UPPER FEATHER RIVER IRWM

PROJECT INFORMATION FORM

I. PROJECT PROPONENT INFORMATION

Agency / Organization	Ecosystem Sciences Foundation/Upper Feather River Trout Unlimited
Name of Primary Contact	Mark Hill, Ecosystem Sciences Foundation
Name of Secondary Contact	Cindy Noble, Feather River Trout Unlimited
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Other Cooperating Agencies / Organizations / Stakeholders	Feather River Trout Unlimited Chapter #905
Is your agency/organization committed to the project through completion? If not, please explain	Yes

II. GENERAL PROJECT INFORMATION

Project Title	FMW-16: Fish Distribution Modeling in Relation to Climate Change
Project Category	☐ **Agricultural Land Stewardship** ■ **Floodplains/Meadows/Waterbodies** ☐ **Municipal Services** ☐ **Tribal Advisory Committee** ☐ **Uplands/Forest**
Project Description	Recent global warming research confirms that fish species shift their range to higher elevations, cooler waters in stream systems, or, in some cases adapt to temperature, flow and velocity changes. Predicting changes that could occur in Upper Feather River cold-water fish distribution as a consequence of climate change will allow adaptation of management actions and stream restoration priorities. This project will develop distribution models from fish species and temperature data for separate time periods, then comparisons made between periods for locations of upstream and downstream distributional boundaries. The shift in fish species across boundaries will be evaluated using existing bioclimatic models. Current fish species presence or absence by stream will be determined with eDNA analysis. The average rate of distribution shift can be expected to lag behind the average climate velocity in streams, which would indicate that species are moving more slowly than their thermal niches. In terms of adapting management and restoration priorities, passage barriers or degraded main

	stream and tributary conditions that impede dispersal can be addressed in order to prevent or minimize some species being overcome by shifting isotherms. Once critical habitats (refugia) are identified, both land use and water use management can be directed toward restoration actions.
Project Location Description	North, South and Middle Forks of the Feather River and their major tributaries within the Upper Feather River IRWM Planning Area.
Latitude:	121'30.0"W to 120'0.0"W
Longitude:	39'30.0"N to 40'30.0"N

III. APPLICABLE IRWM PLAN OBJECTIVES ADDRESSED

For each of the objectives addressed by the project, provide a one to two sentence description of how the project contributes to attaining the objective and how the project outcomes will be quantified. If the project does not address *any* of the IRWM plan objectives, provide a one to two sentence description of how the project relates to a challenge or opportunity of the Region.

Upper Feather River IRWM Objectives:	**Will the project address the objective?**	**Brief explanation of project linkage to selected Objective**	**Quantification** (e.g. acres of streams/wetlands restored or enhanced)
Restore natural hydrologic functions.	■ Yes ☐ N/A	The last step toward protecting critical habitat for coldwater species' thermal refugia will be restoration of the habitat including restoring natural hydrologic functions to the extent possible.	TBD
Reduce potential for catastrophic wildland fires in the Region.	■ Yes ☐ N/A	Improvement in riparian habitat as a function of stream restoration for coldwater species refuge will aid in the reduction and control of wildfires.	TBD
Build communication and collaboration among water resources stakeholders in the Region.	■ Yes ☐ N/A	Stakeholder input and coordination with resource agencies and irrigation districts is essential to manage and adapt fish and habitat to climate changes.	TBD
Work with DWR to develop strategies and actions for the management, operation, and control of SWP facilities in the Upper Feather River Watershed in order to increase water supply, recreational, and environmental benefits to the Region.	■Yes ☐N/A	Recognizing climate change effects on coldwater species will also alert managers and stakeholders to the impacts on water supply, recreation and overall environmental values.	TBD

Upper Feather River IRWM Objectives:	Will the project address the objective?	Brief explanation of project linkage to selected Objective	Quantification (e.g. acres of streams/wetlands restored or enhanced)
Encourage municipal service providers to participate in regional water management actions that improve water supply and water quality.	☐ Yes ■ N/A		
Continue to actively engage in FERC relicensing of hydroelectric facilities in the Region.	■ Yes ☐ N/A	FERC relicensing frequently addresses the issues of lost fish habitat and particularly fish passage and access. Identification of critical habitat areas above and below hydro projects will fold into the FERC process and provide important data and information.	TBD
Address economic challenges of municipal service providers to serve customers.	☐ Yes ■ N/A		
Protect, restore, and enhance the quality of surface and groundwater resources for all beneficial uses, consistent with the RWQC Basin Plan.	■ Yes ☐ N/A	Recharging groundwater and improving surface water is essential to maintaining coldwater habitat. Groundwater in late summer may be the only source of flow in some headwater streams. Protecting headwater surface and groundwater resources are key elements of the RWQC and UPFR IRWM plans.	TBD
Address water resources and wastewater needs of DACs and Native Americans.	■ Yes ☐ N/A	Identification and protection of coldwater species refugia would be pertinent to "first foods" of Native American cultures.	TBD
Coordinate management of recharge areas and protect groundwater resources.	■ Yes ☐ N/A	Groundwater recharge, particularly in headwater basins, is fundamental to maintaining critical fish habitat.	TBD
Improve coordination of land use and water resources planning.	■ Yes ☐ N/A	The project will result in information that will improve long-term planning for land and water uses.	TBD
Maximize agricultural, environmental and municipal	■ Yes	Identification of critical habitats as refugia from increased	TBD

