INTERNATIONAL ASSOCIATION FOR GREAT LAKES RESEARCH

26th CONFERENCE ON GREAT LAKES RESEARCH

ABSTRACTS

MAY 23-27, 1983
STATE UNIVERSITY OF NEW YORK AT OSWEGO

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PROCEEDINGS
OF THE
26th CONFERENCE
ON
GREAT LAKES RESEARCH

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INTERNATIONAL ASSOCIATION FOR GREAT LAKES RESEARCH

Dr. John E. Gannon, President

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in conjunction with
The State University of New York at Oswego
and
The New York Sea Grant Institute

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26th ANNUAL CONFERENCE ON GREAT LAKES RESEARCH

MAY 23-27, 1983 • OSWEGO, NEW YORK

All technical sessions will be held in Lanigan Hall. Coffee breaks: Daily 1000.
Daily at the James Fenimore Cooper Dining Center: Breakfast — 0700 to 0830. Lunch — 1200 to 1300.

MAY 23	MAY 24		MAY 25	MAY 25	MAY 26	MAY 26	MAY 27
Monday PM	Tuesday AM / PM	Room #	Wednesday AM	Wednesday PM	Thursday AM	Thursday PM	Friday AM
1500 - 1700 IAGLR Board of Directors Meeting 1400 - 2000 Check-in and Registration / Hart Hall	0830 - 1130 Plenary Session: Lake Ontario / Room 101 1200 - 1700 Pre-paid tour of Eastern Lake Ontario Region	104	0800 - 1200 Lake Huron Symposium	1300 - 1700 Lake Huron Symposium	0800 - 1200 Lake Champlain Symposium	1300 - 1500 Lake Champlain 1520 - 1700 NY Inland Lakes	POST - CONFERENCE TOURS
		102	0800 - 1000 Coastal Rec. 1020 - 1200 Great Lakes Law Symposium	1300 - 1620 Biofouling Symposium	0800 - 1200 Eutrophication	1300 - 1500 Eutrophication 1520 - 1700 Phytoplankton	
		103	0800 - 1200 Bioassay	1300 - 1700 Fishery Biology	0800 - 1000 General Biology 1020 - 1140 Paleolimnology	1300 - 1500 Sedimentology 1520 - 1700 Sediment Transport	
		105	0920 - 1200 Contaminants	1300 - 1700 Contaminant Transport	0800 - 0940 Contaminant Methods 1020 - 1200 Fish Contaminants	1300 - 1900 Contaminants: Fish/Wildlife 1520 - 1700 Niagara River	
Evening: Welcome, Wine & Cheese Social 1600 - 1700 Dinner 1830	Evening: Cocktail Hour, 1730 - 1830 Lakeshore Bar-B-Q 1830 Informal Workshops	106	0800 - 1000 Climate and Ice 1020 - 1140 Hydrology	1300 - 1500 Physical Limnology			
			Late Afternoon: IAGLR Annual Meeting, Open House 1700	Evening: Cocktail Hour, 1800 - 1900 Banquet, 1900 with entertainment Guest Speaker: William Milliken, Former Governor of Michigan			

DISPLAYS

Oswego County Wetlands Inventory

Michael Corey
Oswego County Environmental Management Council
County Building
Oswego, New York 13126

Marine Education Materials

H. David Greene
N.Y. Sea Grant Extension Program
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Aurora, New York 14052

Great Lakes Tomorrow

Tiffany Hall
Hiram College
Hiram, Ohio 44234

The Sea Grant Great Lakes Network

New York Sea Grant Institute
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Albany, New York 12246

International Joint Commission

100 Ouellette Avenue, 8th Floor
Windsor, Ontario
Canada N98 6T3

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Water quality instrumentation.

The first Conference on Great Lakes Research was held at the University of Michigan Biological Station at Douglas Lake on July 29-31, 1953. The topic of the conference was the upper Great Lakes. In the words of the conference organizer, Dr. F. K. Sparrow, "The primary purpose of the conference was to bring together a representative group of persons actively engaged in research on the Upper Great Lakes (Huron, Michigan and Superior) for an exchange of ideas as to the present status and future objectives of basic scientific research on these Lakes. Also invited to attend were individuals who, because of their special knowledge of other Great Lakes areas or of modern techniques of deep water study, would contribute to any discussion of Great Lakes problems".

In 1955, the second Conference was held on the Ann Arbor Campus of the University of Michigan and focussed on "The Great Lakes and Michigan". The first day of the conference was devoted to two non-technical papers of wide interest to both layman and scientist. On the second day, panel discussions were held that concerned the important topics of utilization of the waters of the Great Lakes by industry and citizens, and the present status of research on the Great Lakes.

The third Conference on Great Lakes Research was held in 1959, again at the University of Michigan. The theme of this conference was broadened from those of the earlier meetings to include the more general topic of "Water Quality and Water Usage of the Great Lakes". Subsequent conferences have been characterized by inclusion of a wide array of subjects dealing with Great Lakes research.

By the time of the Fourth Conference in 1961, it was apparent that the conference should be held annually. At the Ninth Conference in 1966, it was decided that a formal organization was needed to sponsor the Conferences on Great Lakes Research. Bylaws were adopted, and the first formal meeting of the International Association for Great Lakes Research (IAGLR) was held in 1967 at the time of the Tenth Conference. IAGLR Conferences have contributed to the promotion and conduct of research on the Great Lakes, serving as an effective means of communication through discussion and publication, and as a common meeting ground for those concerned with Great Lakes problems.

A review of the history of the Great Lakes Research Conference indicates that a consistent philosophy has prevailed since the beginning. The Bylaws of the Association state this objective very clearly, "the promotion of all aspects of Great Lakes research and the dissemination of research information through publication and meetings". The stated objectives do not limit the interest of the Conference to matters concerning only the Laurentian Great Lakes and their Basins, but allow the scope of meetings to encompass all aspects of research applicable to the understanding of the world's large lakes and the human societies surrounding them. The fundamental philosophy of the Association is that these meetings provide an annual forum for all Great Lakes researchers to present information on the status and the findings of their investigations.

