RESTORING SIERRA MEADOWS:
THE SOURCE OF CALIFORNIA`S WATER

2015
FIELD REPORT
Restoring Sierra Meadows: The Source of California’s Water  
2015 FIELD REPORT

Background Information

**LEAD PI:** Rachel Hutchinson  
River Science Director  
South Yuba River Citizens League

**DISCLAIMER/AUTHOR’S NOTE:**  
Some data collected in 2015 is not yet fully quality controlled and has not been analyzed to be included in this report.
Dear 2015 Earthwatch Volunteers,

I cannot thank you enough for your support of Earthwatch and the South Yuba River Citizens League’s (SYRCL’s) meadow research and restoration efforts in 2015. This was the second year we have worked with Earthwatch to conduct research in the Sierra and we are looking forward to continuing in 2016. With your help, we were able to collect plant data in 720 plots, survey over 100 trees, finish putting in groundwater wells, and walk the perimeter of 3 meadows. I was continually inspired by your positive attitudes, your quick ability to learn and recognize over 75 plant species, and the ways in which you returned to camp every evening eager to share and learn from each other.

Each one of you had a positive impact on the Yuba watershed and the meadows where I am lucky to work. The data you collected will be analyzed and shared in reports, at conferences, and hopefully in a scientific journal over the next several years. I look forward to hearing from some of you over the years as you head off to college, choose majors, and start your own careers. I wish you all the best of luck. Please let me know if you ever need letters of recommendation for your college applications—I would be thrilled to provide them for you!

Sincerely,

Rachel Hutchinson
River Science Director
South Yuba River Citizens League
SUMMARY

In 2015 we began a 5-year research program in the California Sierra Nevada to investigate how greenhouse gas (GHG) emissions, carbon sequestration, groundwater, surface water, and vegetation is affected by meadow restoration activities. We expect that improvements to stream channels will have a cascading impact on the overall ecosystem function within a meadow. This year was successful because we were able to set up and instrument our groundwater monitoring wells and stream gages, establish long term vegetation and aspen monitoring transects, and establish greenhouse gas and carbon sequestration monitoring locations at Loney Meadow.

This initial dataset will be used to help us understand the pre- and post-restoration condition of these parameters at a handful of meadows in the Yuba watershed. The data we collect will add to the scientific body of research on meadows, specifically by comparing each one of the parameters we are measuring over space (from meadow to meadow) and over time (before and after meadow restoration). In addition, the data we collect in the Yuba watershed will be shared with our partners across the Sierra Nevada to establish a Sierra-wide relationship between meadow hydrology, vegetation, soil carbon, and greenhouse gas emissions.

GOALS, OBJECTIVES, AND RESULTS

Mountain meadows in the Sierra Nevada provide multiple ecosystem services. As natural water retention basins, meadows attenuate floods, sustain stream base flows, improve water quality, and support vegetation that stabilizes stream channels and promotes biodiversity. In addition, mountain meadows provide natural storage of atmospheric carbon (Xu 2003). Research to date shows that healthy mountain meadows contain at least two times more carbon, nitrogen, dissolved organic carbon and dissolved organic nitrogen than degraded meadows (Norton 2011).

Management activities and impacts from climate change have degraded Sierra Nevada meadows by altering surface water and groundwater dynamics. In many meadows, overgrazing, road-building, mining, fire suppression and/or development have resulted in localized stream incision, degradation, and partial conversion from wet to dry meadow conditions (Ratliff 1985). Climate change impacts, such as earlier snowmelt, lead to further degradation of meadows through accelerated channel erosion and depletion of groundwater. Impacted meadows have slowly become drier. Shorter, warmer winters will result in accelerated vegetation and habitat loss, mineralization of soil organic matter, and an increase in GHG emissions, specifically the loss of carbon and nitrogen and the release of methane from the system.

In 2015, our meadows work focused on conducting vegetation transects, groundwater well installation and monitoring, measuring aspen (Populus tremuloides) communities, and walking meadow perimeters and streamlines. With the support of our two Earthwatch teen teams, we were able to collect data in Loney Meadow, Deer Meadow, Upper Loney Meadow, and Butcher Ranch Meadow.