Upper Feather River IRWM Objectives:	Will the project address the objective?	Brief explanation of project linkage to selected Objective	**Quantification** (e.g. acres of streams/wetlands restored or enhanced)
water use efficiency.	☐ N/A	instream temperature will help inform water use efficiency and its importance in maintaining habitats. And all users (municipal, agriculture, environmental) are important links to ensure best and most efficient water uses.	
Effectively address climate change adaptation and/or mitigation in water resources management.	■ Yes ☐ N/A	The purpose of the project is to locate future coldwater species refugia as a function of elevated thermal conditions; particularly in response to isotherm velocities due to climate change. These locations will be identified as critical, future habitat to allow fish refuge and/or adaption.	TBD
Improve efficiency and reliability of water supply and other water-related infrastructure.	■ Yes ☐ N/A	Water efficiency to maintain supply and consistency is necessary to maintain critical fish habitats, which would include maintaining existing water related infrastructure.	TBD
Enhance public awareness and understanding of water management issues and needs.	■ Yes ☐ N/A	Stakeholder awareness is a necessary part of education and outreach of each management action to identify and protect critical habitat and to raise understanding of climate change implications to instream resources.	TBD
Address economic challenges of agricultural producers.	■ Yes ☐ N/A	Identification of critical coldwater habitat and restoration of habitat must be sensitive to agriculture to ensure any change in land and water uses will maintain and protect agriculture production.	TBD
Work with counties/ communities/groups to make sure staff capacity exists for actual administration and implementation of grant funding.	☐ Yes ■ N/A		

IV. PROJECT IMPACTS AND BENEFITS

Please provide a summary of the expected project benefits and impacts in the table below or check N/A if not applicable; **do no leave a blank cell.** Note that DWR encourages multi-benefit projects.

If applicable, describe benefits or impacts of the project with respect to:		
a. Native American Tribal Communities	☐ N/A	Improved fish habitat would increase fish populations into the future, which would be of value to Native American culture and a key "first food".
b. Disadvantaged Communities[1]	■ N/A	
c. Environmental Justice[2]	■ N/A	
d. Drought Preparedness	☐ N/A	A key element of identifying critical habitat for longterm protection of coldwater fish species is the fact that the refuge areas are most likely to be natural water storage sites retaining runoff and recharging groundwater basins, so that in the event of drought these areas will contribute water to stream flow as well as for agriculture and municipal needs.
e. Assist the region in adapting to effects of climate change	☐ N/A	The project focus is on the adaption of fish and migration to critical, longterm habitat as temperature (e.g., isotherms) advance over time. The Upper Feather River watershed contains critical headwater and meadow areas that are primary sources for stream flows. Understanding how climate change affects stream temperatures, fish and instream habitats will also enhance understanding of other climate change effects on stream flows and natural resources. This project will also provide prioritization of areas where resources can be better allocated to increase the ability of fish to adapt to climate change.
f. Generation or reduction of greenhouse gas emissions (e.g. green technology)	■ N/A	
g. Other expected impacts or benefits that are not already mentioned elsewhere	☐ N/A	Restoring and protecting critical upper watershed habitats for fish will also result in benefits to water conservation and planning, improved water quality, development or restoration of meadows and wetlands, and promote informed watershed planning and management.

DWR encourages multiple benefit projects which address one or more of the following elements (PRC §75026(a). Indicate which elements are addressed by your project.

a. Water supply reliability, water conservation, water use efficiency	■ Yes ☐ N/A	g. Drinking water treatment and distribution	☐ Yes ■ N/A
b. Stormwater capture, storage, clean-up, treatment, management	■ Yes ☐ N/A	h. Watershed protection and management	■ Yes ☐ N/A
c. Removal of invasive non-native species, creation/enhancement of wetlands, acquisition/protection/restoration of open space and watershed lands	■ Yes ☐ N/A	i. Contaminant and salt removal through reclamation/desalting, other treatment technologies and conveyance of recycled water for distribution to users	☐ Yes ■ N/A
d. Non-point source pollution reduction, management and monitoring	■ Yes ☐ N/A	j. Planning and implementation of multipurpose flood management programs	☐ Yes ■ N/A
e. Groundwater recharge and management projects	■ Yes ☐ N/A	k. Ecosystem and fisheries restoration and protection	■ Yes ☐ N/A
f. Water banking, exchange, reclamation, and improvement of water quality	■ Yes ☐ N/A		

V. RESOURCE MANAGEMENT STRATEGIES

For each resource management strategy (RMS) employed by the project, provide a one to two sentence description in the table below of how the project incorporates the strategy.

