Marker (~45° angle down at ground)		
g	SW Marker	SE Marker (horizon ¼ of the way down from top of frame)		
h	SW Marker	SE Marker (~45° angle down at ground)		
i	SW Marker	NE Marker (horizon ¼ of the way down from top of frame)		
j	SW Marker	NE Marker (~45° angle down at ground)		

k	SW Marker	NW Marker (horizon ¼ of the way down from top of frame)		
l	SW Marker	NW Marker (~45° angle down at ground)		
m	NW Marker	SW Marker (horizon ¼ of the way down from top of frame)		
n	NW Marker	SW Marker (~45° angle down at ground)		
o	NW Marker	SE Marker (horizon ¼ of the way down from top of frame)		
p	NW Marker	SE Marker (~45° angle down at ground)		
q	NW Marker	NE Marker (horizon ¼ of the way down from top of frame)		
r	NW Marker	NE Marker (~45° angle down at ground)		
s	NE Marker	NW Marker (horizon ¼ of the way down from top of frame)		
t	NE Marker	NW Marker (~45° angle down at ground)		
u	NE Marker	SW Marker (horizon ¼ of the way down from top of frame)		
v	NE Marker	SW Marker (~45° angle down at ground)		
w	NE Marker	SE Marker (horizon ¼ of the way down from top of frame)		
x	NE Marker	SE Marker (~45° angle down at ground)		

Photomonitoring Log: Stone Ridge Macroplot C

Shoot all with a focal length equivalent to 27mm on a full frame camera (e.g. 18mm on a Nikon dx lens which is what Jeb uses). All photos should be shot from 5 feet above the ground, or with the tripod extended to maximum height. Take a photo of this monitoring sheet before you begin the monitoring photos.

Date of observation: _____ **Camera and Lens:** _____

Observer(s): _____ **Focal Length:**_____ **Camera Setting:** _____

Photo point	From	Toward	Description/Notes	Photo file name in camera
a	SE Marker	NE Marker (horizon ¼ of the way down from top of frame)		
b	SE Marker	NE Marker (~45° angle down at ground)		
c	SE Marker	NW Marker (horizon ¼ of the way down from top of frame)		
d	SE Marker	NW Marker (~45° angle down at ground)		
e	SE Marker	SW Marker (horizon ¼ of the way down from top of frame)		
f	SE Marker	SW Marker (~45° angle down at ground)		
g	SW Marker	SE Marker (horizon ¼ of the way down from top of frame)		
h	SW Marker	SE Marker (~45° angle down at ground)		
i	SW Marker	NE Marker (horizon ¼ of the way down from top of frame)		
j	SW Marker	NE Marker (~45° angle down at ground)		

k	SW Marker	NW Marker (horizon ¼ of the way down from top of frame)		
l	SW Marker	NW Marker (~45° angle down at ground)		
m	NW Marker	SW Marker (horizon ¼ of the way down from top of frame)		
n	NW Marker	SW Marker (~45° angle down at ground)		
o	NW Marker	SE Marker (horizon ¼ of the way down from top of frame)		
p	NW Marker	SE Marker (~45° angle down at ground)		
q	NW Marker	NE Marker (horizon ¼ of the way down from top of frame)		
r	NW Marker	NE Marker (~45° angle down at ground)		
s	NE Marker	NW Marker (horizon ¼ of the way down from top of frame)		
t	NE Marker	NW Marker (~45° angle down at ground)		
u	NE Marker	SW Marker (horizon ¼ of the way down from top of frame)		
v	NE Marker	SW Marker (~45° angle down at ground)		
w	NE Marker	SE Marker (horizon ¼ of the way down from top of frame)		
x	NE Marker	SE Marker (~45° angle down at ground)		

Photomonitoring Log: Stone Ridge Macroplot D

Shoot all with a focal length equivalent to 27mm on a full frame camera (e.g. 18mm on a Nikon dx lens which is what Jeb uses). All photos should be shot from 5 feet above the ground, or with the tripod extended to maximum height. Take a photo of this monitoring sheet before you begin the monitoring photos.

Date of observation: _____ **Camera and Lens:** _____

Observer(s): _____ **Focal Length:**_____ **Camera Setting:** _____

Photo point	From	Toward	Description/Notes	Photo file name in camera
a	SE Marker	NE Marker (horizon ¼ of the way down from top of frame)		
b	SE Marker	NE Marker (~45° angle down at ground)		
c	SE Marker	NW Marker (horizon ¼ of the way down from top of frame)		
d	SE Marker	NW Marker (~45° angle down at ground)		
e	SE Marker	SW Marker (horizon ¼ of the way down from top of frame)		
f	SE Marker	SW Marker (~45° angle down at ground)		
g	SW Marker	SE Marker (horizon ¼ of the way down from top of frame)		
h	SW Marker	SE Marker (~45° angle down at ground)		
i	SW Marker	NE Marker (horizon ¼ of the way down from top of frame)		
j	SW Marker	NE Marker (~45° angle down at ground)		

k	SW Marker	NW Marker (horizon ¼ of the way down from top of frame)		
l	SW Marker	NW Marker (~45° angle down at ground)		
m	NW Marker	SW Marker (horizon ¼ of the way down from top of frame)		
n	NW Marker	SW Marker (~45° angle down at ground)		
o	NW Marker	SE Marker (horizon ¼ of the way down from top of frame)		
p	NW Marker	SE Marker (~45° angle down at ground)		
q	NW Marker	NE Marker (horizon ¼ of the way down from top of frame)		
r	NW Marker	NE Marker (~45° angle down at ground)		
s	NE Marker	NW Marker (horizon ¼ of the way down from top of frame)		
t	NE Marker	NW Marker (~45° angle down at ground)		
u	NE Marker	SW Marker (horizon ¼ of the way down from top of frame)		
v	NE Marker	SW Marker (~45° angle down at ground)		
w	NE Marker	SE Marker (horizon ¼ of the way down from top of frame)		
x	NE Marker	SE Marker (~45° angle down at ground)		

California Department of Fish and Wildlife Stone Ridge Ecological Reserve Qualitative Monitoring
Date:

Field Personnel:

Location(s) Visited:

Describe the phenological condition of vegetation, soil saturation and soil disturbance

Describe any particularly abundant or notable plants or wildlife observed:

Describe Visible Threats and Disturbances:

Describe Weed Infestations:

Evidence of Livestock Use and Number of Grazing Animals Observed:

Photographs taken:

Recommendations:

STONE RIDGE ECOLOGICAL RESERVE BUTTE COUNTY MEADOWFOAM MONITORING RESULTS AND DISCUSSION 2015-2017

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

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1. INTRODUCTION

This document summarizes the 2015-2017 monitoring results from implementation of the 2017 Stone Ridge Ecological Reserve Butte County Meadowfoam Monitoring Plan (Monitoring Plan). The Monitoring Plan is included as Part 1 of this report and includes detailed instructions on how to implement the monitoring protocol for *Limnanthes floccosa* ssp. *californic*a (Butte County meadowfoam) at the California Department of Fish and Wildlife (CDFW) Stone Ridge Ecological Reserve (Reserve). The purpose of the Monitoring Plan is to facilitate adaptive management of the populations of Butte County meadowfoam at the Reserve. Implementation of the Monitoring Plan is expected to continue into 2021 or later. This document includes an interpretation of results, an assessment of the monitoring project, and management recommendations. The results and recommendations in this document are a critical step in the adaptive management process.

2. SUMMARY OF RESULTS

This document reports on the result of the following monitoring components:

1. Monitoring spring density of the target species Butte County meadowfoam, and a closely related possible indicator species *Limnanthes floccosa* ssp. *floccosa* (woolly meadowfoam);
2. Monitoring residual dry matter (RDM) in the fall;
3. Taking monitoring photographs; and
4. A qualitative description of the grazing that took place.

In addition, precipitation information generated using a PRISM climate model is presented, and general observations of other rare plants on the Reserve are reported.

2.1. SPRING DENSITY MONITORING

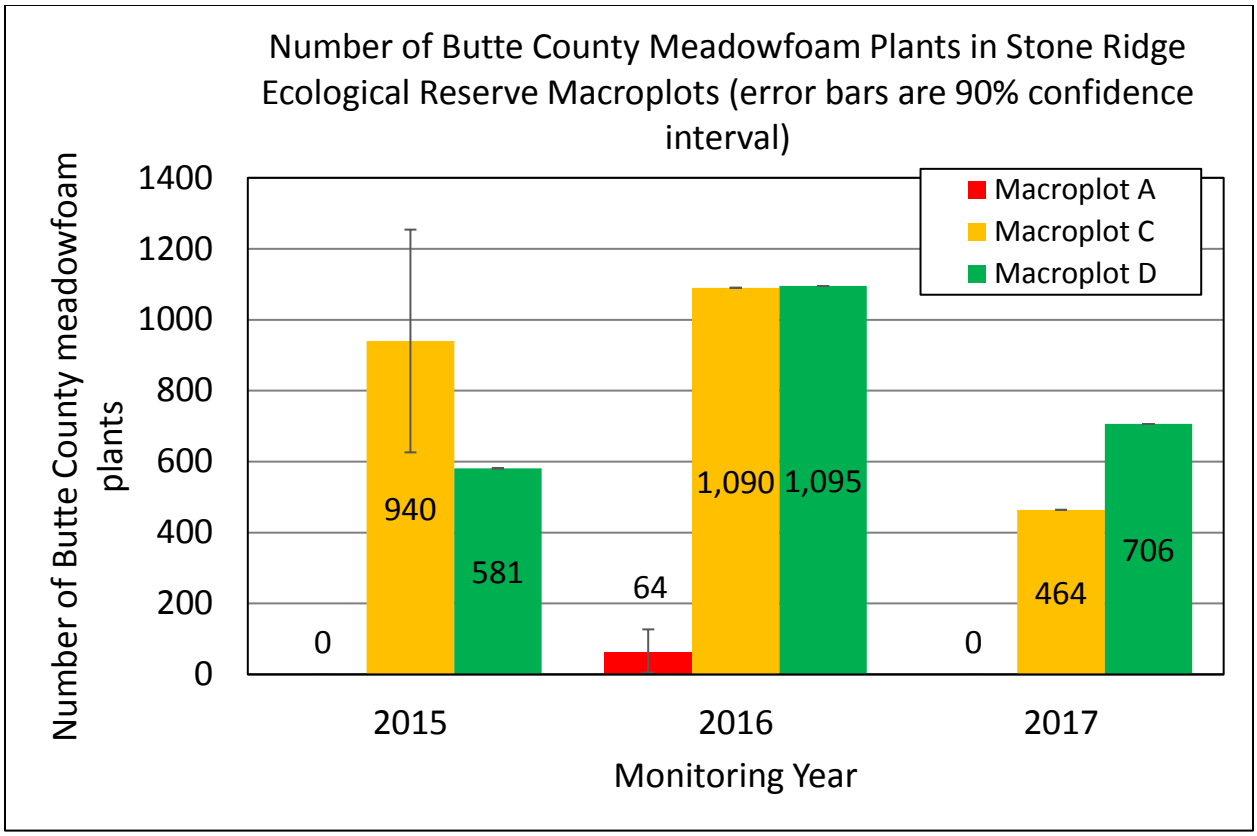
The Locations of Macroplots A-D are presented in Figures 2 and 3 of the Monitoring Plan (See Part 1 of this Report).

Butte County meadowfoam and/or woolly meadowfoam were present in each monitoring macroplot every year from 2015 to 2017. Butte County meadowfoam and woolly meadowfoam also occur elsewhere on the Reserve, outside of the macroplots, and these areas were not monitored.

Butte County Meadowfoam

A small number of Butte County meadowfoam plants (64) were observed in Macroplot A in 2016 and Macroplots C and D contained robust populations of Butte County meadowfoam every year from 2015 to 2017 (Figure 1).

Macroplot C is a relatively large macroplot that contains Butte County meadowfoam plants distributed through a network of swales. The number of Butte County meadowfoam plants in Macroplot C in 2015 was not statistically different than the number observed in 2016 (1,090). The number of Butte County meadowfoam plants in Macroplot C was, however, significantly lower in 2017 than in both 2015 and 2016.



