

# **Significant Increasing Trend in Susquehanna River Water Temperature 1974-2010**

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## **Introduction**

Warming trends of surface temperature have been measured from across the planet for the past 50 years (IPCC 2007). As a result, water temperatures of streams and rivers have also been increasing (Webb and Walling 1992, Webb and Nobilis 1995, Bonacci *et al.* 2008, Pekarova *et al.* 2008). Similar increasing trends have also been reported for streams and rivers across the United States (Bartholow 2005, Kaushal *et al.* 2010).

I analyzed a long-term data set from the Susquehanna River to determine if a significant warming trend was evident. Such warming could have considerable negative consequences for the ecology of the river.

## **Methods**

River temperature data were collected from a temperature probe stationed at the bottom of the river adjacent to the Susquehanna SES Environmental Laboratory, near Berwick, Pennsylvania. The probe was regularly calibrated using a NIST standardized thermometer.

The data were recorded continuously either by graph paper or digital datalogger. Some gaps occurred in the data because of datalogger malfunctions. Attempts will be made to fill these gaps for future analysis. However, at this time I do not think that these gaps will significantly change the outcome of these results.

Data were analyzed for trends by simple linear regression. This analysis is similar to that used by others research trends in stream and river temperatures (Kaushal *et al.* 2010). Alpha was set at 0.05.

## **Results**

A significant increasing trend was evident in average annual water temperatures from 1974-2010 ( $P < 0.05$ , Figure 1). The regression equation describing the linear model predicts an annual increase of  $0.038^{\circ}\text{C yr}^{-1}$ , or an increase of  $3\text{-}4^{\circ}\text{C}$  over a century, if this rate of warming continues. While there is a considerable amount of "noise" evident in the data, the temporal variable accounts for 38% of the variation in river temperature over this 35-year time period.

## **Discussion**

The Susquehanna River's rate of warming is consistent with the warming rates of other streams and rivers in the northeastern United States (Table 1, modified from Kaushal *et al.* 2010). For many locations where increases in water temperature have been documented, significant linear increase in air temperature also occurred. Regression equations for these streams and rivers reported very similar coefficients of determination.

Serious ecological consequences can result from increases in average water temperatures in rivers like the Susquehanna. It is thought that warmer temperatures will assist invasive species, decrease community biodiversity, disrupt the spawning and development of species, and change the relative abundance and distribution of species. In addition, the overall metabolism of ecosystems can be altered and this can subsequently increase the toxicity of a number of environmental contaminants (Kaushal *et al.* 2010).

Table 1. Select data on warming of streams and rivers in the northeastern United States (modified from Kaushal *et al.* 2010).

Name	Nearby City	Time Range	(°C yr <sup>-1</sup> )	R <sup>2</sup>
Susquehanna River	Berwick, PA	1974-2010	0.038	0.37
Delaware River	Hale Eddy, NY	1986-2007	0.040	--
Delaware River	Chester, PA	1965-2007	0.077	0.39
Brandywine Creek	Chadds Ford, PA	1972-2007	0.070	0.28
Gunpowder River	Baltimore, MD	1983-2007	0.059	--
Potomac River	Washington, DC	1922-2006	0.046	0.43
Patuxent River	Solomons, MD	1938-2006	0.022	0.38

