

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

Michael Newbrey

Department of Biological Sciences,
North Dakota State University

Research Needs:

Poor understanding of the response of fish to climate change....

**Hill and Magnuson
(1990)**

**Shuter and
Post (1990)**



Dissertation Objectives

- 1. Examine the age and growth of fossil fish**
- 2. Quantify patterns of growth of contemporary fish in relation to temperature**
- 3. Estimate MAT in the fossil record**
- 4. Examine ecological, evolutionary, and geographic patterns in relation to climate**

Study Species

Taxa

Amia calva



Hiodon alosoides



Hiodon tergisus



Esox lucius



Esox masquinongy



Perca flavescens

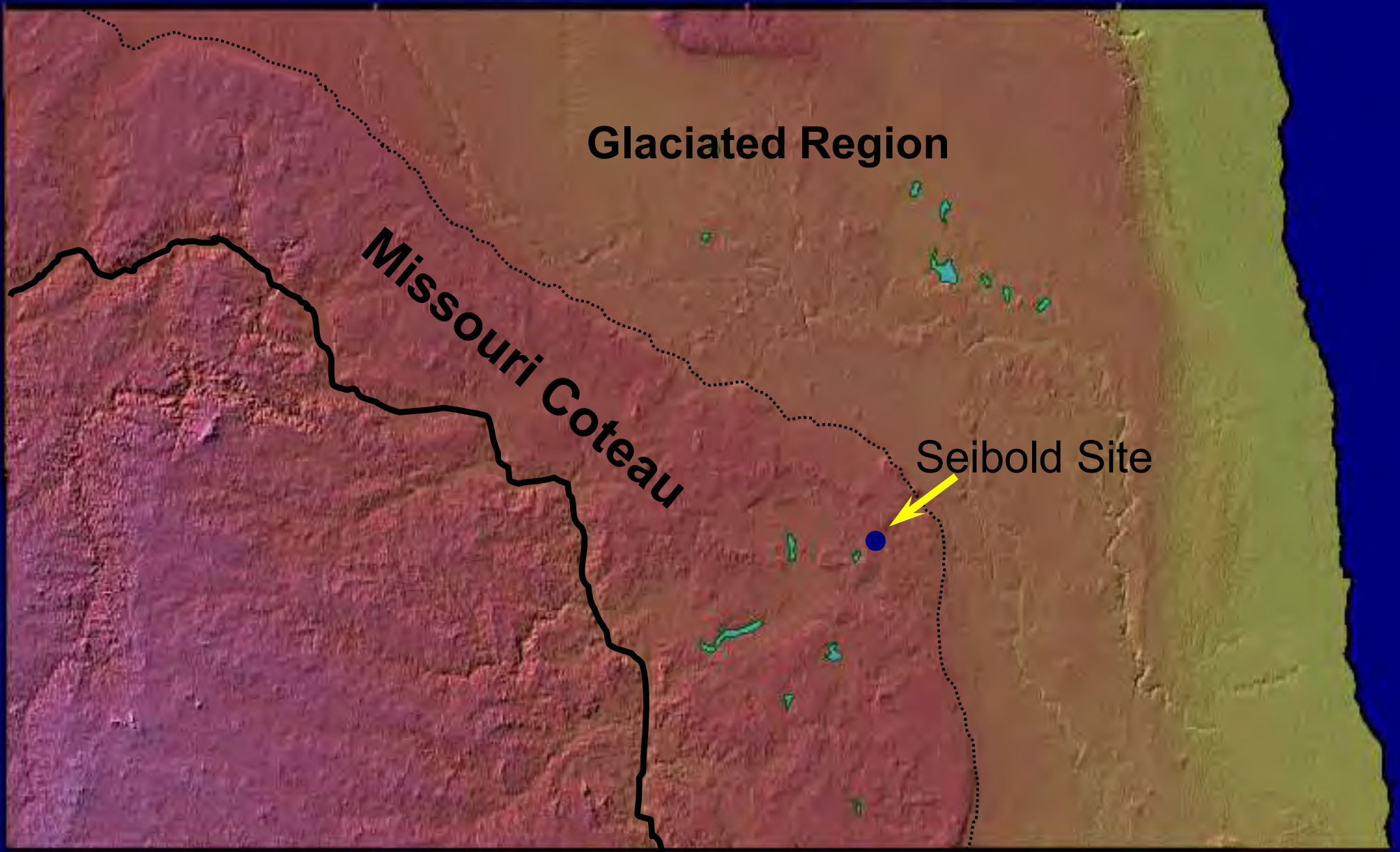


North Dakota

Glaciated Region

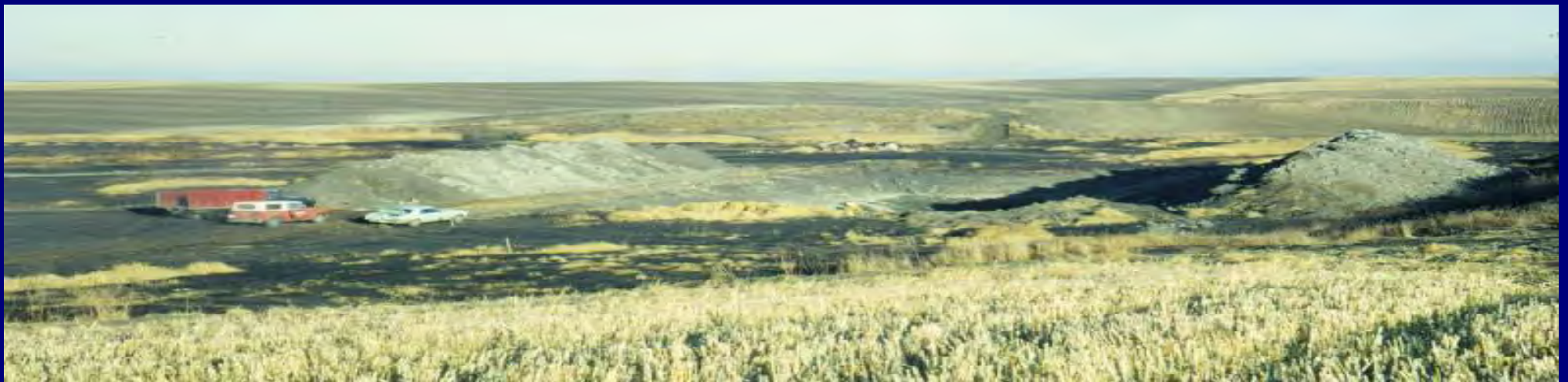
Missouri Coteau

Seibold Site





Seibold Slough in 2002



Seibold Excavation in 1969

Species:

Perca flavescens



Hybognathus hankinsoni



Notropis heterolepis



Culaea inconstans



Fundulus diaphanus





ca. 9,000 years B.P.

12,000 years B.P.



**Prairie Pothole
(Central North Dakota)**



**Oak Savannah
(Northern Minnesota)**



**Boreal Forest
(Central Manitoba)**

Objective 1.

Examine the age and growth of fossil fish



Perca flavescens

Objective 2.

Quantify patterns of growth of extant fish in relation to temperature



Perca flavescens