Stream health is important for meadow communities. Healthy streams support the relatively high groundwater conditions that stabilize stream banks and support wetter meadow vegetation. Many meadow restoration projects focus on bank stabilization and raising the stream bed because of the cascading impacts these actions have on groundwater levels, vegetation rehabilitation, carbon sequestration, and wildlife utilization.

Meadow edges are important because they provide a buffer for meadow ecosystems and support a unique assemblage of plant species. In particular, sierra aspen stands are made up of a single clonal individual, making each stand very unique and extremely susceptible environmental change. As fires have been suppressed and the groundwater levels of meadows have lowered, conifers have encroached on meadow fringes, where aspen stands are most common. Densely growing conifer stands outcompete aspens for sunlight and water.

Our research objectives centered on answering questions that can help SYRCL and partners plan for future stream restoration by understanding the current condition of the streamline, the density of our aspen communities, and the area impacted by encroaching conifers. In 2015, we expanded our interests and included measuring groundwater and meadow vegetation to these objectives specifically to investigate how groundwater levels might be impacted by incised stream channels and consequently how groundwater level impacts meadow vegetation.
Our objectives, as expressed in our research proposal, were to collect data that would enable us to answer the following questions:

- How much of each meadow is impacted by conifer encroachment?
- Is conifer encroachment more common or denser in meadows with impaired hydrology or where fire suppression practices have been in place?
- Are aspens returning to areas where conifers have been removed?
- What is the proportion of aspen stands that are impacted by encroaching conifers?

**OBJECTIVES ADDED IN 2015**

- Do groundwater levels within the meadow drive what types of vegetation occur in a meadow or how much conifer encroachment there is?

**METHODS**

**Aspen Communities**

Aspen communities were measured to determine the health of the aspen stand after the removal of conifers from the stand area. To determine aspen stand health 4 transects were established within every aspen stand. Along each transect tree location (distance along the transect, measured in meters), species type (aspen or conifer), diameter at breast height (DBH measured in cm), height (measured in cm), and canopy cover (at 3 meter intervals) were measured. Our monitoring protocol was adapted from a protocol developed by Bobette Jones (Jones et al. 2005), to monitor aspen stands in the Lassen National Forest about 175 miles northwest of our field sites. At each aspen stand, four randomly spaced transects were established with the same declination. Each transect varied in length and extended at least 5 meters from the first or last aspen recorded along the transect. While transects were measured, a separate Aspen Field Assessment Form was completed to gather qualitative information about each aspen stand, including disturbance history and size of stand. Field data were entered into an Access database and quality controlled for accuracy by Earthwatch Volunteers, SYRCL volunteers, and SYRCL staff. Data was exported and analyzed in R, a free statistical software.

Aspen tree recruitment occurs episodically as cohorts or age class groups. In order to understand the age class structure of aspen stands sampled, we established age groups by looking at natural breaks in tree heights and assigning an age class group to each tree. To determine if these age classes were statistically distinct from one another, a multivariate analysis of variance (MANOVA) was run with tree DBH and height as dependent variables. We hypothesized that newly recruiting trees would occur closer to the meadow edge, rather than the forest edge, because it is a wetter and brighter (less canopy cover). To understand if this was the case, an ANOVA with a Tukey HSD was run with age class as the independent variable and distance along the transect as the dependent variable. Transect length was log transformed to adjust for differences in transect length. In addition, a linear model was run on aspen tree height and transect distance to further understand that relationship (height~log(Transect Distance)).

To understand if aspen stand densities differed between stands or meadows, stand density (per m²) was calculated by dividing the total number of aspens counted within a single transect (n=4 transects per stand) by the area of each transect. The area of each transect was calculated as the length of each transect multiplied the width (2m). A one way analysis of variance (ANOVA) and a Tukey HSD was used, with transect density as the dependent variable and StandID as the independent variable, to determine if densities differed between or within stands and meadows. This data will be used to test our hypothesis that wetter meadows and open canopies are more likely to produce dense aspen stands than drier meadows with more conifer encroachment. Data will be collected in 2016 on soil moisture and groundwater level in each of the aspen stands.

