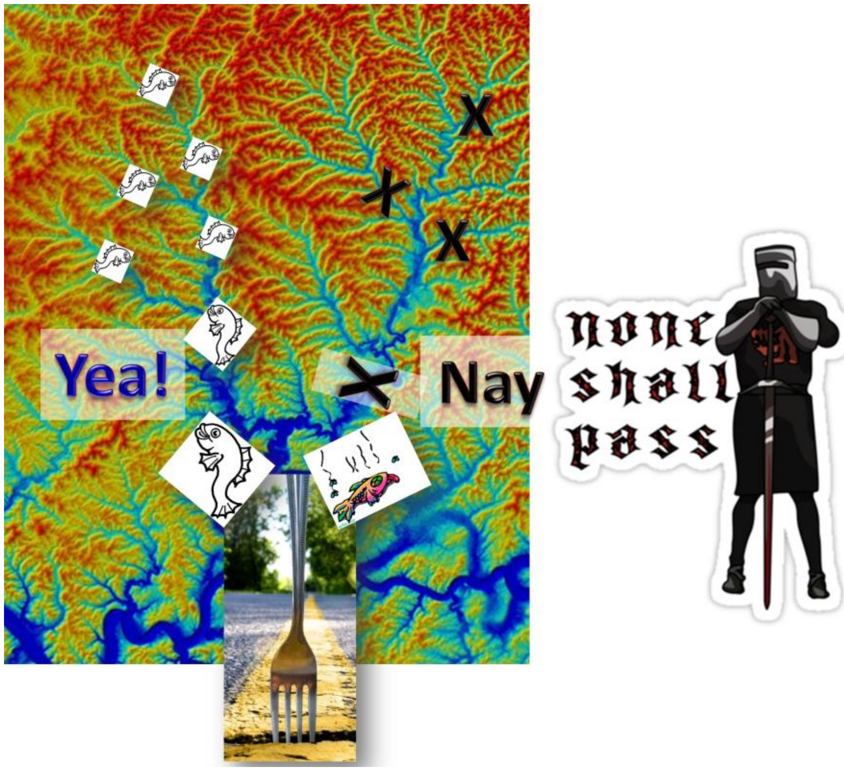
Climate-Aquatics Blog #66: Managing with climate change, part 5: Controlling fish flows across landscapes: placement & removal of barriers



In the grand scheme of things, there are 3 big things we can do this next decade to most usefully combat climate change & prepare for conserving the maximum amount of fish biodiversity this century. They are: 1) conducting geographically broad & intense biodiversity surveys to document the fishy things that live out there, & where exactly those things live (because except for a few charismatic species in a few areas, we know surprisingly little about those specifics (& if you can't describe all of where something lives, it's difficult to strategically assess risk or plan conservation investments efficiently (Blogs 30, 53))); 2) restore/maintain functional riparian areas & natural flow regimes (stream temperature & flow are the two primary vectors by which climate change manifests in streams so righting past wrongs in those regards could do much in some areas to offset future changes (Blogs 58, 59)), and 3) manage fish flows across landscapes, which we start into with today's blog.

There are two sides to the fish flow issue. On the one hand, we want to remove, or facilitate passage past, anthropogenic impediments in rivers and streams so that fish can flex their distributions to go where the thermal pied-piper compels them this century (blogs 34, 35, 42, 56, 65). And with big, old, and cold habitats where dams have long prevented access of species like salmon and trout to portions of their historical range, the benefits are obvious and success stories have begun to emerge. Pess & colleagues provide a recent review of the topic (study attached), but things like the Elwha dam removal on the Olympic peninsula fall into this category (cool video here:
http://www.bing.com/videos/search?q=elwha+dam+removal&qs=VI&form=QBVLPG&pq=elw

h&sc=8-
4&sp=1&sk=#view=detail&mid=6AEEF8569AABB43EF12E6AEEF8569AABB43EF12E).