CONTENTS

TUESDAY, MAY 24

PLENARY SESSION

0830-1130 Room 101

Convenor: Harvey Shear *Moderator:* John E. Gannon

0830

TOM A. MUIR, Inland Waters Directorate - Ontario Region, P.O. Box 5050, Burlington, Ontario L7R 4A6. Human Development of the Lake Ontario Basin - Past, Present and Future.

The development of the Lake Ontario Basin, past, present and future, will be examined within a framework that allows perspectives based on emerging notions of economic-ecological integration, or 'bioeconomics', as well as more conventional social-economic terms.

It wasn't until the late 1960's and early 1970's that socio-political feedback concerning pollution resulted in remedial measures directed primarily at cultural eutrophication and certain aspects of air pollution.

Options selected were largely end-of-pipe technical fixes. Detection of and concern with toxic resultant real costs associated with eutrophication and phosphorus management strategies, and air and other water pollution, have a number of perspectives and will be discussed.

0900

HUGH F.H. DOBSON , Aquatic Ecology Division, National Water Research Institute, P.O.Box 5050 867 Lakeshore Road, Burlington, Ontario L7R 4A6

Highlights of a Lake Ontario Water Chemistry Atlas

The main result of the atlas is a broad assessment of the effects of recent phosphorus loading reduction, and in-lake phosphorus concentration reduction: the summer Secchi-depth and summer oxygen depletion were fairly stable in the 1970's; particulate organic carbon in offshore surface waters in August/September declined steadily, by 20% from 1975 to 1981. Chemical/biological aspects of the springtime thermal bar are illustrated, and also lakewide upwelling/downwelling in response to winds in summer. In July (1972) there was a prominent lakewide subsurface chlorophyll maximum around 10 metres depth. The springtime diatom crop, (see Munawar and Nauwerck, 1971 Great Lakes Proceedings), was located near the lake-bottom the following summer, as indicated by high particulate organic matter and near-bottom release of dissolved silica. March/April nitrate had steadily increasing values, from 215 µg N/L in 1968 to 340 µg N/L in 1981. It is proposed that high values of (particulate)/(particulate, + dissolved inorganic) C, N, or P indicate limitation of plankton stock. Such data for Lake Ontario indicate that phosphorus limited the near-surface plankton stock each summer, but that nitrogen may have been co-limiting with phosphorus a decade ago.

0930

WILLIAM A. PEARCE, NYDEC, Cape Vincent,NY 13618 Lake Ontario Fisheries-Then-Now-Tomorrow.

THEN (1800-1960's): Most of Lake Ontario's highly prized native fish populations, such as Atlantic salmon, lake trout, lake sturgeon, lake whitefish and ciscoes collapsed. Uncontrolled commercial fishing, sea lamprey predation, exotic species and environmental degradation were the major causes. The commercial fishery collapsed and was surpassed by a yellow perch-smallmouth bass type sport fishery.

NOW (1960's-1980's): Michigan's successful Pacific salmon program stimulated Pacific salmon and trout stockings, when combined with sea lamprey control, produced large numbers of 40+ lb. fish to support a new multi-million dollar sport fishery. Findings of contaminants in many fish further depressed the commercial fishery and jeopardized the new salmon-trout and historic bass sport fisheries. By 1979: full stocking was resumed; expansion of hatchery facilities continued; the sport fishery, particularly in the lake, mushroomed; and public interest soared. The Lake Ontario Committee developed lakewide plans to manage common fish stocks that stressed producing naturally spawning lake trout populations.

TOMORROW (1980's-2000+): The contaminant problem should be resolved; a strictly controlled commercial fishery could thrive; sale of surplus salmon could provide fishery agencies funds to meet propagation/research/management needs; worldwide sport fishing vacation flights will help support a half billion dollar industry; lake trout will be reproducing; Atlantic salmon will be spawning in headwater streams.

1030

D.M. WHITTLE, DFO, Great Lakes Fisheries Research Branch, P.O. Box 5050, Burlington, Ontario L7R 4A6. The Influence of Contaminants on the Lake Ontario Ecosystem.

Persistent, bioaccumulable contaminants are the most significant threat to the health of the Great Lakes to date. Concerns about excessive nutrient loadings to the lakes are now replaced by studies to document the trend and impact of toxic substances on the ecosystem. Obvious consequences of elevated ecosystem contaminant levels have included bans on possession of sportsfish, closure of fisheries export markets and concerns about polluted groundwater supplies. More subtle responses are seen in the observed decline in reproductive success of herring gulls or the radical alteration of phytoplankton species composition. Lake Ontario, last in the Great Lakes chain, receives more than 84% of its tributary input from the Niagara River, documented as a major source of contaminants. This tributary input is combined with atmospheric deposition, non-point source loadings and the high volume of industrial and municipal wastes from several large urban centres within the basin. Industrial landfill sites, storage areas for an uncatalogued range of wastes, may now be a source of significant amount of contaminated leachate. With the ever-increasing demand for sources of unpolluted freshwater and the frequent identification of alarming levels of new contaminants, the future ability of Lake Ontario to supply a usable resource must be examined.

PLENARY SESSION (Continued)

1100

HARVEY SHEAR , Great Lakes Fisheries Research Branch, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario L7R 4A6. The Future of Lake Ontario - Management and Surveillance.

Surveillance of Lake Ontario for the past fifteen years has taken the approach of a major lake-wide survey every 4-6 weeks. This has provided a very valuable data base upon which to assess the response of the lake. This approach is, however, costly, and does not give a very detailed picture of short term events in the lake, controlled by biological processes. A new approach, using the biota as an index of lake response is presented. In addition, projections are presented for the potential pollutant loading to Lake Ontario assuming no additional management, and estimates are also given for the recovery of the lake from persistent contaminants assuming effective management of the discharge of these materials.

WEDNESDAY, MAY 25

LAKE HURON SYMPOSIUM

0800-1200 Room 104

Convenor: Mohiuddin Munawar, John E. Gannon *Moderator:* Mohiuddin Munawar

0800

RICHARD L. THOMAS, Great Lakes Fisheries Research Branch, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario L7R 4A6. The Sediments of Lake Huron.