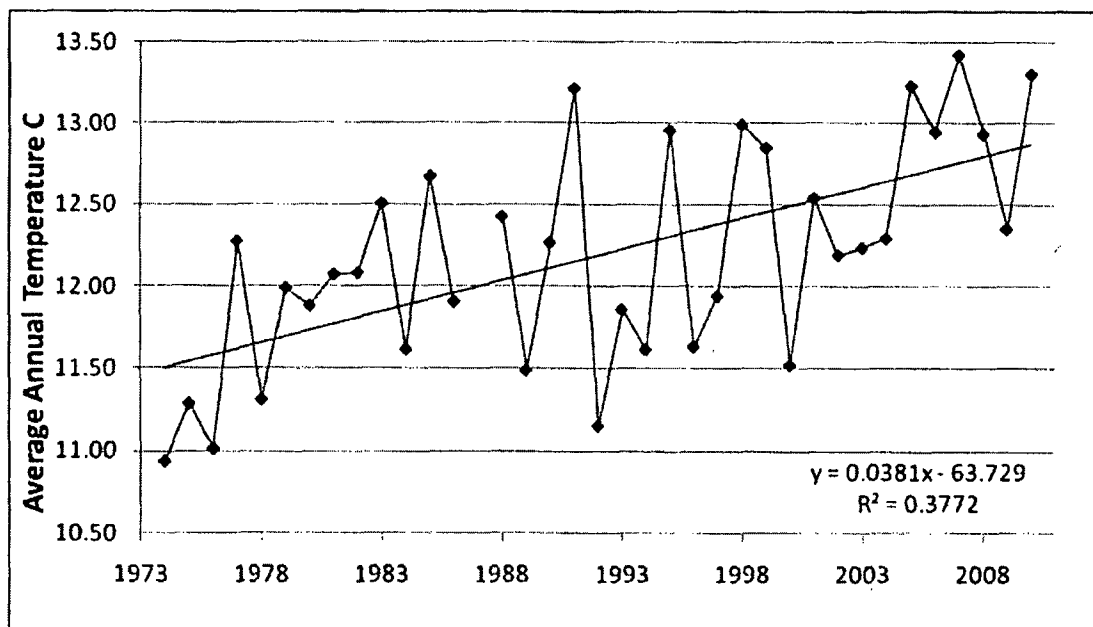


Fig. 1. Average annual river temperatures from the Susquehanna River, 1974-2010. The trend line is the result of a simple linear regression ( $P < 0.05$ ).

### Literature Cited

- Bartholow, J.M. 2005. Recent water temperature trends in the lower Klamath River, California. *North American Journal of Fisheries Management* 25(1):152-162.
- Bonacci, O., D. Trninić, and T. Roje-Bonacci. 2008. Analysis of the water temperature regimen of the Danube and its tributaries in Croatia. *Hydrological Processes* 22(7):1014-1021.
- IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007. Synthesis report. A contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.
- Kaushal, S.S., G.E. Likens, N.A. Jaworski, M.L. Pace, A.M. Sides, D. Seekell, K.T. Belt, D.H. Secor, and R.L. Wingate. 2010. Rising stream and river temperatures in the United States. *Frontiers in Ecology and the Environment* 9(8):461-466.
- Peckarova, P., D. Halmova, P. Miklanek, and M. Onderka. 2008. Is the water temperature of the Danube River at Bratislava, Slovakia, rising? *Journal of Hydrometeorology* 9(5):1115-1122.
- Webb, B.W. and F. Nobilis. 1995. Long term water temperature trends in Austrian rivers. *Hydrological Sciences Journal* 40(1):83-96.
- Webb, B.W. and D.E. Walling. 1992. Long term water temperature behavior and trends in a Devon, UK, river system. *Hydrological Sciences Journal* 37(6):567-579.

## **BRIAN P. MANGAN**

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### **Titles**

Director, Environmental Program and Professor of Environmental Science/  
Biology, King's College, Environmental Program, Wilkes-Barre, PA

Founder/ Director, Susquehanna River Institute, King's College,  
Wilkes-Barre, PA

Senior Environmental Biologist, Ecology III, Inc., Susquehanna SES  
Environmental Laboratory, Berwick, PA

### **Education**

Ph.D., Ecology, Pennsylvania State University, State College, PA (1999)  
Dissertation: The Influence of Flow on Habitat Use by Fish in a Large  
River

M.S., Biology, Bloomsburg University of Pennsylvania, Bloomsburg, PA (1988)  
Thesis: Oviposition and First-instar Larval Behavior of the Dobsonfly  
(*Corydalus cornutus*)

B.S., Biology, Pennsylvania State University, State College, PA (1982)

### **Continuing Education**

Zebra Mussel Workshops and Meetings (New York Sea Grant)

Stream Habitat Assessment Workshop (American Fisheries Society)

Principles and Techniques of Electrofishing (U. S. Fish and Wildlife Service)

Small Mammal Ecology (National Science Foundation)

### **Certifications**

Open Water Scuba Diver (Professional Diving Instructor Corp.)

