Climate-Aquatics Blog #71: Enhancing effectiveness by harnessing social & digital network technologies

Stream networks, social networks, digital networks…all are equally relevant…

So everything that's been discussed here the last 4.5 years—Earth getting warmer, aquatic environments changing, fish habitats & species responding (blog 52)—has been an effort to develop an overarching narrative and common consciousness within the aquatics community about what's happening & how we might adapt & invest our time and limited resources efficiently. But being truly effective at conserving aquatic biodiversity & managing fisheries this century will ultimately mean making some hard choices & integrating the rapidly growing corpus of climate knowledge into the DNA of the ways by which conservation investments are made. Doing that means not only developing good understanding & predictive models about stream networks & their critters, but also packaging and communicating that information effectively because what we know & where we know it ultimately affects what we do & where we do it.

That being the case, it is worth noting & taking advantage of the fact that humans are hugely social animals & collective learners (as evidenced by the fact that retaining, using, and building upon the hard-won lessons of our forebears was what allowed us to develop civilization over the last 10,000 years). The digital networks associated with the internet revolution simply put that capacity for collective learning on steroids by making it possible to communicate huge amounts of information anytime anywhere through email, blogs, websites, smartphones, Facebook, Twitter, YouTube, etc. Graphic 1 shows the growth in monthly peta-bytes of information transmitted through the internet since its inception in the early 90s (1 peta-byte being 1 million giga-bytes & we're somewhere around 50,000 PB/month at present). Those rivers of digital bits flowing around us provide profound possibilities because the barriers to river entry and participation are so low and inexpensive as to be nonexistent, which creates a meritocracy of sorts wherein ideas and technologies will spread rapidly if they provide value (more semi-random thoughts linked here). And at climate times like these, we definitely need to be learning and applying the best information as fast as humanly possible.

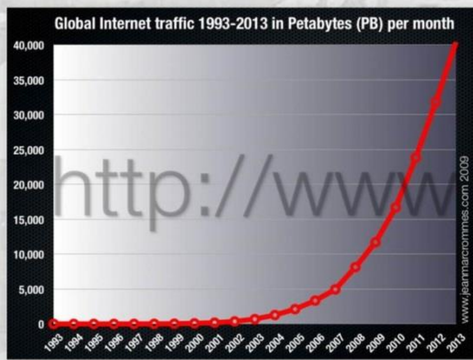
The digital revolution is also transforming the way science gets done. Hyper-connectivity makes it possible to shuffle big digital datasets anywhere in a plug-&-play world, which shrinks the world and makes it possible to perform complex workflow tasks with diverse sets of collaborators spread across time-zones or continents. As a result, diverse interdisciplinary science teams are now more often spontaneously emerging, a phenomenon that has itself become the subject of scientific inquiry (graphic 2; Baker-hyperlinked here; Cheruvelil & colleagues-hyperlinked here). The performance & productivity of those teams ranges from the mundane to the magnificent & seems to be strongly related to "group intelligence" as discussed in this NYTimes summary of a recent study by Woolley and colleagues. Having participated on several geographically disparate science teams, I'd echo many of their basic insights but also add that success seems to require: 1) a motivating vision towards some useful & obtainable goal, 2) complementary technical skillsets, 3) people that like each other and enjoy working together, 4) frequent communication, and 5) standard protocols for how things get done and passed to other team members (graphic 3). Also indispensable are the things they tried to teach us in grade school like basic social etiquette, being responsible & on-time with assignments, empathy towards team-members, and having sufficient time to form group chemistry.

The digital technologies that enable the existence of those science teams also enables the information they produce to be packaged in a variety of user-friendly formats so that those finding it useful can use it. If that information has a strong geographical conservation component, it can be integrated to spatial databases that "paint" the science on real-world landscapes & the information served out via websites to make it broadly accessible. A threshold is often passed at that point wherein those applying the information start to provide feedback on its utility and the dialogue rapidly broadens among researchers, managers, conservationists, and other members of the public. That dialogue leads to joint identification of key uncertainties, which then sets the stage for subsequent data collection efforts. When the information is spatially explicit it can be used to guide broad efforts undertaken via crowd-sourcing and citizen science collaborations (graphic 5; Newman & colleagues—study hyperlinked here) because so many important types of data can now be collected inexpensively using standard protocols (blogs 21, 30, 60). That leads to bigger datasets, new science, revised applications, and improved decision making. Getting there in such a manner is especially powerful because it democratizes the process of science, engages a broad cross-section of society, and harnesses the power of the aquatics army. Most importantly, it helps create and strengthen the social networks and collaborations that are ultimately needed for effective conservation and prioritization this century.

