# American Water Resources Association
# 2009 SPRING SPECIALTY CONFERENCE
# *Managing Water Resources Development in a Changing Climate*
## May 4-6, 2009
**Anchorage, AK**

## Tuesday, May 5
## 8:30 AM – 10:00 AM
## Session 13:  Aquatic Ecosystem Impacts 1

**1.  Integrating Spatially Explicit Watershed Models with In-Stream Habitat Models: A Discussion on Constraints with Regard to the Resolution of the Data - Barnali Dixon**, USF St. Petersbug, St. Petersburg, FL (co-authors: J. Earls, A.F. Casper, and J.A. Gore)

As changes in landuse and the demand for water accelerates, regulators and resource managers are increasingly asked to evaluate increases in water allocation against protection of in-stream habitat. However, only a small number of watersheds have the long-term gauging data typically required to make these assessments. GIS-based modeling of watershed-based flow and discharge patterns have increasingly been viewed as a way to fill data gaps in this resource management efforts. However, before adopting GIS-based integrated watershed-level approaches to bridging the data gap, a comprehensive understating of how resolution of GIS data plays critical role in the watershed–based models in predicting flow and discharge must be examined. This research attempts to link spatially explicit Soil Water Assessment Tool (SWAT) to develop long-term discharge patterns for Physical HABitat SIMulation model (PHABSIM) based on watershed characteristics and precipitation records. Therefore, this research examines: 1) the effects of resolution of GIS data on this integration of these two models by using GIS data at various resolutions (30, 90 and 300m) as model inputs. The results show that the two types of models may be linked, however, not without limitations. A significant limitation of integrations stems from the choice of resolution of the digital elevation models (DEMs). Results confirm that accuracy of the SWAT-predicted hydrograph declines significantly when either the DEM resolution becomes coarser or if DEM data are resampled. The effect is due to both changes in the size and shape of the watershed with DEMs and subsequent shifts in the proportions of physical input characteristics like landuse, soils, and elevation. Despite this limitation, the results still show that the use of 30 m or finer DEMs produced hydrographic patterns that are amenable for using of in-stream habitat protocols like the PHABSIM model in ungauged systems, especially where no other hydrographic information exists.

**2.  Where Will All the Salmon Go? Simulating Future Habitat Conditions and Population Dynamics in a Changing Environment - Jody B. Lando**, Stillwater Sciences, Portland, OR (co-authors: Frank Ligon, William E. Dietrich, Stephen C. Ralph)

Anticipated changes in climate regime shifts have profound, but poorly understood implications for aquatic ecosystems associated with glaciated watersheds in the northern hemisphere. Changes in the timing and magnitude of water and sediment discharges, stream temperatures and nutrient fluxes will rapidly alter current ecological conditions. This is particularly concerning in Alaska and Canada where glaciated watersheds yield rivers that support economically and culturally valuable salmon stocks. In turn, these stocks support fishing industries that are of local, regional and global significance, providing 230 million dollars annually from the commercial fisheries alone to the Alaskan economy. While significant advances have been made in predictions of the nature and magnitude of these changes, little progress has been made to quantify alterations to the ecological processes, aquatic habitats and salmon productivity and capacity within these watersheds. Future conservation and management of salmon will be severely hampered without the means to anticipate and respond to climate change impacts on these populations throughout Alaska and Canada. We simulated the biological ramifications of future climate scenarios using RIPPLE, a digital terrain-based model that calculates the effects of changing landscape and ecosystem processes on salmon population dynamics. Using the model construct and varying degrees of available data, we showcase RIPPLE applications, including the Tonsina Watershed, a tributary basin of the Copper River Watershed in south central Alaska. Model predictions were calibrated to the specific topography and lithology of the watersheds and performed at multiple spatial and temporal scales. The significance of climate changes on life history requirements and the productive capacity of native salmon was best demonstrated across varying spatial scales as it reverberated through multiple life cycles. Results from the

RIPPLE model provide meaningful predictions to aid fisheries conservation and watershed management in a changing environment.

**3. Potential Impacts of Climate Change on the Ability to Maintain Sreamflows to Sustain the Trout Fishery in the Upper Carson River - John Tracy**, IWRRI, University of Idaho, Boise, ID

Throughout much of the western United States many ecological problems have arisen in watersheds where a significant portion of stream flows are diverted to support agriculture. It has also become apparent that changes in the region's climate, especially the temperature regime, are exacerbating these problems in watersheds where the flow in rivers is driven by snowmelt. One such watershed is the Upper Carson River watershed on the California-Nevada border. The Upper Carson River's headwaters form on the eastern side of the Sierra Nevada Mountains in California, just south of the Lake Tahoe Basin. The Upper Carson River watershed encompasses an area of approximately 3,966 square miles with approximately 15% lying within California and the remaining 85% lying within Nevada. The only significant water storage within the Carson River basin is Lahontan Reservoir, which is just downstream of the main irrigation areas within the watershed. The Upper Carson River Watershed is characterized by short, hot summers and long, moderately cold winters. Water rights on the Carson River are adjudicated via the Alpine Decree, issued on October 28, 1980, which set water duties for the diversions from the Carson River by dividing it into distinct sections. This decree did not establish any water rights for in-stream flows or for sustaining trout fisheries in the Carson River within the Carson River Valley and Cottonwood galleries near the outflow of the Upper Carson River to Lahontan Reservoir. Recently, there has been growing interest within the Carson River watershed to develop strategies to sustain both of these ecosystem services, and growing concern that climate change may have a negatively impact their sustainability. This study examines the impacts that increasing temperatures may have on both diversions of flow from the Carson River and the ability of the Carson River to sustain its significant ecological systems. A System Dynamics model that simulates the hydrology and water management within the Carson River is used to assess how climate change will affect the ability of the Carson River to meet sustainable ecosystem flows under several climate change scenarios.

**4. Implications of Climate Change for Okanagan Basin Water Availability and Salmonid Restoration Planning - Clint Alexander**, ESSA Technologies Ltd, Kelowna, BC, Canada (co-authors: -Kim Hyatt, Stacy Langsdale, Margot Stockwell)

We assembled a basin-wide water budget for the 2050s period and ran these net Okanagan Lake inflows through the established operating rules embedded within the Okanagan Fish/Water Management Tool. Our study found that average egg-to-yearling survival for endangered Okanagan River sockeye will fall by 44%. Alarmingly, our simulated 2050s water availability conditions led to the complete loss of high juvenile survival cohorts, reducing the sockeye population's resilience. In addition, our 2050 period fish/water managers were unable to achieve the current September 30 operating benchmark for Okanagan Lake even once in 28 simulated years. Consequences of extensive lake draw-downs would be catastrophic, highlighting the need for more serious preparations and quantitative water budget assessments. The solution includes much more strenuous surface and groundwater license restrictions and sensible, enforceable demand management regulations on all new and existing water extraction activities. Creation of water banks, water markets and water license buy-backs are also foreseeable. Politicians, planners and regulators should meaningfully move forward with these anticipatory water conservation and management steps now to avoid the creation of increasingly complex and insoluble problems later. Failure to do so will have dire consequences for aquatic ecosystems and the quality of life in the Okanagan.