



R & E Grant Application 13-15 Biennium

Project #:
13-055

Assessing hatchery-wild hybridization in steelhead

Project Information

R&E Project Request: \$66,454.00
Match Funding: \$103,361.00
Total Project: \$169,815.00
Start Date: 6/1/2014
End Date: 6/30/2015
Project Email: Marc.Johnson@oregonstate.edu
Project Biennium: 13-15 Biennium
Organization: ODFW - Corvallis Research Lab

Applicant Information

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Past Recommended or Completed Projects

This applicant has no previous projects that match criteria.

Project Summary

This project is NOT part of ODFW's 25 Year Angling Plan.

Activity Type: Research

Summary: Since 1966, summer steelhead have been produced by ODFW hatcheries in the upper Willamette River (UWR) to support a recreational harvest program and mitigate for impacts from USACE operated flood control dams. Summer steelhead are not native to the UWR and a recent study now suggests that this stock can hybridize with native, ESA-listed winter steelhead. However, the extent and location(s) of hybridization remain unclear because most sampling occurred at Willamette Falls and not within UWR subbasins. We propose to collect steelhead tissue samples and develop genetics-based research to provide accurate estimates of hybrid fractions in UWR tributaries. This work will provide information necessary to manage risk from hatchery summer steelhead in the UWR, consistent with the recovery plan goal to conserve and recover winter steelhead while maintaining maximum angling opportunities.

Objectives: This project has four main objectives: 1) collection of field samples

adequate to assess steelhead genetics in the study area; 2) genetic marker assessment; 3) estimation of hybrid fractions within steelhead populations, and 4) dissemination of results. Each of these objectives is described in detail below.

Objective 1. Data collection – ODFW staff will non-lethally collect tissue samples from adult winter and summer steelhead. These samples of known adult run timing will serve as the “baseline” for subsequent genetic analyses of “unknown” juvenile samples. About 100 adult samples will be required from each major group of the genetic baseline (see Johnson et al. 2013). ODFW staff will also sample juvenile steelhead in major upper Willamette River tributaries (e.g. McKenzie, South Santiam, North Santiam and Middle Fork Willamette rivers). We will use a stratified random sampling approach, with target juvenile sample sizes of $n=100$ per subbasin to provide accurate, unbiased estimates of summer steelhead hybridization rates in each subbasin.. Juvenile fish will be captured with pole seines, a portable electrofisher, and other methods amenable to site conditions. After tissue has been collected, juvenile fish will be released.

Objective 2. Genetic marker assessment – Adult steelhead of known run type (summer and winter) will be used to verify the diagnostic power of single nucleotide polymorphism (SNP) genetic markers. Preliminary analyses suggest that these markers can provide exceptionally strong diagnostic power for summer and winter steelhead in other Oregon river systems. Diagnostic markers will then be used to estimate hybrid fractions among juvenile steelhead collected from Willamette River tributaries.

Objective 3. Estimate hybrid fractions within steelhead populations – Tissue samples from juvenile steelhead collected throughout the Willamette River basin will be characterized at a suite of SNP genetic markers. Genetic data will then be

analyzed to produce spatially-explicit estimates of summer steelhead hybridization rates for each tributary.

Objective 4. Disseminate results – We will develop a report to describe the level of hybridization between hatchery summer steelhead and native winter steelhead observed at various study locations. This report will be provided to ODFW management, the Restoration and Enhancement Board and made available online. We will also present our results at state and regional meetings and conferences.

Fishery Benefits:

The upper Willamette summer steelhead hatchery program produces fish for recreational harvest in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette rivers. This hatchery program uses a segregated broodstock approach, which aims to minimize genetic interactions with native fish. From 583 samples of unmarked juvenile steelhead collected during three years at Willamette Falls, Johnson et al. (2013) reported that over 10% of the naturally produced steelhead outmigrating from the upper Willamette basin were summer-winter steelhead hybrids. This degree of hybridization exceeds an acceptable level of genetic risk from the upper Willamette summer steelhead hatchery program and threatens the continuation of this program as currently managed. Relatively few samples were collected during a single year from the Middle Fork Willamette and Santiam rivers, limiting managers' ability to identify where program changes would be most effective to reduce risk – and where current management adequately safeguards against genetic interactions between the hatchery and wild populations.

Our project will provide ODFW managers and the angling public with spatially explicit information regarding the level of genetic risk from this program to native fish species. This information can then be used by ODFW management to direct actions that reduce genetic risk from upper Willamette summer steelhead, so as to promote the health of native steelhead and trout populations, while providing a popular harvest fishery in the upper Willamette River. We emphasize that our findings will not necessarily indicate need for an overall reduction to the steelhead hatchery program, but may instead identify where “shifts” in hatchery production among subbasins or other actions would most effectively reduce risk.

