



WESTERN NATIVE TROUT INITIATIVE

2015 Small Grants Program Grant Application Cover Sheet

Applicant Information

Lead Organization: Western Division American Fisheries Society

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Project Information

Project Title: WDAFS Special Workshop: Taxonomy and Evolutionary Biology of Cutthroat Trout

Native Trout Species Benefitted by Project: Cutthroat Trout

Total Project Budget: ~~\$24,000~~ 30,850

Total Amount Requested: \$ 3,000

Total Matching Funds or In-Kind Support Secured: \$

Project GPS Coordinates:

Project Start Date: Aug. 16, 2015

Project End Date: Aug. 20, 2015

Is your project listed in the U.S. Fish and Wildlife FONS system?

Yes / No No

Please indicate FONS Project Number (if applicable): _____

Project Components (select all that apply)

- ☐ Riparian or In-Stream Habitat Restoration
- ☐ Barrier Removal or Construction
- ☒ Watershed or Population Assessment
- ☐ In-Stream Flow Acquisition

- ☐ Land/Conservation Easement
- ☐ Monitoring
- ☒ Education/outreach
- ☒ Watershed Planning

Anticipated Outcomes (fill in values applicable to project)

- ___ # Stream Miles Restored or Enhanced
- ___ # Stream Miles Reconnected or Reopened
- ___ # Acres of Lake/Wetlands Restored/Enhanced
- ___ # Barriers Removed or Constructed

- ___ # Watersheds or Rivers Assessed
- ___ # Stream Miles Assessed
- ___ # Populations Assessed
- ☒ Other: Re-classification of cutthroat trout subspecies

Project Co-Sponsors and Contributions

U. S. Forest Service

Contact: Nathaniel Gillespie, ngillespie@fs.fed.us

\$7,000 cash contribution.

Region 6 Office, U.S. Fish and Wildlife Service

Contact: Pam Sponholtz, Pamela_Sponholtz@fws.gov

or Doug Fruge, doug_fruge@fws.gov

\$3,000 cash contribution.

International Federation of Fly Fishers (IFFF)

Contact: Richard N. Williams, V.P. Conservation West

\$1,500 cash contribution.

Washington State Council, IFFF

Contact: Carl Johnson, Council President

\$1,500 cash contribution.

California Department of Fish and Wildlife

Contact: Dave Lentz, Dave.Lentz@wildlife.ca.gov

\$2,000 cash contribution.

WDAFS Small Grant Program

Contact: Hilda Sexauer, WDAFS President

\$2,000 grant award.

Alaska Chapter, AFS

Contact: Phil Loring, ploring@alaska.edu

\$500 cash contribution.

Montana Chapter, AFS

Bruce Roberts, Chapter Secretary/Treasurer

\$1,000 cash contribution.

Trout Unlimited (TU)

Jack E. Williams, Senior Scientist, JWilliams@tu.org

\$600 cash contribution.

Oregon Council, TU

Thomas Wolf, Exec. Director, tmilowolf@msn.com

\$1,000 cash contribution.

Idaho Council, TU

Chris Jones, jpaul7@q.com

\$500 cash contribution.

Project Description and Summary of Anticipated Accomplishments

This project will 1) decide if the present 14-subspecies classification of Cutthroat Trout remains valid and defensible given the now available evidence, and 2) if it finds otherwise, define a new subspecies phylogeny that in the panel's judgment does satisfy the available evidence. A third panel objective will be to provide guidelines for what specific character descriptions and supporting information to include in new formal subspecies descriptions given the array of new DNA methodologies now available. For additions details, see attached pages.

