

## **FINAL PROJECT REPORT INSTRUCTIONS**

**for projects funded by a Climate Adaptation Science Center (CASC)**

**Final reports are due 120 days after the close of the performance period for the project.** Failure to provide the required information may delay payments to your project and may jeopardize your ability to participate in future CASC funding opportunities. Please submit completed reports electronically to the Regional CASC Director or National CASC Senior Scientist for the CASC from which funds were received. Additional questions, comments, and supplemental information may also be sent to the CASC Directors.

Additional / more frequent reporting may be required by individual CASCs.

This document contains information and instructions necessary to complete the **final report** for projects funded by a National or Regional Climate Adaptation Science Center (CASC). The final report of your CASC-funded research project provides a record of your study and its results. Your report will serve as a resource for others: copies of project reports are available to the public upon request. The final report serves several important functions to the CASC and is used as:

- An essential component of CASC due diligence activities;
- A metric for gauging the impact of CASC funding programs;
- An opportunity for Principal Investigators (PIs) to suggest areas for improvement in the CASC funding program;
- A tool for the CASCs to gather information about publications, products, presentations and data to advance communications to resource managers, stakeholders and the general public;

The final report shall include the following sections:

**SECTION 1. ADMINISTRATIVE INFORMATION:** Please include:

- Name and contact information of the award recipient: Dr. Matthew Dekar, 2800 Cottage Way, W-2606, Sacramento, CA 95825
- Agency or Institution of the recipient: U.S. Fish and Wildlife Service
- Project title: Frogs to Forest Refugia
- Agreement number: G20PG00058
- Date of the report: 02/14/2023
- Period of time covered by the report: 06/01/2020 to 9/30/2022
- Actual total cost of the project: \$120,659

**SECTION 2. PUBLIC SUMMARY:**

Incorporating considerations about climate change impacts into habitat restoration and at-risk species conservation continues to be difficult because stressors such as catastrophic fires, drought, and invasive species might have a bigger impact on the demographics and persistence of relatively short-lived, at-risk species and many agencies' priorities and funding allocations are not aligned with managing for decadal scales. This collaborative conservation project developed targeted, scientific information that could guide current conservation priorities to ensure Foothill Yellow-Legged Frogs persist in the short-term with an eye toward long-term population viability. Because conservation funding is limited, the project

aimed to maximize the conservation benefits over the long-term by considering how to invest limited resources strategically such that conservation benefits are optimized, measurable, and can be adjusted over time if our assumptions about management efficacy in the face of climate changes are inadequate. To guide this conservation planning effort, a climate refugia model was developed to indicate where frogs will be buffered from climatic changes in the near- and long-term. These results help understand where and how long populations are buffered from climatic changes and when managed relocations will become necessary.

### **SECTION 3. PROJECT SUMMARY:**

This project aimed to advance our process understanding for incorporating climate considerations into managing for the current non-climate threats and priorities. The goal of the project was to develop an on-the-ground demonstration project for a climate refugium that can increase resilience to current stressors as well as for future climatic changes to the long-term means and the extremes. Thus, the project intended to develop new adaptation science and resource management approaches through the co-production model and by designing a climate refugium for several at-risk species that considers current and future habitat needs. Project scientists worked closely with managers and management agency's science staff to develop survey and modeling priorities and to incorporate those results into decision-making. As a result, the project was able to identify the priority management questions and approaches, deliver the modeling results directly to the species recovery team, and is in the process of incorporating the climate refugia modeling results into a species conservation and implementation plan. The modeling results indicate that much of the current occupied habitat remains suitable habitat into the near future and that future climate refugial habitat is near-by to ensure that suitable habitat for species dispersal and translocations is available for species management under future climate scenarios.

### **SECTION 4. REPORT BODY (Please Include the Following Sections):**

#### **Purpose and Objectives:**

Incorporating considerations about climate change impacts into habitat restoration and at-risk species conservation continues to be difficult for managers for several reasons: 1) Currently, stressors such as catastrophic fires, drought, and invasive species have a bigger impact on the demographics and persistence of relatively short-lived, at-risk species. 2) Most agencies' missions and funding allocations are not aligned with managing for decadal scales.

This project aimed to advance our knowledge base for bridging the gap between managing for the current mandates and priorities and long-term climatic changes. The goal of the project was to develop an on-the-ground demonstration project for a climate refugium that can increase resilience to current stressors as well as for future climatic changes to the long-term means and the extremes. Thus, the project intended to develop new adaptation science and resource management approaches through the co-production model and by designing a climate refugium for several at-risk species that considers

current and future habitat needs. Furthermore, the project would demonstrate how to integrate immediate research and conservation needs with longer-term climate adaptation research needs and develop a decision-making approach that can guide within-year planning, 5-year strategic planning, and decadal-scale scenario-based planning.