Watershed Benefits: The first goal of ODFW hatchery management policy is to “foster and sustain opportunities for sport, commercial and tribal fishers consistent with the conservation of naturally produced native fish” (ODFW 2010; emphasis added). Our project will provide information needed to evaluate whether the summer steelhead hatchery program meets this goal, in its entirety, in major watersheds of the upper Willamette River. This information may be used to guide management actions that will provide enhanced angler opportunities with acceptably low risks to native, ESA-listed fish.

Current Situation: The proposed work will not physically alter site conditions. ODFW staff will collect samples using standard methods (e.g. seining, electrofishing, etc.) without producing major disturbances or impacts to non-target species. Genetic analyses will be performed at Dr. Michael R. Miller's research laboratory at University of California, Davis (<http://animalscience.ucdavis.edu/faculty/miller/>).

Alternatives: Molecular genetic analyses provide an unequivocally powerful tool for research projects, such as ours, which aim to estimate hybridization rates between populations. Steelhead can be particularly difficult to observe in large river systems, and our approach provides major advantages over conventional field methods. It is the only available method to positively confirm and quantify genetic interactions between hatchery and wild steelhead in the upper Willamette River.

Designer: Dr. Marc A. Johnson will design this research project in partnership with other research team members.

Methods: Methods for Objective 1 . Field sampling – ODFW staff will (non-lethally) collect tissue samples from adult winter and summer steelhead from the upper Willamette River. These samples of known adult run timing will serve as the “baseline” for subsequent genetic analyses of “unknown” juvenile samples. About 100 samples will be required from each baseline group (i.e. eastern Willamette winter steelhead, western Willamette winter steelhead, hatchery summer steelhead, and resident rainbow trout; see Johnson et al. 2013.) for the genetic baseline. ODFW staff will then collect tissue samples from juvenile steelhead in upper Willamette River subbasins (e.g. Luckiamute, Mary's, McKenzie, South Santiam, North Santiam and Middle Fork Willamette rivers). We will use a stratified random sampling approach, similar to that used to survey Oregon coastal coho (Jacobs and Nickelson 1989), with target juvenile sample sizes of n=100 per subbasin. This sampling design is intended to provide samples for accurate, unbiased estimates of summer steelhead hybridization rates in each Willamette River subbasin. Juvenile fish will be captured with pole seines, a portable electrofisher, and other methods amenable to site conditions, then temporarily anaesthetized with MS-222. A small piece of caudal fin tissue will be collected and stored in a labeled vial, filled with 95% ethanol. Once sampled, juvenile fish will be released.

Methods for Objective 2. Genetic marker assessment – Restriction-site-associated DNA sequencing will be used to identify diagnostic SNPs for steelhead of known run type (i.e. adult summer and winter steelhead), through a method similar to that described by Hale et al. (2013). This work is currently in progress at Dr. Michael Miller's laboratory (UC Davis). Diagnostic markers will then be used to estimate hybrid fractions among juvenile steelhead collected from Willamette River tributaries.

Methods for Objective 3. Estimate hybrid fractions within steelhead populations – DNA will be isolated from fin tissue samples of juvenile steelhead collected throughout the Willamette River basin. We will characterize these samples at a suite of ~100 SNP genetic markers. We will then use the software STRUCTURE (Pritchard et al. 2000) and hybrid classification methods similar to those of Johnson et al. (2013) to produce spatially-explicit estimates of summer steelhead hybrid fractions for each Willamette tributary.

Methods for Objective 4. Disseminate results – We will develop a report to describe the level of hybridization between hatchery summer steelhead and native winter steelhead observed at various study locations. This report will be reviewed by ODFW management, the Restoration and Enhancement Board and at least one third-party agency before dissemination to the general public. After review, the report will be made available online and will be further developed into a manuscript for publication in the peer-reviewed scientific literature. We will also present our findings at a state and/or regional fisheries biology meeting(s), such as the annual Oregon AFS meeting.

Citations

Hale, M. C., F. P. Thrower, E. A. Berntson, M. R. Miller, and K. M. Nichols. 2013. Evaluating adaptive divergence between migratory and nonmigratory ecotypes of a salmonid fish, *Oncorhynchus mykiss*. *Genes, Genomes, Genetics* 3:1273-1285.

Jacobs, S. E. and T. E. Nickelson. 1998. Use of stratified random sampling to estimate the abundance of Oregon coastal coho salmon. Final report to the U.S. Fish and Wildlife Service. Project number F-145-R-09. Oregon Department of Fish and Wildlife, Corvallis. Available at <http://oregonstate.edu/dept/ODFW/spawn/pdf%20files/reports/SRS.PDF> (November 2013).

