

Peer Review File

Decision Support and Guidance for Applying Hydraulic Modeling to Beaver Dam Analog Stream Restoration Projects

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¹Round 1

²Round 2

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Note: All Author responses to reviews are in PURPLE colored text; Lines referencing the “FINAL” version (not tracked) of the revised manuscript are noted in italics, where appropriate. Thank you!

Round 1 Responses

Review #166, Anonymous A

Reviewer summary to be shared with the author and editors:

Please see my full review below. Overall, the strengths of this piece far, far outweigh the weaknesses. It is well written, well researched, and a major contribution to the research area. I'd encourage the authors to provide some more detail in a few sections, and consider revising the title and abstract of the piece, to make the contribution clearer.

Detailed reviewer notes to be shared with the author and editors:

This is an incredibly dense (in a positive way) piece investigating how to model BDAs within existing 2D hydraulic models. The piece also includes guidance for modeling and decision making related to when modeling can be useful in the context of BDA design and site assessment. Overall, this piece is well written, very thoughtful, and represents a TREMENDOUS amount of work. I truly applaud the authors. I have some major comments and several minor recommendations. This is going to be a great addition to the literature.

First, the overarching focus of this piece felt a bit all over the place (though is very clearly stated at the end of the introduction). I think the authors should consider reworking the title, abstract and methods to reflect this focus. As a modeler, there are a lot of ways that other modelers could interpret the first portion of the manuscript, many of them being incorrect. It strikes me that the authors are trying to develop 1) a decision support tool that provides motivation for when modeling can be useful (and less the “why” or “when”) and 2) strategies for BDA implementation and parameter adjustment for effectively simulating BDAs in an existing hydraulics model. I'd encourage the authors to revise the title and abstract and parts of the methods to reflect this.

We made significant changes to the wording/phrasing of the overall objectives/intent of this work in response to this comment. The Title, Abstract, Introduction, sections of the Results, and sections of the Discussion and Conclusions were updated to reflect that tone of the following revised Objectives:

- 1) Develop a practical decision-support tool that helps practitioners identify situations where hydraulic modeling may benefit stream restoration projects proposing BDA features.
- 2) Provide practical guidance for incorporating BDAs into existing hydraulic models, including strategies and parameter adjustments to simulate how BDAs—and subsequent beaver activity—affect channel conditions over time.

Specific details included changing the wording of Decision Tree to Decision Support Tree, and changed the tone throughout to address that this work is to:

- help users evaluate context rather than enforce criteria,
- highlight considerations rather than mandate choices,
- allow for judgement, uncertainty, and nuance, and
- align with “practical cues” rather than a firm “when/why”.

The key here is that we are providing “Decision Support” tool to help practitioners better identify situations where hydraulic modeling of BDAs is beneficial, and to help them make decisions on if modeling should be used to enhance or benefit their project rather than identifying specific cases when modeling is required. Finally, we also updated the Decision Support Tree figure itself to reflect these changes as well. Overall, this was a valuable suggestion, and we believe that the paper has been significantly improved in relating its intent as a result.

Second, this piece is LONG. It needs to be long (and is reasonably close to the 10,000 word requirement). However, I think there are parts that could be shortened and moved to supporting information, especially if additional text is added to address reviewer feedback. I strongly encourage the authors to consider this, though I very much appreciate the level of detail they included.

We appreciate the reviewer’s comments and their recognition of the level of detail in this manuscript. We agree it is long, and throughout the research process, and again during revision, we have looked for opportunities to shorten the paper. Because the sections work together to address the two main objectives, we found each section contributes to the overall narrative. As such, the content was retained in the main text rather than moved to the supplemental material, though we made edits to improve clarity and conciseness.

Third, I’d like to know more about the modeling results. In the results, it would be helpful to introduce the results of all approaches first, before jumping into a comparison. What are the ways these approaches are similar or different in terms of the criteria that was initially introduced at the end of the methods? A table may help organize this information. What approaches yielded similar results, that may not need to be mentioned again? A table would also simplify the complex information provided in section 4.2.

