Climate-Aquatics Blog #18: The neighborhood's getting more crowded these days.

Summer is a challenging time to be a fish in temperate streams sometimes. It's hot and it's crowded with all those young fry and parr swimming around in your face all the time. Everyone's stressed out (metabolically speaking) and has to compete for food and space to sock away enough bodily reserves to make it through the extended winters. Compounding matters in recent decades is that there's less space to do it all because summer flows in some regions have been steadily trending lower.

So this week we're highlighting two studies that focus on this phenomenon in the northwest US. The first is by Jason Leppi and co-authors and here they look at trends in August flows across Idaho, Wyoming, and Montana from 1950 - 2008. Of the 65 long-term gage records on unregulated streams they examined, 89% had declining flow trends and the average decrease in August discharge was 21% (graphic 1).

A second paper by Luce and Holden addresses a similar topic slightly further west by examining the frequency of annual flows (graphic 2). Results of this study show that flows during 25th-percentile low flow years (i.e., the lowest flow every 4 years) have declined substantially (22% - 47%) since 1948. Thus, when low flow drought years occur, they now tend to be much more extreme than they were a half century ago. This paper also shows that summer low flows were strongly correlated with the annual flow in snowmelt dominated streams across the region, suggesting a parallel outcome for summer low flows.

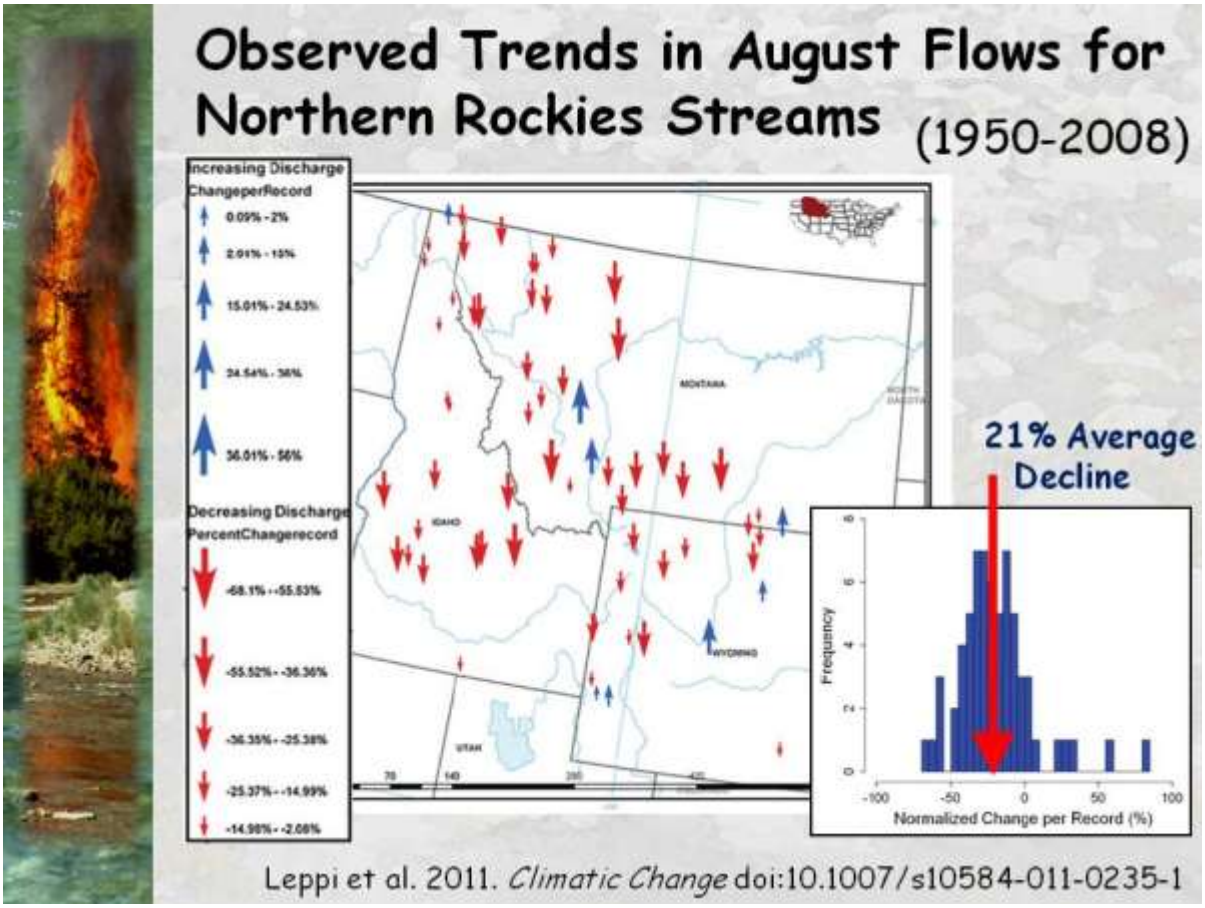
To the extent that these trends have been, and continue to be, driven by a changing climate, it would be a big deal because they'd represent a direct loss of the total amount of habitat for aquatic organisms during the critical summer period. Less discharge means less habitat volume in river mainstems, but it may also mean that the upstream extent of perennially flowing streams slowly creeps downstream over time (graphic 3). And declining flows in headwater streams may also make it more difficult for fall spawning fish to move upstream past migratory constrictions to access traditional spawning areas.