Johnson, M. A., T. A. Friesen, D. J. Teel, and D. M. Van Doornik. 2013. Genetic stock identification and relative natural production of Willamette River steelhead. Final report to the US Army Corps of Engineers, Portland District. Task Order W9127N-10-2-0008-0015. Oregon Department of Fish and Wildlife, Corvallis. Available at <http://oregonstate.edu/dept/ODFW/willamettesalmonidrme/hatchery-publications> (November 2013).

ODFW (Oregon Department of Fish and Wildlife). 2010. Fish Hatchery Management Policy. Available at http://www.dfw.state.or.us/fish/hatchery/docs/hatchery_mgmt.pdf (November 2013).

Pritchard, J.K., M. Stephens and P. Donnelly. 2000. Inference of population structure using multilocus genotype data. *Genetics* 155: 945-959.

Inspector: The project report will be reviewed internally by ODFW managers, a third-party agency and the Restoration and Enhancement Board before distribution to the general public.

Funding Elements: As related to project objectives, we request funds from Restoration and Enhancement for some project elements, as described below:

1. Field sampling (R&E funding requested)

We request support for two ODFW Experimental Biology Aides for six months each: field sampling

We request support for one month's salary for one project administrator* (Tom Friesen - ODFW): project coordination, contracts and report development

2. Genetic marker assessment (NO R&E FUNDING REQUESTED; all work provided in-kind)

Support for RAD sequencing: match or other

3. Estimate hybrid fractions (R&E funding requested)

We request support for 1 month's salary for technical analyst* (Marc Johnson - ODFW): data analysis

Support for genotyping juveniles: match or other

4. Disseminate Results (R&E funding requested)

We request support for 1 month's salary for technical analyst* (Marc Johnson - ODFW): report development

*NOTE: The PEM-D (administrator) and NRS-3 (technical analyst) positions described above are Limited Duration ODFW positions supported entirely through per project "soft" funding. Funding is required for their participation in this project.

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|-----------------------------|--|
| Partners: | No |
| Existing Plan: | No |
| Affected Contacted: | Yes |
| Affected Supportive: | Yes |
| Affected Comments: | We have contacted ODFW District Biologists, Jeff Ziller and Elise Kelley, about this project. Steelhead tissue samples will be collected from rivers and streams in their districts. They are supportive of this research and we expect the results to help inform their management of steelhead populations in the Mid-Willamette and Upper Willamette watershed districts. |

Project Schedule/Participants/Funding

| Activity | Date | Participants |
|---------------------------------------|-----------|--|
| Field sampling | 6/1/2014 | ODFW Experimental Biology Aides (two - TBD) |
| Genotyping and analyses | 11/1/2014 | Dr. Michael R. Miller (UC Davis) |
| Data analysis and report development | 2/1/2015 | Dr. Marc A. Johnson (ODFW; Oregon State Univ.) |
| Administration and report development | 6/1/2014 | Thomas A. Friesen (ODFW) |

Affected Species:

Rainbow Trout
Steelhead

Project Permits

| Name | Issued By | Secured? | Date Secured | Date Expected |
|----------------------------------|-----------|----------|--------------|---------------|
| ESA Section 7 Take Authorization | NMFS | No | 1/1/0001 | 5/21/2014 |
| Oregon Scientific Take Permit | ODFW | No | 1/1/0001 | 5/21/2014 |

Project Monitoring

This project has no monitoring.

Project Maintenance

This project has no maintenance plans.