First Aid, Cardiopulmonary Resuscitation (American Red Cross)

Boating Safety (PA Fish & Boat Commission)

Nuclear Quality Assurance Auditor

### **Professional Organizations**

The American Fisheries Society

The Ecological Society of America

The Wildlife Society

Society for Conservation Biology

North American Lake Management Society

American Association for the Advancement of Science

The Pennsylvania Association of Environmental Professionals

The Pennsylvania Academy of Science

### **Honors**

Phi Kappa Phi Honor Society

Who's Who Among America's Teachers

Manchester Who's Who among Executives and Professionals

**Professional Experience**

2000-present: Director, Environmental Program and Professor of  
Environmental Science/ Biology  
King's College, Wilkes-Barre, PA

*Department Chair for majors in environmental studies and sciences at King's College. Responsible for teaching, curricula, budget, assessment, research and grants. Courses taught are listed in the last section of this c.v.*

2000-present Founder and Director, The Susquehanna River Institute

*Responsible for the organization and promotion of a non-profit institute devoted to education and research focused on the Susquehanna River.*

1996-2000: Adjunct Instructor (Bioscience)  
Penn State University - Hazleton Campus, Hazleton, PA

1988-present: Senior Environmental Biologist  
Ecology III, Inc., 804 Salem Blvd., Berwick, PA

*Manage research and monitoring of aquatic organisms in the Susquehanna River, SSES ESSW Spray Pond, and LTAW.*

*Responsible for biofouling mollusk monitoring in the Susquehanna River and Susquehanna SES.*

*Monitor and control of invasive exotic plant species in the Susquehanna Riverlands.*

*Quality Assurance Representative/Lead Auditor for the Radiological Environmental Monitoring Program - Responsible for internal auditing to ensure adherence to pertinent procedures. Initiate, review, and update procedures. Also responsible for training of sample collectors involved in this program.*

*Provide underwater environmental support work at the Susquehanna SES Environmental Laboratory.*

1985-1987: Environmental Biologist  
Ecology III, Inc., R. R. #1, Berwick, PA

*Non-radiological Environmental Monitoring Program (NEMP): Collection, identification, and report preparation of fisheries data relative to an ecological survey of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (SES); monitor biofouling mollusks near the Susquehanna SES.*

**Professional Experience (cont.)**

*REMP Sample Collection Coordinator (1985-1992): Oversaw scheduling and collection of environmental radiological samples as well as the initiation and revision of procedures relative to this program at the Susquehanna SES; assisted with preparation of annual REMP reports to Nuclear Regulatory Commission; and prepared an annual land use census report of residences, gardens, and dairy farms in the vicinity of the Susquehanna SES.*

*Section Leader (1985-1992): Responsible for direction and processing of environmental radiological samples, spikes, and cross-checks for analyses, such as gross alpha/beta, gamma, and tritium analyses, and also procedural preparation and revision for this processing.*

*Sample collector for the Radiological Environmental Monitoring Program (REMP) and Emergency Radiological Environmental Monitoring Program (EREMP).*

*Scuba Diver: Sample collection for benthic macroinvertebrate program; underwater construction and environmental support work at the Susquehanna SES.*

- 1984-1985: Research Biologist  
Ichthyological Associates, Inc., R. R. #1, Berwick, PA.  
  
