#### Full Project Proposal Effectiveness Monitoring Committee

**Project #:** EMC-2018-003 **Proposal Version**# 1 **Date**: 12/06/18

**Project Title:** EMC -2018-003 Alternative Meadow Restoration

**Principal Investigator(s):** Christopher Surfleet

**Collaborators:** Collins Pine Company, The Plumas Corporation

**Critical Question, Themes and/or Rules or Regulations being tested:** 1. WLPZ- riparian function

**Timeline:** Ongoing, Proposal: 7/1/19-6/30/22

### Background and Justification

as attached) The goal of the EMC -2018-003 Alternative Meadow Restoration project is to test the Effectiveness of meadow and wet area restoration as an alternative to watercourse and lake protection (WLPZ) rules. The project will quantify the hydrologic response, water quality, and soil disturbance before and after meadow restoration on three meadows in the Sierra Nevada and Cascade ranges following removal of WLPZ vegetation and upslope forest thinning. The project monitors the effectiveness

### Objectives and Scope

(as attached) The goal is to quantify the effect on water quantity, water quality, and soil disturbance before and after meadow restoration on meadows in the Sierra Nevada and Cascade mountains.

The monitoring of the meadow restoration allowed by FPR 933.4 [e] will be guided by the following objectives: Objective 1. Quantify the hydrologic response from removal of encroached Pinus contorta to restore meadow and wet area habitat across varied locations. Objective 2. Determine if a key water quality metrics are affected by meadow restoration and WLPZ removal in Rock Creek Meadow by evaluation of streambed sediment and stream temperatures within or downstream of the restoration site. Objective 3. Quantify the amount of soil disturbance and compaction within the WLPZ following meadow restoration.

### Critical Questions and Relevant Forest Practice Regulations

(as attached) The project monitors the effectiveness of 14 CCR § 933.4 [e] of the California Forest Practice Rules (FPR), which states: All trees within aspen stands (defined as a location with the presence of living aspen (Populus tremuloides), meadows and wet areas may be harvested or otherwise treated in order to restore, retain, or enhance these areas for ecological or range values. 14 CCR § 933.4 [e] (5) requires that the project proponent state explicit goals and measures of success for restoration. Furthermore, 14 CCR § 933.4 [e] (7) states that CAL FIRE must prepare a

monitoring report every 5 years to the State Board of Forestry and Fire Protection (BOF) regarding the effectiveness of the Rule in achieving the desired outcome(s) and the occurrence of post-harvest adverse environmental impacts resulting from the use of the Rule. This project will provide the BOF with rigorous findings regarding Rule effectiveness for restoring meadows and wet areas. The project also relates to the EMC Strategic Plan, Theme 1: WLPZ Riparian Function. Specifically, it addresses the critical question of whether 14 CCR § 933.4 is effective in maintaining and restoring water quality and soil disturbance. There have been no scientific studies on the effectiveness of the meadow and WLPZ treatments allowed in FPR 933.4 [e]. This project offers an opportunity to reduce scientific uncertainty on the effectiveness of restoration treatments authorized under the current FPR for meadow and wet areas. We believe that this study will provide information relevant to mid- elevation forested environments in the Northern Sierra Nevada and Southern Cascade ranges of California. We hypothesize that restoration of meadows encroached by conifers and thinning of the forest surrounding the meadows will create greater resiliency in maintenance of meadow habitat.

We hypothesize this will be due to increased water yield to the wet area or meadow from lower evapotranspiration and interception from removal of forest canopy. Forested watersheds across California provide clean water that supports a broad range of beneficial uses. Nearly 85 percent of California’s average annual run¬off is produced from forested watersheds (FRAP, 2010). Sustained, extensive forest harvest treatments in dense Sierra Nevada forests have been estimated to increase water yield by 16% (Bales et al., 2011). Even small increases in water yield or improvements in the timing of water flow in the Sierra Nevada are important because of the high value of water used by both hydroelectric facilities and downstream users. Managing forests to improve meadow hydrology is one aspect of managing forests for future ecosystem values.

### Describe Research Methods

(as attached; figures attached) Study Duration and Locations: We propose a 3 year study that will use a before after control intervention (BACI) approach. We propose to use soil moisture, groundwater, and climate monitoring from one pair of meadows currently being studied near Chester, California. We will use groundwater and climate data for another set of meadows in the headwaters of the American River, collected from a current research effort. We will add one new meadow, Rock Creek, near Chester, California (Figure 1). Meadow Pair 1: Marian Meadow and Marian Control Meadow are located in Lassen County adjacent to Highway 34 approximately 10 miles west of the town of Chester, California. The meadows are located on the Collins Pine Almanor Forest (CPAF). The meadows had soil moisture, groundwater, and climate measurement instruments installed in 2013-2014. Encroached conifers were removed from approximately 70 acres of meadow in 2015. Forest thinning of approximately 30-40% of the forest volume in the watershed above Marian Meadow occurred from 2016-2017. The study will measure and analyze the hydrology of Marian Meadow 1 year with only encroached conifers removed and then the winter following the upslope forest harvest. This study is currently funded through the 2018 fiscal year. This proposal will fund continued monitoring of these meadows for 3 additional fiscal years, 2019-2022. Results from 3 years post meadow restoration: The statistical analysis of the soil moisture and observations of groundwater level in the Marian and Control Meadow identified an increase in ground and soil water. The statistical model showed that there was a statistically significant increase in soil moisture between pre-restoration and all three post-restoration years.

The statistical groundwater model showed that there was a statistically significant increase in

groundwater depth (ft below ground) between pre-restoration and the 1st and 2nd post-restoration years. The 3rd post-restoration year groundwater depth was not significantly different than pre- restoration groundwater depth, however the 3rd year post-restoration was not completed at the time this thesis was prepared. Overall, there was an increase of volumetric soil moisture content of approximately 16.07% during the months of November through June. The third-year post- restoration exhibited higher soil moisture values than the prior two post-restoration years. The increase in the groundwater depth resulted in a total of gain of 27.9 acre feet of water stored as groundwater during the first-year post-restoration and a gain of 34.65 acre feet of water stored as groundwater during the second year post-restoration. Meadow Pair 2: Miranda Cabin Meadow and Wabena Creek Control Meadow are located in the headwaters of the American River on land owned by the American River Conservancy (Figure 1). Groundwater level and climate measurements were installed in the meadows in 2016. The Miranda Cabin Meadow was restored by removal of encroached conifer and upslope forest thinning. The Wabena Creek Control Meadow was not altered during the study period to provide a control for climate effects for comparison to Miranda Cabin Meadow. Measurements occurred for 2 years, summer 2016-summer 2018 to represent the before condition in the BACI design. The treatment of upslope forest thinning and removal of encroached conifers occurred at Miranda Cabin Meadow during summer of 2018. We are currently funded to evaluate the change in meadow hydrology for 1 winter after the treatment, 2018-2019.