The project included the following objectives:

- 1) Spatial and statistical design for habitat conservation and restoration that maximizes short-term conservation needs and long-term climate resilience.
- 2) An Adaptive Management design that leverages existing research and monitoring capacity to enhance populations of at-risk aquatic species, birds, and small mammals.
- 3) A proposal for a long-term climate adaptation research and implementation project that leverages federally funded research results and funding with private and state funds to restore aquatic ecosystems and forested habitat to maximize climate resilience and enhance the adaptive capacity of existing wildlife populations.
- 4) Novel approach and understanding for maintaining at-risk species populations in the Southern Sierra Nevada

**Organization and Approach:** This section of the report should explain in task orientated terms how the research activities of the project were conducted. Briefly list which research methods were used to achieve results and why they were chosen by the team.

This was a collaborative conservation project that included in-situ surveys, modeling, and decision-support and conservation planning. To ensure, actionable research was produced the following approach was used:

1. Initial climate refugia workshop was held to identify climate refugia modeling needs for the Sierra Nevada and finding published in a peer-reviewed publication (see attachments).
2. Regular PI meetings were held to coordinate field-work, structured-decision-making workshops, and climate refugia modeling.
3. In-situ frog surveys were conducted in collaboration with project partners at USGS, NE CASC, Yosemite National Park, UC Santa Barbara, and Forest Service.
4. Occupancy results and other relevant data were used by the NE CASC team to develop the climate refugia model for *Rana boylei*. (see attachments for details)
5. Once the climate refugia modeling results were available, stakeholders and decision-makers were engaged in a 3-part structured decision-making workshop to identify management objectives and alternatives.
6. The workshop outputs are being used to develop a decision-model that can then inform the selection of the optimal portfolio of actions.

**Project Results, Analysis and Findings:** Present your project results. Quantitative results (numerical and/or statistical data) and qualitative results (descriptions of how well or poorly something worked) are both important. Tables, graphs and other figures representing your data are excellent ways to summarize data and present them in an accessible way. Describe your research findings and list major

discoveries, innovative approaches and solutions, and research accomplishments of the project team made possible by receiving CASC funding.

The initial climate refugia workshop was held to identify climate refugia modeling needs for the Sierra Nevada and finding published in a peer-reviewed publication and led to the development of this particular study approach. This first manuscript identified six conservation priorities for the Sierra Nevada and associated climate refugia modeling needs: Snow, fire, meadows, giant sequoia, old growth forests, and alpine communities. The publication can be found here (and attached): <https://conbio.onlinelibrary.wiley.com/doi/epdf/10.1111/csp2.497>

Subsequent field surveys to revisit historically occupied sites for *Rana boylei* resulted in the development of occupancy data for *Rana boylei* across the Tuolumne and Merced watershed as well as visual encounter and eDNA survey data for American bullfrog and a few other invasive species. In addition, Dr. Adams with UCSB conducted egg mass surveys (Adams 2021 report). Results will also be published in an upcoming manuscript (Adams et al, in prep). These occupancy data together with the egg mass surveys were used to inform the Species Status Assessment by Fish and Wildlife Service (USFWS 2021).

We used *Rana boylei* occurrence data and environmental data including temperature and precipitation; stream flow variables; human modification; and slope, aspect, and elevation to build a species distribution model for the foothill yellow-legged frog. This species distribution model was used to create maps of projected present day habitat suitability across the range of the eastern clades of *Rana boylei* as well as maps of forecasted future habitat suitability in 2040 and 2080 under climate change. From these maps, we identified climate change refugia, places on the landscape relatively buffered from contemporary climate change and projected to remain suitable habitat in the future for *Rana boylei*, and produced maps of refugia for use in future conservation planning and prioritization. Our refugia results showed that much of currently occupied habitat will remain suitable in the future, but that in general, available habitat will decline over time, especially under more extreme climate change scenarios. Suitable habitat in small tributaries was especially vulnerable to climate change and experienced the greatest loss while riverine mainstems were more likely to stay suitable over time and serve as refugia. Habitat suitability and climate change refugia maps were presented to managers and decision makers during a workshop. Final maps will be sent to all relevant parties and will be written up in a publication, currently in prep.

**Conclusions and Recommendations:** Did you encounter any problems during the project? What project tasks were not completed and why? What would you do differently if you did this project again? Also state and describe the recommended next steps. Based on what you've learned, what do you think should be studied next? Please indicate how your research results contributed to the advancement of scientific knowledge regionally and/or nationally. Please describe how the results from this project are relevant to natural and/or cultural resource managers.

The project encountered two significant problems:

1. It was difficult to staff this project throughout the duration. The first post-doc on this project received a permanent job offer shortly after beginning her work on this project. Thus, the development of the climate refugia model was delayed by approximately a year until a new post-doc could be identified, hired, brought on board and up-to-speed on the project. The other

staff responsible for the structured-decision making were unable to proceed with that aspect of the project (developing the SDM workshops) until the climate modeling results became available.

2. Additional project delay occurred due to the pandemic. Because the SDM workshop was envisioned as an in-person, one-week workshop, the development of the SDM workshop was further delayed because we initially waited for it to become feasible again to meet in-person. When it became clear that in-person meetings were not an option, the SDM process was restructured for on-line meetings. However, it was not an ideal format, especially because the lead facilitator had little experience with on-line facilitation.

