

EDWARD B. RASTETTER

Senior Scientist

The Ecosystems Center
Marine Biological Laboratory
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Education: Ph.D., University of Virginia, Department of Environmental Sciences, 1986.
Dissertation: The Regulation of Ecosystem Processes within a Sealed Aquatic Microcosm

B.S., University of Hawaii, Zoology and Mathematics, 1976. Marine Options degree in Marine Environmental Management under the Sea Grant Program.

Honors: 1981-1984, Dean's Reserve Fellowship, University of Virginia

Elected Societies: Full member of the Society of the Sigma Xi (1980)

Editorial Board: Ecosystems (1998- present)

Research Experience:

April 2004: Royal Society of Edinburgh visiting Scientist at the The Macaulay Institute, Aberdeen Scotland

April-May 1996: Visiting Scientist, Swedish Agricultural University, Uppsala, Sweden

November 2002 - Present: Senior Scientist, The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA .

February 1994 - November 2002: Associate Scientist, The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA .

June 1987 - February 1994: Assistant Scientist, The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA.

February 1986 - June 1987: Postdoctoral Research Associate, The Ecosystems Center, Marine Biological Laboratory. Modeling global carbon cycling.

September 1985 - January 1986: Postdoctoral Research Associate, University of Virginia, Department of Environmental Sciences. Modeling the effects of acid rain on the soils of small forested catchments.

January 1985 - August 1985: Research Assistant, University of Virginia, Department of Environmental Sciences. Development of a model of community succession on coastal barrier islands and in mangrove forests.

March 1976 - June 1979: Biologist, Research Corporation of the University of Hawaii, on contract to the Naval Ocean Systems Center, Hawaii Laboratory, Kaneohe, Hawaii.

February 1975 - March 1976: Biologist, Marine Options Program, University of Hawaii Sea Grant, on contract to the Naval Undersea Center, Hawaii Laboratory, Kaneohe, Hawaii

Teaching Experience:

Designed and taught a short course entitled: A Review of Calculus and Linear Algebra for the Environmental Sciences (August 1983).

Teaching assistant in the following courses: Systems Analysis (Fall 1979, Spring 1981), Applied Hydrology (Spring 1980, Spring 1981), Terrestrial Ecology (Fall 1981).

Organized and lectured in a series of workshops for beginning graduate students on "Mathematical Modeling in Ecology," funded by the Clowes Fund (1989 - 1992).

Designed and taught an undergraduate course in Mathematical Modeling for the Semester in Environmental Sciences (1997 - present)

Student Committees

Freddrick Wikström, Opponent for PhD defense, Swedish Agricultural University, Uppsala, Sweden
David Bryant, PhD committee, University of New Hampshire

Tenure Review Committee

Riitta Hyvönen-Olsson, Faculty of Forestry, Swedish Agricultural University, Uppsala, Sweden

Post-Doctoral Fellows

Michael Ryan, 1988-1990
Robert McKane 1990-1994
David Fernandes 1994-1996
Mathew Williams 1994-1997
Darrell Herbert 1996-1999
Severine Le Dizes 2000-2001

MBL Committees

Hughes Library Planning Committee 1988-89
MBL Computer Services Committee, Chair since 1989
Housing, Food Services, and Child Care Committee, 2000-present
MBL Housing Study, fall 2000
Resident Science Task Force, Spring 2002

Panels

U. S. Environmental Protection Agency Centers Panel, June 1991
Interagency (NSF/USDA/EPA/NASA) Terrestrial Ecology and Global Change Initiative (TECO) Panel
June 1995.
National Atmospheric and Space Administration Panel, March 2001
National Science Foundation Biocomplexity Panel, May 2002
National Atmospheric and Space Administration Panel, June 2004

Publications:

