RNT CONSULTING INC

CURRICULUM VITAE

Gerald Mackie, Ph.D.

Dr. Mackie is a malacologist. He is a member of the Canadian Academia with extensive industrial experience.

ACADEMIC BACKGROUND

- Doctor of Philosophy (University of Ottawa) - 1973
- Master of Science (University of Ottawa) – 1971
- Bachelor of Science (Laurentian University) – 1969

CONSULTING POSITIONS HELD

- Associate, RNT Consulting Inc. – 2003 to present
- Sole Proprietor, Water Systems Analysts – 1999 to present
- Partner (with Bruce Kilgour), Water Systems Analysts – 1995 to 1999
- President, Mackie and Associates Water Systems Analysts Inc. – 1990 to 1995
- Co-Chair of Mollusca Species Specialist Subcommittee (COSEWIC) – 1995 to 2006

ACADEMIC POSITIONS HELD

- Professor Emeritus, Department of Integrative Biology, University of Guelph – 2003 to present
- Full Professor, Department of Zoology, University of Guelph – 1988 to 2003
- Associate Professor, Department of Zoology, University of Guelph – 1981 to 1988
- Assistant Professor, Department of Zoology, University of Guelph – 1974 to 1981
- Postdoctoral Fellow, National Museums of Canada, Ottawa – 1973 to 1974

SELECTED ACTIVITIES AND ACHIEVEMENTS

- Conducted risk assessments of lakes and reservoirs to Aquatic Invasive Species in Nevada, Arizona and Colorado, 2008 to 2009
- Developed a protocol for relocation and monitoring of mussel species at risk in Canada for Department of Fisheries and Oceans, 2005 to 2008
- Participated as the zebra mussel expert in the peer review evaluation of the OCSWEP/QEA water quality model of the Three Rivers System in Central New York State, January 2003
- Implemented “Do-it-yourself” programs using a variety of continuous and intermittent chlorination strategies for controlling zebra mussel infestations at Quebec & Ontario Paper Company on the Welland Canal, Ontario and Labatt Breweries on the St. Lawrence River,

Montreal, Quebec, Eastman Kodak, Rochester, and Polysar on the St. Clair River, Sarnia Ontario. In this program we taught biologists and pumphouse operators on staff how to monitor the abundance of veliger larvae and how to evaluate the effectiveness of their chlorination programs, 1989 to 2000

- Acted as a subconsultant with numerous engineering firms, including Black & Veatch, Gilbert Commonwealth, Camp Dresser and McKee, Proctor and Redfern, Marshall Macklin Monahan Engineers, and Gore and Storrie, evaluating plant designs for zebra mussel infestations and making recommendations for control at nuclear power stations (e.g. Niagara Mohawk Nine Mile Point, Syracuse, NY), steel manufacturers (e.g. Stelpipe, Welland, Ontario; Caterpillar Inc., Mapleton, Illinois), breweries (e.g. Labatt, Montreal Quebec), cement manufacturers (e.g. ESSROC, Picton, Ontario), chemical manufacturers (e.g. Polysar, Sarnia, Ontario; Eastman Kodak, Rochester, NY), food and drug manufacturers (e.g. Proctor & Gamble, Scranton, Pennsylvania), petroleum industries (e.g. Shell Oil, Corunna, Ontario), and water treatment plants (e.g. Clarke Water Treatment Plant, Metro Toronto, Ontario). Dr. Mackie has also evaluated the potential for zebra mussel infestations at several facilities based on intake water chemistry data from lakes and rivers in North Carolina, Pennsylvania, Illinois, New York, Ohio, and Tennessee, 1989 to 2000
- Evaluated and published on the efficacies of synthetic chemicals, including sodium hypochlorite, hydrogen peroxide, and Bulab 6002 and 6009 which are nonoxidizing quaternary ammonium compounds (produced by Buckman Laboratories Inc.) at 12°C and 22°C for Ontario Hydro. These studies were instrumental in developing the continuous and intermittent control strategies that industries and utilities now use for controlling zebra mussels in their raw water supplies, 1990 to 1995
- Investigated the toxicity of sodium metabisulfite and the accumulation of sulfur compounds in the tissues of adult mussels for the Tennessee Valley Authority, 1993 to 1994
- Examined the efficacy and role of alum in removing veliger larvae from raw water supplies during the coagulation and flocculation stages for the Ontario Ministry of Environment, 1992 to 1993
- Acted as technical advisor at a conference for evaluating the effectiveness of Deep Lake Water Cooling (DLWC) for eliminating potential biofouling problems by zebra mussels in a Lake Water Cooling System for downtown Toronto. The conference was sponsored by the Canadian Urban Institute and resulted in a report (June 1991) available from them: 100 Queen St. W., 2nd Floor, West Tower, Toronto, Ontario, M5H 2N1, 1991 to 1992
- Determined the effects of salinity on growth and survival of zebra mussels for Empire State Electric Energy Research Corporation (ESEERCO), 1991 to 1992

