**INTRODUCTION**

The mass extinction that had the most detrimental effects on marine biodiversity across the globe came at the end of the Permian period (Sepkoski 1981). There are extensive and diverse ecological communities covering the globe, and each of these may be affected differently based on what type of environmental changes they encounter (Walther et al., 2002). If we could understand what ecosystems would be the most susceptible to destruction based on previous extinctions, we may be able to focus our resources on preserving the species of these communities. My objective is to use the Permo-Triassic extinction to look at the changes in diversity experienced between latitudinal ranges from the Late Permian and Early Triassic. I hypothesize that there would be higher rates of survivorship in extra-tropical climates than tropical climates.

**JUSTIFICATION**

There are many hypotheses as to what caused the end-Permian extinction event, but the most likely candidates are related to volcanism from the Siberian Traps during this time interval (Benton & Twitchett, 2003). It has been suggested that the end Permian event could be an analog for our current global conditions such as an increased input of greenhouse gases into the atmosphere (Payne & Clapham 2012). Of particular interest to this study is the impact that this volcanism had on the oceans. Two very important factors likely played a role in the decline of biodiversity: ocean anoxia and ocean acidification (Wignall & Hallam, 1992, Wignall & Twitchett, 1996, and Clarkson et al., 2015). This study will not be focused directly on these causal mechanisms but will instead focus on detecting geographic patterns that may have been the result of such mechanisms.

By examining how ecological communities changed based on latitude, I hope to find patterns that would show a correlation between the geographic latitude at which a species persists and its likelihood of extirpation. This research, in combination with ecological studies on susceptible ecosystems (Linder et al., 2009, Walther et al., 2002, and Scholze et al., 2006), could give us predictive power to know what species would be most at risk in the event of a catastrophe such as global climate change.

Preservation of the biodiversity on this planet is not only important to the balance and sustainability of ecological communities, but also to the sustainability of our own species. An understanding of past extinction events may enable us to predict which environments would experience the greatest losses in such an event, and from that knowledge, we can focus our efforts on preserving those ecosystems.

**RESEARCH PLAN**

I will begin this study by compiling presence data for marine invertebrate taxa from the Paleobiology Database into R. The data collected will be from marine invertebrates from the Mid-Permian through the Mid-Triassic to encompass a wide range of taxa from the intervals before and after the end Permian extinction (Leighton & Schneider 2008). The data will be divided into two groups, those genera present before and during the middle to late Permian and those present from the early to middle Triassic. To analyze the geographic location of each occurrence, I will consider the paleolat component of the data housed in the Paleobiology Database. I will then compare which genera are present at latitudes between 23.5° S and 23.5° N, the Tropic of Capricorn and Tropic of Cancer respectively, and which genera are present at extra-tropical latitudes. I will then test the data using a binary logistic regression, with the two components being survivorship and extinction (Payne & Finnegan, 2007). The data will also be analyzed with an odds ratio test to determine if geographic latitude is a likely explanation of extinction or if it cannot account for the extinction observed in the fossil record.

This data is readily acquired in a public online dataset, the Paleobiology Database. The Paleobiology Database contains accounts of marine and terrestrial fossils from around the globe and categorizes the data using time intervals, paleocoordinates, and taxonomic rank. If my hypothesis is correct the rates of survivorship among the extra-tropical latitudes across the Permian-Triassic boundary, and the odds ratio test would indicate whether the latitude at which the species persists would be a likely explanation for survivorship or extinction.

Since this work is entirely computational, I only ask for funds for housing and food for the summer months. My rent is $660/month and food costs are about $50 per week. The total amount funds requested is $2580 for a total of 12 weeks spent on this project.

**REFERENCES CITED**

Benton, M. J., & Twitchett, R. J. (2003). How to kill (almost) all life: The end-Permian extinction event. *Trends in Ecology & Evolution,* *18*(7), 358-365. doi:10.1016/s0169-5347(03)00093-4

Clarkson, M. O., Kasemann, S. A., Wood, R. A., Lenton, T. M., Daines, S. J., Richoz, S., . . . Tipper, E. T. (2015). Ocean acidification and the Permo-Triassic mass extinction. *Science,* *348*(6231), 229-232. doi:10.1126/science.aaa0193

Leighton, L. R., & Schneider, C. L. (2008). Taxon characteristics that promote survivorship through the Permian–Triassic interval: Transition from the Paleozoic to the Mesozoic brachiopod fauna. *Paleobiology,* *34*(1), 65-79. doi:10.1666/06082.1

Lindner, M., Maroschek, M., Netherer, S., Kremer, A., Barbati, A., Garcia-Gonzalo, J., . . . Marchetti, M. (2010). Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems. *Forest Ecology and Management,* *259*(4), 698-709. doi:10.1016/j.foreco.2009.09.023

Payne, J. L., & Clapham, M. E. (2012). End-Permian Mass Extinction in the Oceans: An Ancient Analog for the Twenty-First Century? *Annu. Rev. Earth Planet. Sci. Annual Review of Earth and Planetary Sciences,* *40*(1), 89-111. doi:10.1146/annurev-earth-042711-105329

Payne, J. L., & Finnegan, S. (2007). The effect of geographic range on extinction risk during background and mass extinction. *Proceedings of the National Academy of Sciences,* *104*(25), 10506-10511. doi:10.1073/pnas.0701257104

Scholze, M., Knorr, W., Arnell, N. W., & Prentice, I. C. (2006). A climate-change risk analysis for world ecosystems. *Proceedings of the National Academy of Sciences,* *103*(35), 13116-13120. doi:10.1073/pnas.0601816103

Sepkoski, J. J.. (1981). A Factor Analytic Description of the Phanerozoic Marine Fossil Record. *Paleobiology*, *7*(1), 36–53. Retrieved from <http://www.jstor.org/stable/2400639>

Walther, G., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J., . . . Bairlein, F. (2002). Ecological responses to recent climate change. *Nature,* *416*(6879), 389-395. doi:10.1038/416389a

Wignall, P., & Hallam, A. (1992). Anoxia as a cause of the Permian/Triassic mass extinction: Facies evidence from northern Italy and the western United States. *Palaeogeography, Palaeoclimatology, Palaeoecology,* *93*(1-2), 21-46. doi:10.1016/0031-0182(92)90182-5

Wignall, Paul B., and Richard J. Twitchett. "Oceanic Anoxia and the End Permian Mass Extinction." *Science* 272.5265 (1996): 1155. *ProQuest.* Web. 9 Apr. 2016.