Lines 564-576; Results Section, in general: We appreciate this suggestion and have revised the Results section to introduce the outcomes of all nine approaches before focusing on detailed comparisons. A new summary table was added (Table 5) to organize the approaches according to the evaluation criteria. Based on this table, five approaches were not emphasized further due to reasons listed in the table (e.g., the roughness adjustment approach showed little improvement over the do nothing approach). Four preferred approaches are highlighted in the table and are emphasized throughout the remainder of

the Results section. The subsequent Results subsections were updated to align with this framework.

Fourth, it's not clear why modeling decisions were made and why nine scenarios were constructed. This is a really comprehensive set of modeling exercises (Line 369 description), really applaud the authors! While I appreciate the details, it is not clear WHY they are using these different schemes, and what they are hoping to test. It would be helpful to see these scenarios presented with the "why" – why test a given scenario? What does it represent in terms of BDAs? Are you testing model representation? Parameter influence? Both? Something else? It is incredibly helpful to know what you did, but the WHY – both overarchingly, as well as in specific for scenarios, is still unclear. This is the part I'm most interested in.

Lines 412-449: We added context for the "why" behind selecting these nine approaches under Methods section 3.2.5. In the process, we decided to move the details about how these approaches are constructed into Table 4. This consolidates the "why" to the bulleted list, and the details for the "what" and "how" to the table.

There is also some key literature that I recommend the authors include in their revision. This study misses two key BDA citations that have performed modeling (there's a third study that I can't seem to find – I know these articles can be tricky to locate, given the many names for these structures).

<https://onlinelibrary.wiley.com/doi/abs/10.1111/1752-1688.13044>

<https://onlinelibrary.wiley.com/doi/10.1002/eco.1953>

It looks like there is also a fairly new thesis on this topic that should likely be cited as well:

<https://www.proquest.com/docview/3243270374?fromopenview=true&pq-origsite=gscholar&sourcetype=Dissertations%20&%20Theses>

I'd also recommend checking out and engaging with this piece:

<https://doi.org/10.5751/ES-13006-270141>

Lines 215-216; Lines 746: We thank the reviewer for suggesting additional literature relevant to this topic. We have incorporated several of these additional studies that highlight groundwater storage and subsurface flow paths/extents. These studies have been cited in the Introduction and Discussion sections. We are grateful to read the recently published thesis as well and found the SRH 2D Obstruction method interesting; this work is referenced in the notes of Table 4, regarding the parameterization of porosity.

Also, from reading the introduction, I'm curious – are there truly no studies that implement beaver dams in a hydraulic model? Upon reading further, I see this now in the Discussion – consider citing some of these studies in the introduction too to show that this type of work is already done for beaver dams.

Yes, in conversations with practitioners and researchers, people are making these decisions on the representation of beaver dams in hydraulic models, but there is still a gap for guidance on the various approaches for representation of these structures as modeled features.

Minor suggestions:

-The highlight is a little unclear to me as written – consider rephrasing; is modeling necessary for designs, the design process, to understand hydrologic implications of designs? Consider including the purpose of modeling in this highlight to make this more clear. *We updated this, in alignment with our significant changes to the wording/phrasing of the overall objectives and intent of this piece.*

-It isn't clear from the abstract that the project includes BDAs – as written, it seems to only focus on a beaver-inhabited site. *We updated this to make it clearer.*

-Consider adding more detail to the abstract – for instance, what hydraulic model did you use? *We reworked the abstract, as mentioned, and added “HEC-RAS” to the list of Keywords.*

-Line 33: are the nine approaches referring to different approaches to the modeling framework (e.g., different equations and implementation schemes), or different approaches to represent the geometry and design of BDAs? This could be clearer. *Line 32: We revised to “nine approaches for the representation of BDAs” to make this clearer*

-Line 36: advantages in terms of what? *Line 34-35: We revised this to clarify these are modeling advantages in terms of capturing/simulating BDA behavior and evolution over time.*