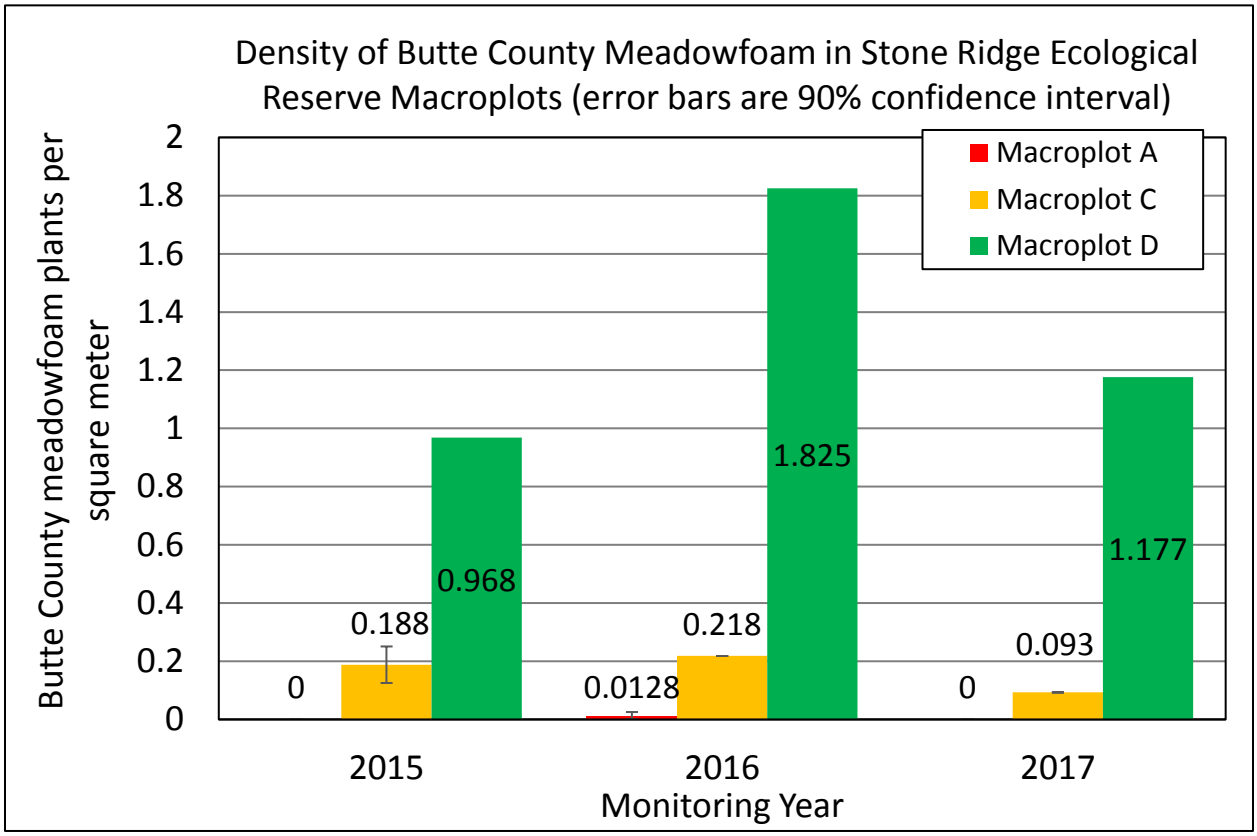


Figure 1
Results of *Limnanthes floccosa* ssp. *californica* Density Monitoring

Macroplot D is a relatively small macroplot located at a swale with a particularly dense population of Butte County meadowfoam. 581 Butte County meadowfoam plants were observed in Macroplot D in 2015, 1,095 were observed in 2016, and 706 were observed in 2017.

Woolly Meadowfoam

Macroplots A and B contained robust populations of woolly meadowfoam every year from 2015 to 2017, and a small number of woolly meadowfoam plants were also counted in Macroplot C in 2016 (45) and 2017 (6) (Figure 2).

Macroplot A is a relatively large macroplot with woolly meadowfoam plants distributed throughout the Macroplot. A statistical difference in the number of woolly meadowfoam plants was not detected in Macroplot A between 2015 and 2016; however, there were significantly fewer plants in 2017.

Macroplot B is one quarter the area of Macroplot A, but similarly contains woolly meadowfoam plants distributed throughout the macroplot. No statistically significant differences in the number of woolly meadowfoam plants were detected between any of the years in Macroplot B.

2.2. ANNUAL MONITORING FOR ADAPTIVE MANAGEMENT OF RESIDUAL DRY MATTER

The weight of residual dry matter (RDM) was monitored within several macroplots from 2015 to 2017. The results of RDM monitoring are presented in Figure 3. In 2014, prior to implementation of the Monitoring Plan, the Reserve manager collected three RDM samples from the Reserve near Cohasset Road, and averaged the three samples to arrive at an estimate of 1472 pounds per acre of RDM. In Macroplot A there was a statistically significant decline in RDM from 2015 to 2016, and another statistically significant decline between 2016 and 2017. There is no data from Macroplot B in 2016, but RDM was significantly lower in 2017 than it was in 2015. There was not a statistically significant decline in RDM in Macroplot C from 2015 to 2016, but there was a statistically significant decline in RDM from both 2015 and 2016 to 2017. RDM samples have not been collected regularly from Macroplot D due to the relatively small size of the macroplot, and its position over a swale.

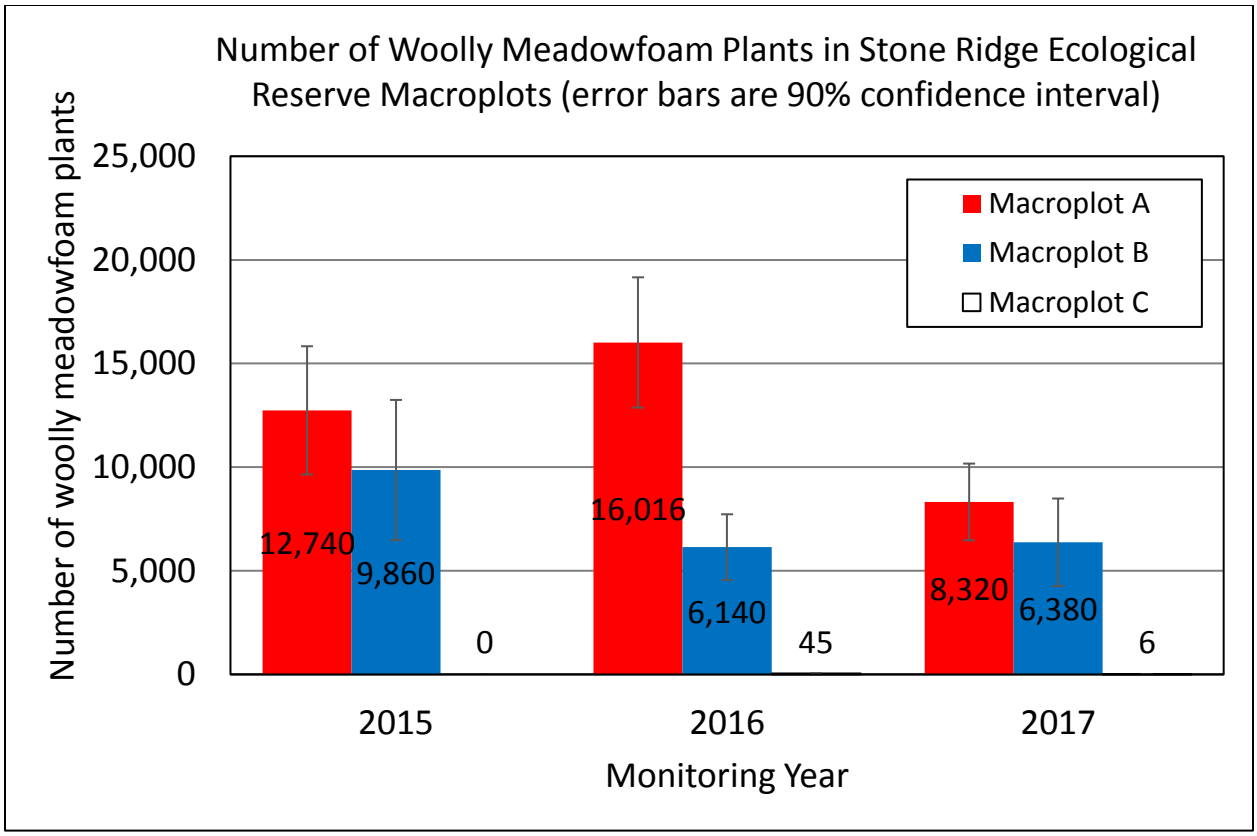
Based on the data available, there appears to have been a clear negative trend in the amount of fall RDM on the Reserve from 2014 to 2017.

2.3. ANNUAL PHOTOMONITORING FOR ADAPTIVE MANAGEMENT

Ninty-six monitoring photo positions were used at the reserve, with 24 monitoring photographs taken whenever density or RDM data was collected at one of the four macroplots. Some of the monitoring photos from 2015-2017 at photo positions Aa, Aq, Bc, Cu and Di are presented in Figures 4 through 9.

2.4. DOCUMENTATION OF GRAZING

There is limited information about the grazing practices at the Reserve prior to implementation of the Monitoring Plan. The Reserve had been grazed for over 40 years by the adjacent landowner and historical grazing operator Mr. Jon Bechtal. Mr. Bechtel grazed 300-400 head of cattle on the Reserve and his land for 30-40 years until 2005 when CDFW purchased the Reserve. Mr. Bechtal continued to be the grazing operator on the site through the spring 2013 grazing season. During this time, the Reserve was grazed by approximately 85 cows from



