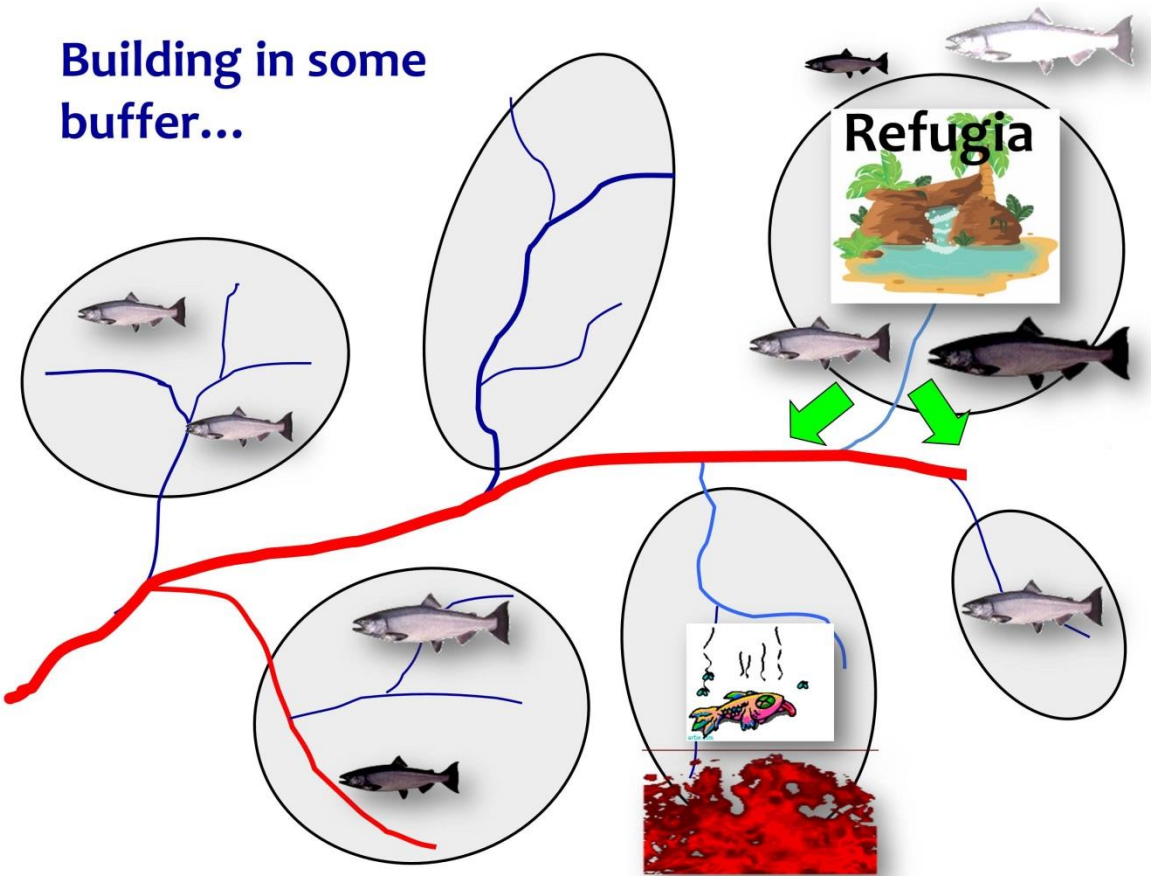
Climate-Aquatics Blog #69: Climate-smart conservation networks (metapopulations + biodiversity + refugia)



So last time it was argued that identifying & protecting climate refugia (which were defined as subsets of currently occupied habitats that retain the capacity to support self-sustaining populations of a target species later this century) could be an effective means of long-term species preservation (Blog #68). But that which constitutes a refugia will ultimately be measured along a sliding scale dependent on the degree of future climate change. Moderate amounts of change by late century and many habitats might serve as refugia; massive amounts of change and perhaps none will. It all depends…and the uncertainties at the outset of this century are large given critical unknowns about future greenhouse gas emissions and at what level they are (hopefully) leveled off. Hedging, therefore, is wise, which means building in some buffer around those refugia rather than putting all eggs in their baskets. One option then is to simply use refugia as foundational elements in the design of climate-smart conservation networks that are comprised of habitats & populations linked by dispersal. Viewed in that context, the rapidly evolving world of climate ecology can be integrated with the corpus of knowledge tied to metapopulation dynamics and population persistence in unstable environments (review article by Hanski hyperlinked here: ftp://193.49.112.3/pub/irisson/papers/Hanski1998-Metapopulation%20ecology00.pdf). An important caveat is that climate change is predicted to increase environmental variation, which is likely to mean that larger habitats will be needed to support populations than was historically the case as Verboom & colleagues discuss (study