Resource Management Strategy	**Will the Project incorporate RMS?**	**Description of how RMS to be employed, if applicable**
Reduce Water Demand		
Agricultural Water Use Efficiency	■ Yes ☐ No	Identification of priority stream restoration areas will typically result in reduced ET and improvement of water delivery systems.
Urban water use efficiency	☐ Yes ■ No	
Improve Flood Management		
Flood management	■ Yes ☐ No	Habitat restoration will promote natural floodplain functions; geomorphic and ecological processes.
Improve Operational Efficiency and Transfers		
Conveyance – regional/local	☐ Yes ■ No	
System reoperation	☐ Yes ■ No	
Water transfers	☐ Yes ■ No	
Increase Water Supply		
Conjunctive management	■Yes ☐ No	Critical habitat for coldwater species will require management of groundwater and surface water, to effectively combat temperature changes due to climate change
Precipitation Enhancement	☐ Yes ■ No	

Resource Management Strategy	Will the Project incorporate RMS?	Description of how RMS to be employed, if applicable
Municipal recycled water	☐ Yes ■ No	
Surface storage – regional/local	☐ Yes ■ No	
Improve Water Quality		
Drinking water treatment and distribution	☐ Yes ■ No	
Groundwater remediation/aquifer remediation	■ Yes ☐ No	Methods to recharge aquifers to protect critical habitats can include changes in crop types as well as irrigation methods.
Matching water quality to water use	■ Yes ☐ No	Matching water of appropriate temperature to instream and ecosystem uses.
Pollution prevention	■ Yes ☐ No	Restoration of critical habitat will include development of riparian vegetation that will buffer nutrient inputs from grazing and other overland flow constituents.
Salt and salinity management	☐ Yes ■ No	
Urban storm water runoff management	☐ Yes ■ No	
Practice Resource Stewardship		
Agricultural land stewardship	■ Yes ☐ No	Critical habitat restoration will result in reduced erosion, improved streambank stability, riparian buffering, modified grazing intensity and timing and cover crops to prevent soil erosion.
Ecosystem restoration	■ Yes ☐ No	Locating and prioritizing critical fish habitat will require restoration of natural flows, elimination of non-native predator species, removal of barriers to migration, recovering headwater marshes and wetlands, and improved forest and land management practices.
Forest management	■ Yes ☐ No	Critical habitats will require conservation of riparian forests. Riparian habitats shade streams and provide fish cover.
Land use planning and management	■ Yes ☐ No	Directing development away from critical habitat areas will permit management of agriculture lands and improve water quality.
Recharge area protection	■ Yes ☐ No	Protection and identification of new recharge areas will be critical to conjunctive water supply and maintenance of critical fish habitat.
Sediment management	■ Yes ☐ No	Access to critical habitat may require deconstruction of dams or dredging. Streambank restoration will reduce sediment loading to streams.
Watershed management	■ Yes ☐ No	Restoring and maintaining critical fish habitat identified by the project will aid many

Resource Management Strategy	Will the Project incorporate RMS?	Description of how RMS to be employed, if applicable
		watershed management goals: improve water retention, improve water quality, restore wetlands, and improve groundwater recharge and retention.
People and Water		
Economic incentives	☐ Yes ■ No	
Outreach and engagement	■ Yes ☐ No	Stakeholder input will be essential for coordinating and accepting identification and protection of critical habitat. This will require outreach and education elements of restoration actions.
Water and culture	■ Yes ☐ No	Historic areas where native fishes thrived will be an integral part of protecting critical habitat; and it can be expected that such areas will have significant cultural value, especially to Native Americans.
Water-dependent recreation	■ Yes ☐ No	While the project will identify those river and tributary reaches that will offer the best longterm protection of coldwater fish species, such areas will also provide some of the last and best angling opportunities for native coldwater fish.
Wastewater/NPDES	■ Yes ☐ No	Once critical fish habitat has been identified, restoration of that habitat will usually include development and protection of riparian habitat as well as buffer zones, which will filter overland flows and reduce nutrient and sediment inputs.

VI. PROJECT COST AND FINANCING

Please provide any estimates of project cost, sources of funding, and operation and maintenance costs, as well as the source of the project cost in the table below.

PROJECT BUDGET

Project serves a need of a DAC?: ☐ Yes ■ No
Funding Match Waiver request?: ☐ Yes ■ No

	Category	Requested Grant Amount	Cost Share: Non-State Fund Source (Funding Match)[1]	Cost Share: Other State Fund	Total Cost
a.	**Direct Project Administration**	$12,500	$1,250		$13,750
b.	**Land Purchase/Easement**				
c.	**Planning/Design/Engineering / Environmental**	$154,000	$15,400		$169,400
d.	**Construction/Implementation**				
e.	**Environmental Compliance/ Mitigation/Enhancement**				
f.	**Construction Administration**				
g.	**Other Costs**				
h.	**Construction/Implementation Contingency**				
i.	**Grand Total (Sum rows (a) through (h) for each column)**	$166,500	$16,650		$183,150

j.	**Can the Project be phased?** ☐ **Yes** ■ **No** If **yes**, provide cost breakdown by phases			
		Project Cost	**O&M Cost**	**Description of Phase**
	Phase 1			
	Phase 2			
	Phase 3			
	Phase 4			

k.	**Explain how operation and maintenance costs will be financed for the 20-year planning period for project implementation (not grant funded).**	NA
l.	**Has a Cost/Benefit analysis been completed?**	☐ **Yes** ■ **No**
m.	**Describe what impact there may be if the project is not funded (300 words or less)**	A 2011 study by PGF&E in sub-basins of the North Fork Feather River reported a declining trend in water year runoff. This combined with increased evapotranspiration caused by warmer air temperatures and increased forest growth account for a 250,000 AF/yr flow decline