(taken from Etnier and Starnes 1993; Becker 1983)

Contemporary *Perca flavescens* Populations

Location:	MAT °C	Citation:
Churchill Lake, SK	1.2	Carlander 1997
Heming Lake, MB	-0.2	Lawler 1953
Red Lakes, MN	3.8	Heyerdahl and Smith Jr. 1971
Lake Sakakawea, ND	4.5	Wahtola 1968
Lake Ashtabula , ND	4.8	Ragan 1970
Flora Lake, WI	4.0	Parker 1958
Silver Lake, WI	3.8	Herman et al. 1959
Oahe, SD	7.9	Carlander 1997
Lake Okoboji, IA	7.3	Carlander 1997
Lake Mendota, WI	7.3	Herman et al. 1959
Lake Wingra, WI	7.3	Churchill 1976
Shell Lake, NE	9.5	Paukert and Willis 2001
Clear Lake, NE	8.5	Paukert and Willis 2001
Cameron Lake, NE	9.5	Paukert and Willis 2001
Tingley Lake, PA	7.0	Miller and Buss 1962
Island Lake, NE	9.3	Paukert and Willis 2001
Ferguson Reservoir, OH	10	Paxton and Stevenson 1978
Claytor Lake, VA	11.0	Kohler 1980
Keowee Reservoir, SC	15.3	Clugston et al. 1978
Singleton Lake, NC	16.2	Carlander 1997



Mean Annual Air Temperature (MAT)

- Examine relationship between length-at-age and MAT using linear regression analysis
- Early Holocene MAT calculated using the rearranged regression equation

MAT Regressions by Age Class

Age	N	<i>m</i>	<i>b</i>	r^2	P
2	20	33.097	-2.026	0.22	0.037
3	20	36.436	21.663	0.27	0.020
4	19	39.567	35.071	0.33	0.010
5	14	43.175	42.254	0.45	0.009
6	9	26.047	135.160	0.46	0.046
7	8	27.737	139.367	0.45	0.070

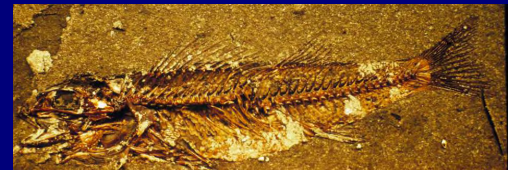


Objective 3.