hyperlinked here: http://se-server.ethz.ch/Staff/af/Fi159/V/Ve217.pdf). How much larger is difficult to predict, but it can just be viewed as another important source of future uncertainty that should further motivate us to design & implement robust conservation networks.

And in so doing, another important buffering agent to draw upon is that that's provided by biodiversity itself. Populations comprising metapopulations are not all created equal—some have big fish-small fish; others have red fish-blue fish—and to the extent that the array of life history types and genotypes underlying that inequality can be maintained/promoted, it can lend important longterm stability and persistence to the whole—what has come to be referred to as the portfolio effect (discussed by Schindler & colleagues; study hyperlinked here: http://www.sportsmansalliance4ak.com/assets/latest_news/2010/Schindler-2010-Population_diversity_bb_sockeye.pdf). Getting to this level of spatially & temporally explicit prediction based on a robust understanding of bioclimatic dynamics is no mean feat but is what's ultimately needed to provide a context for conservation investment successes over the course of this century. Next time out we'll highlight some early success stories...

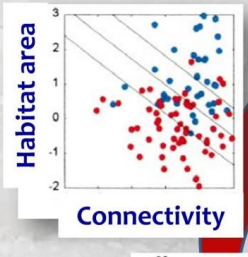
Until then, best regards. Dan

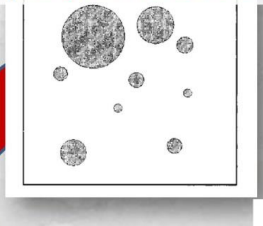
Tweeting at Dan Isaak@DanIsaak

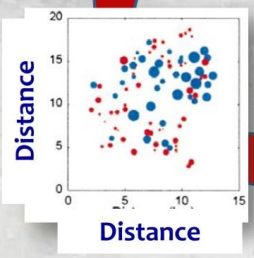
p.s. if anyone ever calls you "tough as a tardigrade", take it as a complement. Just another amazing aquatic animal…http://www.bbc.co.uk/nature/12855775
http://www.nytimes.com/2015/09/08/science/the-tardigrade-water-bear.html

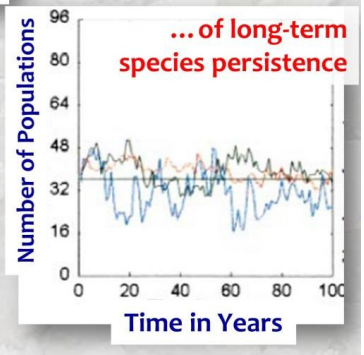
Meta-population Dynamics Enable Species Persistence in Unstable Environments…

Habitat size, connectivity & quality drive the boat…



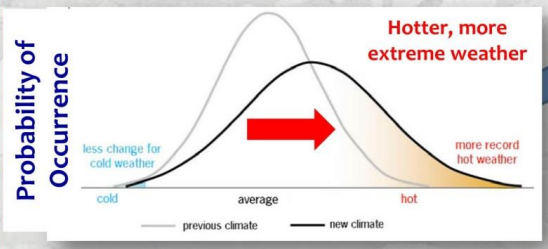


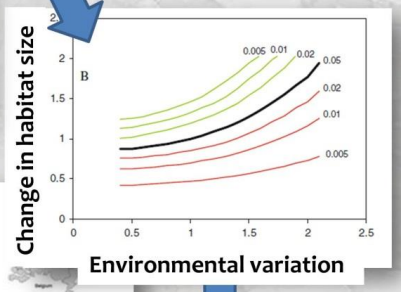


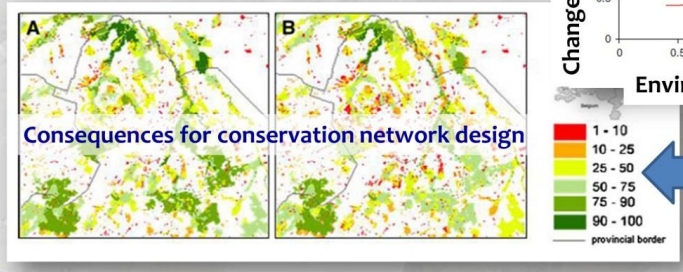


Hanski. 1998. Metapopulation dynamics. *Nature* **396**: 41-49.
Available from: ftp://193.49.112.3/pub/irisson/papers/Hanski1998-Metapopulation%20ecology00.pdf