We intend to use this data set to provide a regional perspective with the proposed meadow study. New Meadow proposed: We propose to instrument the Rock Creek meadow with a network of soil moisture sensors and shallow groundwater wells during summer 2019. The control for the Rock Creek meadow will be one or both of two previously instrumented meadows at Marian Creek, within 15 miles of the Rock Creek meadows (Figure 1). A stream gauge will be located downstream of Rock Creek meadow restoration associated with a planning grant for the meadow restoration by the Plumas Corporation. The perennial watercourses allow determination of water quality effects from WLPZ canopy removal. Stream temperature sensors will be placed above, within, and below the restoration site. The perennial watercourses allow determination of water quality effects from WLPZ canopy removal. Monitoring will occur either one year prior to restoration beginning in July 2019 and approximately two years after restoration ending in June 2022. Water quality impacts on sediment from removal of the WLPZ will be evaluated by V star, stream bed particle size distributions, and cobble embeddedness for one year before and after restoration. Soil disturbance in from the WLPZ will be evaluated by percent ground cover exposed and soil bulk density samples. The ground cover and bulk density measurements will occur the summer prior to harvest and the year after harvest. Soil bulk density will be measured in areas where harvest equipment entered the WLPZ, where soil was disturbed, and in undisturbed areas post-harvest. The justification of adding Rock Creek Meadow to the monitoring for evaluating FPR 933.4 [e] (Figure 2): • Rock Creek Meadow has perennial watercourses that flow through the meadow. The other meadow pairs only have ephemeral watercourses. This allows evaluation of water quality impacts, in addition to surface water changes from restoration. • The landowner has proposed removal of the entire WLPZ allow streamside soil disturbance to be considered. • Rock Creek has a shallow geologic structure which we believe creates a shallow confining layer to the meadow’s groundwater. The other meadow pairs do not have shallow confining layers. This provides a contrast in groundwater response to restoration. • Rock Creek Meadow restoration is over twice the size of the other meadow pairs allowing contrast of restoration size. • Ecosystem functions of foraging habitat for great gray owl

and wet meadow focal species such as willow flycatcher and yellow warbler are proposed to be monitored associated with the implementation of the meadow restoration. Figure 1. Meadow locations for proposed effectiveness monitoring of meadow restoration 933.4 [e] FPR. Figure 2. Rock Creek meadow restoration area located in Plumas County, near Lake Almanor (Latitude 40.3281 Longitude -121.088). Figure adapted from Plumas Corp. NWNF proposal. Methods to Meet the Research Objectives: Objective 1: Groundwater levels will be compared before and after to published values of duration and water table depth for facultative and non-facultative wetland plants (Hammersmark et al., 2009 and 2010). Standard least squared regression will be used to test changes in groundwater depth, volumetric soil moisture content, and total moisture content between all treated and control meadows for pre-restoration and post-restoration time periods.

Differences in the slopes and intercepts of the regression relationships will be compared to determine if a change is detected. We will additionally evaluate the differences in hydrologic response pre- and post- encroached conifer removal and upslope forest thinning by evaluating a water balance. The water balance will factor the inputs and outputs of water as measured through time, notably changes in evapotranspiration (ET). ET will be quantified by diurnal fluctuations in soil moisture and groundwater combined with climate measurements. Changes in the water balance between the treated and the control meadow following treatments will quantify the change in hydrology due to the treatments. Comparison of soil moisture, groundwater depth, and water budgets for the meadows will occur by area restored, amount of upslope forest condition, climate, soil and geologic context. This comparison will be done by evaluation of the different meadow’s hydrologic response and literature on meadow and forest hydrologic characteristics. The sample size of meadows used will not lend itself to a statistical analysis. These comparisons will be driven by interest in knowing: 1) were treatments more or less effective in different locations, 2) how might future treatments be monitored, and 3) negative consequences that might result. Objective 2: Stream and air temperature sensors will be deployed upstream, downstream, and within the restoration area. Metrics of maximum weekly stream temperature, average weekly stream temperature, and minimum weekly stream temperatures will be evaluated comparing upstream and downstream differences before and after restoration during summer within the context of summer air temperature. Evaluations will include comparison of before and after, upstream and downstream temperature response. Comparisons of stream temperatures to predicted values from net radiation control estimates by modified Brown’s equation (Brown, 1971). The V star, stream bed particle size, and cobble embeddedness measurements will occur the summer of 2019 before restoration and repeated the summer of 2021 approximately one year following restoration. V star measurements will occur within 5 pools randomly selected in the Rock Creek treatment area, the methods will follow a systematic sample approach to be statistically unbiased (Hilton and Lisle, 1993). The measurements will occur the summer of 2019 before restoration. The V star measurements will be repeated at the same pools the summer of 2021 approximately one year following restoration. Streambed particle size distribution will be evaluated at approximately 5 - 100 foot sections of Rock Creek. The particle size evaluation sections will have a random start with 10 transects exactly 10 feet apart. The 10 transects will have 20 particles randomly selected and measured along the b axis within the bankfull channel for a total of 200 particles measured per 100 foot section. At each of transects at exactly ¼, ½, and ¾ of the bankfull channel a cobble embeddedness measure will be taken. Objective 3: Line transects with a point/cover approach will be taken within the WLPZ before and after WLPZ removal, as part of the restoration. 5 randomly

selected transect start points will be selected on each side of the Class I watercourse, for a total of 10 start points. At each start point a 100 foot transect will be done at 15 feet, 40 feet, and 60 feet from the bankfull channel. At every 2 foot increment the ground cover will be recorded as covered or bare soil. The following designations will be given to type of cover or baresoil. The relative contribution of each cover or bare soil will be determined before and after WLPZ disturbance. Cover designations Exposed soil designations Vegetation undisturbed Litter road Rock or gravel tree yarding rutting or disturbance from equipment/vehicles Along each transect soil bulk density samples will be taken. At least 1 sample of top soil of exact volume for be taken at each cover or bare soil designation along the transects. The soil samples will be oven dried and weighed to determine soil bulk density (grams/cubic centimeter). The relative change in soil bulk density for proportion of each cover or bare soil designation will be determined before and after WLPZ disturbance.

### Describe Project Deliverables

(as attached) A comprehensive report to the Board of Forestry Effectiveness Monitoring Committee will be provided by the end of the project time period. The report will use results from all three meadow locations to summarize the effectiveness of 14 CCR § 933.4 [e] of the California Forest Practice Rules. Results will include statistical evaluation of meadow treatments, meadow water balance before and after treatment, qualitative evaluation of influence of differing locations and treatments on meadow response, and summarization of water quality metrics measured. At least one Master of Science Thesis will be produced on the Rock Creek Meadow study. At least one Master of Science professional project report will be produced on the water quality and soil disturbance effects from the restoration. A presentation of results will be given to the Board of Forestry Effectiveness Monitoring Committee or Board of Forestry in spring 2022. At least one peer review journal manuscript will be prepared from the research. At least one presentation at a professional forest science related conference will occur. The database of field measurements funded by this proposal for 2019-2022 will be provided to the California Department of Forestry and Fire Protection.

