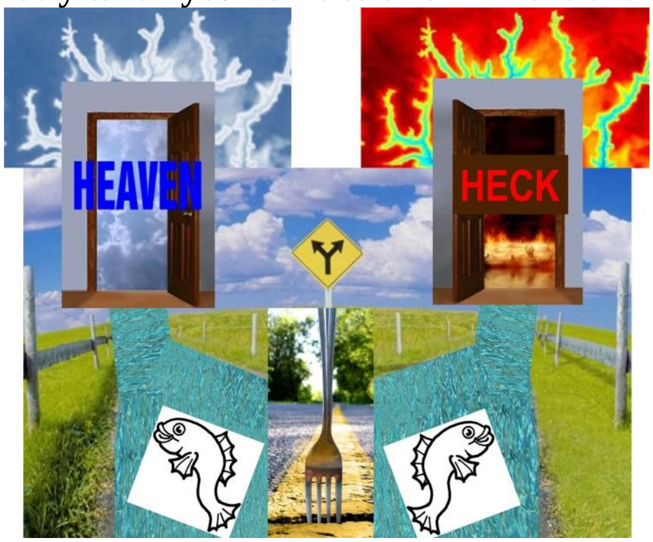
Climate-Aquatics Blog #63: Navigating stream thermalscapes to thrive or merely survive

Choose wisely when you come to a fork in the thermalscape



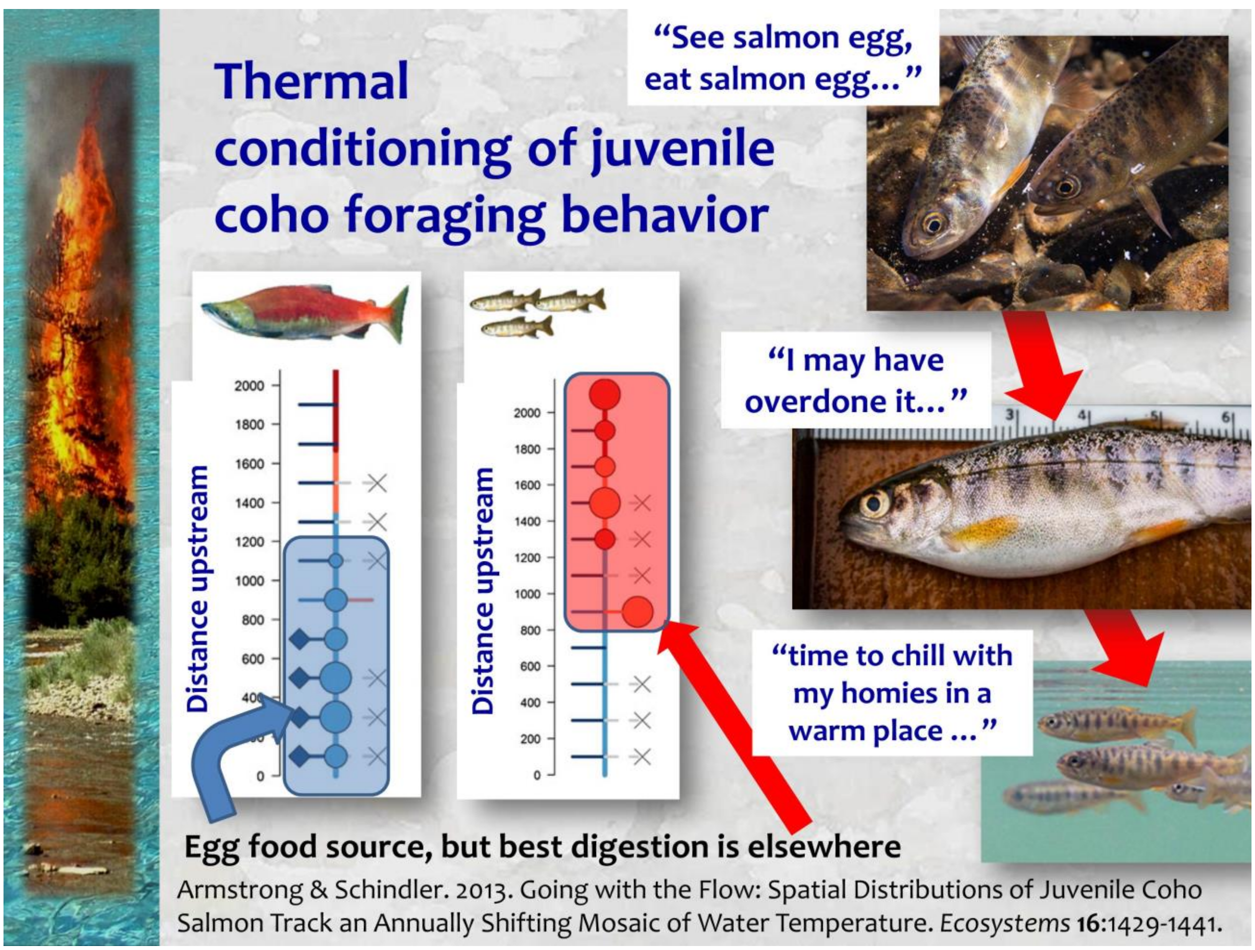
Hi Everyone,
Anyone that manages, researches, fishes for, or otherwise regularly interacts with fish knows that temperature is of paramount importance—second only to water & having enough of it to swim in. Fish are, after all, ectotherms that are physiologically constrained to operate within well-defined and sometimes narrow thermal niches. That said, there is always wiggle room and today we're highlighting some ways (& whys) for fish doing the wiggling that they do. In the first study, Armstrong and Schindler (graphic 1; study attached) describe how juvenile coho in an Alaska stream move among different thermal habitats before/after consuming sockeye salmon eggs. After gorging themselves on eggs in the cold habitats where sockeye spawned, the coho moved to warmer habitats to increase their digestive efficiency and work through their food comas more quickly.

