Journal of Undergraduate Research at Minnesota State University, Mankato

Volume 11 Article 13

2011

Effect of Increased Water Temperature on Warm Water Fish Feeding Behavior and Habitat Use

Eric Walberg
Minnesota State University, Mankato

Effect of Increased Water Temperature on Warm Water Fish Feeding Behavior and Habitat Use.

Eric Walberg, Minnesota State University, Mankato
Dr. Shannon Fisher, *Faculty Mentor*, Minnesota State University, Mankato

Abstract

Global warming could cause changes in species behavior and life history. Stream fish may be significantly affected by climate change because individuals are restricted in their movements by water systems and other physical factors, preventing migration to locations more thermally suitable. The effect of warmer waters on stream fish could change behavior and affect the fish species survival and ultimately ecosystem function. During my experiment I observed the effects of increased water temperature on the feeding behavior and habitat use of two native Minnesota fish species, black crappie (*Pomoxis nigromaculatus*) and black bullhead (*Ameiurus melas*). An increase of 2^{o}C over a period of 4 weeks resulted in a 35% decrease in the number of feeding events by black bullheads and an increase of 22.2% for black crappies. Significant changes in habitat use were also observed during the study, with bullheads increasing their use of open areas, plant cover, and swimming behavior, while decreasing their use of brick interior for cover and searching behavior. Crappies were found to increase their use of open areas and swimming behavior, while decreasing their use of the brick exterior for cover. These results provide insight about the future effects of increased water temperature on the feeding behavior, habitat use, and ecosystems of fish species.

Introduction

Climate change has become a growing issue of debate with a wide range of potential implications. Fish are believed to be among the animals that could be affected to the greatest degree by climate change (Morgan et al., 2001). Fish are vulnerable because the body temperature of fish varies with the ambient temperature due to their ectothermic nature, affecting physiological processes as a result (Pang et al., 2011). Fish are unable to dissipate excess body heat by perspiration; instead they regulate body temperature by moving between areas of different water temperature (Pough et al., 2009). Fish regulate body temperature because of the optimal temperature that they need to survive. Every species has an optimal temperature range at which they can be active, grow, reproduce, and metabolize (Dodson, 2005). Individuals often cannot support life and/or reproduce outside of this optimal temperature range (Dodson, 2005). For some organisms, their optimal temperature range can be as narrow as a few degrees or as large as 20^{o}C (Dodson, 2005). A change in water temperature of only 2^{o}C has been shown to stimulate the metabolism, appetite, and growth of some stream fish by 30-60% (Morgan et al., 2001). When temperature changes are substantial, fish have been shown to move from areas of warmer water to colder water to avoid thermal stress (Howell et al., 2010). While lake fish may have cooler, deeper water to go to escape increased water temperature, fish in shallower lakes and streams often lack cooler refuge options.

Air temperature is often used to discuss climate change, while water temperature represents a more sensitive indicator of climatic change (Hudon et al., 2010). The primary determinate of river water temperature in temperate regions is seasonal variations in air temperature, though hydrological factors play a role as well (Hudon et al., 2010). Several studies have found that water temperatures are increasing, such as the St. Lawrence River in Quebec, Canada, that was found to have increased by 1.3^{o}C since 1960 (Hudon et al., 2010). Other surface waters have also warmed, such as Lake Superior (0.1^{o}C/year, July-September, 1980-2005, Austin and Colman, 2008) and Lake Ontario (0.096^{o}C/year, July-September, 1980-2006, Malkin et al., 2008). Climate-change models generally agree that air temperatures will likely continue to increase in the future (Johnson et al., 2009). Water temperatures will increase as a result of this air temperature increase and potentially result in increased hydrological variability (Britton et al., 2010).