Sediment distributions in Lake Huron are controlled by lake bottom morphology, consisting of arcuate scarp and dip slopes on the north-eastern rim of the Michigan Basin. This creates a series of five basins of fine grained silty clay and clay with intervening bedrock outcrops and deposits of lag gravels and gravels. The textural characteristics of the sediment are related to water depth, which indicates that sediment sorting processes are the product of wind wave action in a deep water lake environment. Sediment composition is closely related to texture, which is reflected in both major and trace element geochemistry.

0820

PHILIP A. MEYERS and KEITH W. DUNHAM, Department of Atmospheric and Oceanic Science, The University of Michigan, Ann Arbor, Michigan 48109; RICHARD A. BOURBONNIERE, National Water Research Institute, Canada Centre for Inland Waters, Burlington, Ontario L7R 4A6. Organic Matter Source Indicators in Lake Huron Sediments: Geolipids, Carbon Isotopes, and Humic Matter Degradation Products.

As part of our continuing organic geochemical study of Great Lakes sediments, we have examined molecular and isotopic indicators of organic matter sources in dated sediment cores from southern Lake Huron. Hydrocarbon distributions in surficial sediments have a strong terrigenous character, whereas distributions deeper in the cores appear more aquatic in origin. This contrast reflects a combination of selective resuspension of bottom sediments on the basis of textural differences and of microbial degradation and resynthesis of geolipids within the lake bottom. Stable carbon isotope ratios of sediment organic matter are -26‰ throughout the cores and indicate a land source for most of this material. Alkaline hydrolysis of humic matter fractions shows that fulvic and humic acid components appear to be formed from aquatic precursors. Humin, which constitutes 70% of sediment organic matter, appears to be derived largely from land-plant detrital material.

0840

KJELL A. JOHANSEN , Great Lakes Research Div., University of Michigan, Ann Arbor, MI 48109; J. A. ROBBINS, Great Lakes Environmental Res. Lab.-NOAA, Ann Arbor, MI 48104. Patterns of Sedimentation and Metal Contaminant Deposition in Southern Lake Huron.

Ca, Cd, Cr, Cu, Fe, Mg, Mn, Ni, Pb, Sb, Sn, Zn, OC, IOC, Pb-210, and Cs-137 were measured in 64 cores obtained in southern Lake Huron (SLH) in 1974-75 in order to determine sedimentation patterns and anthropogenic loadings to SLH. In surficial sediments of the Goderich Basin (GB) concentrations of Ca, Mg, and inorganic carbon (IOC) decreased from E to W. In contrast, organic carbon (OC) was highest along a N-S axis of the GB. Anthropogenically enriched elements (AEE) correlated highly to OC (Cu(0.97)>Pb≥Zn>Co>Hg>Sb> Ni>Cs-137>Sn(r=0.81)). The areal distribution patterns of the total excess deposition (vertically integrated (total concentration-background concentration)) of AEE and of the surficial sediment concentrations of these elements were similar. Cs-137 deposited uniformly on the lake surface accumulated in selected areas. Such focusing, occurring also for contaminant metals, resulted from bathymetric and hydrodynamic factors. The total excess (metric tons) of some AEE in SLH sediments was as follows: Cu, 600; Pb, 2300; Ni, 1000; Zn, 3100; Hg, 5; Sn, 120. The areal distributions of mass AEE and OC accumulation rates were similar. The anthropogenic accumulation rates (metric tons/yr), based upon Pb-210 derived sedimentation rates, of AEE in SLH sediments were: Cu,23;Pb,89;Ni,40;Zn,120;Hg,0.19; Sn,4.5. These rates were 0.38(Cu) to 11.8 (Sn) times higher than the natural rates.

0900

ROBERT J.J.STEVENS AND MELANIE A.T.NEILSON
Water Quality Branch
Canada Centre for Inland Waters
867 Lakeshore Rd.,Burlington,Ontario,L7R 4A6

Nutrient Chemistry of Lake Huron, North Channel and Georgian Bay

Six cruises were conducted between April and November,1980 at 70 stations in Lake Huron, 22 in the North Channel and 40 in Georgian Bay, to assess main lake environmental conditions. Station pattern reflected the need to provide assessment of both potential problem areas and lake trophic status, while maintaining continuity with previous surveys of 1971 and 1974. Cruise frequency coincided with changes in thermal structure so as to provide estimates of seasonal variation. Parameters measured include total, total filtered and soluble reactive phosphorus, total particulate, total kjeldahl, nitrate + nitrite, and ammonia nitrogen, soluble reactive silica, particulate organic carbon, chlorophyll a, conductivity, alkalinity, pH, dissolved oxygen and major ions. Nutrient and chlorophyll concentrations were low throughout the year, indicative of oligotrophic/mesotrophic conditions. The hypolimnetic oxygen deficit rate in the southern basin was within the eutrophic range, but in the extreme oligotrophic in the northern basin.

0920

DAVID C. ROCKWELL
Great Lakes National Program Office
US Environmental Protection Agency
536 S. Clark Street
Chicago, Illinois USA 60605

Spatial Distribution of Dissolved Nutrients by Geographical Regions

Six surveys were conducted from April thru December of 1980 by the USEPA and the Canadian Department of the Environment. Two winter surveys were conducted on the southern basin of Lake Huron and the mouth of Saginaw Bay by USEPA. Results of these surveys will be presented.

Chemical variations between areas were observed and reflect two major influences: 1.) Lake Huron is a mixing basin for outflows from Lakes Michigan and Superior; and 2.) the large amounts of dissolved substances which enter via Saginaw Bay.

Spring total phosphorus concentrations were the lowest observed (5.8 ug/l) since the early 1970's. Surface dissolved reactive silica concentrations in the northern basin decreased from 1.56 + .05 mg/l in April to 0.88 mg/l in September. Nitrate + Nitrite dropped 20% during the same period from spring levels of 0.30 mg/l.

Comparison of 1980 to 1974 segmentation results showed nutrient changes suggestive of improved water quality in the nearshore areas and open lake segments. 1982 total phosphorus concentration levels were lower in 25 of 27 areas.

0940

RUSSELL A. MOLL and WILLIAM Y. B. CHANG , Great Lakes Research Division, University of Michigan, Ann Arbor, MI 48109.