Project Timeline**Start Date:** August 16, 2015**Completion Date:** August 20, 2015**Project Budget Description:**

Description of Service or Activity	Match Dollars	WNTI Grant Dollars
Time and Place: annual meeting rooms and audio-visual facilities; amount is separate from Workshop budget		
Reporting and transcription service for panel working sessions	\$2,400 budgeted, \$2,400 raised	
AFS annual meeting registration fees for expert panel members	\$7,450 budgeted, \$7,450 raised	
Travel, lodging and meal expenses for expert panel members	\$21,000 budgeted, \$10,750 raised	\$3,000
Budget Totals	\$30,850 budgeted, \$20,600 raised	\$3,000

Signature of Applicant*I certify that the above information is true and accurate to the best of my knowledge.***Print Individual Name:** Patrick C. Trotter**Organization Name:** Western Division American Fisheries Society**Signature:** Patrick C. Trotter**Date:** May 16, 2015.



American Fisheries Society

Western Division

President Hilda Sexauer, President-elect Jim Bowker, Vice-president Cleve Steward, Secretary-Treasurer Travis Neebling, Past-president Pam Sponholtz

Special Workshop—Evolutionary biology and taxonomy of the cutthroat trout (*Oncorhynchus clarkii*): Is it time to formally revise the currently recognized 14-subspecies biological classification of this species?

Purpose and Objectives of the Workshop

The purpose of this Special Workshop is to bring together a select panel of leading experts on trout evolutionary biology, systematics, and taxonomy to review and weigh carefully all evidence, both old and new, on which the present 14-subspecies biological classification of *Oncorhynchus clarkii*, as well as the several more recently proposed classifications of the species, are based. The panel's principal objectives will be to 1) decide if the 14-subspecies classification remains valid and defensible given the totality of the evidence; and 2) if it finds otherwise, define and provide the rationale for a new subspecies phylogeny that in its collective judgment does satisfy both the old and newer evidence. A third panel objective will be to provide guidelines to those who may be charged with writing new formal subspecies descriptions as to what specific character descriptions and supporting information to include, given the array of new DNA-based methods now coming into play.

This Workshop will be staged as a special sponsored project of the Western Division American Fisheries Society (WDAFS), and will be held in conjunction with its 2015 joint annual meeting with the parent Society in Portland, Oregon.

The panel will produce a manuscript of its proceedings that will include its findings on the objectives above, as well as all reviews and deliberations of the evidence presented to and considered by the panel, along with the new guidelines for what to include in formally describing subspecies. We propose to seek publication of this manuscript by the parent AFS organization either in its AFS Symposium Series, its Monograph Series, or as a Special Publication. A summary of the findings of the Special Workshop may also be prepared for publication in *Fisheries*, the monthly AFS journal, or in the open-access journal *Zootaxa*.

Justification for the Workshop

Ever since it was first published by the late R.J. Behnke in 1979, a classification consisting of 14 subspecies (12 extant, 2 extinct) has been recognized for the species *O. clarkii* (Behnke 1979, 1988, 1992, 2002). Behnke wrote that he adhered to the biological species concept of Mayr (1969, see also Mayr and Ashlock 1991), and based his classification on an evolutionary history and sequence of radiations first proposed by David Starr Jordan back in 1894. Jordan (1894) believed that ancestors of all

modern Cutthroat Trout traveled up the Columbia and Snake Rivers. From there they reached the Lahontan and Bonneville Basins, the Yellowstone River, the Green and Colorado Rivers, and then, via headwater transfers, the basins of the South Platte, Arkansas, and Rio Grande Rivers. Behnke believed that much of the present diversity, especially at the subspecies level, is the result of events that occurred in the last million years (Behnke 1992). He utilized the fossil record and early chromosome studies, but relied on meristic character differentiation to hone his classification. Although differences of opinion did occasionally arise, he believed that the later allozyme electrophoresis, mtDNA, and VNTR marker studies such as microsatellites largely corroborated his classification (Behnke 1992).

However, workers examining levels of genetic divergence and diversity among subspecies using more recently developed DNA sequence-based methods and a phylogenetic species concept (see Avise 2000) have increasingly called the validity of this classification into question. Also, management agencies charged with making listing decisions and executing recovery actions under the Endangered Species Act (ESA) have increasingly been lumping subspecies together on their own, without input from taxonomists, but citing these newer DNA studies as justification for doing so.