In some cases, increasing temperature may be favorable for reproduction and recruitment of some species; as thermal constraints that may have limited them in the past are removed (Hellman et al. 2008). Rising water temperatures have been shown to result in a sharp increase in the rate of egg development, hatching success, and survival of swim-up larvae for Northern pike (*Esox lucius*; Cooper et al., 2008).

https://cornerstone.lib.mnsu.edu/jur/vol11/iss1/13
DOI: 10.56816/2378-6949.1035

Also, survival of young-of-the-year pike and perch (*Perca fluviatilis*) were shown to also improve with longer growing seasons (Nilsson et al., 2004). Increasing water temperatures have also been shown, however, to negatively impact the survival of juveniles, affecting the overall population size of fish. For example, chronic exposure to water temperatures between 18-25^{o}C led to reduced growth in juvenile bull trout (*Salvelinus confluentus*), while temperatures >20^{o}C led to substantial mortality (Selong et al., 2001).

Based on the current temperature limits of species, it is believed that the habitat range of some species may expand northward in order to remain in conditions that are within their thermal optima (Britton et al., 2010). Temperature, however is only one aspect of the biophysical environment that must meet the requirements of a species in order for a range shift to occur; meaning that the conditions have to be adequate for both the juvenile and adult age classes in order for the population to exist (Figueira and Booth, 2010). It is not believed that specialist species would show a range shift, while a habitat and dietary generalist species could (Figueira and Booth, 2010). It is also believed that warmer temperatures may favor the establishment of populations of non-native fishes in England and Wales, making it more likely that invasives will establish (Britton et al., 2010). The problem with the establishment of non-native fish species is the increased competition for food and habitat that may occur, possibly displacing native species. There is no reason to believe that this same scenario could not happen in other regions as well.

Warmer air temperatures may cause the mortality or emigration of some cool water species [e.g., brook trout (*Salvelinus fontinalis*) and northern redbelly dace (*Phoxinus eos*)], while giving other species a competitive advantage [e.g., creek chub (*Semotilus atromaculatus*)] because they are better adapted to the warmer water temperatures (Eaton et al., 1995). The effects of warmer water temperatures may be heightened in streams with degraded habit that prevents prey production sufficient to satisfy increased metabolic demands of predator species (Ries and Perry, 1995).

While some species may benefit from increased water temperatures, others have shown negative effects. Increased water temperature was shown to have significant effects on the amount of habitat that would be suitable for four species of trout in the interior western United States of America (Wenger et al., 2011). Wenger et al. (2011) projected that by 2080, 47% of the total suitable habitat for all trout species will no longer be inhabitable. Based on models that projected an increase in air temperature between 2.49°C and 5.51°C, the nonnative brook trout showed the largest habitat loss with 77%, while rainbow trout (*Oncorhynchus mykiss*) showed the smallest loss with 35% (Wenger et al., 2011). A decrease in trout habitat is expected to be displayed in the rest of the temperate world because three of the four species that were used during this study [rainbow trout, brown trout (*Salmo trutta*), and cutthroat trout (*Oncorhynchus clarkia*)] are common on other continents (Wenger et al., 2011). Temperature is believed to be the dominant factor that determines the effect of climate change on the future declines of cutthroat, brook, and rainbow trout, though flow regime and biotic interactions also play a role (Wenger et al., 2011).

It is likely that climate change may affect fish to different degrees depending on the season of the year. It is believed that the physiological effects of global warming may be minimal for most of the year, while providing beneficial effects during the winter on appetite, growth, nitrogen metabolism, and protein accretion (Morgan et al., 2001). Increased water temperature may threaten fish species that are located towards the upper end of their thermal tolerance zone during the late summer, when the highest ambient temperatures occur (Morgan et al., 2001). High ambient temperature may result in suppression of appetite, growth, nitrogen metabolism, and decreases in net protein accretion, primarily due to increased degradation rate (Morgan et al., 2001).

Based on the results of past studies, I believe that warmer water temperatures may cause a change in fish behavior that could affect survival and the ecosystem function. During this study, I expect that these species will change their habitat use in order to dissipate excess body temperature and will increase their food consumption in order to meet increased metabolic needs, leading me to make four hypotheses. My hypotheses' are that; 1) black crappies (*Pomoxis nigromaculatus*) will show a significant change in habitat, 2) black bullheads (*Ameiurus melas*) will show a significant change in habitat, 3) crappies will display a significant increase in feeding behavior in relation to increased water temperature, and 4) bullheads will display a significant increase in feeding behavior in relation to increased water temperature.