### Anticipated Project Timeline:

7/1/19-6/30/22 (as attached) Instruments will be installed in Rock Creek meadow July, 2019 and monitoring will begin. Meadow restoration will be implemented during spring and summer 2020. Monitoring will continue through spring 2022.

1. **Requested Funding:** $101,802.00
2. **Principal Investigator(s) and Collaborator(s)** *(Include a contact person with email address, phone number, and mailing address)*

Principal Investigator: Christopher Surfleet, Associate Professor, Watershed Management and Hydrology, Natural Resources Management and Environmental Sciences Department, California Poly Technic State University San Luis Obispo, 93401. [csurflee@calpoly.edu,](mailto:csurflee@calpoly.edu) 805-756-2743.

Collins Pine Almanor Forest. Collins Pine Company, Chester, California. POC: Forest Manager. Landowner for Marian Meadow sites and Rock Creek sites. Managers of timber harvest planning and meadow restoration implementation.

# Project #: 2018-003 Proposal Version # 1 Dec. 7, 2018 Project Name: EMC -2018-003 Alternative Meadow Restoration Principal Investigator: Christopher Surfleet

Collaborators: Collins Pine Company, The Plumas Corporation

## Background and Justification:

The goal of the EMC -2018-003 Alternative Meadow Restoration project is to test the Effectiveness of meadow and wet area restoration as an alternative to watercourse and lake protection (WLPZ) rules. The project will quantify the hydrologic response, water quality, and soil disturbance before and after meadow restoration on three meadows in the Sierra Nevada and Cascade ranges following removal of WLPZ vegetation and upslope forest thinning. The project monitors the effectiveness of 14 CCR § 933.4

[e] of the California Forest Practice Rules (FPR).

Meadows serve several valuable hydrological and ecological functions integral to the maintenance of healthy ecosystems such as promotion of faunal and floral biodiversity and increased late season base flow (UC Davis, 2007). Meadows in the Sierra Nevada and Cascades face myriad of threats, including: overgrazing, habitat degradation associated with recreation, fire prevention/regime alteration, residential/ commercial development, and habitat fluctuations tied to climate change (Stillwater Sciences, 2012). Degradation of meadow habitat generally manifests itself in the form of: a reduction in seasonal soil moisture content, a decreased water table, a loss of endemic meadow species, and the influx of pioneer vegetation such as conifers and xeric plant species.

Historically, fires in the western United States occurred more frequently and at a lower intensity than today. In a review that synthesized multiple studies from across the Sierra Nevada, it is estimated that the pre-1900 fire return interval for red fir, mixed conifer-fir, mixed conifer-pine, and pine forests types were 26, 12,15, and 11 years, respectively (Skinner and Chang, 1996). These small, low intensity fires, often started by lightning strikes or Native Americans, resulted in a spatially complex pattern of montane meadows that had limited net conifer encroachment (Norman and Taylor, 2003). However, due to fire suppression polices that were implemented in the early 20th century, it is estimated that the fire return intervals of these forest types are now 1,644, 644, 185, and 192 years respectively (McKelvey et al., 1996). In a study that assessed the fire interval directly adjacent to meadows in northeastern California, it was estimated that the mean fire interval from 1750 to 1849 was 13 years. From 1850 to 1905, it was determined that the mean fire interval was 19.6 years, and from 1906 to 1996 it was determined that the mean fire frequency was 333 years (Norman and Taylor, 2005). The effects of fire suppression on conifer establishment within meadows is believed to be amplified by historical grazing practices, especially during the first wave of accelerated conifer encroachment in the early 20th century.

Conifer encroachment (also frequently referred to as invasion) is a blanket term for movement of conifers into meadow biotic communities. Depending on elevation, and geomorphic position, *Pinus contorta* may colonize wet meadows opportunistically during times of drought to avoid plant water stress (Gross and Coppoletta, 2013). During wetter and colder periods, soil water may act as a limiting factor on the expansion of most conifer species into wetlands and meadows due to their intolerance for prolonged saturation in their root zone. Conversely, successful recruitment of trees into dry/mesic meadow habitats has been related to the onset of wetter summers and discontinuation of sheep grazing (Miller and Halpern, 1998).

### Objective(s) and Scope:

The goal is to quantify the effect on water quantity, water quality, and soil disturbance before and after meadow restoration on meadows in the Sierra Nevada and Cascade mountains.

The monitoring of the meadow restoration allowed by FPR 933.4 [e] will be guided by the following objectives:

Objective 1. Quantify the hydrologic response from removal of encroached *Pinus contorta* to restore meadow and wet area habitat across varied locations.

Objective 2. Determine if a key water quality metrics are affected by meadow restoration and WLPZ removal in Rock Creek Meadow by evaluation of streambed sediment and stream temperatures within or downstream of the restoration site.

Objective 3. Quantify the amount of soil disturbance and compaction within the WLPZ following meadow restoration.

### Critical questions and Relevant Forest Practice Regulations

The project monitors the effectiveness of 14 CCR § 933.4 [e] of the California Forest Practice Rules (FPR), which states:

All trees within aspen stands (defined as a location with the presence of living aspen (*Populus tremuloides*), meadows and wet areas may be harvested or otherwise treated in order to restore, retain, or enhance these areas for ecological or range values.

14 CCR § 933.4 [e] (5) requires that the project proponent state explicit goals and measures of success for restoration. Furthermore, 14 CCR § 933.4 [e] (7) states that CAL FIRE must prepare a monitoring report every 5 years to the State Board of Forestry and Fire Protection (BOF) regarding the effectiveness of the Rule in achieving the desired outcome(s) and the occurrence of post-harvest adverse environmental impacts resulting from the use of the Rule. This project will provide the BOF with rigorous findings regarding Rule effectiveness for restoring meadows and wet areas.

The project also relates to the EMC Strategic Plan, Theme 1: WLPZ Riparian Function. Specifically, it addresses the critical question of whether 14 CCR § 933.4 is effective in maintaining and restoring water quality and soil disturbance.

There have been no scientific studies on the effectiveness of the meadow and WLPZ treatments allowed in FPR 933.4 [e]. This project offers an opportunity to reduce scientific uncertainty on the effectiveness of restoration treatments authorized under the current FPR for meadow and wet areas. We believe that this study will provide information relevant to mid-elevation forested environments in the Northern Sierra Nevada and Southern Cascade ranges of California.