Until next time, best regards. Dan

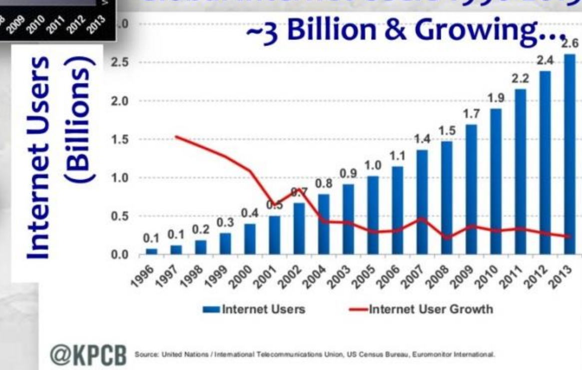
Tweeting at Dan Isaak@DanIsaak

Bytes of Information Created & Transmitted via the Internet

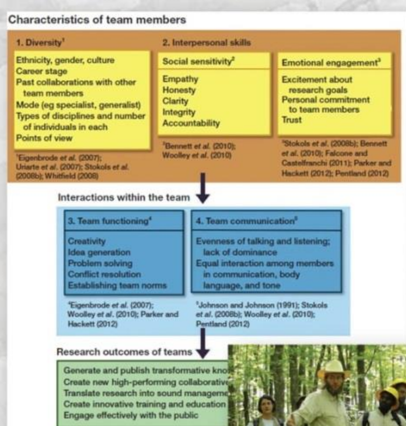


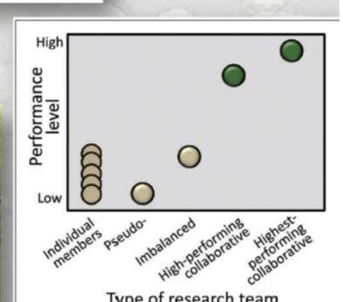
Internet Traffic 1993-2013 in Monthly Petabytes (1 PB = 1 Million Gigabytes)

Global Internet Users 1996-2013 ~3 Billion & Growing…



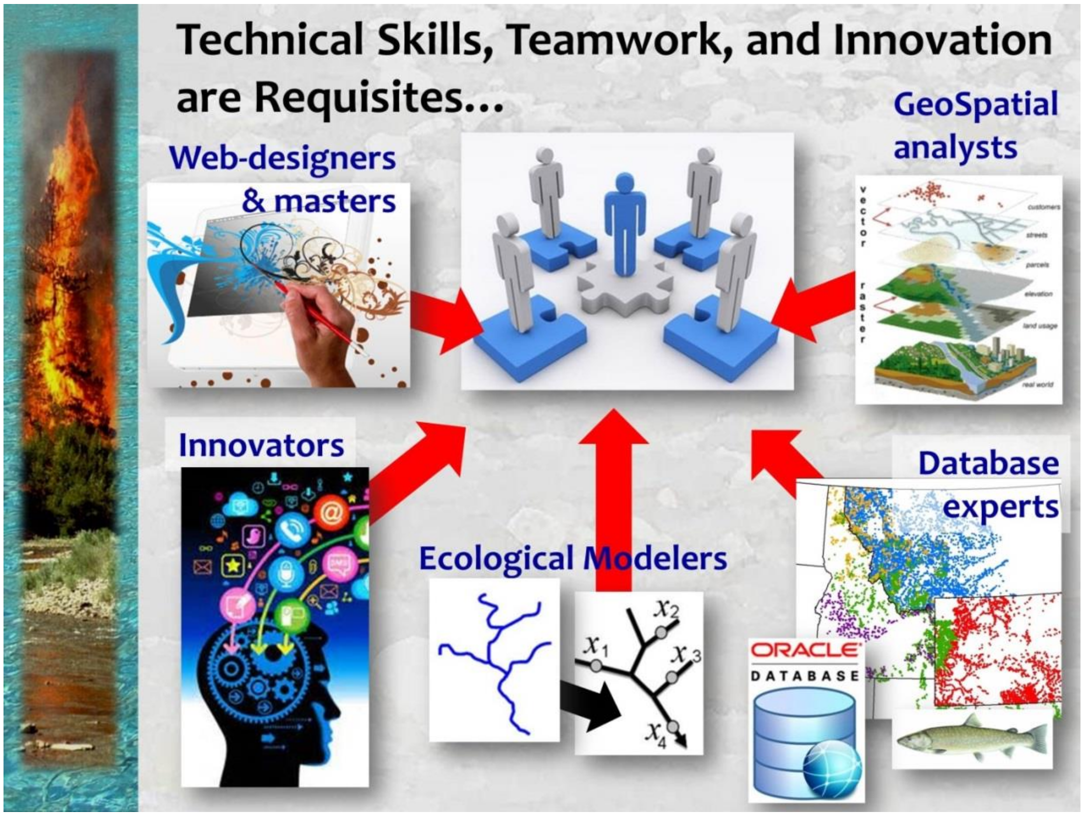
High-Performance Science Teams Excel With a Diverse Mix of Complimentary Skillsets