SELECTION OF PUBLICATIONS

Books and Monographs

Mackie, G. L. and R. Claudi. 2009. Monitoring and control of macrofouling mollusks in fresh water systems, Second Edition. CRC Press, Boca Raton, FL. 508 pp.

Mackie, G. L. 2007. The Cottage Bible. Boston Mills Press, 360 pp. ISBN 13781550464597

Mackie, G . L . 2007 . Biology of freshwater corb icu lid and sp hae riid clams of North America. Ohio Biological Survey, Columbus, OH. 438 pp. + ix. ISBN13 9780867271584.

Mackie, G. L. 2004. Applied Aquatic Ecosystem Concepts, 2nd edition. Kendall/Hunt Publ. Cp., Dubuque, Iowa. 744 pp. ISBN 0787274909.

Mackie, G. L. 2001. Flora and fauna of the Speed River watershed, including exotic and endangered species. Water Systems Analysts, Guelph, Ontario. 274 pp. ISBN0 9010-33781.

Claudi, R. and G. L. Mackie. 1994. Practical manual for zebra mussel monitoring and control. 256 pp., Lewis Publ., Boca Raton, FL. ISBN 0873719859.

Chapters in Books

Mackie, G. L. 2002. Traits of endangered and invading freshwater molluscs in North America. *In*: Claudi, R., P. Nantel, E. MuckleJeffs (eds.). *Alien Invaders in Canada's waters, Wetlands, and Forests*. Publ., Can. Forest Serv., Nat. Resources Canada,Ottawa, ON. 320 pp.

Mackie, G. L. 2000a. Chapter 9: Mollusc introductions through aquarium trade. *In:* Claudi, R. and J . Leach (eds.) . *Nonindigenous freshwater organisms: vectors, biology and impacts.* Published by Lewis Publishers, Boca Raton, FL. pp. 135-150.

Mackie, G. L. 2000b. Chapter 15: Ballast water introductions of Mollusca. *In:* Claudi, R. and J. Leach (eds.). *Nonindigenous freshwater organisms: vectors, biology and impacts.* Published by Lewis Publishers, Boca Raton, FL. pp. 255-272.

Mackie, G. L. 2000c. Chapter 21: Introduction of molluscs through the import for live food. *In:* Claudi, R. and J. Leach (eds.). *Nonindigenous freshwater organisms: vectors, biology and impacts.* Published by Lewis Publishers, Boca Raton, FL. pp. 305-314.

Fears, C. and G. L. Mackie. 1996. Use of low level electric current (AC) to prevent settlement of zebra/quagga mussels on concrete and steel panels at Nanticoke T.G.S. *In*: D'Itri, F. M. (ed.). *Zebra mussels and aquatic nuisance species*. Chapter 26 , pp . 407-417.

Mackie, G. L. 1993. Early biological and life history attributes of the zebra mussel, *Dreissena polymorpha* (Bivalvia: Dreissenidae) and impacts on native bivalves in Lake St. Clair. *In*: T. Nalepa and D. W. Schloesser (eds.). Zebra mussels: Biology, impact and control. CRC Publications, Boca Raton, Fl., pp. 153-156.

Kilgour, B. W. and G. L. Mackie. 1993. Colonization of different construction materials by the zebra mussel, *Dreissena polymorpha* (Bivalvia: Dreissenidae). *In*: T. Nalepa and D. W. Schloesser (eds.). Zebra mussels: Biology, impact and control. CRC Publications, Boca Raton, Fl., pp. 167-174.