But what about the death by a thousand cuts from the large numbers of smaller dams & road crossings that often impede fish movements throughout the networks upstream from mainstem rivers? In those areas, the array of possibilities is daunting & there's typically much less funding with which to pursue the possibilities. Ensuring maximum ecological return on investments requires strategic, and well-informed, prioritization schemes as described by Neeson & colleagues (graphic 1; study hyperlinked here: https://www.researchgate.net/publication/275586128_Enhancing_ecosystem_restoration_efficiency_through_spatial_and_temporal_coordination). In that work, the investigators assessed the costs/benefits of restoration strategies in heavily fragmented stream networks across the Great Lakes region. They found that concentrating investments in a small number of watersheds over a short period of time usually provided greater benefits than spreading things out in space & time (which is quite different from what's usually done).

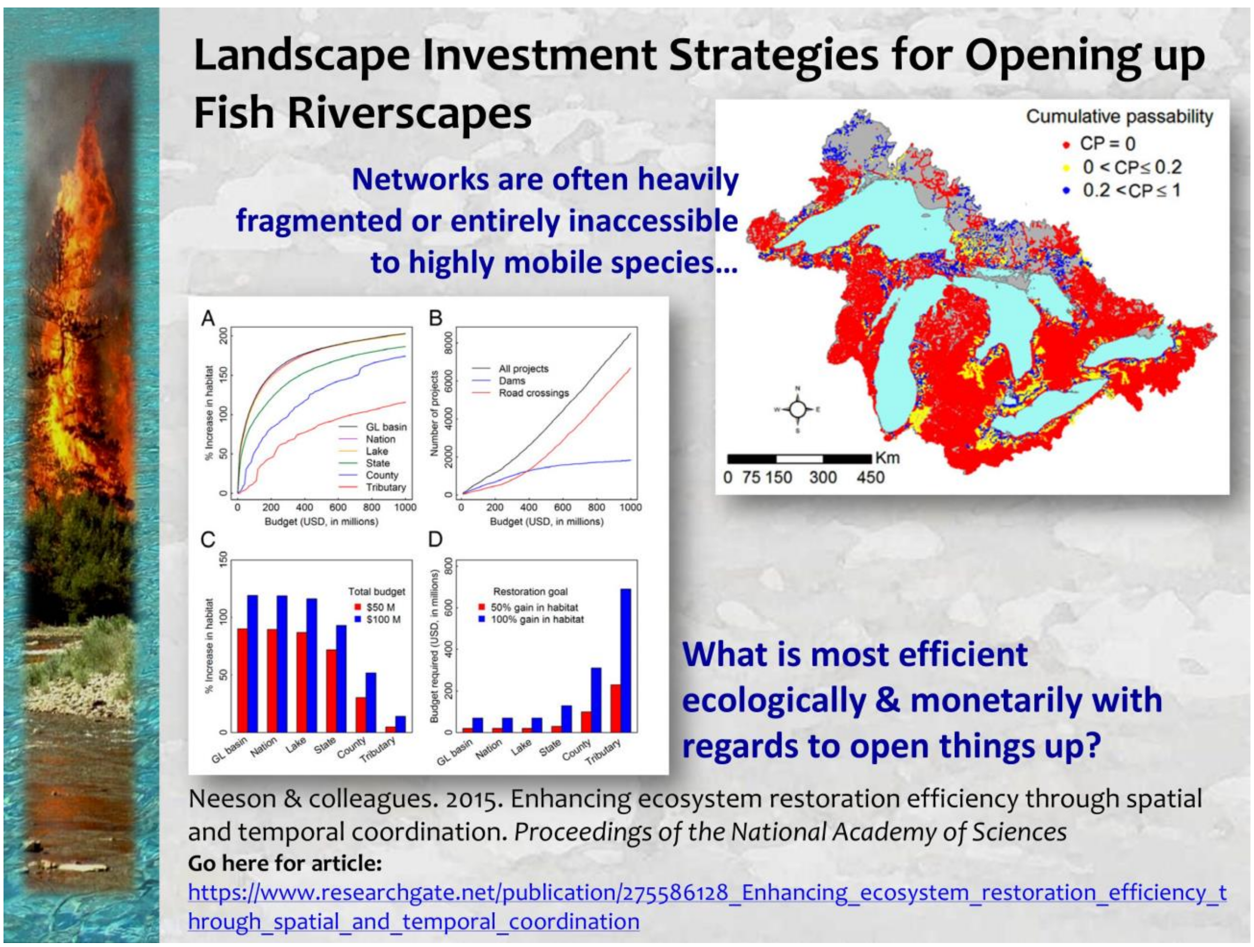
Adding an interesting twist to the fish flow story though is that second hand. That hand holds the facts that artificial barriers are sometimes really good at keeping invasive species out of places where they'd likely extirpate native species if allowed to run riot. Poster child examples here include trout species like brook trout and cutthroat trout within their native ranges, where they are menaced by the downstream presence of European brown trout or the now ubiquitous rainbow trout. In those situations, the conservation strategy may be to intentionally fragment streams through the construction of barriers—a sometimes somewhat Faustian bargain as Fausch & colleagues discuss for cold-water species (graphic 2; study hyperlinked here: http://www.unb.ca/research/institutes/cri/_resources/pdfs/opportunities/Fausch.tmp.pdf), and Rahel discussed for a broader range of aquatic taxa (graphic 3; study hyperlinked here: http://bioscience.oxfordjournals.org/content/63/5/362.full.pdf+html).