Quite smart and good if you're a fish living within a relatively cool portion of your species' range and thoughts of extreme heat denaturing your proteins are far away from your pea-sized brain. But fish are forced physiologically to wiggle for very different reasons in the warm portion of their biothermalverse. As Chadwick & colleagues show, lab and field temperatures near the upper thermal limit of a cold-water species like brook trout trigger the production of thermal-shock proteins (graphic 2; study hyperlinked here http://conphys.oxfordjournals.org/content/3/1/cov017.full.pdf+html). And as that internal thermal unpleasantness grows, fish start to "freak-out" and actively search for local cool-water anomalies. Where they find those areas, dense aggregations may form—a phenomenon that Dugdale & colleagues (graphic 3; study hyperlinked here https://www.researchgate.net/profile/Stephen_Dugdale) document with an innovative application of PIT tag antenna arrays that tracked juvenile Atlantic salmon movements during a heat wave. In a similar vein, Hillyard and Keeley (graphic 4; study hyperlinked here https://sites.google.com/a/isu.edu/fish-ecology-laboratory/publications/pdfs/Hillyard%20and%20Keeley%202012.pdf?attredirects=0&d=1) used a combination of TIR flight imagery, fixed site temperature sensors, and temperature sensitive biotelemetry tags to describe movements by adult cutthroat trout to cooler habitats during especially warm summer periods.

Thus, temperature can be friend or foe depending on the local context. But in aquatic environments that represent the warm end of the thermal spectrum for a given species, important questions to resolve are “how much resilience do thermally-stressed populations have before they go into serious decline?” And “if an important thermal threshold is likely to be passed as temperatures continue increasing, are there habitat impairments that could be ameliorated (blog #’s 55 and 58) to mitigate future warming and increase population resilience?” Because once the fish are “freaking out”, it’s a bad sign that the clock is ticking & we would be wise to heed the message our finned friends are sending us.