[1] Ecosystem Sciences Foundation Match

		since the 1970's. A USFS study in the Pacific Northwest showed that as isotherms advance and no corrective actions are taken to protect and restore critical habitat, the only trout species that might persist will be bulltrout. Cutthroat trout may adapt to some degree but rainbow and brown trout will be extirpated as well as salmon in most areas they now use. In order to prevent the loss of more coldwater species, refuge identification, restoration and protection should begin as soon as possible. Regional temperature models indicate increasing air temperatures and the rapid advancement of isotherms into coldwater species' habitat to the extent that by 2040 most current habitat will be diminished to the point that coldwater species either rapidly adapt or find refuge in other reaches. Given the rapidity of isotherm velocities and the shortterm/longterm temperature predications, there is little time to waste in identifying, quantifying and developing restoration and management plans. Funding and implementation of restoration of critical habitat will in itself take considerable time. Research identifies three critical actions that most usefully combat climate change and loss of fisheries: (1) conduct geographically broad and intense biodiversity surveys to document fisheries, (2) restore and maintain functional riparian areas and flows because stream flow and temperature are two primary vectors of climate change, and (3) manage fish flows across landscapes. All of these elements are time sensitive requiring land and water user collaboration and long-term planning and funding.

VIII. PROJECT STATUS AND SCHEDULE

Please provide a status of the project, level of completion as well as a description of the activities planned for each project stage. If unknown, enter **TBD**.

Project Stage	Check the Current Project Stage	Completed?	Description of Activities in Each Project Stage	Planned/ Actual Start Date (mm/yr)	Planned/ Actual Completion Date (mm/yr)
a. Assessment and Evaluation	■	☐ Yes ■ No ☐ N/A	(1) Assemble pertinent fish data from agency records and oral histories (2) Determine presence/absence of species of concern in selected streams using eDNA analysis (3) Combine historic data, with eDNA data to establish upstream/downstream species' boundaries, past and present (4) Extrapolate NW Temperature Model to UFR using temperature and flow data from local sources to calibrate both temperature model and Climate Shield Model. (5)Correlate shifts (P/A) in distribution w/isotherm velocity (6) Predict how species will disperse over time (7) Identify and map impediments to dispersal (8) Prioritize which impediments need to be addressed over time.	TBD	TBD
b. Final Design	☐	☐ Yes ☐ No ■ N/A			

c. Environmental Documentation (CEQA / NEPA)	☐	☐ Yes ☐ No ■ N/A			
d. Permitting	☐	☐ Yes ☐ No ■ N/A			
e. Construction Contracting	☐	☐ Yes ☐ No ■ N/A			
f. Construction Implementation	☐	☐ Yes ☐ No ■ N/A			
Provide explanation if more than one project stage is checked as current status					

IX. PROJECT TECHNICAL FEASIBILITY

Please provide any related documents (date, title, author, and page numbers) that describe and confirm the technical feasibility of the project.

a. List the adopted planning documents the proposed project is consistent with or supported by (e.g. General Plans, UWMPs, GWMPs, Water Master Plan, Habitat Conservation Plans, TMDLs, Basin Plans, etc.).	Upper Feather River Basin Plan Upper Feather River IRWM Plan California Water Plan Update 2013 Plumas County General Plan Sierra County General Plan Butte County General Plan 2030 Butte County RCD 2008-2013 Long Range Strategic Plan USFS Ecological Restoration Implementation Plan Lake Almanor Watershed Management Plan Lassen County General Plan 2000 USFS Lassen National Forest Land and Resource Management Plan Mountain Meadow Watershed Restoration Action Plan Pacific Forest and Watershed Lands Stewardship Council Land Conservation Plan Plumas National Forest Land and Resource Management Plan Tahoe National Forest Land and Resource Management Plan
b. List technical reports and studies supporting the feasibility of this project.	Almodóvar, A., Nicola, G., Ayllon, D. and Elvira, B. 2012. Global warming

threatens the persistence of Mediterranean brown trout. *Global Change Biology* 18(5):1549–1560

Armstrong, J.B. and Schindler, D.E. 2013. Going with the flow: spatial distributions of Juvenile Coho salmon track an annually shifting mosaic of water temperature. *Ecosystems* 16:1429-1441

Battin, J., Wiley, M., Ruckelshaus, M., Palmer, R., Korb, E., Bartz, K., Imaki, H. 2007. Projected impacts of climate change on salmon habitat restoration. *Proceedings of the National Academy of Sciences (USA)* 104:6720-6725

Buisson, L. and Grenouillet, G. 2009. Contrasted impacts of climate change on stream fish assemblages along an environmental gradient. *Diversity and Distributions* 15:613–626

Chadwick, J., Nislow, K. and McCormick, S. 2015. Thermal onset of cellular and endocrine stress responses correspond to ecological limits in brook trout, an iconic cold-water fish. *Conservation Physiology* 3(1):1-12

