Date: 20 July 2017

Re: Scientific peer reviewer of the proposed listing rule for the Meltwater Lednian Stonefly (*Lednia tumana*) and the Western Glacier Stonefly (*Zapada glacier*).

From: B.C. Kondratieff

Review

1. Are descriptions of the biology, habitat, population trends, and historic and current distribution accurate?
    - A minor taxonomic inaccuracy: *Lednia tumana* adult body size: M = 4.5-5.5 mm, F = 5.5-7.0 mm (Baumann & Kondratieff 2010). The proposed listing rule has body size between 4.5-6.5 mm.
      Reference: Baumann, R.W. and Kondratieff, B.C., 2010. The stonefly genus *Lednia* in North America (Plecoptera: Nemouridae). *Illiesia* 6(25), pp.315-327.

    - In describing the collection area of holotype specimen of *L. tumana*, why not cite Ricker (1952), the original description of the taxon instead using a "personal communication?"
      Reference: Ricker, W.E. 1952. Systematic studies of Plecoptera. *Indiana University Publications Science Series* 18:1-200.

    - *Zapada glacier* nymphs are distinguishable from other *Zapada* species. The one species that it cannot be distinguished from is the sympatric *Z. haysi*. Reference: J. Joseph Giersch, Steve Jordan, Gordon Luikart, Leslie A. Jones, F. Richard Hauer, and Clint C. Muhlfeld. 2015. Climate-induced range contraction of a rare alpine aquatic invertebrate. *Freshwater Science* 34: 53-65.

    - *Zapada* is the most common genus of Nemouridae in **Western North America**. (Baumann 1975)

    - A recent paper by Giersch et al. (2017) mentions that "*Lednia tumana* was detected in 113 streams (175 sites) within Glacier National Park (GNP) and surrounding areas." These 113 sites were then apparently grouped into 58 populations. (Giersch, personal Communication) Adding an explanation on how this was done should clarity to these data.
      Reference: Giersch, J.J., Hotaling, S., Kovach, R.P., Jones, L.A. and Muhlfeld, C.C., 2017. Climate induced glacier and snow loss imperils alpine stream insects. *Global Change Biology*, 23(7): 2577-2589.

- "Giersch et al. (2017) also mention that "*Zapada glacier* was only detected in 10 streams (20 sites), six in Glacier National Park and four in mountain ranges up to ~600 km southwest." The proposed listing indicates that there are four populations. Again, adding how was this number determined should be included?

- "*Lednia tumana* were collected at a mean distance of 592 m (SD = 455 m) from stream source" Giersch et al. (2017). Proposed listing has the mean distance at 565 m? Please clarify.
  Reference: Giersch, J.J., Hotaling, S., Kovach, R.P., Jones, L.A. and Muhlfeld, C.C., 2017. Climate induced glacier and snow loss imperils alpine stream insects. *Global Change Biology*, 23(7): 2577-2589.

- One of the most commonly cited references is Giersch and Muhlfeld (2015) **in progress**. This is not publically available and therefore it was not possible to make an assessment of the methods used to estimate population densities, or determine the number of populations. Included in this publication may be important data in determining the risk of extinction.

- The proposed listing mentions that there is a lack of genetic information for *Z. glacier*. However, Giersch et al. (2015) reports on COI barcoding for *Z.glacier* and related species, which included a phylogram and haplotype network for the various populations.
  Reference: J. Joseph Giersch, Steve Jordan, Gordon Luikart, Leslie A. Jones, F. Richard Hauer, and Clint C. Muhlfeld. 2015. Climate-induced range contraction of a rare alpine aquatic invertebrate. *Freshwater Science* 34: 53-65.

- The proposed listing mentions that there is a lack of genetic information for *L. tumana*. However, Jordan et al. (2016) reports a genetic analysis using mitochondrial and nuclear DNA.
  Reference: Jordan, S., Giersch, J.J., Muhlfeld, C.C., Hotaling, S., Fanning, L., Tappenbeck, T.H. and Luikart, G., 2016. Loss of genetic diversity and increased subdivision in an endemic alpine stonefly threatened by climate change. *PloS One* 11(6), p.e0157386.

