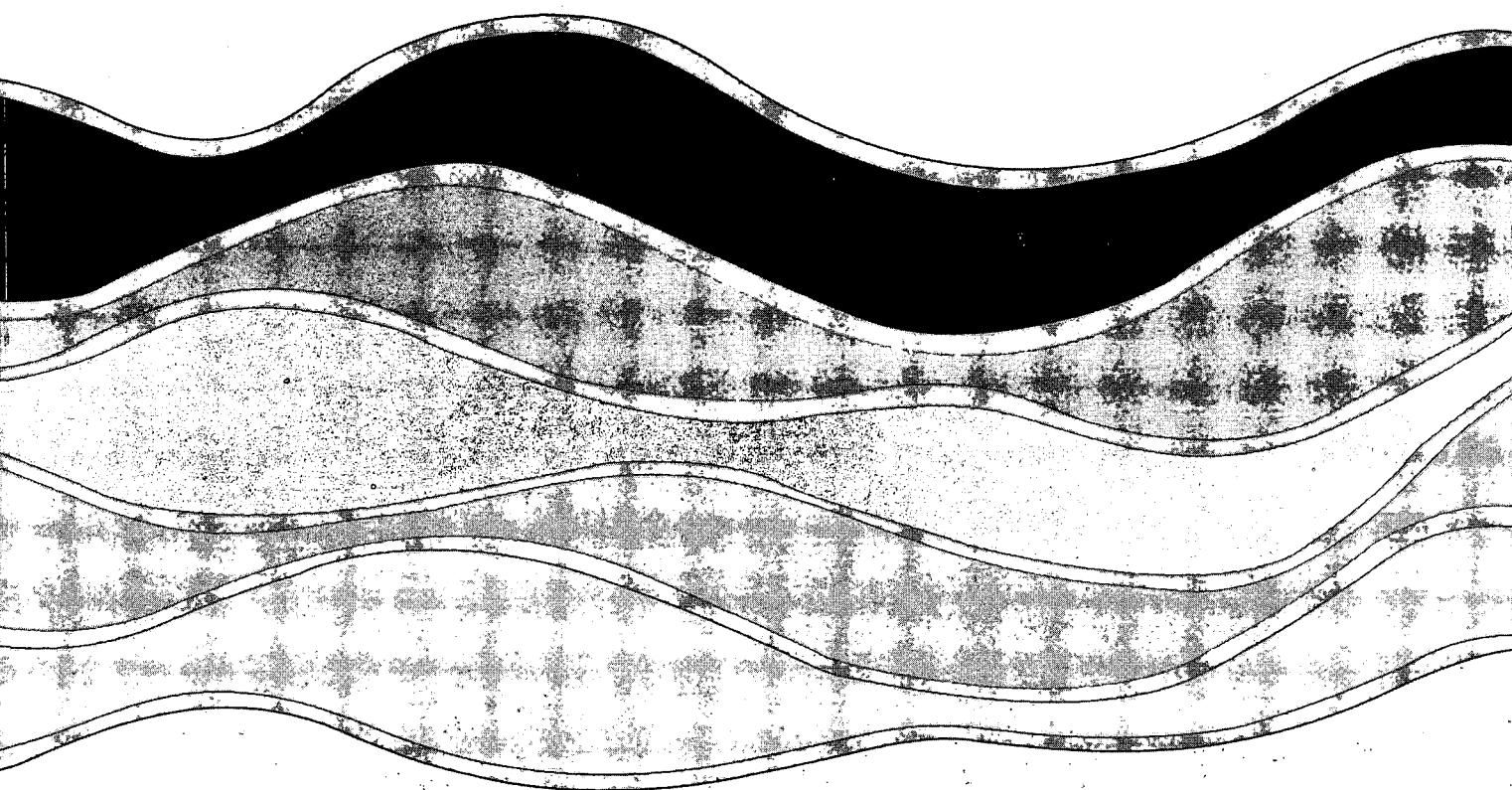
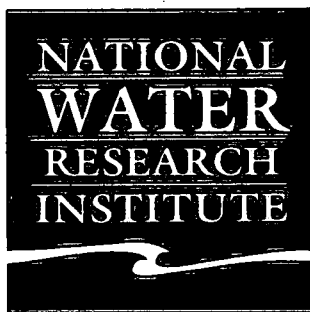


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HIGHLIGHTS OF THE
LAKES RESEARCH BRANCH
April-September 1993

LRB Contribution No. 93-30

HIGHLIGHTS
of the
LAKES RESEARCH BRANCH
April - September 1993

Compiled and edited by
R.J. Allan and E.M. Kerr
Lakes Research Branch
National Water Research Institute

NWRI Contribution No. 93-30
April to September 1993

MANAGEMENT PERSPECTIVE

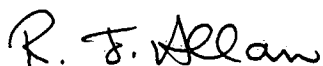
The Lakes Research Branch compiles highlights each month. These are distributed within the Institute and used to provide very selected input of highlights to our parent organisations. However, they contain a wealth of information, selected in the Director's office, and prepared in a reader friendly way at a level understood by most people. Beginning in Fiscal 1993-94, we have decided on a more general release of these in this report form at six month intervals.

SOMMAIRE A L'INTENTION DE LA DIRECTION

La Direction de la recherche sur les lacs prépare à chaque mois une compilation de faits saillants. Ceux-ci sont distribués au personnel de l'Institut, et utilisés pour le rapport des faits saillants destiné à informer les groupes connexes. Ces faits saillants contiennent une mine d'information. Ils sont sélectionnés par le bureau du directeur, et rédigés de façon à être compris par le grand public en général. Pour ces raisons et ce à compter du début de l'année fiscale 93-94, nous avons l'intention de publier ceux-ci sous la forme de rapport semi-annuel.

PREFACE

The transmittal of research results is always difficult. Most people, even scientists outside their own discipline, have difficulty reading the scientific literature and seeing how it fits into issue resolution or policy development. On the other extreme, if the complex science is simplified too much, it can almost appear trivial or obvious. Each month the Lakes Research Branch prepares monthly Highlights in what we feel is a compromise between the above two extremes but closer to the latter. These Highlights do not, of course, represent all that we do in the Branch because they are quite selective. They do, however, give a flavour of our scope of activities and how they fit into issues familiar to the public or other interested groups. We feel that when compiled as here over six months they form an interesting and readily readable report in their own right. We thus decided to begin in fiscal year 1993/94, to release these as six month reports to a wider audience interested in our recent and ongoing activities.



Dr. R.J. Allan
Director
Lakes Research Branch
National Water Research Institute

LAKES RESEARCH BRANCH

MONTHLY REPORT

APRIL 1993

Physical Limnology Pays Off

Physical Limnology studies have shown the major current patterns in the Great Lakes and the fundamental annual warming and cooling cycles. This knowledge is useful for economic purposes such as the proposal to air condition Toronto with Lake Ontario water. Farrell Boyce has recently provided information to the Toronto law firm of Outerbridge and Miller concerning the physical conditions, drift rates of floating objects, at the time of a boating accident in May, 1988. This is an example of expertise and information at NWRI made directly available to the interested public.

Hamilton Harbour RAP

The Hamilton Harbour Remedial Action Plan (RAP) Stakeholders and Technical Team submitted their Plan for rehabilitating the Hamilton Harbour to the federal and provincial environment

ministries in February 1993. The Plan represents a community consensus on the principles, goals and recommendations for restoring or enhancing beneficial water uses of the harbour. These uses include industrial, marine, recreational and environmental aspects.

The Technical Team composed of scientists and engineers from several agencies, developed information on environmental conditions, on the source of problems and on the options available to correct these problems. The options were debated at Stakeholder meetings and workshops. The choices and priorities selected comprise the Plan which was assembled by the Technical Team.

The Plan (Stage 2 of the RAP) was presented to the environment ministries with an updated background report (Stage 1 of the RAP - second edition).

Implementation of the plan will be coordinated through the Bay Area Implementation Team (BAIT) which has already been formed. Auditing of the progress of the RAP will be facilitated and formalized by the Bay Area Restoration Council (BARC). BARC has

also taken up a major role in providing information and educational materials to schools and the public-at-large concerning the details and the significance of the RAP.

Scientists of NWRI and other agencies will be regularly called upon to develop and interpret information about the Harbour that reflects the progress of the RAP as it was implemented.

RAP Advice

Ecosystem management decisions based on environmental research are often made on the weight of evidence available. Advice on decisions based in environmental research contains judgements on reliability, probability, and importance. Limited resources do not always allow inclusion of corroborative techniques such as computer modeling. It is important to continually determine whether decisions are compromised and the best way to improve them. Murray Charlton wrote a review of an IJC, SAB draft document on the hypothetical need for modeling as a necessity for decision making in RAP Areas. Important experience gained locally in the Hamilton Harbour RAP was related. (request of Exec Director, NWRI).

Hamilton Harbour DataBase

Electronic water quality profiling developed at NWRI has been used in Hamilton Harbour for RAP research. Although measurements are streamlined, electronic methods can produce huge quantities of data which must be summarized, validated and checked. Fausto Chiochio has completed the assembly of a geo-referenced database that incorporates all of Hamilton Harbour's temperature profile, dissolved oxygen profile, and water sample data from 1983 to 1992. These data will now be used to produce graphical and numerical output describing the oxygen situation and allowing fine detail to be incorporated into models at NWRI.

RAP Physics: Synthesis and Proposal

A number of physical studies on Hamilton Harbour have resulted in many publications and in some cases masses of un-analyzed data resulting from instrumentation development. There is a need for a synthesis of present knowledge combined with recommendations on further use of the data and the need for further field measurements. Farrell Boyce, after soliciting inputs from colleagues, is completing the report/proposal drafted in October 1992 (Boyce, Charlton, Hamblin, and Tsanis 1992, Proposal: "Physical Study in Hamilton Harbour"). The document puts forward a list of

key physical research questions that relate to the ecosystem management of Hamilton Harbour and reviews the extent to which these questions can be answered by existing data and models.