Rastetter, E. B., and W. J. Cooke. 1979. Responses of marine fouling communities to sewage abatement in Kaneohe Bay, Oahu, Hawaii. *Marine Biology* 53:271-280.
Grovhoug, J. G., and E. B. Rastetter. 1980. Marine fouling dynamics in Hawaiian nearshore ecosystems: a suggested technique for comparison and evaluation. 5th International Congress on Marine Corrosion and Fouling, Madrid, pp. 249-266.
Hornberger, G. M., and E. B. Rastetter. 1982. Sensitivity analysis as an aid in modelling and control of (poorly-defined) ecological systems. NASA Technical Report CR-166308.
Hornberger, G. M., B. J. Cosby and E. B. Rastetter. 1986. Regionalization of predictions of effects of atmospheric acidic deposition on surface waters. Proc. International Conference on Water Quality Modelling in the Inland Natural Environment, Bournemouth, England, 10-13 June 1986.
Rastetter, E. B. 1986a. The Regulation of Ecosystem Processes within a Sealed Aquatic Microcosm. Ph.D. thesis to The University of Virginia.
Rastetter, E. B. 1986b. Analysis of community interactions using linear transfer function models. *Ecological Modelling* 36:101-117.
Cosby, B. J., G. M. Hornberger, E. B. Rastetter, J. N. Galloway and R. F. Wright. 1986. Estimating catchment water quality response to acid deposition using mathematical models of soil ion exchange processes. Workshop on Mechanisms of Ion Transport in Soils, Swiss Federal Institute of Hydrology, Zurich Switzerland, 20-23 May 1985.

- Moore, B., M. P. Gildea, C. J. Vorosmarty, D. L. Skole, J. Melillo, B. J. Peterson, E. Rastetter and P. Steudler. 1989. Strategy for understanding changes in the metabolic system of the planet, pp. 118-141. In: M. B. Rambler, L. Margulis and R. Fester (eds.), *Global Ecology*. Academic Press.
- Shugart, H. H., P. J. Michaels, T. M. Smith, D. A. Weinstein and E. B. Rastetter. 1988. Simulation models of forest succession, pp. 125-153. In: T. Rosswall and R. G. Woodmansee and P. G. Risser (eds.), *Scales and Global Change. Spatial and Temporal Variability in Biospheric and Geospheric Processes*. SCOPE 35. John Wiley & Sons, New York.
- Shugart, H. H., G. B. Bonan and E. B. Rastetter. 1988. Niche theory and community organization. *Can. J. Bot.* 66:2634-2639.
- Vorosmarty, C. J., B. Moore III, A. L. Grace, M. P. Gildea, J. M. Melillo, B. J. Peterson, E. B. Rastetter and P. A. Steudler. 1989. Continental scale models of water balance and fluvial transport: An application to South America. *Global Biogeochemical Cycles* 3(3):241-265.
- Ryan, P. F., G. M. Hornberger, B. J. Cosby, J. N. Galloway, J. R. Webb and E. B. Rastetter. 1989. Changes in the chemical composition of stream water in two catchments in the Shenandoah National Park, VA, in response to atmospheric deposition of sulfur. *Water Resources Research* 25:2091-2099.
- Rastetter, E. B. 1991. A spatially explicit model of vegetation-habitat interactions on barrier islands, pp. 353-378. Chapter 14. In: M. G. Tuner and R. H. Gardner (eds.), *Quantitative Methods in Landscape Ecology*. Springer-Verlag, New York.
