**SE Temp MS: Craig Roghair Comments 6.15.23**

George: Here are my comments and some possible edits for you to ponder. Thanks for the opportunity to provide feedback on this terrific paper!

Throughout much of the intro the methods sections there is lower sensitivity to changes in air temperature is assumed to provide thermal refugia, but is that true? Is lower sensitivity also related to low absolute water temperature? Is it possible to have low sensitivity to changes in air temperature at sites where the absolute temperature is near the upper thermal limit of brook trout making them less desirable thermal refugia? Might want to make a stronger case for lower sensitivity = thermal refugia in the introduction [line 59] if the existing lit supports, or save making the explicit connection between lower sensitivity and refugia until the discussion of this paper [ e.g. lines 284-285].

Addressed this by adding that thermal sensitivity and water temperature are often strongly negatively correlated, meaning that cold streams are typically thermally stable, and thus thermal stability can provide refuge.

Line 93: (~1,000 km); What does this refer to? Do you mean: Here, we characterized  landscape influences on stream thermal sensitivity for approximately 1,000 km of streams across the native range of brook trout in the southern and central Appalachian Mountains regions, USA. See also comment for Line 269.

In both cases, this refers to ~1,000km of brook trout habitat area, since the Appalachians are somewhat of a linear feature. We are trying to emphasize the scale of the study here. What if said “Here, we characterized landscape influences on stream thermal sensitivity across approximately 1,000km of the native range of brook trout in the southern and central Appalachian Mountains regions, USA…”.

Line 205 – 206: “We then defined resistant thermal habitat as the lowest 25th percentile of predicted thermal sensitivity values.” – Selecting the 25thpercentile as the threshold for thermal sensitivity seems like a pretty big deal as the decision on where to set this threshold makes a big difference on which stream reaches are considered sensitive. Should there be some additional info here on why the 25th percentile was selected as the threshold?

You’re right – this is a bit arbitrary. I suppose rather than an objective determination of thermal resistance, this is our subjective determination. What if I said “We then arbitrarily defined preferred thermal habitat as the lowest 25th percentile…”?

Line 209: missing ‘d’ on ‘allowe’

Done

Line 225 – 228: Might consider adding something in here about how to interpret beta, similar to the caption on Fig 3 where you describe how lower beta value = sites where stream temp is less sensitivity to changes in air temperature

Added a sentence clarifying this.

Line 230 – 231: “Slopes were heterogeneous in space, and a latitudinal gradient was apparent, with lower slopes generally present at southerly sites.” – consider this addition… Slopes were heterogeneous in space, and a latitudinal gradient was apparent, with lower slopes (i.e. less sensitivity to changes in air temperature) generally present at southerly sites.

Accepted

Line 231: missing ‘l’ on ‘therma’

Done

Line 265: ‘8,695 sites’ – these sites are variously referred to as ‘sites’ or ‘segments’ throughout the paper. Are they sites or segments? To me sites seem to imply points and segments would imply lines. Recommend picking the most accurate description and use it consistently throughout the paper.

Good point. Temperatures were measured at sites, but then landscape data for the stream segment on which each site is located were associated with it. I’ve tried to use “site” for the most part, except where I am actually referring to the whole stream segment (when landscape data are associated with an NHD segment, for example). I’ll go back through and clean things up so that this is more clear.

Figure 5 caption: I’d consider adding a description of how to interpret beta here, like you did on Figure 3.

Done

Line 269: “203 sites distributed along approximately 1,000 km of habitat” – see comment from Line 93; again, it isn’t clear to me what you mean by 1,000 km of habitat

Line 282 – 291: I was really having trouble wrapping my head around this idea that streams at the southern extent of brook trout range are more thermally resistant than streams further north, but when I remembered we were targeting brook trout streams from the start it does make sense. Is it possible that brook trout at the southern end of their range might already be restricted to the most thermally resistant reaches and have already been lost from reaches with higher beta? At the south end of their range, reaches with higher beta may have already warmed beyond the thermal tolerances of brook trout. So, it isn’t really that streams in the southern Apps are more resistant on average, it is that brook trout are already showing us where the most thermally resistant streams exist. Whereas further north, brook trout may still be able to live in streams with higher beta because there is more wiggle room in the absolute water temps there. In the future might we expect brook trout to become restricted to streams with lower beta in more northern areas as well? This might suggest that conservation efforts focus on areas where beta is high in the north because where beta is low, brook trout are more likely to persist on their own, like the southern populations now. Am I thinking about this correctly?

I hadn’t thought about it this way, but that’s a great point.

This counterintuitive finding may also be explained by the possibility that brook trout in the southern part of their range may have already been lost from the most thermally sensitive habitat, and thus could be constrained to thermally stable reaches. In these southern range limits, thermally sensitive habitat (high $\bm{\beta}$) may reach or exceed the thermal tolerances of this species. The preference of thermally stable, high elevation sites in the south could also be explained by interspecies interactions. Rainbow trout now occupy historic brook trout habitat in much of the region [@larson1985], and in Great Smoky Mountains National Park, allopatric brook trout populations are restricted to high elevations due to these interspecific interactions [@kanno2016a]. Perhaps it is not that more resilient habitat is located in southern areas, but that remaining populations simply occupy the most thermally stable and uninvaded habitat.