-Line 44: I think it may be more clear to say the implementation of BDAs aims to restore – the jury is still out on which outcomes BDAs can achieve *Line 45: Agreed, revised as suggested.*

-Line 52: do you mean less pre-installation modeling? Or modeling in what context? *Line 54-55: We changed this to “prescriptive engineered design” to be more inclusive and contrast with “field-fit design”.*

-Line 65-67: I'm not sure I agree with this statement – I don't think BDAs are being overprescribed, and I don't think we have enough data to say they are underperforming. I also don't think any of the papers you cite here support that view. Instead, some of these papers support the idea that this has the potential to happen if we are not careful. Consider softening this statement. *Line 68-69: Good point, we reworked this statement to align with published research and focus on the cautionary/constructive side of this message.*

-Line 70: no comma needed *Revised, thanks.*

-Line 76-77: I'm not sure this is cited correctly – consider verifying *Updated in-text and in references to CSE-Name Year format. Line 78.*

-Line 80: is this an 'instead' or an 'in addition to' – in my experience, both widening and flanking can happen *In the case of Fanno Creek, we emphasize that the flanking of the BDA structures resulted in less widening than anticipated if the creek did not flank the structures. We revised to make this clearer. Line 81-82.*

-Line 177-183: a lot of repetition of the word 'show' – consider switching up word choice *Thanks, updated. Line 181-186.*

-Line 194: and perhaps most importantly – data! *Agreed! Added. Line 202.*

-Table 1 caption – common themes from where? Indicate where these common themes were derived from. *Changed to "situations" to be consistent with revisions and noted the literature review and stakeholder engagement that helped to populate this table – even though this table does not capture all the possible situations where hydraulic modeling could be applied to a BDA design. Line 224-225.*

-Table 2 caption: what was the source of these values? Include in the caption. *Added in the caption, with in-text citation and reference. Line 303-304.*

-Line 283-285: I understand that this is sometimes needed. However, were elevation distributions between the two watersheds similar? If not, that would be good to mention. What was the difference in watershed size between these two sites? Also, would be good to mention (e.g., translating flow at a very massive site to a very small site would not be recommended) *We added this information to Section 3.2.3 to be transparent about the differences, but also reiterate that this choice of data was the best available at the time. The drainage areas for both sites are listed in Table 3. Line 308-314; Table 3.*

-Line 294: I'm not sure this is the correct way to include an equation in a manuscript – check the journal guide for more information about this (update for other equations, too) *Microsoft Word equation editor is the recommended process, based on the information available. Thanks! Line 327.*

-Line 299-300: how far away is this site from the project site? Again, would be good to mention *Added to the description. Line 309.*

-Line 317: approach -> model representation? *Ok. Line 352.*

-Line 315: so is the goal to test different structural representations for BDAs in HEC-RAS? Or did you just use weirs as the primary representation? Consider explaining and justifying these decisions here. *This reference to weirs is simply to demonstrate that we chose to test one approach at a time. Line 350-353.*

-Line 523: add 'the' at the start of the sentence *Reworked this section (Lines 564-574).*

-Given the length of this piece, I'm unsure if section 4.2.4 needs to be in the main text, or could be paired down, with most of this text moved to supporting information. Consider broadening this discussion to make it a general interpretation that would be useful to other readers, and putting the specific interpretation into supporting information. *As stated above, we think the case study sections work together to address the two main objectives*

and contribute to the overall narrative. Section 4.2.4 has been retained in the main text rather than moved to the supplemental material, though we made edits to improve clarity and conciseness.

Review #168 Anonymous B

Note - We noticed this set of reviewer comments references a different line numbering scheme than the other two reviews.

Reviewer summary to be shared with the author and editors:

See next field down.

