PeerJ review Revision

Growth of Lahontan Cutthroat Trout from multiple sources re-introduced into Sagehen Creek, CA

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This revised paper is a significant improvement on the first version! However, the revised sections often do not flow well with the unedited original text and as a result the manuscript reads like it was cut and pasted together, this needs to be smoothed out. That said I think the take home message that both strains have a role in recovery of this species in the Truckee River watershed is solid. Indeed the work done on migratory and life history strategies as well as metapopulation dynamics in the large interconnected multiple order stream systems that remain occupied by this subspecies (Dunham et al. 1997; Neville et al. 2006, 2016) suggests that population viability and long term occupancy was driven historically by such life history variation. Although we do not have early 20th century historical samples for Independence Lake, the comparison of genetic data for contemporary Independence Lake population with that of Lake Tahoe and Pyramid Lake museum samples from 1911 suggest interbreeding between the Lahontan cutthroat trout in Independence Lake with the larger Pilot Peak strain, which occupied Lake Tahoe and Pyramid Lake, was likely infrequent. This result is consistent with population genetic structure that has been documented in other Lahontan cutthroat trout watersheds and indeed other cutthroat trout subspecies. The back story here is that there has been a push by some in the USFWS to use one strain over the other for all recovery activities in the Lake Tahoe basin and I suspect this may have been part of the motivation to conduct this study. Although there are some valid concerns with the experimental design the authors do show that the Independence strain grew faster and gained more weight on average compared to the Pilot Peak strain and Austin Meadows trout under their experimental conditions. I think it is important to place their results squarely in the context of life history variation and movement/metapopulation dynamics for this subspecies and their importance for recovery of the historic dynamic.

Abstract

Lines 23-25. Need to clarify that these are hatchery stocks derived from native fish from the Truckee River basin and are used for recovery activities in the western GMU only, specifically the Truckee River basin.

Line 28. the source population for the fish in Austin Meadows remains unclear.

Introduction

Line 47. Pluvial Lake Lahontan ebbed and flowed throughout the Pleistocene and the high stand was actually 650 kyr BP – see Reheis et al. 2002.

Line 51. Don't use "e.g." as Pyramid and Walker are the only remnants of the pluvial lake not just an example of remnant lakes use "i.e."

Lines 54-55. It would be worth it to add a sentence or describing the entire distribution which includes two large river systems the Quinn and Humboldt Rivers. Although the Quinn River was inundated periodically by the pluvial lake, the Humboldt River was not and so retained fluvial forms of LCT.

Line 65. It is not just California – and there are three hatchery strains of LCT used for recovery – contemporary Pyramid Lake strain which is derived from Summit Lake in addition to Pilot Peak and Independence lake hatchery strains. And the main source of Pilot Peak strain is the Lahontan National Fish Hatchery at Garnerville in Nevada.

Lines 65-66. You need to make the distinction here that Independence and Pilot Peak hatchery stocks are for western basin (where all of the lake habitat exists) recovery activities not for range wide reintroductions in keeping with the GMU designations.

Line 73. Add here that the hybrids you are referring to are rainbow x cutthroat hybrids.

Line 74. Add that Sagehen and Independence are neighboring watersheds and historically fish could move between them.

Line 75. Genomic distinctiveness among what subpopulations specifically – Independence and Pilot? Need to clarify what populations you are talking about here – rangewide or Truckee River specifically. If rangewide then the term subpopulation does not fit.

Line 83. Delete "in the world" replace with "within the historic range". Change to "the other being mesotrophic Summit Lake found in the Northwest Lahontan basin GMU"

Lines 84-85. Hybridization due to recent incursion by rainbow trout as a result of dam maintenance.

Line 93. Lahontan misspelled

Line 94. "Fish and Wildlife (CDFW) in Mammoth Lakes, CA" Are you talking about June Lake. Odd that you mention this source but not Independence Lake LCT in Heenan Lake where they have been for decades managed by CDFW.

Lines 111-114. here instead of juxtaposing the two strains the point should be made that the life history variation (migratory versus resident; lacustrine versus fluvial) should be taken into consideration when formulating recovery strategies

Lines 113-115. Add that Sagehen Creek was ultimately connected to the mainstem Truckee River prior to construction of the Stampede and Boca dams.

Methods

Lines 193-194. Earlier in the manuscript you state that the genetic data support a Lake Tahoe and/or Pyramid Lake origin for the Pilot Peak strain. Here you say "Pilot Peak fish are presumed pure Pyramid Lake stock". This needs to be updated.

Paragraph starting at line 200. Add verbiage explaining why Pilot Peak fish were transferred to net pens at June Lake and the Independence fish were not. This is potentially confounding.

Line 229. Move the sentence that begins with “Mesh barriers…” here

Lines 235-236. This is vague – what ecosystems are you talking about?

Line 259. Robert got these numbers for densities while working on a PVA project at UNR. The density data for LCT for a large number of populations (including Frazer and Gance creeks) is now published in Wenger et al. 2017. Viability analysis for multiple populations. Biological Conservation 216:69-77.