We hypothesize that restoration of meadows encroached by conifers and thinning of the forest surrounding the meadows will create greater resiliency in maintenance of meadow habitat. We hypothesize this will be due to increased water yield to the wet area or meadow from lower evapotranspiration and interception from removal of forest canopy. Forested watersheds across California provide clean water that supports a broad range of beneficial uses. Nearly 85 percent of

California's average annual runoff is produced from forested watersheds (FRAP, 2010). Sustained, extensive forest harvest treatments in dense Sierra Nevada forests have been estimated to increase water yield by 16% (Bales et al., 2011). Even small increases in water yield or improvements in the timing of water flow in the Sierra Nevada are important because of the high value of water used by both hydroelectric facilities and downstream users. Managing forests to improve meadow hydrology is one aspect of managing forests for future ecosystem values.

### Research Methods

#### Study Duration and Locations:

We propose a 3 year study that will use a before after control intervention (BACI) approach. We propose to use soil moisture, groundwater, and climate monitoring from one pair of meadows currently being studied near Chester, California. We will use groundwater and climate data for another set of meadows in the headwaters of the American River, collected from a current research effort. We will add one new meadow, Rock Creek, near Chester, California (Figure 1).

Meadow Pair 1: Marian Meadow and Marian Control Meadow are located in Lassen County adjacent to Highway 34 approximately 10 miles west of the town of Chester, California. The meadows are located on the Collins Pine Almanor Forest (CPAF). The meadows had soil moisture, groundwater, and climate measurement instruments installed in 2013-2014. Encroached conifers were removed from approximately 70 acres of meadow in 2015. Forest thinning of approximately 30-40% of the forest volume in the watershed above Marian Meadow occurred from 2016-2017. The study will measure and analyze the hydrology of Marian Meadow 1 year with only encroached conifers removed and then the winter following the upslope forest harvest. This study is currently funded through the 2018 fiscal year. This proposal will fund continued monitoring of these meadows for 3 additional fiscal years, 2019-2022.

*Results from 3 years post meadow restoration:* The statistical analysis of the soil moisture and observations of groundwater level in the Marian and Control Meadow identified an increase in ground and soil water. The statistical model showed that there was a statistically significant increase in soil moisture between pre-restoration and all three post-restoration years. The statistical groundwater model showed that there was a statistically significant increase in groundwater depth (ft below ground) between pre-restoration and the 1st and 2nd post-restoration years. The 3rd post-restoration year groundwater depth was not significantly different than pre-restoration groundwater depth, however the 3rd year post-restoration was not completed at the time this thesis was prepared. Overall, there was an increase of volumetric soil moisture content of approximately 16.07% during the months of November through June. The third-year post-restoration exhibited higher soil moisture values than the prior two post-restoration years. The increase in the groundwater depth resulted in a total of gain of 27.9 acre feet of water stored as groundwater during the first-year post-restoration and a gain of 34.65 acre feet of water stored as groundwater during the second year post-restoration.

Meadow Pair 2: Miranda Cabin Meadow and Wabena Creek Control Meadow are located in the headwaters of the American River on land owned by the American River Conservancy (Figure 1). Groundwater level and climate measurements were installed in the meadows in 2016. The Miranda Cabin Meadow was restored by removal of encroached conifer and upslope forest thinning. The Wabena Creek Control Meadow was not altered during the study period to provide a control for climate effects for comparison to Miranda Cabin Meadow. Measurements occurred for 2 years, summer 2016-

summer 2018 to represent the before condition in the BACI design. The treatment of upslope forest thinning and removal of encroached conifers occurred at Miranda Cabin Meadow during summer of 2018. We are currently funded to evaluate the change in meadow hydrology for 1 winter after the treatment, 2018-2019. We intend to use this data set to provide a regional perspective with the proposed meadow study.

New Meadow proposed: We propose to instrument the Rock Creek meadow with a network of soil moisture sensors and shallow groundwater wells during summer 2019. The control for the Rock Creek meadow will be one or both of two previously instrumented meadows at Marian Creek, within 15 miles of the Rock Creek meadows (Figure 1). A stream gauge will be located downstream of Rock Creek meadow restoration associated with a planning grant for the meadow restoration by the Plumas Corporation.

The perennial watercourses allow determination of water quality effects from WLPZ canopy removal. Stream temperature sensors will be placed above, within, and below the restoration site. The perennial watercourses allow determination of water quality effects from WLPZ canopy removal. Monitoring will occur either one year prior to restoration beginning in July 2019 and approximately two years after restoration ending in June 2022.

Water quality impacts on sediment from removal of the WLPZ will be evaluated by V star, stream bed particle size distributions, and cobble embeddedness for one year before and after restoration. Soil disturbance in from the WLPZ will be evaluated by percent ground cover exposed and soil bulk density samples. The ground cover and bulk density measurements will occur the summer prior to harvest and the year after harvest. Soil bulk density will be measured in areas where harvest equipment entered the WLPZ, where soil was disturbed, and in undisturbed areas post-harvest.

The justification of adding Rock Creek Meadow to the monitoring for evaluating FPR 933.4 [e] (Figure 2):

* + - Rock Creek Meadow has perennial watercourses that flow through the meadow. The other meadow pairs only have ephemeral watercourses. This allows evaluation of water quality impacts, in addition to surface water changes from restoration.
    - The landowner has proposed removal of the entire WLPZ allow streamside soil disturbance to be considered.
    - Rock Creek has a shallow geologic structure which we believe creates a shallow confining layer to the meadow's groundwater. The other meadow pairs do not have shallow confining layers. This provides a contrast in groundwater response to restoration.
    - Rock Creek Meadow restoration is over twice the size of the other meadow pairs allowing contrast of restoration size.
    - Ecosystem functions of foraging habitat for great gray owl and wet meadow focal species such as willow flycatcher and yellow warbler are proposed to be monitored associated with the implementation of the meadow restoration.