- Rastetter, E. B., M. G. Ryan, G. R. Shaver, J. M. Melillo, K. J. Nadelhoffer, J. E. Hobbie and J. D. Aber. 1991. A general biogeochemical model describing the responses of the C and N cycles in terrestrial ecosystems to changes in CO₂, climate and N deposition. *Tree Physiology* 9:101-126.
- Raich, J. W., E. B. Rastetter, J. M. Melillo, D. W. Kicklighter, P. A. Steudler, B. J. Peterson, A. L. Grace, B. Moore III and C. J. Vorosmarty. 1991. Potential net primary productivity in South America: Application of a global model. *Ecological Applications* 1:399-429.
- Rastetter, E. B., A. W. King, B. J. Cosby, G. M. Hornberger, R. V. O'Neill and J. E. Hobbie. 1992a. Aggregating fine-scale ecological knowledge to model coarser-scale attributes of ecosystems. *Ecological Applications* 2:55-70.
- Rastetter, E. B., R. B. McKane, G. R. Shaver and J. M. Melillo. 1992b. Changes in C storage by terrestrial ecosystems: How C-N interactions restrict responses to CO₂ and temperature. *Water, Air & Soil Pollution* 64:327-344.
- Rastetter, E. B., and G. R. Shaver. 1992. A model of multiple element limitation for acclimating vegetation. *Ecology* 73:1157-1174.
- Shaver, G. R., W. D. Billings, F. S. Chapin, III, A. E. Giblin, K. J. Nadelhoffer, W. C. Oechel and E. B. Rastetter. 1992. Global change and the carbon balance of arctic ecosystems. *BioScience* 42(6):433-441.
- Kicklighter, D. W., J. M. Melillo, W. T. Peterjohn, E. B. Rastetter, A. D. McGuire, P. A. Steudler and J. D. Aber. 1994. Aspects of spatial and temporal aggregation in estimating regional carbon dioxide fluxes from temperate forest soils. *Journal of Geophysical Research* 99:1303-1315.
- Rastetter, E. B., and G. R. Shaver. 1995. Functional redundancy and process aggregation: Linking ecosystems to species. In: C. G. Jones and J. H. Lawton (eds.) *Linking Species and Ecosystems*. Chapman and Hall, New York, pp. 215-223.
- Hobbie, J. E., L. A. Deegan, B. J. Peterson, E. B. Rastetter, G. R. Shaver, G. W. Kling, W. J. O'Brien, F. S. Chapin, Michael C. Miller, G. W. Kipphut, W. B. Bowden, A. E. Hershey and M. E. McDonald. 1995. Long-term measurements at the Arctic LTER site, pp. 391-409. In: T. M. Powell and J. H. Steele (eds.), *Biological Time Series*. Chapman and Hall, New York.
- McKane, R. B., E. B. Rastetter, J. M. Melillo, G. R. Shaver, C. S. Hopkinson, D. N. Fernandes, D. L. Skole and W. H. Chomentowski. 1995. Effects of global change on carbon storage in tropical forests of South America. *Global Biogeochemical Cycles* 9(3):329-350.
- Johnson, L. C., G. R. Shaver, A. Giblin, K. Nadelhoffer, E. Rastetter, J. Laundre and G. Murray. 1996. Effects of enhanced drainage and elevated temperature on carbon balance of tussock tundra microcosms. *Oecologia* 108:737-748.
- Rastetter, E. B. 1996. Validating models of ecosystem response to global change. *BioScience* 46(3):190-198.