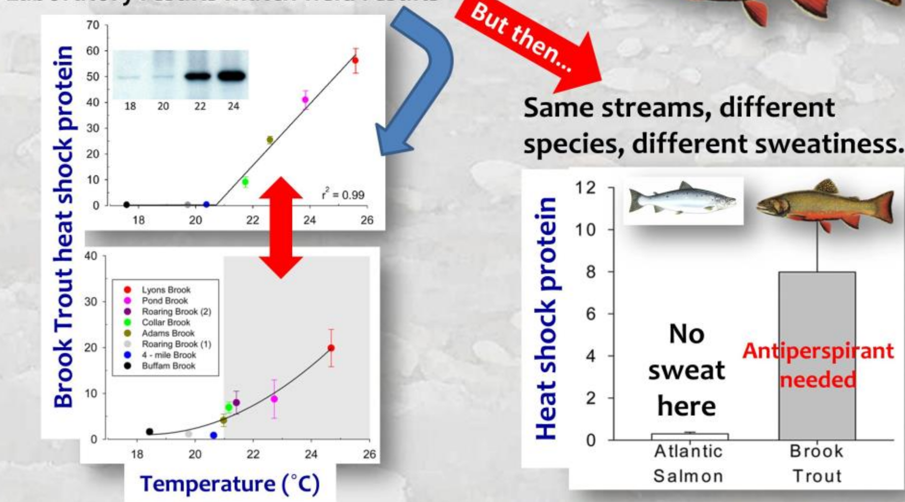
Until next time, best regards,
Dan

Now Tweeting at Dan Isaak@DanIsaak



I'm a cold-water fish, is it surprising that the heat makes my cells sweat?

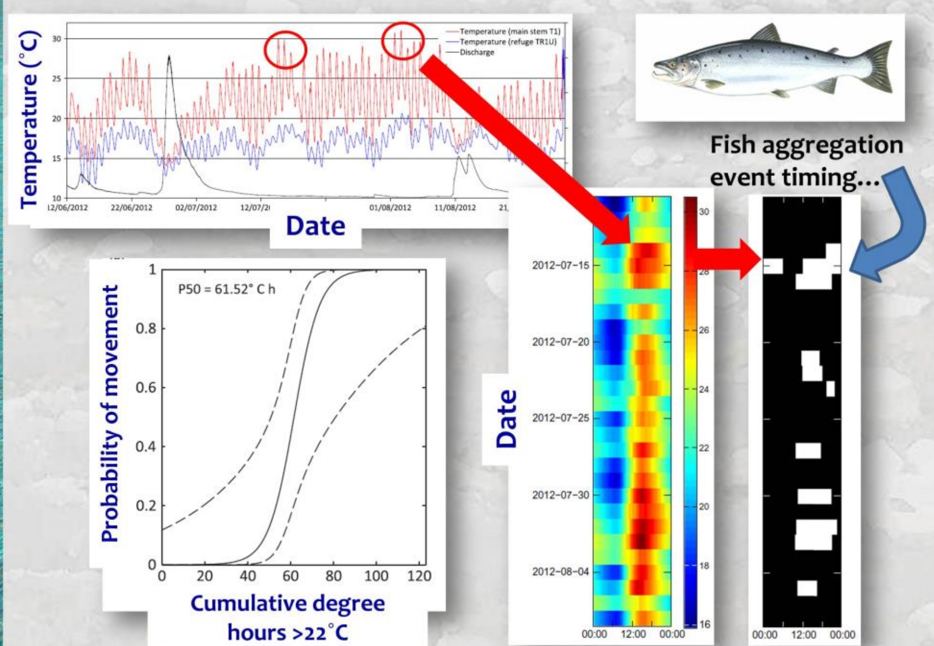
Laboratory results match field results



Chadwick et al. 2015. Thermal onset of cellular and endocrine stress responses correspond to ecological limits in brook trout, an iconic cold-water fish. *Conservation Physiology* **3**:doi 10.1093/conphys/cov017