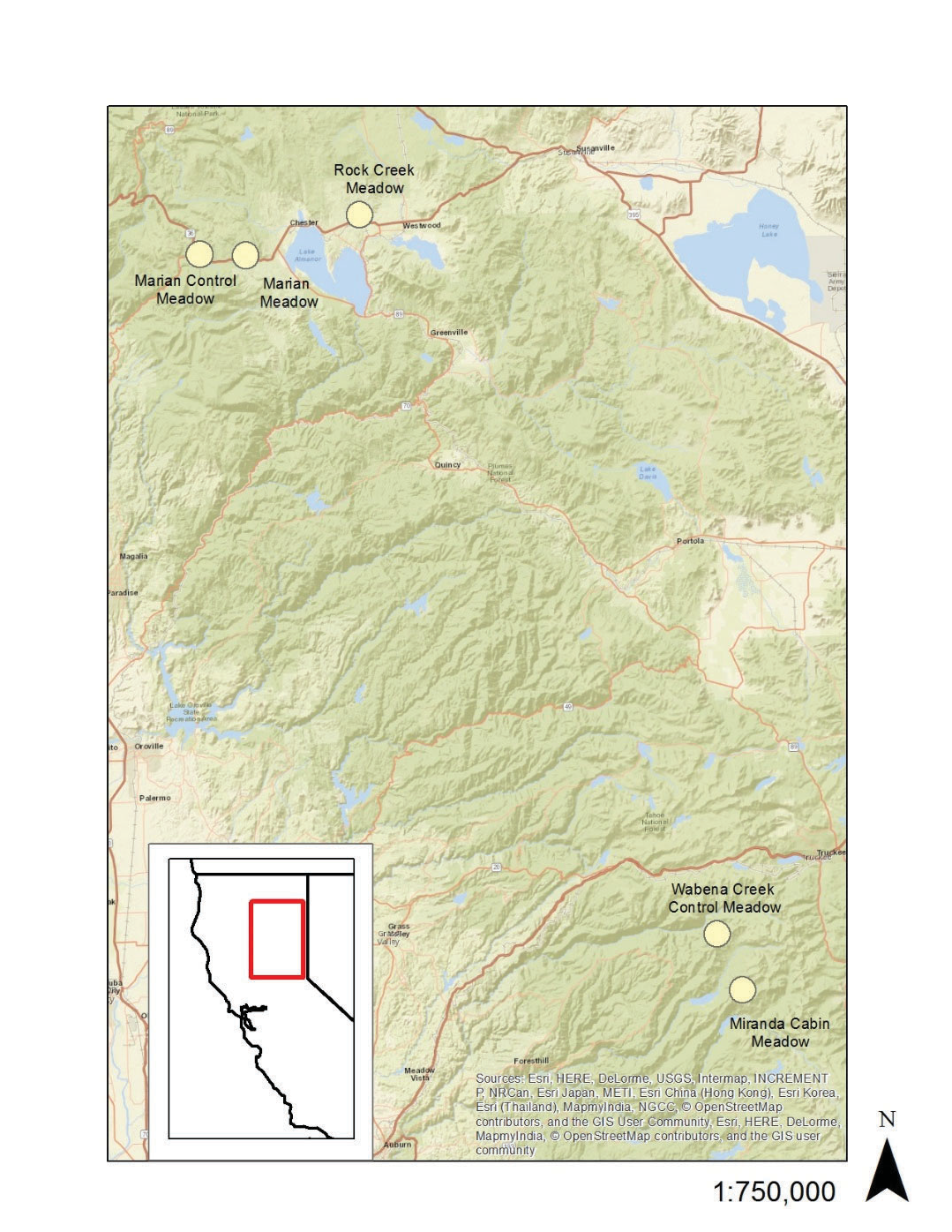


Figure 1. Meadow locations for proposed effectiveness monitoring of meadow restoration

933.4 [e] FPR.

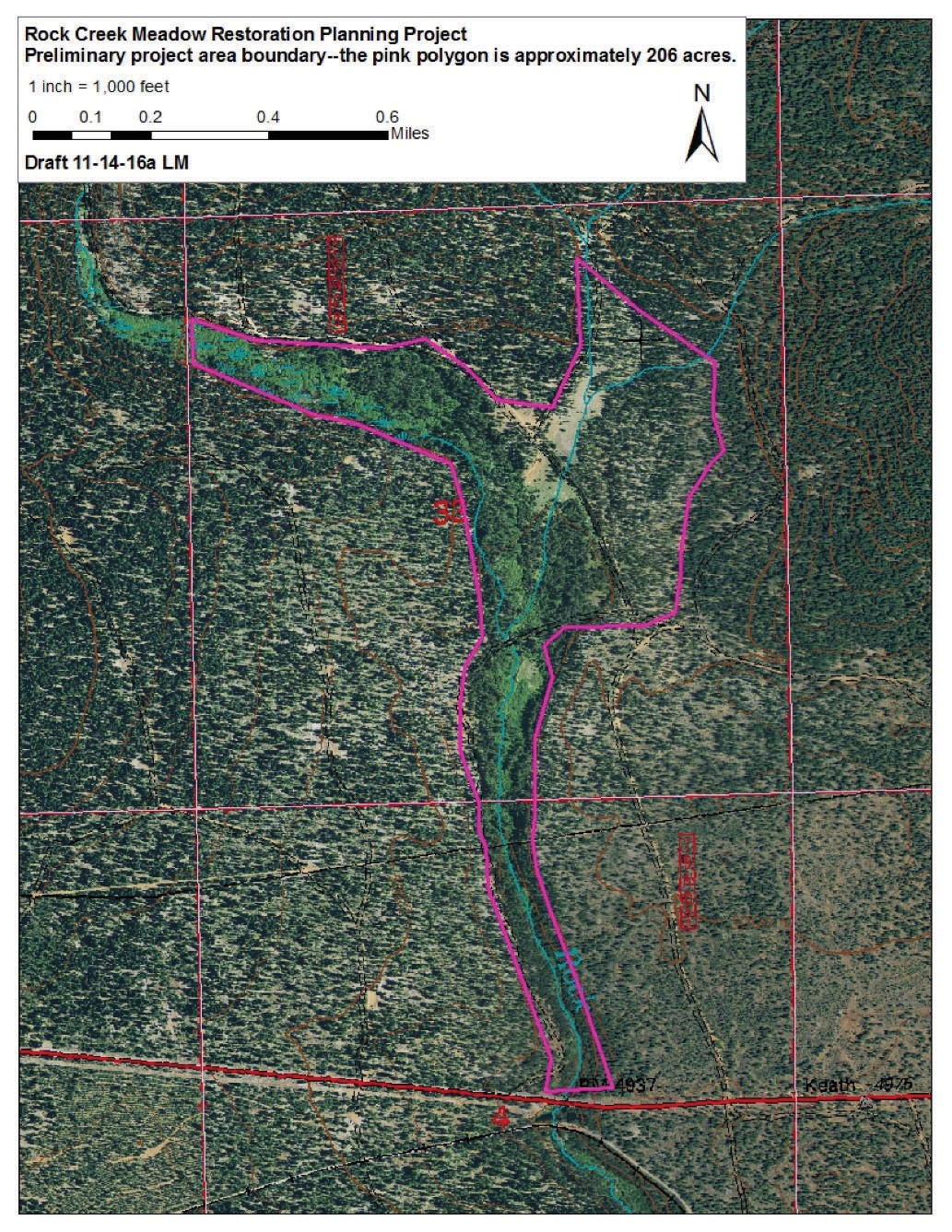


Figure 2. Rock Creek meadow restoration area located in Plumas County, near Lake Almanor (Latitude 40.3281 Longitude -121.088). Figure adapted from Plumas Corp. NWNF proposal.