For example, in 2001, the U.S. Fish and Wildlife Service lumped the Fine-Spotted Snake River Cutthroat, a separate subspecies in the Behnke classification, together with the Yellowstone subspecies as a single distinct population segment (DPS) when it issued its decision not to list the Yellowstone Cutthroat as threatened under the ESA (Kaeding 2001). The Service based its decision on the lack of genetic distinction found in allozyme and mtDNA markers. A spokesman for the Service later wrote that the Service considers the Yellowstone Cutthroat to comprise but a single DPS everywhere across the subspecies range including the Fine-Spotted Snake River enclave, and that taxonomic validation of the Fine-Spotted Snake River Cutthroat as a separate subspecies was the role of taxonomists, geneticists, and other qualified scientists, not the Service (Kaeding 2006). So the question remains, are there two subspecies in that area as per Behnke's classification, or are these two forms merely spot-size and ecological variants of a single Yellowstone Cutthroat subspecies as the Fish and Wildlife Service and the other management agencies treat them? In 2006, the Idaho Chapter AFS held a symposium to tackle this question, but reached no resolution (Van Kirk et al. 2006).

In the Lahontan and Willow/Whitehorse basins of the Great Basin region, what Behnke recognized as three subspecies based on morphological and meristic character distinctions (i.e., the Lahontan subspecies of the western part of the basin, the Humboldt subspecies in the eastern part of the basin, and the Willow/Whitehorse subspecies in its own contiguous basin) have been lumped into just one subspecies, the Lahontan (ESA-listed), based largely on results from mtDNA methods (Coffin and Cowan 1995). Is this really justified, based on the totality of evidence? A fourth similar-appearing subspecies now believed extinct in pure form existed in the contiguous Alvord basin; would this subspecies also be lumped with the Lahontan? And how should the long-recognized but rare (and also ESA-listed) Paiute Cutthroat subspecies fit into this classification? It is also a western Lahontan Basin subspecies. Based on the DNA evidence available to date (Nielsen and Sage 2002; Peacock and Kirchoff 2004), there is about the same amount of genetic divergence between the Paiute and western-basin Lahontan as there is between the western-basin Lahontan and Humboldt forms that the agencies have already lumped into one. So again, is this lumping justified based on the totality of evidence, and if so, should it be extended to also absorb the rare Paiute subspecies?

Most recently, mtDNA and microsatellite DNA studies of the Cutthroat Trout of Colorado (Evans and Shiozawa 2001; Metcalf et al. 2007) raised doubts about the genetic purity of Colorado River and Greenback Cutthroat populations being used in recovery programs, and effectively stalled the recovery program for the ESA-listed Greenback subspecies. Then, in 2012, came a publication that makes a case

for seven subspecies (two extinct) in the southern Rocky Mountain region historically rather than the four subspecies (one extinct) we have long recognized from Behnke's classification, but with substantially different distributional boundaries, particularly for the Greenback (Metcalf et al. 2012; see also Bestgen et al. 2013). In 2013, the Fish and Wildlife Service convened a panel of taxonomic experts similar to the one being proposed here to examine this latest evidence with a focus on the taxonomic status of just the Colorado subspecies (see AMEC [2014] for that panel's findings). That panel serves as a model for the much broader Special Workshop we propose here.