Long-term Trends in Water Quality of Lake Huron.

Long-term trends were identified for conductivity, chloride, sulfate, silicon, nitrate-nitrogen, and total phosphorus in Lake Huron between 1955 and 1980. The trends, which were derived from nine separate studies, were primarily curvilinear rather than linear. These curvilinear trends suggest that the direction of the changes has fluctuated during the 26 years. Changes in direction were noted for chloride, silicon, and total phosphorus between 1970 and 1974. All of the long-term trends for Lake Huron indicated changes on a considerably smaller scale than those identified for Lakes Michigan and Erie; furthermore, most trends provided evidence for decreasing nutrient concentrations. The results indicated that Lake Huron's oligotrophic status remained relatively stable over the past 26 years.

1020

RONALD ROSSMANN , Great Lakes Research Division, The University of Michigan, Ann Arbor, Michigan 48109 - Trace Metal Concentrations in the Waters of Lakes Huron, Erie, and Michigan.

Filtered and unfiltered water samples were collected from Lake Huron in July of 1980 and from Lakes Erie and Michigan in October of 1981. All samples were collected from a depth of 1 m using a metal-free sampler. Those samples filtered were filtered through 0.5 µm pore size teflon filters using a metal-free filtration apparatus housed in a laminar flow hood. Metals measured for one or more of the lakes were Ag, Al, As, Ba, Be, Bi, Cd, Co, Cr, Cu, Fe, Hg, Li, Mn, Mo, Ni, Pb, Sb, Se, Sn, Sr, V, and Zn. Comparing the lakes, Lake Erie had the highest total Al, Ba, Cd, Co, Cu, Fe, Mn, Mo, Ni, Pb, Sr, and Zn concentrations. This is in part related to the resuspension of sediments in western Lake Erie during sampling. Lake Michigan had the highest total Ag, As, Bi, Cr, Hg, Sb, Se, and Sn concentrations. Total As, Be, Co, Fe, Hg, V, and especially Mn were relatively high in Green Bay compared to open Lake Michigan. Lake Huron had the lowest total Ag, Al, As, Cd, Cr, Fe, Pb, Se, and V concentrations. Lake Erie had the highest dissolved Al, Be, Cd, Co, Cu, Fe, Mn, Mo, Ni, Sr, and Zn concentrations. Concentrations of dissolved Ag, As, Bi, Cr, Hg, Li, Sb, and Se were highest in Lake Michigan. In Green Bay, dissolved concentrations of As, Co, Cr, Fe, Mn, Sn, and V were elevated relative to open Lake Michigan concentrations. Lake Huron had the lowest dissolved Ag, As, Cd, Cr, Hg, Ni, Pb, and V concentrations. Metals strongly associated with particulates include Al, Fe, Hg, Mn, Pb, and Zn.

1040

JOHN C. FILKINS , Cranbrook Institute of Science, P.O. Box 801, Bloomfield Hills, Michigan 48013. Organochlorines in offshore waters of Lake Huron, North Channel and Georgian Bay, 1980 and 1981.

Organochlorine toxins were measured in large volume samples of whole water (100ℓ) and suspended particulate (100ℓ - 400ℓ) collected at 18 offshore stations in Lake Huron, Georgian Bay and North Channel during two cruises of the R/V Roger Simons, July 14-28, 1980 and May 13-17, 1981. Methylene chloride extracts of whole water and acetone-hexane soxhlet extracts of GFF glass fiber filters (size fraction .7 µm to 1000 µm) were analyzed for polychlorinated biphenyls (PCBs), hexachlorobenzene, 4,4'-DDT and 4,4'DDE using high-resolution capillary gas chromatography. Concentrations of PCBs ranged from .1 to 3.2 ng/ℓ in whole water and .081 to .182 ng/ℓ in suspended particulate samples. The other organochlorine concentrations were measured at levels below .1 ng/ℓ for whole water and .04 ng/ℓ for suspended particulates.

1100

M. Munawar and I.F. Munawar, Great Lakes Fisheries Research Branch, Canada Centre for Inland Waters, Burlington, Ontario, Canada. L7R 4A6

Phytoplankton of Lake Huron

The horizontal and vertical distribution of Lake Huron phytoplankton was studied on a lakewide basis (22 stations) at approximately monthly intervals from April to December, 1971. Taxonomic identification and enumeration were carried out by the Utermöhl technique. The mean phytoplankton biomass showed a low homogeneous distribution across the lake (0.4 to 0.79 gm-3). Seasonal fluctuations of biomass showed a range of 0.4 to 1.5 gm-3 with diatoms as the most abundant and phytoflagellates as the least abundant group. The size analyses of phytoplankton revealed that netplankton were relatively more abundant than the nannoplankton. Among the nannoplankton, the ultraplankton (5 to 20 µm) was the most common. The phytoplankton of Lake Huron were further studied at selected stations during 1980 to 1982 in conjunction with toxicity studies. These data were compared to the baseline data of 1971 to examine changes in phytoplankton composition. These species data collected during the past 10 years represent an extensive Canadian effort to expand the presently limited knowledge of Lake Huron limnology.

1120

RUSSELL G. KREIS,JR., EUGENE F. STOERMER, and RONALD ROSSMANN. Great Lakes Research Division, The University of Michigan, Ann Arbor, Mi. 48109. Historical perspective of Lake Huron algal studies including the current lake status as determined from 1980 sampling.

Algal studies in Lake Huron date back to 1842, possibly representing the earliest systematic algal reports for all of the Great Lakes. Even though Lake Huron algal records have a long history, development of continuous monitoring programs, surveillance with rigorous sampling intensity and frequency and experimental phycological studies have lagged behind the other Great Lakes. Lake Huron algal studies can be divided into three main time periods: 1) pre-1900, 2)1900-1960 and 3) 1960-present. Collections in the first two periods were strictly qualitative, very local and were concentrated in nearshore zones. The first quantitative phytoplankton investigations were conducted in 1960. Available phytoplankton data show abundances and species composition to have a north-south differentiation, as well as distinct differences in Saginaw Bay compared to the remainder of the basin. Data from Saginaw Bay show phytoplankton abundance peaking between 1974-76 with the offshore waters showing stability or modest increases. 1980 data indicate that abundances have decreased substantially in Saginaw Bay, accompanied by the reduction or elimination of nuisance algal species, ie. Aphanizomenon flos-aquae.

