Climate-Aquatics Blog #59: Managing with climate change, part 4: Keeping water on the landscape for fish

Dam Nation – Time to go Bigger & Broader with Buckey

Hi Everyone,
One of the concerns about climate change is that droughts could become more extreme and prolonged as the weather becomes more variable (Blog #12). In many streams with snowmelt related hydrographs, those extreme events could be exacerbated by long-term trends toward lower summer flows as snowpacks continue to decline with ongoing warming (Blog #18). Less water equals less fish and nobody likes that. One way of buffering the effects of lower flows on fish is to use water more efficiently and keep more of it in channels (Blog #55), but what if we could also just retain more of it on the landscape for longer? The human engineering approach is of course to build dams and store it in reservoirs, but many of the best sites are already taken and dams are expensive—both ecologically and monetarily—as Graf points out in this accurately titled, "Dam Nation" article (study hyperlinked here: http://www.limnoreferences.missouristate.edu/assets/limnoreferences/Graf1999.pdf).

So what if we could store more water throughout the network in an ecologically beneficial way at relatively low cost? Sounds too good to be true, but our furry friend—the beaver—would argue otherwise and is willing to put his money where his considerable teeth are housed by doing most of the heavy lifting for us. With a distribution that once stretched across much of Eur-Asia and North America (graphic 1), and historical populations numbering in the 10's of millions, beavers once had significant effects on hydrologic regimes and stream ecosystems at very large scales (good review by Naiman & colleagues hyperlinked here: http://www.jstor.org/stable/1310784). To get a sense of how much beavers can matter to local hydrology, the study by Hood and colleagues is particularly instructive (study hyperlinked here: http://landscouncil.org/documents/Beaver_Project/Hood_Bayley.pdf). Over a 54 year period from 1948-2002, they studied the amount of wetted surface area across a wetlands district in western Canada as beavers re-established themselves. By the end of that period, the amount of wetted area had increased by 2x – 3x and the number of beaver lodges explained 80% of the increase when also considering climatic variability (graphic 2). Particularly relevant for the fishes was that during an extreme drought in 2002, the amount of wetted area remained much larger than it would have otherwise been before beaver were back in the system.

So although beaver hats have been out of style for more than a century, and a general sense that beaverdom is slowly recovering, populations are nowhere near pre-beaver-hat day abundances. In many areas, it's thought that the loss of beavers is also a contributing factor to the incision and degradation of floodplains, which has ultimately simplified and decreased diversity in stream and riparian habitats. Pollock and colleagues (study hyperlinked here: http://www.martinezbeavers.org/wordpress/wp-content/uploads/2014/04/Pollock-et-al-Using-beaver-dams-to-restore-incised-streams-BioScience-2014.pdf) demonstrate how those trends might well be reversed through the reintroduction of beavers and application of sound geomorphic principles (graphic 3). The changes don't occur overnight—it might take a decade or two—but anyone that's walked along a valley with a healthy beaver colony knows what a dramatic difference it makes. That whole valley floor is a sort of semi-aqueous sponge with fish showing up in all sorts of side-channels, pools, backwaters, and other fish friendly environments. That diversity translates to the terrestrial as well, where more birds & bees & trees show up to appreciate & enhance the work of nature's pre-eminent engineer. It won't be possible, or sensible, to 'beaver-up' the bottoms everywhere, but doing so where it does make sense should be another tactic in a diverse portfolio of adaptation actions as we work to improve the resilience of streams against climate change this century.

Until next time, best regards,
Dan

Other recent beaver reviews…

Gibson and Olden. 2014. Ecology, management, and conservation implications of North American beaver in dryland streams. Aquatic Conservation: Marine and Freshwater Ecosystems 24:391-409. (study hyperlinked here: http://depts.washington.edu/oldenlab/wordpress/wp-content/uploads/2013/01/AquaticConservation_2014.pdf

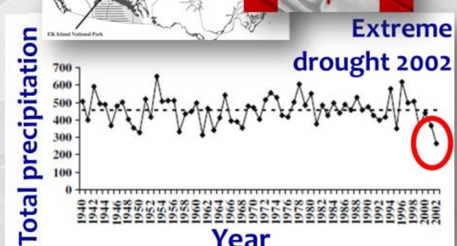
Persico & Meyer. 2012. Natural and historical variability in fluvial processes, beaver activity, and climate in the Greater Yellowstone Ecosystem. Earth Surface Processes and Landforms DOI: 10.1002/esp.3349 (study hyperlinked here: http://montanaioe.org/sites/default/files/resources/Moor/August_14/Persico_2012_EarthSurProcLandforms.pdf)

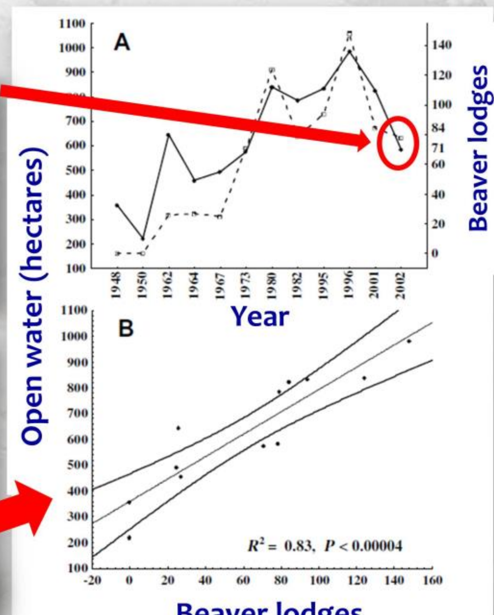
Now Tweeting at Dan Isaak@DanIsaak

Now that's plugging a valley & creating some fish habitat…

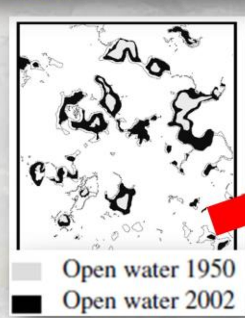
Beavers Keep More Water on the Landscape…

(Even During Droughts)



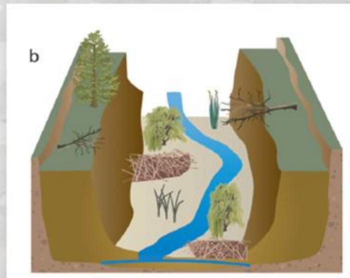


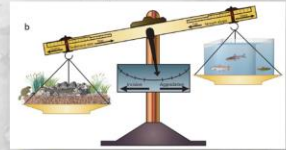
Surface water 50 years after beaver reintroduction



Hood & Bayley. 2008. Beaver mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. *Biological Conservation* **141**: 556-567.

Beavers Can Restore Stream Valleys & Create Habitat Diversity for Many Critters





Beavers can tip the balance towards more fish habitat by decreasing stream power, retaining sediment, and aggrading valley floors

"I moved in when the neighborhood was nice & quiet…"

"… & now there are all these noisy neighbors"

Pollock et al. 2014. Using Beaver Dams to Restore Incised Stream Ecosystems. *BioScience* **64**: 279-290.

Fish like water, ergo ipso facto…

… beavers must be fishes friends

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 8,524 (& 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

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 #57: Identifying & protecting climate refuge lakes for coldwater fishes
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 #58: Part 3, Managing with climate change: Maintaining & improving riparian vegetation & stream shade

Future topics…
Climate-Aquatics End Game