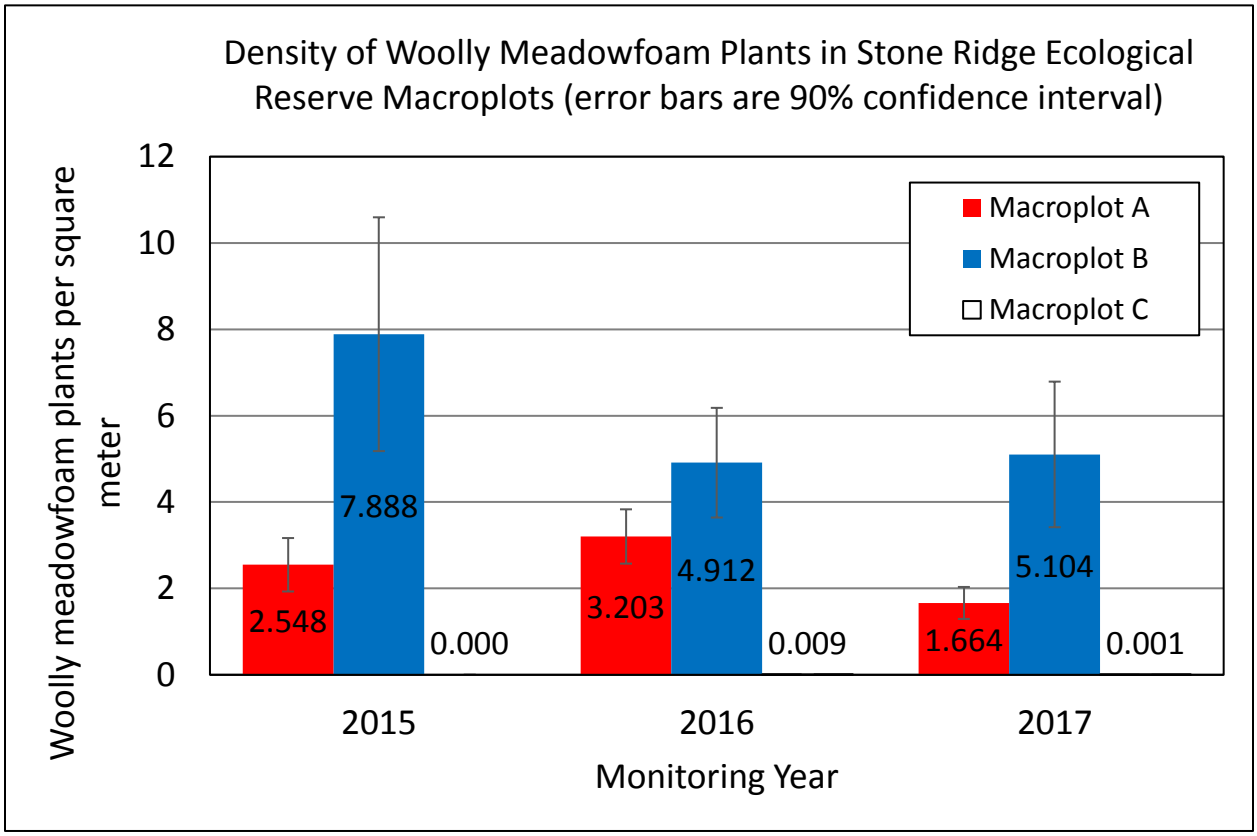


Figure 2
Results of *Limnanthes floccosa* ssp. *floccosa* Density Monitoring

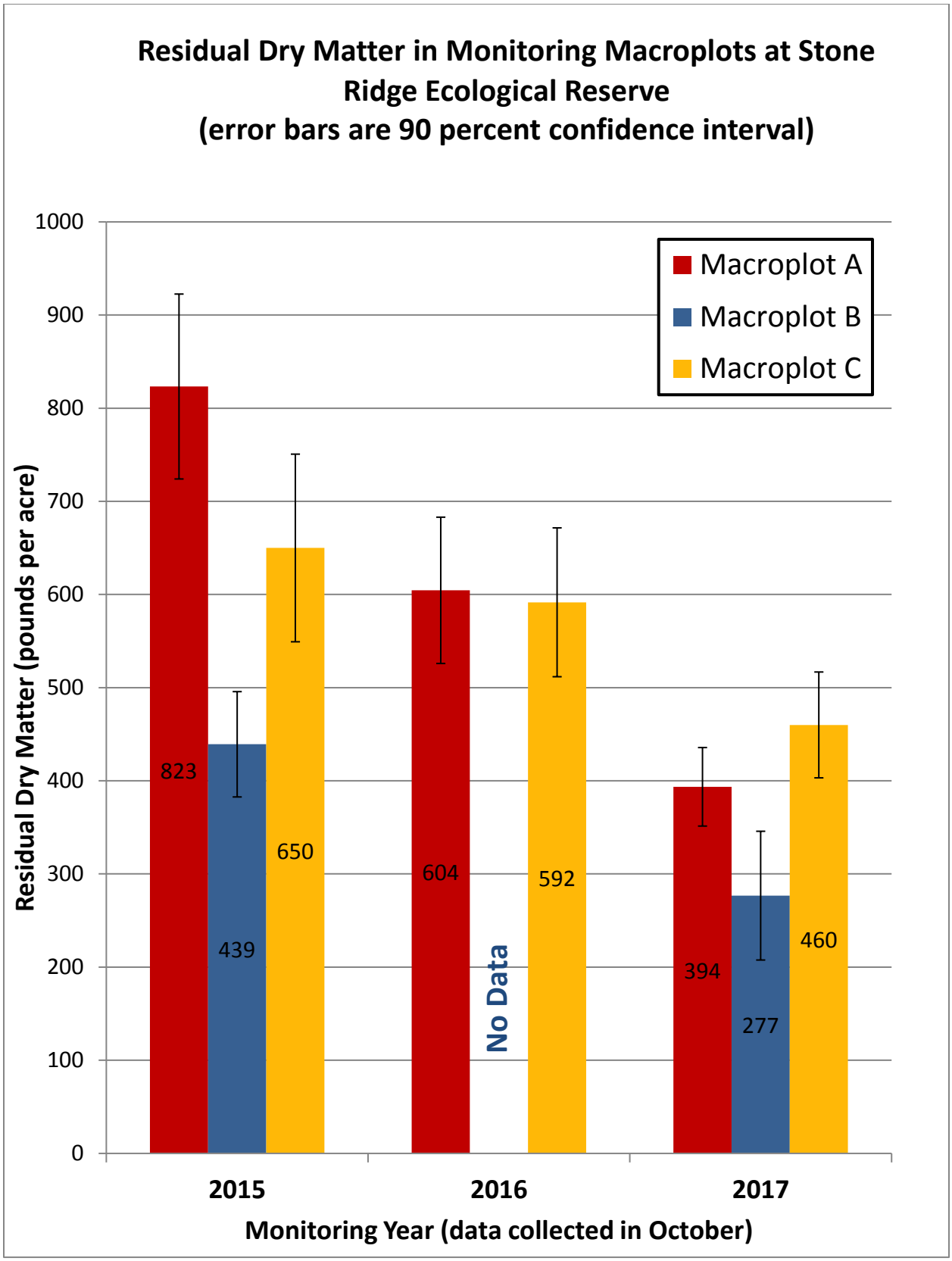


Figure 3
Results of Fall Residual Dry Matter Monitoring

2015

2016

2017

Figure 4
Photopoint Aa 2015-2017 (Spring)

2015

2016

2017

Figure 5
Photopoint Aq 2015-2017 (Fall)

2015

2016

2017

Figure 6
Photopoint Aq 2015-2017 (Spring)

2015

2016

2017

Figure 7
Photopoint Bc 2015-2017 (Spring)

2015

2016

2017

Figure 8
Photopoint Cu 2015-2017 (Spring)

2015

2016

2017

Figure 9
Photopoint Di 2015-2017 (Spring)

December through May 31. The Reserve was not grazed in the spring of 2014 due to the change in grazing operator. As a result, the Reserve manager, Henry Lomeli, observed that there was a particularly high amount of RDM on the Reserve in the Fall of 2014, higher than any of the other years he had observed the property (since approximately 2000).

CDFW established a land use agreement with a different grazing operator, Mr. Scott Larrabee, for the removal of vegetation from the Reserve, and grazing resumed for the spring 2015 grazing season. The agreement allows cattle to be on the Reserve from December 1 through May 31 (6 months). Grazing is limited to no more than 360 animal unit months (AUMs) per year (60 AUMs/month multiplied by 6 months = 360 AUMs/year). Weaned calves and light steers between 350 -600 pound weight class are each counted as 0.7 animal unit and bulls, cows, cows with calves, and steers over 600 pounds are counted as 1.0 animal unit. The current land use agreement expires on May 31, 2018.

There are three pastures on the Reserve (Figure 10). Pasture 1 is adjacent to Cohasset Road and the access gate, and all Butte County meadowfoam observed on the Reserve by CDFW staff since 2015 has been in Pasture 1. Pasture 2 is the largest pasture and the only pasture with permanent access to water from Mud Creek. Pasture 3 is the smallest and most remote pasture, with access to a seasonal stream.

2014/2015 Grazing Season: An e-mail from Mr. Larrabee reported that 55 cow/calf pairs were added to the Reserve on December 14, 2014, and an additional 25 cow/calf pairs were added on February 2, 2015. The pastures were rotated approximately every two weeks, however the largest pasture, which has access to Mud Creek, was always accessible because it is the only pasture with reliable water. No supplemental water was provided. Animals were allowed to graze freely and were reported to spread out over the Reserve well. The 80 cow/calf pairs were removed on April 26, 2015. Mr. Larrabee also reported that Mr. Betchtal constantly complained to him about the use of the gravel road on the Reserve.

2015/2016 Grazing Season: Cows were observed on the Reserve but not counted. Due to the low amount of water on the Reserve, water was trucked in to the Reserve for the cows, and some cows were sequestered in the pasture near Cohasset Road that supports Butte County meadowfoam to increase the grazing pressure in this area. Two 600 gallon water tanks had to be used and water was hauled in every day for some time.

2016/2017 Grazing Season: After noticing an unusually high number of cows on the Reserve, CDFW staff completed a rough count of animals while walking from the access gate to the northern part of the Reserve, and then south and back to the access gate. On March 3, 2017, CDFW staff counted approximately 130 animals (cows, calves, and at least 2 large males with horns) on the reserve, trying as best as possible not to double count. CDFW staff did not walk the entire Reserve, and therefore this count likely underestimates the total number of animals that were present on the Reserve. The adjacent landowner, Mr. Bechtal, reportedly released some of his cows on the Reserve as well, without permission. CDFW staff observed the Reserve to be much more disturbed and trampled from muddy hoofprints in March of 2017 than in the previous two years (see Figures 4, 6, 7, 8, and 9). The high number of animals present and muddy ground from high rainfall likely contributed to the site disturbance observed.

2.5. PRECIPITATION

Precipitation information generated using a PRISM climate model is presented in Figure 11 (PRISM 2017). Butte County meadowfoam germinates in the Fall after the onset of winter precipitation, and blooms in March and April, therefore September to March precipitation is