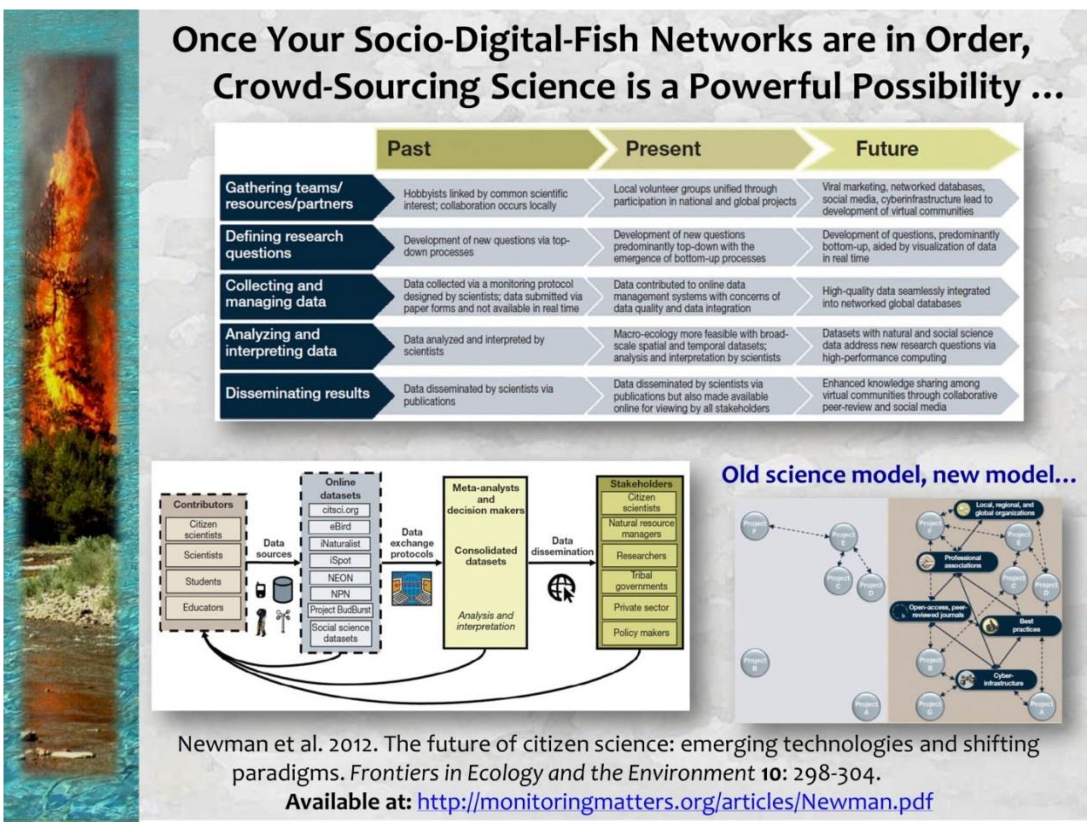




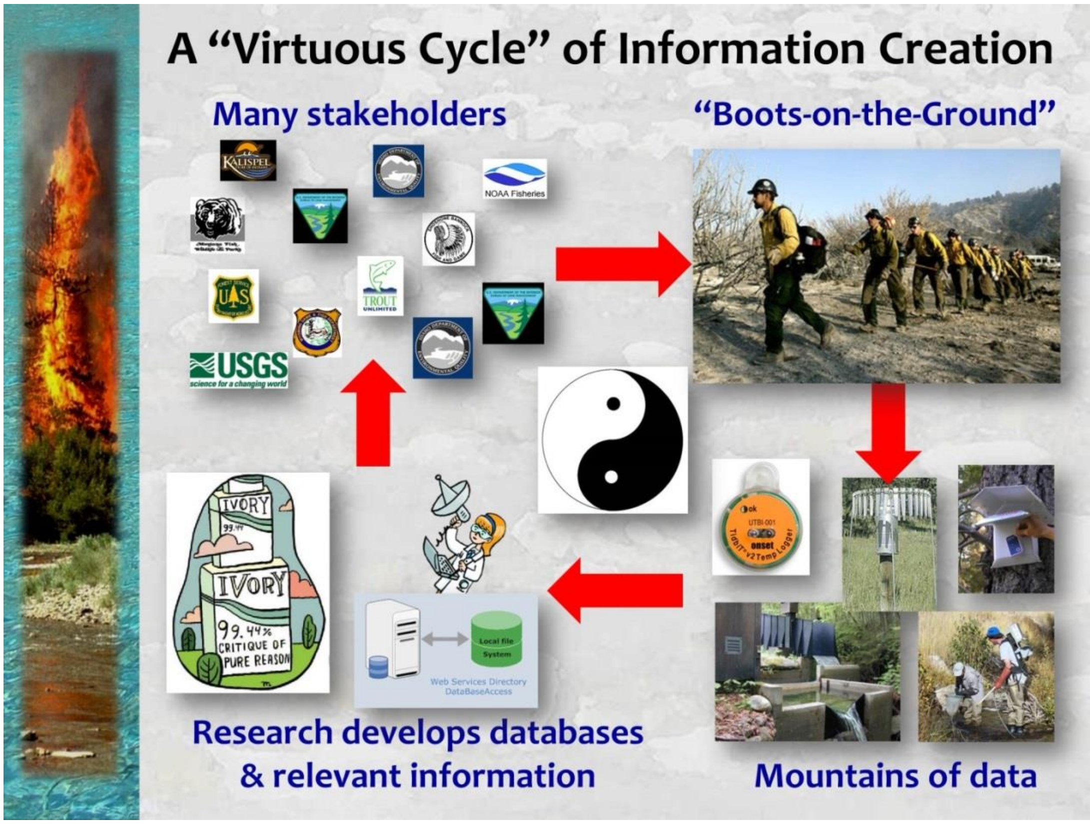
Baker. 2015. The science of team science. *BioScience* **65**:639-644.