Spanish Harbour RAP

F. Rosa attended the Spanish Harbour RAP meeting in Dorset, Ontario, on 21 April 1992. He presented his response to the Federal and Provincial Stage I reviews, and participated on planning of the draft of Stage II document. Based on the results of the SWI Project study at the Spanish River mouth, recommendations were made to the RAP team to include the Whalesback Channel of the North Channel into the Spanish Harbour AOC.

NWRI-OMEE-University Cooperation

Green Plan funding to universities as well as the GLURF has resulted in more contact with universities. Presently, universities lack data. Government data on RAP programs are now becoming available. Murray Charlton consulted with and sent Hamilton Harbour data to J. McMahon at McMaster University for modeling exercises funded by OMEE. These data were published in NWRI report format last year. Transmission of the data is another example of the growing cooperation between OMEE, McMaster U, and NWRI brought about by the RAP program.

NWRI Science to the Public

NWRI often receives requests to provide speakers for organizations who want first hand information on environmental questions. Murray Charlton presented two talks on "State of The Great Lakes and The Hamilton Harbour Remedial Action Plan" to the Burlington Central Lions Club and to The Sertoma Club of Burlington. These talks, to action oriented service clubs, highlight the successes of the GLWQA to date, the remaining problems, their local causes, Remedial Action Plan strategies, Clean-Up Fund activities, Pollution Prevention concepts, and a sample of research input to decision making.

Dr. John P. Coakley gave an invited presentation on "The postglacial evolution of Hamilton Harbour" to the Hamilton Geological Society. He spoke on the significance of Hamilton Harbour cores in unravelling the pre-historical evolution of Hamilton Harbour from about 10,000 BC to the present.

Dr. Jerome Nriagu delivered an invited lecture to the Environmental Studies Program at Trent University on lead in the environment. He discussed the history of lead in gasoline, especially the discovery of the anti-knock properties of TEL and the public debate following introduction of leaded gasoline into the market place. He

showed the relationships between ambient environmental lead levels and consumption of leaded gasoline between 1940 and 1970 and concluded with a discussion on the effects of the introduction of lead-free gasoline on lead levels in various environmental media.

Dr. Efraim Halfon and student Ken Birch completed a three-dimensional animation of Hamilton Harbour oxygen and temperature data, collected by M.N. Charlton. In this visualization, the harbour is displayed as three-dimensional object, is rotated and viewed from several locations. The visualization is available on video tape.

Eutrophication on the Prairies

Prairie Lakes face eutrophication effects from natural sources of phosphorus as well as from agricultural loading. In their reactions to excessive nutrient loadings, the eutrophic prairie lakes show a remarkably diversity which may provide clues for future management efforts. Dr. Phil Manning is collaborating on a study of the causes of eutrophication of Prairie lakes. Following a request from Prof. E.E. Prepas, University of Alberta, Edmonton, the analysis has begun, using NWRI equipment and expertise, of the forms of iron and phosphorus in the bottom sediments of Lofty Lake, Alberta. This successful program of research collaboration, which has been on-going since 1985, further confirms

the value of the NWRI Mössbauer facility in determining active forms of iron and their role in controlling the availability of phosphorus.

Why are Fish so Contaminated?

Ecosystem scale research is expensive and labour intensive. To solve this problem a federal/provincial government program was interfaced with university collaboration from Dr. William Taylor of University of Waterloo, Drs. David Lasenby and Brendan Hickie of Trent University and Dr. Frances Pick of University of Ottawa. Dr. Ellen Bentzen of Trent University, working with Dr. David Lean (NWRI), coordinated the work. The project was called FACILE (Fate of Atmospheric Contaminants in Lake Ecosystems). The aim of the program was to develop simple relationships to predict fish contaminant levels. The research team hoped to find out why some remote lakes contain fish just as contaminated with the same suite of compounds as fish in Lake Ontario while other nearby lakes have fish with levels near detection limits. Twenty-five inland lakes and 5 stations in Lake Ontario, including Hamilton Harbour and the Bay of Quinte were investigated. Limnological features and organo- chlorine contaminants were measured in water, suspended particulates and zooplankton. Values for fish contamination were previously available (MOE). Surveys were conducted in spring, summer and fall 1992. We hypothesize that the concentration in the water is similar in all lakes receiving only atmospheric

inputs but it is the bioconcentration pathways through contrasting food webs that cause greater contamination in fish from some lakes. Critical variables include intensity of planktivory, lipid level and nutrient concentration. Support for graduate student collaboration was from NSERC and GLURF, and post doctoral support for Ellen Bentzen from MOE). The ultimate aim of this work is to predict the contribution of atmospheric organic pollutants to the Great Lakes. Some of the results have been published and over 10 presentations made at symposia and workshops (mostly by Bentzen or Lean). The results indicate the effect of changing food web structure due to abundance of planktivorous fish (eg. smelt and alewife) and invertebrates such as *Mysis relicta* on contaminant bioconcentrations. The food webs are modified by lake management practices such as sport fish stocking and nutrient controls and inadvertent introductions of exotic species. Thus, this research will be important in deciding just how much control we may have over the fish contamination problem.

International Technology

Mike Fox was sent on development leave at the invitation (and expense) of the National Institute of Water and Atmospheric Research Inc., Water Quality Centre in Hamilton New Zealand. Mr. Fox is participating in an international effort to correlate the

biological effects of sediment contaminants with analytical results in order that the importance of deposits may be judged.

Canada/Germany Strategic Planning Workshop

Several of the Sediment-Water Interaction (SWI) Project staff members participated in the Canada/Germany Strategic Planning Workshop held at CCIW, April 5 to 7. Alena Mudroch presented a review of the research activities and a 3 to 5 years strategic planning for the SWI Project of Lakes Research Branch, NWRI; Dr. Tom Murphy presented a review of the in situ contaminated sediments treatment technology developed at the NWRI; and Alex Zeman presented the research of the development of in situ capping of fine-grained contaminated sediments at the NWRI. As a result of the Workshop, cooperative projects are being developed between German and SWI Project scientists on 1) speciation and remediation of mercury in sediments in river Elbe, Red Rock AOC, and abandoned gold mining sites in Canada; 2) flocculation and remediation of phenol- and heavy metals contaminated sediments; and 3) co-precipitation /adsorption of contaminants and nutrients with calcium carbonate in oligotrophic lakes: Lake Stechlin in Germany and Lake Ontario in Canada; 4) research involving sediment guidelines/sediment toxicity and related sediment biogeochemistry. The proposals for the cooperative projects have been prepared by the German

scientists and will be send for a review and comments to participating scientists at the SWI Project.

Manuscripts and Reports

A manuscript entitled "Trace Metals and Sampling Methods in Cloud Waters and Precipitation" (H.K.T. Wong, C.M. Banic and W.M.J. Strachan) describes the results of a trial sampling while flying in clouds to determine if cloud water or below cloud scavenge is responsible for deposits. The manuscript has been submitted for inclusion in the proceedings of the 9th International Conference on Heavy Metals in the Environment to be held in September 1993 in Toronto.

Dr. C.R. Murthy and co-authors from Sweden and Finland completed a report on the Gulf of Bothnia physical transport experiments undertaken in 1991.

LAKES RESEARCH BRANCH

MONTHLY REPORT

MAY 1993

Treatment of Contaminated Sediments in Hamilton Harbour

Under contaminated sediments remediation studies by Dr. Tom Murphy, six tones of calcium nitrate were added to the sediments of the Dofasco boatslip, Hamilton Harbour, to enhance biodegradation of organic contaminants. The new injector used in the treatment and designed and built at the NWRI was three times as efficient as the earlier model. Dofasco supported the treatment with the assistance of a labourer and air monitoring equipment. The project is primarily funded by the Great Lakes Cleanup Fund.

Advice on Habitat Restoration to Hamilton Harbour RAP

Proposals to enhance fish habitat entail building rock structures in the nearshore of the Bay. The effects of these on currents and the build-up of sediment is an uncertainty. Farrell Boyce provided advice to the Bay Area Restoration Council concerning the numerical simulation of

Harbour circulation in the embayments that will be created by proposed habitat restoration structures.

Hamilton RAP Research

Farrell Boyce has developed a physics field program for Hamilton Harbour that will help to coordinate the work of several Harbour investigators both within and outside NWRI (Drs. Paul Hamblin and John Coakley, NWRI; Dr. I. Tsanis, McMaster, and possibly others). This program is an offshoot of the larger review and study plan for Harbour circulation and mixing now under way (see April report).

Hamilton Harbour Exchange with Lake Ontario

A review and analysis of existing time-series on currents within the Burlington Canal will form the starting point for research by Dr. Paul Hamblin into exchange flows between Hamilton Harbour and Lake Ontario. This

study, part of a larger project of modelling circulation and sediment transport in Hamilton Harbour and western Lake Ontario, is being funded by the Great Lakes Cleanup Fund.

Consistent transport patterns were identified by Dr. John Coakley and Tonny Bachtar (McMaster University) for coprostanol and isotopes of carbon and nitrogen in bottom samples taken around the Burlington Skyway STP. The dominant pattern of transport was found to be southward, with a secondary plume directed northwestward to westward. These results are in good agreement with surface water circulation patterns obtained using the numerical model of Dr. I. Tsanis at McMaster University. Discussions are being held with Dr. Tsanis to run the model in "time-integrated" mode for a simulation more realistic of sediment transport and deposition.

