Kelly, M. G., C. J. Penny, and B. A Whitton. 1995. Comparative performance of benthic diatom indices used to assess river water quality. Hydrobiologia 302:179-88.

Kelly, M. G., A. Cazaubon, E. Coring, A. Dell'Uomo, L. Ector, B. Goldsmith, H. Guasch, J. Hürlimann, A. Jarlman, B. Kawecka, J. Kwandrans, R. Laugaste, E.-A. Lindstrøm, M. Leitao, P. Marvan, J. Padisák, E. Pipp, J. Prygiel, E. Rott, S. Sabater, H. van Dam, and J. Viznet. 1998. Recommendations for the routine sampling of diatoms for water quality assessments in Europe. J. Appl. Phycol. 10:215-224.

Kentucky Division of Water. 1993. *Methods for Assessing Biological Integrity of Surface Waters*. Kentucky Natural Resources and Environmental Protection Cabinet, Frankfort, KY.

Kerans, B. L. and J. R. Karr. 1994. A benthic index of biotic integrity (B-IBI) for rivers of the Tennessee Valley. Ecol. Appl. 4:768-785.

Klotz, R. L. 1992. Factors influencing alkaline phosphatase activity of stream epithilon. J. Freshwater Ecol. 7(2):233-242.

Kolkwitz, R. and M. Marsson. 1908. Ökologie der pflanzliche Saprobien. *Ber. Deutsche Bot. Ges.* 26:505-519.

Land & Water Consulting. 1996. Water Quality Status and Trends Monitoring System for the Clark Fork-Pend Oreille Watershed. Report to Montana Dept. Env. Quality.

Leopold, L. B., M. G. Wolman, and J. P. Miller. 1964. *Fluvial Processes in Geomorphology*. W. H. Freeman, San Francisco, CA.

Lohman, K., J. R. Jones, and C. Baysinger-Daniel. 1991. Experimental evidence for nitrogen limitation in an Ozark stream. J. N. Am. Benthol. Soc. 10:13-24.

Lohman, K., J. R. Jones, and B. D. Perkins. 1992. Effects of nutrient enrichment and flood frequency on periphyton biomass in northern Ozark streams. Can. J. Fish. Aquat. Sci. 49:1198-1205.

Lowe, R. L. 1974. *Environmental Requirements and Pollution Tolerance of Freshwater Diatoms*. U.S. Environmental Protection Agency, Cincinnati, OH. EPA-670/4-74-005.

Lowe, R. L. and G. D. LaLiberte. 1996. Benthic Stream Algae: Distribution and Structure. In: *Methods in Stream Ecology.* Hauer, F. R. and G. A. Lamberti (eds.). Academic Press, San Diego, CA. pp. 269-293.

Lowe, R. L., and Y. Pan. 1996. Benthic algal communities and biological monitors. In: *Algal Ecology: Freshwater Benthic Ecosystems*. Stevenson, R. J., M. L. Bothwell, and R. L. Lowe (eds.). Academic Press, San Diego, CA. pp. 705-739.

Lowrance, R., R. Todd, J. Fail, Jr., O. Hendrickson Jr., R. Leonard, and L. Asmussen. 1984. Riparian forests as nutrient filters in agricultural watersheds. Bioscience 34(6):374-377.

Lung, W. and K. Larson. 1995. Water quality modeling of the Upper Mississippi River and Lake Pepin. J. Env. Engineering 121:691-699.

Martí, E., S. G. Fisher, J. J. Schade, and N. B. Grimm. (In press). (b) Effect of flood frequency on hydrological and chemical linkages between streams and their riparian zones: An intermediate disturbance model. In: *Surface-Subsurface Interactions in Streams*. Jones, Jr., J. B. and P. J. Mulholland (eds.).

Martí, E., S. G. Fisher, J. J. Schade, J. R. Welter, and N. B. Grimm. (n press). (a) Hydrological and chemical linkages between streams and their riparian zones: An intermediate disturbance model. Internationale Vereinigung fur Theoretische und Angewandt Limnologie, Verhandlungen 27.

Marti, E., N. B. Grimm, and S. G. Fisher. 1997. Pre- and post-flood nutrient retention efficiency in a desert stream ecosystem. J. N. Am. Benthol. Soc. 16:805-819.

Marzolf, E. R., P. J. Mulholland, and A. D. Steinman. 1994. Improvements to the diurnal upstream-downstream dissolved oxygen change technique for determining whole-stream metabolism in small streams. Can. J. Fish. Aquat. Sci. 51:1591-1599.

Marzolf, E. R., P. J. Mulholland, and A. D. Steinman. 1998. Reply: Improvements to the diurnal upstream-downstream dissolved oxygen change technique for determining whole-stream metabolism in small streams. Can. J. Fish. Aquat. Sci. 55:1786-1787.

May, C. W., E. B. Welch, R. R. Horner, J. R. Karr, and B. W. Mar. 1997. *Quality Indices for Urbanization Effects in Puget Sound Lowland Streams*. Department of Civil Engineering, University of Washington, Water Res. Series Tech. Rep. No. 154.

McCormick, P. V. and J. Cairns, Jr. 1994. Algae as indicators of environmental change. J. Appl. Phycol. 6:509-526.

McCormick, P. V. and R. J. Stevenson. 1998. Periphyton as a tool for ecological assessment and management in the Florida Everglades. J. Appl. Phycol. 34:726-733.

McGarrigle, M. L. 1993. Aspects of river eutrophication in Ireland. Ann. Limnol. 29:355-364.

McIntire, C. D., S. V. Gregory, A. D. Steinman, and G. A. Lamberti. 1996. Modeling benthic algal communities: An example from stream ecology. In: *Algal Ecology: Freshwater Benthic Ecosystems*. Stevenson, R. J., M. L. Bothwell, and R. L. Lowe (eds.). Academic Press, San Diego, CA. pp. 669-704.

McIntire, C. D. and H. K. Phinney. 1965. Laboratory studies of periphyton production and community metabolism in lotic environments. Ecol. Monogr. 35:237-258.

Miltner, R. J. and E. T. Rankin. 1998. Primary nutrients and the biotic integrity of rivers and streams. Freshwater Biol. 40:145-158.

Molles, M. C., Jr. and C. N. Dahm. 1990. A perspective on El Niño and La Niña: Global implications for stream ecology. J. N. Am. Benthol. Soc. 9:68-76.

Moore, L. W., C. Y. Chew, R. H. Smith, and S. Sahoo. 1992. Modeling of best management practices on North Reelfoot Creek, Tennessee. Water Environ. Res. 64:241-247.

Mueller, D. K. 1998. *Quality of Nutrient Data from Streams and Ground Water Sampled During 1993-95*. National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 98-276. 25 pp.

Mueller, D. K., P. A. Hamilton, D. R. Helsel, K. J. Hitt, and B. C. Ruddy. 1995. *Nutrients in Ground Water and Surface Water of the United States--Analysis of Data Through 1992.* U.S. Geological Survey Water-Resources Investigations Report 95-4031. 74 pp.

