Response to Reviewer 3

This paper investigates turbulent velocity fluctuations around a submerged object in a flume. This type of research has been conducted, using the tools they report (acoustic Doppler velocimetry) for nearly 40 years. Because turbulence around submerged objects along a bed has been so extensively studied in the past, it's incumbent upon the authors to explain clearly how their work contributes to the field. The important contributions have not been clearly stated in this manuscript.

The authors would like to thank the Reviewer for his/her interest and careful review of the manuscript and for useful technical comments and recommendations. We have carefully gone over the manuscript and incorporated these suggestions into the revised manuscript.

In addition to investigating the studied turbulence parameters in relation to fish behavior, this study covers a variation of such parameters around a large roughness element (LRE) in a wake-interference flow regime, which is expected in the design of rock-ramp fish passages (lines 50-52). Very limited studies have focused on these turbulence parameters, which are important from sediment transport and fish habitat preference point of view, in a wake-interference flow regime. Lines 92-95 were added to describe this gap in a more clear way.

It appears that the contribution is the application to nature-like fishways. The primary purpose of nature-like fishways is to aid in the upstream migration of fish. If the novelty of this research is therefore the novel application of existing metrics on previously studied geometries, then the important contribution should be the connection of these metrics to the biological organisms effected by the turbulent metrics reported. Such connections are not made clear until the last two paragraphs prior to conclusion of this paper (paragraphs 2 and 3 of Section 3.4). These connections are not made for each metric reported, and the connections aren't substantiated by literature references. For this paper to be useful to the fish passage community, the authors need to connect their metrics and findings directly and clearly to migrating fish throughout the paper.

We have incorporated a general description of the variations of the studied parameters around the boulder and their effects on aquatic habitat in the separated subsection. Therefore, researchers who are interested in turbulence around LREs and those who are interested in effects of turbulence on aquatic habitat can find their desired results in a more clear way. We also added another objective to the introduction section, which is discussing the connection of the studied parameters to the habitat (line 106).

Figures 11 and 12 along with the required explanation with referring to the relevant literature were added to subsection 3.4 to describe implications of the results in relation to stream biota, especially fish. Lines 357-360 were added to give information on the possible effects of higherorder moments on the aquatic life in addition to sediment transport. Analysis of the integral length scale is highly related to fish length. Following the previous work, a 200 mm body-length fish was considered to discuss possible effects of the integral length scale on fish swimming (lines 372-374). Energy dissipation factor (EDF) is highly related to the fish species. Therefore, we covered the recommended thresholds for different fish species (Figure 12). Although, we have covered major studies about the relation of the studied parameters with fish swimming performance, due to the variability of fish species, further studies are still required to connect to the behavior of target fish species.

1) It's unclear how the work adds to the general body of knowledge about turbulence around submerged objects. What do they find that hasn't already been reported for turbulence in gravel bed rivers? An introduction which more clearly states what's known, what's not known, and what they add will clear things up significantly.

As mentioned in the beginning of the response, in addition to investigating the studied turbulence parameters in relation to fish behavior, this study covers a variation of such parameters around an LRE in a wake-interference flow regime. Lines 92-95 were added to highlight the gap we intend to cover more clearly.

2) Section 2.3: The physical meaning of the skew in the u'w' plane isn't explained.

Lines 177-178 were added to clarify the meaning of u'w' skewness.

3) Line 176: Need to be careful about the use of the term "eddy" throughout the paper. Eddy in this case is a coherent bundle of fluid all moving at the same speed. That's in contrast to other places in the paper, and other citations, which use the term "eddy" to mean a rotating body of fluid. The physical meaning is different so the effects on fish swimming ability are likely to be different.

In the literature, integral length scales are often called eddy length scales (line 75). We have reviewed the term "eddy" throughout the paper and changed that to integral length scales or eddy length scales, if required.

4) Lines 179 - 188: The energy dissipation rate metric and subsequently the Kolmogorov length scale depend on "assuming an isotropic and homogeneous turbulent flow". It's unlikely that this assumption's likely to be valid in all regions directly around a submerged object. The authors should either provide citations which support the use of this assumption in the regions it's being applied or find another way to calculate this metric. A third option would be to remove these two metrics from the paper to give more space for a thorough discussion of the remaining metrics.

Such an assumption has been made to study turbulence characteristics in the previous studies. Citations to the relevant literature have been provided in line 196 for Equation (3) and are also applicable for Equation (4).

5) Line 268: With r2 values ranging from 0.38 to 0.60, it's unclear that the best-fit lines are accounting for a significant trend. Please provide a statistical analysis which shows that the slopes of these lines are significantly different than zero. Perhaps more importantly, does the physics of this scenario infer that we should expect a linear change in length scales? It seems like it would be more likely to expect a threshold or non-linear pattern. Finally, these equations are reported to 2 sig-figs of accuracy, with such wide variation in the data a single sig-fig of accuracy seems more accurate.

We have highlighted that such relationships can be used for approximate prediction of length scales under specific circumstances (lines 290-292). Also, to show that the linearity of the proposed relationship is significant, a t-test was performed and the results confirmed this significance (line 293-296). Following the performed tests, the authors decided to keep two significant numbers in the proposed relationships.

6) Table 1: The energy dissipation rate is reported to 4 sig-figs of accuracy. Given the uncertainty of the assumption inherent in this calculation (see my 4th concern) it seems like 4 sig figs of accuracy is unlikely to be appropriate.

We changed that to two significant numbers of accuracy to make it more reasonable.

In general, I would rather see the authors report fewer metrics, but spend more time explaining why what they found is important to fish passage.

We have tried to enrich the subsection on fish passage implication by providing more information and descriptions about the effects of the studied parameters on aquatic habitat especially fish. We have not focused on the connection of Kolmogorov’s length scale to aquatic organisms because our focus is macro biota especially fish (line 354-355). However, we kept the reported results for the Kolmogorov’s length scales for two main reasons: 1) the accuracy of the results is high as described in lines 208-210; 2) Future research focusing on the microbiota in a nature-like fish passage may benefit from the reported results in this paper.