LAKE HURON SYMPOSIUM (Continued)

1140
M. Munawar, Great Lakes Fisheries Research Branch, Canada Centre for Inland Waters, Burlington, Ontario, Canada. L7R 4A6

Differential toxicity of Lake Huron phytoplankton size assemblages to contaminants

During the period 1980 to 1982, experiments were conducted in Lake Huron to determine the impact of contaminants (heavy metals) on phytoplankton Carbon-14 uptake as part of the continuing toxicity research programme of the Great Lakes Fisheries Research Branch in the Great Lakes. *In situ* as well as illuminated incubator experiments were performed aboard the vessel C.S.S Bayfield. The experimental matrix included algal fractionation bioassays, species/size compositions and chlorophyll *a*/size distributions. Sources of contaminants used were dilution series of metal and metal-nutrient mixtures. The results indicated a differential response of various size assemblages of phytoplankton to these contaminant mixtures as shown by the enhancement or inhibition of Carbon-14 uptake. The nannoplankton, particularly the smaller size fractions, were found to be sensitive to some contaminant mixtures and less sensitive to others. These results have strong ecological implications for food chain dynamics since nannoplankton are known to be the preferred food of herbivorous zooplankton.

SOCIOECONOMIC ASPECTS OF COASTAL RECREATION

0800-1000 Room 102

Convenor: Robert Buerger

0800
Francis M. Domoy
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"Great Lakes Recreation/Tourism Futurescapes"

The research project "Great Lakes Recreation/Tourism Futurescapes" was an attempt to portray future scenarios. The future scenarios have been linked to the Delphi planning process into which opinion leaders surrounding the Great Lakes have contributed time and effort. The objectives of this forecasting effort can simply be listed as follows: (1)to determine future economic, social, and physical environmental scenarios for the Great Lakes coastline; (2)to identify trends within specific time periods as suggested by the years 1985, 1990 and 2000; (3)to make recommendations as to educational programming areas based upon specific scenario characteristics and descriptors. The economic future scenario ranked water-based recreation, sportsfishing, technological development, and an overall emphasis on private investment in a service economy. The social future scenario presented a lengthening of the tourist season, planned vacations, middle-income consumption, and preference for associate and sensory behavioral forms. The physical future scenario pointed to an increase in coal power generation, water quality, and construction of recreation facilities.

0820
TOMMY L. BROWN
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The Relative Dependence of Great Lakes Tourism on Other Segments of the Local Economy

Many rural areas along the Great Lakes coast have historically suffered from the lack of a diversified economy. Low populations, distance from markets, and lack of investment capital have all been cited as reasons for suppressed economies. Tourism has often played a prominent role in the limited economic development that has occurred in many Great Lakes communities. Because of the success tourism has achieved in various sections of the Great Lakes, it is common for planners and developers to continue to concentrate on tourism in future development strategies. This paper examines the relationships between tourism and other economic sectors. A general finding is that a more balanced economy is not only more stable seasonally, it actually enhances tourism.

0840

MICHAEL P. VOILAND, SUNY/Cornell Sea Grant Program, SUNY, Brockport NY 14420. The rise of Lake Ontario's charter boat industry: some indications of the socioeconomic impact of a developing salmonid fishery.

Due to salmonid stocking efforts of fishery agencies in New York and the Province of Ontario, Lake Ontario has developed into a sportfishery of local, regional and national significance. Recent studies indicate that the fishery is having substantive regional economic effects, principally due to angler expenditures made at the retail level. Since 1975, when no charter fishing operations existed on the lake's south shore, a charter industry has arisen, primarily based on salmonid angling.

As of late 1982, an total of 115 licensed captains were identified, via their advertising, as working out of New York ports. A survey of these operators helped to profile the new industry.

Survey results and other field observations indicated that over 90 percent of the businesses were carried out as sideline, seasonal occupations. The typical vessel was 23 feet in length, valued at $15,347 and trailerable. The captain conducts, on average, 30 charters annually and has a total of $29,813 invested in capital equipment. The industry's capital assets were in excess of $3 million in 1982.

Based upon other economic studies of charter industries elsewhere, it is reasonable to estimate that the lake's charter fleet had a regional economic impact of close to $2 million in 1982.

0900

J. RICHARD PFUND, Department of Industrial Arts & Technology, SUNY, Oswego NY 13126. Safe Boating Education: Concerns - Efforts - Needs

Boating safety has become an important factor in our way of life. Between 60 and 70 million Americans are on the water each year using approximately 14.5 million pleasure boats. In 1980 alone there were 5,513 reported boating accidents resulting in 1,360 deaths. Recent restructuring of the U.S. Coast Guard Boating Safety Program has reduced their effects in this field by 66% in the past two years. This report to the Conference on Great Lakes Research will provide information collected to date concerning the programs of the National Safe Boating Council and its member organizations; Boat Owners Association of the U.S. Education Foundation; American Red Cross; and other public and private associations and organizations as they attempt to fill the boating safety "education gap." A correlation of these programs within a needs matrix should assist in identifying the work to be done in this important water research related field.

0920

MICHAEL W. DUTTWEILER
Sea Grant Extension Program
Fernow Hall, Cornell University
Ithaca, New York 14853

Communicating Human Health Implications of Great Lakes Fish Contaminants

Effective communication of potential human health implications of Great Lakes fish contaminants is a shared responsibility for health, resource management and educational institutions. A wide range of educational techniques are used across the Great Lakes basin resulting in highly variable consumer awareness and understanding of fish contaminants. Current techniques of communicating fish contaminant information were reviewed and analyzed for content, intended messages and effectiveness in influencing fish consuming publics. Selected health communications and consumer education research was reviewed. Parallels were drawn to illustrate communication needs related to fish contaminants. It was concluded that the effectiveness of current fish contaminant educational programs is limited and that a blend of informational and educational activities is required to produce an informed fish consuming public. Specific suggestions were made for communicating environmental occurrence data, health research and consumer options.