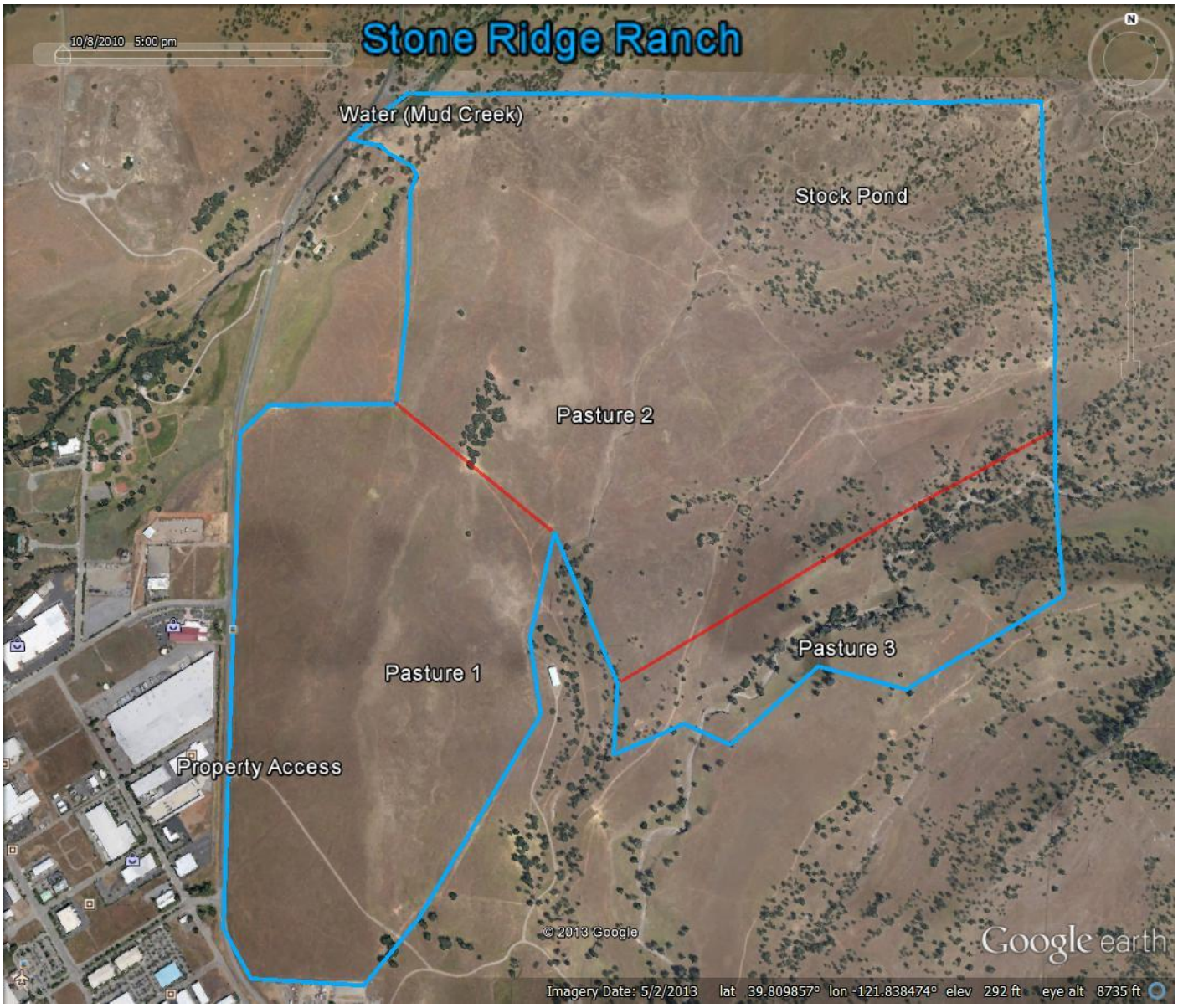
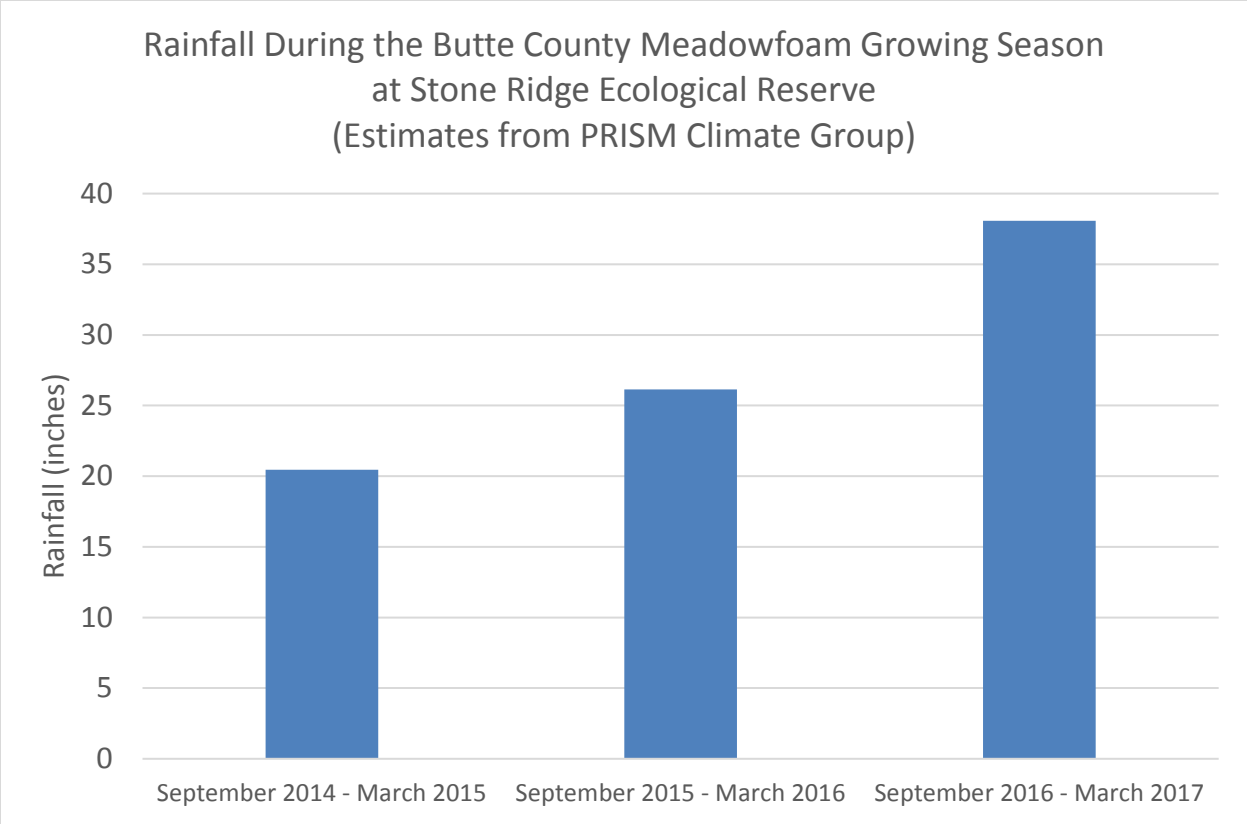


Figure 10
Grazing Pastures at Stone Ridge Ecological Reserve



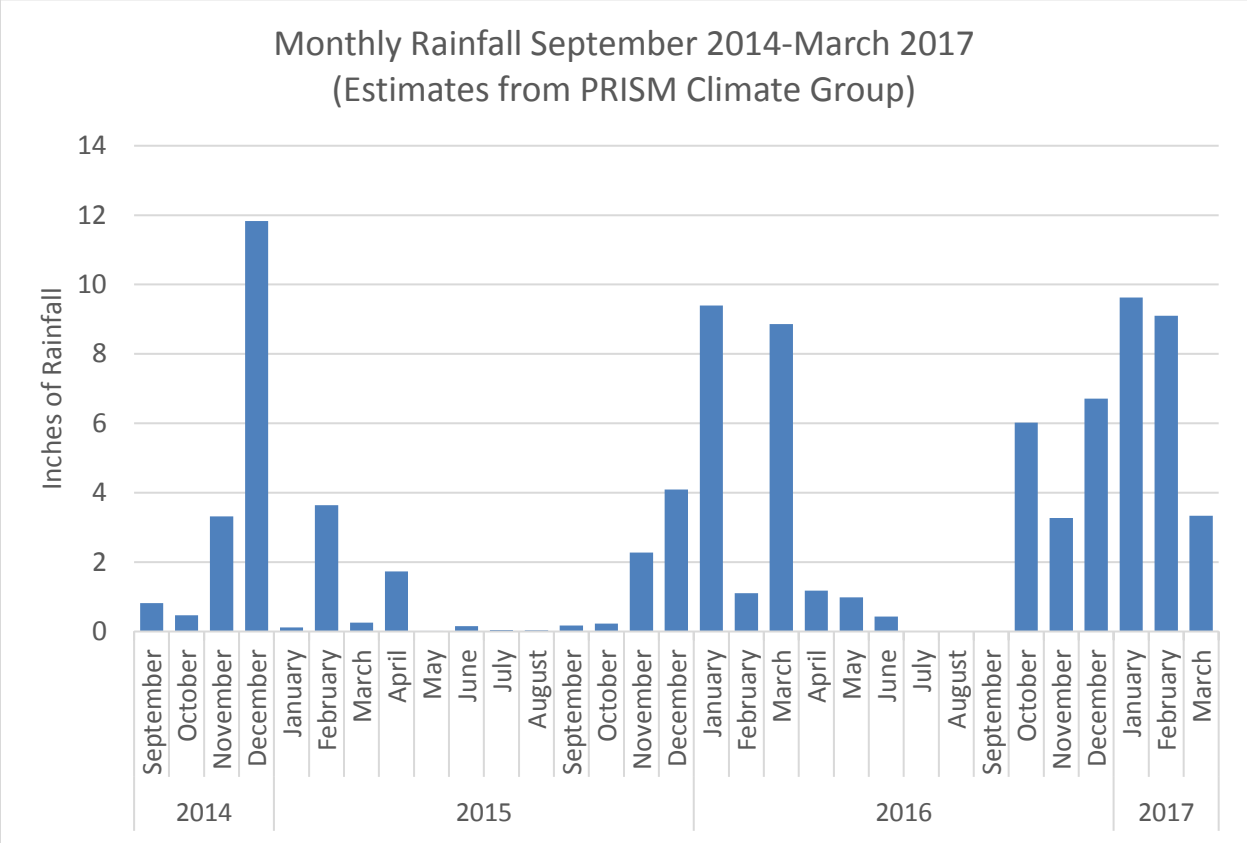


Figure 11
Rainfall at Stone Ridge Ecological Reserve 2015-2017

assumed to be an important factor for Butte County meadowfoam growth and survival. Overall, there was a clear positive trend in growing season precipitation from 2015 to 2017. January and March of 2015 were very dry, with little rainfall. February of 2016 also had very little rainfall. The winter of 2016-2017 was very wet in every month of the growing season.

2.6. OTHER OBSERVATIONS

In addition to Butte County meadowfoam and woolly meadowfoam, several other rare plants were observed on the Reserve.

Adobe lily (*Fritillaria pluriflora*) has a California Rare Plant Rank of 1B.2 and California Natural Diversity Database element occurrence number 118 occurs on the Reserve. Adobe lily was observed by CDFW staff on the Reserve in 2015, 2016, and 2017, but no quantitative estimates of the population were made. On February 24, 2017 the Adobe lily population was visually estimated to consist of between 100-1000 individuals with only approximately 5 percent of them flowering. Many of the individuals were heavily grazed with only a few inches of leaves left and no flowering stalk remaining. The ground was very pocketed by hoof prints and the impressions were pooled with water that was not infiltrating. The adobe lily population was noticeably impacted by trampling. The adobe lily population is in Pasture 2.

Ahart's paronychia (*Paronychia ahartii*) has a California Rare Plant Rank of 1B.1 and California Natural Diversity Database element occurrence number 62 occurs on the Reserve. The Ahart's paronychia population on the Reserve was observed by CDFW staff in 2015 and 2016, but no quantitative estimates of the population were made.

Depauperate milk-vetch (*Astragalus pauperculus*) has a California Rare Plant Rank of 4.3 and occurs on the Reserve. A small population was discovered at approximately 39 48'50.32", -121 50'05.05" (WGS84) on March 7, 2016.

3. INTERPRETATION OF RESULTS

With only three years of monitoring data, it is difficult to make strong conclusions; however, because growth and reproduction of a considerable number of Butte County meadowfoam and woolly meadowfoam plants has occurred within monitoring macroplots every year, the populations within the monitoring macroplots may be relatively stable. If the conditions within monitoring macroplots are representative of the conditions for meadowfoam populations on the Reserve as a whole, as was intended with the design of the Monitoring Plan, the populations of both Butte County meadowfoam and woolly meadowfoam may be similarly stable on the Reserve.

2016 was the "best" year for Butte County meadowfoam, with the highest number of plants in monitoring macroplots, and 2017 appears to have been the "worst" of the three monitoring years for Butte County meadowfoam, with 2015 somewhere in between.

The number of Butte County meadowfoam plants in 2015 may have been lower than the numbers in 2016 due to very low precipitation levels in January and March of 2015.

The high number of Butte County meadowfoam plants in 2016 may have been due to the relatively low impacts from grazing and trampling in the 2016 growing season due to relatively low water availability in the pasture supporting the Butte County meadowfoam population, but still with sufficient rainfall in January and March to support growth and survival of plants.

A plausible explanation for the lower number of Butte County meadowfoam plants in 2017 is the increased impacts from grazing and trampling in 2017 due to an increase in the number on animals on the reserve, combined with very wet winter and spring conditions that left the ground susceptible to more hoof disturbance from cows. Another explanation could be that years with high precipitation in every month of the growing season and the resulting ground conditions are less suitable for Butte County meadowfoam growth and survival than years with less precipitation.

Woolly meadowfoam monitoring results are less precise than the monitoring results for Butte County meadowfoam due to the reliance on sampling. The only statistically significant difference detected for woolly meadowfoam populations was a lower number of plants in Macroplot A in 2017 compared with the number of plants in 2015 and 2016, which contributes to the theory that plant populations were likely impacted by increased impacts from grazing and trampling in 2017. Plant density monitoring results for Macroplot B were not very insightful because no statistically significant differences between monitoring years were detected. Macroplot B is the only macroplot located within Pasture 2, and it is the only macroplot located near a pasture gate. Because Macroplot B is located in an area that cows are funneled through to move between Pastures 1 and 2, it is likely subject to unique grazing pressures that depend on the number of cows that use the gate.

March monitoring photographs from 2015 and 2016 are generally similar with regard to the amount of green annual vegetation on the landscape; however, monitoring photos from March 2016 generally show many more plants in bloom, and the photos are therefore more colorful than the same photos from 2015. March monitoring photographs from 2017 showed the ground on the Reserve to be considerably disturbed by cow hoof prints.

