Climate-Aquatics Blog #65: The Fish Jumble as they Stumble along with the Shifting ThermalScape

I Compel You to Move…

Just as the late great Christopher Lee could compel his evil armies to march across Middle Earth, so it is with the thermal pied piper in invoking the nonvolitional movement of ectotherms across thermalscapes. Being ectotherms, they really have very little choice in the matter—fundamental physiology is at play as Kingsolver aptly describes in "The well-temperatured biologist" (study hyperlinked here: http://jgking.web.unc.edu/files/2012/06/Kingsolver.AmNat_.2009.pdf). And those relationships between temperature & physiological mechanisms have consequences both at global scales as Buckley & colleagues describe (graphic 1; study hyperlinked here: http://labs.bio.unc.edu/hurlbert/pubs/Buckley,%20Hurlbert%20and%20Jetz%202012.pdf), and at small fishy scales like an individual pool as Bonneau & Scarnecchia documented in a north Idaho stream (graphic 2; study hyperlinked here: www.uidaho.edu/~/media/Files/orgs/CNR/wildlifefish/Faculty%20publications/Scarnecchia/1996%20Bonneau%20Scarnecchia.pdf).

As temperatures continue to rise, then, some species will be more/less adept at tracking their thermal niches across aquatic landscapes due to differences in connectivity, local climate velocity (Blog #36), dispersal ability, geomorphology and other factors. This leads to all sorts of interesting ways that distributions can shift when moving through space; so much so that Grenouillet & Comte were inclined to develop a taxonomy of fish species shifts based on empirical patterns observed across France (graphic 3; study hyperlinked here: http://gael.grenouillet.free.fr/grenouillet_publications_fichiers/Grenouillet_GCB2014.pdf). And it's this jumble as the fish stumble along with climate change that may at times lead to no-analog communities, extirpations, range extensions, and the like as Williams & colleagues describe (graphic 4; study hyperlinked here: http://www.geography.wisc.edu/faculty/williams/lab/pubs/WilliamsJackson2007Frontiers_NovelClimates.pdf).

Next time out, we'll start looking at what we can do to facilitate (or inhibit) fish flows across landscapes, and how those actions may ultimately be some of our most powerful tools for conserving aquatic biodiversity this century.

Until then, best regards. Dan

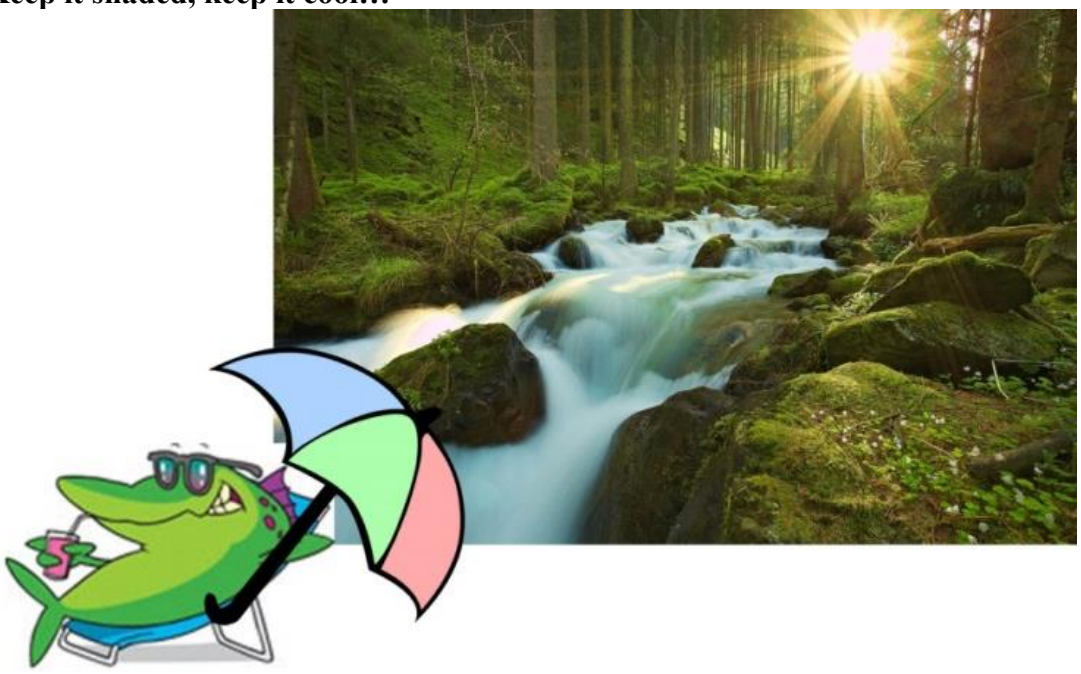
Postscript. In that stream shading through maintaining/improving riparian vegetation is one of the most effective things we can do to combat warming of streams caused by climate change (Blog #58), these recent studies warrant mention…