Sediment (Contaminant) Resuspension in Lake Ontario

The contaminants in Lake Ontario are largely stored in sediments. We know, however, that the sediments can be resuspended by currents even at great depths and the contaminants can be reintroduced into the water and biota. For modeling the fate of contaminants, information on the spatial extent of the process is needed. Murray Charlton and co-workers have installed sediment traps in Lake Ontario on a north south transect covering stations from deep to shallow. Samples are retrieved monthly and analysed for the amount of deposition and resuspension as well as the concentration of various contaminants. The results will be extrapolated to the whole lake and compared with Murray Charlton's

earlier studies to detect changes in contaminant status.

Hudson/James Bay Research

At the request of D. Egar, Director-General of Environmental Conservation and Protection, Dr. John P. Coakley attended a meeting organized in Ottawa by Fisheries and Oceans Canada to review research proposals relating to cumulative impacts of hydroelectric power development in the region. The 34 proposals ranged from mercury contamination of downstream areas, to phytoplankton and fish perturbations, to marine mammals.

The Sediment Phosphorus Problem in the Bay of Quinte

The Bay of Quinte is shallow and, unlike the surface waters of lakes, the phosphorus content of the water tends to increase in the summer. The amount of summer phosphorus increase has responded somewhat to nutrient controls but it is apparent that the main source is stored in sediments. It is critical to RAP plans to know the original source of the phosphorus and the duration over which the phenomenon is likely to be a problem. The degree to which in-place sediments return phosphorus to the eutrophic waters of the Bay of Quinte, over the summer, is now better defined as a result of sampling and calculations by Dr. Phil Manning. Importantly, the rate of diffusional reflux increases from June through September,

such that in late summer, reflux accounts for more than 75% of the total input of available phosphorus. (Other sources are riverine P and sewage plant P). Thus, the in-place sediments, although not the main source of phosphorus to the Bay, represent the main source of bioavailable phosphorus during the critical summer period. Remedial action to further control the effects of eutrophication will hinge on reducing the pool of phosphorus within the in-place sediments. This requires further reductions in the loadings of (a) phosphorus from the sewage treatment plants and (b) of particulate matter from the rivers.

PAHs from Trees

Toxic properties of man-made PAHS are a concern in several RAP sites. In sediments at the Red Rock & Saulte Ste. Marie RAP sites Mike Fox and his colleagues have reported very high concentrations of retene. This naturally occurring PAH derives from tree resin acids. It is only found in large amounts in anoxic sediments near pulp and paper mills. The pathways, fate and toxicological significance of this compound are of considerable interest to the area RAPs. Mike has found that work on this topic is quite advanced in New Zealand. Researchers at NIWA and the University of Waikato have explored the complex chemical pathways involved in the formation of retene in reducing sediments. They have found that accumulations of retene and related compounds in mussels in the Tarawera River downstream of a New Zealand pulp and paper mill far exceed the accumulation of chlorinated organic compounds. Further collaboration is planned.

Relationship Between Trophic Status and Contaminants

Dr. Micheline Hanna is beginning a study of phytoplankton biology in Amituk Lake NWT. Samples will be collected weekly as a component of Dr. Dennis Gregor's Green Plan study of Arctic contaminants. The abundance and species' lipid content determine contaminant uptake in algae. From Mid-June to Mid-August the phytoplankton population will be enumerated and compared to southern populations as a way of predicting the potential to mobilize contaminants in both ultra oligotrophic and eutrophic systems

Reliable Levels for Trace Metals in Lakewater

The mobile "clean" laboratory was finally received in working order. All laminar flow and air filtration systems are installed and testing, following exhaustive cleaning, demonstrated that the facility achieves the desired Class-100 conditions. It will be used in FY 1993/4 field work to generate reliable trace metals levels in several Great Lakes and in lakes in the Sudbury region.

Paleoclimatic Database

Dr. Denis Delorme participated in a NOAA (USA) invitational workshop which discussed the creation of a paleoclimatic data base focussed on ostracodes and diatoms. A consensus was reached that sufficient data

existed to develop such a database; funding will be sought to do this.

Subaqueous Mining Tailings Disposal Research

In cooperation with the Ontario Ministry of Natural Resources and Mattabi/Sturgeon Lake Mines, Sediment/Water Interaction Project staff members conducted field research at Ignace, Ontario. They met with the mine's managers and their Environmental Coordinator, to visit the past base-metal mining site and plan logistics for future field research. Strategic sites within the mining complex were chosen on the basis of environmental impact. Different samples were collected and field instrumentation was deployed for continuous monitoring of physico-chemical parameters in a man-made reservoir for disposal of acid drainage generating mine tailings. These sites will become the focus of future research of the feasibility of subaqueous disposal of acid drainage generating mine tailings and waste rock.

Biological Significance of Sediment Contaminant Concentrations

A growing awareness of the importance of sediment organic carbon normalised concentrations and pore water concentrations is leading to more meaningful reporting of data. Mike Fox worked with NIWA and other visiting scientist colleagues to explore and refine these concepts. Equilibrium partitioning theory shows that pore water concentrations of contaminants are important

predictors of sediment toxicity to many benthic organisms. The analysis of hydrophobic organic contaminants in pore water is a considerable challenge due to small sample sizes and low concentrations. High levels of sediment organic carbon (most of the Great Lakes RAP sites) leads to lower pore water concentrations and lower toxicities. The nature or source of the organic carbon appears to be much less important than the amount. Thus, sediment carbon from eutrophication processes can alter the toxicity of sediment contaminants.

Technology Transfer

Mike Fox introduced a recent Environment Canada patented technique - Microwave Assisted Process (MAP™) and developments of this technique by Dr F. I. Onuska (RAB) to the NIWA lab in New Zealand. Mike worked with Dr Onuska and his N.Z. colleagues to extend the application of microwave extraction to PAHs in sediments. This technique has the potential to be time and cost effective while using very small amounts of solvents. Collaboration on this work is continuing.

NWRI-New Zealand Cooperative Research

Mike Fox returned from seven weeks as a visiting scientist at the invitation of the National Institute of Water & Atmospheric Research Ltd (NIWA) in Hamilton New Zealand. The topic of the work was PAHs in sediments and together with NIWA researchers and other visiting scientists Mike focussed on three areas of PAH research.

Cooperative Zebra Mussel Study Begins at NWRI

Murray Charlton reached agreement with researchers at the University of Guelph which will allow use of the NWRI site and trailer accommodation for Zebra Mussel research. Useful information of mussel larvae numbers will be forthcoming which will give perspective on the potential of the mussels to help clear up Hamilton Harbour.

International Cooperation with India and Russia

Two workshops dealing with coastal marine/estuarine pollution have been organized by Dr. C. Raj Murthy to be held this August in India. Dr. Murthy's visit will be sponsored by UNDP (United Nations Development Project). He has also been invited to join the editorial committee for the proceedings of the International Lake Ladoga Symposium which will be published in 1994 in Hydrobiologia.

Planned Cooperation with Japan

Alena Mudroch was contacted by the Institute of Technology, Shimizu Corporation, Tokyo, to prepare a proposal for a cooperative study between the Institute of Technology and Sediment/Water Interactions Project team. The three years-long study will involve research for development of a technique for remediation of acid mine drainage from metal mines.

Farrell Boyce is Environmentalist of Year. Congratulations!

Farrell Boyce has been named 1993 Environmentalist of the Year by a consortium of local environmental groups on the strength of work carried out both within and outside NWRI.

Presentation

Drs. John Coakley and Tonny Bachtiar gave a seminar to the WAVES seminar series (Hydraulics) entitled: "Tracing the movement of contaminated fine sediments in Hamilton Harbour"

Science in the Classroom

Farrell Boyce continues his involvement with the Third International Conference of School and Popular Meteorological and Oceanographic Education (Ontario Science Centre, 14 - 18 July) as member of the local arrangements committee. The Conference is sponsored by the Royal Meteorological Society, the American Meteorological Society and the World Meteorological Organization. The target clients of the conference are teachers; the conference serves as a clearing house for teaching methods and curriculum materials that bring meteorological and oceanographical topics into the classrooms.

Mass Balances of Toxic Chemicals

Dr. Bill Strachan delivered an invited lecture to graduate students and staff of the Harvard School of Public Health. The subject was mass balance of toxic chemicals in aquatic systems and some of the difficulties and advantages of this approach. About 20 persons were in attendance. Some co-operative work is now underway with this group under Prof. Jack Spengler both in the sediment metals and system organics areas.

Environmental Teaching in Argentina

Dr. Jerome Nriagu left to present a 2-week course to students at the University in Buenos Aires in Argentina. He will be teaching Environmental Chemistry under the auspices of World University Service of Canada (WUSC) to approximately 30 students.

Publications

Millard, E.S.; Halfon, E.; Minns, C.K.; and Charlton, C.C. 1993. Effect of primary productivity and vertical mixing on PCB dynamics in planktonic model ecosystems. *Environ. Toxicol. Chemistry* **12**: 931-946.

This paper analyzes the relationship between eutrophication and fate of PCBs in aquatic microcosms. Data were analyzed using a computer model.

Jackson, T.A. 1993. The influence of phytoplankton blooms and environmental variables on the methylation, demethylation, and bio-accumulation of mercury (Hg) in a chain of eutrophic mercury-polluted riverine lakes in Saskatchewan, Canada. *Proceedings of 9th International Conference on Heavy Metals in the Environment*, Toronto: in press.

Jackson, T.A. and Bystricki, T. 1993. Selective scavenging of copper, zinc, and arsenic by iron and manganese oxyhydroxide coatings on plankton in lakes polluted by a base-metal mine and smelter: results of energy dispersive x-ray micro-analysis. *Proceedings of 9th International Conference on Heavy Metals in the Environment*, Toronto: in press.