Overstory cover in aspen stands is thought to outcompete aspens for sunlight, making it more difficult for aspens to recruit and establish. To understand the relationship between aspen stands and overstory cover, a ANOVA and TukeyHSD was performed with overstory cover as the dependent variable and aspen stand was the independent variable.
Photo 1. Earthwatch team measuring aspen’s in Butcher Ranch Meadow.
Data from Butcher Ranch collected in 2015 are not yet available for analysis.

**Conifer Encroachment**

Encroaching conifers were measured to determine their density and distribution along the meadow’s edge. The aspen transect method used above was adapted for conifers. Transects were established within encroaching conifers perpendicular to the meadow edge. Along the transect, data collected for every conifer within one meter on either side of the transect included the following measurements:

- Distance along the transect (measured in meters)
- Diameter at breast height (DBH measured in cm)
- Height (measured in cm)
- Canopy cover (at 3 meter intervals)

Field data was entered into an Access database and quality controlled for accuracy by Earthwatch Volunteers, SYRCL volunteers, and SYRCL staff. Data will be exported to R, a free statistical software, for analysis. Conifer transect length was log transformed to adjust for differences in transect length and a linear model was run on conifer tree height and transect distance to further understand that relationship (height ~ log(Transect Distance)).

*No additional data were collected on conifer encroachment in 2015. See 2014 field report for information about conifer encroachment in Loney and Van Norden Meadow.*

**Stream Channel Measurements**

Stream channel degradation is an indicator of meadow health as heavily incised and gullied streamlines indicate that the groundwater levels may be lowering over time. To measure the streamline, a TopCon HiPer V TRK system was employed to walk the thalweg, or the deepest section of the channel, to document stream cross sections, and vegetation transects in Van Norden Meadow. Thalweg locations were taken every 1-2 meters, we were unable to complete these surveys in 2014 due to lack of field time.

*No additional data were collected on stream channel depth in 2015.*
Groundwater Monitoring

Ten groundwater wells in three longitudinal cross-sections (see Map 1) were installed in Loney Meadow to investigate how groundwater levels changed across the meadow. Wells were installed using the piezometer method, with metal poles and well points driven 2-3 meters into the ground. Six of the ten groundwater wells were instrumented with pressure transducers in the fall of 2015 and will remain in place for at least 5 years.

Map 1. Map of Loney Meadow piezometers and stream gages installed in 2015.

In Sierran meadows, groundwater levels are understood (Hammersmark et al. 2008) to be a key driver of vegetation type and diversity, carbon sequestration and methane and nitrous oxide production (Blankinship et al. 2014). Groundwater data from Loney and Deer Meadows will be contributed to a modelling effort to understand greenhouse gas emissions as part of the Sierra Meadows Restoration Research Partnership (SMRRP).
Vegetation Sampling
Vegetation sampling occurred along the three groundwater transects (see Map 1) and will be used to identify vegetation types and link them to groundwater levels, understand spatial patterning of diversity, and to be included in the modelling efforts by the SMRP. Vegetation data has not yet been analyzed.

Along each transect, stands of vegetation were visually stratified to create separate macro plots along the transect. Within each macro plot, 25 or 50 micro plots of 400cm² were sampled for all species (see Photo 2). Frequency of each identified species was assessed by counting a species as present first in the entire 400cm² inner square and again if present in the 100cm² inner square. Species present in only the 400cm² square but that were not rooted in the 100cm² square were given a 0/1, species present in both were given a 1/1 score.

Photo 2. Earthwatch Teen Teams building transect squares and collecting vegetation plot data at Loney Meadow.

RESULTS AND CONCLUSIONS

Aspen Community Structure

In 2014 and 2015, volunteers collected data at 12 aspen stands in Loney Meadow (4), Upper Loney Meadow (2), Loney Road (1) Van Norden (1), Butcher Ranch Meadow (2), and Rucker Lake (1), totaling in 48 transects. At present, data is not yet available from the two stands at Butcher Ranch Meadow.