2. Are the factors affecting the species adequately and accurately reviewed?
   - No, not entirely. The effects of population isolation are not addressed. Jordan et al. (2016) examined mitochondrial and nuclear DNA and concluded that "Extant *L. tumana* populations bear the signature of recent declines in genetic diversity. Mean nucleotide and gene diversity for historic samples were higher than those for the 2010 samples (7.4×10^{-4}

vs. 2.4 x 10^{-4} and 0.60 vs. 0.30, respectively, including only populations with n>6). Furthermore, in spite of extensive sampling, we found no LtB haplotypes in 2010 populations, including many that were within 3 km of historic sampling sites where LtB was found. Additionally, historic populations had higher mean allelic richness than 2010 populations (2.5 vs. 2.0). This apparent loss of genetic diversity in *L. tumana* is consistent with small effective population sizes, which can lead to reduced fitness and evolutionary potential and increased genetic drift and extinction risk." "Rapidly changing genetic composition, reduced gene flow, and loss of haplotypes suggest that *L. tumana* is vulnerable to extinction."
Reference: Jordan, S., Giersch, J.J., Muhlfeld, C.C., Hotaling, S., Fanning, L., Tappenbeck, T.H. and Luikart, G., 2016. Loss of genetic diversity and increased subdivision in an endemic alpine stonefly threatened by climate change. *PloS One, 11*(6), p.e0157386

Giersch et al. (2015) mention that "Lower diversity caused by genetic isolation has been reported in some alpine species. For example, in a European mayfly, genetic diversity was significantly lower in recently deglaciated vs glaciated regions (Finn et al. 2013b). Climate-warming-induced range retraction also can result in a decline in genetic diversity, population fragmentation, and reduced population size in vertebrates, such as the alpine chipmunk (Rubidge et al. 2012). *Zapada glacier* genetic data are consistent with such processes. For example, the TCS network shows relatively few, closely related *Z. glacier* haplotypes, and its within-species genetic diversity is the 2nd lowest of the sampled *Zapada* species in spite of the largest sample size in our data set."
Reference: J. Joseph Giersch, Steve Jordan, Gordon Luikart, Leslie A. Jones, F. Richard Hauer, and Clint C. Muhlfeld. 2015. Climate-induced range contraction of a rare alpine aquatic invertebrate." *Freshwater Science* 34: 53-65.

3. Are the assumptions about habitat logical and adequate?
    - Yes

4. Are there any oversights, omissions, or inconsistencies?
    - Information about and consequences of population isolation are not included.
      Reference: Jordan, S., Giersch, J.J., Muhlfeld, C.C., Hotaling, S., Fanning, L., Tappenbeck, T.H. and Luikart, G., 2016. Loss of genetic diversity and increased subdivision in an endemic alpine stonefly threatened by climate change. *PloS One, 11*(6), p.e0157386\
      Reference: Jordan, S., Giersch, J.J., Muhlfeld, C.C., Hotaling, S., Fanning, L., Tappenbeck, T.H. and Luikart, G., 2016. Loss of genetic diversity and

increased subdivision in an endemic alpine stonefly threatened by climate change. *PloS One, 11*(6), p.e0157386.

5. Are the conclusion logical and adequately supported by evidence?
    - Yes. However, if the conclusions of Giersch et al. (2015) and Jordan et al. (2016) are considered, then there is **imminent danger of extinction** due to continuous decreasing genetic diversity resulting from increased population isolation.

6. Were all the necessary literature included?
    - No. Reference: Jordan, S., Giersch, J.J., Muhlfeld, C.C., Hotaling, S., Fanning, L., Tappenbeck, T.H. and Luikart, G., 2016. Loss of genetic diversity and increased subdivision in an endemic alpine stonefly threatened by climate change. *PloS one, 11*(6), p.e0157386
      Reference: Jordan, S., Giersch, J.J., Muhlfeld, C.C., Hotaling, S., Fanning, L., Tappenbeck, T.H. and Luikart, G., 2016. Loss of genetic diversity and increased subdivision in an endemic alpine stonefly threatened by climate change. *PloS one, 11*(6), p.e0157386.

Review of Proposed rule for Meltwater Lednian Stonefly and Western Glacier Stonefly

Review prepared by: Lusha Tronstad, PhD, Invertebrate Zoologist, Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming 82070, tronstad@uwyo.edu, 307-766-3115

65 Page document

Page 12: replace "Wind River Range" with "Teton Range". *Lednia tetonica* is only know from the Teton Range.

Page 12: See new report by Hotaling et al. 2017 that investigates the genetics of *Lednia* species and *Zapada* species. The reports validates morphology showing the genetic distinction of *Lednia* species.

Page 13: See new report by Hotaling et al. 2017 that investigates the genetics of *Lednia* species and *Zapada* species. The reports shows that *Zapada* species are genetically different between Glacier National Park, the Absaroka -Beartooths and the Tetons; however, differences were not as great as between the *Lednia* species and do not rise to the level of species with the information at this time.