### Methods to Meet the Research Objectives:

*Objective 1:* Groundwater levels will be compared before and after to published values of duration and water table depth for facultative and non-facultative wetland plants (Hammersmark et al., 2009 and 2010). Standard least squared regression will be used to test changes in groundwater depth, volumetric soil moisture content, and total moisture content between all treated and control meadows for pre- restoration and post-restoration time periods. Differences in the slopes and intercepts of the regression relationships will be compared to determine if a change is detected. We will additionally evaluate the differences in hydrologic response pre- and post- encroached conifer removal and upslope forest thinning by evaluating a water balance. The water balance will factor the inputs and outputs of water as measured through time, notably changes in evapotranspiration (ET). ET will be quantified by diurnal fluctuations in soil moisture and groundwater combined with climate measurements. Changes in the water balance between the treated and the control meadow following treatments will quantify the change in hydrology due to the treatments.

Comparison of soil moisture, groundwater depth, and water budgets for the meadows will occur by area restored, amount of upslope forest condition, climate, soil and geologic context. This comparison will be done by evaluation of the different meadow's hydrologic response and literature on meadow and forest hydrologic characteristics. The sample size of meadows used will not lend itself to a statistical analysis. These comparisons will be driven by interest in knowing: 1) were treatments more or less effective in different locations, 2) how might future treatments be monitored, and 3) negative consequences that might result.

*Objective 2:* Stream and air temperature sensors will be deployed upstream, downstream, and within the restoration area. Metrics of maximum weekly stream temperature, average weekly stream temperature, and minimum weekly stream temperatures will be evaluated comparing upstream and downstream differences before and after restoration during summer within the context of summer air temperature. Evaluations will include comparison of before and after, upstream and downstream temperature response. Comparisons of stream temperatures to predicted values from net radiation control estimates by modified Brown's equation (Brown, 1971).

The V star, stream bed particle size, and cobble embeddedness measurements will occur the summer of 2019 before restoration and repeated the summer of 2021 approximately one year following restoration. V star measurements will occur within 5 pools randomly selected in the Rock Creek treatment area, the methods will follow a systematic sample approach to be statistically unbiased (Hilton and Lisle, 1993). The measurements will occur the summer of 2019 before restoration. The V star measurements will be repeated at the same pools the summer of 2021 approximately one year following restoration. Streambed particle size distribution will be evaluated at approximately 5 - 100 foot sections of Rock Creek. The particle size evaluation sections will have a random start with 10 transects exactly 10 feet apart. The 10 transects will have 20 particles randomly selected and measured along the b axis within the bankfull channel for a total of 200 particles measured per 100 foot section.

At each of transects at exactly X, Yi, and % of the bankfull channel a cobble embeddedness measure will be taken.

*Objective 3:* Line transects with a point/cover approach will be taken within the WLPZ before and after WLPZ removal, as part of the restoration. 5 randomly selected transect start points will be selected on

each side of the Class I watercourse, for a total of 10 start points. At each start point a 100 foot transect will be done at 15 feet, 40 feet, and 60 feet from the bankfull channel. At every 2 foot increment the ground cover will be recorded as covered or bare soil. The following designations will be given to type of cover or baresoil. The relative contribution of each cover or bare soil will be determined before and after WLPZ disturbance.

Cover designations Exposed soil designations Vegetation undisturbed

Litter road

Rock or gravel tree yarding

rutting or disturbance from equipment/vehicles

Along each transect soil bulk density samples will be taken. At least 1 sample of top soil of exact volume for be taken at each cover or bare soil designation along the transects. The soil samples will be oven dried and weighed to determine soil bulk density (grams/cubic centimeter). The relative change in soil bulk density for proportion of each cover or bare soil designation will be determined before and after WLPZ disturbance.

### Project Deliverables

A comprehensive report to the Board of Forestry Effectiveness Monitoring Committee will be provided by the end of the project time period. The report will use results from all three meadow locations to summarize the effectiveness of 14 CCR § 933.4 [e] of the California Forest Practice Rules. Results will include statistical evaluation of meadow treatments, meadow water balance before and after treatment, qualitative evaluation of influence of differing locations and treatments on meadow response, and summarization of water quality metrics measured.

At least one Master of Science Thesis will be produced on the Rock Creek Meadow study.

At least one Master of Science professional project report will be produced on the water quality and soil disturbance effects from the restoration.

A presentation of results will be given to the Board of Forestry Effectiveness Monitoring Committee or Board of Forestry in spring 2022.

At least one peer review journal manuscript will be prepared from the research.

At least one presentation at a professional forest science related conference will occur.

The database of field measurements funded by this proposal for 2019-2022 will be provided to the California Department of Forestry and Fire Protection.

* 1. **Timeline**

Instruments will be installed in Rock Creek meadow July, 2019 and monitoring will begin. Meadow restoration will be implemented during spring and summer 2020. Monitoring will continue through spring 2022.

## Funding.

A total of ***$1011802*** is requested from the Effectiveness Monitoring Committee (EMC) for the implementation of this project. Please see attached budget and justification for a detailed breakdown of this cost.