Residual dry matter appears to have reduced every year since 2014. This reduction could be due to seasonal weather patterns that are less favorable for the accumulation of RDM (i.e. drought), trampling of vegetation due to saturated soils in the winter and spring of 2017, and removal of more RDM as a result of increased grazing pressures in 2017.

Considering the information observed during the 2015-2017 monitoring period, the factors that are most likely to be negatively affecting the Butte County meadowfoam population on the Reserve are:

- Soil disturbance from cows when the ground is saturated;
- Prolonged inundation of habitat during the growing season due to record rainfall in 2017;
- Low precipitation levels in January and March as observed in 2015.

Of these factors listed above, the only factor that CDFW has some control over is the level of soil disturbance from cows when the ground is saturated.

4. ASSESSMENT OF THE MONITORING PROJECT

The monitoring project has been largely successful. Our methods have resulted in some insightful data, and by monitoring the site in 2017 we were able to detect the high levels of site disturbance that resulted from the wet winter and spring conditions combined with additional cows released onto the Reserve by Mr. Bechtel. All Butte County meadowfoam plants in Macroplots C and D were counted in 2016 and 2017 and therefore the monitoring data for Butte County meadowfoam is highly accurate. The monitoring data for woolly meadowfoam is less accurate due to a reliance on sampling, but because woolly meadowfoam is not the primary

focus of the monitoring project, the accuracy of the woolly meadowfoam density data may be sufficient.

One drawback to the monitoring project so far has been the commitment of staff time required to complete it. The monitoring requires approximately 216 staff hours per year to implement. Despite the staff time commitment, the plan continues to be a valuable approach to adaptive management of the Reserve. If the Monitoring Plan were to be scaled back, a reasonable approach would be to discontinue monitoring the density of meadowfoam in Macroplots A and/or B, or discontinue monitoring of RDM at Macroplot B. Due to the position of Macroplot A away from any gates or fences, its large area, and the absence of any cattle trails going through it, Macroplot A is likely the most representative macroplot for RDM within all of Pasture 1. Pasture 1 contains all Butte County meadowfoam plants that were observed on the Reserve by CDFW staff during the 2015-2017 monitoring period, and is therefore the most important pasture for Butte County meadowfoam on the Reserve. CDFW should continue monitoring RDM in Macroplot A, even if the Monitoring Plan were to be scaled back.

Additionally, attempts to precisely align monitoring photos has been difficult. Precise alignment of monitoring photos is important because it allows direct comparison of specific areas of the ground in the photograph, and it may be very difficult to determine which areas of the ground are the same if two monitoring photos are even slightly misaligned. Differences in perspective resulting from photographs taken with different cameras, from slightly different positions and in slightly different directions can be very distracting, and may require careful correction with photo editing software such as Photoshop before insightful comparisons become possible. Because correcting the differences in perspective requires photo editing expertise and a considerable time commitment, every effort should be made to standardize monitoring photos as much as possible in the field.

5. MANAGEMENT RECOMMENDATIONS

The management objectives and management implications identified in the Monitoring Plan are repeated below, with a discussion of whether the management implications should be triggered based on the monitoring results. Additional management recommendations for the project are also included.

5.1. MANAGEMENT OBJECTIVE #1

Prevent the RDM of all Stone Ridge Ecological Reserve macroplots that are known to contain Butte County meadowfoam from exceeding 1000 lbs/acre in two consecutive years.

Management Implication from Monitoring Plan: If any part of the 80 percent confident interval for our RDM estimate for Stone Ridge Ecological Reserve macroplots A or C exceeds 1000 lbs/acre in two consecutive years, the grazing intensity shall be increased by increasing the number of grazing animals on Stone Ridge Ecological Reserve in the following year.

Recommendation: RDM has been lower than 1,000 lbs/acre for every year of monitoring in all macroplots monitored. An increase in grazing intensity is not necessary.

5.2. MANAGEMENT OBJECTIVE #2

Prevent grazing-related disturbances from impacting the ability of Butte County meadowfoam and other rare plants to maintain healthy self-sustaining populations at Stone Ridge Ecological Reserve.

Management Implication from Monitoring Plan: If a qualitative assessment of photomonitoring and Butte County meadowfoam density indicates that grazing-related disturbances in any year are impacting the ability of Butte County meadowfoam to maintain a healthy self-sustaining population at Stone Ridge Ecological Reserve, the grazing intensity at Stone Ridge Ecological Reserve Pasture 1 shall be reduced by decreasing the number of grazing animals on Stone Ridge Ecological Reserve Pasture 1 in the following year, or beginning with implementation of the next grazing lease. This conclusion may be supported by a statistically significant reduction in the density of Butte County meadowfoam in Stone Ridge Ecological Reserve macroplots C and/or D or other information.

Recommendation: Grazing-related disturbances were high in 2017, and there was a statistically significant reduction in the number of Butte County meadowfoam plants in 2017. Despite the grazing-related disturbances, there was still a considerable number of Butte County meadowfoam plants in macroplots C and D in 2017. If the grazing related disturbances of 2017 continued, this could be an impact to the ability of Butte County meadowfoam to maintain a healthy self-sustaining population at the Reserve; however, it is unlikely that the impacts of 2017 will be a common occurrence. 2017 was an unusually wet year, and it is unlikely that similarly wet years will be a common occurrence. Nevertheless, it may be appropriate for CDFW to restrict cow access to Pasture 1 in some way when wet years do occur (see additional Management implication suggested below).

Furthermore, because CDFW was alerted to the additional cows on the property in 2017, CDFW will also be more careful about the number of cows grazing the property in the future. Based on the monitoring data collected from 2015 to 2017, the level of grazing used in 2015 and 2016 appears to be compatible with maintaining a population of Butte County meadowfoam on the Reserve, and no change in grazing intensity from what was used in in the 2014-2015 and 2015-2016 grazing seasons appears to be needed at this time to avoid impacting the ability of Butte County meadowfoam to maintain a healthy self-sustaining population.

The current a land use agreement to graze cows on the Reserve for vegetation control is scheduled to expire at the end of the 2017-2018 grazing season, and the operator, Mr. Scott Larrabee has indicated that he might not graze the property for the final, 2017-2018 grazing season. Butte County meadowfoam plants tends to occur in the deeper parts of rocky swales, in areas that experience less competition from invasive Mediterranean grasses. Mediterranean grasses are therefore less likely to produce thatch in areas where Butte County meadowfoam is found, and the presence of a greater biomass of Mediterranean grasses on the Reserve in the absence of grazing for a year, would likely only have a small to negligible negative impact on the Butte County meadowfoam population from increased thatch and competition. A complete rest from grazing, and from grazing-related impacts for a season may therefore be beneficial for the Butte County meadowfoam population. Furthermore, if cows do not graze the property during the 2017-2018 grazing season, it will be an opportunity to observe how the amount of RDM and the populations of Butte County meadowfoam and woolly meadowfoam respond to a complete rest from grazing for a season.

Management Implication Proposed for Addition to the Monitoring Plan: If there has been more than six inches of precipitation in February of any year as indicated by weather modeling in the vicinity of Stone Ridge Ecological Reserve, cows shall be excluded from Pasture 1 as early as possible in March of that same year. The gates to Pasture 1 shall remain closed until the ground in Pasture 1 has become considerably less saturated, or a majority of Butte County meadowfoam plants have set seed.

5.3. OTHER RECOMMENDATIONS

CDFW should build a barbed wire fence around as much of the adobe lily population on the Reserve as possible, and implement a simple photomonitoring plan in the area using fenceposts as the locations to take monitoring photos from.

CDFW should place a field marker near the Ahart's paronychia population and implement a simple photomonitoring plan in the area using the field marker as the location for monitoring photos.

CDFW should map the extent of the Butte County meadowfoam population on the Reserve within the next three years, and should prioritize this mapping if a particularly high number of Butte County meadowfoam plants are observed in a year. The current CNDDB polygon of the Butte County meadowfoam population is quite a bit larger than the actual extent of the population as observed by CDFW in 2015, 2016 and 2017.

CDFW should include a requirement in the next vegetation management agreement for the Reserve that the grazing manager provide a simple report to CDFW at the end of the grazing season. The report should provide a brief summary of the grazing that took place during the year, and should include the following information:

- The actual number and size classes of animals that were present on the site.
- The dates that animals were actually added to and removed from the Reserve, including dates for any animals that were added late or removed early.
- The dates that pasture gates were opened and closed and the purposes for opening and closing them.
- The dates that supplemental water was brought to the site (if any), and the locations where it was placed.
- The dates of any efforts to herd animals to specific portions of the site, the locations where animals were herded from and herded to, and the reason for herding them.
- Whether any unauthorized grazing or other unauthorized activity has taken place on the Reserve.
- Any other information on grazing-related activities that took place.

CDFW should take note of the number of livestock on the Reserve during monitoring visits, and ensure that livestock are not released onto the Reserve without permission.

6. REFERENCES

Elzinga, C.L., D.W. Salzer, and J. Willoughby. 1998. Measuring and Monitoring Plant Populations. BLM Technical Reference 1730-1. U.S. Dept. of the Interior, Bureau of Land Management, Denver, CO. 492 pp.

PRISM Climate Group. 2017. Oregon State University. Available online at: http://prism.oregonstate.edu. [Accessed November 21, 2017].

7. REVIEWERS

This document was prepared by Jeb McKay Bjerke, a senior environmental scientist (specialist) in the CDFW's Native Plant Program. The following individuals reviewed this document:

- Cherilyn Burton, CDFW Native Plant Program
- Katie Gross, CDFW California Natural Diversity Database
- Kristi Lazar, CDFW California Natural Diversity Database
- Henry Lomeli, Reserve Manager, CDFW Region 2

APPENDIX A

Stone Ridge Ecological Reserve

This worksheet was updated to current taxonomy on 5/11/2015 by Jill Spear, Native Plant Program. Minor updates in 2016 and 2017.