Page 29: *Zapada glacier* lives in some rock glacier streams in the Teton Range. Rock glaciers are moving glaciers that are covered by rocks and debris. Small, cold streams originate from rock glaciers and we have found *Z. glacier* in such streams.

Page 30: The Teton Range has much less sedimentary bedrock compared to Glacier National Park. Springs appear to be more common in sedimentary bedrock and springs are less frequently observed in igneous (e.g., granite) bedrock.

Page 34: I think a section discussing how rock glacier might respond to climate change would be a good addition, because *Zapada glacier* live in some rock glacier streams in the Tetons. Rock glaciers may respond differently to climate change compared to traditional glaciers, because rock glaciers are covered by rocks and perhaps insulated from warmer temperatures. On the other hand, a dark covering of rocks may increase temperatures and cause rock glacier to melt faster. I am not sure how rock glaciers may respond to a warming climate. We surveyed rock glaciers described by Fegel et al. 2016 in the Tetons last summer (2016) and found several that once produced a stream but were now dry.

Fegel, T.S., J.S. Baron, A.G. Fountain, G.F. Johnson, and E.K. Hall. 2016. The differing biogeochemical and microbial signatures of glaciers and rock glaciers. Journal of Geophysical Research-Biogeosciences 121:919-932.

Page 49: We sampled aquatic invertebrates using a Surber sampler in the Tetons in 2015 and 2016. We have analyzed the 2015 samples and we will analyze the 2016 samples this coming winter. Densities for *Zapada glacier* are lower in the Tetons compared to Glacier National Park. We collected 11 and 56 *Zapada* individuals/square meter in two streams in the Tetons. *Zapada* cannot be identified as larvae, so not all the individuals we counted may be *Zapada glacier*. Larvae must be barcoded in order to determine if they are *Zapada glacier*.

19 Page document (with updated information)

Page 11: The paragraph at the top of the page states that glaciers may be buffered in the Teton Range because the sites in the Tetons are at higher elevations compared to in Glacier National Park. The Teton Range is farther south compared to Glacier National Park. Many factors may vary as you move south. For example, treeline is located at higher elevations as you move south. Therefore, stating that glaciers may be buffered in the Tetons compared to Glacier National Park because the sites in the Tetons are located at higher elevations cannot be compared directly. Many factors may affect the rate at which glaciers melt, including size, latitude, elevation and aspect. I would recommend finding articles that address how climate change is affecting glaciers in the Tetons or Wind River Range of Wyoming to address this question.

Page 15: We sampled aquatic invertebrates using a Surber sampler in the Tetons in 2015 and 2016. We have analyzed the 2015 samples and we will analyze the 2016 samples this coming winter. Densities for *Zapada glacier* are lower in the Tetons compared to Glacier National Park. We collected 11 and 56 *Zapada* individuals/square meter in two streams in the Tetons. *Zapada* cannot be identified as larvae, so not all the individuals we counted may be *Zapada glacier*. Larvae must be barcoded in order to determine if they are *Zapada glacier*.

Page 17: Replace “seasonal snowpack” with “glaciers and permanent ice”

Page 18: I would recommend including information on how rock glaciers are expected to respond to a warming climate. Are they predicted to melt slower than traditional glaciers? I observed fewer springs in the Tetons compared to Glacier National Park (likely because of the geology), so springs may not be a refuge in the Teton Range.

Backsen, Sarah <sarah_backsen@fws.gov>

Fwd: Peer Review U.S. Fish and Wildlife Stoneflies Proposed Listing Rule

Jaka, Jonathan <jonathan_jaka@fws.gov> Tue, Jul 25, 2017 at 7:59 AM
To: "Boyd, James" <james_boyd@fws.gov>
Cc: Sarah Backsen <sarah_backsen@fws.gov>

---------- Forwarded message ----------
From: **Dewalt, R Edward** <dewalt@illinois.edu>
Date: Mon, Jul 24, 2017 at 3:39 PM
Subject: RE: Peer Review U.S. Fish and Wildlife Stoneflies Proposed Listing Rule
To: "Jaka, Jonathan" <jonathan_jaka@fws.gov>

Jonathan,

Your researchers/writters have done a good job with this. Answers to your questions are below in red. My notes are further down.

1. Is our description and analysis of the biology, habitat, population trends, and historic and current distribution of the species accurate? Your analysis of the biology of the two species is mostly accurate. Examine the list below to see where I think what was written deviates from known information.

2. Does the proposed rule provide accurate and adequate review and analysis of the factors affecting the species? Absolutely, it does; I am in complete agreement.