*Same responsibilities as listed for Ecology III, Inc. (1985-87)*
- 1982-1984: Research Technician  
Ichthyological Associates, Inc., R. R. #1, Berwick, PA  
  
*Assisted with collection, analyses, interpretation, and report preparation of water quality data and freshwater fishes (larval and adult) as related to the ecological survey of the Susquehanna River.*
- 1981-1982: Laboratory Assistant  
Dr. James Wright, Dept. of Biology, Pennsylvania State University, State College, PA  
  
*Assisted in preparation of salmonids for genetic studies using starch gel electrophoresis.*

### **Scientific Publications**

- Mangan, B. P. 1986. Natural reproduction of the muskellunge (*Esox masquinongy*) in the Susquehanna River near Berwick, Pennsylvania. *Proc. Pa. Acad. Sci.* 60: 200.
- \_\_\_\_\_. 1992. Oviposition of the dobsonfly (*Corydalus cornutus* Megaloptera) on a large river. *Am. Midl. Nat.* 127: 348-354.
- \_\_\_\_\_. 1994. Pupation ecology of the dobsonfly *Corydalus cornutus* (Corydalidae: Megaloptera) along a large river. *J. Freshwater Ecology* 9: 57-62.
- \_\_\_\_\_. 1998. Long-term retention of a radio transmitter by a muskellunge. *J. Freshwater Ecology* 13(4): 485-487.
- \_\_\_\_\_. 2002. Range expansion of the Asiatic clam, *Corbicula fluminea*, into the North Branch Susquehanna River. *J. Pa. Acad. Sci.* 76(1): 40-42.
- \_\_\_\_\_. 2003. A field evaluation of the efficiency of rotenone-laced fish food for removing fish from a small artificial impoundment. *J. Freshwater Ecology* 18(2): 299-303.
- \_\_\_\_\_. and J. G. Rish. 2005. Wind power in Pennsylvania: It isn't easy being green. *J. Pa. Acad. Sci.* (79(2/3): 75-80.
- \_\_\_\_\_. A. D. Ciliberto, and M. T. Homewood. 2009. A versatile and economical trap for capturing wild crayfish. *J. Freshwater Ecology* 24(1): 119-124.
- \_\_\_\_\_. J. J. Savitski, and N. T. Fisher. 2009. Comparison of two traps used for capturing wild crayfish. *J. Freshwater Ecology* 24(3): 445-450.
- \_\_\_\_\_. and M. D. Bilger. 2012. First record of phoresy between chironomid larvae and crayfish. *Am. Midl. Nat.* 167: 410-415.
- Kohlert, J.G., B. P. Mangan, C. Kodra, L. Drako, E. Long and H. Simpson. 2012. Decreased aggressive and locomotor behaviors in *Betta splendens* after exposure to fluoxetine. *Psychol. Rep.* 110(1):51-62.
- Mangan, B.P. and M.R. Gavlick. (in prep.). Total mercury concentrations in the Spined Micrathena spider (*Micrathena gracilis*) in a riparian forest.
- \_\_\_\_\_. S.A. Harrall and L.R. Harvey. (in prep.). Climate change and the Susquehanna River: Warming across four decades.
- \_\_\_\_\_. (in prep.). Decline in the relative abundance of two suckers in the Susquehanna River.
- \_\_\_\_\_. (in prep.). Crayfish of the Susquehanna River.
- \_\_\_\_\_. (in prep.). Total mercury burden of a common forest salamander: Morph matters.

### **Technical Reports**

- Soya, W. J., B. P. Mangan, and T. V. Jacobsen. 1983. Physicochemical analyses. Pages 4-46 in T. V. Jacobsen (ed.), *Ecological studies of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station* (1982 annual report). Ichthyological Associates, Inc., Berwick, PA.
- \_\_\_\_\_. \_\_\_\_\_, and \_\_\_\_\_. 1984. Physicochemical analyses. Pages 7-57 in T. V. Jacobsen (ed.), *Ecological studies of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station* (1983 annual report). Ichthyological Associates, Inc., Berwick, PA.