DOI: 10.56816/2378-6949.1035

Methods

Black crappies and black bullheads were captured from a lake near Mankato, Minnesota and placed in a stream tank (a tank with constant flow of water) at approximately 21^{o}C with a consistent amount of food daily and habit cover, including synthetic plants, bricks, and rocks. The bullheads and crappies were approximately 102-152 mm in length and were allowed to acclimate to the new conditions and food source for a period of two weeks. A baseline of common feeding behavior and habitat use was determined once consistent behavior was observed. Each 5-day observation period was followed by 9 days of acclimation after the water temperature was raised by approximately 1^{o}C. A total of 3 observation periods were conducted during this experiment. During each day of the observation period a technique called scan sampling was used, where the fishes feeding behavior and habitat use was observed for a 15-min period, recording the behavior state of each individual every 30-seconds. Observations were conducted at 1600 hour daily to avoid changes in behavior caused by the time of day. Scan sampling and an ethogram were used in order to record behavior changes and reduce observation bias. The ethogram included 7 behavior states, including 1 feeding behavior and 6 habitat behaviors: combined eating, floating in open, in plant cover, in brick cover, outside brick, searching, and swimming. The definition that was used to classify each behavior is located in Table 5. The data were analyzed in Microsoft Excel 2007 with t-tests and descriptive statistics to identify any trends that may have occurred during the experiment.

Results

Crappies displayed results in three of the seven behavior states that were significant ($P<0.05$) enough to indicate that any difference that occurred between the different trials was not by chance (Table 1). Floating in open, using the outside of the bricks for cover, and the swimming behavior showed significant results (Table 1). The remaining behaviors did not show significant results when compared (Table 1). Bullheads were observed to have six of the seven behavior states with significant results during the study (Table 2). Using the outside of the bricks for cover was the only behavior state that did not have significant results during the experiment (Table 2). When comparing the difference of trial 1 to trial 3, crappies showed an average increase of 66 observations/day (O/D, 270% increase) for floating in the open, a decrease of 53.2 O/D (63%) in the use of the brick exterior for cover, and a decrease of 3.2 O/D (84%) in swimming behavior (Table 3). The other behaviors were not found to be significant in Table 1 and any change between trials is unreliable. Bullheads showed a decrease in combined eating of 17 O/D (35%), an increase of 29.4 O/D (N/A) for floating in open, an increase of 54.6 O/D (8067%) for using plant cover, a decrease of 32 O/D (30%) for using the brick interior, a decrease of 23.3 O/D (56%) for searching behavior, and an increase of 6.1 O/D (852%) for swimming behavior (Table 4). Table 5 displays the exact definition for each of the behavior states that were used during this experiment. The results from the observed behaviors of black crappies (Table 3) are displayed as a bar graph in Figure 1 and the behaviors of black bullheads (Table 3) are displayed in Figure 2. Figure 1 displays changes in crappie behavior such as the large increase that occurred in the behavior of floating in open and the large decrease of using the brick exterior for cover. Figure 2 displays the behavior changes for bullheads such as the increase in floating in open and using plant cover, but the decrease in using the brick interior, combined eating, and searching behavior.

Discussion

The optimal temperature range for each fish species used during this study can explain many of the results that occurred during this experiment. The optimal temperature range for crappies is 22-25^{o}C (Brungs and Jones, 1977) and 20-23^{o}C for bullheads (Stuber, 1982), placing bullheads outside of their optimal temperature range during the last observation period. I believe that the effects of increasing the water temperature above the optimal temperature of black bullheads was displayed by their reduction in feeding behavior (Table 4), which was unexpected to me because increased water temperature should increase the metabolism of the fish, resulting in increased feeding behavior. Though some cold-water fish species have been shown to reduce their consumption of animal material when they experience an increase in water temperature (Behrens and Lafferty, 2007). It may have been possible that a diet shift may have occurred among the bullheads that was not followed by a shift in the availability of different food types, resulting in a reduction in overall feeding behavior.