0940

Robert B. Buerger, Sea Grant Extension Program, 66 Sheldon Hall, SUNY, Oswego, NY 13126 The Perceptional Differences of Beach Users and Management Staff Towards the Recreational Attributes of Lake Ontario State Park Beaches.

Growth in the concentration of industry, business residential and private recreation use has resulted in only two percent of the relatively undisturbed coastal lands remaining in public ownership. The limited amount of remaining coastal land for expansion coupled with projected increased demand for coastal recreation facilities places growing pressure on those who presently manage public recreation areas in the coastal zone to assure that the opportunity they provide meet the expectations of the users. During the summer of 1982 the users and management staff at three eastern Lake Ontario beach state parks were studied to determine their perception of the attributes of beach recreation. Management staff was then asked to predict what users would identify as important beach attributes. The results of the study indicate that users perceptions need to be incorporated into management decisions affecting the recreational character of the beach.

BIOASSAY

0800-1200 Room 103

Moderator: Richard Sugatt

0800

E. W. WILDE , R. J. SORACCO , L. A. MAYACK , R. L. SHEALEY, T. L. BROADWELL , and R. F. STEFFEN . [1]Fresh Water Institute, Rensselaer Polytechnic Institute, Troy, NY 12181, [2]E.I. DuPont de Nemours & Co., Aiken, SC 29808, [3]Enwright Laboratories, Greenville, SC 29606.

Comparison of Chlorine and Chlorine Dioxide Toxicity to Fathead Minnows and Bluegill.

The comparitive toxicity of total residual chlorine (TRC) and chlorine dioxide (ClO_2) was evaluated by conducting 96-h flow-through bioassays with three types of fish. The fish were subjected to an intermittent exposure regime in which biocide residuals were present for approximate 2-h periods beginning at 0, 24, 48, and 72 h into the tests. These conditions simulated the antifouling procedure (1h/day biocide addition) used to control biofouling of nuclear reactor heat exchangers at the Savannah River Plant near Aiken, South Carolina. LC_{50} values showed that ClO_2 was approximately 2 to 4 times more toxic than TRC to: (1) juvenile and one-year-old fathead minnows (Pimphales promelas), and (2) young-of-the-year bluegill (Lepomis macrochirus). The TRC mean 96-h LC_{50} values were: 0.08 mg/L for juvenile fathead minnows 0.35 mg/L for adult fathead minnows and 0.44 mg/L for young-of-the-year bluegills. The ClO_2 mean LC_{50} values were: 0.02 mg/L for juvenile fathead minnows, 0.17 mg/L for adult fathead minnows and 0.15 mg/L for young-of-the-year bluegills.

The information contained in this paper was developed during the course of work under contract No. DE-AC09-76SR00001 with the U.S. Department of Energy.

0820

KATHRYN H. MARTIN
Research Center
State University of New York
Oswego, NY 13126

Effects of a Lake Ontario Fish Diet on Reproduction in Voles

Prairie voles were fed a chronic diet of 70% rabbit chow and 30% Lake Ontario salmon (known to be contamined with mirex and PCB's). Most of the animals were bred and reproductive success ascertained. Animals were sacrificed for liver pathology and organochlorine residue analysis. Results were compared to data obtained from control groups.

Voles fed salmon showed a significant decrease in the # young born/litter and weaned/litter. Liver examination revealed increased vacuolation and swelling of parenchymal cells.

Unbred females retained the most organochlorine contaminants, mirex and/or PCB's. Both mirex and PCB's were found in feti and nursing young.

Some young from all groups were raised on diets of 100% rabbit chow and were bred as adults. All reproduced normally suggesting no permanent reproductive effects from fetal and postnatal exposure to mirex and PCB's.

0840

PAUL M. SAWYKO , RG&E, 89 East Ave., Rochester, N.Y. 14649 and A. GARRY SMYTHE, Beak Consultants, Inc. 12072 Main Rd., Akron, N.Y. 14001.

Findings of Rochester Gas and Electric's Cold-Shock Studies on Selected Fishes of Lake Ontario.

In 1979 RG&E initiated investigation into the potential for cold-shock to fish at its Lake Ontario power plants for such species as brown trout (Salmo trutta) and rainbow trout (Salmo gairdneri). Test organisms were collected from the discharge canal at RG&E's Ginna Station which had discharge water temperatures of 11.5-15.0°C. These fish were then immediately placed in test waters ranging from 0.4-0.6°C and held for 96 hours (Immediate Cold-Shock) or were acclimated to discharge temperatures for a maximum of two weeks and then placed in test waters for 96 hours (Acclimated Cold-Shock). During ICS Testing 99 brown and 70 rainbow trout were tested with resulting survival rates of 97% and 73%, respectively. ACS Testing completed through 1981 resulted in 92% survival for 37 brown trout tested and 62% survival for 13 rainbow trout tested. Long term survival of these fish has been indicated by subsequent tag return information. Results indicated some substantial differences from previously reported literature, suggesting that application of laboratory results should not be generalized to include a field location for which relevant parameters are unknown. Study results also suggest that fish in the discharge canal are not physiologically adapted, i.e. acclimated, to discharge temperatures, but are instead acclimated to some temperature intermediate between lake ambient and discharge canal temperatures.

0900

JUAN M. RIBO and KLAUS L.E. KAISER, National Water Reserach Insititue, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario, L7R 4A6 - Correlation of acute and sublethal effects of selected chemicals to rainbow trout (Salmo gairdneri) with the acute toxic effects on photoluminescent bacteria.

Investigations on structure-activity correlations of toxic chemicals to fish require statistically valid sample sizes and good reproducibility of the results. Frequently, neither condition is met, particularly with compounds of very high or very low toxicity. Also, such tests are expensive and time consuming relative to certain other tests.

We report here on the five and fifteen minute 50 percent reductions of light emitted by photoluminescent bacteria (Microtox[R] Test) in relation to acute and sublethal effects of the same chemicals to rainbow trout. In particular, chloro-phenols, chloro-benzenes, and para-substituted phenols have been investigated. Results will be discussed both in terms of correlation of toxicity data between fish and bacteria and between toxicity and molecular parameters.