3. Are our assumptions and definitions of suitable habitat logical and adequate? Yes, I am in agreement with your assertions about suitable habitat.

4. Are there any significant oversights, omissions, or inconsistencies in our proposed rule? One omission, see below, is the Lednia tumana has been reported from Waterton Lakes. A female specimen is presented in Baumann & Kondratieff (2010).

5. Are the conclusions we reach logical and supported by the evidence we provide? All conclusions are well supported by available evidence.

6. Did we include all the necessary and pertinent literature to support our assumptions/arguments/conclusions? Not all, but most. See below.

1. Taxonomy is a dynamic science and a species concept may change over time. I think it important to fix in time the concepts being used in this document as:

   a. **for Lednia tumana:** Baumann, R.W. & B.C. Kondratieff 2010. The stonefly genus *Lednia* in North America (Plecoptera: Nemouridae). Illiesia, 6(25):315-327.

b. **for Zapada glacier (originally as Nemoura (Zapada) glacier:** Baumann, R. W. & A. R. Gaufin. 1971. New Species of *Nemoura* from Western North America (Plecoptera: Nemouridae). The Pan-Pacific Entomologist. 47(4):270-278.**).** This species was first moved to genus *Zapada* by Zwick, P. 1973. Insecta: Plecoptera Phylogenetisches System und Katalog. Das Tierreich – Eine Zusammenstellung und Kennzeichnung der rezenten Tierformen. 94:465 pp

2. p. 13, the following statement is inaccurate "Members of the *Zapada* genus are the most common of the Nemouridae family..." This is place specific. In much of the western USA, this is so, but certainly not for the east.

3. p. 15, updates of literature needed on "Giersch and Muhlfeld 2015, in progress)". Is this the reference: Giersch, J. Joseph; Scott Hotaling; Ryan P. Kovach; Leslie A. Jones & Clint C. Muhlfeld. 2016. Climate-induced glacier and snow loss imperils alpine stream insects. Global Change Biology. 23(7):2577–2589. doi: 10.1111/gcb.13565 . Perhaps some other papers, seems that several were published with similar titles in the past few years, may be absent. Also, the docket at the website did not provide the literature cited in the proposed rule. It should be there!

4. p. 18, Add reference: Baumann, R.W. & B.C. Kondratieff. 2010. The stonefly genus *Lednia* in North America (Plecoptera: Nemouridae). Illiesia, 6(25):315-327. http://illiesia.speciesfile.org/papers/Illiesia06-25.pdf who list the following location, for a single female (probably L. tumana) CANADA: Alberta: Waterton Lakes National Park, Bertha Brook, below Bertha Lake, 25 August 1976, D.B. Donald, 1♀ (DBDC).

5. p. 20, "...and nymphs rely on perennial water sources to breathe through gills, similar to fish." statement is inaccurate: Lednia lacks gills, Zapada has gills, other Nemouridae may or may not have gills.

6. p. 20 use of the reference "Stewart and Harper 1996" is suspect—it is a key to genera, two decades old. There are several original life history sources cited in Stewart & Stark. 2002. Nymphs of North American Stonefly Genera (Plecoptera). 2nd. Ed. 510 pp. for both *Lednia tumada* and *Zapada* spp. that should be cited here.

7. p. 21, "....and western glacier stoneflies, have limited dispersal capabilities." This statement is best attributed to both stoneflies being confined to glacial melt waters since there have been so few studies of dispersal capabilities of the order. Some small species get to distant islands (Leuctra ferruginea and Nemoura trispinosa on Isle Royale, 15 miles from mainland) (DeWalt RE, South EJ (2015) Ephemeroptera, Plecoptera, and Trichoptera on Isle Royale National Park, USA, compared to mainland species pool and size distribution. ZooKeys 532: 137–158. doi: 10.3897/zookeys.532.6478). At least one of these has been found on Canadian Maritime Islands as well—greater distances yet. That there are now several species of *Lednia*, and one in the Tetons (Baumann, R.W. &. R.G. Call. 2012. *Lednia tetonica*, a new species of stonefly from Wyoming (Plecoptera: Nemouridae). Illiesia, 8(08):104-110. http://illiesia.speciesfile.org/papers/Illiesia08-08.pdf), there may be greater dispersal capability than we give them credit for, just the habitat is so limited.

8. p. 45, "....stoneflies in general are poor disperser (on the order of meters)." is an overgeneralization. Very few studies exist. See DeWalt and South (2015) above.

Sincerely,

R. Edward DeWalt

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