- Ryan, M. G., E. R. Hunt, Jr., R. E. McMurtrie, G. I. Ågren, J. D. Aber, A. D. Friend, E. B. Rastetter, W. Pulliam, J. Raison and S. Lindner. 1996(a). Comparing models of ecosystem function for temperate conifer forests. I. Model description and validation. In: A. Breymeyer, D. O. Hall, J. M. Melillo and G. I. Ågren (eds.), *Global Change: Effects on Coniferous Forests and Grasslands*. SCOPE 56. John Wiley & Sons, New York, pp 313-362.
- Ryan, M. G., R. E. McMurtrie, G. I. Ågren, E. R. Hunt, Jr., J. D. Aber, A. D. Friend, E. B. Rastetter and W. M. Pulliam. 1996(b). Comparing models of ecosystem function for temperate conifer forests. II. Simulations of the effect of climatic change,. In: A. Breymeyer, D. O. Hall, J. M. Melillo and G. I. Ågren (eds.), *Global Change: Effects on Coniferous Forests and Grasslands*. SCOPE 56. John Wiley & Sons, New York, pp 363-387.
- Shaver, G. R., A. E. Giblin, K. J. Nadelhoffer and E. B. Rastetter. 1996. Plant functional types and ecosystem change in arctic tundras. In: T. Smith, H. Shugart and I. Woodward (eds.), *Plant Functional Types*. Cambridge University Press, Cambridge, UK.
- Townsend, A. R., and E. B. Rastetter. 1996. Nutrient constraints over carbon storage in forested ecosystems, pp. 35-45. In: M. Apps and D. Price (eds.), *Forest Ecosystems, Forest Management and the Global Carbon Cycle*. NATO ASI Series, Vol I 40. Springer-Verlag, Berlin.
- Townsend, A. R., M. T. Sykes, M. J. Apps, I. Fung, S. Kellomäki, P. J. Martikainen, E. B. Rastetter, B. J. Stocks, W. J. A. Volney and C. Zoltai. 1996. WG1 Summary: Natural and anthropogenically-induced variations in terrestrial carbon balance, pp. 97-107. In: M. Apps and D. Price (eds.), *Forest Ecosystems, Forest Management and the Global Carbon Cycle*. NATO ASI Series, Vol I 40. Springer-Verlag, Berlin.
- Williams, M., E. B. Rastetter, D. N. Fernandes, M. L. Goulden, S. C. Wofsy, G. R. Shaver, J. M. Melillo, J. W. Munger, S.-M. Fan and K. J. Nadelhoffer. 1996. Modelling the soil-plant-atmosphere continuum in a *Quercus-Acer* stand at Harvard Forest: the regulation of stomatal conductance by light, nitrogen and soil/plant hydraulic properties. *Plant, Cell and Environment* 19:911-927.
- McKane, R., E. Rastetter, G. Shaver, K. Nadelhoffer, A. Giblin, J. Laundre and F. Chapin. 1997a. Climatic effects on tundra carbon storage inferred from experimental data and a model. *Ecology* 78:1170-1187.
- McKane, R., E. Rastetter, G. Shaver, K. Nadelhoffer, A. Giblin, J. Laundre and F. Chapin. 1997b. Reconstruction and analysis of historical changes in carbon storage in arctic tundra. *Ecology* 78:1188-1198.
- Nadelhoffer, K. J., G. R. Shaver, A. E. Giblin and E. B. Rastetter. 1997. Potential impacts of climate change on nutrient cycling, decomposition and productivity in arctic ecosystems, pp. 349-364. In: W. C. Oechel, T. Callaghan, T. Gilmanov, J. I. Holten, B. Maxwell, U. Molau and B. Sveinbjörnsson (eds.), *Global Change and Arctic Terrestrial Ecosystems*. Springer-Verlag, New York.
- Rastetter, E. B., G. I. Ågren and G. R. Shaver. 1997a. Responses of N-limited ecosystems to increased CO₂: A balanced-nutrition, coupled-element-cycles model. *Ecological Applications* 7:444-460.
- Rastetter, E. B., R. B. McKane, G. R. Shaver, K. J. Nadelhoffer and A. E. Giblin. 1997b. Analysis of CO₂, temperature, and moisture effects on carbon storage in Alaskan arctic tundra using a general ecosystem model, pp.437-451. In: W. C. Oechel, T. Callaghan, T. Gilmanov, J. I. Holten, B. Maxwell, U. Molau and B. Sveinbjörnsson (eds.), *Global Change and Arctic Terrestrial Ecosystems*. Springer-Verlag, New York.
- Shaver, G. R., E. B. Rastetter, A. E. Giblin and K. J. Nadelhoffer. 1997. Carbon-nutrient interactions as constraints on recovery of arctic ecosystems from disturbance, pp. 553-562. In: R. M. M. Crawford (ed.), *Disturbance and Recovery in Arctic Lands: An Ecological Perspective*. Kluwer Academic Publishers, Dordrecht.
- Williams, M., E. B. Rastetter, D. N. Fernandes, M. L. Goulden, G. R. Shaver and L. C. Johnson. 1997. Predicting gross primary productivity in terrestrial ecosystems. *Ecological Applications* 7:882-894.
- Williams, M., Y. Malhi, A.D. Nobre, E.B. Rastetter, J. Grace, and M.G. Pereira. 1998. Seasonal variation in net carbon exchange and evapotranspiration in a Brazilian rain forest: a modelling analysis. *Plant, Cell, and Environment* 21: 953-968.
- Hobbie, J. E., B. L. Kwiatkowski, E. B. Rastetter, D. A. Walker and R. B. McKane. 1998. Carbon cycling in the Kuparuk Basin: Plant production, carbon storage, and sensitivity to future changes. *Journal of Geophysical Research* 103:29,065-29,073.

