

## Appendix I

### Bibliography Critical Review of Battelle Report Dr. Larry LaFleur

Berry, R., Flemming, B., Voss, R., Luthe, C., and Wrist, P. 1989. Toward preventing the formation of dioxins during chemical pulp bleaching. *Pulp and Paper Canada*. **90**(8):T279-T289.

Doring, J., Damberg, M., Gamradt, A., and Oheme, M. 1992. Screening method based on the determination of perchlorinated aromatics for surface soil contaminated by copper slag containing high levels of polychlorinated dibenzofurans and dibenzo-p-dioxins. *Chemosphere*. **25**(6):755-762.

Federal Register: April 15, 1998. Volume 63, Number 72; page 18503-18552 40 CFR Parts 63, 261, and 430 National Emissions Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production; Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper, and Paperboard Category; Final Rule.

Firestone, D., Ress, J., Brown, N.L., Barron, B.P., and Damico, J.N. 1972. Determination of polychlorinated dibenzo-p-dioxins and related compounds in commercial chlorophenols. *JAOAC*. **55**(1):85-92.

Jensen, S., and Renberg, L. 1972. Contaminants in pentachlorophenol: chlorinated dioxins and predioxins. *Ambio*. **1**(2):62-65.

Jensen, S., and Renberg, L. 1973. Chlorinated dimers present in several technical chlorophenols used as fungicides. *Environ. Health Perspectives*. **5**:37-39.

Kaminsky, R., and Hites, R.A. 1984. Octachlorostyrene in Lake Ontario: Sources and Fates. *Environ. Sci. Technol.* **18**(4):275-279.

*Kirk-Othmer Encyclopedia of Chemical Technology*. 1996. John Wiley & Sons: New York.

Kringstad, K.P., deSousa, F., Johansson, L., Kolar, M-C., Swanson, S.E., Rappe, C., and Glas, B. 1988. Bleaching and the environment. Addendum to the paper presented by Knut P. Kringstad, STFI, Stockholm, Sweden at the 1988 International Pulp Bleaching Conference, Orlando, Florida.

LaFleur, L., Brunck, B., McDonough, T., Ramage, K., Gillespie, W., and Malcolm, E. 1990. Studies on the mechanism of PCDD/PCDF formation during the bleaching of pulp. *Chemosphere*. 20:10-12.

- Nilsson, C.-A., Andersson, K., Rappe, C., and Westermark, S.-V. 1974. Chromatographic evidence for the formation of chlorodioxins from chloro-2-phenoxyphenols. *J. Chrom.* **96**:137-147.
- Oheme, M., Mano, S., and Bjerke, B. 1989. Formation of polychlorinated dibenzofurans and dibenzo-p-dioxins by production processes for magnesium and refined nickel. *Chemosphere.* **18**(7-8):1379-1389.
- Pereira, W., Rostad, C., Chiou, C., Brinton, T., Barber, L. II, Demcheck, D., and Demas, C. 1988. Contamination of estuarine water, biota and sediment by halogenated organic compounds: A field study. *Environ. Sci Technol.* **22**(7):772-778.
- Rappe, C., Glas, B., Kjeller, L.-O., and Kulp, S.E. 1990. Levels of PCDDs and PCDFs in products and effluent from the Swedish pulp and paper industry and chloralkali process. *Chemosphere.* **20**(10-12):1701-1706.
- Schulman, E., and Klingele, H. 1985. *Sources of polychlorinated styrenes in the Great Lakes and their tributaries*. Final Report for U.S. Environmental Protection Agency under Grant No. R00-5764-01.
- United States Environmental Protection Agency (US EPA). 1980. *Dioxins*. EPA-600/2-80-197.
- United States Environmental Protection Agency (US EPA). 1993. *Proposed Technical development document for the pulp, paper and paperboard category effluent limitations guidelines, pretreatment standards and new source performance standards*. Engineering and Analysis Division, Office of Science and Technology.
- Voss, R., Luthe, C., Flemming, B., Berry, R., and Allen, L. 1988. Some new insights into the origin of dioxins formed during chemical pulp bleaching. *Pulp and Paper Canada.* **89**(12):T401-410.

## Appendix II

### Bibliography Critical Review of Battelle Report Dr. Robert Bailey

Cortes, D. R., I. Basu, C. W. Sweet, K. A. Brice, R. M. Hoff, and R. A. Hites, 1998, Temporal trends in gas-phase concentrations of chlorinated pesticides measured at the shores of the Great Lakes, *Environ. Sci. Technol.*, 32, 1920-1927.