Detailed reviewer notes to be shared with the author and editors:

Review of “Improved Guidance for When and How to Apply Hydraulic Modeling to Beaver Dam Analog Designs”

The manuscript presents results of a study that developed a work flow and best practices for incorporating hydraulic modeling into BDA design. The study presents a flow chart for determining whether to include hydraulic modeling and compares different approaches for modeling BDAs to hydraulic data from real restoration sites. The study seems to be well executed overall and the effort to provide practical tools for applied projects is commendable. However, the manuscript suffers from a lack of clarity in the Methods section and various grammatical/typographical errors. It is also unclear in the Introduction whether the applied practitioner community supports this effort and would use the resulting product.

We revised the manuscript to address these concerns. The Methods section was substantially clarified and updated; the manuscript was carefully edited to correct grammatical and typographical errors. In the Introduction, we also expanded the discussion of the practitioner needs to clarify that the community has expressed demand for practical guidance and tools, indicating that such products would be widely embraced and used by practitioners.

Specific comments:

Introduction – somewhere in here please better explain/document the interest of designers, practitioners, regulators, permittees, etc in the topic of this study. Otherwise this may be an academic exercise that does not translate.

We expanded discussion in the second to last paragraph of the Introduction to document the need/interest from the applied practitioner community. *Lines 85-90.*

L176-179 Please provide some citations for these statements

Updated with citations for both potential risks and benefits. *Lines 215-219.*

L178-179 Can these models also evaluate ecological benefits? *Yes, added.*

Table 1 - Top right corner metrics should also include lateral distance to concerns? Also, what are “design intent”, “landscape restoration gaps”, and “flow adjustment device”?

In this table, “distance” is the lateral distance (i.e., the area of influence, depending on the channel slope and height of the BDA), and to maintain simplicity at this level of developing the decision-support tool, we left it as “distance” in this table. We added description and citations to clarify “design intent” as being the intention of the design to be stable/persistent vs. a temporary structure. We also added key citations to explain “landscape restoration gaps” and “flow adjustment device”. *Table 1 (Line 225)*

L188 Replace “A” with “The” *Updated. Line 230.*

L192 What is “formal engineering support”? *Revised this to be clearer. Line 235.*

L202 “useful for those with limited experience with beaver restoration” – I understand the motivation for this statement, but I am concerned that phrasing it this way may make people with limited experience think they can competently design these projects with just this tool and no oversight by someone more experienced. *Revised this sentence to clarify this is a resource to compliment, not fully substitute, more experienced oversight/support. Line 250-252.*

L205 “aims” should be “aimed”. What you did for this study should be past tense for clarity, otherwise it sounds like you’re still doing it. Check whole section for any similar issues. *Revised, and checked tense consistency throughout. Thanks. Line 254.*

L212 What are the timelines for these two projects? Did you model these projects? These basic characteristics of what you did are unclear. *We revised this section to reference the Study Site information and focus on the site evolution of the selected modeling site. Section 3.2.2 states that we selected restoration conditions on June 18, 2024, to model for this study; along with the data that was used to build the model. Line 263, Lines 284-285.*

L222 “breaklines...adequately represented downstream hydrology” – how does model /topography represent hydrology? This doesn’t make sense to me. *We revised this section to be explicit that this methodology was sufficient for hydraulic simulations of downstream flow in the 2021 project reach. Lines 273-276.*

L230 When did restoration actually occur? *The project occurred in 2021; we edited this section and the previous section to clearly state this. Lines 284-285.*

L232 When were the dams built? *These were dams built from project implementation (summer 2021) thru June 18, 2024. Revised to state this. Line 287.*

L241 NLCD? *Spelled out. Line 292.*

Table 2 What does “developed” mean, and how does it have the same Mannings n as open space? *“Developed – Open Space” is one NLCD Land Cover type. We removed the commas, and added dashes to make this clearer. In this modeling effort, it represents the gravel road prism. Line 304.*