In many ways, the choices we face with regards to fish barriers perfectly epitomize the choices we face with climate change (graphic 4). In what parts of the system, and for which set of resources, do we choose to coexist with climate change & work to make a smooth transition into something new? And where do we resist, push back against change, and try to hang onto something we hold dear? There will be ongoing uncertainty for decades to come about what the "new normal" world will look like 50-100 years from now if the climate can be stabilized. But there's little uncertainty that the choices we're making now affect the trajectories taken and where we do someday land.

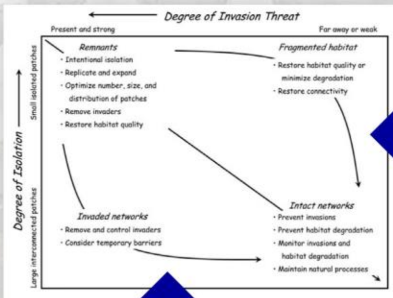
Until next time, best regards. Dan

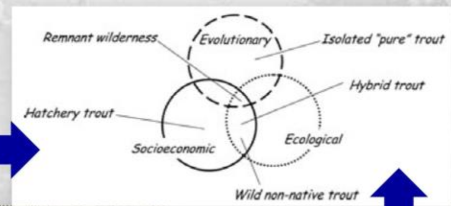
Postscript. As we all already knew, most of the biosphere is comprised of water. But did you know a fish species is the world's most abundant vertebrate—by far? Fish do rule.
http://www.nytimes.com/2015/06/30/science/bristlemouth-ocean-deep-sea-cyclothone.html?action=click&pgtype=Homepage&version=Moth-Visible&module=inside-nyt-region&region=inside-nyt-region&WT.nav=inside-nyt-region

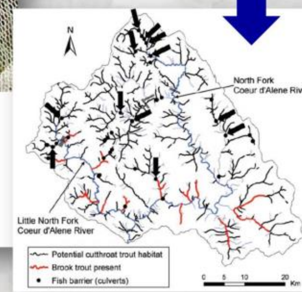
Tweeting at [Dan Isaak@DanIsaak]



Many Tradeoffs & Resource Values to Consider when Improving/impeding Stream Access…