Chu, C., Mandrak, N. and Minns, C. 2005. Potential impacts of climate change on the distribution of several common and rare freshwater fishes in Canada. *Diversity and Distributions* 11:299-310

Comte, L. and Grenouillet. 2013. Do stream fish track climate change? Assessing distribution shifts in recent decades. *Ecography* doi:10.1111/j.1600-0587.2013.00282.x

Cooney, S., Covich, A., Lukas, P., Harig, A. and Faush, K. 2005. Modeling global warming scenarios in greenback cutthroat trout (*Oncorhynchus clarki stomias*) streams: implications for

	species recovery. *Western North American Naturalist* 65:371-381 Dugdale, S., Franssen, J., Corey, E., Bergeron, N., Lapointe, M. and Cunjak, R. 2015. Main stem movement of Atlantic salmon parr in response to high river temperature. *Ecology of Freshwater Fish* 24 Eaton, J. and Schaller, R. 1996. Effects of climate warming on fish thermal habitat in streams of the United States. *Limnology and Oceanography* 41:1109-1115 Flebbe, P., Roghair, L. and Bruggink, J. 2006. Spatial modeling to project southern Appalachian trout distribution in a warmer climate. *Transactions of the American Fisheries Society* 135:1371-1382 Freeman, G.J. 2011. Climate change and the changing water balance for Califoria's North Fork Feather River. Operations and Maintenance, Power Generation Department, PG&E, San Francisco, California Hamlet, A. and Lettenmaier, D. 2007. Effects of 20th century warming and climate variability on flood risk in the western U.S. *Water Resources Research* 43(6) Hillyard, R. and Keeley, E. 2012. Temperature-related changes in habitat quality and use by Bonneville cutthroat trout in regulated and unregulated river segments. *Transactions of the American Fisheries Society* 141:1649-1663 Isaak, D., Luce, C., Rieman, B., Nagel, D., Peterson, E., Horan, D., Parker, S. and Chandler, G. 2010. Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network.

Ecological Applications 20:1350-1371

Isaak, D., Wollrab, S., Horan, D., Chandler, G. 2011. Climate change effects on stream and river temperatures across the northwest U.S. from 1980-2009 and implications for salmonid fishes. *Climate Change* 113:499-524

Isaak, D., Young, M., Nagel, D, Horan, D. and Groce, M. 2015. The Cold-Water Climate Shield: delineating refugia for preserving salmonid fishes through the 21st Century. *Global Change Biology* doi: 10.1111/ gcb.12879

Jager, H.I., Van Winkle, W. and Holcomb, B.D. 1999. Would hydrologic climate changes in Sierra Nevada streams influence trout persistence? *Transactions of the American Fisheries Society* 128:222-240

Keleher, C. and Rahel, F. 1996. Thermal limits to salmonid distributions in the Rocky Mountain region and potential habitat loss due to global warming: a geographic information system (GIS) approach. *Transactions of the American Fisheries Society* 125:1-13

Kennedy, T., Gutzler, D. and Leung, R. 2009. Predicting future threats to the long-term survival of Gila trout using a high-resolution simulation of climate change. *Climate Change* 94:503-515

Lawler, J., Tear, T., Pyke, C., Shaw, R., Gonzalez, P., Kareiva, P., Hansen, L., Hannah, L., Klausmeyer, K., Aldous, A., Bienz, C. and Pearsall, S. *2010.* Resource management in a changing and uncertain climate. *Frontiers in Ecology and the Environment* 8(1):35-43

Lyons, J., Stewart, J., Mitro, M. 2010. Predicting effects of climate warming on the distribution of 50 stream fishes in Wisconsin, U.S.A. *Journal of Fish Biology* 77:1867-1898

Matthews, W. and Zimmerman, E. 1990. Potential effects of climate change on native fishes of the southern Great Plains in the Southwest. *Fisheries* 15:26-32

Meisner, J. 1990. Effect of climatic warming on the southern margins of the native range of brook trout. *Canadian Journal of Fisheries and Aquatic Sciences* 47:1065-1070

Moshseni, O., Stefan, H. and Eaton, J. 2003. Global warming and potential changes in fish habitat in U.S. streams. *Climate Change* 59:389-409

Mote, P., Hamlet, A., Clark, M. and Lettenmaier, D. 2005. Declining mountain snowpack in western North America. *Bulletin of the American Meteorological Society* 86:39-49

Painter, R.E., Wixom, L.H. and Taylor, S.N. 1977. An evaluation of fish populations and fisheries in the post-Oroville project Feather River. California Department of Fish and Game, Anadromous Fish Branch, California

Rahel, F., Keleher, C. and Anderson, J. 1996. Potential habitat loss and population fragmentation for cold water fish in the North Platte River drainage of the Rocky Mountains: response to climate warming. *Limnology and Oceanography* 41:1116-1123

Regonda, S., Rajagopalan, B., Clark, M. and Pitlick, J. 2005. Seasonal cycle shifts in hydroclimatology over the western United States. *Journal of Climate* 18:372-384

Rieman, B. and Isaak, D. 2010. Climate change, aquatic ecosystems, and fishes in the Rocky Mountain West: implications and alternatives for management. Gen. Tech. Rep. RMRS-GTR-250. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado