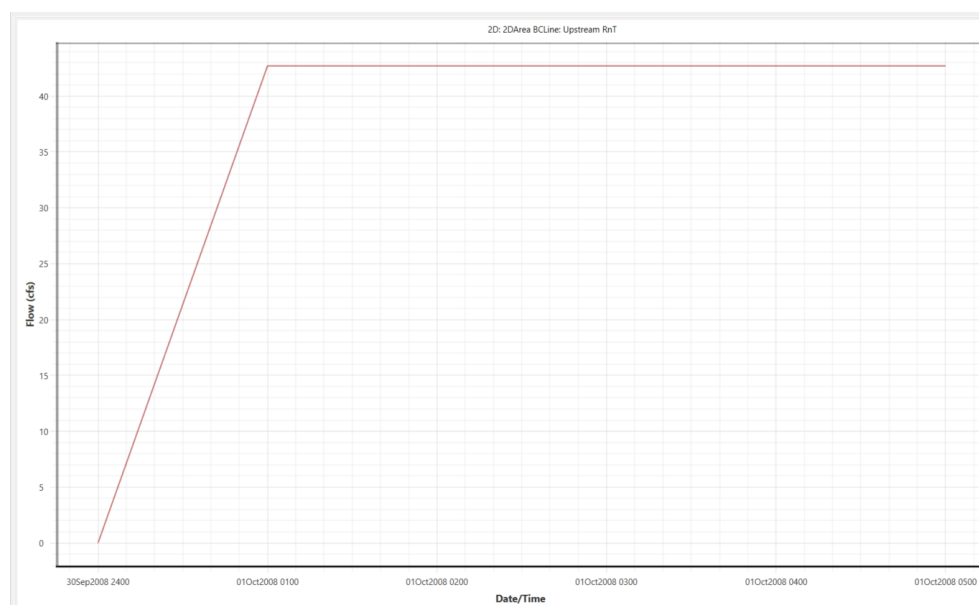
Table 2 0.06 for channel seems fairly high unless the channel is very bouldery. While 0.06 may seem high for a typical channel, we consider it appropriate for this reach of Rough and Tumbling Creek due to its complex morphology post-restoration. The channel contains a diverse bed composition, abundant large wood from both beaver activity and 2021 restoration work, and multiple flow obstructions, all of which increase resistance to flow and support the use of a high Manning's n roughness coefficient. *Table 2.*

L249 Where is the gage relative to this? The spatial relationship of gage, project, and trib are unclear. A map would be helpful. *Revised Section 3.2.3 with more information. Line 308-314.*

L249-250 What is the recurrence interval for this 24-hr storm? Did you do the scaling with Eq 1? *This flow is a steady snowmelt and baseflow combination (Rocky Mountain high elevation subalpine stream in June). Yes, we scaled peak Q of the project site using Equation 1. Line 315-319.*

L252 Does 4-hour mean the duration of the hydrograph? Or the temporal resolution? *"4-hour" refers to the duration of the hydrograph. Line 320-322.*

L252 What does "1-hour step up" mean? Please show the hydrograph/plot it. *The "1-hour step up" refers to the method used to bring flow from 0 cfs to the peak discharge Q listed in Table 3. Flow increased linearly over a one-hour period until the peak Q was reached. A hydrograph of this ramp-up has been included in this response document; however, because the manuscript is already near the journal limit, we believe this plot does not need to be included in the main text. Line 320-322.*



L252 “This is a common and recommended practice” – actually I’ve worked in practice and research for decades and have not heard of this, so please describe better. We revised the text to clarify the methods for developing the scaled hydrograph, and we cite the HEC-RAS 2D Modeling User’s Manual (USACE 2025) as a document that recommends this approach for defining upstream boundary conditions in unsteady flow simulations. *Line 322-325.*

L254 “stable state” – what does this mean? Steady state? Stable? “Stable” refers to the model solution, not steady flow, and we added text to clarify this in the manuscript. *Line 323.*