Dan, T., 1999, telephone conversation with Netta Benazon.

Durham, R. W. and B. G. Oliver, 1983, History of Lake Ontario contamination from the Niagara River by sediment radiodating and chlorinated hydrocarbon analysis, *J. Great Lakes Res.*, 9, 160-168.

Huestis, S. Y., M. R. Servos, D. M. Whittle, and D. G. Dixon, 1996, Temporal and age-related trends in levels of polychlorinated biphenyl congeners and organochlorine contaminants in Lake Ontario lake trout (*Salvelinus namaycush*), *J. Great Lakes Res.*, 22, 310-330.

Hillery, B. R., M. F. Simcik, I. Basu, R. M. Hoff, W. M. J. Strachan, D. Burniston, C. H. Chan, K. A. Brice, C. W. Sweet, and R. A. Hites, 1998, Atmospheric deposition of toxic pollutants to the Great Lakes as measured by the Integrated Atmospheric Deposition Network, *Environ. Sci. Technol.*, 32, 2216-2221.

Hoff, R. M., D. C. G. Muir, and N. P. Grift, 1992, Annual cycle of polychlorinated biphenyls and organohalogen pesticides in air in southern Ontario. 1. Air concentration data, *Environ. Sci. Technol.*, 26, 266-275.

Kaminsky, R. and R. A. Hites, 1984, Octachlorostyrene in Lake Ontario: Sources and Fates, *Environ. Sci. Technol.*, 18, 275-279.

Karickhoff, S. W., D. S. Brown, and T. A. Scott, 1979, Sorption of hydrophobic pollutants on natural sediments, *Water Research*, 13, 241-248.

Kuehl, D. W., B. Butterworth, and P. J. Marquis, 1994, A national study of chemical residues in fish. III: study results, *Chemosphere*, 29, 523-535.

Lahaniatis, E. S., W. Bergheim, and C. Rainer, 1989, Hazardous halogenated substances formed during combustion processes, *Toxicol. Environ. Chem.*, 20-21, 501-506.

Mackay, D., W. Y. Shiu, and K. C. Ma, 1992, Illustrated handbook of physical-chemical properties and environmental fate for organic chemicals, Vol I, Lewis Publishers, Chelsea, MI.

Mahan, J., 1999, Ashtabula River Partnership, Coordinator, Telephone call 22 February. Niagara River Toxics Management Plan, Progress Report: Part II, 1997, [www.hazmatmag.com/library/nrtmp/niagara\\_3.html](http://www.hazmatmag.com/library/nrtmp/niagara_3.html).

Pugsley, C. W., P. D. N. Hebert, G. W. Wood, G. Brotea, and T. W. Obal, 1985, Distribution of contaminants in clams and sediments from the Huron-Erie corridor. I-PCBs and octachlorostyrene, *J. Great Lakes Res.*, 11, 275-289.

St. Clair River Remedial Action Plan, 1997, [www.geomatics.com/stclairRAP/update.htm](http://www.geomatics.com/stclairRAP/update.htm).

Schulman, E. M. and H. Klingele, 1985, Sources of polychlorinated styrenes in the Great Lakes and their tributaries, Final report for the USEPA under grant number R00-5764-01.

Syracuse Research Corp, Environmental Science Center, Estimation Software, 1999, <http://esc.syrres.com/cgi-bin/odbic.exe/~templates/kowdemotp.htm>.

Vogelsang, J., 1986, Hexachlorobenzene, octachlorostyrene and other organochlorine compounds in waste water from industrial high-temperature processes involving chlorine, *Z. Wasser-Abwasser-Forsch.* 19, 140-144.

Westberg, H. B., A. I. Selden, and T. Bellander, 1997, *Appl. Occup. Environ. Hyg.*, 12, 178-183.