Rukavina, N.A. 1993. Acoustic monitoring of St. Lawrence river-bed erosion and sedimentation with a fixed-transducer system: Operations Guide for the Cornwall survey. NWRI Lakes Research Branch Technical Note.

Yang, Jing-Rong, H. C. Duthie and L. D. Delorme. Reconstruction of the recent environmental history of Hamilton Harbour (Lake Ontario, Canada) from analysis of siliceous microfossils. *J. Great Lakes Res.* **19**(1): 55-71 (1993).

Ridal, J., L. Durham, J. Sharples, B. Kerman and M. Alaei. Measurement of dissolved gases in freshwater by a membrane inlet mass spectrometry (MIMS) technique. Presented at the ASLO Conference in Edmonton, 1993.

LAKES RESEARCH BRANCH

MONTHLY REPORT

JUNE 1993

Hamilton Harbour

A field program of physical measurements is now underway in Hamilton Harbour. This program has been designed to meet the needs of several groups of researchers within and outside NWRI (J. Coakley: mixing in the vicinity of the Burlington Sewage Treatment Plant outfall; P. Hamblin: Lake/Harbour exchanges through the ship canal; I. Tsanis (McMaster): background data for model verification). A network of 3 meteorological buoys, 3 current meters, 2 thermographs, and a wave-and-tide recorder is operating in the Harbour. 5, day-long drogue experiments were conducted in the vicinity of the Burlington S.T.P. outfall during the week of June 14 - 18. Twice-weekly temperature transects of the Harbour and its Lake Ontario approaches have been carried out. The drogue experiments with drifters set at 2, 4, and 6m depths, demonstrate convincingly the importance of weak, near-surface thermal stratification in sustaining velocity shears. The so-called shear dispersion effect is likely to dominate the spring and summer heating season.

Sewage Traces in Hamilton Harbour RAP

A promising collaboration is developing between Dr. John Coakley (LRB) and Murray Charlton (NCI). A joint field sampling of bottom sediment samples from the eastern part of Hamilton Harbour took place on June 16. The samples will be used jointly to determine the distribution of coprostanol for Dr. Coakley's study, and pore-water ammonia in the top 20 cm for Mr. Charlton's. Like sewage tracers such as coprostanol, a large portion of ammonia inputs to the Harbour is from STP outfalls, and high concentrations in the sediments might also be a factor in the toxicity of Hamilton Harbour sediments.

Sediment Restoration at RAPs

Under Dr. Tom P. Murphy's research activities, 12 tonnes of calcium nitrate were injected into sediments of the St. Marys

River to remediate the contaminated sediments. A new chemical handling system and injection boom used in the project allowed the completion of the treatment within six hours.

Pulp and Paper

Mike Fox recently added Total Petroleum Hydrocarbon (TPH) analyses to the NCI Organics Lab capabilities. This will allow Mike's lab to provide complete trace organic capability to a proposed study, coordinated by Dr. Tom Murphy, on the toxicity and biodegradation of pulpmill sediments at two Great Lakes RAP sites. Mike's lab will also offer analytical expertise in the analysis of retene and related compounds which he found in large quantities in the sediments at these sites.

Arctic Restoration

The month of June was an intensive field work period for studies in the Arctic. Dr. Dennis Gregor and his assistants were sampling snow cores on the Agassiz ice cap and Dr. Mehran Alaei was setting up mass balance studies on Lake Laberge (Yukon Territory) where toxaphene levels are a particular concern, on the Yukon River and on Amituk Lake (Northwest Territories). Of particular note is the development of a solar panel operated air sampler which seems to be performing well at the latter site.

Berpac-IV Toxic Chemical Investigation in the Arctic

Details of the forthcoming BERPAC cruise were completed in June. This oceanographic cruise is intended to examine the largescale movement of persistent toxic substances into the region. The combined US-Russia effort has invited Dr. Bill Strachan will provide the central data on water toxicant levels and toxic chemical fluxes (to biota, sediment, to and from the air, intra-media movement) in the Bering Sea-Bering Strait-Chucki Sea area. Field collections will occur from August 1 to September 15, 1993 and will provide an unprecedented opportunity to meet with, exchange samples and experience with a number of Russian researchers as well as colleagues from the US. Costs are largely borne by the US-EPA.

Relationship Between Trophic Status and Contaminants

Micheline Hanna became involved with processing and analysis of water samples for various biological parameters required for the study of the relationship between primary productivity and fate of contaminants the Arctic, specifically at NWRI's calibrated watershed lake near Resolute Bay. The study is carried out as a component of Dr. Dennis Gregor's Green Plan Arctic Toxic Chemical Program study. Phytoplankton abundance and species composition have never been documented in this lake.

Partnership Leads to Prestigious Award

The Chandler-Meisner Award is presented annually by the International Association of Great Lakes Research for the paper judged to be the most significant publication during the previous year in the Journal of Great Lakes Research. At this year's annual meeting held at Green Bay, Wisconsin, in June 1993, the winners Dr. Asit Mazumder (now at the University of Montreal), Dr. David Lean (Lakes Research Branch, NWRI), and Dr. William Taylor (University of Waterloo). The work was conducted during 1989/90 when Dr. Mazumder was a visiting scientist working at NWRI and later as an NSERC post doctoral fellowship with Dr. Lean (through his adjunct association at Trent University). Dr. Taylor provided expertise on microzooplankton and has been collaborating with NWRI for over ten years.

The paper "Dominance of small filter feeding zooplankton in Lake Ontario Foodweb" (published in J. Great Lakes Res. 18:456-466) compares current zooplankton structure with that of the early 1970's and discusses what happens to zooplankton community structure when large numbers of vertebrate predators (smelt and alewives) and the invertebrate predator *Mysis relicta* are present. Most of the zooplankton present in Lake Ontario are now so small that they pass through the nets usually used for their collection. Food chains such as that found in Lake Ontario are very inefficient for fish production. Energy is lost in the transfer through at least another trophic level.

Sediment Phosphorus: Importance to Lake Management

Phil Manning has accepted an invitation to join the Bay of Quinte RAP Research and Surveillance Implementation Working Group. This group will support the Quinte RAP with technical advice, the study of ecosystem response to remedial action, etc. It will also provide a basis for delisting the Bay as an Area of Concern.

The analysis of sediments from the eutrophic prairie lakes Lofty and Island began in June. This work is in response to a request from Prof. E. E. Prepas, U. Alberta, Edmonton, for a collaborative study leading to an improved understanding of phosphorus and iron dynamics within the lakes. Novel work at NWRI has underscored the many and varied geochemical processes underlying eutrophication in prairie lakes (P. G. Manning et al., Can. Mineral. Vol. 26, pp 965-972, 1988; *ibid* Vol. 29, pp 77-85, 1991; *ibid* in press).

Biodiversity

Dr. Trefor B. Reynoldson was appointed member of the EC Biodiversity Science Assessment Team, and attended the initial two-day meeting in Ottawa, Ontario.

Journal Advisory Board

Dr. Sewak Joshi accepted an invitation to join the Editorial Advisory Board of the Journal of Radioanalytical and Nuclear Chemistry.

Indonesian Contacts

Alena Mudroch presented a review of research activities carried out at the NWRI on the effects of metal mining on aquatic ecosystem in Canada to the members of the Environmental Management Development in Indonesian Project on June 24.

External Examiner

Dr. Coakley was as external examiner for a M.Sc. thesis defence for Tonny Bachtiar at McMaster University. Mr. Bachtiar, a lecturer at Diponegoro University in Java on scholarship from the Indonesian government, worked on sediment tracers in Hamilton Harbour. He has not returned to Indonesia and will endeavour to obtain support for collaborative work with Dr. Coakley on Indonesian contaminant sediment problems. A journal article on his thesis work is in final stages of preparation.

Invited Speaker

Dr. L. Denis Delorme gave a presentation to the Lake Sediment Coring Workshop held in Edmonton. A description of the techniques employed here at CCIW was well received.

Fate of Contaminants in the Great Lakes

Dr. Klaus Kaiser gave an invited plenary lecture on the "Fate and effects of Contaminants in the Great Lakes Basin" at the TOCOEN '92 Conference, Znojmo, Czech Republic. He also presented a paper on volatile halocarbons as tracers for industrial effluents and presented three posters for colleagues, Alena Mudroch and Bernard Bourgoin. He also visited the GSF-PUC Institute at Neuherberg, FRG, and presented a lecture on "The COMPUTOX Toxicity Database: Structure, Contents and Some Results on Inter-Endpoint and Interspecies Toxicity Correlations".

Media and Presentation

Dr. John Coakley was a special guest at the opening of the new Ontario Science Centre exhibit, "The Living Earth", on June 19. A part of the exhibit features Dr. Coakley's display on the interpretation of prehistoric natural events in a lake basin using sediment cores as records.

Joint Meeting, DFO-ELA

A contingent of scientists from the Lakes Research Branch, lead by the Director, Dr. Rod Allan, met with DFO scientists from the Freshwater Institute in Winnipeg and the Experimental Lakes Area. The meeting, chaired by the Executive Director of NWRI, Dr. Ralph Daley, was intended to explore and promote cooperative study among the groups in areas of common interest. Several of the DFO scientists made presentations on their most recent work, followed by open discussion on DFO and DOE priority issues. The Executive Director suggested an annual scientific meeting to improve information exchange and areas for further discussion that could foster joint work.

International Conferences

Dr. Michael Zarull presented a paper, co-authored by Dr. Rod Allan, entitled "Remedial Action Plans in the Laurentian Great Lakes" at the 5th International Conference - *Strategies for Lake Ecosystems Beyond 1000*", on the Conservation and Management of Lakes, in Stresa, Italy. This paper has been published as part of the conference proceedings.