**Technical Reports (cont'd)**

- Deutsch, W. G., B. P. Mangan, A. J. Gurzynski, and T. V. Jacobsen. 1985. Larval fishes. Pages 112-149 in T. V. Jacobsen (ed.), Ecological studies of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (1984 annual report). Ichthyological Associates, Inc., Berwick, PA.
- \_\_\_\_\_, A. J. Gurzynski, B. P. Mangan, and T. V. Jacobsen. 1985. Fishes. Pages 150-173 in T. V. Jacobsen (ed.), Ecological studies of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (1984 annual report). Ichthyological Associates, Inc., Berwick, PA.
- \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. 1986. Fishes. Pages 111-139 in T. V. Jacobsen (ed.), Ecological studies of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (1985 annual report). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. 1986. Susquehanna Steam Electric Station, 1986 Land Use Census. Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1987. Susquehanna Steam Electric Station, 1987 Land Use Census. Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1987. Fishes. Pages 107-139 in T. V. Jacobsen (ed.), Ecological Studies of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (1986 annual report). Ecology III, Inc., Berwick, PA.
- Gurzynski A. J. and B. P. Mangan. 1987. Susquehanna Steam Electric Station discharge diffuser maintenance report. Prepared for Pennsylvania Power & Light Company. Ecology III, Inc., Berwick, PA 5 pp.
- Mangan, B. P. 1988. Fishes. Pages 109-141 in T. V. Jacobsen (ed.), Ecological Studies of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (1987 annual report). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1988. Susquehanna Steam Electric Station, 1988 Land Use Census. Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1989. Fishes. Pages 84-110 in Ecological studies in the vicinity of the Susquehanna Steam Electric Station (1988 annual report). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1989. Susquehanna Steam Electric Station, 1989 Land Use Census. Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1990. Fishes. Pages 80-94 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1989 annual report). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1991. Fishes. Pages 73-83 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1990 annual report). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1992. Fishes. Pages 76-86 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1991 annual report). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1993. Fishes. Pages 63-73 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1992 annual report). Ecology III, Inc., Berwick, PA.



**Technical Reports (cont'd)**

- \_\_\_\_\_. 1994. Fishes. Pages 63-82 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1993 annual report). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1994. Quality assurance program for the Radiological Environmental Monitoring Program, 1993 summary report. Prepared for Pennsylvania Power & Light Company. Ecology III, Inc., Berwick, PA. 14 pp.
- \_\_\_\_\_. 1995. Fishes. Pages 68-81 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1994 annual report). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1995. Quality assurance program for the Radiological Environmental Monitoring Program, 1994 summary report. Prepared for Pennsylvania Power & Light Company. Ecology III, Inc., Berwick, PA. 16 pp.
- \_\_\_\_\_. 1996. Fishes. Pages 7-11 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1995 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1996. Quality assurance program for the Radiological Environmental Monitoring Program, 1995 summary report. Prepared for Pennsylvania Power & Light Company. Ecology III, Inc., Berwick, PA. 17 pp.
- \_\_\_\_\_. 1997. Fishes. Pages 7-11 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1996 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 1997. Quality assurance program for the Radiological Environmental Monitoring Program, 1996 summary report. Prepared for Pennsylvania Power & Light Company. Ecology III, Inc., Berwick, PA. 15 pp.
- \_\_\_\_\_. 1998. Fishes. Pages 9-13 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1997 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. and M. S. Hidlay. 1998. Quality assurance program for the Radiological Environmental Monitoring Program, 1997 summary report. Prepared for PP&L, Inc. Ecology III, Inc., Berwick, PA. 16 pp.
- \_\_\_\_\_ and \_\_\_\_\_. 1999. Quality assurance program for the Radiological Environmental Monitoring Program, 1998 summary report. Prepared for PP&L, Inc. Ecology III, Inc., Berwick, PA. 22 pp.
- Mangan, B. P. 1999. Fishes. Pages 8-12 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1998 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 2000. Fishes. Pages 9-13 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (1999 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 2000. Susquehanna Steam Electric Station 2000 discharge diffuser pipe inspection report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 2 pp.
- \_\_\_\_\_. 2000. 2000 biological survey of Lake Took-a-while: A report on the status of the warm water sport and forage fisheries. Prepared for PPL Corporation, Susquehanna Riverlands. Ecology III, Inc., Berwick, PA. 12 pp.
- Mangan, B. P. and M. S. Hidlay. 2000. Quality assurance program for the Radiological Environmental Monitoring Program, 1999 summary report. Prepared for PPL Corporation. Ecology III, Inc., Berwick, PA. 15 pp.

