Climate-Aquatics Blog Post #10: Long-term Monitoring Shows Global Warming of Rivers & Streams

Hi Everyone,
Before introducing this week's topic, I thought I'd first provide a quick overview of where the blog is going. The overall response I've received thus far has been very positive (except for some of the email sizes, which I'm trying to reduce), so I'll keep plugging along on it as time permits to help facilitate the broad & rapid dissemination of pertinent information on climate & aquatic ecosystems. The schedule for the next several weeks is to work through several remaining topics on stream/river temperatures (with a brief diversion next week to look at lake temperature trends), then we'll transition into one or two months on stream hydrology & climate change. The thinking is that the first two temperature/hydrology modules will cover, more or less, what constitutes "climate" in streams and lay the foundation for next considering biological effects. We'll conclude, then, with a module on management implications and consider ways of integrating climate considerations with resource management.

One of the intriguing things that's becoming apparent to me as research in the climate-aquatics arena progresses, is that the improved models & integrated databases being developed due to climatic concerns could have equal, if not greater, relevance for addressing traditional management concerns. Endeavors as varied as fisheries regulation, species conservation, optimizing monitoring strategies, facilitating interagency coordination/collaboration, and integrating terrestrial-aquatic considerations could all benefit from more accurate, higher-resolution information that transcends jurisdictional, agency, and disciplinary boundaries. It may take a while to get there (both in the real world & on the blog) but there may well be some silver linings to a changing climate.

With that bit of house-keeping aside, on to this week's post…

Global Warming of Streams & Rivers is More Than a Hypothetical…

Difficulty in garnering public acknowledgement & acceptance of climate change has, in part, been due to its gradual nature relative to short-term weather patterns and inter-annual variation. This is also true in the aquatics professions, but is further exacerbated by a dearth of long-term monitoring data on stream and river temperatures. As a result, means of reconstructing past warming trajectories for streams have been developed & often provide very accurate results (blog post #7; & subject of future blog post). Regardless, the "gold standard" is, and ever shall be, a long-term monitoring record wherein the attribute of interest is directly & consistently measured over a period of time. There are several published examples of long-term monitoring records from western US streams that show evidence of warming (see graphic), but these generally focus on a single site, usually on a large river where thermal regimes altered by reservoirs & other modifications provide somewhat equivocal evidence. This week, therefore, I'd like to highlight two long-term monitoring studies by our European colleagues that overcome some of these limitations.

The first study is by Bruce Webb and Franz Nobilis (graphic below) and focuses on three temperature monitoring sites on three Austrian rivers. Temperature monitoring at these sites has been conducted for more than 100 years and may constitute the longest continuous records anywhere in the world. Key points from the paper are that:

1) Strong evidence of warming was apparent at all three sites, especially during the latter half of the 20th century. Total warming for the 100 year period from 1901-2000 ranged from 1.3 °C to 1.6 °C.
2) River warming trends generally, although not perfectly, tracked air temperature trends at nearby monitoring stations.
3) River warming amounts differed by season of the year & among the three sites, one of which was on a heavily altered main-stem river, one was downstream from a large lake complex, and one was in a less altered headwater site.

The second study is by Renata Hari et al. (graphic below) and focuses on a stream temperature monitoring dataset for a 25 year period across 25 Swiss streams. Key points from the paper are that:

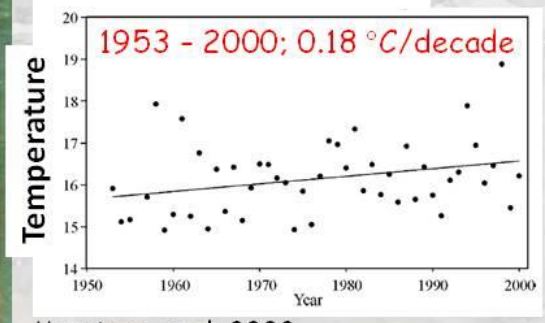
1) Stream temperatures respond synchronously across large regions in response to inter-annual and long-term climate forcing.
2) Attributes of individual streams, or reaches within streams, can create deviations from this regional synchrony. In the streams Hari et al. studied for example, the presence & extent of glaciers was an important factor that made some streams less synchronous.
3) Climate cycles like the Atlantic Oscillation (or Pacific Decadal Oscillation, or El Nino Southern Oscillation) periodically exacerbate/dampen stream warming across regions subject to their influence. The effects of these transient cycles are typically much larger in the short-term (i.e., 5 – 20 years) than gradual trends associated with anthropogenic climate change.
4) Warming observed in Swiss streams had important biological consequences and this study provides some of the best evidence regarding how stream warming can affect distributions of a fish species (we'll return to this in a future blog post).