Black bullheads are bottom dwellers and are adapted to cooler water temperatures, while crappies are located higher in the water column and would be more apt to handle warmer water physiologically. The water temperature could also explain the change in habitat use and searching behavior by bullheads. In the wild, bullheads and crappies would compensate for the increased water temperature by finding areas that contain cool water temperatures, allowing their body temperature to cool as a result. During this experiment, though, the fish species were forced to utilize different behaviors or habitats in order to dissipate their excess body heat. Bullheads appeared to compensate for the increased water temperature by floating in the open and using plant cover more often, instead of utilizing the interior of the bricks that they used at the beginning of the study (Table 4). The bricks provided adequate protection in their new environment but blocked water flow. Floating in the open and within plant cover provided a significantly lower amount of protection but allowed them to increase the water flow that they were exposed to, potentially allowing them to dissipate excess body heat. Bullheads also appeared to reduce their body temperature by reducing their searching behavior and increasing their swimming behavior (Table 4). When searching, bullheads swam at a faster rate, likely resulting in excess body heat, while swimming occurred at a slower speed but allowed them to increase the amount of water flowing over their body.

During this experiment, the crappies also displayed a shift in their habitat use from using the exterior of the bricks for cover a majority of the time to floating in the open more often (Table 3). This change in habitat use may be a result of the fish trying to dissipate excess body heat. Some of the behavior changes may have occurred because the fish in this study were still acclimating to their surroundings, though this does not appear to be true for bullheads because of the significant changes that occurred between each of the trials (Table 2). Due to this result, I believe that water temperature may be causing the significant change to occur between trials. The differences in behavior states between each of the trials for crappies was often more variable and showed a less significant result, suggesting that they were not effected as much as the bullheads.

The results of this research can have impacts in areas such as the future management of these species, but can also help us to predict how these species would handle changes in the environment that may occur. Though these results are likely to be most beneficial for fish populations that exist in river systems because of the design of the experiment, it may still be applicable to other water bodies increasing in temperature too. The reason this experiment provides insight about a river system is because fish were unable to swim to locations of cooler water to alleviate their excess body temperature, which would be an option in a large water body. Some fish species will be affected to a greater degree by this habitat limitation as warmer water temperatures occur, such as black bullheads during this study.

I believe that the main use of this study could be in the realm of management, as this information allows us to better understand changes in fish behavior that may occur in the environment due to warming. It is likely that conservation organizations need to recognize global change as a significant factor when creating long-term management plans for freshwater fish species. The results of this study suggest that management plans cannot be a one-size-fits-all approach because what is needed to ensure the long-term survival of black bullheads will be different than the one needed for black crappies. My hypotheses' for this study were; 1) black crappies will show a significant change in habitat, 2) black bullheads will show a significant change in habitat, 3) crappies will display a significant increase in feeding behavior in relation to increased water temperature, and 4) bullheads will display a significant increase in feeding behavior. Hypotheses' 1 and 2 were supported by the results of this study because crappies displayed a significant change in 3 of the 6 habitat uses and bullheads displayed a significant change in 5 of the 6 habitat uses. Hypotheses' 3 and 4 were not supported because crappies showed an insignificant change in feeding behavior and bullheads showed a significant decrease in feeding behavior. I believe that research needs to be conducted in the area of the abilities of fish species to adapt to changing environments over an extended period of time. Also, research could be conducted on the effects of increased water temperature on the vegetative and biotic prey structure of lakes.

DOI: 10.56816/2378-6949.1035

Tables and Figures

Table 1. Results for T-tests comparing each trial of black crappie (*Pomoxis nigromaculatus*) behavior. Significant results (P<0.05) are displayed with a yes, while insignificant results are represented by a no.

Trial	Combined Feeding	Floating In Open	In Plant Cover	In Brick Cover	Outside Brick	Searching	Swimming
1 v 2	No	Yes	No	No	Yes	No	No
1 v 3	No	Yes	No	No	Yes	No	No
2 v 3	No	No	No	No	No	No	Yes

Table 2. Results for T-tests comparing each trial of black bullhead (*Ameiurus melas*) behavior. Significant results (P<0.05) are displayed with a yes, while insignificant results are represented by a no.