These conferences are organised by the International Lake Environmental Committee and are held biennially. It was attended by

scientists from 35 countries and focussed on the application of scientific research in a variety of areas to the management of lakes. Topics included the scientific basis for managing eutrophication, non-point nutrient sources and their control, acid micropollutants, water quantity and quality in lakes and reservoirs for human uses, scientific findings and their utilization at socio-economic and administrative levels for lake/reservoir management, and citizen participation.

Dr. Zarull presented one of two keynote papers at a special symposium entitled "*Operationalizing the Ecosystem Approach in Regulatory and Resource Management Programs*", an integral part of the 36th Conference of the International Association of Great Lakes Research. The paper is entitled "The Great Lakes Ecosystem: Function and Dysfunction".

This annual conference was held in DePere, Wisconsin and was attended by approximately 400 scientists and managers from the Great Lakes region and elsewhere in the world. The conference presented research information on a variety of topics, including the Green Bay mass balance study, the assessment and remediation of contaminated sediments, zebra mussels, trophic transfer and production dynamics of Lakes Ontario and Michigan, and a large lakes research roundtable.

A special symposium, which Dr. Zarull organized along with other scientists from LRB, IJC, USDA Forest Service, GLC and Wayne State University, sought to review the state of knowledge within a variety of resource and economic areas, including fisheries, agriculture, forestry, point source pollution control, fish and wildlife habitat,

transportation, human demographics, governance and regulation, and identify pragmatic methods of employing an ecosystem approach to management.

Dr. Zarull presented a paper at the *First International, Specialized Conference on Contaminated Aquatic Sediments: Historical Records, Environmental Impact and Remediation*, held in Milwaukee, Wisconsin in June. The paper, entitled "Sediment Research at the National Water Research Institute, Canada", was also published in the conference proceedings. Dr. Zarull also served as chairman of the session entitled "Control Strategies".

The conference, organized by the University of Wisconsin-Milwaukee, brought together scientists from North America, Europe, Scandinavia, Asia, Africa, Japan, Australia, New Zealand, and the U.K., to assess the present state of knowledge, define developing problems and needs, and the review and evaluate technologies for cleaning up contaminated sediments.

Publications

Mudroch, A. and M.A. Zarull. 1993. Sediment research at the National Water Research Institute, Canada. proceedings First International Specialized Conference on Contaminated Aquatic Sediments: Historical Records, Environmental Impact, and Remediation, Milwaukee, WI:359-367. A review of different past and present studies of contaminated sediments in Canada by the NWRI scientists.

Mudroch, A., K.L.E. Kaiser., M.E. Comba, and M. Neilson. 1993. Transport and cycling of PCB in Lake Ontario. Proceedings TOCOEN 93 International Conference, Znojmo, Czech Republic:114-119. The study showed that PCB may reside in Lake Ontario water column between one or two decades after all inputs of PCB to the lake become eliminated.

Burgoin, B.P. and Mudroch, A. 1993. Distribution of herbicides and pesticides from agricultural activities in Lake Erie coastal marshes. Proceedings TOCOEN 93 International Conference, Znojmo, Czech Republic:197-198. The results of the study indicated a continuous transport of herbicides and pesticides mainly by the aqueous phase through Lake Erie coastal marshes.

A paper by Dr. M.A. Zarull and A. Mudroch, entitled "Remediation of Contaminated Sediments in the Laurentian Great Lakes", was recently published by Reviews of Environmental Contamination and Toxicology (Vol. 132). The paper reviews contaminated sediments in the Great Lakes, methods of assessment, removal and treatment techniques.

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Arctic Research Activities

Intensive field work continued in the month of July. Regular samples (water, sediment, suspended sediments, air, and snow) were taken from Amituk Lake (NWT) and Lake Laberge (YT). Dr. Dennis Gregor and his assistants sampled 8 over bank sediments cores in the outer Mackenzie Delta (NOGAP study). He also set up a new snow sampling station in Dawson (YT).

Physics and Parks

On July 16, Farrell Boyce visited Steve McClellan of the Canadian Parks Service in Tobermory, Ontario. Mr. McClellan is seeking advice on understanding and controlling erosion of lake bottom sediments adjacent to a 19th century wreck in Big Tub Harbour that

has become an important tourist attraction. Recommendations for simple field measurements have been offered and there may be opportunities further collaboration.

Reconnaissance Field Trip to Moose River Estuary

Dr. John Coakley made a 3-day reconnaissance field trip to Moosonee in northern Ontario and collected 10 bottom samples from the lower Moose River and its estuary. He also flew over and photographed the river and estuary. The Moose River estuary, more than 3 km wide at the mouth and characterised by a tidal range of more than 3 m, apparently does not have a well-defined turbidity maximum. However, like the St. Lawrence, the bottom is covered overwhelmingly by sand and gravel, with some sparser outcropping of the stiff glaciomarine clay (Tyrrell Sea Clay). Dr. Coakley provided advice and guidance to Tania Poehlman, a MSc student at Guelph University, whom he co-supervises with Dr. Peter Martini. Tania's thesis topic deals with

the sediment/process regime in the Moosonee area of the river.

Clean Up Fund Investigations Lead To Better Methods

Mike Fox analyzed 48 sediment samples from Sault Ste Marie and Toronto Harbour for total petroleum hydrocarbons and retene as part of a collaborative study with Dr. Tom Murphy. We plan to further streamline these analyses in August by conducting a parallel extraction using the newly developed supercritical fluid extraction (SFE) technique. If, as expected, the results compare favourably with the established but inefficient EPA method, the SFE technique will be used in future analyses.

Perspective On Lake Erie

Charlton, M.N., Milne, J. E., Booth, W.G., and Chiochio, F. 1993. Lake Erie Offshore in 1990: Restoration and Resilience in the Central Basin. J. Great Lakes Res. 19(2):291-309. This paper summarizes Canadian data since nutrient controls were begun around 1970. The statistically insignificant slope in summer phosphorus and the continuing low oxygen concentrations in late summer are thought to be consistent with a lake size effect which conferred resilience to the offshore area. Thus, nutrient controls may have been largely prophylactic for much of the lake and therefore are a success even if the already good water quality does not improve. Data from the mid 1980s and 1990 are now being used to help

assess the effect of Zebra Mussels.

Cost Reductions

Kaiser, K.L.E. and M.E. Comba. 1993. Volatile Halocarbons as Indicators of Industrial Pollution in Surface Waters. Increased levels of volatile halocarbons in surface waters (in particular such compounds as di-, tri-, and tetrachloro-ethanes, ethylenes, and -methanes) are typically associated with increased levels of other organic and inorganic contaminants from industrial origins. As there are comparatively simple sample collection processing and analytical methods available, their determination can help reduce the cost of surveys to find hotspots and/or sources of contamination. This work reviews some recent findings and relates them to other environmental data and conditions.

Tracking Effluents

Comba, M.E., V. Palabrica and K.L.E. Kaiser. 1993. Volatile Halocarbons as Tracers of Pulp Mill Effluent Plumes. This work uses volatile halocarbons in a pulp mill effluent, including chloroform, bromodichloromethane, tri- and tetrachloroethylene, as tracers for the distribution and movement of effluent currents in a receiving water bay on the north shore of Lake Superior. The results indicate the simplicity and usefulness of the technique and the significantly improved resolution of effluent plume delineation over the customary use of conductance profiles. In the specific

case at hand, the distribution patterns of chloroform and a brominated analog, bromodichloromethane, also suggest the release of chloroform from sediments in the bay.

Tenable Water Cooling Scheme

Boyce, F.M., Hamblin, P.F., Harvey, L.D., Schertzer, W.M., McCrimmon, R.C., 1993. Response of the Thermal Structure of Lake Ontario to Deep Cooling Water Withdrawals and to Global Warming. *J. Great Lakes Res.* 19 (3) (in press). It has been proposed that buildings in the downtown Toronto area could be cooled by using cold, deep water withdrawn from Lake Ontario. The environmental impact of Deep Lake Water Cooling (DLWC) Scheme on Lake Ontario and the whole lake under present and future climatic conditions is assessed using a one-dimensional thermodynamical model.

The Agassiz Ice Cap

Nriagu, J.O., Lawson, G.S. and Gregor D.J. 1993. Cadmium Concentrations in Recent Snow and Firm Layers in the Canadian Arctic. Long-range transported pollutants can have a devastating effect on the fragile ecosystems of the Canadian Arctic region. This report presents the first set of reliable data on the Agassiz Ice Cap, Canada. The data were obtained using ultra-clean sampling and analysis procedures.

International Cooperation

Reynoldson, T.B. and Metcalfe-Smith, J.L. 1992. An Overview of the Assessment of Aquatic Ecosystem Health Using Benthic Invertebrates. *J. Aquatic Ecosystem Health* 1:295-308. Species composition of benthic invertebrates is frequently used in environmental monitoring and assessment of aquatic systems. In the past few years considerable advances have been made by applying multivariate statistical techniques to large data matrices and relating benthic community structure to key environmental variables. Using these techniques it is possible to establish reference communities for a set of environmental conditions, to predict the benthic community that should occur at new sites and thus measure deviation from an expected community type. Functional measures of ecosystem health, such as chronic measures of toxicity or stress, should be incorporated into any assessment process in the future.