L260 Justify choice of exponent We used the exponent $c = 1$ to reflect linear scaling of discharge with drainage area. This assumption is appropriate for the study reach which is a high-elevation, subalpine headwater system during June snowmelt conditions. Runoff during this period is dominated by snowmelt and baseflow contributions, which produce relatively uniform unit discharge, compared to rainfall-driven floods (often $c < 1$) or highly urbanized systems (sometimes $c > 1$). Justification is summarized in the revised manuscript. *Line 315-316; Line 329.*

L262-263 “indicate 0.25...during the preceding week” – what is the significance of this? What does this have to do with the rain on snow event mentioned in the following sentence? We clarified the text to explain the significance of these precipitation observations, which justify the use of the downstream gage as a suitable reference for scaling the project site hydrology while acknowledging the limitations of unmeasured site flows. *Line 332-338.*

L279 Is this a heading? If so, why is it the only one at this level of the outline? Confusing. We deleted “2D Mesh Development”, so all this text is now clearly part of section 3.2.4.

L321 What does “porosity” mean in this context? We made some significant revisions to Section 3.2.5, which includes a description of “porosity” under the bulleted list (“Approach 6...”), with reference to HEC-RAS version 6.6 that has more information in the HEC-RAS manual. *Line 431-439.*

L326 What are “breaklines” in this context? Breaklines are linear features used in this modeling effort to represent abrupt changes in elevation (such as dam crest) in the terrain model. In the context of “do nothing” approach, they were simply used to refine cell spacing around the BDAs for the unedited LIDAR terrain, despite no terrain modifications added for that approach (Approach 1). This Section 3.2.5 was revised significantly, so this instance of “breaklines” was removed in the process.

L342 Are “vertical posts” a built-in feature of HEC-RAS? Yes, they are a terrain modification feature where the user can add shapes, including these circular shapes. *Line 425-430.*

L347-353 This whole section was unclear to me. We made significant revisions to Section 3.2.5, which includes more description for the novel addition of the porosity layer in HEC-RAS version 6.6. *Lines 440-449.*

L404 I believe this is the only subheading at this level of the outline. Standard practice is to not subdivide a section into subsections unless there will be more than one. We wanted to distinguish between presenting the decision-support tool, and the tool demonstration, so we added section 4.1.1 and 4.1.2 to separate these out.

L430 I do not believe that “overbanks” is a verb. Recommend “overbank flow” or similar. Revised, *Line 545*.

L452 What is the difference between “site-scale results” and “hydraulic results”? We clarified that “Site-scale” refer to results at the scale of the entire project complex, while “local hydraulics” focus on individual BDAs, examining flow behavior at the finer scale – upstream, through, around and downstream of each structure. *Subheadings 4.2.1 and 4.2.2; Lines 578 and 623*.

L460-463 I would start the paragraph with this material. We reworked the Results of the hydraulic modeling approaches per suggestions from Reviewer 166, so this section now introduces the overall results of the nine approaches and improves the transition into the detailed results. *Lines 564-574*.

Figure 4 – It is hard to see the light green, light orange, and gray colors from the upper right corner of the legend on the figure itself. This figure has been revised for better visualization.

L500 The wording of this heading is unclear. Recommend replacing “Local hydraulics” with “Surface water velocities” or similar. This will make it more consistent/parallel with 4.2.1 on L455 We re-worked these headings to be clearer about the results we are presenting in Section 4.2.1 and Section 4.2.2.

L539 Is there a word missing in “posts even”? Revised, thanks. *Line 674*.

L540 What does “at the BDAs and smaller time step” mean? We revised this to clarify the differences in required cell sizes and computation time steps, in order to capture the respective levels of terrain details for the different approaches. *Line 674-676*.

L542 “For this approach, align” – who is doing this? i.e. what is the subject of the sentence? We revised, thanks. *Line 679*.

L545 What is the “Normal 2D equation”? We have updated the manuscript to briefly describe this equation and its applicability under submerged weir conditions. *Line 683-684*.

L553-554 What is meant by “relatively adjusted”? We revised the text to clarify that this refers to the ease of modifying each modeling approach, see updated sentence. *Line 694-696*.