Estimate MAT in the fossil record

Fossil *Perca flavescens* Inferred MAT

Age	TL (mm)	MAT °C
1	86	?
2	101	-0.30
3	137	0.02
3	103	-5.01



Objective 4.

Examine ecological patterns in relation to
climate



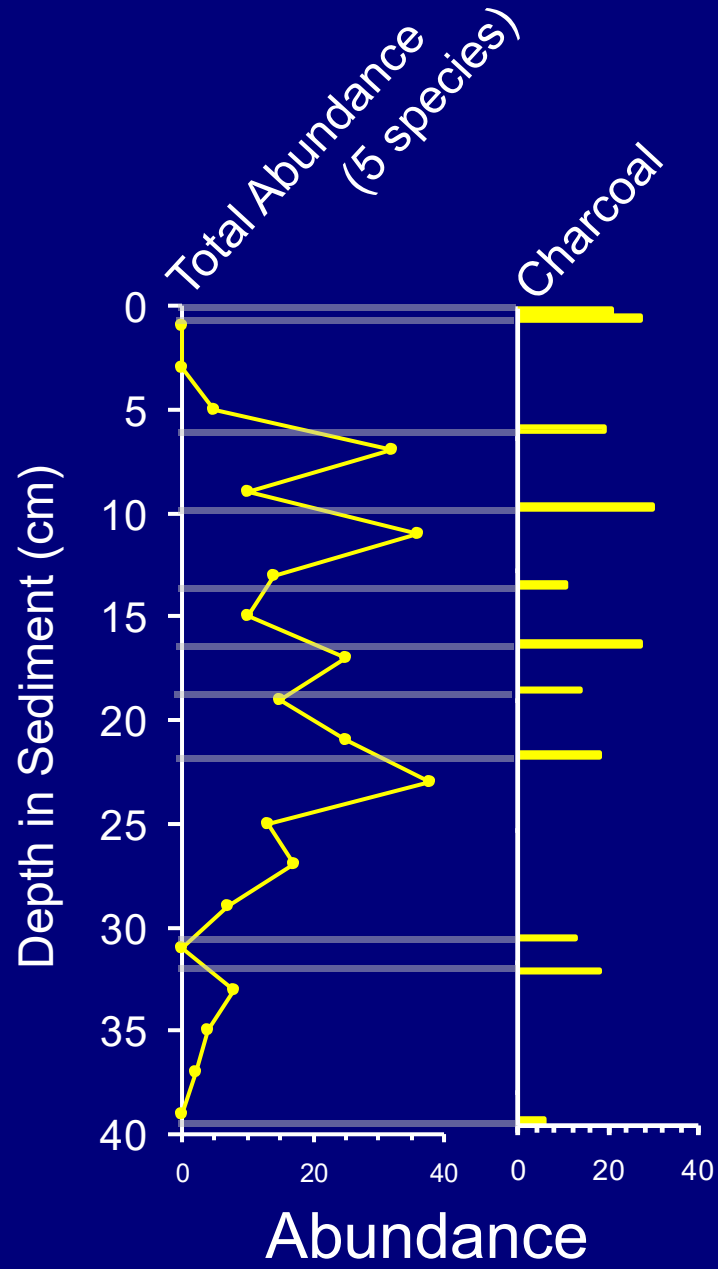


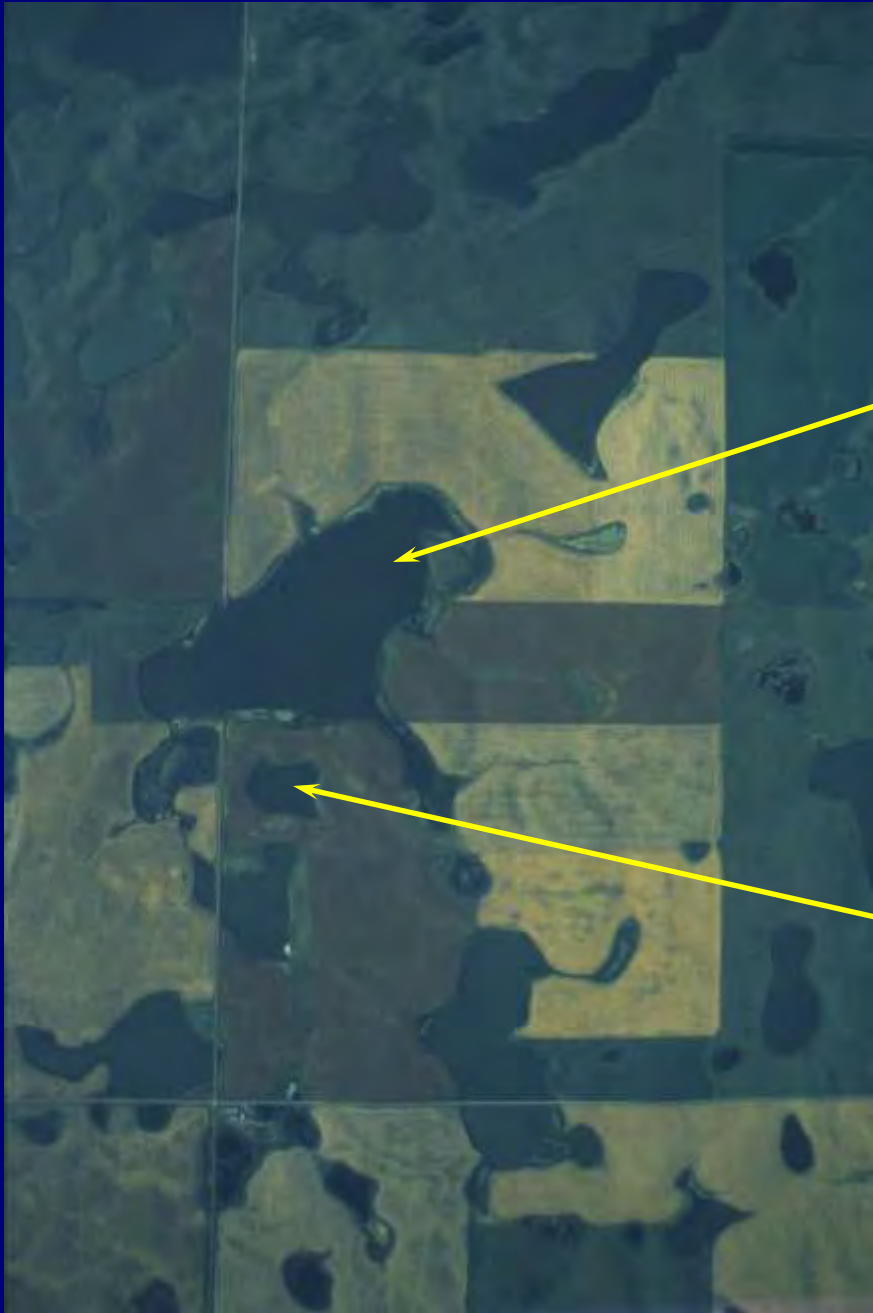
ca. 9,000 years B.P.

12,000 years B.P.



11,065 Calendar Years B.P.





Progress Summary

Newbrey, M.G. and A.C. Ashworth. July 2003. A new method to estimate early Holocene mean annual temperature using growth characteristics of fossil *Perca flavescens* (yellow perch). XVI International Union for Quaternary Research Congress.

Newbrey, M.G. and A.C. Ashworth. October 2003. Fish community dynamics, growth of yellow perch, and correlations with climate and fire in an early Holocene lake in North Dakota. Society of Vertebrate Paleontology 63rd Annual Meeting. Vol. 23.

Manuscript: A fossil record of colonization and response of lacustrine fish populations to climate change and fire

M.G. Newbrey and A.C. Ashworth

Formatted for the Canadian Journal of Fisheries and Aquatic Sciences

Acknowledgements

Funding:

USGS - ND Water Resources

Research Institute Fellowship

GraSUS Fellowship – 2002/2003

Committee Members:

Dr. Allan C. Ashworth

Dr. James W. Grier

Dr. Craig A. Stockwell

Dr. Gary K. Clambey

Dr. David A. Rider

Dr. Mark V. H. Wilson