Trial	Combined Feeding	Floating In Open	In Plant Cover	In Brick Cover	Outside Brick	Searching	Swimming
1 v 2	Yes	No	No	No	No	No	No
1 v 3	Yes	Yes	Yes	Yes	No	No	Yes
2 v 3	Yes	Yes	Yes	Yes	No	Yes	Yes

Table 3. Average number of black crappie (*Pomoxis nigromaculatus*) behaviors per observation period by trial.

Trial	Combined Feeding	Floating In Open	In Plant Cover	In Brick Cover	Outside Brick	Searching	Swimming
1	21.6	24.4	3.0	7.2	85.0	2.4	3.8
2	21.6	82.8	0.4	0.0	39.2	0.0	5.2
3	26.4	90.4	0.0	0.6	31.8	0.0	0.6

Table 4. Average number of black bullheads (*Ameiurus melas*) behaviors per observation period by trial.

Trial	Combined Feeding	Floating In Open	In Plant Cover	In Brick Cover	Outside Brick	Searching	Swimming
1	30.0	0.0	0.4	108.4	0.3	41.3	0.7
2	9.8	0.7	7.9	115.9	0.0	45.3	0.5
3	13.0	29.4	35.0	76.4	0.0	18.0	6.8

Table 5. Ethogram used during the table in order to record feeding behavior and habitat use of both black bullheads (*Ameiurus melas*) and black crappies (*Pomoxis nigromaculatus*).

Combined Eating: Any act of consuming food during observations.

Floating in Open: Fish floating idly in open water and was not near a cover structure.

In plant cover: Fish has a portion or its whole body in the fake plants and is not swimming.

In brick cover: Fish is partly or fully contained within the cinder block bricks and is not swimming.

Outside brick: Fish is floating closely to the exterior of the cinder block bricks and is not swimming.

Searching: Fish is swimming near the bottom of the tank at a fast rate looking for food.

Swimming: Fish is swimming at a slower rate and is not at the bottom of the tank bottom.

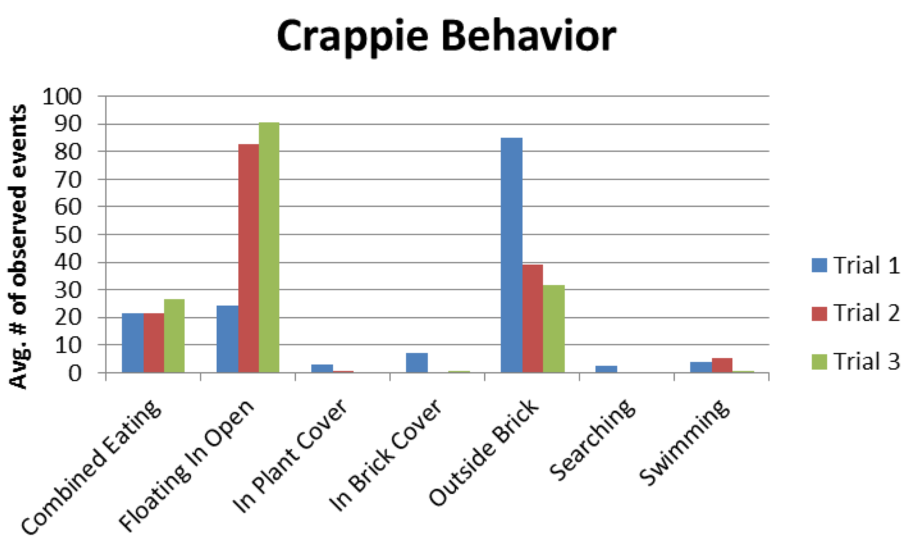

Figure 1. Graph displaying the average number observed behaviors per day based on each series of observations for black crappies (*Pomoxis nigromaculatus*).