These examples illustrate the extent to which lumping (or in the Metcalf et al. [2012] case, splitting) of Cutthroat Trout subspecies has either been proposed or put into practice without regard for recognized taxonomic classification in recent years. Three additional papers, one published in 2009 and the other two in 2012, but each based on DNA sequence comparisons of mitochondrial gene segments, offered revised subspecies classifications of *O. clarkii* (Wilson and Turner 2009; Loxterman and Keeley 2012; Houston et al. 2012). Wilson and Turner's (2009) results support Behnke's original classification in part, but they do group Behnke's Lahontan, Paiute, Humboldt, and Willow-Whitehorse subspecies together as a single Lahontan subspecies, and they do consider the Fine-Spotted Snake River and Yellowstone subspecies to be just one subspecies, the Yellowstone. Loxterman and Keeley (2012) propose an 8-clade classification for the extant subspecies, in which the Coastal, Westslope, Colorado River, Greenback, and Rio Grande subspecies are the same as Behnke's, but, like Wilson and Turner (2009), their Lahontan clade now includes Behnke's Lahontan, Paiute, Humboldt, and Willow-Whitehorse subspecies. But these authors propose two new clades: a Bonneville-Yellowstone clade that includes the majority of Bonneville Cutthroat sampling locations plus all the Yellowstone and Fine-Spotted Snake River Cutthroat locations; and a distinct Great Basin clade that comprises the remainder of the Bonneville locations that did not cluster with the Yellowstone. This new Great Basin clade appeared to the authors to be more closely related to the Colorado River clade than to the other Bonneville-Yellowstone clade, but nevertheless they considered it a distinct subspecies (Loxterman and Keeley 2012). The paper by Houston et al. (2012) was focused on discovering diagnostic single nucleotide polymorphisms (SNPs) for each subspecies, but in so doing these authors proposed a 10 subspecies classification for the extant subspecies. Like Behnke, they recognized the Coastal, Westslope, Colorado River, Greenback, and Rio Grande forms as distinct subspecies, and they also recognized the Lahontan of the western basin and Humboldt of the eastern basin as distinct subspecies. But unlike Behnke, they folded the Paiute subspecies into the western basin Lahontan subspecies owing to genetic similarity, and the Willow/Whitehorse form into the Humboldt subspecies as Trotter and Behnke (2008) had done earlier. They also lumped the Fine-Spotted Snake River form together with the Yellowstone as a single Yellowstone subspecies. As for the Bonneville subspecies, they recognized it as a distinct subspecies but split out the Bear River strain, which they set apart as its own distinct subspecies (Houston et al. 2012).

The bottom line from these three papers is that each of these newly proposed classifications shows some congruence with Behnke's original classification of *O. clarkii*, but not always the same congruence; and, where they differ from Behnke's classification, they also differ among themselves as to what the new subspecies classification should be. These differences highlight issues that beg resolution in a Special Workshop setting.

And finally, we point to a paper published in 2002 that proposed an entirely different evolutionary history and sequence of radiation for the modern cutthroat subspecies—one centered around an inland, Bonneville Basin origin of Cutthroat Trout much earlier in geological time than Behnke had believed, followed by an outward radiation of the various Cutthroat lineages that spanned about the last 4 million years (Smith et al. 2002). The authors of this paper reached their conclusions from their own

interpretation of the fossil record coupled with mtDNA analysis of modern specimens and molecular clock estimates of divergence times based on that analysis. Although this work did not offer a new classification for the species, it did challenge Jordan's basic evolutionary and radiational history assumptions that provided the underpinning for Behnke's classification.

These examples highlight issues that have cropped up in recent years regarding the proper biological classification of the Cutthroat Trout species. All could have direct bearing on ESA listings and recovery programs, in addition to their importance for land and aquatic habitat managers, fisheries managers, and scientists engaged in research on cutthroat trout. We submit that these are all issues that should be addressed and resolved by experts in trout taxonomy in face-to-face working sessions, not by operating remotely from one another or by corresponding back and forth via the scientific journals. We believe it is high time that a panel of such experts is convened to critically review all the evidence and, if deemed necessary, come up with a new, agreed-upon classification at the subspecies level for the entire Cutthroat Trout species. As noted above, the Fish and Wildlife Service convened a panel to consider the taxonomy of the Cutthroat Trout of the southern Rocky Mountain region. The findings of that panel will be incorporated into the deliberations of this Workshop as well.

Nature, Organization, and Staging of the Workshop

This Special Workshop will be held at the same time and place as the 2015 WDAFS annual meeting in Portland, Oregon, and will run concurrently with that meeting. It will be staged in two parts. Part 1 will be a 1-day symposium session consisting of 16 invited presentations of 20-minute or 40-minute duration depending on the nature and depth of the material being presented. These presentations are intended for the edification of the Special Workshop panel members, but, since this part of the Special Workshop is scheduled as an annual meeting symposium session, the session will be open to all registered annual meeting attendees who may ask questions and offer comments just as they would at any other annual meeting symposium.