Mueller, D. K., J. D. Martin, and T. J. Lopes. 1997. *Quality-Control Design for Surface-Water Sampling in the National Water-Quality Assessment Program.* U.S. Geological Survey Open-File Report 7-223. 17 pp.

Mulholland, P. J., E. R. Marzolf, S. P. Hendricks, R. V. Wilkerson, and A. K. Baybayan. 1995. Longitudinal patterns of nutrient cycling and periphyton characteristics in streams: A test of upstream-downstream linkage. J. N. Am. Benthol. Soc. 14(3):357-370.

Munn, M. D., L. L. Osborne, and M. J. Wiley. 1989. Factors influencing periphyton growth in agricultural streams of central Illinois. Hydrobiologia 174:89-97.

Myers, R. 1990. *Classical and Modern Regression with Applications*. PWS-Kent, Boston, MA.

Nebel, B. J. and R. T. Wright. 2000. *Environmental Science: The Way the World Works*. 7th ed. Prentice-Hall, Upper Saddle River, NJ.

Newbold, J. D., J. W. Elwood, R. V. O'Neill, and W. Van Winkle. 1981. Measuring nutrient spiraling in streams. Can. J. Fish. Aquat. Sci. 38:860-863.

Nolan, B. T., B. C. Ruddy, K. J. Hitt, and D. R. Helsel. 1997. Risk of nitrate in groundwaters of the United States – A national perspective. Environ. Sci. Technol. 31(8):2229-2236.

Nordin, R. N. 1985. *Water Quality Criteria for Nutrients and Algae (Technical Appendix)*. British Columbia Ministry of the Environment, Victoria, BC. 104 pp.

Nordin, R. N. 1995. Personal communication. Water Management Branch, British Columbia Ministry of the Environment, Victoria, British Columbia.

OAR (Oregon Administrative Rules). 2000. Water Quality Program Rules, 340-041-0150, Nuisance Phytoplankton Growth.

Odum, H. T. 1956. Primary production in flowing waters. Limnol. Oceanogr. 1:102-117.

OECD. 1982. *Eutrophication of Waters: Monitoring, Assessment and Control*. OECD, Paris. 154 pp.

O'Hearn, M. O. and J. P. Gibb. 1980. *Groundwater Discharge to Illinois Streams*. Illinois Institute of Natural Resources, State Water Survey Division, Groundwater Section, SWS Contract Report 246, Champaign, IL. 31 pp.

Oliver, B. G. and D. B. Schindler. 1980. Trihalomethanes from the chlorination of aquatic algae. Environ. Sci. Technol. 14:1502-1505.

Olsen, D. S. and J. P. Potyondy (Eds.). 1999. *Wildland Hydrology.* American Water Resources Association. Herndon, VA. TPS-99-3. 536 pp.

Omernik, J. A. 1977. *Nonpoint Source-Stream Nutrient Level Relationships: A Nationwide Study*. U.S. Environmental Protection Agency, Corvallis, OR. 151 pp. EPA 600/3-77-105. (Map scale 1:7,500,000)

Omernik, J. A. 1987. Ecoregions of the conterminous United States. Ann. Assoc. Am. Geographers 77:118-125.

Omernik, J. A. 1995. Ecoregions: A spatial framework for environmental management. In: *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Davis, W. S. and P. S. Thomas (eds.). Lewis Publishers, Boca Raton, FL. pp. 49-66.

Omernik, J. A. 2000. *Draft Aggregations of Level III Ecoregions for the National Nutrient Strategy*. [http://www.epa.gov/ost/standards/ecomap.html].

Omernik, J. M. 1986. Ecoregions of the United States. U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory. 1 p.

O'Neill, R. V., D. L. DeAngelis, J. B. Waide, and T. F. H. Allen. 1986. *A Hierarchical Concept of Ecosystems*. Princeton University Press, Princeton, NJ.

Ott, L. 1988. *An Introduction to Statistical Methods and Data Analysis.* 3rd ed. PWS Publishing Company, Boston, MA.

Ott, W. R. 1995. *Environmental Statistics and Data Analysis*. Lewis Publishers, Boca Raton, FL.

Palmer, C. M. 1962. Algae in Water Supplies. U.S. Department of Health, Education and Welfare. Washington, DC.

Pan, Y., R. J. Stevenson, B. H. Hill, A. T. Herlihy, and G. B. Collins. 1996. Using diatoms as indicators of ecological conditions in lotic systems: A regional assessment. J. N. Am. Benthol. Soc. 15:481-495.

Pan, Y., R. J. Stevenson, B. H. Hill, and A. T. Herlihy. (In press). Ecoregions and benthic diatom assemblages in the Mid-Atlantic Highland streams, USA. J. N. Am. Benthol. Soc.

Paulsen, S. G., D. P. Larsen, P. R. Kaufmann, T. R. Whittier, J. R. Baker, D. V. Peck, J. McGue, R. M. Hughes, D. McMullen, D. Stevens, J. L. Stoddard, J. Larzorchak, W. Kinney, A. R. Selle, and R. Hjort. 1991. *Environmental Monitoring and Assessment Program (EMAP) Surface Waters Monitoring and Research Strategy – Fiscal Year 1991.*

Pearsall, W. H. 1920. The aquatic vegetation of the English Lakes. J. Ecol. 8:163-199.

Perdue, E. M., F. Mantoura, J. Ertel, C. Lee, K. Mopper, G. Peyton, E. Tanoue, P. M. Williams, O. Zafirou, and P. Coble. 1993. Mechanisms subgroup report. Mar. Chem. 41:51-60.

Perrin, C. J., M. L. Bothwell, and P. A. Slaney. 1987. Experimental enrichment of a coastal stream in British Columbia: Effects of organic and inorganic additions on autotrophic periphyton production. Can. J. Fish. Aquat. Sci. 44:1247-1256.

Peterjohn, W. T. and D. L. Correll. 1984. Nutrient dynamics in an agricultural watershed: Observations on the role of a riparian forest. Ecology 65(5):1466-1475.

Peterson, B. J., L. Deegan, J. Helfrich, J. E. Hobbie, M. Hullar, B. Moller, T. E. Ford, A. Hershey, A. Hiltner, G. Kipphut, M. A. Lock, D. M. Fiebig, V. McKinley, M. C. Miller, J. R. Vestal, R. Ventullo, and G. Volk. 1993. Biological responses of a tundra river to fertilization. Ecology 74:653-672.

Peterson, C. G. 1996. Mechanisms of lotic microalgal colonization following space-clearing disturbances at different spatial scales. Oikos 77:417-435.

Pickett, S. T. A., J. J. Kolasa, and S. L. Collins. 1989. The ecological concept of disturbance and its expression at various hierarchical levels. Oikos 54:129-136.

Pielou, E. C. 1975. *Ecological Diversity*. Wiley, New York.

Pielou, E. C. 1984. *The Interpretation of Ecological Data, A Primer on Classification and Ordination.* John Wiley, New York. 263 pp.

Pinay, G. and H. Decamps. 1988. The role of riparian woods in regulating nitrogen fluxes between the alluvial aquifer and surface water: A conceptual model. Regulated Rivers; Research and Management 2:507-516.

