Report for 2003ND25B: Comparative Study of Fossil and Extant Fish Growth: Including Analyses of Mean Annual Temperature in the Geologic Record

Publications

- Conference Proceedings:
  - Newbrey, M.G., M.V.H. Wilson, and A.C. Ashworth. 2005. Growth characteristics of Cretaceous and Cenozoic North American Esociformes: Implications for systematics. In Fourth International Meeting on Mesozoic Fishes - Systematics, Homology, and Nomenclature, Extended Abstracts; edited by F.J. Poyato-Ariza; Madrid, Servicio de Publicaciones de la Universidad Autónoma de Madrid / UAM Ediciones. pp. 201-204.
  - Newbrey, M.G. and M.V.H. Wilson. 2005. Recognition of annular growth on centra of Teleostei with application to Hiodontidae of the Cretaceous Dinosaur Park Formation. Poster at Dinosaur Park Symposium, Royal Tyrrell Museum, Drumheller, Alberta.
- Other Publications:
  - Newbrey, M.G., M.V.H. Wilson, and A.C. Ashworth. 2005. Growth characteristics of North American Hiodontidae (Teleostei) from the Late Cretaceous to Recent. Society of Vertebrate Paleontology 65 th Annual Meeting. Journal of Vertebrate Paleontology 25(supplement to 3). Presented in Phoenix, AZ, October 19-22.
  - Newbrey, M.G., M.V.H. Wilson, and A.C. Ashworth. 2005. Growth characteristics of Cretaceous and Cenozoic North American Esociformes: Implications for systematics. Presented in Fourth International Meeting on Mesozoic Fishes, Miraflores de la Sierra, Madrid, Spain, August 8-13.
  - Newbrey, M.G. and A.C. Ashworth. 2005. If fossil fish could talk we would hear stories about drought: An examination of a late Pleistocene deposit near Jamestown, North Dakota. Presented at North Dakota Geological Society Meeting, Bismarck, North Dakota. May 17th.
  - Newbrey, M.G., A.C. Ashworth, and M.V.H. Wilson. 2005. Geographic trends in North American Freshwater Fishes from the Cretaceous to the Pliocene: A climatic effect? Presented at Northern Plains Biological Symposium, Fargo, North Dakota.

Report Follows

COMPARATIVE STUDY OF FOSSIL AND EXTANT FISH GROWTH: INCLUDING ANALYSES OF MEAN ANNUAL TEMPERATURE IN THE GEOLOGIC RECORD

Fellow: Michael Newbrey
Adviser: Allan Ashworth

DESCRIPTION OF THE REGIONAL WATER PROBLEM

It is important to consider the implications of climatic change on surface water resources in light of potential consequences of global warming. North Dakota boasts some of the best long-term data sets in the form of a fossil record to measure the effect of climatic warming on a single population of fish. Very little is known about growth and the life history characteristics of fish in the fossil record. Fossils can provide valuable information about growth of extinct forms of fish, thereby providing insight into their life histories and ecology. A fossil lake bed near Jamestown, ND will provide perhaps thousands of years of continuous data of fish growth during a warming climate. This research will provide insight for fishery biologists and wetland ecologists concerning the long-term response of contemporary fish growth in North Dakota given potential climatic changes.

Project objectives:

The project entails an examination of the relationships between age, growth, longevity, and climate on a geologic scale. The objectives of this study are to: 1). examine the age and growth patterns of fossil freshwater hiodontids, esocids, and the percid, *Perca flavescens* from all fossil localities known to produce these taxa in North America; and 2). quantify patterns of growth of extant hiodontids, esocids, and the percid, *Perca flavescens* from a range of latitudes and ambient mean annual temperatures (MAT) to understand the effects of MAT on fish growth; 3) contrast the growth patterns from fossil fish to that of extant populations to examine evolutionary patterns.

Progress:

In previous research, we have contrasted growth of living forms of pike (*Esox*) to that of fossils. More recently, we have been working with yellow perch (*Perca flavescens*). The research has shown that growth of living and extinct closely related species are similar. By examining the growth patterns of contemporary pike and yellow perch across their ranges, we found that mean annual air temperature describes variation in growth. Furthermore, changes in age and growth of Esociformes and Hiodontiformes since the Cretaceous show trends in time that are correlated with climate change.

Pleistocene fossils can also be used to examine the effects of climate change on fish. We reexamined a well-preserved late Pleistocene to early Holocene fossil fish assemblage from lake deposits on the Missouri Coteau, near Buchanan, North Dakota. Our findings were published in the Canadian Journal of Fisheries and Aquatic Sciences. We reported

that fossil fish abundance, stratigraphy, pollen, and charcoal provided information about postglacial colonization and the subsequent population fluctuations during a time of climatic warming. The fossil fish included complete specimens of *Perca flavescens, Hybognathus hankinsoni, Notropis heterolepis, Fundulus diaphanous, and Culaea inconstans*. The sequence of colonization for each species was correlated with individual thermal and relative water velocity tolerances. We found that fish abundance fluctuates six times during an approximate 1000 year depositional history. Charcoal abundance, representing fires, was inferred to represent episodic droughts during which nutrient levels were reduced and fish abundance declined. The fluctuations followed an overall trend to increased abundance during a time when the lake-margin vegetation changed from a spruce to a deciduous forest in response to climatic warming. The research provides insight into the effects of a changing climate on fish populations and demonstrates the potential of using fossils to examine long-term processes regarding contemporary fish species.

Significance:

Ultimately, this research will document the changes in evolution of growth of extinct species during climate change and help to understand how contemporary species respond to climate change.