Understanding the age structure of each aspen stand will allow us to determine how healthy existing aspen stands are and whether new trees are recruiting. We set four age classes by producing a scatter plot of aspen heights and used this plot to visually assign age classes. We tested for whether these age classes were statistically distinct using a MANOVA with DBH and height as dependent variables. The four groups were statistically differentiated from one another and we will use the following cohort/age classes in further analyses: New Growth: <2m, Young Aspens: 2-5 meters tall, Mid-Age Aspens: 5-10 meters tall, and Large Aspens: >10m (F(1,2408)=4990.6, p<0.0001). A multi-age stand, like Loney 1 (see Figure 1) indicates that there is new tree recruitment occurring and that those recruiting trees are maturing. A stand like Van Norden 1 indicates that while recruitment is occurring, the lack of mid-age trees indicates that trees that recruit do not survive.
Figure 1. Age Class distribution within aspen stands in the Yuba watershed. Stands with evenly distributed age classes are healthier stands where aspen are sprouting and growing into older trees.

To understand whether specific age classes were more likely to occur near the meadow edge or near the forest edge, we ran an ANOVA and a TukeyHSD for age class vs. log transformed distance along the transect. While the New Growth (<2m tall) age group was more dispersed along the transect, distance along the transect did not differentiate by Age Class ($F_{(1,1916)} = 6.63$, $p=0.09$). While significant, there was no relationship between transect distance and aspen height as well ($r^2=0.003$, $p=0.006$).
Figure 2. There is no relationship between height and distance along the transect, indicating that aspens age does not predict where within an aspen stand they will occur. Distances and heights were transformed for normality.
Aspen Stand Density
Across the 9 aspen stands, aspen stands at Upper Loney were the most densely populated ($F(8,26)=4.02$, $p<0.003$; Figure 3). We hypothesize that this is because Upper Loney is also our wettest meadow and supports more recruitment, but not necessarily a diversity in age classes (see Figure 1). In 2016, we will gather data on soil moisture to help us better understand why recruitment is occurring in greater densities in some meadows versus others.

![Figure 3](image)

**Figure 3.** Aspen stands in Upper Loney (UL1, UL2) were denser than stands in any of the other 7 stands surveyed as part of this study. L=Loney, LR=Loney Road, RL=Rucker Lake, UL=Upper Loney, and VN=Van Norden.

For example, of the 4 transects collected at Rucker Lake, over half of the aspens counted were considered new growth (Table 1). Rucker Lake was initially cleared of small conifers in 2012 and 2013. The “New Growth” aspens are well dispersed along the transect from the meadow edge to the forest edge. While no monitoring was conducted before the conifers were removed, we are concluding that the population is responding favorably to the restoration action at the site. Along the transect, the majority of new growth aspens are closer to the edge of the forest rather than within close proximity with the lake (Figure 1). These findings are similar to what we found in from data collected Loney and Van Norden Meadows.
**Overstory Cover in Aspen Stands**

Overstory cover was significantly higher in Rucker lake, compared to all other aspen stands ($F(8,610)=25.36$, $p<0.0001$; Figure 4). This is likely because there are many larger trees within the stand at Rucker Lake that could not be removed by SYRCL volunteers.

**Figure 4.** Overstory cover was higher in the aspen stand Rucker Lake compared to all the other stands.
Encroaching Conifers
Volunteers collected data on 314 encroaching lodgepole pine (*Pinus contorta*) and white fir (*Abies Concolor*) in Van Norden Meadow. Two transects running 258.6 meters and 151.2 meters resulted in conifer densities of 0.36 and 0.42 conifers per square meter, respectively. The majority of the conifers measured (90%) were less than 4 meters tall. Almost 98% of encroaching conifers were less than 10 inches (25 cm) in diameter. The US Forest Service and many other agencies support the removal of conifers less than 10 inches in diameter in order to support a healthy forest.