L559 What is meant by “the other non-ponding roughness features with relatively greater porosity”? This is mentioned first in Section 2.2 and refers to the non-BDA modified structures that are intended to increase channel roughness and slow velocities. We revised this sentence to explain this further. *Lines 700-703*.

L569-570 What is meant by “A 1D model does not have terrain modifications”? The terrain modifications in RasMapper to construct the geometry adjustment and vertical posts approaches are unique to 2D modeling, however this was a possible pathway for building a similar approach in 1D. The manuscript was revised to explain this. *Line 715-718.*

L584-607 This section is broadly redundant with the Results section, with the exception of the citations/comparison to literature. We revised the Discussion section to address redundancy and highlight the importance of the citations. *Line 732-748.*

L600 Insert “in” before “and use”. Revised. *Line 740.*

Figure 6 – I like this figure, but would call it a table. Updated in manuscript. *Line 756.*

L613-616 How do you know the roughness without data to calibrate? Roughness adjustments were kept constant for this modeling effort, however this important comment is discussed in the numbered list of future directions, where more data is needed to better approximate the ranges of roughness through BDAs and beaver dams. *Line 842-844.*

L654 What is meant by “the partitioning of BDAs to total roughness”? We revised the text to clarify that we were referring to the relative contribution of BDAs to the overall hydraulic roughness of the reach, which can vary with flow stage and other roughness elements. *Line 812-813.*

L662 Replace “lower” with “shorter” Revised, thanks. *Line 821.*

Review #170 Lauren McPhillips, The Pennsylvania State University

Reviewer summary to be shared with the author and editors:

This article describes a decision making framework for whether it is recommended to create a hydraulic model of proposed Beaver Dam Analogues (BDAs). The article also tests out different modeling approaches for an existing site. Overall, this article fills an important gap, and is well written and orchestrated. I primarily have minor comments below.

Detailed reviewer notes to be shared with the author and editors:

Line 115- it would be helpful to include example images of BDA vs PALS. In some literature, these seem to be used interchangeably and thus it'd be helpful to clarify the context and difference here. We included the photo of the RnT site as Project Photo 1 in the beginning, we are already nearing the journal limit for figures, so we described these structures in the text to explain this distinction (“BDAs and PALS, designed to mimic beaver dams and wood jams, respectively...”) *Line 17; Line 138-139.*

Fig 2. Is the black point on the small inset state map supposed to be the location of the study watershed? Or the city of Colorado Springs? Please make it clearer where the watershed is located. Additionally, it's a bit tough to see the pink color of the beaver dams on the background layer. Updated this figure to address these items. *Line 148 (Fig. 2).*

Line 193- it feels like words might be missing here to give appropriate meaning. Should this sentence say something like 'Practitioners apply hydraulic modeling to HELP QUANTIFY ecosystem functions....' where the words in caps are suggested additions. *Correct, we updated this in the manuscript. Line 201.*

Line 375- missing reference *We substantially revised Section 3.2.5 in response to Reviewer #166. While the nine approaches presented are not intended to be an exhaustive list of all possible methods for representing BDAs in hydraulic models, they were developed based on a combination of literature review, interviews with practitioners, and the authors' combined professional judgement. We believe these approaches serve as a starting point for adequately addressing the second objective of this research. Line 408-410.*

Line 395- could be helpful to briefly explain this a bit more because this reasoning is not clear (without digging into the reference more) and it seems important to justify this better in the paper. 'based on the positive relationship of roughness to channel slope normalized by drainage area' *We revised the description of Approach 4 to clarify the reasoning behind the use of Manning's n to represent BDAs and better explain the reference to Addy and Wilkinson (2019). In this additional context, we clarified that, due to limited field data describing reasonable ranges for roughness values associated with BDAs, we used the empirical Manning's n relationship developed for large wood in streams as a reasonable approximation, and also noted in the Discussion section there is a need for more data collected in the field to better understand reasonable n -values. Line 422-423; Line 453; Line 842-844.*