The Mayfly

Reynoldson, T.B. and Hamilton, A.L. B993. Historic Changes in Populations of H. limbata from Lake Erie Based on Sediment Tusk Profiles. *J. Great Lakes Res.* 19:250-257. There has been some controversy regarding the historic status of the central basin of Lake Erie and whether anoxic events have always occurred or are a relatively recent phenomenon arising from cultural eutrophication. The burrowing mayfly, *Hexagenia*, is particularly

sensitive to oxygen depletion and a decline in mayfly numbers in the central basin was first noted in 1949, though they recovered in 1950 and were reported annually until 1957. They were not reported after 1958 (IJC 1969). These reports of mayfly emergence in the central basin suggest that populations of *Hexagenia* may have been present. If these were widely distributed throughout the deeper areas of the central basin, this would support the view that the central basin was oxygenated throughout the summer period and that recovery to this state would be an appropriate management objective. If *Hexagenia* was never present offshore in the central basin this would suggest that intermittent anoxia may be an inherent property of the basin and that management to achieve a state where anoxia does not occur is not a realistic goal for lake managers.

This study supports the view that the deeper waters of the central basin exhibited periodic anoxia prior to European colonization. However, these data suggest that there were significant populations of *Hexagenia* in the central basin probably limited to an area above the thermocline (< 20 m) and in suitable substrate. It is likely that these nearshore areas, as a result of enrichment, supported the nuisance emergences recorded by shoreline communities in the early part of the 20th century. It is from these same areas that mayflies were subsequently eliminated either by the extension of the anoxic area and its duration or possibly in combination with other contaminants.

Finally, the fact that the numbers of tuskos observed in the lower parts of cores from both the central and western basins are similar suggests that *Hexagenia* can be used as an ecosystem objective for those areas of the central basin where it was historically present.

Remediation in the Great Lakes Basin

Reynoldson, T.B. and Zarull (1993). An Approach to the Development of Biological Sediment Guidelines. In: Woodley, S.J., G. Francis and J. Kay (editors), *Ecological Integrity and the Management of Ecosystems*. St. Lucie Press, Delray Beach, FL. This paper describes an alternate approach to environmental decision making using biological rather than chemical endpoints to determine both the need for and the success of sediment remediation and cleanup undertaken in Areas of Concern. It demonstrates how criteria will be developed and applied and possible significant implications in the cost of remediation in the Great Lakes basin.

Zarull, M.A. and Reynoldson (1992). A Management Strategy for Contaminated Sediment: Assessment and Remediation. *Water Poll. Res. J. Canada* 27(4): 871-882. Sediments contaminated with metals, persistent toxic organics and nutrients remain a significant problem throughout the Great Lakes. The highest levels of sediment-associated contaminants and some of the worst manifestations of their related problems can be found in urban-industrial nearshore harbours, embayments and river mouths. Sixteen of the seventeen Canadian and binational Areas of Concern, in the Great Lakes, have contaminated sediments. The degree and extent of contamination are viable among areas and contaminant types, as are their associated use impairments. Our ability to fully remediate contaminated sediments, in these nearshore areas, is limited by the availability of proven technology, adequate assessment data and suitable restoration goals. This report describes some of the technical and management problems associated with assessing, treating and managing contaminated

sediments; some of the actions and programs being employed under GLAP to address these problems and; some further requirements to assist future remediation and prevention.

Sedimentation Rate Of Lake Laguna

Sly, P. G., (Rawson Academy) Charlton, M. N., and S. R. Joshi. 1993. Results of Exploratory Coring in Laguna Lake, Philippines. *Hydrobiologia* 257: 153-164. The work for this paper was conducted during a CIDA sponsored workshop on Laguna Lake near Manila. The watershed of this lake is subjected to much ad hoc logging, settlement, and industrial expansion. The paper describes the sedimentation rate of the lake in terms of the loss of 4%-8% of water capacity per year and this raises important concerns for the long-term usefulness of the lake for fisheries and water supply. The paper recommends an extensive sediment survey as a way of integrating several ecological stresses.

Capping In Hamilton Harbour

Zeman, A.J. 1993. Subaqueous Capping of Very Soft Contaminated Sediments. *Proceedings 4th Canadian Conference on Marine Geotechnical Engineering*, St. John's, Newfoundland, v.2:598-609. Subaqueous capping has become an important concept for isolating contaminated fine-grained sediments and is considered one of several sediment

remediation measures for Areas of Concern on the Great Lakes. This paper describes the selection of a location in Hamilton Harbour where such a cap will be placed as a pilot-scale project. Its effectiveness will be tested by physical, chemical and biological monitoring.

Meetings And Committees

Dr. T.B.Reynoldson attended a meeting with EP, Pacific & Yukon, in Vancouver, B.C. to discuss NWRI participation in Fraser River Action Plan and prepare a workplan for research component of the Action Plan.

A.J. Zeman visited the Restoration Technologies Section, Technology Development Branch, Centre Saint-Laurent, Montreal, Quebec, to discuss coordination of Research and Development in the field of remediation of contaminated sediments.

A. Mudroch participated on a review of remediation of a mining site at Ignace, Ontario. The review was organized jointly by the Ontario Ministry of the Environment and Energy, Ontario Ministry of Natural Resources, Mattabi Mines Ltd. of Noranda Minerals Inc. and Minnova Inc., Mining Innovation. A conducted tour, organized by the Remedial Project Manager of the Mattabi Mines Ltd. enabled the participants to inspect different remedial techniques applied to acid mine drainage and treatment of about 230 hectares of tailing ponds at the mining site at Ignace.

Conferences And Workshop Presentations

Bourgoin, B.P., Mudroch, A., Day, K., Millette, J.A., Gamble, D.S., Goodsmann, D.W., Roshon, R. and Topp, E. The Impact of Agricultural Activities on Lake Erie Coastal Marshes. Poster Presentation at the 1st Annual Symposium of the Institute of Environmental Health, University of Toronto, Toronto, Ontario.

Zeman, A.J. Subaqueous Capping of Very Soft Contaminated Sediments. Poster presentation at the Joint CSCE-ASCE Conference on Environmental Engineering, Montreal, Quebec.

Patent

A patent for process and equipment for in-situ sediment treatment, developed by Dr. T.P. Murphy, was filed in Canada and the United States.

F. Rosa and Dr. J. Azcue, SWI Project, provided assistance with in-situ collection of sediment interstitial water in a project on evaluation of subaqueous disposal of metal mine tailings in Anderson Lake, Manitoba. The project has been carried out by Mine Environment Neutral Drainage (MEND) Program.

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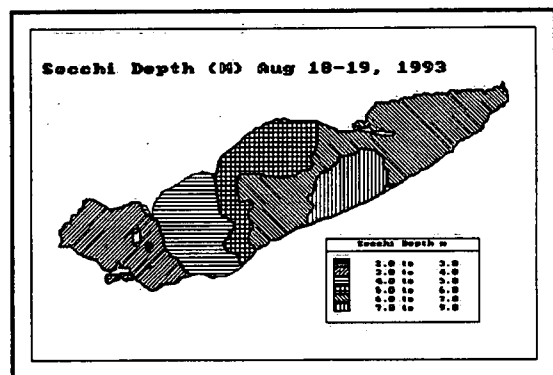
Relationship Between Trophic Status and Contaminants

Micheline Hanna compiled and tabulated the data on selected n-alkanes and PAH concentrations in sediment core slices collected from 12 Northeastern Ontario lakes (MODLES lakes area). She initiated a bibliographical search for research relevant to this topic. The purpose of this study was to characterize and quantify the sources of the organic material to lake sediments as aquatic, terrestrial or anthropogenic. Determination of the sources of organic material to a lake allows better understanding of critical process in lakes.

NWRI Lake Erie Initiative

Increasing concern for the impact of Zebra Mussels on fish production has led to much speculation. Since the mussels filter food organisms which otherwise may have

participated in fish food chains the feeling is that fish production is adversely affected. Research surveys conducted by Murray Charlton in 1990 showed some of the first water clearing effects of the mussels with Secchi disk readings up to 7M. These unusual readings were, however, balanced by more readings in the 2-3M range. At the request of M. Charlton, Computing and Programming/RSB retrieved all West Basin Secchi readings available at CCIW. These historic data span 25 years and show that many of the current readings are quite typical. The problem in interpreting the meaning of the unusually high readings is to discover the total area they represent. A confusing aspect of the apparently improved readings is the degree to which they are caused by water quality improvements resulting from nutrient reductions instead of



the actions of Zebra Mussels. A research sampling exercise was carried out August 18-19 at 34 stations in Lake Erie. The results have been analyzed by M. Charlton using RAISON software. These and other data from 1990 show that the West Basin of Lake Erie is highly variable from survey to survey and from location to location. These variations are not merely statistical oddities. For example, total phosphorus can vary by 100% between surveys even in the summer. Although a second sampling is taking place in late September it is apparent that a major effort is needed to sample the variability of water quality in West Lake Erie in order to find the extent to which Zebra Mussels have modified the potential fisheries production.

Quality Results Affirmed

The NCI Trace Organics Laboratory was successfully re-accredited for the analysis of organochlorine pesticides and PCBs in water by the Canadian Association of Analytical Laboratories. A further 36 sediment samples from Sault Ste. Marie and Toronto Harbour were analyzed for TPH and retene in a collaborative study with Dr. Tom Murphy of SWI. These results will feature in two forthcoming presentations by Dr. Murphy to the Lake Huron Basin Symposium and the 20th Annual Toxicity Workshop in Quebec City.

Phosphorus Releases Clarified

The release of bioavailable phosphorus from sediments during the summer, when lakes are commonly stratified and bottom waters anoxic, is often attributed to redox processes and the reduction and dissolution of hydrated (ferric) iron oxides. This release is often massive and is an important feature of the phosphorus cycle in lakes, e.g. Prairie lakes. Following submission of a manuscript (*"Forms of iron and the bioavailability of phosphorus in eutrophic Amisk Lake, Alberta"*; authored by P. Manning, T.P. Murphy and E.E. Prepas, University of Alberta) to the Canadian Mineralogist, one of the referees questioned the insignificant amounts of hydrated iron oxides measured (by spectrometer) in the sediments and suspended particulates, and hence the process accounting for the release. In reply, we point out that other redox horizons exist in organically-enriched sediments; one is the sulfate-reducing horizon. The reaction of sulfide ion with most iron-phosphate compounds would also lead to dissolution of phosphate ion. These compounds need not necessarily be oxides but could be poorly crystalline ferrous or ferric iron moieties, possibly associated with organic matter. This manuscript is accepted for publication pending minor changes.