0920

RICHARD L. JONES-WITTHUHN , ARTHUR S. BROOKS, and, MARTIN E. BORAAS. Center for Great Lakes Studies and Department of Zoology, Univ. Wis.-Milwaukee, Milwaukee, WI 53201. The importance of sulfur concentration in defining the toxicity of selenium to the alga Chlamydomonous reinhardtii.

The toxicity of selenium to Chlamydomonas appears to be due to interference with the normal uptake of sulfur. The toxic effects are therefore not limited to a particular selenium concentration but rather dependent on the ratio of sulfur to selenium. Batch and continuous culture methods have shown different growth rates, steady states and final productivity dependent on the ratio of sulfur to selenium (S/Se). A concentration of 750 ug/1 selenium in media with 6 mg/1 sulfur shows only a slight reduction in algal production using continuous culture methods. However, concentrations of 250 ug/1 can reduce algal growth by 75% if the sulfur level is only 500 ug/1. When attempting to define the toxicity of selenium to certain algal species it is important to look not only at the selenium concentration but more importantly at the ratio of sulfur to selenium. By using very high S/Se ratios, even high concentrations of selenium can be made to appear relatively innocuous.

0940

BOYUM, KENT W. and ARTHUR S. BROOKS, Center for Great Lakes Studies and Department of Zoology, University of Wisconsin-Milwaukee, Milwaukee, WI 53201. Differential toxicity of selenium on lab cultures of Daphnia magna and field isolates of Daphnia pulicaria.

Selenium has been shown to be an essential micronutrient for organisms while exhibitng toxic effects on algae, zooplankton, and fish populations. The 48 hr LC-50 of a lab culture of Daphnia magna was 1.0105 mg/1 Se, as Na_2SeO_4. The 48 hr LC-50 of a field isolated culture of Daphnia pulicaria from Lake Michigan was 0.2458 mg/1 Se, as Na_2SeO_4. These results indicate a tolerance of Daphnia magna to selenium four times that of Daphnia pulicaria.

Twenty-eight day chronic studies were run on both species in Lake Michigan water at selenium levels of 0, 0.05, 0.10, 0.50, and 1.00 mg/1 Se as Na_2SeO_4. Chlamydomonas reinhardtii, raised in the appropriate Se concentration, was fed daily to each culture. The chronic studies indicated D. magna to be more resistant to selenium levels than D. pulicaria. The use of D. magna as a laboratory bioassay animal may be inappropriate in estimating the tolerance of natural populations to an introduced toxicant. Studies on sub-lethal effects of Se on these populations of Daphnia continue.

1020

ALENA MUDROCH and MOHUDIN MUNAWAR, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario L7R 4A6.
Bioassessment and geochemistry of contaminated sediment.

Programs in the Great Lakes have focused in the past mostly on problems of nutrient enrichment and water-borne contaminants. The Great Lakes Water Quality Agreement has emphasized an ecosystem approach; however, studies dealing with nutrient and contaminants input from sediments and its eventual impact on the biota in the Great Lakes are lacking. The IJC dredging subcommittee has recently identified the importance of bioassessment in addition to the chemical characterization of sediment. In this context, research was initiated at CCIW to assess the impact of sediment-associated contaminants on phytoplankton and zooplankton. Some typical examples to demonstrate the importance of including bioassessment studies in water quality planning are discussed.

1040

GEORGE B. FLYNN , John E. Gannon, Ronald J. Scrudato, SUNY-Oswego, Oswego, NY 13126
Biological and Physicochemical Interactions of Stabilized Scrubber Sludge/Fly Ash Blocks with the Freshwater Environment of Lake Ontario

Combustion wastes from coal fired power plants, consisting of scrubber sludge and fly ash, have been stabilized by formation into 20cm x 20cm x 40cm blocks. These scrubber sludge/fly ash (SSFA) blocks were evaluated for compatibility with the Lake Ontario environment, in response to proposed use of SSFA in underwater construction.
An elutriate prepared from crushed block material was evaluated for bioreactivity in laboratory bioassay procedures utilizing Selenastrum capricornutum and Daphnia pulex as test organisms. Elutriate concentrations of 0.1, 1, 5, 10 and 20% were used in the algal bioassay. Maximum standing crop as percent of control was 96, 103, 90, 78, and 63%, respectively. 96 hr. bioassays involving D. pulex revealed no such toxic effect.
In the fall of 1981, a number of SSFA and cement (control) blocks were placed in Mexico Bay, southeastern Lake Ontario. Blocks were sampled in the summer of 1982, and were evaluated for chemical and physical stability as well as benthic community development. Compressive strength of recovered blocks served as a measure of physical stability. Chemical stability was assessed through trace metals analyses of gastropods present on block surfaces. Community analyses of SSFA blocks showed markedly diminished colonization with respect to many of the major invertebrate groups while exhibiting greater development of the amphipod populations.

1100

Richard Playle
Freshwater Institute
501 University Crescent
Winnipeg, Manitoba. R3T 2N6

Radioactive Aluminum for Fish Toxicity Studies

Elevated Al levels (>100 µg/L) in acidified waters have recently been found to be toxic to fish. Aluminum has been shown to be absorbed/adsorbed by fish and the toxic site of Al is assumed to be at the gills. However it is unclear whether Al is adsorbed preferentially onto the gills or onto the body surfaces in general. Electron microscopy and an Al-backscattering device have been unsuccessful in localising Al on fish gills.

A radioactive Al tracer should provide a means to follow Al uptake by fish. Unfortunately ^{26}Al is very expensive commercially (≈$50,000/µCi). Some ^{26}Al has been prepared by bombarding high-purity Al foil with protons in a cyclotron. Iron impurities were transformed to ^{56}Co. The removal of the ^{56}Co was problematic but it appears the ^{26}Al will be very useful in determining the reactive sites of Al. Likewise laboratory-scale sedimentation or speciation studies would be feasible. ^{26}Al prepared in this fashion costs ≈$1,000/µCi.