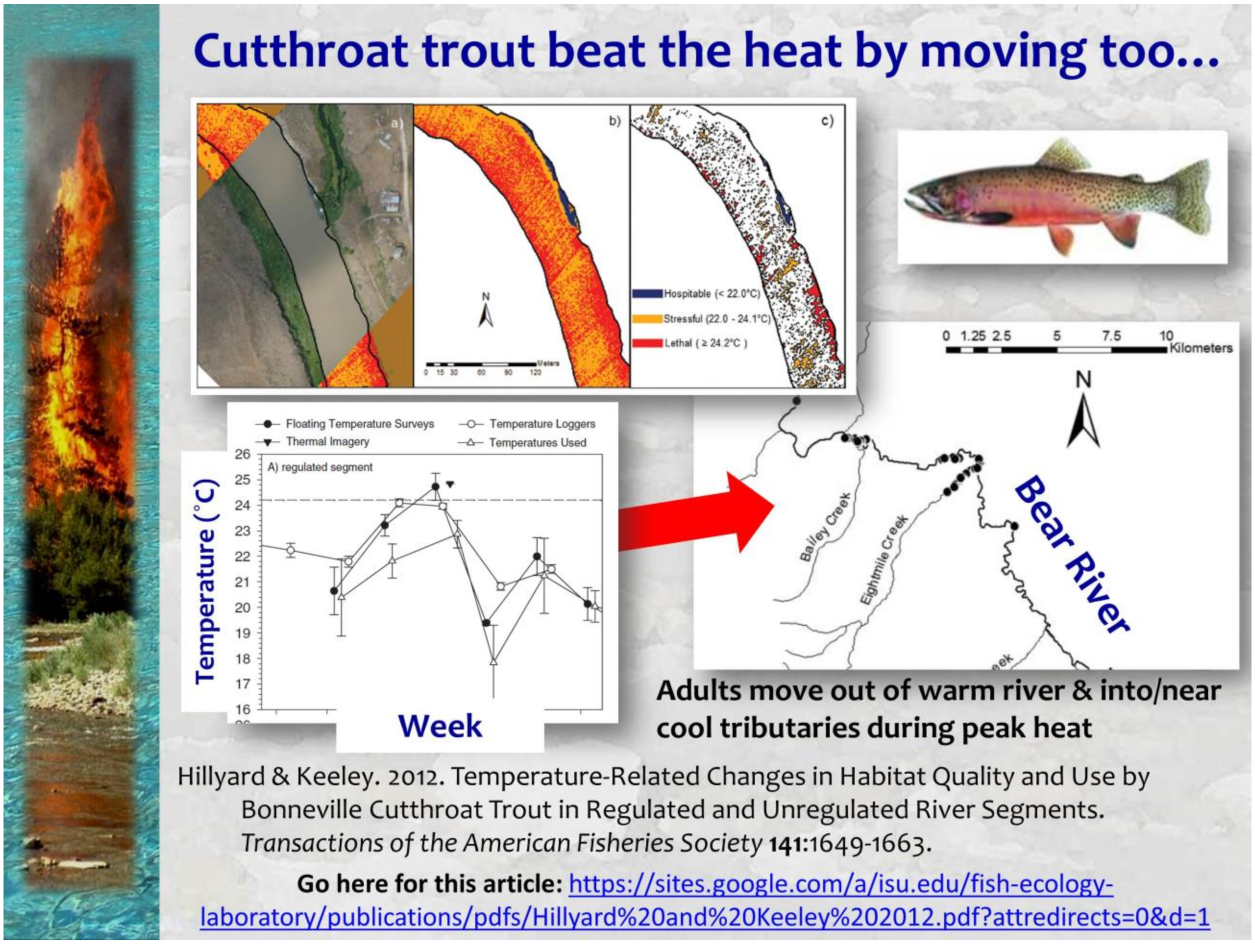
Go here for this article: http://conphys.oxfordjournals.org/content/3/1/cov017.full.pdf+html

Too Hot, Time to Move to Cooler Microclimes...