In Van Norden Meadow, the meadow edge is impacted by road and power line construction. The edge of the meadow is densely covered with conifers; smaller trees dominate the canopy until about 125 meters from the open meadow (Figure 5). At around 125 meters, larger conifers, ranging in size from 10-14 meters high begin to dominate the tree canopy. This older ring of trees may be an indication of the natural “meadow edge”, though an even taller group of trees is prevalent around 240 meters. There was no relationship between conifer height and distance along the transect ($r^2=0.03$, $p=0.0008$) Further investigation of the understory vegetation and groundwater levels will help define the true or historic meadow edge.

![Figure 5. Conifer encroachment at Van Norden Meadow.](image)
Stream Channel Measurements

Figure 6. Thalweg measurements at Loney Meadow.
In Loney Meadow, three distinct stream segments were measured along Texas Creek: Created Channel, Remnant Channel, and Below Loney Meadows (Figure 6 and Figure 7). These thalweg measurements showed that there is usually less than a one meter difference in thalweg heights from one point to the next. The Created Channel is hypothesized to have been created in the late 1800’s to dry out the center of the meadow for grazing. At that time, there was a dairy operating between Loney Meadow and Deer Meadow. The Remnant Channel, which has more channel incision because of the loss of water after the diversion into the Created Channel, will need to be further surveyed in 2015.

Figure 7. Depth of Thalweg along stream channels at Loney Meadow.
In Van Norden Meadow, we measured the streamline of the South Yuba River as it enters the meadow (Figure 8). Our surveys were cut short here because of the intensive conifer measurements and because we also collected datapoints to help with other long term monitoring happening in Van Norden Meadow, including stream cross sections and vegetation transects (data not reported here).

Figure 8. Depth of Thalweg and cross section data at Van Norden Meadow.

In 2015, we collected basic information about the location of stream channels in Deer and Upper Loney Meadow to be used by the USFS for restoration planning. We did not collect channel depths in 2015.
**Groundwater Monitoring**

All ten groundwater wells were installed in 2015 and 6 were instrumented in the fall months. At the end of summer, groundwater levels were low (or farthest from the ground surface) and in November, most of the piezometer levels moved closer to the ground surface (Figure 2). While we have not yet established clear trends, it appears that the driest locations in Loney Meadow are at the bottom of the meadow along Transect C.

Well A03 is located about 50 meters from the largest aspen stand in Loney Meadow and was one of the driest areas in mid-August. This particular piezometer will help us understand how water is accumulating under the soil surface and determine whether

![Loney Piezometer: depth from ground surface](image)

**Figure 2.** Groundwater data from Loney Meadow. Deeper groundwater levels are farther from the ground surface. See Map 1 for location of piezometers.

**Vegetation Monitoring**

We measured plant frequency in 720 400cm² micro plots along 3 transects at Loney Meadow. Over 75 species were identified and documented. All of the data is not yet entered and quality controlled, but we expect to have more results from this task within the coming months.
PROJECT IMPACTS
Earthwatch volunteers and facilitators contributed 900 hours of assistance to our projects during summer 2015.

Peer-reviewed publications

Non-peer reviewed publications: Books and book chapters
N/A

Non-peer reviewed publications: Technical reports, white papers, articles, sponsored or personal blog
• Media and Web: http://yubariver.org/our-work/restoration/meadow-restoration/

Presentations

MENTORING

Graduate students

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Graduate Degree</th>
<th>Project Title</th>
<th>Anticipated Year of Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darren Blackburn</td>
<td>Masters Student at San Francisco State University</td>
<td>Working title: Greenhouse gas emissions in restored and unrestored meadows. Mr. Blackburn will be installing an eddy-covariance tower at Loney Meadow to measure carbon dioxide emissions and collect local climate data.</td>
<td>2017</td>
</tr>
<tr>
<td>Alyssa Obester</td>
<td>Master Student at the Bren School UC Santa Barbara</td>
<td>Return on Investment: How restoring the lower Yuba River will improve Salmon Populations and other ecosystem services. Ms. Obester is writing her thesis on some of our lower Yuba Restoration work and will be joining us in summer 2016 as an intern to work on meadow restoration activities.</td>
<td>2017</td>
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</tbody>
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Community members