Part 2 of the Special Workshop will follow the symposium session, and will consist of a series of panel work sessions, spanning 1.5 days, in which the 16 panelists will deliberate on the evidence, resolve the issues involved, and reach the three earlier-stated Special Workshop objectives. These will be closed sessions with only the invited panelists and session moderators taking part.

The core of this Special Workshop will be the select panel of leading scientists with expertise in paleogeology, evolutionary biology, phylogenetics, and taxonomy that bears responsibility for accomplishing the objectives and completing the work products of the Workshop. Most of the individual panelists will also be presenters of the 16 papers comprising the Part 1 symposium session. The presentations themselves will be detailed reviews of the evidence on which both the currently recognized and more recently proposed classifications of Cutthroat Trout subspecies are based, including individual presentations of: 1) evidence from landscape and river drainage changes over geological time; 2) evidence revealed by the fossil record; 3) evidence from studies of chromosome evolution in salmonids and within the Cutthroat species; 4) evidence from morphological and meristic character measurements; 5) evidence from allozyme electrophoresis studies; 6) evidence from DNA studies ranging from early mitochondrial DNA restriction fragment length polymorphisms (RFLPs) and studies utilizing VNTR markers such as microsatellites, to evidence based on the newer DNA sequence-based molecular taxonomy methodologies. Presentations from a principal author of each of the most recently proposed classifications, i.e., Wilson and Turner (2009), Loxterman and Keeley (2012) and Houston et al. (2012) will also be invited, and the findings of the Fish and Wildlife Service's 2013 workshop on the southern Rocky Mountain subspecies will also be presented. Invited presentation on species and subspecies

concepts and on naming conventions under the international rules of zoological nomenclature will also be delivered.

Panel Members and Presenters

Leading experts from a list of known experts compiled and vetted by the organizers were invited to sit as the Special Workshop's core panel. Our panelists include several individuals who also participated in the 2013 Fish and Wildlife Service workshop, and one of those experts will present that workshop's findings in our symposium session. Our expert panelists include: R. Mayden, St. Louis University; P.K. Link, Idaho State University; R. Stearley, Calvin College; G.R. Smith, University of Michigan, emeritus; G. Thorgaard, Washington State University; K. Bestgen, Colorado Dept. of Wildlife and Parks; R. Leary, University of Montana; D. Shiozawa, Brigham Young University; A. Martin, University of Colorado; M. Douglas, University of Arkansas; M. Young, U.S. Forest Service; E. Keeley, Idaho State University; M. Campbell, Idaho Fish and Game Dept.; C. Ferraris, California Academy of Science, retired; D. Markle, Oregon State University, emeritus; and K. Rogers, Colorado Dept. of Parks and Wildlife. In addition, we will be assisted by R.P. Evans, Brigham Young University and L. Schultz, Oregon State University and Chairman, WDAFS Western Native Fishes Committee.

Cost Estimates

The Fish and Wildlife Service compensated its invited participants for travel, lodging, and per diem expenses. Because they will be asked to spend significant time and effort in our Special Workshop and will be expected to deliver one or more work products, we propose to do likewise for our panelists and invited presenters. We expect that this item will be the major expense for staging this Workshop.

Cost for facilities, audio-visual, and other time-and-place support.	Provided by WDAFS
Special recording and transcription services =	\$2,400
AGM registration for Workshop panelists =	\$7,450
Compensation for invited Workshop panelists.	
Lodging, and meal costs for 5 days est. from GSA per diem rates =	\$15,000
Round-trip air fare, est. major cities closest to invitees to Portland =	\$6,000
	Total = \$30,850
Publication costs for Workshop proceedings.	Unknown at this time.

Special Workshop Planning Committee

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Consulting fishery biologist, retired	USDA Forest Service, retired	USDA Forest Service
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References Cited

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