**Technical Reports (cont'd)**

- \_\_\_\_\_ and \_\_\_\_\_. 2001. Quality assurance program for the Radiological Environmental Monitoring Program, 2000 summary report. Prepared for PPL Corporation. Ecology III, Inc., Berwick, PA. 15 pp.
- Mangan, B. P. 2001. Fishes. Pages 8-12 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2000 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 2002. Fishes. Pages 9-13 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2001 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. and M. S. Hidlay. 2002. Quality assurance program for the Radiological Environmental Monitoring Program, 2001 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 13 pp.
- \_\_\_\_\_ and \_\_\_\_\_. 2003. Quality assurance program for the Radiological Environmental Monitoring Program, 2002 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 14 pp.
- Mangan, B. P. 2003. Fishes. Pages 9-15 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2002 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 2003. Susquehanna Seam Electric Station 2003 Discharge Diffuser Pipe Inspection Report. Prepared by PPL Susquehanna, LLC. 2 pp.
- Mangan, B. P. and King's College 2003 Water Quality Class. 2004. Fisheries survey of Lake Silkworth, 2003 report. Prepared for Lake Silkworth Protective Association.
- Mangan, B. P. and M. S. Hidlay. 2004. Quality assurance program for the Radiological Environmental Monitoring Program, 2003 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 12 pp.
- Mangan, B. P. 2004. Fishes. Pages 9-14 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2003 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. and M. S. Hidlay. 2004. Quality assurance program for the Radiological Environmental Monitoring Program, 2003 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 12 pp.
- \_\_\_\_\_ and \_\_\_\_\_. 2005. Quality assurance program for the Radiological Environmental Monitoring Program, 2004 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 12 pp.
- Mangan, B. P. 2005. Fishes. Pages 10-15 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2004 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. and M. S. Hidlay. 2006. Quality assurance program for the Radiological Environmental Monitoring Program, 2005 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 17 pp.
- \_\_\_\_\_ and \_\_\_\_\_. 2007. Quality assurance program for the Radiological Environmental Monitoring Program, 2006 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 20 pp.

**Technical Reports (cont'd)**

- Mangan, B. P. 2007a. Fishes. Pages 6-11 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2005 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 2007b. Fishes. Pages 7-12 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2006 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 2008. Benthic Macroinvertebrates. Pages 9-10 and Fishes. Pages 12-17 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2007 Water Quality, Benthic Macroinvertebrates and Fishes). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. and M. S. Hidlay. 2008. Quality assurance program for the Radiological Environmental Monitoring Program, 2007 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 21 pp.
- \_\_\_\_\_ and \_\_\_\_\_. 2009. Quality assurance program for the Radiological Environmental Monitoring Program, 2008 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 22 pp.
- Mangan, B. P. 2009. Benthic Macroinvertebrates. Pages 7-8 and Fishes. Pages 9-13 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2008 Water Quality, Benthic Macroinvertebrates and Fishes). Ecology III, Inc., Berwick, PA.
- \_\_\_\_\_. 2010. Fishes. Pages 7-11 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2009 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. and M. S. Hidlay. 2010. Quality assurance program for the Radiological Environmental Monitoring Program, 2009 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 24 pp.
- \_\_\_\_\_ and \_\_\_\_\_. 2011. Quality assurance program for the Radiological Environmental Monitoring Program, 2010 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 18 pp.
- Mangan, B. P. 2011. Fishes. Pages 6-10 in Environmental studies in the vicinity of the Susquehanna Steam Electric Station (2010 Water Quality and Fishes). Ecology III, Inc., Berwick, PA.
- Mangan, B. P. and M. S. Hidlay. 2012. Quality assurance program for the Radiological Environmental Monitoring Program, 2011 summary report. Prepared for PPL Susquehanna, LLC. Ecology III, Inc., Berwick, PA. 24 pp.