It's cautioned, however, that the causal linkages between summer flow trends and climate change are still somewhat unclear. Yes, shrinking snowpacks (Blog #16) and earlier stream flow runoff (Blog #17) that have been linked to warming temperatures probably contribute to decreased flows later in the year. But there are also important effects due simply to trends in total precipitation/annual stream runoff that may either exacerbate or ameliorate trends in summer flows. And the observed trends for total precipitation/runoff are much less clear cut (graphic 4), as are the climate model projections for these factors. So there's still some sorting out to do regarding how much of the summer flow declines is attributable to climate change.

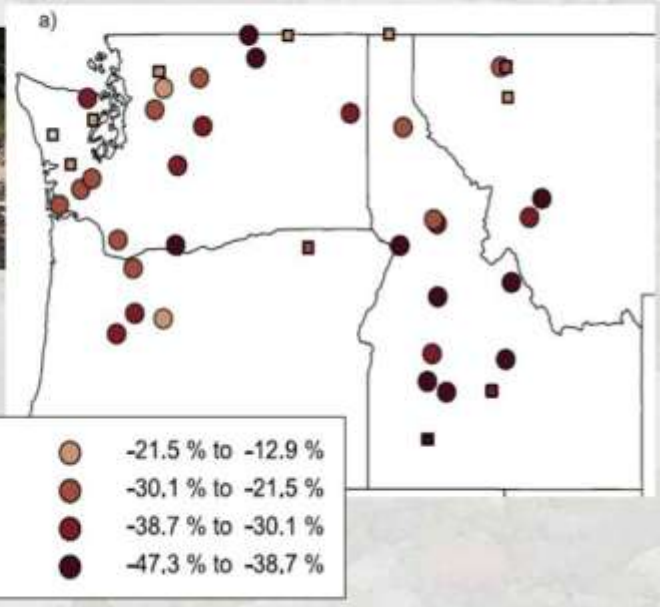
Fish don't really care, however, all they know is that there's less elbow room these days and it's starting to get warm too…