Perry & colleagues. 2015. Incorporating climate change projections into riparian restoration planning and design. Ecohydrology DOI: 10.1002/eco.1645 (Study available here: https://www.researchgate.net/profile/Timothy_Beechie)

Johnson & Wilby. 2015. Seeing the landscape for the trees: Metrics to guide riparian shade management in river catchments. *Water Resources Research* DOI 10.1002/2014WR016802 (Study available here: https://www.researchgate.net/profile/Matthew_Johnson39/publications)

Reiter & colleagues. 2015. Stream temperature patterns over 35 years in a managed forest of western Washington. *Journal of the American Water Resources Association* DOI:10.1111/1752-1688.12324

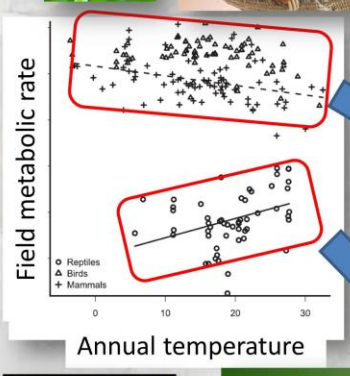
Keep it shaded, keep it cool…

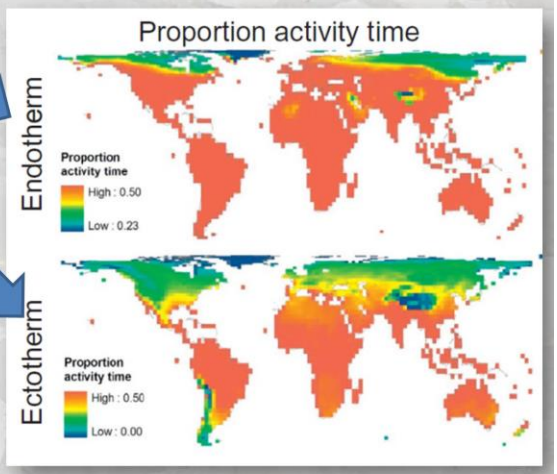


Tweeting at Dan Isaak@DanIsaak

Global Temperature Gradients Strongly Affect What, Where, and When Ectotherms do Things…