DOI: 10.56816/2378-6949.1035

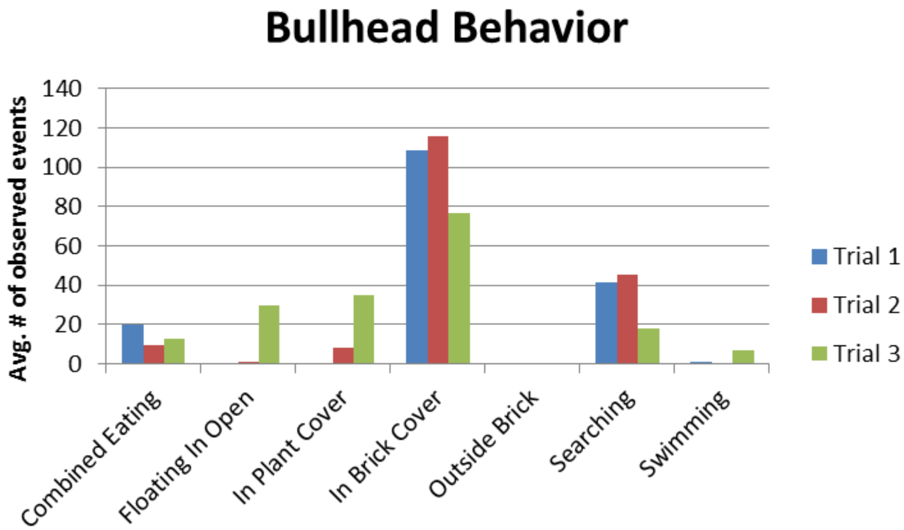

Figure 2. Graph displaying the average number observed behaviors per day based on each series of observations for black bullheads (*Ameiurus melas*).

Acknowledgement

Thank you to the Minnesota State University-Mankato Undergraduate Research Conference grant committee for their generous financial support, Dr. Fisher for his guidance, instruction, and resources during my research, and all of Dr. Fisher's graduate students for their generous help and instruction.

Works Cited

Austin, J.A. and S.M. Colman. 2008. A century of temperature variability in Lake Superior. *Limnology and Oceanography* 53:2724-2730.

Behrens, M.D. and K.D. Lafferty. 2007. Temperature and diet effects on omnivorous fish performance: implications for the latitudinal diversity gradient in herbivorous fishes. *Canadian Journal of Fisheries and Aquatic Sciences* 64:867-873.

Britton, J.R., J. Cucherousset, G.D. Davies, M.J. Godard, and G.H. Copp. 2010. Non-native fishes and climate change: predicting species responses to warming temperatures in a temperate region. *Freshwater Biology* 55:1130-1141.

Brungs, W.A., and B.R. Jones. 1977. Temperature criteria for freshwater fish: protocol and procedures. U.S. Environmental Protection Agency, Environ. Res. Lab., Ecol. Res. Ser. EPA-600/3-77-061. 139 pp.

Cooper, J.E., J.V. Mead, J.M. Farrell, and R.G. Werner. 2008. Potential effects of spawning habitat changes on the segregation of northern pike (*Esox lucius*) and muskellunge (*E. masquinongy*) in the Upper St. Lawrence River. *Hydrobiologia* 601:41-53.

Dodson, Stanley. 2005. "Aquatic ecosystems and physiology: energy flow." *Introduction to limnology*. New York, NY: McGraw-Hill. 221-222.

Eaton, J.G., J.H. McCormick, B.E. Goodno, D.G. O'Brien, H.G. Stefan, M. Hondzo, and R.M. Scheller. 1995. A field information-based system for estimating fish temperature tolerances. *Fisheries* 20:10-18.

Figueira, W.F. and D.J. Booth. 2010. Increasing ocean temperatures allow tropical fishes to survive overwinter in temperate waters. *Global Change Biology* 16:506-516.

Hellmann, J.J., J.E. Byers, B.G. Bierwagen, and J.S. Dukes. 2008. Five potential consequences of climate change for invasive species. *Conservation Biology* 22:534-543.

Howell, P.J., J.B. Dunham, and P.M. Sankovich. 2010. Relationships between water temperatures and upstream migration, cold water refuge use, and spawning of adult bull trout from the Lostine River, Oregon, USA. *Ecology of Freshwater Fish* 19:96-106.

Hudon, C., A. Armellin, P. Gagnon, and A. Patoine. 2010. Variations in water temperatures and levels in the St. Lawrence River (Quebec, Canada) and potential implications for three common fish species. *Hydrobiologia* 647:145-161.