FAMILY	GENUS	SPECIES	var/ssp	A.K.A.	DATE	NAT	COMMENTS
Agavaceae	Chlorogalum	angustifolium		Narrow-Leaved Soap-Plant	3/4/2007	Y	
Alliaceae	Allium	amplectens		Clasping Onion	3/17/2007	Y	
Amaranthaceae	Amaranthus	albus		Tumbleweed	6/9/2007	N	
Anacardiaceae	Toxicodendron	diversilobum		Western Poison-Oak	3/28/2007	Y	
Apiaceae	Anthriscus	caucalis		Bur-Chervil	4/29/2007	N	
Apiaceae	Daucus	pusillus		Rattlesnake-Weed	5/5/2007	Y	
Apiaceae	Eryngium	castrense		Coyote-Thistle	3/4/2007	Y	
Apiaceae	Lomatium	utriculatum		Bladder Lomatium	3/4/2007	Y	
Apiaceae	Sanicula	bipinnata		Poison Sanicule	3/4/2007	Y	
Apiaceae	Sanicula	bipinnatifida		Purple Sanicle	3/4/2007	Y	
Apiaceae	Torilis	nodosa		Knotted Hedge-Parsley	4/29/2007	N	
Apocynaceae	Apocynum	cannabinum		Indian-Hemp	4/15/2007	Y	adjacent Mud Creek
Apocynaceae	Asclepias	eriocarpa		Indian Milkweed	3/28/2007	Y	
Apocynaceae	Asclepias	fascicularis		Narrow-Leaved Milkweed	4/15/2007	Y	adjacent Mud Creek
Aristolochiaceae	Aristolochia	californica		California Pipevine	3/28/2007	Y	one patch each observed along Sheep Hollow Creek and Mud Creek
Asteraceae	Achyrachaena	mollis		Blow-Wives	3/24/2007	Y	
Asteraceae	Artemisia	douglasiana		Mugwort	4/15/2007	Y	adjacent Mud Creek
Asteraceae	Baccharis	salicifolia	ssp. salicifolia	Mule's-Fat	4/15/2007	Y	adjacent Mud Creek
Asteraceae	Bidens	frondosa		Sticktight	6/9/2007	Y	adjacent Mud Creek
Asteraceae	Blennosperma	nanum	var. nanum	Yellow-Carpet	3/4/2007	Y	
Asteraceae	Brickellia	californica		California Brickellia	3/28/2007	Y	in and about a dry seasonal streambed in the se corner of the property
Asteraceae	Centaurea	melitensis		Tocalote	5/5/2007	N	
Asteraceae	Centaurea	solstitialis		Yellow Star-Thistle	3/17/2007	N	NOXIOUS WEED, C List
Asteraceae	Centromadia	fitchii		Fitch's Spikeweed	6/9/2007	Y	
Asteraceae	Eriophyllum	lanatum	var. grandiflorum	Large-Flowered Woolly-Sunflower	3/28/2007	Y	
Asteraceae	Gnaphalium	palustre		Western Marsh Cudweed	6/9/2007	Y	adjacent Mud Creek
Asteraceae	Grindelia	camporum		Foothill Gumplant	5/5/2007	Y	drainage ditch adjacent Cohasset Hwy and S.R.Ranch
Asteraceae	Hedypnois	rhagadioloides		Hedypnois	4/29/2007	N	
Asteraceae	Helianthus	bolanderi		Bolander's Sunflower	6/10/2007	Y	adjacent Mud Creek
Asteraceae	Hesperevax	acaulis	var. acaulis	Dwarf Evax	3/17/2007	Y	
Asteraceae	Hesperevax	caulescens		Hogwallow Evax	4/15/2007	Y	CNPS List 4
Asteraceae	Hypochaeris	glabra		Smooth Cat's-Ear	3/25/2007	N	
Asteraceae	Lactuca	serriola		Prickly Lettuce	6/9/2007	N	
Asteraceae	Lasthenia	californica		California Goldfields	3/17/2007	Y	
Asteraceae	Lasthenia	fremontii		Fremont's Goldfields	3/24/2007	Y	
Asteraceae	Lasthenia	gracilis		Common Goldfields	3/3/2017	Y	
Asteraceae	Layia	fremontii		Fremont's Tidytips	3/17/2007	Y	
Asteraceae	Logfia	gallica		Narrow-Leaved Filago	3/31/2007	N	
Asteraceae	Madia	elegans		Spring Madia	5/5/2007	Y	
Asteraceae	Matricaria	discoidea		Common Pineapple-Weed	3/25/2007	Y	
Asteraceae	Micropus	californicus	var. californicus	Slender Cottongrass	3/17/2007	Y	
Asteraceae	Psilocarphus	oregonus		Oregon Woolly-Marbles	3/25/2007	Y	

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NATive: Y=yes; N=No

FAMILY	GENUS	SPECIES	var/ssp	A.K.A.	DATE	NAT	COMMENTS
Asteraceae	Pseudognaphalium	luteoalbum		Weedy Cudweed	6/9/2007	N	adjacent Mud Creek
Asteraceae	Microseris	acuminata		Sierra Foothill Microseris	3/24/2007	Y	
Asteraceae	Microseris	douglasii	ssp. douglasii	Douglas' Microseris	4/15/2007	Y	
Asteraceae	Senecio	vulgaris		Old-Man-In-The-Spring	3/4/2007	N	
Asteraceae	Silybum	marianum		Milk-Thistle	4/15/2007	N	adjacent Mud Creek
Asteraceae	Sonchus	oleraceus		Common Sow-Thistle	4/15/2007	N	
Asteraceae	Taraxacum	officinale		Common Dandelion	4/29/2007	N	
Asteraceae	Xanthium	strumarium		Cocklebur	4/15/2007	Y	adjacent Mud Creek
Boraginaceae	Amsinckia	intermedia		Common Fiddleneck	3/17/2007	Y	
Boraginaceae	Amsinckia	lycopsoides		Bugloss fiddleneck	4/29/2007	Y	
Boraginaceae	Cryptantha	flaccida		Weak-Stemmed Crytantha	5/5/2007	Y	
Boraginaceae	Cryptantha	intermedia		Common Crytantha	5/5/2007	Y	
Boraginaceae	Nemophila	pedunculata		Meadow Nemopila	3/4/2007	Y	
Boraginaceae	Pectocarya	pusilla		Little Pectocarya	3/17/2007	Y	
Boraginaceae	Phacelia	egena		Rock Phacelia	3/28/2007	Y	
Boraginaceae	Plagiobothrys	austiniae		Austin's Popcorn-Flower	3/17/2007	Y	
Boraginaceae	Plagiobothrys	canescens		Valley Popcorn-Flower	3/28/2007	Y	
Boraginaceae	Plagiobothrys	greenei		Greene's Popcorn-Flower	3/17/2007	Y	
Boraginaceae	Plagiobothrys	fulvus	var. campestris	Fulvous Popcorn-Flower	3/17/2007	Y	
Boraginaceae	Plagiobothrys	nothofulvus		Common Popcorn-Flower	3/28/2007	Y	
Boraginaceae	Plagiobothrys	scriptus		Scribe's Popcorn-Flower	3/4/2007	Y	
Boraginaceae	Plagiobothrys	stipitatus	var. micranthus	Small-Flowered Stalked Popcorn-	4/11/2007	Y	
Brassiaceae	Athysanus	pusillus		Petty Athysanus	3/4/2007	Y	
Brassiaceae	Capsella	bursa-pastoris		Shepherd's Purse	3/20/2007	N	
Brassiaceae	Cardamine	oligosperma		Western Bittercress	3/31/2007	Y	
Brassicaceae	Draba	verna		Spring Draba	2/25/2016	Y	collected
Brassiaceae	Lepidium	nitidum	var. nitidum	Shining Pepper-Grass	3/17/2007	Y	
Brassiaceae	Lepidium	strictum		Upright Pepper-Grass	4/5/2007	N	
Brassiaceae	Nasturtium	officinale		Watercress	4/15/2007	Y	Mud Creek
Brassiaceae	Sisymbrium	officinale		Hedge-Mustard	4/29/2007	N	
Brassiaceae	Thysanocarpus	curvipes	var. curvipes	Clasping-Leaved Fringepod	3/17/2007	Y	
Brassiaceae	Thysanocarpus	radians		Spokepod	3/17/2007	Y	
Campanulaceae	Githopsis	pulchella	ssp. campestris	Large-Flowered Bluecup	4/29/2007	Y	graveled soil of a seasonal streambed
Campanulaceae	Heterocodon	rariflorum		Heterocodon	3/28/2007	Y	
Caprifoliaceae	Lonicera	interrupta		Chaparral Honeysuckle	3/28/2007	Y	thinly scattered plants
Caryophyllaceae	Cerastium	fontanum	ssp. vulgare	Common Mouse-Eared Chickweed	3/27/2007	N	
Caryophyllaceae	Cerastium	glomeratum		Sticky Mouse-Eared Chickweed	3/25/2007	N	
Caryophyllaceae	Minuartia	californica		California Sandwort	3/17/2007	Y	
Caryophyllaceae	Paronychia	ahartii		Ahart's Nailwort	3/25/2007	Y	CNPS List 1B, 2nd known Butte County population
Caryophyllaceae	Petrorhagia	dubia		Grass-Pink	3/25/2007	N	
Caryophyllaceae	Sagina	decumbens	ssp. occidentalis	Western Pearlwort	4/29/2007	Y	adjacent Mud Creek
Caryophyllaceae	Scleranthus	annuus	ssp. annuus	Knawel	4/15/2007	N	
Caryophyllaceae	Silene	gallica		Windmill-Pink	4/15/2007	N	adjacent Mud Creek
Caryophyllaceae	Spergularia	rubra		Ruby Sandspurry	4/15/2007	N	adjacent Mud Creek

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FAMILY	GENUS	SPECIES	var/ssp	A.K.A.	DATE	NAT	COMMENTS
Caryophyllaceae	Stellaria	media		Common Chickweed	3/17/2007	N	
Caryophyllaceae	Stellaria	nitens		Shining Chickweed	2/24/2017	Y	
Caryophyllaceae	Stellaria	pallida		Pallid Starwort	3/20/2007	N	
Caryophyllaceae	Velezia	rigida		Velezia	5/5/2007	N	
Convolvulaceae	Convolvulus	arvensis		Bindweed	4/29/2007	N	
Crassulaceae	Crassula	connata		Pigmyweed	3/4/2007	Y	
Crassulaceae	Crassula	tillaea		Mossy Pigmyweed	3/4/2007	Y	
Crassulaceae	Sedella	pumila		Dwarf-Stonecrop	3/4/2007	Y	
Cyperaceae	Cyperus	squarrosus		Awned Cyperus	6/10/2007	Y	adjacent Mud Creek
Cyperaceae	Cyperus	eragrostis		Tall Cyperus	4/29/2007	Y	adjacent Mud Creek
Cyperaceae	Eleocharis	macrostachya		Pale Spike-Rush	6/10/2007	Y	adjacent Mud Creek
Cyperaceae	Schoenoplectus	pungens		Common Threesquare	4/15/2007	Y	wet edge of Mud Creek
Ericaceae	Arctostaphylos	manzanita	ssp. manzanita	Big Manzanita	3/31/2007	Y	only one medium sized plant observed to date
Euphorbiaceae	Croton	setiger		Turkey-Mullein	3/17/2007	Y	
Euphorbiaceae	Euphorbia	ocellata	ssp. ocellata	Valley Spurge	6/9/2007	Y	
Fabaceae	Acmispon	parviflorus		Small-Flowered Lotus	3/28/2007	Y	
Fabaceae	Acmispon	wrangelianus		Wrangel Lotus	3/4/2007	Y	
Fabaceae	Astragalus	pauperculus		Depauperate Milk-Vetch	3/25/2007	Y	CNPS List 4, observed on thin soiled slopes
Fabaceae	Cercis	occidentalis		Western Redbud	3/28/2007	Y	
Fabaceae	Medicago	polymorpha		Common Bur-Clover	3/20/2007	N	
Fabaceae	Medicago	praecox		Mediterranean Bur-Clover	3/27/2007	N	
Fabaceae	Melilotus	albus		White Sweet-Clover	6/10/2007	N	adjacent Mud Creek
Fabaceae	Lotus	corniculatus		Bird's-Foot Trefoil	4/29/2007	N	
Fabaceae	Lupinus	bicolor		Bicolor Lupine	3/20/2007	Y	
Fabaceae	Lupinus	nanus		Sky Lupine	3/17/2007	Y	
Fabaceae	Trifolium	bifidum	var. decipiens	Deseptive Clover	4/15/2007	Y	
Fabaceae	Trifolium	ciliolatum		Foothill Clover	5/5/2007	Y	
Fabaceae	Trifolium	depauperatum	var. depauperatum	Dwarf Cowbag Clover	3/17/2007	Y	
Fabaceae	Trifolium	dubium		Little Hop Clover	4/8/2007	N	
Fabaceae	Trifolium	fragiferum		Strawberry Clover	6/9/2007	N	adjacent Mud Creek
Fabaceae	Trifolium	glomeratum		Sessile-Headed Clover	5/5/2007	N	
Fabaceae	Trifolium	hirtum		Rose Clover	3/17/2007	N	
Fabaceae	Trifolium	microcephalum		Small-Headed Clover	3/28/2007	Y	
Fabaceae	Trifolium	olivaceum		Olive Clover	3/25/2007	Y	
Fabaceae	Trifolium	repens		White Clover	4/29/2007	N	
Fabaceae	Trifolium	subterraneum		Subterranean Clover	3/17/2007	N	
Fabaceae	Trifolium	willdenovii		Tomcat Clover	3/24/2007	Y	
Fabaceae	Trifolium	wormskioldii		Springbank Clover	4/29/2007	Y	
Fabaceae	Trifolium	variegatum		White-Tipped Clover	3/28/2007	Y	
Fabaceae	Vicia	sativa	ssp. sativa	Garden Vetch	3/17/2007	N	
Fabaceae	Vicia	sativa	ssp. nigra	Garden Vetch	3/28/2007	N	
Fabaceae	Vicia	villosa	ssp. villosa	Winter Vetch	3/17/2007	N	
Fagaceae	Quercus	douglasii		Blue Oak	3/17/2007	Y	