Mackie, G. L. 1991. Biology of the exotic zebra mussel, *Dreissena polymorpha*, relative to native bivalves and its potential impact in Lake St. Clair. *In:* Environmental Assessment and Habitat Evaluation of the Connecting Channels. M. Munawar and T. Edsall (eds). Hydrobiologia 219: 251-268.

Mackie, G.L. 1984. Reproduction in Bivalvia. *In:* The Mollusca, Volume VII, Reproduction. Tompa, A. S., Verdonk, N. H. and J. A. M. van de Biggelaar (eds), Academic Press, New York. Chapter 5, pp. 351-418.

Refereed Publications

McGoldrick, D. J., Metcalfe-Smith, J. L., Arts, M. T., Schloesser, D. W., Newton, T. J., Mackie, G. L., Monroe, E. M., Biberhofer, J. and K. Johnson. 2009. Characteristics of a natural refuge for native freshwater mussels (Bivalvia: Unionidae) in Lake St. Clair and evaluation of relocation as a tool for mitigating impacts of the zebra mussel (*Dreissena polymorpha*). Journal of the North American Benthological Society 35(1): 137-146.

Hoftyzer, E., Ackerman, J. D., Morris, T. J. and G. L. Mackie. 2008. Genetic and environmental implications of repatriating laboratoryraised unionid mussels to the wild. Canadian Journal of Fisheries and Aquatic Sciences 65(6): 1217-1229.

Metcalfe-Smith, J. L., Di Maio, J., Mackie, G. L. and S. K. Staton. 2000. Changes over time in the diversity and distribution of freshwater mussels (Unionidae) in the Grand River, southwestern Ontario. J. Great Lakes Res. 26: 445-459.

Metcalfe-Smith, J. L., Stanton, S. K., Mackie, G. L. and N. M. Lane. 1998. Selection of Candidate species of freshwater mussels (Bivalvia: Unionidae) to be considered for national status designation by COSEWIC. Canadian FieldNaturalist. 112: 425-440.

Metcalfe-Smith, J. L., Stanton, S. K., Mackie, G. L. and N. Lane. 1998. Changes in biodiversity of freshwater mussels in the Canadian waters of the lower Great Lakes drainage basin over the past century. J. Great Lakes Research. 24: 845-858.

Claxton, W. T. and G. L. Mackie. 1998. Seasonal and depth variations in gametogenesis and spawning of *Dreissena polymorpha* and *Dreissena bugensis* i n eastern Lake Erie. Can. J . Zool. 76 : 2010-2019.

Claxton, W. T., Mackie, G. L. and E. G. Boulding. 1998. A genetic and morphological comparison of deep and shallow water populations of the introduced *Dreissena polymorpha* and *Dreissena bugensis*. Can J. Zool. 76: 1269-1276.

Dobson, E. and G. L. Mackie. 1998. Biodeposition and accumulation of polychlorinated biphenyls and Cd by zebra mussels in Lake Erie. Can J. Fish. Aq. Sci., 55: 1131-1139.

Hincks, S. S. and G. L. Mackie. 1997. Effects of pH, calcium, alkalinity, hardness, and chlorophyll on the survival, growth and reproductive success of zebra mussels (*Driessena polymorpha*) in Ontario lakes. Can J. Fish. Aquat. Sci. 54: 2049-2057.

Wainman, B., Hincks, S., Kaushik, N. and G. L. Mackie. 1996. Biofilm and substrate preference in dreissenid larvae in Lake Erie. Can. J. Fish. Aq. Sci. 53:134-140.

Mackie, G. L. and D. W. Schloesser. 1996. Comparative biology of zebra mussels in Europe and North America: An overview. Amer. Zool. 36: 244-258.

Schloesser, D. W., Nalepa, T. and G. L. Mackie. 1996. Review of the impacts of the zebra mussel on Unionidae in North America. Amer. Zool. 36:300-310.

Mackie, G. L. and B. W. Kilgour. 1995. Efficacy and role of alum in removal of zebra mussel veliger larvae from raw water supplies. Wat. Res. 29: 731-744.

Mackie, G. L. and C. A. Wright. 1994. Ability of the zebra mussel, *Dreissena polymorpha*, to biodeposit and remove phosphorous and BOD from diluted activated sewage sludge. Wat. Res. 28: 1123-1130.