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- Rastetter, E. B., L. Gough, A. E. Hartley, D. A. Herbert, K. J. Nadelhoffer and M. Williams. 1999. A revised assessment of species redundancy and ecosystem reliability. *Conservation Biology* 13:440-443.
- Ågren, G. I., G. R. Shaver and E. B. Rastetter. 1999. Nutrients: Dynamics and Limitations. Pages 333-345 in Y. Luo and H. A. Mooney (eds.), *Carbon Dioxide and Environmental Stress*. Academic Press, San Diego.
- Herbert, D. A., E. B. Rastetter, G. R. Shaver, G. I. Ågren. 1999. Effects of plant growth characteristics on biogeochemistry and community composition in a changing climate. *Ecosystems* 2:367-382.
- Williams, M. and E. B. Rastetter. 1999. Vegetation characteristics and primary productivity along an arctic transect: implications for scaling up. *Journal of Ecology*. 87: 885-898.
- Williams, M., W. Eugster, E. B. Rastetter, J. P. McFadden and F. S. Chapin III. 2000. The controls on net ecosystem productivity along an arctic transect: a model comparison with flux measurements. *Global Change Biology* Vol. 6, Supplement I:116-126.
- Clein, J. S., B. L. Kwiatkowski, A. D. McGuire, J. E. Hobbie, E. B. Rastetter, J. M. Melillo and D. W. Kicklighter. 2000. Modelling carbon responses of tundra ecosystems to historical and projected climate: A comparison of a plot- and a global-scale ecosystem model to identify process-based uncertainties. *Global Change Biology* Vol. 6, Supplement I:127-140.
- Chapin, S.F. III, A.D. McGuire, J. Randerson, R. Pielke, D. Baldocchi, S.E. Hobbie, N Roulet, W. Eugster, E. Kasischke, E.B. Rastetter, S.A. Zimov, and S.W. Running. 2000. Arctic and boreal ecosystems of western North America as components of the climate system. *Global Change Biology* Vol 6 Suppl. I: 211-223.
- Johnson, L.C. , G.R. Shaver, D.H.Cades, E. Rastetter , K. Nadelhoffer, A. Giblin, J. Laundre, and A. Stanley. 2000. Plant carbon-nutrient interactions control ecosystem CO₂ exchange in Alaskan wet sedge tundra ecosystems. *Ecology* 81:453-469.
- Williams, M., Rastetter, E. B., Shaver, G. R., Hobbie, J. E., Carpino, E. and Kwiatkowski, B. L. 2001. Primary production in an arctic watershed; an uncertainty analysis. *Ecological Applications* 11:1800-1816
- Rastetter, E.B., P.M. Vitousek, C. Field, G.R. Shaver, D. Herbert, G.I. Ågren. 2001. Resource Optimization and Symbiotic N Fixation. *Ecosystems* 4:369-388.
- McKane, R.B., L.C. Johnson, G.R. Shaver, K.J. Nadelhoffer, E.B. Rastetter, B. Fry, A.E. Giblin, K. Kieland, B.L. Kwiatkowski, J.A. Laundre, and G. Murray. 2002. Resource-based niche provide a basis for plant species diversity and dominance in arctic tundra. *Nature* 415: 68-71
- Pontius, R.G. Jr, L. Claessens, C. Hopkinson Jr, A. Marzouk, E.B. Rastetter, L.C. Schneider, and J. Vallino. 2002. Scenarios of land-use change and nitrogen release in the Ipswich watershed, Massachusetts, USA. GIS/EM4 No. 165 <http://www.colorado.edu/research/cires/banff/pubpapers/165/>
- Rastetter, E.B., and G.I. Ågren. 2002. Changes in Individual Allometry Can Lead to Species Coexistence without Niche Separation. *Ecosystems* 5: 789-801.
- Vitousek, P.M., K. Cassman, C. Cleveland, T. Crews, C.B. Field, N. Grimm, R.W. Howarth, R. Marino, L. Martinelli, E.B. Rastetter, and J. Sprent. 2002. Towards an ecological understanding of biological nitrogen fixation. *Biogeochemistry* 57/58:1-45.
- Williams, M., Y. Shimabokuro, D.A. Herbert, S. Pardi-Lacruz, C. Renno, E.B.Rastetter. 2002. Heterogeneity of soils and vegetation in eastern Amazonian rain forest: implications for scaling up biomass and production. *Ecosystems* 5:692-704.
- Rastetter, E. B., J. D. Aber, D. P. C. Peters, D. S. Ojima, and I. Burke. 2003. Using Mechanistic Models to Scale Ecological Processes Across Space and Time. *BioScience* 53:68-76.
- Rastetter, E.B. 2003. The collision of hypotheses: What can be learned from comparisons of ecosystem models? Pp. 211-224 In: Canham, C.D., J.J. Cole, and W.K. Lauenroth, editors. *Models in Ecosystem Science*. Princeton (NJ): Princeton University Press.