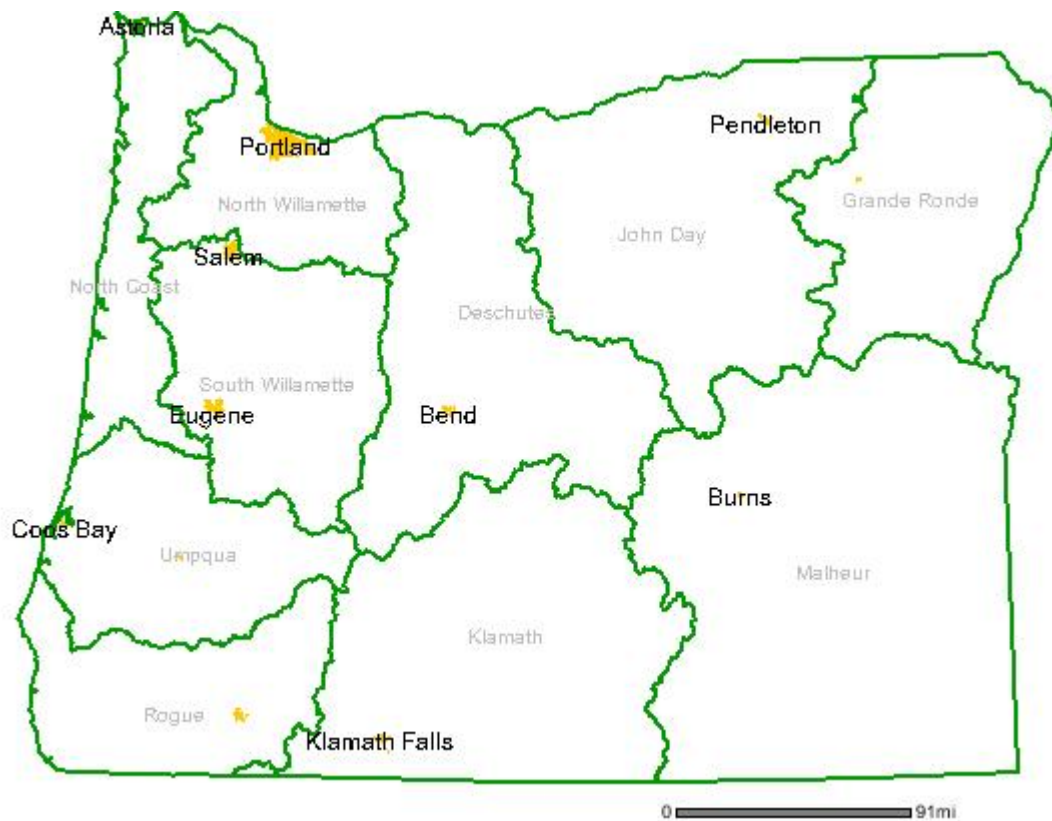
Project Match Funding

| Funding Source | Cash | In-Kind | Other | Description | Total | Secured? | Conditions? | Comments |
|-----------------------|-------------|--------------|--------|--|--------------|----------|-------------|---|
| R&E Request | \$66,454.00 | \$0.00 | \$0.00 | ODFW Corvallis Research will provide field sampling equipment (pole seines, electrofisher, scales, etc.) | \$66,454.00 | No | No | |
| Miller Lab - UC Davis | \$0.00 | \$103,361.00 | \$0.00 | Genetic lab analyses of steelhead samples | \$103,361.00 | Yes | No | All lab work will be performed with in-kind support or match funds to be obtained |
| | | | | Total Match Funding: | \$169,815.00 | | | |

Project Budget

| Item | Item Type | Units | Unit Cost | R&E Funds | Match Funds | Total |
|--|------------------------------|-------|-------------|-------------|---------------|--------------|
| UC Davis overhead | Administration | 1 | \$15,393.41 | \$0.00 | \$15,393.41 | \$15,393.41 |
| Dr. Miller summer salary and benefits | Personnel | 1 | \$9,167.59 | \$0.00 | \$9,167.59 | \$9,167.59 |
| Graduate student academic stipend and benefits | Personnel | 1 | \$11,900.00 | \$0.00 | \$11,900.00 | \$11,900.00 |
| Graduate student summer stipend and benefits | Personnel | 1 | \$7,500.00 | \$0.00 | \$7,500.00 | \$7,500.00 |
| ODFW EBA; field sampling | Personnel | 4 | \$3,968.25 | \$15,873.00 | \$0.00 | \$15,873.00 |
| ODFW NRS-3; Data analysis, report development | Personnel | 2 | \$7,985.00 | \$15,970.00 | \$0.00 | \$15,970.00 |
| ODFW PEBA; field sampling | Personnel | 4 | \$4,416.00 | \$17,664.00 | \$0.00 | \$17,664.00 |
| ODFW PEM-D; contracts and report development | Personnel | 1 | \$8,683.00 | \$8,683.00 | \$0.00 | \$8,683.00 |
| Cell phone charges | Supplies/Materials /Services | 4 | \$60.00 | \$240.00 | \$0.00 | \$240.00 |
| Field gear (waders, boots, uniforms, buckets) | Supplies/Materials /Services | 1 | \$2,000.00 | \$2,000.00 | \$0.00 | \$2,000.00 |
| Genetic analysis for hybrid tests - baseline & unk | Supplies/Materials /Services | 3000 | \$15.00 | \$0.00 | \$45,000.00 | \$45,000.00 |
| Genetic analysis for marker selection | Supplies/Materials /Services | 192 | \$75.00 | \$0.00 | \$14,400.00 | \$14,400.00 |
| Office supplies | Supplies/Materials /Services | 1 | \$500.00 | \$500.00 | \$0.00 | \$500.00 |
| Vehicle, state motor pool; lease, fuel, service | Supplies/Materials /Services | 4 | \$1,256.00 | \$5,024.00 | \$0.00 | \$5,024.00 |
| Vials, labels and ethanol for samples | Supplies/Materials /Services | 1 | \$500.00 | \$500.00 | \$0.00 | \$500.00 |
| | | | | | Total Budget: | \$169,815.00 |

Project Map



Additional Files

Click a link to view that particular file.

[Letter of Support](#)

[Letter of Support](#)

[Signature Authorization Page](#)

[The Real Project Map](#)