Pitcairn, E. R. and H. A. Hawkes. 1973. The role of phosphorus in the growth of *Cladophora*. Water Res. 7:159-171.

Poff, N. L. and J. V. Ward. 1989. Implications of streamflow variability and predictability for lotic community structure: A regional analysis of streamflow patterns. Can. J. Fish. Aquat. Sci. 46:1805-1818.

Poole, R. W. 1972. *An Introduction to Quantitative Ecology*. McGraw-Hill, New York.

Power, M. E. 1990. Effects of fish in river food webs. Science 250:811-814.

Power, M. E. 1992. Hydrologic and trophic controls of seasonal algal blooms in northern California rivers. Arch. Hydrobiol. 125:385-410.

Power, M. E. and A. J. Stewart. 1987. Disturbance and recovery of an algal assemblage following flooding in an Oklahoma stream. Am. Midland Naturalist 117:333-345.

Prairie, Y. T., C. M. Duarte, and J. Kalff. 1989. Unifying nutrient-chlorophyll relations in lakes. Can. J. Fish. Aquat. Sci. 46:1176-1182.

Preston, S. D. and J. W. Brakebill. 1999. *Application of Spatially Referenced Regression Modeling for the Evaluation of Total Nitrogen Loading in the Chesapeake Bay Watershed*. U.S. Geological Survey Water Resources Investigation Report 99-4054. 12 pp.

Pringle, C. M. and F. J. Triska. 1996. Effects of nutrient enrichment on periphyton. In: *Methods in Stream Ecology*. Hauer, F. R. and G. A. Lamberti (eds.). Academic Press, San Diego. pp. 607-623.

Puckridge, J. T., F. Sheldon, K. F. Walker, and A. J. Boulton. 1998. Flow variability and the ecology of large rivers. Marine Freshwater Res. 49(1):55-72.

Quinn, J. M. 1991. *Guidelines for the Control of Undesirable Biological Growths in Water*. National Inst. Water and Atmos. Res., Consultancy Report No. 6213/2.

Quinn, J. M., R. J. Davies-Colley, C. W. Hickey, M. L. Vickers, and P. A. Ryan. 1992. Effects of clay discharges on streams 2. Benthic invertebrates. Hydrobiologia 248:235-247.

Rabalais, N. N., R. E. Turner, Q. Dortch, W. J. Wiseman, Jr., and B. K. S. Gupta. 1996. Nutrient changes in the Mississippi River and system responses on the adjacent continental shelf. Estuaries 19(2B):386-407.

Raschke, R. 1993. Guidelines for assessing and predicting eutrophication status of small southeastern piedmont impoundments. EPA Region IV. Environmental Services Division, Ecological Support Branch, Athens, GA.

Reckhow, K. H. and S. C. Chapra. 1983. *Data Analysis and Empirical Modeling; Engineering Approaches for Lake Management Volume I.* Butterworths, Boston, MA.

Remington, R. D. and M. A. Schork. 1985. *Statistics with Applications to the Biological and Health Sciences*. Prentice Hall, Englewood Cliffs, NJ.

Renberg, I. and T. Hellberg. 1982. The pH history of lakes in Southwestern Sweden, as calculated from the subfossil diatom flora of the sediments. Ambio 11:30-33.

Resh, V. H., M. J. Myers, and M. J. Hannaford. 1996. Macroinvertebrates as biotic indicators of environmental quality. In: *Methods in Stream Ecology*. Hauer, F. R. and G. A. Lamberti (eds.). Academic Press, San Diego. pp. 647-667.

Resh, V. H. and D. M. Rosenberg (eds.). 1984. *The Ecology of Aquatic Insects*. Praeger Special Studies-Praeger Scientific, New York.

Rickert, D. A., R. R. Petersen, S. W. McKenzie, W. G. Hines, and S. A. Wille. 1977. Algal conditions and the potential for future algal problems in the Willamette River, Oregon. U.S. Geological Circular 715-G. 39 pp.

Rodhe, W. 1948. Environmental requirements of freshwater plankton algae. Experimental Studies in the Ecology of Phytoplankton. Symbol. Bot. Upsalien 10. 149 pp.

Rosen, B. H. and R. L. Lowe. 1984. Physiological and ultrastructural responses of *Cyclotella meneghiniana* (Bacillariophyta) to light intensity and nutrient limitation. J. Phycol. 20:173-183.

Rosenfield, J. and J. C. Roff. 1991. Primary production and potential availability of autochthonous carbon in southern Ontario streams. Hydrobiologia 224:99-109.

Rosgen, D. L. 1994. A classification of natural rivers. Catena 22:169-199.

Rosgen, D. 1996. *Applied River Morphology*. Wildland Hydrology, Pagosa Springs, CO. 380 pp.

Sartory, D. P. and J. U. Grobbelaar. 1984. Extraction of chlorophyll a from freshwater phytoplankton for spectrophotometric analysis. Hydrobiologia 114:117-187.

Schanz, F. and H. Juon. 1983. Two different methods of evaluating nutrient limitations of periphyton bioassays using water from the River Rhine and eight of its tributaries. Hydrobiologia 102:187-195.

Scheckenberger, R. B., and A. S. Kennedy. 1994. The use of HSPF in subwatershed planning. In: *Current Practices in Modelling the Management of Stormwater Impacts.* W. James (ed.). Lewis Publ., Boca Raton, FL. pp. 175-187.

Schiefele, S. and C. Schreiner. 1991. Use of diatoms for monitoring nutrient enrichment, acidification, and impact of salt in rivers in Germany and Austria. In: *Use of Algae for Monitoring Rivers.* Whitton, B. A., E. Rott, and G. Friedrich (eds.). Institut für Botanik, Universität Innsbruck, Austria. pp. 103-110.

Schade, J. D. and S. G. Fisher. 1997. The influence of leaf litter on a Sonoran Desert stream ecosystem. J. N. Am. Benthol. Soc. 16:612-626.

Sheath, R. G. and J. M. Burkholder. 1985. Characteristics of soft water streams in Rhode Island. II. Composition and seasonal dynamics of macroalgal communities. Hydrobiologia 128:109-118.

Shelton, L.R. 1994. *Field Guide for Collection and Processing Stream-Water Samples for the National Water Quality Assessment Program.* U.S. Geological Survey Open-File Report 94-455. 42 pp.

Silvey, J. K. G. and J. T. Watt. 1971. The interrelationship between freshwater bacteria, algae, and actinomycetes in Southwestern reservoirs. In: *The Structure and Function of Freshwater Microbial Communities*. J. Cairns, Jr. (ed.). American Microscopical Society Symposium. Research Division monograph 3. Virginia Polytechnic Institute and State University, Blacksburg, VA.

Slack, K. V. 1971. Average dissolved oxygen-measurement and water quality significance. J. Water Pollut. Control Fed. 43:433-446.

Slaney, P. A. and B. R. Ward. 1993. Experimental fertilization of nutrient deficient streams in British Columbia. In: *Le Development du Saumon Atlantique Au Quebec: Connaitre Les Regles du Jeu Pour Reussir*. Shooner G. and S. Asselin (eds.). Colloque international de la Federation quebecoise pour le saumon atlantique, Quebec, Canada.