Rieman, B., Isaak, D., Adams, S., Horan, D., Nagel, D., Luce, C. and Meyers, D. 2007. Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River Basin. *Transactions of the American Fisheries Society* 136:1552-1565

Ruesch, A.S., Torgersen, C.E., Lawler, J.J., Olden, J.D., Peterson, E.E., Volk, C.J. and Lawrence, D.J. 2012. Projected climate-induced habitat loss for salmonids in the John Day River network, Oregon, USA. *Conservation Biology* 26(5):873-882

Sharma, S. and Jackson, D. 2008. Predicting smallmouth bass Micropterus *dolomieu occurance* across North America under climate change: a comparison of statistical approaches. *Canadian Journal of Fisheries and Aquatic Sciences* 65:471-481

Snider, W.M. and Linden, A. 1981. Trout growth in California streams. Inland Fisheries Administration Report No. 81-1. California Department of Fish and Game, Inland Fisheries Branch, Sacramento, California

Stein, B.A., Staudt, A., Cross, M.S., Dubois, N., Enquist, C., Griffis, R., Hansen, L., Hellman, J., Lawler, J., Nelson, E. and Pairis, A. 2013. Preparing for and managing change: climate adaptation for biodiversity and ecosystems. *Frontiers in Ecology and* *the Environment* 11:502-510

Stewart, I., Cayan, D. and Dettinger, M. 2005. Changes toward earlier streamflow timing across western North America. *Journal of Climate* 18:1136-1155

Tisseuil, C., Vrac, M., Grenouillet, G., Wade, A., Gevrey, M., Oberdorff, T., Grodwohl, J. and Lek, S. 2012. Strengthening the link between climate, hydrological and species distribution modeling to assess the impacts of climate change on freshwater biodiversity. *Science of the Total Environment* 424:193-201

Vorosmarty, C. McIntyre, P., Gessner, M., Dudgeon, D., Pruevich, A., Green, P., Glidden, S., Bunn, S., Sullivan, C., Liermann, C. and Davies, P. 2010. Global threats to human water scarcity and river biodiversity. *Nature* 467:555-561

Wegner, S., Isaak, D., Luce, C., Neville, H., Fausch, K., Dunham, J., Dauwalter, D., Young, M., Elsner, M., Riemann, B., Hamlet, A. and Williams, J. 2011. Flow regime, temperature, and biotic interactions drive differential declines of trout species under climate change. *Proceedings of the National Academy of Sciences* 108:1475-1480

Williams, J., Haak, A., Neville, H., Colyer, W. 2009. Potential consequences of climate change to persistence of cutthroat trout populations. *North American Journal of Fisheries Management* 29:533-548

c. Concisely describe the scientific basis (e.g. how much research has been conducted) **of the proposed project in 300 words or less.**	The basis for this work is summarized in a new study published in *Ecography*. This report is a watershed event because it provides biological evidence in support of basic predictions made by some 23 fish bioclimatic models. ESF recently incorporated Oregon Department of Fish and Wildlife temperature and fish habitat modeling (EDT models) that identified stream reach limitations for the John Day River Basin watershed atlas. A bioclimatic model developed by the USFS (Climate Shield) has been used to identify streams and watersheds that can serve as refugia for cold-water species. The Climate Shield Model uses the NorWest Temperature Model, in combination with climate scenarios and survey data or professional judgment on species presence/absence as well as species biological needs to delineate cold-water fish habitat by stream reach. GIS generated maps spatially depict the model's habitat predications. Most bioclimatic models assume that the habitat requirements of species remain constant even if the distribution of habitats shifts. Fish distributions are delimited by critical temperature isotherms (temperature where it is too warm for a species to survive), and species will redistribute on the basis of changing isotherms. Climate change velocity in an area determines if a species' response to isotherm change results in redistribution, adaption or extinction. Consequently, it is essential to know what climate velocities are in different areas, and to match that information with biological distributions. The data

	needed for this are readily derived from global air temperature models and projections regarding climate change scenarios. The Sierra Institute has developed regional temperature models as part of their climate change work. The outcome will predict stream areas that fish will seek out in response to changing isotherms. It is then essential that species are able to access and use those "habitat areas", which means identifying and prioritizing restoration and intervention actions that make habitat areas suitable in the future.
d. Does the project implement green technology (e.g. alternate forms of energy, recycled materials, LID techniques, etc.).	☐ Yes ■ No ☐ N/A If yes, please describe.
e. Are you an Urban Water Supplier?	☐ Yes ■ No ☐ N/A
f. Are you are an Agricultural Water Supplier?	☐ Yes ■ No ☐ N/A
g. Is the project related to groundwater?	■ Yes ☐ No ☐ N/A If yes, please indicate which groundwater basin. Lake Almanor Meadow Valley Indian Valley Middle Fork Humbug Valley Grizzly Valley Clover Valley Last Chance Creek Yellow Creek Valley Sierra Valley Long Valley Mohawk Valley American Valley Modoc Plateau Pleistocene Area

Climate Change – Project Assessment Checklist

This climate change project assessment tool allows project applicants and the planning team to assess project consistency with Proposition 84 plan standards and RWMG plan assessment standards. The tool is a written checklist that asks GHG emissions and adaptation/resiliency questions.