- Herbert, D. A., M. Williams, and E. B. Rastetter. 2003. A modeled analysis of N and P limitation on carbon accumulation in an Amazonian forest site after alternate land-use abandonment. *Biogeochemistry* 65: 121-150.
- Le Dizès, S., B.L. Kwiatkowski, E.B. Rastetter, A. Hope, J.E. Hobbie, D. Stow, S. Daeschner. 2003. Modeling biogeochemical responses of tundra ecosystems to temporal and spatial variations in climate in the Kuparuk River Basin (Alaska). *Journal of Geophysical Research-Atmospheres* 108(D2), 8165, doi:10.1029/2001JD000960.
- Herbert, D. A., E. B. Rastetter, L. Gough, and G. R. Shaver. 2004. Species diversity across nutrient gradients: An analysis of resource competition in model ecosystems. *Ecosystems* 7: 296-310.
- Rastetter, E.B., B. L. Kwiatkowski, S. Le Dizès, and J.E. Hobbie. 2004. The Role of Down-Slope Water and Nutrient Fluxes in the Response of Arctic Hill Slopes to Climate Change. *Biogeochemistry* 69:37-62.
- Williams, M., C. Hopkinson, E. Rastetter, and J. Vallino. 2004. N budgets and aquatic uptake in the Ipswich River basin, northeastern Massachusetts. *Water Resources Research* 40 W11201, doi:10.1029/2004WR003172.
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- Rastetter, E. B., S. S. Perakis, G. R. Shaver, and G. I. Ågren. 2005. Carbon Sequestration in Terrestrial Ecosystems Under Elevated CO₂ and Temperature: Role of Dissolved Organic N Loss. *Ecological Applications* 15:71-86.
- Booth, M.S., J.M. Stark, and E.B. Rastetter. 2005. Controls on nitrogen cycling in terrestrial ecosystems: a synthetic analysis of literature data. *Ecological Monographs* 75: 139-157.
- Rastetter, E.B., B.L. Kwiatkowski, and R.B. McKane. 2005. A Stable Isotope Simulator that Can Be Coupled to Existing Mass-Balance Models. *Ecological Applications* 15:1772-1782.
- Chapin, F.S. III, G.M Woodwell, J.T. Randerson, E.B. Rastetter, G.M. Lovett, D.D. Baldocchi, D.A. Clark, M.E. Harmon, D.S. Schimel, R. Valentini, C. Wirth, J.D. Aber, J.J. Cole, M.L. Goulden, J.W. Harden, M. Heimann, R.W. Howarth, P.A. Matson, A.D. McGuire, J.M. Melillo, H.A. Mooney, J.C. Neff, R.A. Houghton, M.L. Pace, M.G. Ryan, S.W. Running, O.E. Sala, W.H. Schlesinger, E.-D. Schulze. 2006. Reconciling carbon-cycle concepts, terminology, and methods. *Ecosystems* 9:1041-1050.
- Claessens, L., C. Hopkinson, E. Rastetter, and J. Vallino (2006), Effect of historical changes in land use and climate on the water budget of an urbanizing watershed, *Water Resour. Res.*, 42, W03426, doi:10.1029/2005WR004131.
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- Yano, Y, GR Shaver, AE Giblin, and EB Rastetter. 2009. Depleted ¹⁵N in hydrolysable-N of arctic soils and its implication for mycorrhizal fungi-plant interaction. *Biogeochemistry* DOI 10.1007/s10533-009-9365-1
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- Rastetter, E.B. In Press. Modeling coupled biogeochemical cycles. *Frontiers in Ecology and the Environment*.

Short Papers and Abstracts:

Pease, K., L. Claessens, C. Hopkinson, E. Rastetter, J. Vallino and N. Kilham. 1999. Ipswich River nutrient dynamics: Preliminary assessment of a simple nitrogen-processing model. *Biol. Bull.* 197:289-290.

Canfield, S., L. Claessens, C. Hopkinson, Jr., E. Rastetter and J. Vallino. 1999. Long-term effect of municipal water use on the water budget of the Ipswich River Basin. *Biol. Bull.* 197:295-297.

Letters:

Rastetter, E. B. and R. A. Houghton. 1992. Carbon budget estimates. *Science* 258: 382.

Book Reviews:

Rastetter, E. B. 1993. Scaling physiological processes: leaf to globe. J. R. Ehleringer and C. B. Field (eds.) *Ecology*: 74:2470-2471.

Rastetter, E. B. 1999. Forest ecosystems: Analysis at multiple scales. R. H. Waring and S. W. Running. *Tree Physiology* 19:138.

Rastetter, E. B. 1999. Scaling up from cell to landscape. P. R. van Gardigen, G. M. Foody and P. J. Curran (eds.), *Ecology* 80:354-355.