Smart, R. M. 1990. *Effects of Water Chemistry on Submersed Aquatic Plants: A Synthesis.* Miscellaneous Paper A-90-4. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Smith, R. A., G. E. Schwarz, and R. B. Alexander. 1997. Regional interpretation of water-quality monitoring data. Water Res. 33(12):2781-2798.

Smith, R. E. H. and J. Kalff. 1981. The effect of phosphorus limitation on algal growth rates: Evidence from alkaline phosphatase. Can. J. Fish. Aquat. Sci. 38:1421-1427.

Smith, V. H. 1982. The nitrogen and phosphorus dependence of algal biomass in lakes: An empirical and theoretical analysis. Limnol. Oceanogr. 27:1101-1112.

Smith, V. H. 1998. Cultural eutrophication of inland, estuarine, and coastal waters. In: *Successes, Limitations and Frontiers in Ecosystem Science*. Pace, M. L. and P. M. Groffman (eds.). Springer-Verlag, New York. pp. 7-49.

Smith, V. H., G. D. Tilman, and J. C. Nekola. 1999. Eutrophication: Impacts of excess nutrient inputs on freshwater, marine, and terrestrial ecosystems. Environ. Pollut. 100:179-196.

Sneath, P. H. A. and R. R. Sokal. 1973. *UPGMA (Unweighted Pair-Group Method Using Arithmetic averages)*. Numerical Taxonomy. W. H. Freeman, San Francisco, CA.

Sokal, R. R. and F. J. Rohlf. 1998. *Biometry: The Principles and Practice of Statistics in Biological Research.* W. H. Freeman, New York. 887 pp.

Sorenson, S. K., S. D. Porter, K. K. B. Akers, M. A. Harris, S. J. Kalkhoff, K. E. Lee, L. R. Roberts, and P. J. Terrio. 1999. *Water Quality and Habitat Conditions in Upper Midwest Streams Relative to Riparian Vegetation and Soil Characteristics, August 1997: Study Design, Methods, and Data.* U.S. Geological Survey Open-File Report 99-202. 53 pp.

Sosiak, A. J. Personal communication. Long-term response of periphyton and macrophytes to reduced municipal nutrient loading to the Bow River (Alberta, Canada). Alberta Environment Protection, Calgary, Alberta.

Spence, D. H. N. 1975. Light and plant responses in freshwater. In: *Light as an Ecological Factor*. Evans, G. C., R. Bainbridge, and O. Rackham (eds.). Blackwell Scientific Publishers, Oxford. pp. 93-134.

Squillace, P. J., J. P. Caldwell, P. M. Schulmeyer, and C. A. Harvey. 1996. *Movement of Agricultural Chemicals Between Surface Water and Ground Water, Lower Cedar River Basin, Iowa.* U.S. Geological Survey Water-Supply Paper 2448. 59 pp.

Stanley, E. H. 1999. personal communication. Department of Zoology, University of Wisconsin, Madison, WI.

Stanley, E. H. and A. J. Boulton. 1995. Hyporheic processes during flooding and drying in a Sonoran Desert stream. I. Hydrologic and chemical dynamics. Arch. Hydrobiol. 134:1-26.

Stanley, E. H., S. G. Fisher, and N. B. Grimm. 1997. Ecosystem expansion and contraction in streams. BioScience 47:427-436.

Stanley, E. H. and H. M. Valett. 1992. Interaction between drying and the hyporheic zone of a desert stream ecosystem. In: *Climate Change and Freshwater Ecosystems*. Firth, P. and S. G. Fisher (eds.). Springer-Verlag, New York. pp. 234-249.

Steinberg, C. and S. Schiefele. 1988. Indication of trophy and pollution in running waters. Zeitschrift für Wasser-Abwasser Forschung 21:227-234.

Steinman, A. D. 1996. Effects of grazers on freshwater benthic algae. In: *Algal Ecology: Freshwater Benthic Ecosystems.* Stevenson, R. J., M. L. Bothwell, and R. L. Lowe (eds.). Academic Press, San Diego, CA. pp. 341-373.

Steinman, A. D. and G. A. Lamberti. 1996. Biomass and pigments of benthic algae. In: *Methods in Stream Ecology.* Hauer, F. R. and G. A. Lamberti (eds.). Academic Press, San Diego, CA. pp. 295-313.

Steinman, A. D. and P. J. Mulholland. 1996. Phosphorus limitation, uptake, and turnover in stream algae. In: *Methods in Stream Ecology.* Hauer, F. R. and G. A. Lamberti (eds.). Academic Press, San Diego, CA. pp. 161-189.

Stevenson, J. Personal communication. Michigan State University, East Lansing, MI.

Stevenson, R. J. 1984. Epilithic and epipelic diatoms in the Sandusky River, with emphasis on species diversity and water quality. Hydrobiologia 114:161-175.

Stevenson, R. J. 1996. An introduction to algal ecology in freshwater benthic habitats. In: *Algal Ecology: Freshwater Benthic Ecosystems.* Stevenson, R. J., M. Bothwell, and R. L. Lowe (eds.). Academic Press, San Diego, CA. pp. 3-30.

Stevenson, R. J. 1997. Scale dependent determinants and consequences of benthic algal heterogeneity. J. N. Am. Benthol. Soc. 16(1):248-262.

Stevenson, R. J. 1998. Diatom indicators of stream and wetland stressors in a risk management framework. Environ. Monitor. Assess. 51:107-118.

Stevenson, R. J. (In press). Using algae to assess wetlands with multivariate statistics, multimetric indices, and an ecological risk assessment framework. In: *Biomonitoring and Management of North American Freshwater Wetlands.* Batzger, D., R. Rader, and S. Wissinger (eds.). John Wiley, New York.

Stevenson, R. J. and L. L. Bahls. 1999. Periphyton protocols. In: *Revision to Rapid Bioassessment Protocols for Use in Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish.* Barbour, M. T., J. Gerritsen, and B. D. Snyder (eds.). U.S. Environmental Protection Agency, Washington, DC.

Stevenson, R. J. and Y. Pan. 1999. Assessing ecological conditions in rivers and streams with diatoms. In: *The Diatoms: Applications to the Environmental and Earth Sciences*. Stoermer, E. F. and J. P. Smol (eds.). Cambridge University Press, Cambridge, UK. pp. 11-40.

Stevenson, R. J. and J. P. Smol. (In press). Use of algae in environmental assessment. In: *Freshwater Algae in North America: Classification and Ecology.* Wehr, J. D. and R. G. Sheath (eds.). Academic Press, San Diego, CA.

Stockner, J. G. and K. R. S. Shortreed. 1976. Autotrophic production in Carnation Creek, a coastal rainforest stream on Vancouver Island, British Columbia. J. Fish. Res. Board Can. 33:1553-1563.

Stoermer, E. F. and J. P. Smol (eds.). 1999. *The Diatoms: Applications for the Environmental and Earth Sciences.* Cambridge University Press, Cambridge. 484 pp.