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FAMILY	GENUS	SPECIES	var/ssp	A.K.A.	DATE	NAT	COMMENTS
Fagaceae	Quercus	lobata		Valley Oak	3/28/2007	Y	partial live tree growing in seasonal streambed; two medium sized trees on flood plain adjacent Mud Creek
Fagaceae	Quercus	wislizeni	var. wislizeni	Interior Live Oak	3/28/2007	Y	
Gentianaceae	Cicendia	quadrangularis		Timwort	3/25/2007	Y	
Gentianaceae	Zeltnera	muehlenbergii		June Centaury	4/29/2007	Y	
Gentianaceae	Zeltnera	venusta		Canchalagua	6/9/2007	Y	adjacent Mud Creek
Geraniaceae	Erodium	brachycarpum		Short-Fruited Stork's-Bill	3/17/2007	N	
Geraniaceae	Erodium	botrys		Long-Beaked Stork's-Bill	3/31/2007	N	
Geraniaceae	Erodium	cicutarium		Red-Stemmed Filaree	3/28/2007	N	
Geraniaceae	Geranium	dissectum		Cut-Leaved Geranium	3/28/2007	N	
Geraniaceae	Geranium	molle		Dove's-Foot Geranium	3/17/2007	N	
Hypericaceae	Hypericum	perforatum	ssp. perforatum	Klamathweed	5/5/2007	N	
Lamiaceae	Lamium	amplexicaule		Giraffehead	3/24/2007	N	
Lamiaceae	Mentha	arvensis		American Wild Mint	6/9/2007	Y	adjacent Mud Creek
Lamiaceae	Monardella	sheltonii		Shelton's Coyote-Mint	3/28/2007	Y	
Lamiaceae	Pogogyne	douglasii		Douglas' Pogogyne	4/29/2007	Y	
Lamiaceae	Pogogyne	zizyphoroides		Sacramento Valley Pogogyne	3/24/2007	Y	
Lamiaceae	Scutellaria	siphocampyloides		Gray-Leaved Skullcap	5/5/2007	Y	growing in a dry streambed
Lamiaceae	Trichostema	lanceolatum		Vinegar-Weed	3/17/2007	Y	
Juncaceae	Juncus	bufonius	var. bufonius	Common Toad-Rush	4/29/2007	Y	adjacent Mud Creek
Juncaceae	Juncus	capitatus		Leafy-Bracted Dwarf Rush	3/20/2007	N	observed in vernal areas, considered uncommon in Jepson
Juncaceae	Luzula	subsessilis		Sessile Wood-Rush	4/29/2007	Y	
Liliaceae	Calochortus	luteus		Yellow Mariposa-Lily	4/29/2007	Y	
Liliaceae	Fritillaria	pluriflora		Adobe-Lily	3/31/2007	Y	CNPS List 1B, with Zigadenus & blue oaks
Limnanthaceae	Limnanthes	alba	ssp. alba	White Meadowfoam	4/15/2007	Y	single plant observed along Mud Creek
Limnanthaceae	Limnanthes	floccosa	ssp. floccosa	Woolly Meadowfoam	3/4/2007	Y	CNPS List 4, populations & habitat seemed mixed
Limnanthaceae	Limnanthes	floccosa	ssp. californica	Shippee Meadowfoam	3/20/2007	Y	CNPS List 1B, CE, FE.
Linaceae	Hesperolinon	californicum		California Western-Flax	5/5/2007	Y	growing on open grassland/pasture
Lythraceae	Lythrum	hyssopifolia		Hyssop Loosestrife	6/9/2007	N	adjacent Mud Creek
Malvaceae	Sidalcea	calycosa	ssp. calycosa	Annual Checkerbloom	4/29/2007	Y	marshy area adjacent Mud Creek
Malvaceae	Sidalcea	robusta		Butte County Checkerbloom	5/5/2007	Y	CNPS List 1B
Melanthiaceae	Toxicoscordion	fremontii		Fremont's Zigadene	3/28/2007	Y	
Molluginaceae	Mollugo	verticillata		Indian-Chickweed	4/29/2007	N	
Montiaceae	Calandrinia	menziesii		Redmaids	3/17/2007	Y	
Montiaceae	Claytonia	parviflora	ssp. parviflora	Small-Flowered Miner's Lettuce	3/17/2007	Y	
Montiaceae	Claytonia	perfoliata	ssp. perfoliata	Common Miner's Lettuce	3/17/2007	Y	
Montiaceae	Montia	fontana		Water Montia	3/4/2007	Y	
Moraceae	Ficus	carica		Edible Fig	4/15/2007	N	one small tree observed adjacent Mud Creek
Myrsinaceae	Lysimachia	arvensis		Scarlet Pimpernel	4/15/2007	N	adjacent Mud Creek
Oleaceae	Fraxinus	latifolia		Oregon Ash	4/15/2007	Y	adjacent Mud Creek
Onagraceae	Clarkia	purpurea	ssp. quadrivulnera	Purple Clarkia	4/11/2007	Y	
Onagraceae	Epilobium	ciliatum	ssp. ciliatum	Fringed Willowherb	6/9/2007	Y	adjacent Mud Creek
Onagraceae	Epilobium	torreyi		Torrey's Spike-Primrose	6/9/2007	Y	adjacent Mud Creek

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FAMILY	GENUS	SPECIES	var/ssp	A.K.A.	DATE	NAT	COMMENTS
Orobanchaceae	Castilleja	affinis		Lay & Collie's Indian-Paintbrush	5/5/2007	Y	
Orobanchaceae	Castilleja	attenuata		Valley-Tassels	3/31/2007	Y	
Orobanchaceae	Triphysaria	eriantha	ssp. eriantha	Johnnytuck	3/4/2007	Y	
Papaveraceae	Eschscholzia	caespitosa		Foothill-Poppy	3/17/2007	Y	
Papaveraceae	Eschscholzia	lobbii		Fryingpans	3/20/2007	Y	
Papaveraceae	Meconella	californica		California Fairypoppy	2/25/2016	Y	collected
Phrymaceae	Mimulus	douglasii		Purple mouse ears	2/25/2016	Y	
Phrymaceae	Mimulus	glaucescens		Shield-Bracted Monkey-Flower	4/15/2007	Y	CNPS List 4, adjacent Mud Creek & Sheep Hollow Creek
Phrymaceae	Mimulus	guttatus		Seep Monkey-Flower	3/27/2007	Y	
Pinaceae	Pinus	sabiniana		Gray Pine	3/28/2007	Y	
Plantaginaceae	Collinsia	sparsiflora	var. sparsiflora	Few-Flowered Collinsia	3/4/2007	Y	
Plantaginaceae	Collinsia	tinctoria		Sticky Chinese-Houses	5/5/2007	Y	growing in a dry streambed
Plantaginaceae	Keckiella	breviflora	var. glabrisepala	Gaping Keckiella	5/5/2007	Y	
Plantaginaceae	Kickxia	elatine		Sharp-Leaved Fluellin	4/15/2007	N	adjacent Mud Creek
Plantaginaceae	Penstemon	heterophyllus	var. purdyi	Purdy's Beardtongue	6/9/2007	Y	several plants observed, vegetative state only
Plantaginaceae	Plantago	elongata		Elongate Plantain	3/20/2007	Y	
Plantaginaceae	Plantago	erecta		Erect Plantain	3/17/2007	Y	
Plantaginaceae	Plantago	lanceolata		English Plantain	4/15/2007	N	adjacent Mud Creek
Plantaginaceae	Veronica	anagallis-aquatica		Water Speedwell	5/15/2007	N	Mud Creek
Plantaginaceae	Veronica	peregrina	ssp. xalapensis	Purslane Speedwell	4/8/2007	Y	
Platanaceae	Platanus	racemosa		Western Sycamore	4/29/2007	Y	one medium sized tree adjacent Mud Creek
Poaceae	Aira	caryophyllea		Silver European Hairgrass	3/17/2007	N	
Poaceae	Alopecurus	saccatus		Vernal Pool Fescue	3/24/2007	Y	
Poaceae	Avena	barbata		Slender Wild Oat	3/17/2007	N	
Poaceae	Avena	fatua		Wild Oat	5/5/2007	N	
Poaceae	Briza	maxima		Greater Quaking-Grass	4/29/2007	N	adjacent and growing into Mud Creek
Poaceae	Briza	minor		Lesser Quaking Grass	3/24/2007	N	
Poaceae	Brachypodium	distachyon		False-Brome	5/5/2007	N	
Poaceae	Bromus	hordeaceus		Soft Chess	3/17/2007	N	
Poaceae	Bromus	madritensis	ssp. rubens	Red Brome	3/31/2007	N	
Poaceae	Bromus	sterilis		Poverty Brome	5/5/2007	N	
Poaceae	Bromus	tectorum		Cheatgrass	5/5/2007	N	
Poaceae	Crypsis	vaginiflora		African pricklegrass	6/9/2007	N	adjacent Mud Creek
Poaceae	Cynodon	dactylon		Bermuda-Grass	6/9/2007	N	adjacent Mud Creek
Poaceae	Cynosurus	echinatus		Hedgehog Dogtail	3/28/2007	N	
Poaceae	Deschampsia	danthonioides		Annual Hairgrass	3/25/2007	Y	
Poaceae	Digitaria	ischaemum		Smooth Crabgrass	4/29/2007	N	adjacent Mud Creek
Poaceae	Elymus	caput-medusae		Medusa-head	3/17/2007	N	NOXIOUS WEED, C List
Poaceae	Elymus	ponticus		Tall Wheatgrass	6/10/2007	N	adjacent Mud Creek
Poaceae	Festuca	bromoides		Six-Weeks Fescue	3/17/2007	N	
Poaceae	Festuca	microstachys		Fringed Fescue	3/24/2007	Y	
Poaceae	Festuca	microstachys		Hairy-Leaved Fescue	3/31/2007	Y	
Poaceae	Festuca	microstachys		Few-Flowered Fescue	3/25/2007	Y	