Name of project: FMW-16: Fish Distribution Monitoring in Relation to Climate Change

Project applicant: Ecosystem Sciences Foundation and Feather River Trout Unlimited (Chapter 905)

GHG Emissions Assessment

Project Construction Emissions

(If you check any of the boxes, please see the attached worksheet)

☐ The project requires nonroad or off-road engines, equipment, or vehicles to complete.
☐ The project requires materials to be transported to the project site.
☐ The project requires workers to commute to the project site.
☐ The project is expected to generate GHG emissions for other reasons.
X The project does not have a construction phase and/or is not expected to generate GHG emissions during the construction phase.

Operating Emissions

(If you check any of the boxes, please see the attached worksheet)

☐ The project requires energy to operate.
☐ The project will generate electricity.
☐ The project will proactively manage forests to reduce wildfire risk.
☐ The project will affect wetland acreage.
☐ The project will include new trees.
☐ Project operations are expected to generate or reduce GHG emissions for other reasons.

Adaptation & Resiliency Assessment

Water Supply

Describe how the project makes the watershed (more/less) resilient to one or more of the following high priority water supply vulnerability issues:

☐ Not applicable

X Reduced snowmelt

☐ Unmet local water needs (drought)

X Increased invasive species

Climate change has a significant impact on snow pack in the Sierras. A reduced snowpack can result in a reduction in warm-season instream flows which may lead to increases stream temperatures in streams throughout the Upper Feather River range. The NW Temperature Model and Climate Shield Model used to predict coldwater fish habitat will provide some predictive power when studying the effects of reduced snowmelt throughout the Northern Sierras.

Bull trout and cutthroat trout are two California special status species. The principle threats to these native species are the loss of suitable habitat and competition from non-native fish species. This project will identify critical habitat for the long-term survival of native species. By identifying the habitat areas most resilient to climate change induced increased thermal loading, conservation and protection efforts may be prioritized in the most effective and resilient areas.

Water Demand

Describe how the project makes the watershed (more/less) resilient to one or more of the following high priority water demand vulnerability issues:

☐ Not applicable

X Increasing seasonal water use variability

X Unmet in-stream flow requirements

X Climate-sensitive crops

X Groundwater drought resiliency

☐ Water curtailment effectiveness

As stream flows attenuate due to climate change, normal or expected seasonal flow regimes will change. This must be taken into account when examining life stage periodicity for coldwater fish species in that usual spawning migration timing will change as will the periodicity for agriculture irrigation causing a shift in timing and use of refugia. Understanding the shifts in seasonal stream flow will provide some information to aid in the adaptation of watershed practices, particularly agriculture and fish migration. Implementation of restoration actions on priority streams identified by this project will improve seasonal flows regimes through enhanced bank storage and groundwater recharge.

Output from the temperature and climate model used in this project can inform agricultural projects especially in regard to climate-sensitive crops. Data input and output can be shared and used to strategize actions that combat the effects of long-term climate change throughout the Upper Feather River watershed.

Recharge of groundwater is critical to summer instream flows. Fish in need of temperature refugia will require access to groundwater inflow areas. In addition, year-round habitat continuity will improve the long-term health of the fishery. Groundwater recharge can be improved with restoration of riparian habitat and stream bank conditions. It is imperative that precious restoration and enhancement resources be allocated in locations that are resilient to climate change. Identification of restoration actions to make refugia available to stressed fish is an integral part of this project.

Flows required to give coldwater fish species access to critical areas of the watershed will support the need for maintaining instream flows. The data and information generated by this project will be an important component of designing strategies to increase unmet in-stream flow needs.

Water Quality

Describe how the project makes the watershed (more/less) resilient to one or more of the following high priority water quality vulnerability issues:

☐ Not applicable

X Increasing catastrophic wildfires

X Eutrophication (excessive nutrient pollution in a waterbody, often followed by algae blooms and other related water quality issues)

X Seasonal low flows and limited abilities for waterbodies to assimilate pollution

☐ Water treatment facility operations

X Unmet beneficial uses (municipal and domestic water supply, water contact recreation, cold freshwater habitat, spawning habitat, wildlife habitat, etc.)

Wildfires in degraded landscapes often burn right to the river’s edge thereby removing riparian habitat and degrading water quality. Restoration of riparian habitat by increasing buffers, setbacks, bank storage and groundwater conditions will contribute to streamside habitat acting as natural firebreaks and green-zones that limit wildfire impacts on streams and especially refugia areas, which will reduce the catastrophic effects of wildfires.

One output from identifying fish refugia will be identifying and prioritizing blockages and impediments to fish migration and emigration. Many of these impediments are remnant dams and diversions, which when breached or removed, will allow access to critical habitats. Some dams or barriers create a ponding or backwater effect that encourages concentration of nutrients particularly in grazing areas leading to noxious algal blooms. Elimination of such standing water will improve water quality conditions downstream.

Identification of critical coldwater habitat for fish spawning and rearing, and access to critical habitat will be a principle output of this project. In many streams this will mean opening-up essential life stage habitat in otherwise unmet beneficial use areas.