## **Appendix III**

### **Figures 1 - 12**

#### **Status and Trends of OCS In Great Lakes Media**

Figure 1. First order decline (10% per year decrease) on linear XY plot

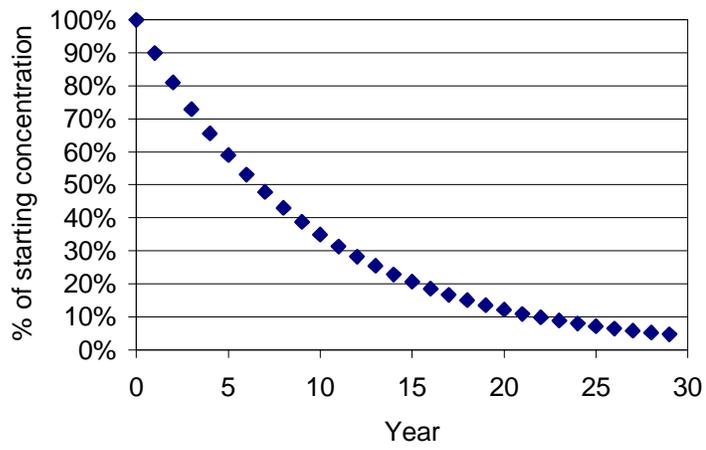


Figure 1. A first order decline graphed on the more usual linear XY plot.

Figure 2. First order decline (10% per year decrease) on semi-log XY plot

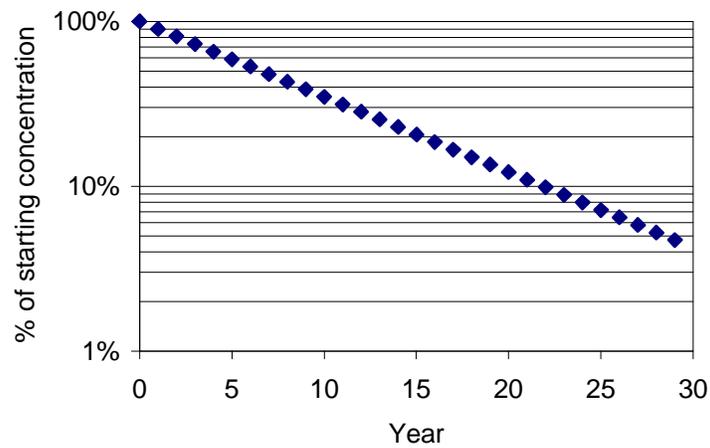


Figure 2. The same first order decline plotted on semi-log paper.

Figure 3. Location of Herring Gull colonies on the Great Lakes.

Figure 4. Yearly % Decline vs. Colony

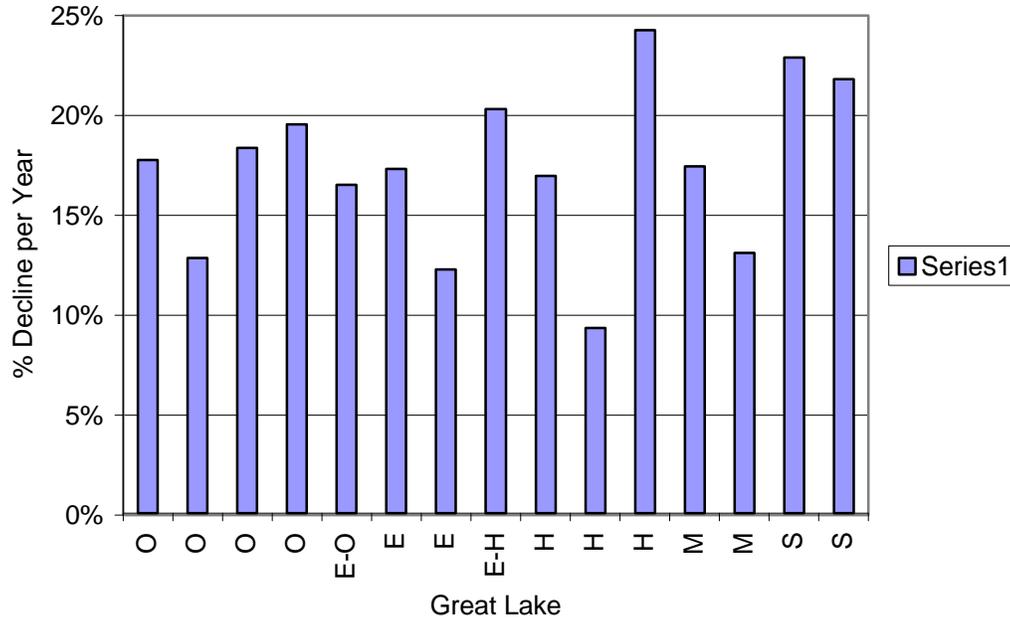


Figure 4. Best-fit % declines per year estimated from linear regression. Colonies are plotted in the following order which generally follow an east-west gradient: Lake Ontario colonies in the order of Strachan Island, Snake Island, Leslie Spit, Hamilton Harbor, Niagara River, Lake Erie colonies in the order of Port Colborne and Middle Island, Detroit River, Lake Huron colonies in the order of Channel Shelter Island, Chantry Island, and Double Island, Lake Michigan colonies with ?/ and ??, and Lake Superior colonies Agawa Rock and Granite Island.