**Professional Presentations**

- "Oviposition of the dobsonfly, *Corydalus cornutus*. Entomological Society of Pennsylvania (Annual Meeting, 1986)
- "Fishes of the Susquehanna River" - Susquehanna Energy Information Center (1986)
- "The Susquehanna SES Biological Laboratory" - Luzerne County Conservation Service (1988)
- "Environmental Impacts of Nuclear Power" –Nuclear Energy Seminar for Teachers, PPL annual guest lecture (1990-present)

**Professional Presentations (cont.)**

- "Where Have All The Fish Gone?" - Nuclear Technology Group, Pennsylvania Power & Light Company (Nov 1996)
- "Environmental Monitoring at Susquehanna SES" – Bryn Mawr College (1996-2009)
- "Long-term Ecological Monitoring" – Conference of PA Department of Environmental Protection Biologists (Nov 2002)
- "North Branch Fishes and Other Environmental Indicators" – From the branches to the Confluence: The Upper Susquehanna River Basin and Its Communities, Bucknell University (Sep 2006)
- "PPCPs in the Water: The Effects of Fluoxetine on Fish Behavior" – Annual meeting of the American Fisheries Society, Lake Placid, NY (Sep 2006)
- "Trends in Fishes of the Susquehanna River"—First Annual Susquehanna River Conference, Bucknell University (Sep 2006)
- "Wind Power and the Municipality" – Conference on the Small City, King's College (Oct 2006)
- "Wind Energy and Site Evaluation in Pennsylvania" -- Wildlife and Utility-Scale Wind Energy Development of the Central Appalachians within Maryland, Pennsylvania, Virginia, and West Virginia—the Risks and Trade-offs, Kutztown University, (Dec 2006)
- "Environmental Education: A Bridge Between Academia and Industry"-- No Child Left Inside—Pennsylvania Association of Environmental Educators Annual Conference, Wilkes-Barre (Apr 2007)
- "Density and Size Range of Asian Clams in the Susquehanna River: Profile of an Invasion"—Ecology of a Region in Changing Landscapes, Mid-Atlantic Ecological Society of America Conference, Wilkes-University (Apr 2008) and at the 64<sup>th</sup> Annual Northeast Fish and Wildlife Conference, Galloway, NY (Apr 2008)
- "A Versatile and Economical Trap for the Capture of Wild Crayfish"-- Ecology of a Region in Changing Landscapes, Mid-Atlantic Ecological Society of America Conference, Wilkes-University (Apr 2008) and at the 64<sup>th</sup> Annual Northeast Fish and Wildlife Conference, Galloway, NY (Apr 2008)
- "Comparison of Two Traps Used for the Capture of Wild Crayfish"--65th Annual Northeast Fish and Wildlife Conference, Lancaster, PA (Apr 2009)
- "First record of phoresy between chironomid larvae and crayfish"-- 95<sup>th</sup> Ecological Society of America Annual Meeting, Pittsburgh, PA (Aug 2010)
- "Crayfish of the Susquehanna River"—140<sup>th</sup> Annual Meeting of the American Fisheries Society, Pittsburgh, PA (Sep 2010)
- "Pharmaceuticals in the Environment"—*Power to Save* TV Show WNEP-16, Wilkes-Barre, PA (Sep 2010)
- "Medications in Our Waterways"—*Pennsylvania Outdoor Life* TV Show WNEP-16, Wilkes-Barre, PA (Oct 2010)
- "Crayfish of the Susquehanna River"—Exploring Our Vital Resource, Bucknell University (Oct 2010)
- "Phoretic Midges on Hellgrammites (*Corydalis cornutus*: Megaloptera) from the Susquehanna River"—Northeast Natural History Conference, Albany, NY (Apr 2011)

**Professional Presentations (cont'd)**

- “Comparison of Two Artificial Cover Object Grid Densities for Sampling Terrestrial Salamanders”—Northeast Natural History Conference, Albany, NY (Apr 2011)
- “Mercury in a Common Riparian Forest Salamander: Morph Matters”—2012 Conference of the Pennsylvania Chapter of The Wildlife Society, State College, PA (Mar 2012) and the 2012 Conference of the Northeastern Natural History Conference, Syracuse, NY (Apr 2012)
- “Mercury in the Forest Spider *Micrathena gracilis*: Does the Mercury Burden Vary with Location?”—2012 Conference of the Pennsylvania Chapter of The Wildlife Society, State College, PA (Mar 2012) and the 2012 Conference of the Northeastern Natural History Conference, Syracuse, NY (Apr 2012)
- Many radio, television and newspaper articles on environmental topics –WKOK Radio, Sunbury, PA; *Times Leader*, Wilkes-Barre, PA, Citizen's Voice, Wilkes-Barre, PA; Chesapeake Bay Foundation, Annapolis, MD, *PA Outdoor Life*, WNEP-TV, *Call the Doctor*, WVIA, etc.

