

## CUMULATIVE FREQUENCY DISTRIBUTION OF PAST SPECIES EXTINCTIONS

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Analysis of Sepkoski's compendium of the time ranges of 30,000+ taxa yields a mean duration of 28.4 ma for genera of fossil invertebrates. This converts to an average extinction rate of 3.5 percent per million years or about one percent every 286,000 years. Using survivorship techniques, these estimates can be converted to the species level, yielding a Phanerozoic average of one percent species extinction every 40,000 years.

Variation in extinction rates through time is far greater than the null expectation of a homogeneous birth-death model and this reflects the well-known episodicity of extinction -- ranging from a few large mass extinctions to so-called background extinction. The observed variation in rates can be used to construct a cumulative frequency distribution of extinction intensity, and this distribution, in the form of a "kill curve" for species, shows the expected waiting times between extinction events of a given intensity. The kill curve is an average description of the extinction record and does not imply any cause or causes of extinction.

The kill curve shows, among other things, that only about five percent of total species extinctions in the Phanerozoic were involved in the five largest mass extinctions. The other 95% were distributed among large and small events not normally called mass extinctions.

As an exploration of the possibly absurd proposition that most past extinctions were produced by the effects of large-body impact, the kill curve for species has been mapped on the comparable distribution for comet and asteroid impacts. The result is a curve predicting the species kill for a given size of impacting object (expressed as crater size). The results are reasonable in that impacts producing craters less than 30 km (diameter) cause negligible extinction but those producing craters 100-150 km (diameter) cause extinction of species in the range of 45-60 percent.