**Sponsor:** State of California - The Natural Resources Agency

**Title:** EMC - 2018-003 Alternative Meadow Restoration

**Project Term:** July 1, 2019 - June 30, 2022

**Personnel**  WTUs

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year 1 | | Year 2 | | Year 3 | |  | | |
| 7/1/19 - | 6/30/20 | 7/1/20 - | 6/30/21 | 7/1/21 - | 6/30/22 |
| **Sponsor** | **CPSU** | **Sponsor** | **CPSU** | **Sponsor** | **CPSU** | **Total Sponsor** | **Total CPSU** | **Total** |
| $0 | $17,483 | $0 | $17,483 | $0 | $17,483 | $0  $0  $0  $0 | $0  $17,483  $17,483  $17,483 | $0  $17,483  $17,483  $17,483 |
| $2,500 |  |  |  |  |  | $2,500  $7,497 | $0  $0 | $2,500  $7,497 |
| $7,497 |  |  |  |  |  |
| **$9,997** | **$17,483** | **$25,007** | **$17,483** | **$12,495** | **$17,483** | **$47,499** | **$52,449** | **$99,948** |
| $0  $113  $750 | $9,319 | $0  $0  $2,501 | $9,319 | $0  $0  $1,250 | $9,319 | $0  $113  $4,501 | $27,957  $0  $0 | $27,957  $113  $4,501 |
| $863 | $9,319 | $2,501 | $9,319 | $1,250 | $9,319 | $4,614 | $27,957 | $32,571 |
| **$10,860** | **$26,802** | **$27,508** | **$26,802** | **$13,745** | **$26,802** | **$52,113** | **$80,406** | **$132,519** |
|  |  |  |  |  |  |  |  |  |
| $4,195  $0 |  | $4,195  $0 |  | $1,806  $1,732 |  | $10,196  $1,732 | $0  $0 | $10,196  $1,732 |
| **$4,195** | **$0** | **$4,195** | **$0** | **$3,538** | **$0** | **$11,928** | **$0** | **$11,928** |
|  |  |  |  |  |  |  |  |  |
| $3,000 |  | $2,000 |  | $2,000 |  | $7,000 | $0 | $7,000 |
| **$3,000** | **$0** | **$2,000** | **$0** | **$2,000** | **$0** | **$7,000** | **$0** | **$7,000** |
| $6,000 |  | $6,000 |  | $1,000 |  | $13,000 | $0 | $13,000 |
| **$6,000** | **$0** | **$6,000** | **$0** | **$1,000** | **$0** | **$13,000** | **$0** | **$13,000** |
| **$9,000** | **$0** | **$8,000** | **$0** | **$3,000** | **$0** | **$20,000** | **$0** | **$20,000** |
|  |  |  |  |  |  |  |  |  |
| **$24,055** | **$26,802** | **$39,703** | **$26,802** | **$20,283** | **$26,802** | **$84,041** | **$80,406** | **$164,447** |
|  |  |  |  |  |  |  |  |  |
| $18,055 | $26,802 | $33,703 | $26,802 | $19,283 | $26,802 | $71,041 | $80,406 | $151,447 |
| $4,514 | $6,701 | $8,426 | $6,701 | $4,821 | $6,701 | $17,761 | $20,103 | $37,864 |
|  |  |  |  |  |  |  |  |  |
| **$28,569** | $33,503 | **$48,129** | $33,503 | **$25,104** | $33,503 | **$101,802** | $100,509 | $202,311 |
|  |  |  |  |  |  |  |  |  |
| $18,055 | $26,802 | $33,703 | $26,802 | $19,283 | $26,802 | $71,041 | $80,406 | $151,447 |
| $2,437 | $3,618 | $4,550 | $3,618 | $2,603 | $3,618 | $9,590 | $10,854 | $20,444 |
|  |  |  |  |  |  |  |  |  |
| **$31,006** | **$37,121** | **$52,679** | **$37,121** | **$27,707** | **$37,121** | **$111,392** | **$111,363** | **$222,755** |

**Chris Surfleet, PI** no compensation $98,328 /AY

*Yr 1* 8.0 17.78% Assigned @ $98,328 /AY

*YR 2* 8.0 17.78% Assigned @ $98,328 /AY

*YR 3* 8.0 17.78% Assigned @ $98,328 /AY

Undergraduates 200 hours @ 12.50 /HR

Graduate Students 441 hours @ 17.00 /HR

**Subtotal Personnel**

**Fringe Benefits**

Faculty assigned time Chris Surfleet, PI 53.305%

Undergraduates Undergraduates 4.5%

Graduate Students Graduate Students 10.0%

**Subtotal Fringe Benefits TOTAL Personnel Services**

**Domestic Travel**

Travel to Chester, CA

Conference Travel (CalFire & other)

**Other Direct Costs**

**Materials & Supplies (<$5K each item)**

**TOTAL Domestic Travel**

Water level recorders, soil moisture sensor, data loggers, stream temp probes, misc. ha

**SUBTOTAL Materials & Supplies**

**Other**

Tuition (partial graduate tuition)

**Indirect Costs**

Cal Poly Recovered Indirect Cost Base

**SUBTOTAL Other TOTAL Other Direct Costs**

**TOTAL DIRECT COSTS:**

Cal Poly recovered IDC **25.0% of Modified Total Direct**

**TOTAL ALLOWABLE REQUEST COSTS:**

**Unrecovered Indirect Costs**

Cal Poly Unrecovered Indirect Cost Base

Cal Poly unrecovered IDC 38.5% of Modified Total Direct

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **TOTAL PROJECT COSTS:** | Year 1 |  | Year 2 |  | Year 3 |  | TOTAL |
| **EMC FUNDING REQUEST:** | **$28,569** |  | **$48,129** |  | **$25,104** |  | **$101,802** |

### BUDGET JUSTIFICATION

**SALARIES AND WAGES**: The salary and wage rates are based on the California Polytechnic State University (CPSU) and Cal Poly Corporation (CPC), jointly Cal Poly, established salary and wage rates paid during the 2018-2019 Fiscal year (July 1 - June 30). Faculty duties at CPSU consist of a full fifteen units each of three Academic quarters per nine month Academic year. The salary and wage rates for faculty and non-student staff includes a projected 0% salary increase per year. The rates shown are for budgetary purposes; the rates in effect at the time the work is performed will be charged to the project.

Employee salaries have not been escalated for the voluntary cost share. As voluntary cost share is not required, Cal Poly elects to under-estimate the value of the cost share to ensure the commitment to the sponsor is met if the project is awarded.

**FRINGE BENEFITS & EMPLOYER PAYROLL TAXES**: Benefits for CPSU Faculty summer and overload work include FICA, SUI and Workers Compensation and are calculated at the DHHS pooled rate of 10.0%. Full time benefits for CPSU faculty and staff Release time and Assigned time include a benefit package consisting of FICA, State Unemployment Insurance (SUI), Worker's Compensation, non-industrial leave including vacation and sick leave, medical, dental, and life insurance benefits, and retirement benefits (PERS). The rate is established by the State of California and CPSU, is currently estimated for budgetary purposes as 53.305%.

CPC undergraduate student benefits include SUI and Worker's Compensation. The DHHS pooled rate of 4.5% is used for budgetary purposes.

CPC graduate student fringe benefits include SUI and Worker's Compensation which would result in the pooled rate of 4.5%. CPC graduate students convert to intermittent employees if the graduate student is not fully enrolled when the work is performed, resulting in the addition of FICA to fringe benefits and the current intermittent fringe benefit rate of 10%. Cal Poly elects to budget graduate student fringe benefits at the 10% intermittent rate, assuming that the graduate students will not be fully enrolled. It is not feasible to assess enrollment status at the time of proposal submission.

The rates in effect at the time the work is performed will be charged to the sponsor.

### DOMESTIC TRAVEL:

First Year: The initial baseline data collection and instrument installation will require 4 people for 8 days, including rental car, fuel, and meals. The estimated cost is $2389. At least 3 additional field visits will be required for maintenance and data download. These trips will consist of 2 people for approximately 3 days each including rental car, fuel, and meals. Each trip is estimated to cost $602 for a total of $1806.

Second Year: We anticipate similar costs as first year. The post harvest data collection and instrument maintenance will require 4 people for 8 days, including rental car, fuel, and meals. The estimated cost is

$2389. At least 3 additional field visits will be required for maintenance and data download. These trips will consist of 2 people for approximately 3 days each including rental car, fuel, and meals. Each trip is estimated to cost $602 for a total of $1806.