Same geography, but different worlds depending on your physiology

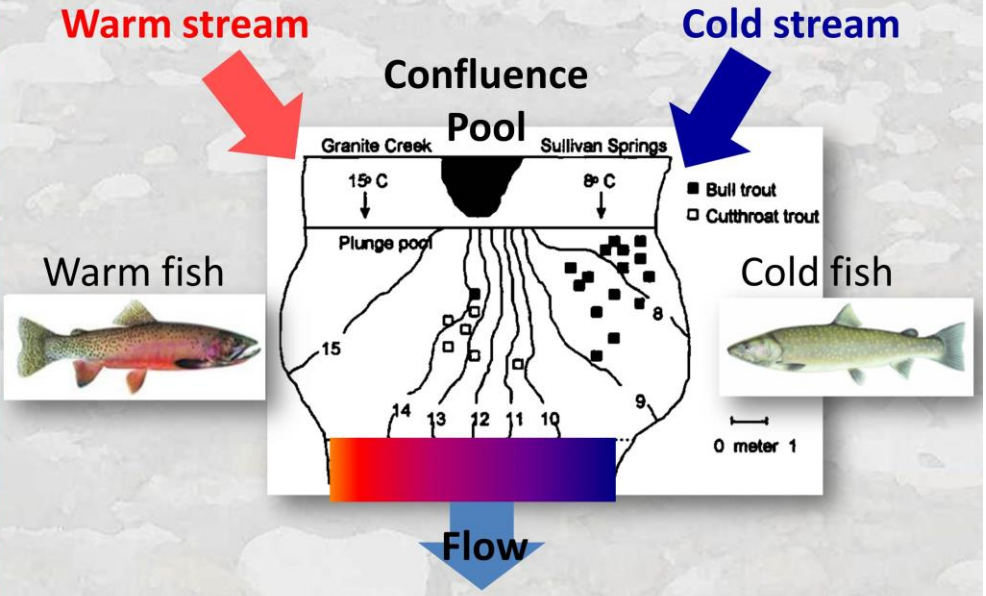





Buckley et al. 2012. Broad-scale ecological implications of ectothermy and endothermy in changing environments. *Global Ecology and Biogeography* **21**:873–885.

Go here for article: http://labs.bio.unc.edu/hurlbert/pubs/Buckley,%20Hurlbert%20and%20Jetz%202012.pdf

Local Temperature Gradient Affects Species Distributions Within a Single Stream Pool



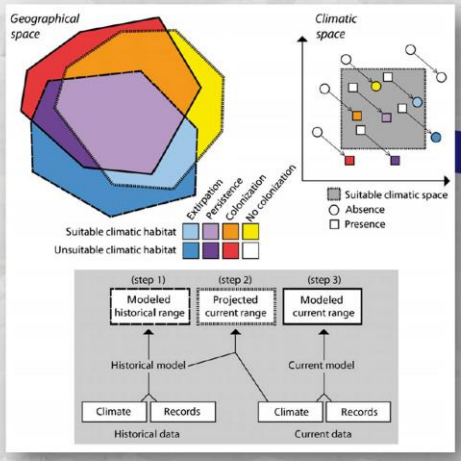
Bonneau & Scarnecchia. 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. *Transactions of the American Fisheries Society* **125**:628-630.

Go here for article:

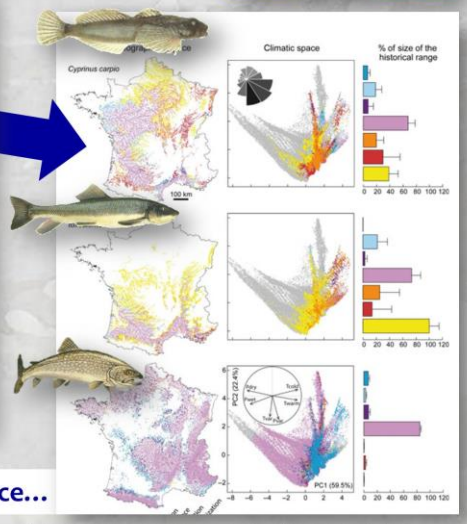
www.uidaho.edu/~/media/Files/orgs/CNR/wildlifefish/Faculty%20publications/Scarnecchia/1996%20Bonneau%20Scarnecchia.pdf

A Taxonomy of Ways that Fish Distribution Shifts Occur Across France…

Conceptual model



Fish reality

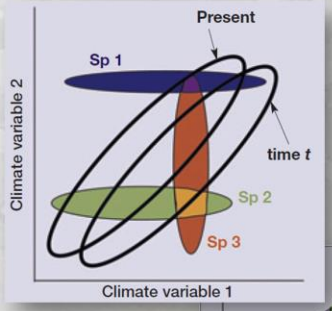


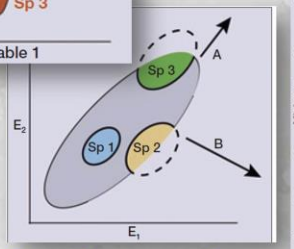
Fish March Differently Through Space…

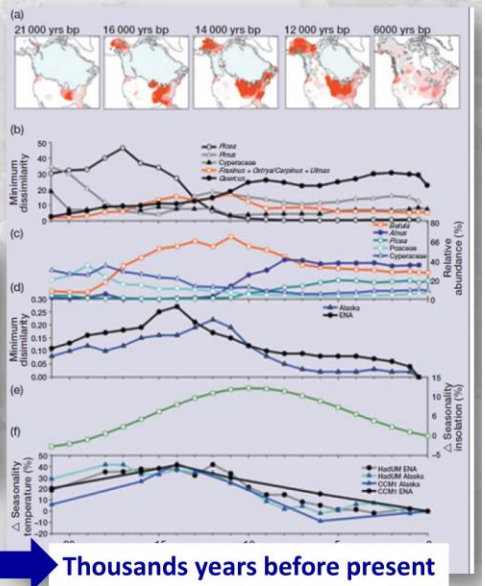
Grenouillet & Comte. 2014. Illuminating geographical patterns in species' range shifts. *Global Change Biology* **20:**3080–3091.