**Grants**

- PPL Inc. 2001 PI (\$5000 grant towards The Susquehanna River Institute)
- PPL Inc. 2001 PI (\$2000 grant for incentive scholarships in EDUC 5270)
- NSF Equipment Grant, CoPI (\$103,000 for gas chromatograph)
- PPL Inc. 2002 PI (\$1500 to investigate remediation of soil contamination)
- PA DEP Growing Greener Grant PI (\$110,000 grant towards reclamation of the Little Wapwallopen Creek)
- PPL Inc. 2003 PI (\$2500 equipment grant for environmental education initiatives)
- Central Susquehanna Community Foundation 2005 PI (\$6,500 to study environmental connections to human health and wellness)
- Hazleton City Authority Water Department 2005 PI (\$6350 to compile baseline water-quality data for Quakake Creek, Schuylkill County)
- Foundation for the Alleghenies 2008 Student Internships (\$5000)
- Margaret A. Cargill Foundation Grant 2009-14 (\$438,600)
- Foundation of Pennsylvania Watersheds 2009 Student Internships (\$5000)
- PPL Corporation Environmental Education Grant 2010 (\$5000)
- PPL Corporation Environmental Education Grant (River Institute; \$1000)
- Community Foundation for the Alleghenies 2010 (\$2000)
- Foundation for Pennsylvania Watersheds 2010 Mercury & Internships (\$10,000)
- Foundation for Pennsylvania Watersheds 2010 Student Internships (\$4000)
- PA Fish and Boat Commission 2010 Unassessed Waters Grant (\$3600)
- Degenstein Foundation 2011 Mercury & Internships (\$10,000)
- PA Fish and Boat Commission 2011 Unassessed Waters Grant (\$2300)
- Degenstein Foundation 2012 Mercury & Internships (\$10,000)
- Foundation for the Alleghenies (\$3500)

**Total to date \$736,850**

**College/Community Service**

King's College Environmental Program – Director (2000-present)  
Susquehanna River Institute – Founder/ Director (2000-present)  
King's College Environmental Club – Advisor (2000-present)  
Environmental Studies Committee – Chair (2000-2010)  
PA Consortium for Interdisciplinary Environmental Policy – College Representative (2000-present)  
Morris K. Udall Scholarship – College Representative (2001-present)  
Susquehanna River Heartland Coalition for Environmental Studies – College Representative (2003-present)  
Barry M. Goldwater Scholarship – College Representative (2002-2005)  
Middle States Faculty Study Group – Member (2003)  
Lake Silkworth Protective Association – Advisor (2003-2005)  
PA Wildlands Recovery Project – Scientific Advisor (2003)  
Wyoming Valley Watershed Coalition – College Representative (inactive)  
Shoval Center for Community Engagement and Learning, Service Learning Project Team (2005-present)  
King's College Climate Change Working Group -- Chair (current)

**Undergraduate Courses Taught**

Environmental Science I  
Environmental Science II  
Environmental Art  
Environmental Seminar  
Conservation Biology  
Wildlife Ecology & Management  
Ecotoxicology  
Wildlife Techniques  
Water Quality Analysis  
Chesapeake Bay Ecology  
Adirondack Park Ecology  
Environmental Health  
Wildlife Natural History  
Independent Study  
Environmental Research  
Environmental Internship

**Graduate Courses Taught**

Susquehanna River Ecology  
Energy and the Environment  
Pennsylvania Wildlife  
Chesapeake Bay Ecology