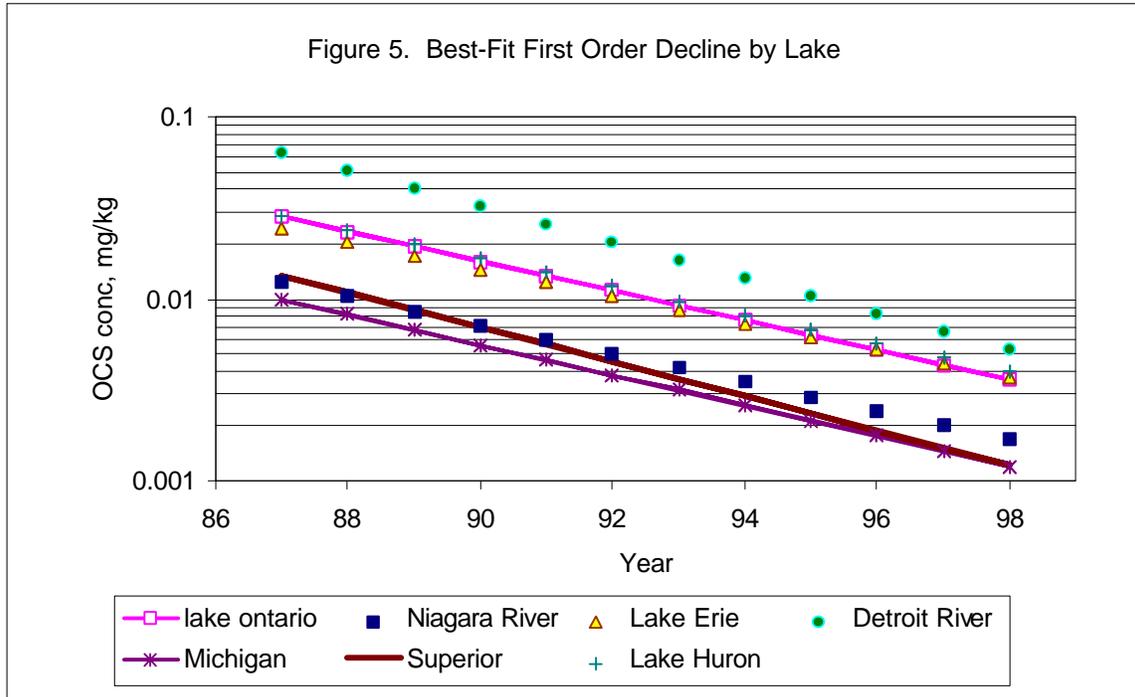


Figure 5. Best-fit declines of OCS in herring gull eggs grouped by Lake and Connecting Channel.