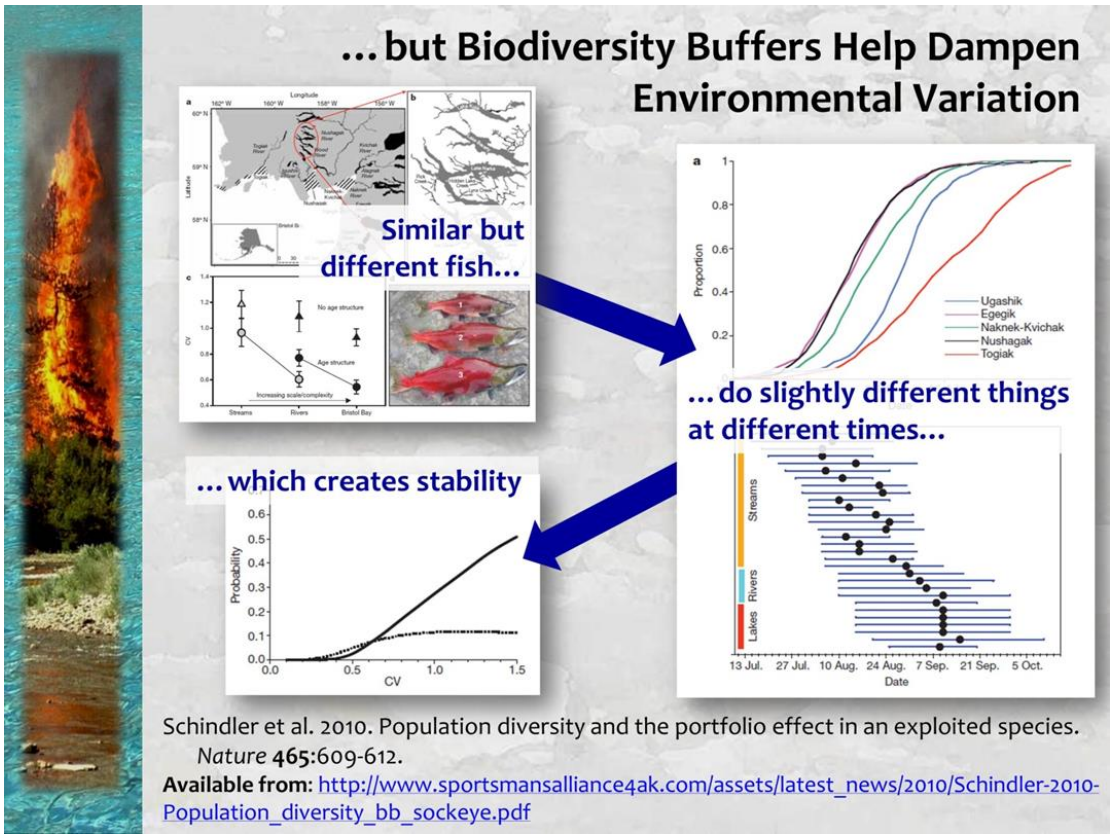
Climate Change Increases Environmental Variation, which Means Larger Habitats Needed for Persistence…







Verboom et al. 2010. Population dynamics under increasing environmental variability: implications of climate change for ecological network design criteria. *Landscape Ecology* **25**:1289–1298.
Available from: http://se-server.ethz.ch/Staff/af/Fi159/V/Ve217.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
Blog #65: The Fish Jumble as they Stumble along with the Shifting ThermalScape

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)
Blog #66: Part 5, Managing with climate change: Barrier placements to facilitate fish flows across landscapes
Blog #67: Part 6, Managing with climate change: Assisted migration to facilitate fish flows across landscapes
Blog #68: Identifying & protecting climate refugia as a strategy for long-term species conservation