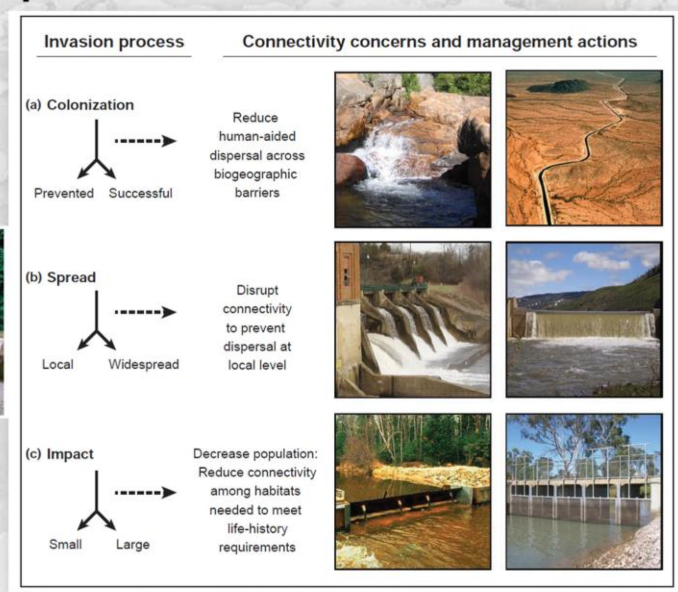




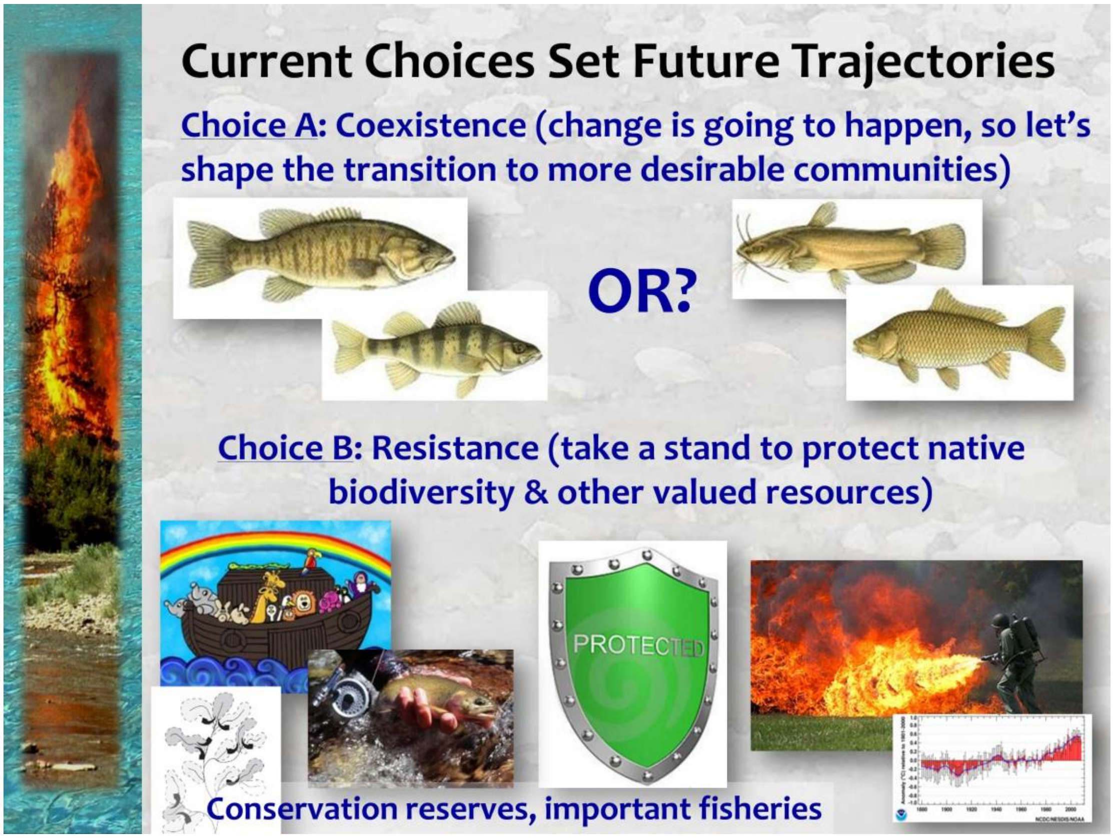
Fausch et al. 2009. Invasion versus Isolation: trade-offs in managing native salmonids with barriers to upstream movement. *Conservation Biology* **23**: 859-870.
Go here for study:
http://www.unb.ca/research/institutes/cri/_resources/pdfs/opportunities/Fausch.tmp.pdf