Figure 6. Mean OCS (94-98) versus Lake

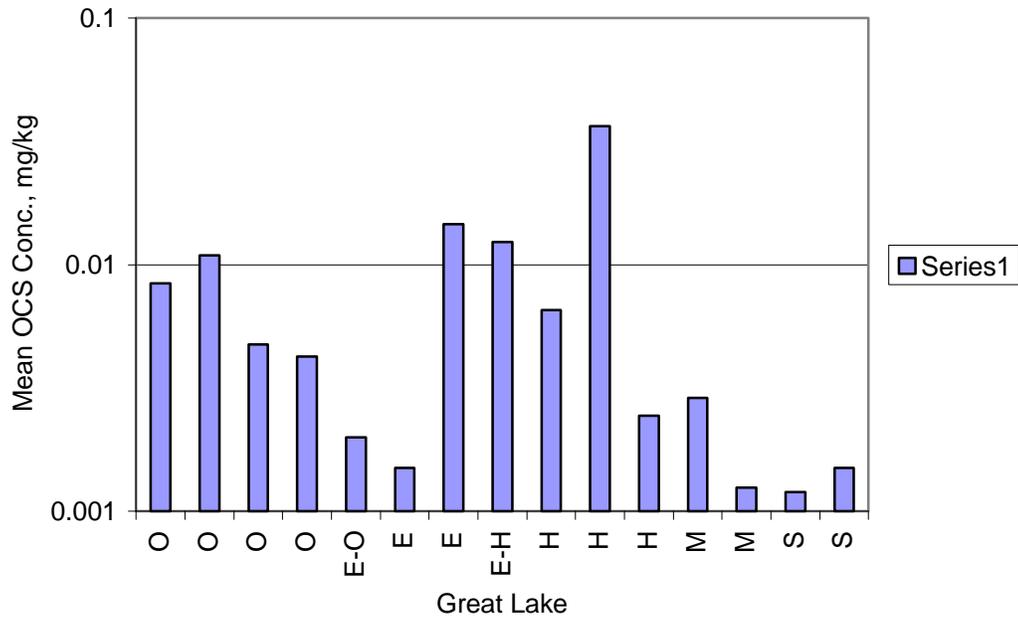


Figure 6. Most-recent (1994 to 1998) concentrations of OCS by colony. Sequence of colonies same as in Figure 6.

Figure 7. OCS in Spottail Shiners in Lower Niagara River (MOE Data)

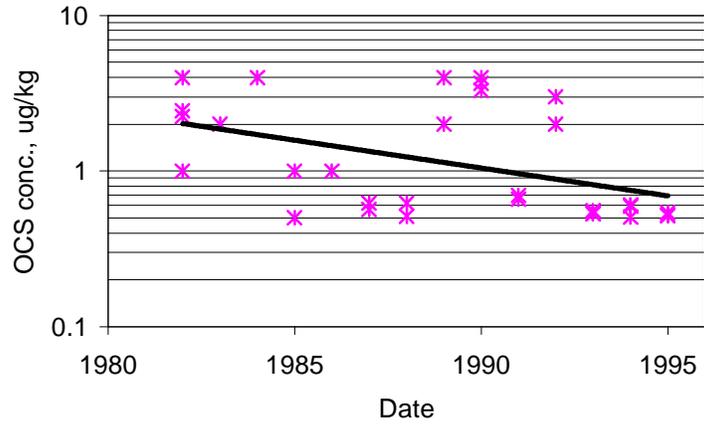


Figure 7. OCS concentrations in spottail shiners from the lower Niagara River. Values less than detection limit (1 ug/kg) set equal to 0.5 ug/kg. Some data points have been altered somewhat (e.g., 10% to 20%) to aid viewing when more than one sample on the same date had the same concentration.

Figure 8. Estimated whole water concentrations of OCS at Niagara-on-the-Lake

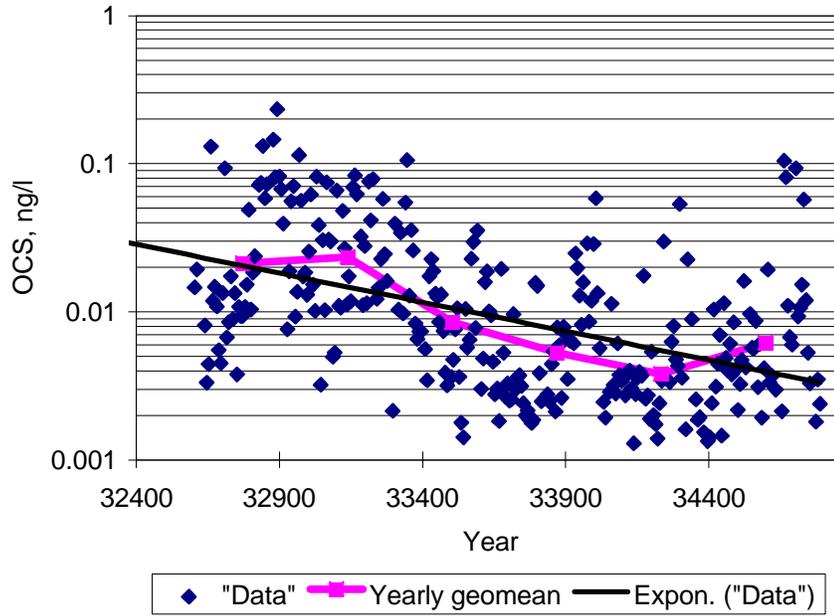


Figure 8. Concentrations of OCS in Niagara River water at the mouth of the Niagara River.