Next time out, we'll focus on the same basic topic of temperature monitoring, but will highlight some of the research pertaining to lake systems instead.

Best Regards,
Dan

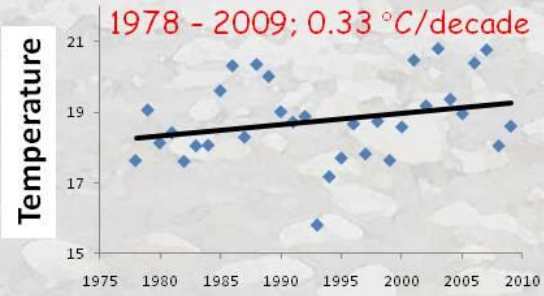
Trends In Western North American Rivers

Fraser River - Summer



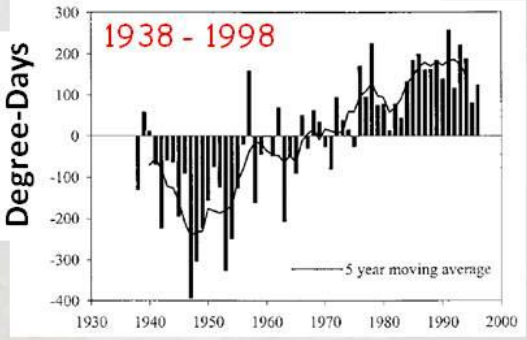
Morrison et al. 2002

Missouri R. @ Totson - Summer