Line 261. Jason Dunham published a paper on self-thinning a number of salmonids including Lahontan cutthroat trout - Dunham JB and G. Vinyard. 1997. Relationships between body mass, population density, and the self-thinning rule in stream-living salmonids. Can. J. Fish. Aquat. Sci. 54: 1025–1030 (1997). I would cite this here instead of Schroeter personal communication

Line 287. Replace “in” with “into”

Line 293. What are “hard parts” otoliths?

Line 298. Define “secondary production patterns”

Lines 320-321. replace “mostly normal” with “mostly normally distributed”

Line 325. write out standard length before using the abbreviation SL

Results

Line 346. You need to include a table with the lengths and weights for all individual fish identified by strain at the beginning and end of your study.

Lines 349-350. “did not differ in weight or length for any stocks examined before versus after experiments” This is confusing. Are you saying the data were normally distributed prior to and after the experiment? If so say that.

Discussion

Lines 404-410. First it is Vinyard not Vineyard so these citations need to be corrected. Second, the Dickerson and Vinyard experiment was examining upper thermal tolerance and the temperature the trout were exposed to (24 C) is close to the upper thermal limit of 26 C. You cannot use this study to support the statement “thus early life-growth is a predictor of mortality risk for juvenile Lahontan Cutthroat Trout and useful in evaluating relative success of reintroduced strains.” The fish in the experiment were in a purposeful stressful environment the fact that they did not grow in such an experimental condition has no bearing on your experimental design – none.

Lines 413-414. “However vigorous growth of Independence Lake fish suggests some individuals adjusted to novel conditions over the experiment.” Without the data on length and weight for each of the strain prior to the experiment – I have no clue if the vigorous growth had to do with age and size or strain. To control for this the fish would have to have been similarly sized across all three groups. Figure 3 looks like it might contain these data but the figure legend does not identify which panels represent which

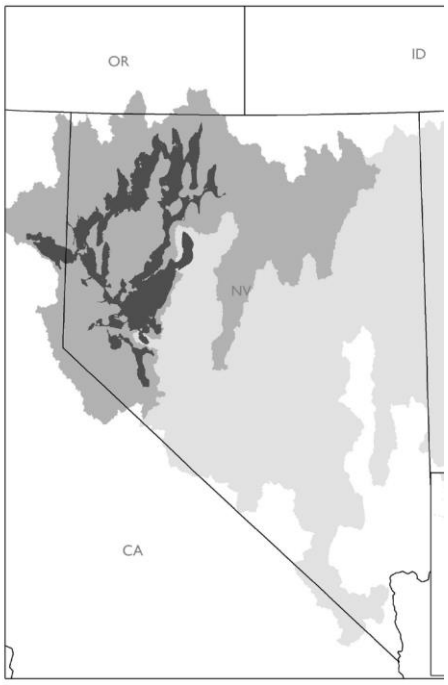
strains and the Y axis is frequency. It would be nice to have a table with all of the fish lengths and weights with means and variances.

Line 444. the Lahontan cutthroat trout in the Alexiades (2012)study were the Pilot Peak strain in the mainstem Truckee River – a much large waterbody than Sagehen obviously. Stream size may play a role in whether fish move substantially.

Line 450. add “genetically” before “similar”

Line 451-452. Yes Pilot Peak is a lacustrine strain but all cutthroat trout are stream spawners and can spend multiple years in the river prior to returning to the lake. This is a false dichotomy. Evidence from the museum samples for the Lake Tahoe/Pyramid Lake system show some admixture between these two populations so these lake fish do use the river. Rather than present this as a difference between fluvial and lacustrine I think the comparison between resident and migratory may be more germane.

Lines 452-453. “Indeed Pyramid Lake is a remnant lake of ancient Lake Lahontan, which once covered the entire state of Nevada”. Nope it did not. It covered the north western portion of the state in the Lahontan hydrographic basin.



Lines 461-463. There is growth rate information comparing the contemporary Pyramid Lake strain derived from Summit Lake strain to the Pilot Peak strain in Pyramid Lake see Budy et al. 2014

Line 464. change “stain” to “strain”

Line 470. Change to “Our approach had potentially confounding issues”

Lines 474-476. “. Constriction of fish movement may have altered growth results such that fish were unable to move to obtain food resources or were “forced” into artificially higher densities that aren’t encountered any longer in extant populations.” You need to add verbiage here that discusses how this may have influenced your result.

Line 482. Change “broodstock” to hatchery “raised” because you were likely sampling production fish not the actual broodstock.

Line 496. Dunham and Vinyard (1997) do discuss self-thinning in Lahontan cutthroat trout populations. See Dunham JB and G. Vinyard. 1997. Relationships between body mass, population density, and the self-thinning rule in stream-living salmonids. Can. J. Fish. Aquat. Sci. 54: 1025–1030.

Figure 3 legend does not match the figure. There is no strain information for any of the panels presented. There are no black curves in the figures despite the legend.

Figure 4 legend does not match the figure.