Gillis, P. L. and G. L. Mackie. 1994. The impact of *Dreissena polymorpha* on populations of Unionidae in Lake St. Clair. Can. J. Zool., 72: 1260-1271.

Kilgour, B. W., Baker, M. and G. L. Mackie. 1993. Effects of salinity on growth and condition of adult zebra mussels (*Dreissena polymorpha*). Estuaries 17: 385-393.

Pathy, D. A. and G. L. Mackie. 1993. Shell features of *Dreissena polymorpha*, the quagga mussels, and *Mytiopsis leucophaeta* (Bivalvia: Dreissenidae) in North America. Can. J. Zool. 71: 1012-1023.

Martin, I. D., Mackie, G. L. and M. Baker. 1993. Control of the biofouling bivalve, *Dreissena polymorpha*, with sodium hypochlorite and with polyquaternary and benzothiazole compounds. Arch. Environ. Contam. Toxicol. 24: 381-388.

Martin, I. D., Mackie, G. L. and M. Baker. 1993. Acute toxicity and pulsedosed delayed mortality at 12°C and 22°C in the zebra mussel, *Dreissena polymorpha*. Arch. Environ. Contam. Toxicol. 24:389-398.

Publications in Conference Proceedings

Fears, C. and G. L. Mackie. 1997. Efficacy of low level electric current (AC) for controlling quagga mussels on concrete and steel panels after 17 months exposure at Nanticoke T.G.S. *In:* Proc.: 7th Internat. Zebra Mussel and Other Nuisance Organisms Conf., New Orleans, U.S.A. January 2831, 1997, 722 pp.

Fears, C. and G. L. Mackie. 1996. Efficacy of low level electric current (AC) for controlling quagga mussels on concrete and steel panels at Nanticoke T.G.S. *In*: Proc.: 6th Internat. Zebra Mussel and Other Nuisance Organisms Conf., Dearborn, Michigan, March 1421, 1996, pp. 114-124.

Mackie, G. L. 1995. Adaptations of exotic Mollusca for life in regulated rivers and their potential impacts. Keynote Speaker. Proc.: Fifth Annual Symposium on Natural History of Lower Tennessee and Cumberland River Valleys, Murray State University, March 3-4, 1995. 130 pp.

Fears, C. and G. L. Mackie. 1994. Use of low level electric current (AC) for controlling quagga mussels. *In*: Proc.: 4th Internat. Zebra Mussel Conf., March 710, 1994, Madison, Wisconsin. pp. 191-206.

Neuhauser, E. F., Rhode, M. A., Knowlton, J. J., Wahanik, R. J., Borden, M., Lewis, D. P. and G. L. Mackie. 1993. Thermal treatment to control zebra mussels at the Dunkirk Steam Station. *In*: Proc.: 3rd Internat. Zebra Mussel Conf., Feb. 23-26, 1993, Toronto, pp. 47-196.

Mackie, G.L. 1991. Monitoring, sampling and identification techniques for adult and veliger zebra mussels. pp. 163-214. Annual Conference Proceedings, American Water Works

Association, "Resources, Engineering and Operations for the New Decade", Philadelphia, PA, June 23 - 27, 1991.

Commissioned Reports

Mackie , G . L . , T. J. Morris , and D. Ming. 2008. Protocol for the detection and relocation of freshwater mussel species at risk in Ontario Great Lakes area (OGLA.). Can. Manuscr. Rep. Fish. Aquat, Sci. 2790: vi + 50 p. Cat. No. Fs 974/2790E ISSN 07066473.

Claudi, R., G. L. Mackie, T. Prescott. 2008 (March). Assessment of the Cragin Water Project Potential For Infestation by Quagga and Zebra Mussels, Assessment of Impact on Civil and Mechanical Structures and Recommendations for Monitoring and Control. 29 pp.

Mackie, G. L. 2008 (June). Risk assessments of intakes of Alfred Merritt Smith and River Mountains Water Treatment Facilities and of Big Bend Plant to zebra/quagga mussel infestations. Report for Southern Nevada Water Authority, 35 pp.

Mackie, G. L. 2008 (July). Risk assessment of Lake Oswego and the Buoyant Interceptor Sewer System (BISS) to zebra/quagga mussel infestations. Report for Brown & Caldwell, Lake Oswego Corporation, City of Oswego. 81 pp.