Figure 9. OCS in Suspended Sediments in St. Clair River at Port Lambton

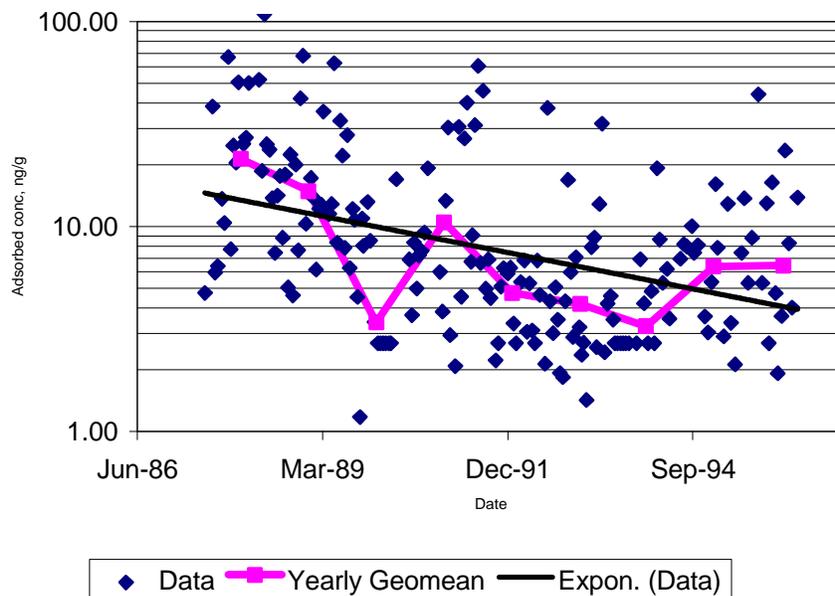


Figure 9. Concentrations of OCS on suspended particle from the St. Clair River at Port Lambton.

Figure 10. OCS Concentrations in Niagara Bar Sediments

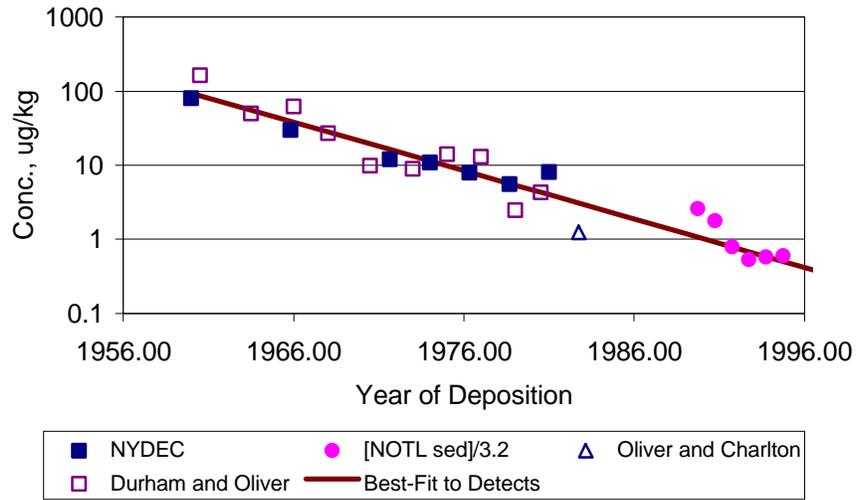


Figure 10. Concentrations of OCS in sediments from Lake Ontario. For the NYDEC sample, all analyses for sediments deposited between 1981 and 1995 were below the detection limit, but these data are not depicted on this graph.

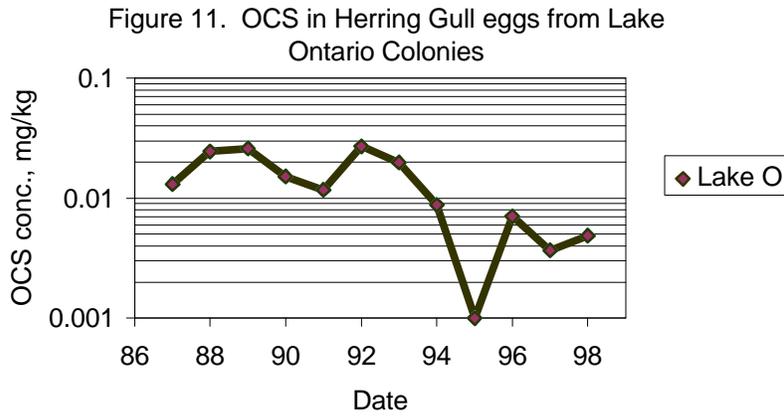


Figure 11. Mean concentrations of OCS in gull eggs from the four Lake Ontario gull egg colonies (Strachan Island, Snake Island, Leslie Spit, and Hamilton Harbor.)