<table>
<thead>
<tr>
<th>Name of school, organization, or group</th>
<th>Education level</th>
<th>Participants local or non-local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delphine Griffith</td>
<td>High School Senior</td>
<td>local</td>
</tr>
<tr>
<td>SYRCL High School Internship Program</td>
<td>High School Level</td>
<td>local</td>
</tr>
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</table>
DETAILS ON CONTRIBUTION(S)/ACTIVITY(IES):

1. Ms. Griffith is our 2015-2016 River Science Intern from Nevada Union High School. She assists SYRCL with data collection and data entry efforts as part of our meadow restoration program. She was one of our 2015 Earthwatch Fellows and has continued on with SYRCL since that time. We estimate that she will contribute over 60 hours of volunteer time to SYRCL through June 2016.

2. Our SYRCL High School Internship Program began in Fall 2015 as a way to create environmental leaders in our watershed. The interns participate in activities like our annual River Cleanup, as naturalists for our Salmon Raft and Walking Tours, as docents for our Water Audit Program, and as restoration and water quality monitoring volunteers. In 2016, these students will be assisting SYRCL with our meadow restoration data collection work.

PARTNERSHIPS

<table>
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<tr>
<th>Partner</th>
<th>Support Type(s)</th>
<th>Years of Association (e.g. 2006-present)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Forest Service- Tahoe National Forest</td>
<td>Land owner, permits, collaboration</td>
<td>2011-present</td>
</tr>
<tr>
<td>Sierra Nevada Conservancy</td>
<td>Funding</td>
<td>2012-2015</td>
</tr>
<tr>
<td>National Fish and Wildlife Foundation</td>
<td>Funding</td>
<td>2014-present</td>
</tr>
<tr>
<td>CA Department of Fish and Wildlife</td>
<td>Funding</td>
<td>2015-present</td>
</tr>
<tr>
<td>CA Department of Water Resources</td>
<td>Funding</td>
<td>2014-present</td>
</tr>
<tr>
<td>Sierra Meadow Restoration Research Partnership (SMRRP)</td>
<td>Data, technical support, collaboration, academic support</td>
<td>2015-present</td>
</tr>
<tr>
<td>UC Davis Center for Watershed Sciences</td>
<td>Data, technical support, collaboration, academic support</td>
<td>2013-present</td>
</tr>
<tr>
<td>UC Merced</td>
<td>Data, Technical support, collaboration, academic support</td>
<td>2014-present</td>
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<tr>
<td>University of Nevada Reno</td>
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<td>2015-present</td>
</tr>
<tr>
<td>Stillwater Sciences</td>
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<tr>
<td>Truckee Donner Land Trust</td>
<td>Land owner, funding, logistics, permits, collaboration</td>
<td>2014-present</td>
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1Support type options: funding, data, logistics, permits, technical support, collaboration, academic support, cultural support, other (define)

CONTRIBUTIONS TO MANAGEMENT PLANS OR POLICIES

<table>
<thead>
<tr>
<th>Plan/Policy Name</th>
<th>Type2</th>
<th>Level of Impact3</th>
<th>New or Existing?</th>
<th>Primary goal of plan/policy4</th>
<th>Stage of plan/policy5</th>
<th>Description of Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse Gas Reduction Legislation (AB32)</td>
<td>Policy</td>
<td>State</td>
<td>Existing</td>
<td>To reduce greenhouse gas emissions in California.</td>
<td>Early</td>
<td>SYRCL is contributing data to better understand how unrestored/restored meadows store carbon and release methane, carbon dioxide, and nitrous oxide.</td>
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</table>

2Type options: agenda, convention, development plan, management plan, policy, or other (define)

3Level of impact options: local, regional, national, international

4Primary goal options: cultural conservation, land conservation, species conservation, natural resource conservation, other

5Stage of plan/policy options: proposed, in progress, adopted, other (define)
### Conservation of Taxa

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>IUCN Red List category</th>
<th>Local/regional conservation status</th>
<th>Local/regional conservation status source</th>
<th>Description of contribution</th>
<th>Resulting effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Populus tremuloides</em></td>
<td></td>
<td>Not Assessed</td>
<td>target species for restoration</td>
<td>Tahoe National Forest</td>
<td>Removing conifers which outcompete aspens for sunlight and water.</td>
<td>Decreased competition, improved habitat for species, population increase, improved population structure, increased breeding success, maintained/enhanced genetic diversity</td>
</tr>
</tbody>
</table>

#### In the past year, has your project helped conserve or restore populations of species of conservation significance? If so, please describe below.