Mackie, G. L. 2008 (July). Risk assessment of Tualatin River water quality to zebra/quagga mussel infestations. Report for Brown & Caldwell, Lake Oswego Corporation, City of Oswego. 29 pp.

Mackie, G. L. 2008 (October). Risk assessment of water quality in Salt River Project watersheds, canal systems and lakes to zebra/quagga mussel infestations. Phase I. Report for Salt River Project Participants, Phoenix, Arizona. 137 pp.

Mackie, G.L. 1993. Efficacy and role of alum in removal of zebra mussel veliger larvae from raw water supplies. A final report to Ontario Ministry of Environment and Energy, Research Advisory Council Project No. 615C. 63 pp.

Mackie, G.L., Pathy, D., Gillis, P., Dobson, E. 1992. Biology and impact of zebra mussels in Lake St. Clair and Lake Erie. A final report submitted to Ontario Ministry of Environment for Project 443G. 81 pp.

Mackie, G.L., Sprules, W.G., Hebert, P.D.H., BeverleyBurton, M., Haffner, D. 1992. Biological attributes and ecological impacts of the invading mollusc, *Dreissena polymorpha*. A final report submitted to Great Lakes University Research Fund. 113 pp.

Mackie, G.L., Kilgour, B.W. 1992. Effects of salinity on growth and survival of zebra mussels (*Dreissena polymorpha*). A report prepared for ESSERCO. 37 pp.

Mackie, G.L., Chiles, C., Gordon, S., MacDonald, M., MacDougall, J., Mitchell, T., Neumann, L., Repaso, T., Surgeoner, K., Wiebe, R. 1991. Review of chemicals proposed for controlling zebra mussels in industrial and domestic pipelines in North America. A class project report for Toxicology (92420). 101 pp.

Mackie, G.L. 1990. Zebra mussels: The Great Lakes under seige, again. Rotunda 23: 1926.

Mackie, G.L., Gibbons, W.N., Muncaster, B., Gray, I. 1989. Biology and control of the zebra mussel, *Dreissena polymorpha*; A synopsis of the European experiences, a preview for North America. A report for the Ontario Ministry of Environment, 76 pp., Queen's Printer, Toronto.

Mackie, G.L., Rooke, J.B., Servos, M.R. 1983. Cause and effect relationships between Mollusca and the acidneutralizing capacity of acidifying lakes. Report to National Research Council of Canada Associate Committee on Scientific Criteria for Environmental Quality. 260 p.

Mackie, G.L., Roff, J.C., Gerrath, J.F., Ferguson, M., Morton, W. 1979. Effects of discharge level on oxygen regimes and biota within and downstream of Guelph Lake. Ontario Ministry of Environment, Experience '79 Project Report. 101 pp.

Mackie, G.L., Roff, J.C., Gerrath, J.F., Cichocki, F. 1978. Effects of impoundment on water quality and biota in Guelph Lake during the first three summers of inundation. Ontario Ministry of the Environment, Experience '78 Project Report. 98 pp.

Mackie, G.L., Roff, J.C., Gerrath, J.F., Joyner, D., Cichocki, F. 1977. Evaluation of effects of impoundment on water quality in the Guelph Reservoir. Ontario Ministry of the Environment, Experience '77 Project Report. 77 pp.

McKee, P.M., Mackie, G.L. 1977. Keys to benthic organisms in the Guelph Reservoir and tributaries. Dept. Zool., Univ. Guelph, Guelph, Ontario 95 pp.

Mackie, G.L. 1977. Collection, preservation, and examination techniques of freshwater invertebrates. Dept. Zool., Univ. Guelph, Guelph, Ontario 115 pp.

Mackie, G.L., Roff, J.C., Gerrath, J.F., Mahon, R.C., Counsell, K., Newman, L. 1976. Effects of impoundment on water quality in Guelph Reservoir. Ontario Ministry of the Environment. Experience Project Report. 78 pp.

Qadri, S. U., Mackie, G. L., Hamill, S. E., Clair, T. A. 1974. Macrobenthos: Standing crop biomass, density, production and distribution. *In*: Distribution and Transport of Pollutants in flowing water ecosystems. Ottawa River Project Annual Report, 1973. pp. 15.115.38. Published by National Research Council, Ottawa, February, 1974.