Identification and prioritization of streams will include riparian habitat values and the beneficial uses of wildlife habitat and wildlife species. Restoration actions that improve riparian habitat as part of the effort to make refugia suitable will improve water quality and reduce pollution loading by virtue of filtering and buffering runoff.

Flooding

Describe how the project makes the watershed (more/less) resilient to one or more of the following high priority flooding vulnerability issues:

☐ Not applicable

X Aging critical flood protection

X Wildfires

X Critical infrastructure in a floodplain

☐ Insufficient flood control facilities

Remnant dams and diversions as well as log jams, slides and even beaver dams can all inhibit fish passage to critical habitat in response to climate change. These structures can also increase the risk of flooding on floodplains if abandoned or improperly maintained. Identifying these structures and their capacity to allow fish passage and a determination of removal or improvement might also reduce flood risk in some cases.

In addition to reducing flood risks from antiquated or improper structures, restoration actions will be identified that will reduce flood risk. Healthy and functioning floodplain and riparian areas reduce flood velocities, allow for infiltration, and have higher bank storage capacities. This improved riparian habitat, bank storage and groundwater recharge will reduce the occurrence of wildfires by maintaining green-zones.

Ecosystem and Habitat

Describe how the project makes the watershed (more/less) resilient to one or more of the following high priority ecosystem and habitat vulnerability issues:

☐ Not applicable

X Climate-sensitive fauna or flora

☐ Recreation and economic activity

X Quantified environmental flow requirements

X Erosion and sedimentation

X Endangered or threatened species

X Fragmented habitat

Coldwater fish species are sensitive to small temperature changes. Research has shown that fish species shift their range to higher elevations, cooler waters in stream systems, and move at a rate related to the average climate velocity in a watershed. This project will identify velocity isotherms that will predictably cause a shift in the distribution of key fish species into higher elevations or cooler water areas as a function of climate change.

When restoration actions are implemented on priority streams, streambank and riparian improvements will reduce erosion and sediment loading. A healthier stream filters more pollutants, provides better habitat and protects down-gradient areas from flood and drought risk.

Providing access to critical habitats will require maintaining environmental flows if fish species are to reach spawning and rearing areas. A proper flow regime and removal of barriers to movement will de-fragment essential life stage habitat and allow migration and emigration into critical habitat areas. Successful utilization of spawning, early rearing, and adult rearing habitat requires habitat connectivity.

Threatened and endangered bull trout and state species of concern cutthroat trout will be the primary beneficiaries of identifying and protecting critical habitat. Allowing access to these areas will expand their range and provide opportunities for reintroduction of bull trout and their long-term survival.

Hydropower

Describe how the project makes the watershed (more/less) resilient to one or more of the following high priority hydropower vulnerability issues:

☐ Not applicable

X Reduced hydropower output

Identifying and maintaining fish passage to critical habitat areas will require thoughtful planning for future hydropower projects. Existing hydropower facilities may represent fish passage blocks to critical habitat identified by climate change modeling. In this case the ability to bypass the facility in relation to the value of the habitat above it and reduced hydropower output will have to be assessed as part of the prioritization process.

FMW-18: Fish Distibution Modeling in Relation to Climate Change

GHG Emissions Analysis

Project Construction Emissions

☒ The project requires non-road or off-road engines, equipment, or vehicles to complete. If yes:

Type of Equipment	Maximum Number Per Day	Total 8-Hour Days in Operation	Total $MTCO_2e$
Tractors/Loaders /Backhoes	1	10	3
			0
			0
			0
			0
			0
			0
			0
			0
			0
		Total Emissions	**3**

☒ The project requires materials to be transported from outside of the UFR watershed. If yes:

Total Number of Round Trips	Average Trip Distance (Miles)	Total $MTCO_2e$
1	170	**0**

☒ The project requires workers from outside of the UFR watershed. If yes:

Average Number of Workers	Total Number of Workdays	Average Round Trip Distance Traveled (Miles)	Total $MTCO_2e$
5	10	170	**3**

☐ The project is expected to generate GHG emissions for other reasons. If yes, explain:

☐ The project does not have a construction phase and/or is not expected to generate GHG emissions during the con phase.

FMW-18: Fish Distibution Modeling - Climate Change

Project Operating Emissions

☐ The project requires energy to operate. If yes:

Annual Energy Needed	Unit	Total $MTCO_2e$
	kWh (Electricity)	**0**
	Therm (Natural Gas)	**0**

☐ The project will generate electricity. If yes:

Annual kWh Generated	Total $MTCO_2e$
	0

*A negative value indicates GHG reductions

☐ The project will proactively manage forests to reduce wildfire risk. If yes:

Acres Protected from Wildfire	Total $MTCO_2e$
	0

*A negative value indicates GHG reductions

■ The project will affect wetland acreage. If yes:

Acres of Protected Wetlands	Total $MTCO_2e$
36	**-156**

*A negative value indicates GHG reductions

☐ The project will include new trees. If yes:

Acres of Trees Planted	Total $MTCO_2e$
	0

*A negative value indicates GHG reductions

GHG Emissions Summary

Construction and development will generate approximately:	6	$MTCO_2e$
In a given year, operation of the project will result in:	-156	$MTCO_2e$