Because of these delays, the final conservation plan could not be developed or implemented. Given what we learned, we would have scaled back the complexity of the decision-model and proceeded with a simpler workshop format and get to a first draft of a conservation implementation plan.

**Outreach and Products:** List the type of outreach that you did, or expect to do, including any publications or other presentations of your project to the public. Include a description of if/how the results from this project are accessible to the resource management community. Include a list of products that emerged from this research. The list should include:

**Articles in preparation, under review, accepted, or published in peer reviewed journals and other non-peer reviewed journals:**

Peer-reviewed article published:

Balantic et al. 2020, Toward climate change refugia conservation at an ecoregion scale. Conservation Science and Practice. <https://conbio.onlinelibrary.wiley.com/doi/epdf/10.1111/csp2.497>

Non-peer-reviewed article published:

Isobel Whitcomb, An Ark for Amphibians: The quest to find climate-safe habitats for endangered creatures. Sierra Magazine. <https://www.sierraclub.org/sierra/2022-2-summer/feature/ark-for-amphibians>

Peer-reviewed article in preparation:

Adams et al. in prep.

Mengelt et al. in prep.

Mozelewski et al. Mapping climate change refugia to inform management decisions under global change. In prep.

**Project-related conference presentations, seminars, webinars, workshops, or other presentations to the public made by research team members.**

Mengelt et al. Poster at the AGU 2020 Fall meeting: "From Frog to Forest Conservation: Identifying Climate-Refugia for At-Risk Species in the Southern Sierra Nevada Forest"

Mozelewski et al. 2022. *Identifying climate change refugia for an imperiled frog species in the Sierra Nevadas*. North American Congress for Conservation Biology. Reno, NV.

Morelli and Mozelewski. 2022. *Using climate change refugia to inform conservation planning and prioritization for the National Park Service*. Acadia National Park Science Series. Virtual.

Mozelewski et al. 2022. *Integrating global change into conservation planning and prioritization to improve biodiversity outcomes*. Organismic and Evolutionary Biology Seminar Series. Amherst, MA.

Mozelewski et al. 2022. *Identifying climate change refugia for the foothill yellow-legged frog*. Presented to the US Fish and Wildlife Service and resulted in the incorporation of our map products into critical habitat designation decisions for *Rana boylei*.

Enquist/Mengelt Presentation at the SouthWest Adaptation Forum, Albuquerque, 2022. Value-focused thinking for conservation and adaptation.

Mengelt et al., presentation and contribution to the LCP Climate Refugia Workshop, 2023.

**Communications with decision-makers**, including their name and agency and the date(s) and frequency of your communications. Information on whether the decision-makers were involved in the design of the project plan or if the research has been tailored to address a specifically-stated management need is also helpful.

#### **Yosemite National Park:**

- Nicole Athearn, Division Lead, Resources Management and Science
- Chad Anderson, Deputy Lead, Resource Management and Science
- Rob Grosso, Park Aquatic Biologist

The project was scoped to inform the park's frog management objectives. Nicole Athearn was consulted regularly during the proposal preparation, project scoping, and was involved during the structured decision-making workshops. Rob Grosso was a key partner in developing the aquatic biology survey and was frequently consulted during all aspects of this project and was involved during the structured decision-making workshops. Chad Anderson was consulted a few times to provide information on landscape and ecosystem considerations.

#### **U.S. Fish and Wildlife Service:**

- Kat Powelson, Science Support Coordinator

Kat Powelson was an integral part of the project team from scoping the project through the implementation and coordination with project partners such as Forest Service, California Department of Fish and Wildlife, USGS, and others. As a member of the Species Status Assessment (SSA) core team, she also helped bridge the knowledge-to-action barrier by communicating to the SSA core team the availability of new data and products. Therefore, the latest occupancy data and egg mass survey data

from our project were incorporated into the SSA. Lastly, the development of critical habitat designation was also informed by the latest results from the climate refugia modeling thanks to the conversations Kat Powelson arranged between Dr. Mozelewski and the SSA core team.

**U.S. Forest Service:**

Jason Kuiken, Forest Supervisor  
Michael Jow, District Resource Mgmt. Program Area Leader  
Crispin Holland, Forest Biologist  
Steven Holdeman, Forest Aquatic Biologist

We consulted with Steven Holdeman throughout the project, especially, with regards to study design, in situ survey efforts, and potential habitat and in situ management alternatives.

- Websites created for the project and/or containing project information, data etc.

<https://www.climaterefugia.org/frogstoforests>

- Other products, such as data or databases, audio/video productions, fact sheets etc.

2-page Fact Sheet (see attached)

CASC-funded projects will not be considered complete until all data/products have been delivered to the CASC and the Data Management Plan has been updated. All projects with a USGS-affiliated researcher must comply with the [USGS Fundamental Science Practices](#) policy.

**Attachment:**

- Factsheet