Go here for article: http://gael.grenouillet.free.fr/grenouillet_publications_fichiers/Grenouillet_GCB2014.pdf

Climate Change Moves the Same Climate to Different Places, but also Creates new Climates…







Some species adapt/move, others don't, & communities change…

Thousands years before present

Williams et al. 2007. Novel climates, no-analog communities, and ecological surprises. *Frontiers in Ecology & the Environment* **5**:475–482.

Go here for article:

http://www.geography.wisc.edu/faculty/williams/lab/pubs/WilliamsJackson2007Frontiers_NovelClimates.pdf

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…

Climate-Aquatics Overviews

Blog #1: Climate-aquatics workshop science presentations available online
Blog #2: A new climate-aquatics synthesis report

Climate-Aquatics Thermal Module

Blog #3: Underwater epoxy technique for full-year stream temperature monitoring
Blog #4: A GoogleMap tool for interagency coordination of regional stream temperature monitoring
Blog #5: Massive air & stream sensor networks for ecologically relevant climate downscaling
Blog #6: Thoughts on monitoring air temperatures in complex, forested terrain
Blog #7: Downscaling of climate change effects on river network temperatures using inter-agency temperature databases with new spatial statistical stream network models
Blog #8: Thoughts on monitoring designs for temperature sensor networks across river and stream basins
Blog #9: Assessing climate sensitivity of aquatic habitats by direct measurement of stream & air temperatures
Blog #10: Long-term monitoring shows climate change effects on river & stream temperatures
Blog #11: Long-term monitoring shows climate change effects on lake temperatures
Blog #12: Climate trends & climate cycles & weather weirdness
Blog #13: Tools for visualizing local historical climate trends
Blog #14: Leveraging short-term stream temperature records to describe long-term trends
Blog #15: Wildfire & riparian vegetation change as the wildcards in climate warming of streams
Blog #23: New studies describe historic & future rates of warming in Northwest US streams
Blog #24: NoRRTN: An inexpensive regional river temperature monitoring network
Blog #25: NorWeST: A massive regional stream temperature database
Blog #26: Mapping thermal heterogeneity & climate in riverine environments
Blog #40: Crowd-sourcing a BIG DATA regional stream temperature model
Blog #60: Bonus Blog: New report describes data collection protocols for continuous monitoring of temperature & flow in wadeable streams
Blog #61: Significant new non-American stream temperature climate change studies

Blog #62: More Bits about the How, What, When, & Where of Aquatic Thermalscapes
Blog #63: Navigating stream thermalscapes to thrive or merely survive
Blog #64: Building real-time river network temperature forecasting systems

Climate-Aquatics Hydrology Module
Blog #16: Shrinking snowpacks across the western US associated with climate change
Blog #17: Advances in stream flow runoff and changing flood risks across the western US
Blog #18: Climate change & observed trends toward lower summer flows in the northwest US
Blog #19: Groundwater mediation of stream flow responses to climate change
Blog #20: GIS tools for mapping flow responses of western U.S. streams to climate change
Blog #21: More discharge data to address more hydroclimate questions
Blog #22: Climate change effects on sediment delivery to stream channels

Climate-Aquatics Cool Stuff Module
Blog #27: Part 1, Spatial statistical models for stream networks: context & conceptual foundations
Blog #28: Part 2, Spatial statistical models for stream networks: applications and inference
Blog #29: Part 3, Spatial statistical models for stream networks: freeware tools for model implementation
Blog #30: Recording and mapping Earth's stream biodiversity from genetic samples of critters
Blog #53: DNA Barcoding & Fish Biodiversity Mapping

Climate-Aquatics Biology Module
Blog #31: Global trends in species shifts caused by climate change
Blog #32: Empirical evidence of fish phenology shifts related to climate change
Blog #33: Part 1, Fish distribution shifts from climate change: Predicted patterns
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)