#### Conservation of ecosystems

<table>
<thead>
<tr>
<th>Habitat type</th>
<th>Habitat significance</th>
<th>Description of contribution</th>
<th>Resulting effect</th>
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</thead>
<tbody>
<tr>
<td>Meadow</td>
<td>Feeding site, refuge</td>
<td>Plans to restore stream channels</td>
<td>Improved resilience and extent maintained</td>
</tr>
<tr>
<td>Aspen Community</td>
<td>Feeding site, breeding ground, refuge</td>
<td>Removed conifers in over 8 acres of aspen habitat.</td>
<td>Extent maintained, condition achieved, restored, improved resilience.</td>
</tr>
</tbody>
</table>

#### Ecosystems services

- ☒ Food and water
- ☐ Flood and disease control
- ☐ Spiritual, recreational, and cultural benefits
- ☐ Nutrient cycling

#### Details

By restoring Sierra meadows we are helping to improve the amount of water that is stored in underground reservoirs. This water is slowly released during the summer months, with the Sierras are dry, improving summer baseflows in downstream streams and rivers.
Conservation of cultural heritage

<table>
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<tr>
<th>Cultural heritage component</th>
<th>Description of contribution</th>
<th>Resulting effect</th>
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<td>traditional agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>artifacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>building(s)</td>
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<td></td>
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<tr>
<td>hunting ground or kill site</td>
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<tr>
<td>traditional ecological</td>
<td></td>
<td></td>
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<tr>
<td>knowledge and practices</td>
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<tr>
<td>monument(s)</td>
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<tr>
<td>oral traditions and history</td>
<td></td>
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<tr>
<td>spiritual site</td>
<td></td>
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<tr>
<td>traditional subsistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>living</td>
<td></td>
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</tbody>
</table>

Cultural heritage component options: traditional agriculture, artifacts, building(s), hunting ground or kill site, traditional ecological knowledge and practices, monument(s), oral traditions and history, spiritual site, traditional subsistence living

RESEARCH PLAN UPDATES

1. Have you added a new research site or has your research site location changed? Yes

2. Has the projected area status of your research site changed? No

3. Has the conservation status of a species you study changed? No

4. Have there been any changes in project scientists or field crew? Yes

Details - provide more information for any ‘yes’ answers

In 2015, we began working to collect data in Butcher Ranch Meadow, Deer Meadow, Bear Trap Meadow, and Freeman Meadow to assess pre- and post-restoration condition for aspen communities, groundwater and surface water, biodiversity, and greenhouse gases.

Our 2015-2016 Restoration Coordinator is Cordi Craig, who joined our staff in the fall of 2015 and Heather Kallevig, River Science Education Coordinator, joined our staff in August 2015. Both will be helping us in the field during the 2016 season. In addition, we expect to bring on two other field staff (TBD) for the summer months.

Provide details on any changes to your objectives, volunteer tasks, or methods, include reason for the change.

We have not removed any of our research objectives, but have added groundwater and vegetation monitoring to our projects. By adding this to our existing data collection regime, we will be able to better understand how the meadows groundwater, surface water, and vegetation interact throughout the year. Vegetation data was collected successfully by volunteers in 2015 as was groundwater data. We are hopeful that in 2016, volunteers can continue to contribute to the vegetation datasets and groundwater datasets we are collecting. Please see SYRCL’s 2016 proposal for more information about new research objectives and how they fit into the larger picture and new funding opportunities in the Yuba watershed. We hope this will give us more information about what species are in the understory of aspen stands and whether or not groundwater levels near the aspen stands indicate that aspen need higher groundwater tables than other areas. In 2016, we will be adding greenhouse gas and plant biomass sampling as well.

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LITERATURE CITED

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