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FAMILY	GENUS	SPECIES	var/ssp	A.K.A.	DATE	NAT	COMMENTS
Poaceae	Festuca	myuros		Rattailed Fescue	3/31/2007	N	
Poaceae	Festuca	perennis		Ryegrass	3/17/2007	N	
Poaceae	Gastridium	phleoides		Nitgrass	6/9/2007	N	
Poaceae	Glyceria	X occidentalis		Western Mannagrass	4/29/2007	Y	adjacent Mud Creek
Poaceae	Hordeum	marinum	ssp. gussoneanum	Mediterranian Barley	3/17/2007	N	
Poaceae	Hordeum	murinum	ssp. leporinum	Hare Wall Barley	3/24/2007	N	
Poaceae	Koeleria	gerardi		Bristly Koeler's Grass	4/29/2007	N	
Poaceae	Muhlenbergia	rigens		Deergrass	3/28/2007	Y	several clumps observed along Mud Creek and Sheep Hollow Creek
Poaceae	Panicum	acuminatum	var. acuminatum	Western Panicgrass	6/9/2007	Y	adjacent Mud Creek; **does not occur in CA according to JMT2**
Poaceae	Paspalum	dilatatum		Dallisgrass	6/9/2007	N	adjacent Mud Creek
Poaceae	Poa	annua		Annual Bluegrass	3/17/2007	N	
Poaceae	Poa	bulbosa		Bulbous Bluegrass	3/28/2007	N	
Poaceae	Poa	secunda	ssp. secunda	One-Sided Bluegrass	3/31/2007	Y	
Poaceae	Poa	tenerrima		Delicate Bluegrass	3/17/2007	Y	growing in recently dried vernal swells & seasonal streambeds
Poaceae	Polypogon	monspeliensis		Annual Beardgrass	4/29/2007	N	
Poaceae	Scribneria	bolanderi		Scribner's-Grass	3/20/2007	Y	
Poaceae	Stipa	pulchra		Purple Needlegrass	6/9/2007	Y	occasional near waterways in blue oak woodlands
Polemoniaceae	Gilia	tricolor	ssp. tricolor	Bird's-Eye Gillia	3/24/2007	Y	
Polemoniaceae	Leptosiphon	bicolor		Bicolored Linanthus	3/17/2007	Y	
Polemoniaceae	Leptosiphon	filipes		Wild Baby's-Breath	3/25/2007	Y	
Polemoniaceae	Microsteris	gracilis		Slender Phlox	3/4/2007	Y	
Polemoniaceae	Navarretia	heterandra		Tehama Navarretia	4/15/2007	Y	CNPS List 4
Polemoniaceae	Navarretia	intertexta		Needle-Leaved Navarretia	5/5/2007	Y	
Polemoniaceae	Navarretia	leucocephala	ssp. leucocephala	White-Flowered Navarretia	3/24/2007	Y	
Polemoniaceae	Navarretia	pubescens		Downy Navarretia	4/29/2007	Y	
Polemoniaceae	Navarretia	tagetina		Marigold Navarretia	4/29/2007	Y	
Polemoniaceae	Navarretia	viscidula		Sticky Navarretia	6/9/2007	Y	
Polygonaceae	Chorizanthe	polygonoides	var. polygonoides	Knotweed Spineflower	3/25/2007	Y	
Polygonaceae	Eriogonum	nudum	var. pubiflorum	Hairy-Flowered Buckwheat	3/28/2007	Y	
Polygonaceae	Periscaria	maculosa		Lady's-Thumb	4/29/2007	N	adjacent Mud Creek
Polygonaceae	Periscaria	punctata		Dotted Smartweed	6/10/2007	Y	adjacent Mud Creek
Polygonaceae	Pterostegia	drymarioides		Pterostegia	3/28/2007	Y	
Polygonaceae	Rumex	salicifolius		Willow Dock	4/15/2007	Y	adjacent Mud Creek
Polygonaceae	Rumex	crispus		Curly Dock	3/31/2007	N	
Primulaceae	Primula	clevelandii	var. patula	Lowland Shootingstar	3/17/2007	Y	
Primulaceae	Primula		hybrid?		3/4/2007	Y	
Pteridaceae	Pentagramma	triangularis	ssp. triangularis	Gold-Backed Fern	3/17/2007	Y	
Ranunculaceae	Delphinium	hansenii	ssp. hansenii	Hansen's Larkspur	5/5/2007	Y	
Ranunculaceae	Delphinium	variegatum	ssp. variegatum	Royal Larkspur	3/17/2007	Y	
Ranunculaceae	Ranunculus	arvensis		Field Buttercup	4/15/2007	N	
Ranunculaceae	Ranunculus	canus		Sacramento Valley Buttercup	3/28/2007	Y	
Ranunculaceae	Ranunculus	muricatus		Prickle-Seeded Buttercup	3/31/2007	N	
Rhamnaceae	Ceanothus	cuneatus	var. cuneatus	Buckbrush	3/28/2007	Y	

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Stone Ridge Ecological Reserve

FAMILY	GENUS	SPECIES	var/ssp	A.K.A.	DATE	NAT	COMMENTS
Rhamnaceae	Frangula	californica	ssp. tomentella	Hoary Coffeeberry	3/28/2007	Y	
Rhamnaceae	Rhamnus	ilicifolia		Holly-Leaved Redberry	6/9/2007	Y	two plants obs. to date
Rosaceae	Cercocarpus	betuloides	var. betuloides	Birch-Leaved Mountain-Mahogany	5/5/2007	Y	only a few shrubs observed along Sheep Hollow Creek
Rosaceae	Drymocallis	glandulosa		Sticky Cinquefoil	3/28/2007	Y	one population observed hanging on a moist, shaded creek rockface
Rosaceae	Rubus	armeniacus		Himalayan Blackberry	4/15/2007	N	adjacent Mud Creek
Rubiaceae	Cephalanthus	occidentalis	var. californicus	California Button-Willow	4/29/2007	Y	adjacent Mud Creek
Rubiaceae	Crucianella	angustifolia		Crosswort	5/5/2007	N	
Rubiaceae	Galium	aparine		Cleavers	3/17/2007	Y	
Rubiaceae	Galium	parisiense		Wall Bedstraw	5/5/2007	N	
Rubiaceae	Sherardia	arvensis		Field-Madder	3/28/2007	N	
Salicaceae	Populus	fremontii	ssp. fremontii	Fremont's Cottonwood	3/28/2007	Y	on se property several small trees on edge of a seasonal stream; one med. size tree adjacent Mud Creek
Saxifragaceae	Lithophragma	bolanderi		Bolander's Woodlandstar	3/28/2007	Y	
Saxifragaceae	Micranthes	integrifolia		Smooth Leaf Saxifrage	2/25/2016	Y	collected
Saxifragaceae	Micranthes	californica		Green's Saxifrage	2/26/2016	Y	collected
Scrophulariaceae	Verbascum	balattaria		Moth Mullein	3/15/2007	N	adjacent Mud Creek
Scrophulariaceae	Verbascum	thapsus		Woolly Mullein	3/15/2007	N	adjacent Mud Creek
Selaginellaceae	Selaginella	hansenii		Hansen's Spike-Moss	3/4/2007	Y	
Tamaricaceae	Tamarix	gallica		French Tamarisk	3/11/2007	N	population along Mud Creek at nw end of property
Tecophilaeaceae	Odontostomum	hartwegii		Hartweg's Odontostomum	4/8/2007	Y	
Themidaceae	Brodiaea	californica		California Brodiaea	4/29/2007	Y	
Themidaceae	Brodiaea	elegans	ssp. elegans	Elegant Brodiaea	4/29/2007	Y	
Themidaceae	Brodiaea	minor		Bluestars	4/8/2007	Y	
Themidaceae	Dichelostemma	capitatum	ssp. capitatum	Bluedicks	3/17/2007	Y	
Themidaceae	Dichelostemma	multiflorum		Round-Toothed Ookow	3/28/2007	Y	
Themidaceae	Dichelostemma	volubile		Twining Ookow	4/15/2007	Y	
Themidaceae	Triteleia	bridgesii		Bridges' Triteleia	5/5/2007	Y	
Themidaceae	Triteleia	hyacinthina		Wild Hyacinth	3/24/2007	Y	
Themidaceae	Triteleia	laxa		Ithuriel's Spear	3/17/2007	Y	
Themidaceae	Triteleia	lilacina		Glassy Wild Hyacinth	3/28/2007	Y	
Typhaceae	Typha	domingensis		Southern Cattail	6/9/2007	Y	adjacent Mud Creek
Valerianaceae	Plectritis	ciliosa		Long-Spurred Pink Plectritis	3/31/2007	Y	
Valerianaceae	Plectritis	ciliosa		Short-Spurred Pink Plectritis	3/17/2007	Y	
Valerianaceae	Plectritis	macrocera		White Plectritis	3/28/2007	Y	
Violaceae	Viola	douglasii		Douglas' Violet	3/17/2007	Y	
Vitaceae	Vitis	californica		California Wild Grape	3/28/2007	Y	occasional along several of the larger drainages

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APPENDIX B

Workflow for Aligning Monitoring Photos in Photoshop

This procedure provides a rough outline of a technique for aligning monitoring photos taken from the same location using Photoshop CS6.

1. Open Photoshop CS6
2. Under "**File**", select "**Scripts**" > "**Load Files into Stack**"
3. Select "**Browse**" and select all monitoring photos you would like to align
    a. Only check "**Attempt to Automatically Align Source Images**" if there are lots of buildings or other visually distinct aspects to the image, and even then, this may not work well. If the result does not look good, start over and uncheck this box.
4. Select "**Image**", and "**Canvas Size**" and increase the vertical and horizontal canvas size by a few inches.
5. Select the top layer in the layers window, select "**Filter**" and "**Lens Correction…**" For "**Edge**" select "**Edge Extension**". Select **OK**.
    a. **NOTE:** For photos taken with an SLR camera (Nikon d3100/d3300) a lens profile is available, and should be used. The Native Plant Program point and shoot Sony camera does not have a lens profile, so skip the lens correction step for photos taken on the Sony.
6. Use the **eye button** to make the top layer that was just corrected invisible, click on the next layer down to select it, and repeat Step 5 for all remaining monitoring photos.
7. Make the top layer visible again and click it to select it in the layers window. Click and hold the **eyedropper icon** in the tools window, and select the **ruler tool** in the submenu.
8. Click and hold on a specific feature on the horizon on the left side of the image, and drag a ruler line to a specific feature on the horizon on the right side of the image. Click the "Straighten Layer" button at the top of the window. Repeat steps 6 and 7 for the remaining layers so that the horizon is straightened in the same way for all monitoring photos.
9. Select a reference photo with lots of landmarks and identifiable features, and move it down to the bottom layer in the layers window. (This will be your Reference Photo)
10. Make all layers invisible in the layers window, except for the bottom two layers. Make the layer above the bottom layer about 50 percent transparent by selecting it in the layers window, and using the "**Opacity**" slider, so that you can see features from both images at the same time.
11. Use the "**Move Tool**" by pressing **V** on the keyboard, and dragging the top layer so that it matches the bottom layer as best as possible. Getting the horizon to match as much as possible is a good first step. Matching features in the foreground is more difficult. There are several techniques that can be used to help with this:
    a. Resizing the layer by holding the **shift key** (to maintain aspect ratio) and clicking and dragging a corner of the layer. -> be sure that "**Show Transform Controls**" is checked.
    b. "**Edit**" > "**Transform**" > "**Warp**" can be used to drag features to where they need to be. If a rock or tree needs to be moved to line up with the same rock or tree underneath, simply drag it and move it. You will likely need to go back to other areas of the photo to stretch everything into the right place. Just work on the photo until you are happy with

the result. (**Important note**: do not accept the changes and apply the transformation by pressing the "**enter**" key until you are completely happy with the result. Every time you accept a transformation, the act is destructive, and it permanently degrades the quality of the image)

c. "**Edit**" > "**Transform**" > "**Perspective**" can also be used if a side of the image is skewed in one way or the other. Grab the edge you want to move and move it. I have only used this successfully a few times, typically if most to the telephone poles are leaning in one direction, for instance.

d. Once you have begun transforming the layer, you cannot turn the layer on and off to check your work anymore, and you should therefore use the "**Opacity**" slider to see what is underneath and check your work.

12. When you have completed a layer, make it invisible with the eye button, and make the next layer above visible, select it, and continue with Steps 8, 9 and 10 until you have edited all of the layers.
13. Select "**File**" > "**Save As**" and save the photoshop file as the photopoint name in the appropriate location on the U Drive, for example: U:\Groups\HCPB\Shared Folders\NPP\Section 6\2014\Priority Plant Surveys\Project Files\Butte County Limnanthes Files\Stone Ridge\All renamed photos here for comparison**Aligned Photos\Aq**
(You might need to make a new Aligned photos folder in renamed photos folder)
14. Make all layers visible and select all layers. Select "**View**" > "**Show**" > "**Layer Edges**" to give you an idea of where all of the layers overlap. Select the Rectangular Marquee Tool from the toolbar window (a dashed rectangle).
15. Draw a selection within the area that all (or most) of the layers overlap. -> The layer edges will disappear once you start to draw your rectangle so be sure to get a good idea of where to draw before you start.
16. After the photoshop file has been saved, crop the image down by selecting "**Image**" > "**Crop**"
17. Make only the top layer visible and select it. If there are any areas along the edges where you can see the transparency underneath and want to fill it in with camouflage, select the area using the **magic wand tool** from the toolbar. After selecting the transparency, select "**Select**" > "**Modify**" > "**Expand**" and increase the selection by **5** pixels.
18. Next click "**Edit**" > "**Fill…**" and select "**Content Aware**" to fill the blank areas.
19. Next click "**File**" > "**Save as**", change the file type to JPEG and save the file in the appropriate photopoint folder on the U drive, with the filename corresponding with that photopoint and the date the photo was taken.
20. Repeat steps 15, 16 and 17 for the remaining layers.