Storr, J. F. and R. A. Sweeney. 1971. Development of a theoretical seasonal growth response curve of *Cladophora glomerata* to temperature and photoperiod. Proc. 14^{th} Conf. Gt. Lakes Res. 14:119-127.

Strahler, A. N. 1964. Quantitative geomorphology of drainage basins and channel networks. In Chow, V. T. (ed.). *Handbook of Applied Hydrology*. McGraw-Hill, New York. pp. 439-476.

Strayer, D. L., N. F. Caraco, J. J. Cole, S. Findlay, and M. L. Pace. 1999. Transformation of freshwater ecosystems by bivalves. Bioscience 49(1):19-27.

Stromberg, J. C., D. T. Patten, and B. D. Richter. 1991. Flood flows and dynamics of Sonoran riparian forests. Rivers 2(3):221-235.

Stumm, W. G. and J. J. Morgan. 1981. *Aquatic Chemistry*. John Wiley, New York.

Suess, M .J. 1981. Health aspects of eutrophication. Water Qual. Bull. 6:63-64.

Tate, C. M. 1990. Patterns and controls of nitrogen in tallgrass prairie streams. Ecology 71:2007-2018.

Taylor, W. D., L. R. Williams, S. C. Hern, V. W. Lambou, C. L. Howard, F. A. Morris, and M. K. Morris. 1981. *Phytoplankton Water Quality Relationships in U.S. Lakes, Part VIII: Algae Associated with or Responsible for Water Quality Problems*. Environmental Protection Agency, Las Vegas, NV. Report EPA-600/S3-80-100 or NTIS PB-81-156831.

ter Braak, C. J. F. and H. van Dam. 1989. Inferring pH from diatoms: A comparison of old and new calibration methods. Hydrobiologia 178:209-223.

Thoms, M. C. and F. Sheldon. 1996. The importance of channel complexity for ecosystem processing: An example of the Barwon-Darling River. In: *Stream Management in Australia*. Rutherfurd, I. (ed.). CRC for Catchment Hydrology, Melbourne, Australia. pp. 111-118.

TNDEC (Tennessee Department of Environment and Conservation). 1996. *Standard Operating Procedure for Modified Clean Technique Sampling Protocol*. Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Nashville, TN.

Turner, R. E. and N. N. Rabalais. 1991. Changes in Mississippi River water quality this century: Implications for coastal food webs. Bioscience 41(3):140-147.

Turner, R. E. and N. N. Rabalais. 1994. Coastal eutrophication near the Mississippi River delta. Nature 368:619-621.

USEPA. 1971. *Algal Assay Procedure: Bottle Test*. National Eutrophication Research Program, Corvallis, OR.

USEPA. 1973. *Water Quality Criteria - 1972.* Tech. Adv. Comm., Nat. Acad. Sci. Engr. U.S. Government Printing Office.

USEPA. 1986. *Quality Criteria for Water - 1986.* Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA 440/5-86-001.

USEPA. 1993a. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.* Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA 840-B-92-002.

USEPA. 1993b. *Clark Fork-Pend Oreille Basin Water Quality Study*. EPA 910/R-93-006.

USEPA. 1994. *Water Quality Standards Handbook.* 2nd ed. Office of Water, U.S. Environmental Protection Agency. EPA 823-B-94-005a.

USEPA. 1995. Drinking water regulations and health advisories. Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA 822-R-95-001.

USEPA. 1996. *National Water Quality Inventory 1996 Report to Congress*. Office of Water, U.S. Environmental Protection Agency. EPA 841-R-97-008.

USEPA. 1998a. *National Strategy for the Development of Regional Nutrient Criteria*. Office of Water, U.S. Environmental Protection Agency. EPA 822-R-98-002.

USEPA. 1998b. *Guidance for Quality Assurance Project Plans*. Office of Research and Development, U.S. Environmental Protection Agency. EPA/600/R-98/018.

USEPA. 1999. *Protocol for Developing Nutrient TMDLs.* Office of Water (4503F), U.S. Environmental Protection Agency. EPA 841-B-99-007.

UK Environment Agency. 1998. *Aquatic Eutrophication in England and Whales*. Environmental Issues Series Consultative Report.

Valett, H. M., S. G. Fisher, and E. H. Stanley. 1990. Physical and chemical characteristics of the hyporheic zone of a Sonoran Desert stream. J. N. Am. Benthol. Soc. 9:201-215.

Valett, H. M., S. G. Fisher, N. B. Grimm, and P. Camill. 1994. Vertical hydrologic exchange and ecological stability of a desert stream ecosystem. Ecology 75:548-560.

Van Dam, H., A. Mertenes, and J. Sinkeldam. 1994. A coded checklist and ecological indicator values of freshwater diatoms from the Netherlands. Netherlands J. Aquat. Ecol. 28:117-133.

Van Nieuwenhuyse, E. E. and J. R. Jones. 1996. Phosphorus-chlorophyll relationship in temperate streams and its variation with stream catchment area. Can. J. Fish. Aquat. Sci. 53:99-105.

Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Can. J. Fish. Aquat. Sci. 37:130-137.

Vitousek, P. M., J. D. Aber, R. W. Howarth, G. E. Likens, P. A. Matson, D. W. Schindler, W. H. Schlesinger, and D. G. Tilman. 1997. Human alteration of the global nitrogen cycle: Sources and consequences. Ecol. Appl. 7(3):737-750.

Wallace, J. B. and J. R. Webster. 1996. The role of macroinvertebrates in stream ecosystem function. Ann. Rev. Entomol. 41:115-139.

Walton, S. P., E. B. Welch, and R. R. Horner. 1995. Stream periphyton response to grazing and changes in phosphorus concentration. Hydrobiologia 302:31-46.

Walton, W. C. 1965. *Ground Water Recharge and Runoff in Illinois*. Report of Investigation 48, Illinois State Water Survey, Urbana, IL. 55 pp.

Ward, M. H., S. D. Mark, K. P. Cantor, D. D. Weisenburger, A. Correa-Vilasenore, and S. H. Zahm. 1996. Drinking water nitrate and the risk of non-Hodgkin's lymphoma. Epidemiology 7(5):465-471.

Warren, C. E., J. H. Wales, G. E. Davis, and P. Douderoff. 1964. Trout production in an experimental stream enriched with sucrose. J. Wildlife Manage. 28:617-660.

Watershed Management Institute, Inc. 1998. Operation, maintenance, and management of stormwater management systems. Technical report with USEPA. (http://www.epa.gov/OWOW/NPS/wmi/wmi.html)

Watson, V. J. 1989a. Dissolved oxygen levels in the middle Clark Fork River, summer 1987. Proc. Mont. Acad. Sci. 49:147-156.

Watson, V. J. 1989b. Dissolved oxygen levels in the upper Clark Fork River, summer 1987. Proc. Mont. Acad. Sci. 49:157-162.

Watson, V. J. and B. Gestring. 1996. Monitoring algae levels in the Clark Fork River. Intermountain J. Sci. 2:17-26.

Watson, V. J., P. Perlind, and L. Bahls. 1990. Control of algal standing crop by P and N in the Clark Fork River. Proc. Clark Fork River Symposium, Montana Academy of Sci., Missoula, MT.