Johnson, A.C., M.C. Acreman, M.J. Dunbar, S.W. Feist, A.M. Giacomello, R.E. Gozlan, S.A. Hinsley, A.T. Ibbotson, H.P. Jarvie, J.I. Jones, M. Longshaw, S.C. Maberly, T.J. Marsh, C. Neal, J.R. Newman, M.A. Nunn, R.W. Pickup, N.S. Reynard, C.A. Sullivan, J.P. Sumpter, and R.J. Williams. 2009. The British river of the future: how climate change and human activity might affect two contrasting river ecosystems in England. *Science of the Total Environment*, 407: 4787-4798.

Malkin, S.Y., S.J. Guildford, and R.E. Hecky. 2008. Modeling the growth response of *Cladophora* in a Laurentian Great Lake to the exotic invader *Dreissena* and to lake warming. *Limnology and Oceanography* 53:1111-1124.

Morgan, I.J., D.G. McDonald, and C.M. Wood. 2001. The cost of living for freshwater fish in a warmer, more polluted world. *Global Change Biology* 7, 345-355.

Nilsson, J., J.J. Anderson, P. Karas, and O. Sandstrom. 2004. Recruitment failure and decreasing catches of perch (*Perca fluviatilis* L) and pike (*Esox lucius* L.) in the coastal waters of southeast Sweden. *Boreal Environmental Research* 9:295-306.

Pang, X., Z.D. Cao, and S.J. Fu. 2011. The effects of temperature on metabolic interaction between digestion and locomotion in juveniles of three cyprinid fish (*Carassius auratus*, *Cyprinus carpio*, and *Spinibarbus sinensis*). *Comparative Biochemistry and Physiology* 159:253-260.

Pough, F. Harvey, Christine M. Janis and John B. Heiser. 2009. *Vertebrate Life 8th edition.* San Francisco, CA: Pearson Education, Inc. 380.

Ries, R.D., and S.A. Perry. 1995. Potential effects of global climate warming on brook trout growth and prey consumption in central Appalachian streams, USA. *Climate Research* 5:197-206.

Selong, J.H., T.E. McMahon, A.V. Zale, and F.T. Barrows. 2001. Effect of temperature on growth and survival of bull trout, with application of an improved method for determining thermal tolerance for fishes. *Transactions of the American Fisheries Society* 130:1026-1037.

Stuber, R.J. 1982. Habitat suitability index models; Black bullhead. FWS/OBS-82/10.14. U.S. Fish and Wildlife Service, Washington, D.C.

Wenger, S.J., D.J. Isaak, C.H. Luce, H.M. Neville, K.D. Fausch, J.B. Dunham, D.C. Dauwalter, M.K. Young, M.M. Elsner, B.E. Rieman, A.F. Hamlet, and J.E. Williams. 2011. Flow regime, temperature, and biotic interactions drive differential declines of trout species under climate change. *Proceedings of the National Academy of Sciences of the United States of America* 108(34):14175-14180.

Professional Biography of Student

Eric Walberg is from Becker, MN and graduated from Becker High School in 2007. He is currently attending Minnesota State University-Mankato and is majoring in biology with a focus on zoology and working towards achieving a certificate in Geographic Information Science (GIS). After receiving his B.S. in biology- zoology and a certificate in GIS, he plans to attend graduate school to pursue his M.S. degree in wildlife biology or a similar field. Eric has worked for the Minnesota DNR as an intern since 2009. After earning his M.S. he would like to continue to work for an organization such as the MN DNR in a research capacity.

Professional Biography of Mentor

Dr. Fisher received his B.S. (1994) from Northland College and his M.S. (1996) and Ph.D. (1999) from South Dakota State University. He was an Environmental Review Ecologist and Fisheries Biologist for the MN DNR for 5 years before starting with the Water Resources Center in April 2005. In addition to his WRC duties, he serves as the Executive Director for the Minnesota River Basin Joint Powers Board (MRB) and as an Assistant Professor of Biology.

In his collective capacity, Dr. Fisher provides administrative support to the WRC/MRB staff, leads a 38-county delegation of local officials, advises student researchers, maintains stakeholder relations, instructs courses, coordinates conferences, and lobbies policymakers. These activities focus on the WRC/MRB mission to collect and disseminate water quality, watershed, and aquatic ecology information – with an emphasis on engaging students and educating our regional community.