Dugdale et al. 2015. Main stem movement of Atlantic salmon parr in response to high river temperature. *Ecology of Freshwater Fish* **24**:doi: 10.1111/eff.12224.

Go here for this article: https://www.researchgate.net/profile/Stephen_Dugdale



Welcome to the Climate-Aquatics Blog. For those new to the blog, previous posts with embedded graphics can be seen by clicking on the hyperlinks at the bottom or by navigating to the blog archive webpage here: (http://www.fs.fed.us/rm/boise/AWAE/projects/stream_temp/stream_temperature_climate_aquatics_blog.html). The intent of the Climate-Aquatics Blog is to provide a means for the 9,214 (& growing) field biologists, hydrologists, anglers, students, managers, and researchers currently on this mailing list across North America, South America, Europe, and Asia to more broadly and rapidly discuss topical issues associated with aquatic ecosystems and climate change. Messages periodically posted to the blog highlight new peer-reviewed research and science tools that may be useful in addressing this global phenomenon. Admittedly, many of the ideas for postings have their roots in studies my colleagues & I have been conducting in the Rocky Mountain region, but attempts will be made to present topics & tools in ways that highlight their broader, global relevance. I acknowledge that the studies, tools, and techniques highlighted in these missives are by no means the only, or perhaps even the best, science products in existence on particular topics, so the hope is that this discussion group engages others doing, or interested in, similar work and that healthy debates & information exchanges occur to facilitate the rapid dissemination of knowledge among those concerned about climate change and its effects on aquatic ecosystems.

If you know others interested in climate change and aquatic ecosystems, please forward this message to them. If you do not want to be contacted again in the future, please reply to that effect and you will be de-blogged.

Previous Blogs…

Blog #34: Part 2, Fish distribution shifts from climate change: Empirical evidence for range contractions
Blog #35: Part 3, Fish distribution shifts from climate change: Empirical evidence for range expansions
Blog #36: The "velocity" of climate change in rivers & streams
Blog #37: Part 1, Monitoring to detect climate effects on fish distributions: Sampling design and length of time
Blog #38: Part 2, Monitoring to detect climate effects on fish distributions: Resurveys of historical stream transects
Blog #39: Part 3, Monitoring to detect climate effects on fish distributions: BIG DATA regional resurveys
Blog #41: Part 1, Mechanisms of change in fish populations: Patterns in common trend monitoring data
Blog #42: BREAKING ALERT! New study confirms broad-scale fish distribution shifts associated with climate change
Blog #56: New studies provide additional evidence for climate-induced fish distribution shifts
Blog #43: Part 2, Mechanisms of change in fish populations: Floods and streambed scour during incubation & emergence
Blog #44: Part 3, Mechanisms of change in fish populations: Lower summer flows & drought effects on growth & survival
Blog #45: Part 4, Mechanisms of change in fish populations: Temperature effects on growth & survival
Blog #46: Part 5, Mechanisms of change in fish populations: Exceedance of thermal thresholds
Blog #47: Part 6, Mechanisms of change in fish populations: Interacting effects of flow and temperature
Blog #48: Part 7, Mechanisms of change in fish populations: Changing food resources
Blog #49: Part 8, Mechanisms of change in fish populations: Non-native species invasions
Blog #50: Part 9, Mechanisms of change in fish populations: Evolutionary responses
Blog #51: Part 10, Mechanisms of change in fish populations: Extinction
Blog #52: Review & Key Knowable Unknowns

Climate-Aquatics Management Module

Blog #54: Part 1, Managing with climate change: Goal setting & decision support tools for climate-smart prioritization
Blog #55: Part 2, Managing with climate change: Streams in channels & fish in streams
Blog #57: Identifying & protecting climate refuge lakes for coldwater fishes
Blog #58: Part 3, Managing with climate change: Maintaining & improving riparian vegetation & stream shade
Blog #59: Part 4, Managing with climate change: Keeping water on the landscape for fish (beaverin' up the bottoms)