Weber, C. I. 1973. Recent developments in the measurement of the response of plankton and periphyton to changes in their environment. In: *Bioassay Techniques and Environmental Chemistry*. Glass, G. (ed.). Ann Arbor Science Publishers, Ann Arbor, MI. pp. 119-138.

Wehr, J. D. and J. P. Descy. 1998. Use of phytoplankton in large river management. J. Phycol. 34:741-749.

Welch, E. B. 1992. *Ecological Effects of Wastewater*. Chapman and Hall, London.

Welch, E. B., R. R. Horner, and C. R. Patmont. 1989. Prediction of nuisance periphytic biomass: A management approach. Water Res. 23:401-405.

Welch, E. B., J. M. Jacoby, R. R. Horner and M. R. Seeley. 1987. Nuisance biomass levels of periphytic algae in streams. Hydrobiologia 157:161-168.

Welch E. B., J. M. Jacoby, and C. W. May. 1998. Stream quality. In: *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*. Naiman, R. J. and R. E. Bilby (eds.). Springer-Verlag. pp. 69-94.

Welch, E. B., C. L. May, and J. M. Jacoby. (In press). Stream quality. In: *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion.* Bilby, R. E. and R. J. Naiman (eds.). Springer-Verlag.

Welch, E. B., J. M. Quinn, and C. W. Hickey. 1992. Periphyton biomass related to point-source enrichment in seven New Zealand streams. Water Res. 26:669-675.

Welschmeyer, N. A. 1994. Fluorometric analysis of chlorophyll *a* in the presence of chlorophyll *b* and phaeopigments. Limnol. Oceanogr. 39:1985-1992.

Wetzel, R. G. 1983. *Limnology*. 2nd ed. Saunders College Publishing, Philadelphia. 860 pp.

Wetzel, R. G. 1992. Clean water: A fading resource. Hydrobiologia 243/244:21-30.

Wetzel, R. G. and G. E. Likens. 1991. *Limnological Analyses.* 2nd ed. Springer-Verlag, New York.

Wetzel, R. G. and A. K. Ward. 1992. Primary production. In: *Rivers Handbook*. P. Calow and G. E. Petts (eds.). Blackwell Scientific Publications, Oxford, England. pp. 354-369.

Whitmore, T. J. 1989. Florida diatom assemblages as indicators of trophic state and pH. Limnol. Oceanogr. 34:882-895.

Whittaker, R. H. 1952. A study of summer foliage insect communities in the Great Smoky Mountains. Ecol. Monogr. 22:1-44.

APPENDIX A. NUTRIENT CRITERIA CASE STUDIES

The following five case studies are meant to capture some of the variability of stream systems located throughout the country. Although these case studies exhibit varying levels of complexity, they are meant to provide the reader with real-world examples of how criteria can be developed on a practical level and several region-specific issues that may be encountered as one works through the criteria development process. The ecoregional nutrient criteria process discussed in the Tennessee case study involves refinement of the Level III ecoregions found within the State; identification and monitoring of reference stream systems; and correlational analyses of nutrient levels, conventional water chemistry parameters, and biological indices to derive criteria. In contrast, the Clark Fork, Montana, case study delineates a process for setting target nutrient and algal levels based on a combination of modified established criteria, literature values, and observed thresholds for nuisance algal growth. The Upper Midwest river systems case study describes the results of a cooperative effort among three USGS NAWQA projects in the upper Midwest Corn Belt region that evaluated algal and macroinvertebrate response to nonpoint agricultural sources relative to naturally-occurring factors (e.g., riparian vegetation, hydrology). The Bow River, Canada, case study details the reduction of nuisance biomass (both periphyton and macrophytes) over a 16-year period through decreases in nitrogen (~50%) and phosphorus (80%) from domestic wastewater effluent. Finally, the desert stream case study discusses several of the determinants of nutrient regimes in desert streams that should be considered when developing nutrient criteria for these, as well as other, complex, highly variable stream systems.

TENNESSEE ECOREGIONAL NUTRIENT CRITERIA

In 1992, the Tennessee DWPC (Division of Water Pollution Control) faced an important decision on how water quality assessment would be done in the future. When program status was assessed, there were problems that were likely to be amplified in the future. For example:

- The "one-size-fits-all" statewide numeric criteria approach provided stability, but lacked regional flexibility. Statewide criteria were clearly overprotective in parts of the state, but arguably underprotective in other areas.

- Narrative criteria were based on a verbal description of water quality, rather than a number. Thus, they provided flexibility, but lacked an objective means of interpretation. As an example, the narrative criterion for biological integrity states "*waters shall not be modified to the extent that the diversity and/or productivity of aquatic biota within the receiving waters is substantially reduced*". However, an interpretation of the word "substantially" was not provided.

- Unlike biological integrity, nutrients did not have specific narrative criteria. Nutrients were assessed under the more generic "free from" statements found in toxicity sections of the fish and aquatic life criteria and under "aesthetic" sections of the recreational criteria. Thus, before any stream could be assessed as impacted by nutrients, the existence of a "problem" had to be established.

- Tennessee was encouraged by EPA to convert to a watershed approach for issuance of water quality permits. Without a sense of regional variability in water quality, there was a distinct disadvantage in goal setting for these watersheds. Additionally, the rigors of 303(d) listing and TMDL development required accurate interpretation of Tennessee's narrative water quality criteria. The specter of lawsuits by citizens and members of the regulated community required that assessments be defensible.

A method was needed for comparing the existing conditions found in a stream to unimpacted conditions. This reference condition varied across the state. The reference condition established should be within a similar area, to avoid "apples and oranges" comparisons. It was determined that *ecoregions* were the best geographic basis upon which to make this assessment.

An ecoregion is a relatively homogeneous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables.

The "Ecoregions of the United States" map (Level III) developed in 1986 by James Omernik of EPA's Corvallis Laboratory delineated eight ecoregions in Tennessee. The DWPC arranged for Omernik and Glenn Griffith to sub-regionalize and update state ecoregions.

The Tennessee Ecoregion Project began in 1993 and was envisioned to occur in three phases:

PHASE I: DELINEATE SUB-ECOREGION BOUNDARIES

Phase I of the project involved geographic data gathering, development of a draft sub-regionalization scheme, and ground-truthing of the draft into a final product. This product included new maps and digitized coverages for use in the DWPC GIS system. This part of the project began in 1993 and was completed in 1995. This refinement resulted in a total of 14 ecoregions for the state (Figure A-1).

PHASE II: REFERENCE STREAM SELECTION

EPA and DWPC staff identified potential reference streams. Reference streams selected were located in relatively unimpacted watersheds typical for that ecoregion (Figure A-2). When possible, watersheds within state or federally protected areas were selected.

A reference stream is a least impacted waterbody within an ecoregion that can be monitored to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans.

Division staff visited each candidate stream. Chemical and benthic macroinvertebrate samples were used to cull the list of streams down to a final list. Three reference streams per sub-ecoregion were considered the minimum requirement.

