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Stream captures: Dynamics and impacts on biodiversity

Nathan Lyons (1), Pedro Val (2), James Albert (3), Nicole Gasparini (1), and Jane Willenbring (2)

(1) Department of Earth and Environmental Sciences, Tulane University, New Orleans, LA, USA (nlyons@tulane.edu), (2) Scripps Institution of Oceanography, University of California – San Diego, San Diego, CA, USA, (3) Department of Biology, University of Louisiana at Lafayette, Lafayette, LA, USA

Evidence of stream network rearrangement exists in numerous landscapes, and the dynamics of stream capture influences the evolution and structure of regional biotas. The organisms of a species can disperse across a greater geographic range when the stream network expands. Conversely, a shrinking range increases the likelihood of species extinction. Shifting divides can also fragment species, leading to speciation (creation of new species). We integrated these processes of macroevolution (dispersal, speciation, and extinction) into a landscape evolution model. Here, we explore: (1) under what conditions do simulated networks rearrange, and (2) when networks do rearrange, what are the regional-scale geomorphological controls on biodiversity. The model and its outcomes are evaluated in two scenarios: stream capture initiated by a vertical fault, and drainage divide migration driven by differential base level change. The outcome of hundreds of model runs shows that captures occurred within a limited combination of parameters and conditions. In the fault scenario, captures were larger when topographic relief was low, and stream topology strongly affected capture occurrence. The erodibility parameter in the stream power model had a greater influence on capture area size in the base level fall scenario. In both scenarios, large captures were more common above an erodibility threshold, and biodiversity increased with the quantity of large captures.