Fig 3- it would be helpful to include reference(s) for selection of suitable BDA sites. *There is some discussion of BDA site selection in resources such as the LTPBR Guidebook and The Beaver Restoration Guidebook. However, these emphasize site-specific judgment, uncertainty, and adaptive management rather than standardized criteria or prescriptions. They highlight the need for continued research to better identify site-specific controls (e.g., stream power thresholds) for BDA implementation and beaver recolonization. As such, we have incorporated this context into the manuscript text in the Results section but have not included it directly within the tool itself. Line 482-486.*

Fig 4- colors in legend to not exactly match the colors in the map, for example the pink/purple colors. It creates some confusion about which results the colors correspond to. Is this because of overlap in the colors/results? *Updated this figure. Fig. 4 on Line 594.*

Section 4.2.2- it's a bit surprising to have so much discussion on velocity results when there were no observations for this. Model evaluation is pretty subjective based on what is 'deemed reasonable and expected for site conditions.' It would be helpful to at least have a bit more discussion up front in this paragraph on what is hypothesized based on velocity observations elsewhere, before evaluating the model output. *Although we acknowledge it would be ideal to have discharge and velocity measurements to evaluate model results, this remote BDA project on a subalpine headwater tributary is not unique for not having*

readily available data. We added discussion on the “why” behind what velocity ranges were “reasonable and expected”, and we also recommended more testing at future sites, if possible, in the Discussions section. *Lines 624-633; Lines 842-844.*

Line 631- word missing after vertical posts. *Reworked this sentence, thanks. Line 674.*

Round 2 Responses

Review #225 Anonymous A

Reviewer summary to be shared with the author and editors:

I have read the author's response to my reviews and re-read the manuscript. I appreciate the authors' efforts to make the text more fluid, and to include further justification in the methods sections. My comments have been thoroughly addressed. I have two minor comments listed below.

Detailed reviewer notes to be shared with the author and editors:

I have two minor comments to raise:

Table 6: The authors should verify whether color in tables is allowed, or if Table 6 should instead become a figure (it looks more figure-like than table-like, and converting this to a figure may improve the resolution)

Thank you, we are addressing this with Aimee Diehl, the Editorial Director, to satisfy journal and accessibility requirements of all figures and tables for publication.

(Lines 771) I'm a little on the fence about the conclusion that treating a BDA as weir is an endorse-able idea for simulating BDAs. In my experience, BDAs degrade relatively rapidly, and only become more porous though time (perhaps this is not the authors' experience?). This is in strong contrast to the true behavior of a weir. I don't disagree at all with the observation that this modeling strategy outperforms other modeling strategies. I am curious whether the authors think that a BDA truly behaves like a weir, or whether a sentence or two discussing this is needed. It may be worth including a caveat with this conclusion that there is still a mismatch between the physical behavior of a BDA and a true weir. Or, perhaps a more general statement that caution should be exercised when translating understanding of a physical system into a model, given the assumptions this entails. (Again, I find it really interesting that several others are observing weir-like properties associated with BDAs - this has just not been my personal experience.)

I look forward to seeing this work out in the literature!

We appreciate this observation and agree that a BDA is not physically equivalent to an engineered weir. Our intent was not to suggest that BDAs behave as engineered weirs, but rather that a weir representation showed some of the best performance among the modeling approaches across the multiple criteria we evaluated. We have added text to the

discussion (4th paragraph) acknowledging that BDAs are dynamic, porous structures whose hydraulic behavior likely evolves through time and differs substantially from that of a traditional weir. We further clarify that the success of the weir formulation should be interpreted as a useful modeling abstraction rather than evidence of physical equivalence.

Review #227 Lauren McPhillips, The Pennsylvania State University

Reviewer summary to be shared with the author and editors:

All of my suggested edits/issues were resolved.

Detailed reviewer notes to be shared with the author and editors:

None (as all issues were resolved in revisions, thank you!)

Thank you for reviewing!