PHASE III: INTENSIVE MONITORING OF REFERENCE STREAMS

Since August 1996, final selected reference sites have been monitored quarterly. During the first year of the project, water chemistry was monitored using grab samples collected on three consecutive days (if possible). Chemical sampling procedures followed modified clean technique methodology as outlined in the Division's Chemical Standard Operating Procedure: Modified Clean Technique Sampling Protocol (TNDEC 1996).

Chemical sampling at reference sites generally included all the parameters historically included by the Division in its long-term ambient monitoring network. As a concession to resource constraints, certain parameters, such as mercury, were dropped after they were never detected the first year of sampling. Additional parameters such as chlorophyll *a* were considered to have value, but were not sampled due to the need make the best use of program funding. Division staff were recently trained in algal assessment techniques and will likely incorporate rapid biological assessment protocols in future sampling efforts.

Macroinvertebrate samples were collected at ecoregional reference sites beginning in August 1996. Habitat and flow were also assessed. Outside expertise was sought to analyze the monitoring data to determine how sub-ecoregions aggregate by aquatic habitat and biological community to form ecosystems or bioregions. This step was essential for assessing benthic communities accurately and consistently.

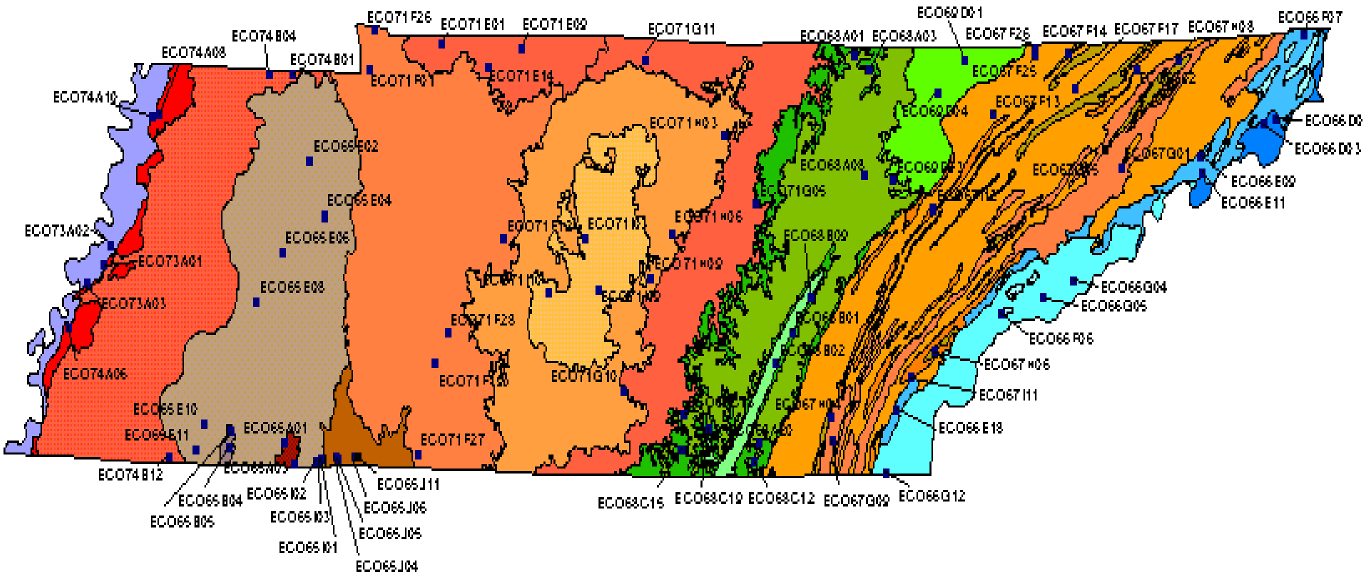

Figure A-1. Tennessee Level IV ecoregions and locations of reference streams.

Figure A-2. The Little River within the Great Smoky Mountains National Park was selected as a reference stream for sub-ecoregion 66g.

How Are Reference Stream Data Being Used?
For the first time, the DWPC has regionally-based chemical, physical, and biological data representing least impacted conditions in Tennessee. These data are important to our program and have multiple applications.

For some time, it was known that an ecoregion-specific approach to certain water quality standards would provide greater accuracy. This ecoregion project has provided the data necessary to initiate nutrient criteria discussions.

Figures A-3 and A-4 illustrate the levels of total phosphorus (TP) and nitrate-nitrite (NO_3-NO_2), respectively, documented at reference streams within each ecoregion. The box and whisker plot shows median measured concentrations and ranges. Based on the data collected, TP at less impacted streams is generally higher in West Tennessee than Middle and East Tennessee.

Finalizing the Ecoregion Reference Stream Nutrient Database
Additional steps are needed to finalize the ecoregion nutrient database:

- Incorporate data from other States. If reference streams in neighboring States are located within shared ecoregions and are selected and sampled in a similar manner to those in Tennessee, the nutrient data can be added into our database.

- Review the database for quality assurance. Data will be checked for outliers that may represent data entry errors. Outliers that indicate degrading conditions in reference streams will be identified. The Division considered eliminating outliers based on a consistent rationale, such as values more than two standard deviations from the mean, but decided against such an approach.

Development of Regional Interpretations of Narrative Nutrient Criteria
Division staff will propose ecoregion-specific interpretations of the narrative nutrient criteria for TP and nitrate-nitrite for the year 2000 triennial water quality standards review. These numeric goals will be used primarily for water quality assessment purposes.

The specific goals will likely be based on the establishment of the nutrient concentration for each ecoregion or subecoregions database at the 90^{th} percentile of the reference stream data. (However, the Division has not ruled out the possibility of setting the criteria at the 75^{th} percentile.) As an important part of the process, Division staff will statistically analyze nutrient levels and their ranges at each sub-ecoregion. Where significant differences exist between sub-ecoregions, the nutrient criteria will be established at the sub-ecoregion level. Where no significant difference is found between sub-ecoregions, the data will be aggregated back to the ecoregion level.

These numeric goals will provide the means to assess nutrient levels at similar streams within the same ecoregion. Streams with nutrient levels less than the 90^{th} (or 75^{th}) percentile of the reference stream database will be considered to meet the narrative criteria. Streams with nutrient levels higher than the reference stream database range will be considered in violation of the narrative criteria. These streams