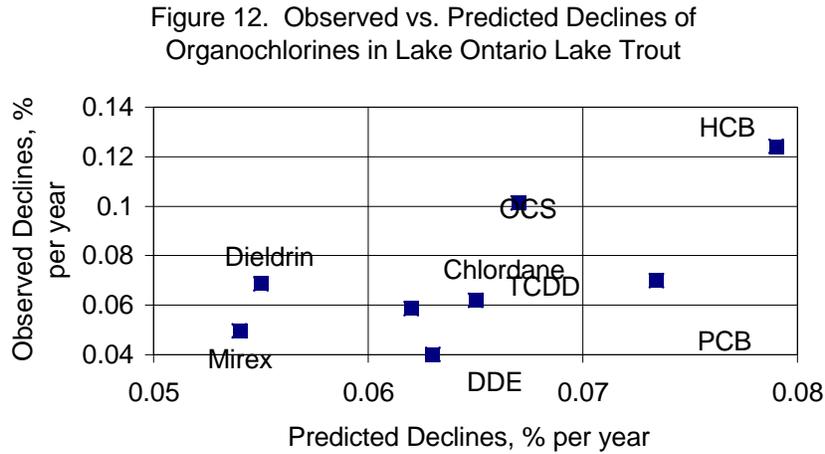


Figure 12. Observed versus predicted declines of different organochlorines in Lake Ontario lake trout. Predicted rates of decline (per year) from the Endicott et al. model (1992a) after cessation of loading. Observed rates are best-fit declines observed in lake trout, data from Huestis et al. (1996).

## Appendix IV

### Bibliography Status and Trends of OCS in Great Lakes Media

- Battelle. 1998. Great Lakes Binational Toxics Strategy Octachlorostyrene (OCS) Report: A Review of Potential Sources. Prepared by Battelle Memorial Institute for United States Environmental Protection Agency Great Lakes National Program Office. Draft. December 22, 1998
- Biberhofer, J. 1995. Concentrations and Loadings of Trace Organic Compounds Measured in the St. Lawrence River Headwaters at Wolfe Island, 1989-1993. Prepared by J. Biberhofer Environment Canada, Environmental Conservation Branch, Ontario Region, Ecosystem Health Division, Report No. EHD\ECB-OR\95-03\1. August 1995.
- Bishop, C. A.; Weseloh, D. V.; Burgess, N. M.; Struger, J.; Norstrom, R. J.; Turle, R.; Logan, K. A. 1992. An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988). Technical Report Series No. 152, Canadian Wildlife Service; Ontario Region.
- Chan, C.H. 1993. St. Clair Head and Mouth Water Quality Monitoring, 1987-89, Water Poll. Res. J. Canada **28**(2):451-471.
- Dann, T. 1997. Monitoring of persistent toxic substances in Ontario Great Lakes Basin. Report AAQD97-1 of the Analysis and Air Quality Division of the Environmental Technology Centre
- Debusk, T.A.; B. Laughlin Jr.; L.N. Schwartz. (1996) Retention and Compartmentalization of Lead and Cadmium in Wetland Microcosms, Water Resources **30**(11):2707-2716.
- Durham, R.W. and Oliver, B.G. (1983) History of Lake Ontario Contamination from the Niagara River by Sediment Radiodating and Chlorinated Hydrocarbon Analysis, J. Great Lakes Res. **9**(2): 160-168.
- Endicott, D. D.; Richardson, W. L; Kandt, D. J. 1992. MICHTOX: A Mass Balance and Bioaccumulation Model for Toxic Chemicals in Lake Michigan, US. EPA Large Lakes Research Station, Grosse Ile, MI, 1992.
- Endicott, D.D., , W. L. Richardson, T. F. Parkerton, and D.M. DiToro. 1992. A steady state mass balance and bioaccumulation model for toxic chemicals in Lake Ontario. Report to the Lake Ontario Fate of Toxics Committee, Environmental Research Laboratory, Duluth, MN.