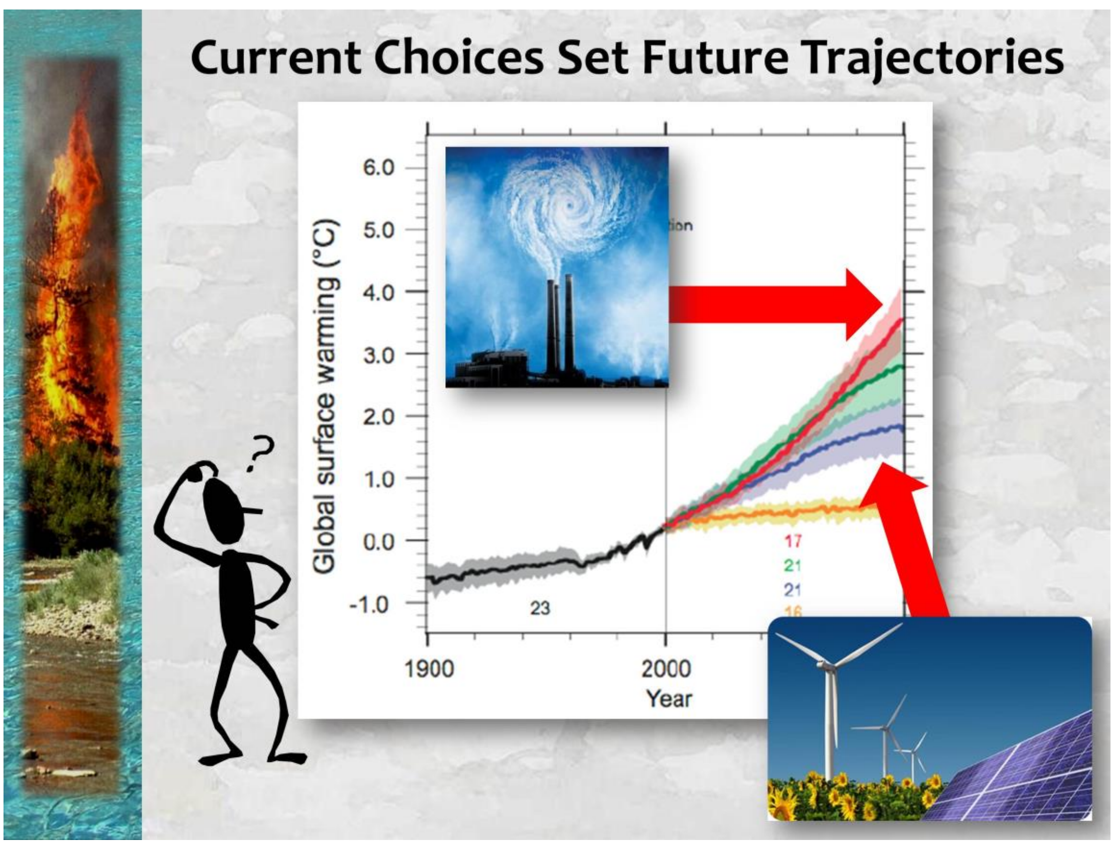
Fish Passage Issues will Become Ever More Important as Species & Infrastructures Continue to Spread…

Crawdad attacks…an underappreciated future terror…



Rahel. 2013. Intentional Fragmentation as a Management Strategy in Aquatic Systems. *BioScience* **63**:362-372
Go here for article: http://bioscience.oxfordjournals.org/content/63/5/362.full.pdf+html


Current Choices Set Future Trajectories
Choice A: Coexistence (change is going to happen, so let's shape the transition to more desirable communities)
OR?
Choice B: Resistance (take a stand to protect native biodiversity & other valued resources)
PROTECTED
Conservation reserves, important fisheries


Current Choices Set Future Trajectories
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
23
17
21
21
16
1900
2000
Year

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 #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)