Sediment Treatment Marketed

A Principal of Association with Golder Associates was signed for the NWRI contaminated sediments treatment process developed and tested by Dr. Tom Murphy. The

NWRI will support commercial efforts with the R & D paid by Golder Associates via a 4% royalty and other resources. The signing was described by the officials in Ottawa as potentially the biggest licence agreement of the federal government of Canada. The Deputy Minister of Environment, Mr. N. Mulder, approved the NWRI business plan for the release of the technology to the private sector. Dr. Murphy recently presented a review of in-situ treatment of contaminated sediments, including a demonstration at the CCIW dock, to the ARCS Committee. The meeting led to several new commercial contacts for a Canadian company, Golder Associates, for potential treatment of contaminated sediments at different sites in the USA.

Cooperative Research on Mining Pollution/Remediation

Dr. Bernard Bourgoïn attended a meeting at the Freshwater Institute, DFO in Winnipeg, to discuss the results of studies on the ELA lakes with representatives of the Canadian mining industry (MEND and MACEC). The scientists of the Freshwater Institute suggested using the present and future studies in the assessment of effects of mining on aquatic environment in Canada.

Conferences

Dr. Paul Hamblin attended the 25th Congress of the International Association of Hydraulics Research in Tokyo where Disaster Prevention was the central topic. His talk was on Remote Sensing. The physics of stirring deep

mountain reservoirs by air bubbler plumes to maintain acceptable levels of water quality was observed at a field trip to Migasse Dam near Tokyo. He visited Lake Biwa and took part in a large international study, BITEX '93. Dr. Hamblin also took part in two cruises which were organized by J. Imberger of the Centre for Water Research, West Australia, who deployed his portable turbulent flux probe at key locations in Lake Biwa. This was an eventful experience as Lake Biwa had just been energized by Typhoon 13 so that there were plenty of turbulent mixing events found.

Dr. Sylvia Esterby chaired an invited round table session, "Statistical Issues in Water Quality Monitoring" at the American Statistical Association Joint Meetings in San Francisco, August 8-12. The session was sponsored by the American Statistical Association Section on Statistics and the Environment and Canadian Statistical Association.

Dr. M.A. Zarull was assigned to the Ontario Regional Integration Monitoring Sub-Group of the Operations Work Group.

Visiting Scientists

Mr. Brendan Ruck, a visiting scientist from Aston University, UK, will be associated with the Sediment-Water Interactions Project for 3 months. He will be examining the application of neural networks to the development of biologically-based sediment guidelines for the Great Lakes.

A six-months visiting scientist, Dr. J. Triska from the Czech Academy of Sciences, Czech Republic, will be participating in a study under the SWI Project. He will be studying the processes affecting the distribution of herbicides and pesticides from agricultural activities in Lake Erie coastal marshes.

Dr. Daqui Zhu, a professor at the Nanuing University Centre of Marine Science, accompanied by Dr. Peter Martini (University of Guelph), visited Dr. John Coakley on August 16. Dr. Zhu was briefed on the Centre and given an abbreviated tour of the facilities. Discussions focusing on the possibility of cooperation with NWRI and Guelph on analysis and interpretation of the huge database he has on the south China Sea coastal sedimentary regime were entered into. At the conference, Dr. Coakley met Prof. Ying Wang (Dr. Zhu's wife, who is the Director of the Centre of Marine Sciences) and continued these discussions.

On August 2, a group of 15 students, enrolled in the McMaster Summer Geology course, visited CCIW and were hosted by Dr. John Coakley. After a briefing in the auditorium, the students were shown research and facilities of geological interest, ending with a tour of the CSS Louis Lauzier.

Publications

Schertzer, W.M. 1993. *"Water budget and evaporation estimates for Little Turkey Lake, September 1986 to December 1987"*. NWRI Contribution No.93--. Detailed overlake meteorological and hydrological data were used to evaluate (daily, monthly and annual) water budget components of Little Turkey Lake from September 25, 1986 to December 31, 1987.

Mudroch, A., G.E.M. Hall, J. Azcue, T.A. Jackson, T.B. Reynoldson and F. Rosa. 1993. This preliminary report deals with the effects of abandoned mine tailings at Wells, B.C., on the aquatic ecosystem of Jack of Clubs Lake. National Water Research Institute Contribution No. 93-23, p. 174.

Esterby, S.R. and P.E. Bertram. 1993. *"Compatibility of Sampling and Laboratory Procedures Evaluated for the 1985 Three-Ship Intercomparison Study on Lake Erie"*. J. Great Lakes Res. 19(2):400-417.

Toxic Chemicals in the Arctic BERPAC-IV

Dr. W. (Bill) M.J. Strachan is participating in the U.S.-Russian oceanographic cruise to examine large scale movement of persistent toxic substances in the region. He will be responsible for water toxicant levels and toxic chemical fluxes in the Bering Sea, Bering Strait and Chucki Sea areas. The month long cruise ends on September 15.

North Atlantic Regional Experiment (NARE)

Henry Wong participated in the multi-agency experiment in collaboration with AES personnel in the study of cloud scavenging of airborne trace metals. He was in Yarmouth to set up "clean" ground and cloud level sampling protocol and facilities.

Clean Laboratory On-Board LIMNOS

George Lawson, H. Wong and A. Kabir tested the new portable clean laboratory for metals (class 100) on-board the Limnos during a recent Lake Erie cruise. During the cruise,

some 70 water samples and 15 suspended solids were collected for analyses of toxic metals.

NWRI Arctic Research

The end of August saw the conclusion of intensive field work in the Arctic. A total of 100 water, 25 suspended sediment (trapped and centrifuged) and six peat samples were collected during this period at Yukon River basin. During this period 10 air samples and 72 water samples for organic contaminants and 600 samples (400 water 75 snow and 125 sediments) for inorganic analysis were collected at Amituk lake. Samples for inorganic analysis that complements the organic contaminant measurements are now being processed through RRB.

Reports of Interest

During the month of August, several reports were completed. The resourcing exercise for GLWG GLAP2 submission for the Institute, the NWRI inventory of Great Lakes research studies for CGLRM of the IJC, 1992/93, and the 1993/94 NWRI GLAP RAP study inventory and resourcing for GLEO was completed. The GLAP-1 NWRI activity and results summary report was initiated.

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Canada-Russia Arctic Ocean Expedition

Dr. Bill Strachan returned from the American-Russian expedition in the Bering/Chukchi Seas. This BERPAC research expedition took place in the area between August 1 and September 20 and was particularly designed to look at organic contaminants in the area and their flux through the Bering Strait into the Arctic. A scientific crew of over 60 persons collected samples from environmental compartments including air, fog, surface and sub-surface water, suspended matter, sediments and benthic invertebrates, several fish and fish organs. Microbiological studies on the degradation of PCBs and HCH isomers with resident micro-organisms were investigated. In addition, more traditional oceanographic parameters were followed such as chlorophyll, primary productivity, nutrients, major ions, etc.

Climate change impacts on Lake Erie

A study entitled "Adaptation strategies for climate related changes in Lake Erie Water Quality" has received funding under the Great Lakes-St. Lawrence part of the Green Plan. Dr. Bill Schertzer will lead this investigation which aims at testing a NWRI model of the impact of various future climate scenarios on the water quality of Lake Erie. Other partners in the study include IWD (OR), DFO, AES, MOEE and OMNR.

Lake Erie

The sampling and extraction of large volume water samples from selected sites on Lake Erie for a preliminary study of the effect of zebra mussels on contaminants in Lake Erie was undertaken by Dr. Ellen Bentzen (Trent U.) on

behalf of the study initiator, Mike Fox. A series of stations were visited for Murray Charlton as part of the preliminary work in planning research on the effects of Zebra Mussels on water quality.

Hamilton Harbour Cores

Using techniques developed at the University of Guelph, Dr. John Coakley was able to make resin peels of the bottom sections of two long piston cores taken from Hamilton Harbour earlier in the summer. The peels were successful in bringing out the finer details of deposition-related structures that will enhance interpretation of Hamilton Harbour evolution.

Relationship between trophic status and contaminants

Micheline Hanna initiated data analysis of selected n-alkanes and PAH concentrations in sediment core slices collected from 10 Northeastern Ontario lakes (Modles lakes area). This work is carried out in order to characterize and quantify the sources of the organic material to lake sediments as aquatic, terrestrial or anthropogenic. Determination of the sources of organic material to a lake allows better understanding of critical process in lakes. This work will be presented as a poster during SETAC 1993.

Remediation of Small Lakes

Remedial action in the highly eutrophic prairie Amisk Lake, Alberta, hinges on methods to increase the binding of phosphorus by the sediments. Oxygenation of previously anoxic hypolimnia is one method thought to control phosphorus release from sediments. Collaborative work with Prof. E. E. Prepas, Univ. Alberta, on the phosphorus and iron cycles in eutrophic lakes, continued this month with the recording at (NWRI) of the Mossbauer spectra of sediments from Amisk Lake. These sediments were collected following oxygen injection into the hypolimnion. Preliminary results indicate that, as a consequence of oxygen injection, concentrations of sulfide, as pyrite or FeS_2 , are significantly lower in the top 20 cm of sediment. The inference is that the oxygen demand by the sediments may have been lowered. More cores are to be analyzed in order to confirm this result. How this affects the phosphorus binding capacity of the sediments has yet to be determined.