- Hebert, C. E., J. L. Shutt, and R. J. Norstrom, 1997. Dietary changes cause temporal fluctuations in PCB levels in herring gull eggs from Lake Ontario. In press, Environ. Sci. Tech.
- Huestis, S.Y., Servos, M.R., Whittle, D.M., and Dixon, D.G. (1996) Temporal and age-related trends in levels of polychlorinated biphenyl congeners and organochlorine contaminants in Lake Ontario lake trout (*Salvelinus namaycush*), J. Great Lakes Res. **22**(2):310-330.
- Kuntz, K.W. 1984. Toxic Contaminants in the Niagara River, 1975-1982. Technical Bulletin No. 134, Inland Waters Directorate, Ontario Region, Burlington, Ontario.
- Kuntz, K.W. 1997. The Niagara River Data Interpretation Group Report: Joint Evaluation of Upstream/Downstream Niagara River Monitoring Data for the Period April 1994 to March 1995. Report to the River Monitoring Committee. Final. June 16, 1997.
- Kuntz, K.W. and M. Hanau. 1995. The Niagara River Data Interpretation Group Report: Joint Evaluation of Upstream/Downstream Niagara River Monitoring Data for the Period April 1992 to March 1993. Report to the River Monitoring Committee. Final. January 16, 1995.
- Kuntz, K.W. and M. Hanau. 1994. The Niagara River Data Interpretation Group Report: Joint Evaluation of Upstream/Downstream Niagara River Monitoring Data for the Period April 1991 to March 1992. Report to the River Monitoring Committee. Final. May 17, 1994.
- Kuntz, K.W. 1989. The Niagara River Data Interpretation Group Report: Joint Evaluation of Upstream/Downstream Niagara River Monitoring Data for the Period April 1987 to March 1988. Report to the River Monitoring Committee. Final. May 10, 1989.
- NYDEC. 1996. Lake Ontario Sediment Survey, 1995 Sediment Coring Results. Draft.
- Oliver, B.G. and Niimi, A.J. (1988) Trophodynamic Analysis of Polychlorinated Biphenyl Congeners and Other Chlorinated Hydrocarbons in the Lake Ontario Ecosystem, Environ. Sci. Technol. **22**(4):388-397.
- Petit, K. E., C. A. Bishop, D. V. Weseloh, and R. J. Norstrom. 1994. An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1989-1992). Technical Report Series No. 193., Canadian Wildlife Service.
- Rasmussen, J. B., D.J. Rowan, D. R. S. Lean, and J. H. Carey 1990. Food chain structure in Ontario lakes determines PCB levels in lake trout and other pelagic fish. Can. J. Fish Aquat. Sci. **47**: 2030-2038.

- Rowan, D.J., and Rasmussen, J.B. 1992. Why Don't Great Lakes Fish Reflect Environmental Concentrations of Organic Contaminants? An Analysis of Between-Lake Variability in the Ecological Partitioning of PCBs and DDT. Journal of Great Lakes Research, Vol. 18, No. 4, p. 724-741.
- Smith, D.W. 1995a. Synchronous response of hydrophobic chemicals in Herring Gull eggs from the Great Lakes. Environ. Sci. Technol. 29: 740-750.
- Smith, D. W. 1995b. Current and Near Future Trends of PCBs in the Great Lakes. Report completed for the PCB panel of the Chemical Manufacturers Association. Available from CMA, Washington, D. C.
- Suns, K. and Hitchin, G.G. 1992. Species-specific Differences in Organochlorine Accumulation in Young-of-the-Year Spottail Shiners, Emerald Shiners, and Yellow Perch, J. Great Lakes Res. **18**(2):280-285.
- Suns, K., Craig, G.R., Crawford, G., Rees, G.A., Tosine, H., and Osborne, J. 1983. Organochlorine Contaminant Residues in Spottail Shiners (*notropis Hudsonius*) from the Niagara River, J. Great Lakes Res. **9**(2):335-340.
- Suns, K., Hitchin, G.G, and Toner, D. 1993. Spatial and temporal trends of organochlorine contaminants in spottail shiners from selected sites in the Great Lakes. J. Great. Lakes. Res. 19: 703-714.