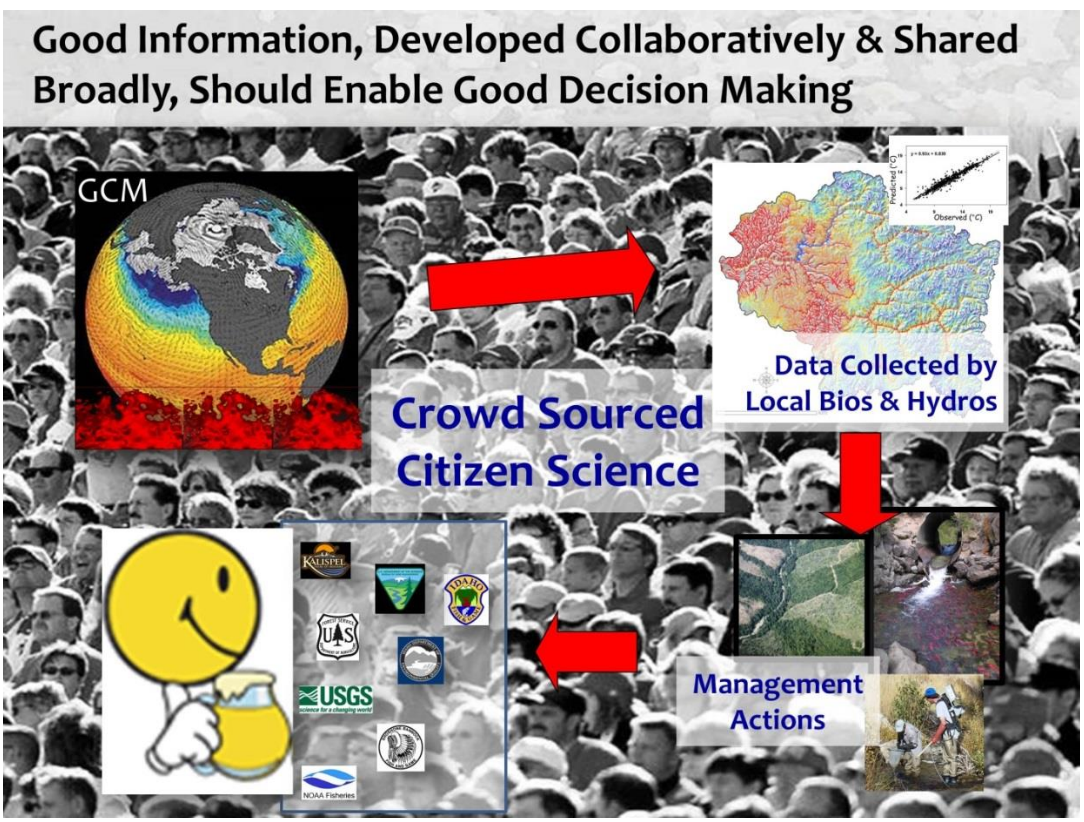
Cheruvelil et al. 2014. Creating and maintaining high-performing collaborative research teams: the importance of diversity and interpersonal skills. *Frontiers in Ecology and the Environment* **12**: 31-38.





	Past	Present	Future
Gathering teams/ resources/partners	Hobbyists linked by common scientific interest; collaboration occurs locally	Local volunteer groups unified through participation in national and global projects	Viral marketing, networked databases, social media, cyberinfrastructure lead to development of virtual communities
Defining research questions	Development of new questions via top-down processes	Development of new questions predominantly top-down with the emergence of bottom-up processes	Development of questions, predominantly bottom-up, aided by visualization of data in real time
Collecting and managing data	Data collected via a monitoring protocol designed by scientists; data submitted via paper forms and not available in real time	Data contributed to online data management systems with concerns of data quality and data integration	High-quality data seamlessly integrated into networked global databases
Analyzing and interpreting data	Data analyzed and interpreted by scientists	Macro-ecology more feasible with broad-scale spatial and temporal datasets; analysis and interpretation by scientists	Datasets with natural and social science data address new research questions via high-performance computing
Disseminating results	Data disseminated by scientists via publications	Data disseminated by scientists via publications but also made available online for viewing by all stakeholders	Enhanced knowledge sharing among virtual communities through collaborative peer-review and social media


A "Virtuous Cycle" of Information Creation
Many stakeholders
"Boots-on-the-Ground"
Research develops databases
& relevant information
Mountains of data
NOAA Fisheries
USGS
science for a changing world
TROUT UNLIMITED
KALISPEL
IVORY
99.44%
CRITIQUE OF
PURE REASON
Local file System
Web Services Directory
DataBaseAccess


Good Information, Developed Collaboratively & Shared
Broadly, Should Enable Good Decision Making
GCM
Data Collected by
Local Bios & Hydros
Crowd Sourced
Citizen Science
Management
Actions
KALISPEL
USGS
science for a changing world
NOAA Fisheries
IDAHO

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 ~9,000 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: Part 7, Identifying & protecting climate refugia as a strategy for long-term species conservation
Blog #69: Part 8, Building climate-smart conservation networks (metapopulations + biodiversity + refugia)
Blog #70: Part 9, Restoration success stories that improve population resilience to climate change