Rice Lake PCB Contamination

While on assignment with IWD-Ontario Region, Scott Painter assisted C&P Ontario Region address the PCB issue in Rice Lake near Peterborough. The Ontario Ministry of Environment and Energy had released two reports on PCB contamination in Rice Lake as a result of contamination from industrial sources upstream on the Otonabee River in Peterborough. Since the MOEE data was over 5 years old and abatement actions at the source had occurred, Environmental Protection,

Ontario Region undertook a sediment PCB survey to obtain more recent information. IWD - Ontario Region was responsible for consolidating all available information on PCB contamination in Rice Lake (provincial as well as federal) to assist Environment Canada develop a federal response to the problem. A document entitled "Rice Lake PCB Contamination, 1992" which summarized the available information was produced by Scott Painter using Spans-Map desktop mapper software from Intera-Tydac. The report has been accepted by Environmental Protection - Ontario Region with minor revisions. Printing of the final graphics is proceeding so that distribution of the report can proceed.

Metals: Background levels in sediments

Sediment quality assessment must incorporate an analysis of regional background concentrations of metals since the occurrence and concentration of metals such as copper, nickel, and zinc is dependent on the regional geology of the surrounding watershed. Concentrations which would be considered normal background levels in one area of Canada would be considered anthropogenically enriched in another. The Geological Survey of Canada has been collecting background lake sediment samples for mineral exploration purposes for over 20 years. Scott Painter purchased the data from the GSC and a database of background sediment metals levels from almost 300,000 lakes across Canada was created. The database has been queried to extract sediment metal data from areas of concern across Canada such as the Atlantic Coastal Action Plan areas, the Fraser River, and northern Rivers. A histogram analysis and various maps are available for Canada and selected areas of interest.

Laboratory Modernization: Quality plus Quantity

An ongoing process of upgrading and linking major laboratory instrumentation is paying dividends in sample throughput. In September the NCI Trace Organics Laboratory was able to extract and analyze several hundred air, water and sediment samples from NCI studies (Dr. David Lean) and collaborative studies with SWI (Dr. Tom Murphy) and AES, Burlington (Dr. Jeff Ridall). The addition of a six position automated water sample extractor and the linking of laboratory and office PCs in a work group in October will complete the current phase of modernization.

International Recognition

Mike Fox joined the board of referees of the Foundation for Research, Science & Technology, Wellington, New Zealand. The Foundation is responsible for investing \$250 million (N.Z.) annually in scientific research on behalf of the New Zealand Government.

Conferences and Workshops

A. Mudroch chaired the session Aquatic Assessment of Mining Impact, Physical and Biological Processes at the 9th International Conference on Heavy Metals in the Environment in Toronto.

T.A. Jackson presented two papers, A. Mudroch presented one paper and J.M. Azcue presented one paper at the 9th International Conference on Heavy Metals in the Environment in Toronto.

Canada-Russia Workshop

Mr. Schertzer has been appointed the co-editor of the proceedings of a Canada-Russia workshop (October 1992) on "Physical Limnology and Water Quality Modelling of Large Lakes in Europe and North America", held under the auspices of the Canada-Russia MOU on the Environment.

Lake Erie Workshop

Dr. Michael A. Zarull participated in a DOE sponsored, DFO run workshop on Lake Erie to identify the major ecological/environmental issues affecting the lake; and the research, surveillance and monitoring programs necessary to address these issues. The workshop was attended by staff from OMNR, OMOEE, DFO, IWD, academia and NWRI. A subsequent meeting took place to develop research project areas and further develop a consortium of partners in preparation for a GLURF submission.



Mr. Helen Jarview, PhD student from the University of Reading, UK, visited NWRI and presented a seminar on her work.

Dr. C.Raj Murthy visited India through the United Nations Development Program to advise the Government of India on environmental research priorities related to the Council of Marine Pollution. In addition to presentation of several seminars, he conducted a workshop on Marine Pollution Monitoring and Modelling. He has prepared a report for the Government of India on National Marine Pollution Monitoring and Modelling of Coastal Oceans.

Cooperative Studies

Study Leaders of the Sediment/Water Interactions Project discussed future cooperative studies and a joint research proposal on contaminated sediments in Germany and Canada with Professor U. Forstner, Technical University of Hamburg-Harburg, Germany.

Publications

Azcue, J.M., Mudroch, A., Rosa, F., Hall, G.E.M., Jackson, T.A. and Reynoldson, T.B., 1993. Heavy metals concentrations in water, sediments, porewater and biota from an abandoned gold mine in Wells, B.C., Canada. In Proceedings of 9th International Conference on Heavy Metals in the Environment (Allan, R.J. and Nriagu, J.O. eds.), Toronto, vol. 2:247-250.

Azcue, J.M., Collins, P. and Mudroch, A. 1993. Comparison of different methods for metal analysis in plants. In Proceedings of 9th International Conference on Heavy Metals in

the Environment (Allan, R.J. and Nriagu, J.O.. eds.), Toronto, vol. 2:304-307.

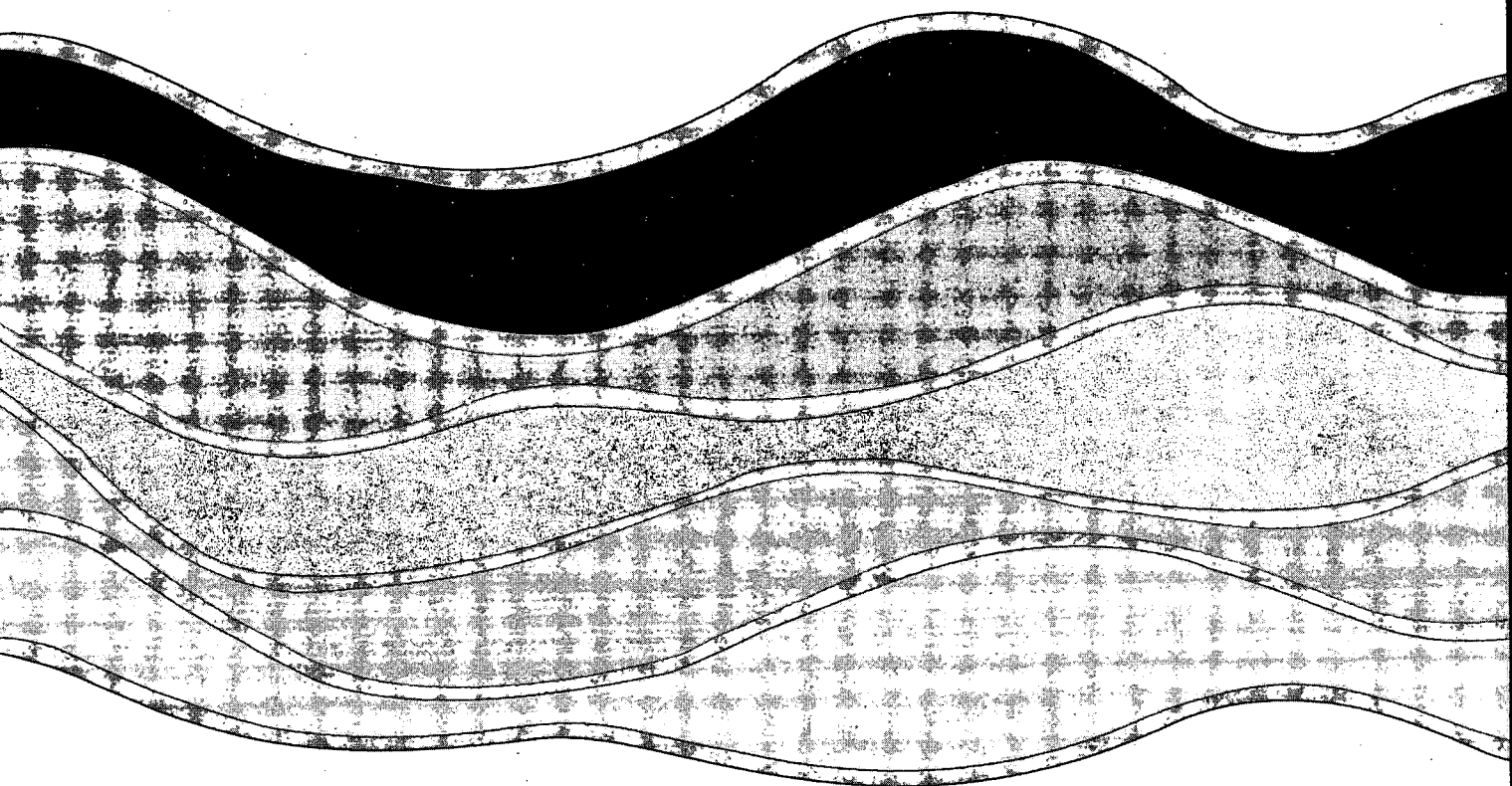
Jackson, T.A., 1993. Effects of environmental factors and primary production on the distribution and methylation of mercury in a chain of highly eutrophic riverine lakes. *Water Pollution Research Journal of Canada*, 28:177-216.

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Jackson, T.A. and Bistricki, T., 1993. Selective scavenging of copper, zinc, and arsenic by iron and manganese oxyhydroxide coatings on plankton in lakes polluted by a base-metal mine and smelter: results of energy dispersive X-ray micro-analysis. In *Proceedings of 9th International Conference on Heavy Metals in the Environment* (Allan, R.J. and Nriagu, J.O.. eds.), Toronto, vol. 2:325-328.



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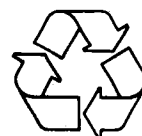
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