

Species diversity gradients in relation to geological history in North American freshwater fishes

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ABSTRACT

Hypothesis: Geological events and their timing influence local climate, size and shape of fluvial habitats, isolating barriers, and different rates of speciation and extinction, which interact to create gradients of freshwater fish diversity at regional and continental scales.

Organisms: Recent freshwater fishes of North America south to southern Mexico and Cenozoic fossil species of the families Ictaluridae, Catostomidae, Cyprinidae, Salmonidae, Centrarchidae, and Cottidae.

Analytical methods: (1) Regression of species diversity in upper, middle, and lower reaches of five eastern and six western rivers against discharge and its variation, elevation, and gradient; (2) compilation of numbers of species native to quadrats of the Simpson Grid, a system of 150 × 150 mile units covering the continent; (3) estimation of the effects of nine environmental variables on species numbers in quadrats of the grid using spatial autoregression and regression trees; (4) estimation of origination and extinction rates from numbers of fossil and recent species contrasted between Atlantic drainage and Pacific drainage North America.

Results: (1) Fish species diversity responds positively to stream discharge and negatively to elevation, gradient, and discharge variation, except where these variables are overridden by proximity to a large source fauna. (2) Species diversity is high in the Mississippi Basin and low in the western mountains, far north, and Mexico. Spatial autoregression and regression trees reveal positive effects of precipitation, warm temperature, and fluvial connectedness on local fish diversity, followed by lesser effects of minimum temperature, elevation, run-off, frost-free days, drainage size, and temperature range. (3) Estimated origination and extinction rates are usually higher in the west where spatial units are small and temporal scales of the geological events that create them can be short. Extinction rates are usually much lower in the east where large-scale spatial and long-term geological processes interact to produce environmental stability.

Keywords: discharge variation, elevation, extinction rate, speciation rate, stability, tectonics.

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