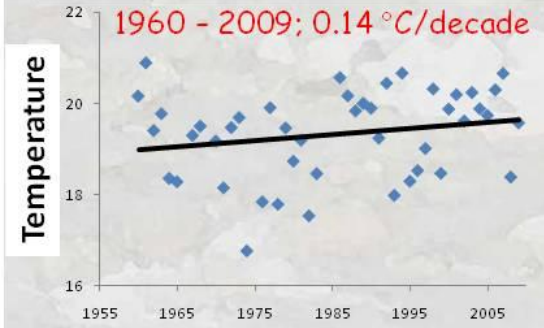
Isaak et al., In Review

Columbia River - Summer

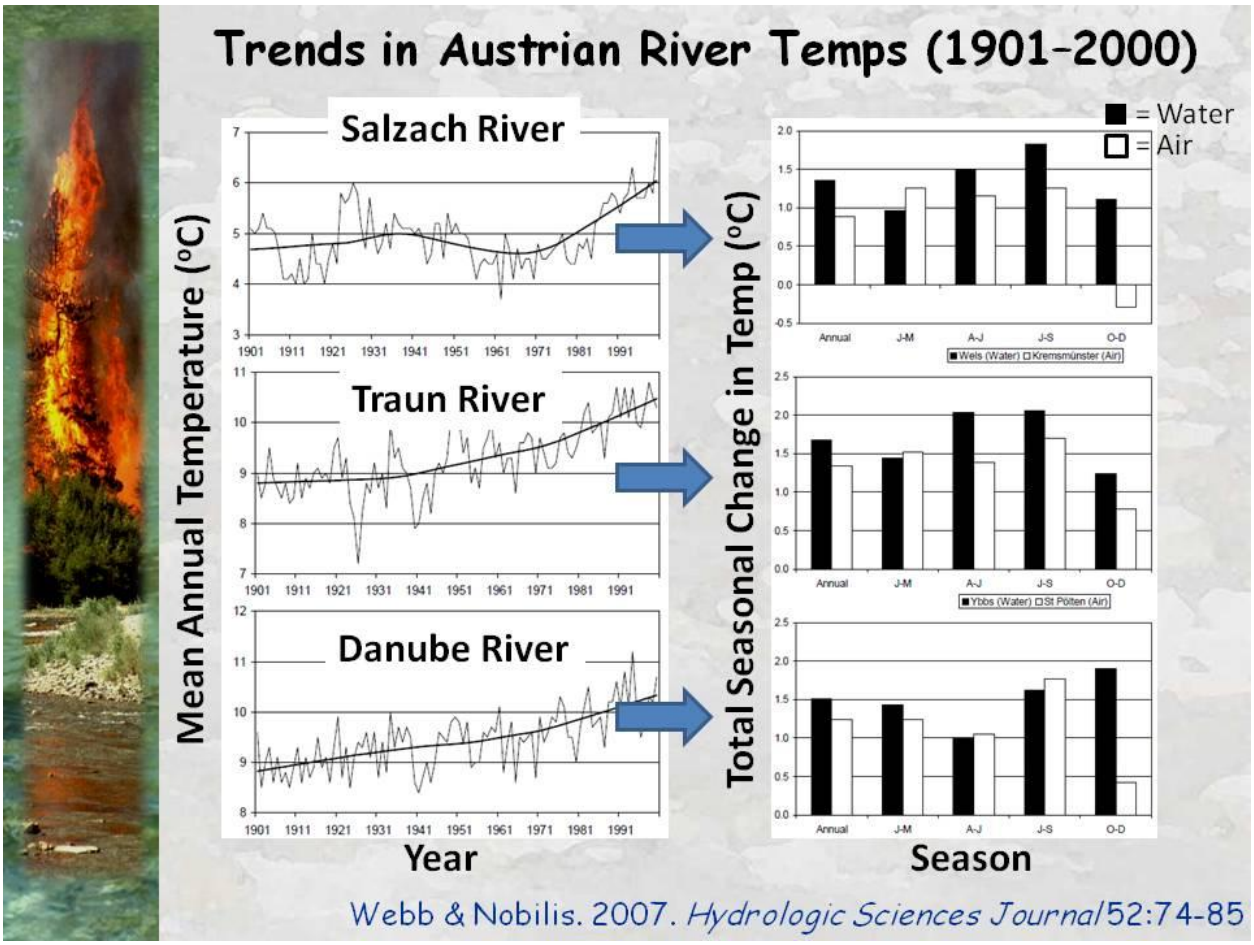


Robards & Quinn 2002

Snake R. @ Anatone - Summer

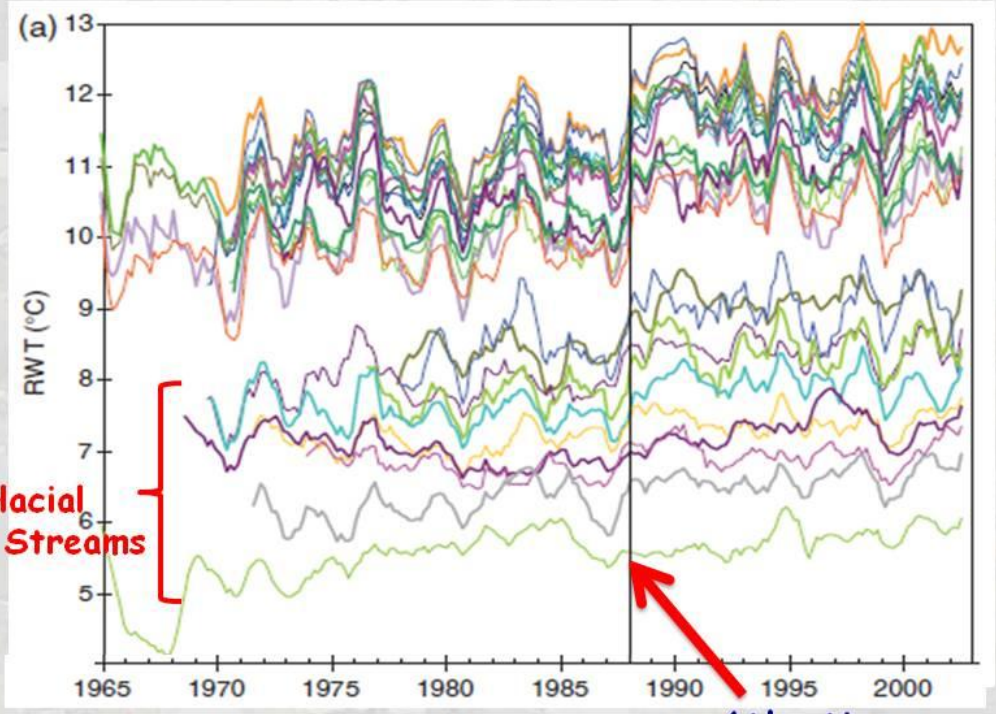


Isaak et al., In Review



Webb & Nobilis. 2007. *Hydrologic Sciences Journal* 52:74-85

Trends in Swiss Stream Temperatures



Hari et al. 2006. *Global Change Biology* 12:10-26