Until next time, best regards,

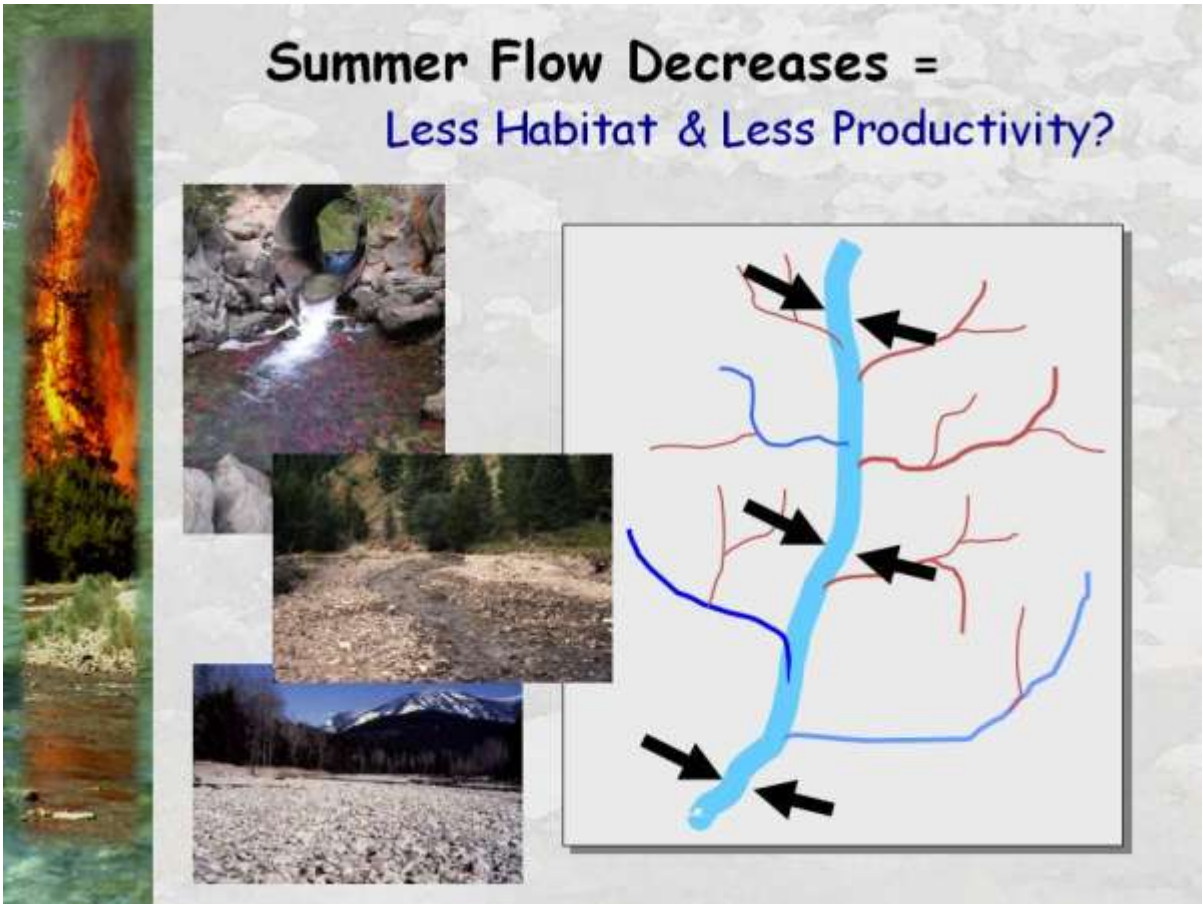
Dan

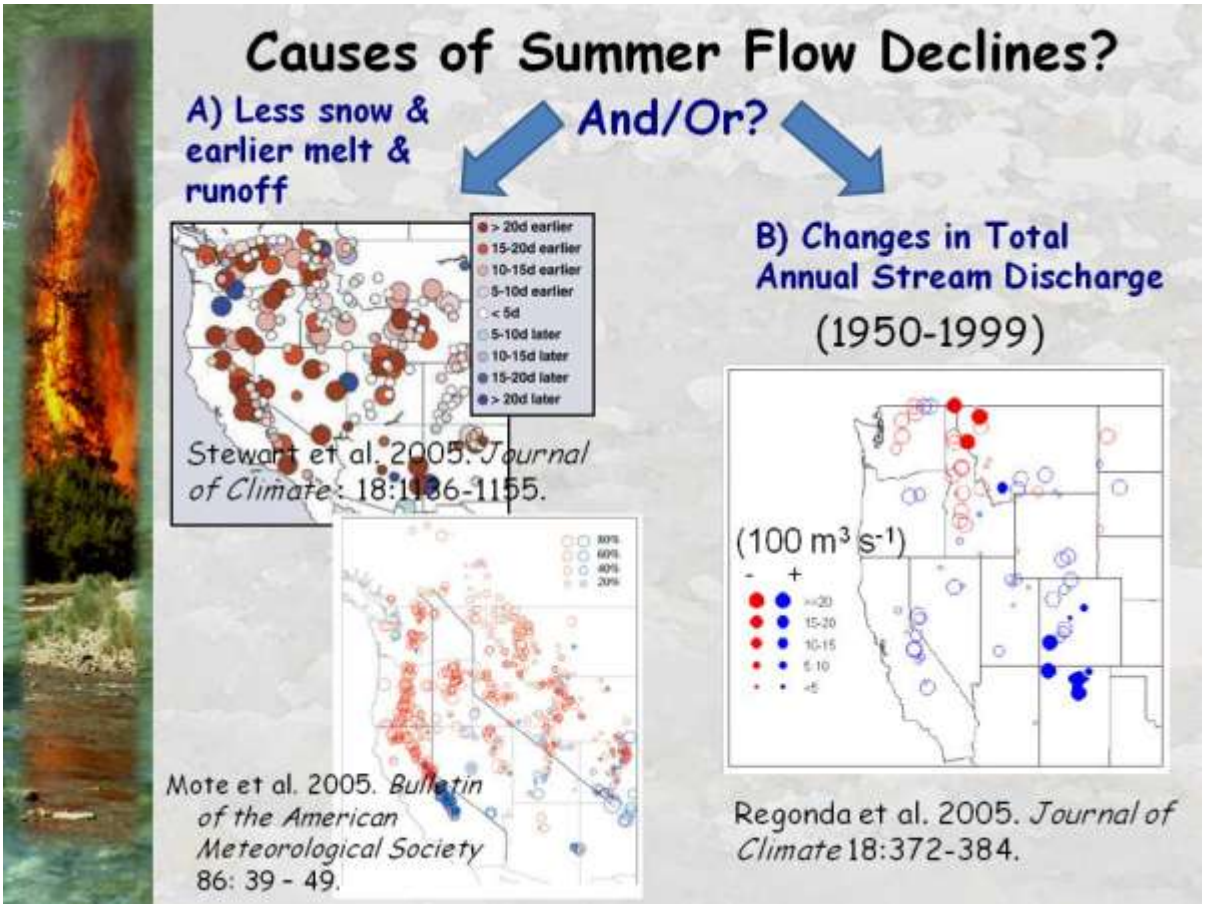

Observed Trends in August Flows for Northern Rockies Streams (1950-2008)
Increasing Discharge ChangeperRecord
0.09% - 2%
2.01% - 15%
15.01% - 24.53%
24.54% - 36%
36.01% - 56%
Decreasing Discharge PercentChangerecord
-68.1% - -55.53%
-55.52% - -36.36%
-36.35% - -25.38%
-25.37% - -14.99%
-14.98% - -2.08%
MONTANA
IDAHO
WYOMING
UTAH
21% Average Decline
Frequency
-100
-50
0
50
100
Normalized Change per Record (%)
Leppi et al. 2011. Climatic Change doi:10.1007/s10584-011-0235-1

Observed Trends in 25% Low Flows (1 in 4 year lowest flow) (1948-2006)



Luce and Holden. 2009. *Geophysical Research Letters* 36, L16401, doi:10.1029/2009GL039407


Summer Flow Decreases =
Less Habitat & Less Productivity?



Welcome to the Climate-Aquatics Blog. For those new to the blog, previous posts can be seen by clicking on the hyperlinks below or by navigate to the blog webpage at this hyperlink (Climate-Aquatics Blog). To discuss these topics with other interested parties, a Google discussion group has also been established and instructions for joining the group are also on the webpage. The intent of the Climate-Aquatics Blog and associated discussion group is to provide a means for the 2,596 (& growing) field biologists, hydrologists, anglers, students, managers, and researchers currently on this mailing list across North 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 will 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 I and my colleagues have been a part of in the Rocky Mountain region, but attempts will be made to present topics & tools in ways that highlight their broader, global relevance. Moreover, I acknowledge that the studies, tools, and techniques highlighted in future 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 will occur to facilitate the rapid dissemination of knowledge among those most concerned about climate change and its effects on aquatic ecosystems.

If you know of others interested in climate change and aquatic ecosystems, please forward this message and their names can be added to the mailing list for notification regarding additional

science products on this topic. If you do not want to be contacted regarding future such notifications, please reply to that effect and you will be removed from this mailing list.

Previous Posts

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: Accurate downscaling of climate change effects on river network temperatures through use of inter-agency temperature databases and application of new spatial statistical stream 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

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

Future topics…

Climate-Aquatics Biology Module
Climate-Aquatics Management Module