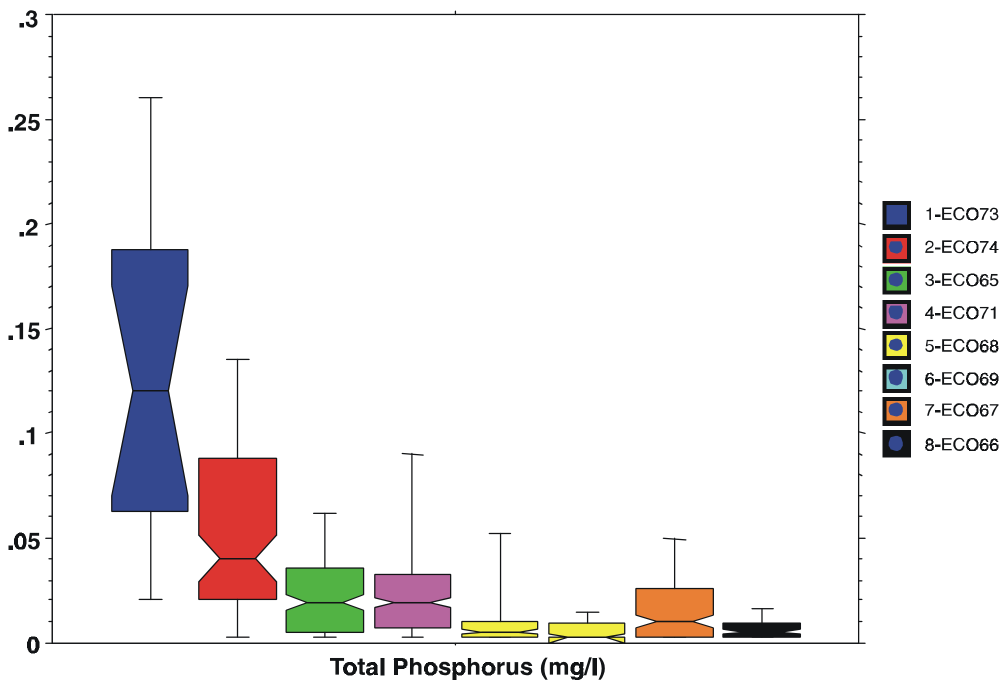

Figure A-3. Total phosphorus concentrations (μg/L) for reference streams within each ecoregion.

Key: 1 = Mississippi Alluvial Plain, 2 = Mississippi Valley Loess Plains, 3 = Southeastern Plains, 4 = Interior Plateau, 5 = Southeastern Appalachians, 6 = Central Appalachians, 7 = Ridge and Valley, 8 = Blue Ridge Mountains.

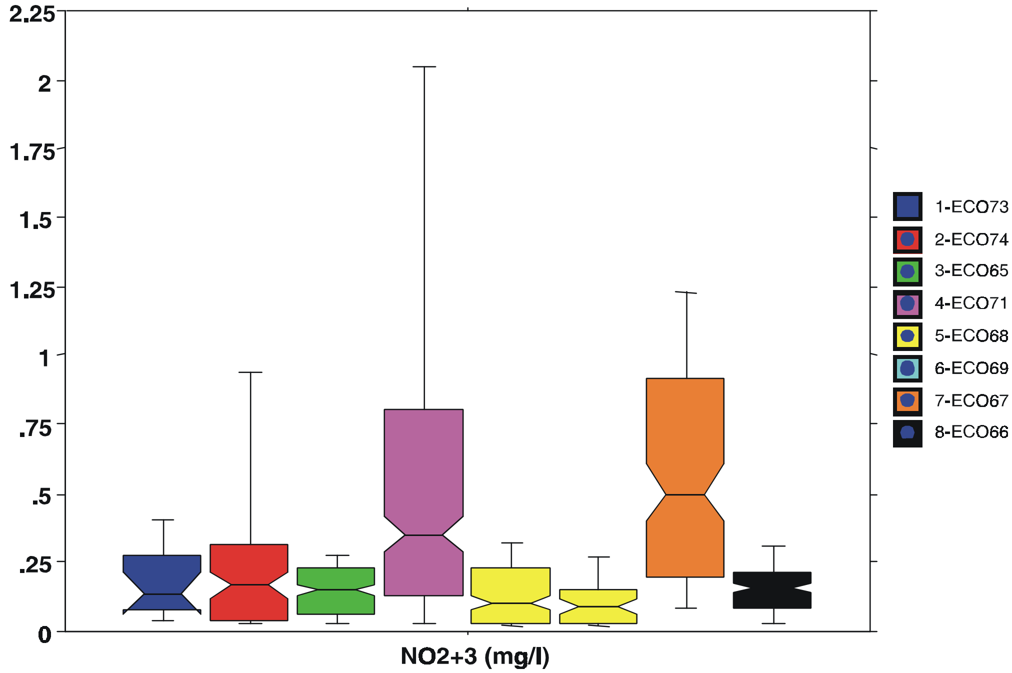

Figure A-4. Total nitrate-nitrite concentrations (mg/L) for reference streams within each ecoregion.

Key: 1 = Mississippi Alluvial Plain, 2 = Mississippi Valley Loess Plains, 3 = Southeastern Plains, 4 = Interior Plateau, 5 = Southeastern Appalachians, 6 = Central Appalachians, 7 = Ridge and Valley, 8 = Blue Ridge Mountains.

will be added to the 303(d) list for future TMDL generation. Additionally, the regional interpretation of the narrative criteria will provide the goal for TMDL control strategies.

Data Relationships

Division staff have taken a preliminary look at the reference stream data in an attempt to investigate relationships between sampled parameters. Examination of these relationships has three facets: (1) consideration of possible nutrient data surrogates, (2) exploring relationships between nutrient levels and biological indices, and (3) comparison of reference stream data to EPA's regional nutrient database.

1. The initial investigation was whether there was a relationship between nutrient levels and other chemical constituents in the water column. If a strong correlational relationship could be established, these other values could be used as data surrogates if nutrient data were unavailable or as a less costly substitute for nutrient sampling.

   Relationships were investigated primarily for turbidity, total organic carbon (TOC), and suspended solids. We found numerous positive correlations, but the large number of data points at the detection level caused relationships to be suspect. For example, Figures A-5 and A-6 illustrate the relationship between total phosphorus and turbidity (r^2 value = 0.282) as well as total phosphorus and TOC (r^2 value = 0.163) in ecoregion 67g.

   We intend to do the same type analysis with regional data from EPA's national nutrient database. At least in theory, this database would contain fewer observations below detection level.

2. If the correlation between either TP or nitrate+nitrite levels and the quality of biological communities can be established, a stronger rationale for ecoregion-specific numerical nutrient criteria can be provided. However, it should be noted that even where correlation is strong, identifying a numeric nutrient criteria is dependent on knowing the biological integrity score above which, the community is considered impaired. Fortunately, as in the case of nutrients, this biological integrity goal can be established from the reference stream data.

   In sub-ecoregion 71h (Outer Nashville Basin), a preliminary comparison was done. Nitrate-nitrite levels were compared to two biological indices frequently used by the Division, the North Carolina Biotic Index (NCBI) and the Hilsenhoff Biotic Index (EPA Rapid Bioassessment Protocols, 1999). While there was some scatter in the dataset, a relationship was suggested which was slightly stronger for the Hilsenhoff index (Figure A-7) than the NCBI. (Figure A-8).

   An additional test was done with the appearance of a relationship between nitrate-nitrite and NCBI scores. According to the reference stream database for sub-ecoregion 71h, the 75th percentile of the NCBI data is a score of approximately 5.0. Presuming that an NCBI score of 5.0 is the biological goal for sub-ecoregion 71h, then according to the above chart, nitrate-nitrite levels should not exceed approximately 1.2 mg/L. Following the same approach with the Hilsenhoff scores also produced a similar nitrate-nitrite level, approximately 1.2 mg/L. It is interesting to note that the 90th percentile of the reference stream nitrate-nitrite data for 71h is approximately 1.0 mg/L.