Third Year: At least 3 additional field visits will be required for maintenance and data download. These trips will consist of 2 people for approximately 3 days each including rental car, fuel, and meals. Each trip is estimated to cost $602 for a total of $1806. We have also budgeted for travel to a professional conference and presentation at the EMC meeting for an estimated $1732 for rental car, fuel, lodging, conference fees, and meals.

### OTHER DIRECT COSTS:

**SUPPLIES AND MATERIALS**: **(Items $5K and under)**

Funds will be used to support the purchase of supplies, including but not limited to, water level records, soil moisture sensor, data loggers, stream temperature probes, soil sampling items, miscellaneous hardware, etc.

### OTHER COSTS:

**Tuition: $13K** is included to support graduate student tuition and fees. The funds will support partial tuition for at least one student. Cal Poly treats tuition as a direct cost, not as a fringe benefit for graduate and undergraduate students.

### MATCHING FUNDS:

* + - 8 WTU of Research Support Assigned Time contributed from the NRES Department. This is salary, not recovered in the request, for the principal investigator's work on the project.

**INDIRECT COSTS:** Cal Poly's federally negotiated indirect rate is 38.5% of modified total direct costs, effective July 1, 2018. Modified total direct costs exclude equipment, capital expenditures, charges for patient care, tuition remission, rental costs of off-site facilities, scholarships, and fellowships, participant support costs, and the portion of each subaward in excess of $25,000. If admissible, unrecovered indirect costs may be contributed as match by the University.

Sponsor limits Indirect Costs to 25% of Total Direct Costs, less Tuition.

### Previous or Existing Support

**These funds are related to the ongoing study that will be supported by this funded research. The funding below is not meant to be match and will not be tracked as match. This funding is provided to demonstrate ongoing research that will be leveraged in support of the objectives of this research:**

Previous:

Marian Meadow study from 2013-2016 was funded by a combination of sources totaling over 165K.

* + - Agriculture Research Initiative (ARI) for instruments, travel, and student support for $40,909.
    - McIntire Stennis Grant for instruments, travel, and student support for $45,000.
    - Collins Pine Company, in-kind support for implementation of meadow restoration for $81,830.

Existing:

Marian Meadow and American River Headwaters studies from 2016-2019 are funded by a combination of sources totaling over 170K.

* + - Agriculture Research Initiative (ARI) for instruments, travel, and student support for $79,790.
    - McIntire Stennis Grant for instruments, travel, and student support for $54,282.
    - Collins Pine Company, in-kind support for administration for meadow restoration. LOC is included for this existing commitment.
    - American River Conservancy, CEQA work, administration for meadow restoration for $38,000. Rock Creek Meadow 2016-2019. Planning, permits, initial monitoring of Rock Creek Meadow is funded for just over 64K.
    - National Fish Wildlife Foundation grant to The Plumas Corp. for planning, permits, and monitoring for $64,114.

### Proposal Collaborators

Principal Investigator: Christopher Surfleet, Associate Professor, Watershed Management and Hydrology, Natural Resources Management and Environmental Sciences Department, California Poly Technic State University San Luis Obispo, 93401. [csurflee@calpoly.edu,](mailto:csurflee@calpoly.edu) 805-756-2743.

Collins Pine Almanor Forest. Collins Pine Company, Chester, California. POC: Forest Manager. Landowner for Marian Meadow sites and Rock Creek sites. Managers of timber harvest planning and meadow restoration implementation. [ajuska@collinsco.com](mailto:ajuska@collinsco.com) 530-258-2111

Plumas Corporation, Quincy, California. POC: Leslie Mink. Conducting planning and permit acquisition for implementation of Rock Creek Meadow Restoration. [1es1ie@p1umascorporation.org](mailto:1es1ie@p1umascorporation.org) 530-283-3739

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Collins pine company logo

To: Christopher Surfleet

Natural Resources Management and Environmental Sciences Department California Polytechnic State University

San Luis Obispo, CA 93407 Date: November 29, 2018

Re: Support by Collins Pine Company for the proposal to the Effectiveness Monitoring Committee titled: *Effectiveness of meadow and wet area restoration as an alternative to watercourse and lake protection zone (WLPZ) rules.*

To Whom it May Concern,

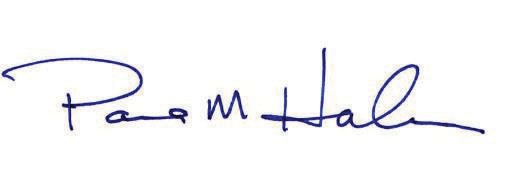
Collins Pine Company supports the proposed monitoring of Rock Creek and Marian Meadows for examining the effectiveness of 14 CCR § 933.4 [e] of the California Forest Practice Rules (FPR).

The proposed meadow for monitoring, Rock Creek, is entirely on Collins Pine Land. The existing research on Marian Meadow is entirely within Collins Pine Land.

We agree to manage operations on land around the meadows in accordance with the proposed study design. We intend to implement the forest harvest in and around Rock Creek meadow and will avoid further forest management operations at the same location until 2022.

Researchers from Cal Poly will be allowed access to Collins Pine Land to conduct the monitoring. Collins Pine intends to offer in kind support to the monitoring through housing for Cal Poly researchers and staff time toward implementation of the restoration and in support of the monitoring.

Respectfully,



Paul M. Harlan VP, Resources

| Plumas Logo | **PLUMAS**  ***Co1J1orart0!L,*** | PO Box 3880  Quincy, CA 95971  530-283-3739  530-293 -5465 fax  plumascorporat ion .org |
| --- | --- | --- |

Christopher Surfleet

Natural Resources Management and Environmental Sciences Department California Polytechnic State University

San Luis Obispo, CA 93407 November 29, 2018

Dear Christopher,

Thank you for including the Rock Creek project area in your effectiveness monitoring proposal. As you know, we have been working with the landowner (Collins Pine) and other partners to treat this area, which is severely overgrown with lodgepole. The lodgepole is choking out an important riparian habitat corridor, and is posing a significant fire danger to a large area of private and public timber land that provides habitat for a number of species of concern. Plumas Corporation has been working on meadow restoration for over 30 years, and is just beginning to work in timber lands. One of the aspects of planning this project that has struck me is the constraints that project partners have expressed regarding our treatment options under the California Forest Practices Rules. This is an ideal area for intensive monitoring that could improve the rules. There are many synergistic benefits that could be realized at Rock Creek from a creative solution. Point Blue, another project partner, is focusing on wildlife monitoring.

We are excited to be part of this important project. As you know, we have been collecting continuously recorded stream flow and groundwater elevation data since June 2017 with funding from the National Fish and Wildlife Foundation, and also have two seasons of summer water temperature data. We are committed to continue the data collection in the pre-project and post­ project conditions, and to share the data for your use in research. We are grateful to have your participation, and encourage any potential funders you are soliciting to join us in monitoring the effects of this project.

**Besrtegadrs'.**

. **Project Manager**

Plumas Corporation