1120

C. J. HART -1, H. C. Duthie-1, P. T. S. Wong-2
1-University of Waterloo, Waterloo, Ontario, N2L 3G1. 2-Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario. L7R 4A6

Effects of Metal Mixtures On Natural Phytoplankton Communities in Lake Column Simulators

The Community structure response of the natural phytoplankton of Lake Ontario to heavy metal spikes (Cu, Cd, Zn) was studied with the use of four stainless steel lake column simulators (LCS). Varying combinations of metals at different concentrations based on the International Joint Commission Water Quality Objectives for Lake Ontario (Cu 5.0, Cd 0.2, Zn 30.0 - $\mu g\ L^{-1}$) were added to volumes of 3300 liters of screened (153 um) raw lake water. The phytoplankton community was then monitored for 12 to 21 days.
Earlier reported results dealing with depression or stimulation of different measures of production indicated that both antagonistic and synergistic effects were occuring in the phytoplankton community. Subsequent findings indicate that increased metal concentrations caused shifts in phytoplankton community structure favoring less susceptible species.
Blue-green algae were dominant at low levels of toxicity. Green algae persisted while other groups disappeared or were greatly reduced. Cryptophytes and dinoflagellates proved to be the most susceptible groups of those surveyed.

1140

DANIEL H. POPE, LAWRENCE W. EICHLER , THOMAS H. COATES, JEFFREY F. KRAMER, AND REGINALD J. SORACCO. Fresh Water Institute, Rensselaer Polytechnic Institute, Troy, NY 12181. The Effect of Ozone on Legionella pneumophila and Other Bacterial Populations in Cooling Towers.

Ozone was found to reduce the numbers of bacteria detectable by plate counts and the numbers of presumptive Legionella pneumophila (DFA reactive cells) including those which were INT positive, in test cooling towers. The numbers of DFA reactive L. pneumophila eventually reached those of the make-up water (Troy, N.Y., city water). Microbial slime on the interior tower surfaces and Pseudomonas populations in the tower waters, were also reduced. Water chemistry parameters measured showed no tendency toward a condition which would cause accelerated deterioration of tower material.

ICE AND CLIMATE

0800-1000 Room 106

Moderator: Robert Sykes

0800

RAYMOND A. ASSEL
Great Lakes Environmental Research Laboratory, NOAA, 2300 Washtenaw, Ann Arbor, MI 48104 USA

Lake Huron Ice Cover Climatology

As part of a study to update the Great Lakes ice atlas a 20-year (1960-79) digital ice concentration data base was established for Lake Huron and this data set was partitioned into 9 half month periods (December 16-31 through April 16-30). Maximum, minimum, and median ice concentrations were calculated for each period for 5 x 5 km grid cells which constitute the surface area of the lake. This analysis will be published as part of a National Oceanic and Atmospheric Administration Great Lakes ice atlas. In this presentation lake averages of the (1) maximum and minimum, and (2) the median ice concentrations for each half month are used to illustrate lakewide trends of ice cover variation over the period of record and lakewide trends in the normal seasonal progression of ice cover extent, respectively. In addition ice charts of the median ice cover are presented to illustrate the normal distribution patterns of ice concentrations over the 9 half month periods.

0820

GORDON M. GREENE
Great Lakes Environmental Research Laboratory
2300 Washtenaw, Ann Arbor, MI 48104 USA

Forecasting Ice Events on the St. Marys River

A ten-year time series of meteorological variables, water temperatures, and ice observations was used to develop forecasting methods for the prediction of ice cover formation, growth rates, and ice cover decay at five sites along the St. Marys River, the channel connecting Lake Superior and Lake Huron. Ice cover formation is predicted by use of a site-specific heat transfer coefficient and observed water temperatures at Sault Ste. Marie. Standard errors in the predictions at the five sites are 30-60% lower than the corresponding standard deviations of the observations. Ice cover growth can be simulated using a simple Stefan relation with an average standard error of 6 cm at the time of maximum thickness. Unlike the ice formation prediction method, ice growth prédiction is quite sensitive to the accuracy of the air temperature forecasts. No one method can be used to predict ice cover breakup at all five sites. Breakup dates are most strongly correlated with the date at which water temperature rises above 0°C at Sault Ste. Marie. This date, however, can be less than one week prior to breakup at some sites or may occur after breakup. Maximum ice cover thickness in the river and maximum ice cover extent on Lake Superior are both poor predictors of the breakup dates.

0840

W.A. VANDEVALK, H.T. SHEN , G.B. BATSON, and I.L. MAYTIN, Department of Civil and Environ. Engineering, Clarkson College of Technology, Potsdam, N.Y. 13676

Field Investigation of Hanging Ice Dams in the St. Lawrence River

The existence of hanging dams in ice-covered rivers has been known for many years. The presence of hanging dams in a river constricts the flow cross section and could cause large head losses. In this paper, results of a field study on the hydraulic characteristics of hanging dams in the St. Lawrence River are presented. Major conclusions obtained in this study are: a) the channel bottom topography may be used to provide a convenient guide for determining the location where a hanging dam will form beneath the ice cover; b) the shape of a hanging dam is affected by river currents; c) the critical Froude number for the progression of the ice cover and the critical velocity of deposit of ice particles underneath the dam are 0.06 and 3 fps, respectively; d) the ice surface roughness at the upstream side of the hanging dam is smaller than that of the downstream side; e) the gross roughness coefficient of the hanging dam remains relatively constant.

0900

ROBERT S. WEINBECK, PAUL J. MROZ, Department of the Earth Sciences, SUNY College at Brockport, Brockport, NY 14420 and WOKR-TV, W. Henrietta Rd., P.O. Box L, Rochester, NY 14623

Winter precipitation patterns of the southern and eastern shores of Lake Ontario.

Significant areas of the United States to the lee of the Great Lakes are subject to a unique winter precipitation phenomenon - lake effect snow squalls. This mesoscale activity is presently not well understood or capable of detailed forecasting. In cooperation with WOKR-TV in Rochester, SUNY at Brockport is proceeding with the development of a snow squall climatology based on radar snow band morphology and positions. Preliminary results of the Winter 1983 season will be presented. Also historical precipitation patterns from a 12 station climatological network surrounding the southern and eastern half of Lake Ontario as derived from Empirical Orthogonal Function analysis of up to 125 years of precipitation values are shown. Patterns are derived for December, January, February and the combined Winter season. The monthly change in patterns in relation to each other and the 1983 radar results will be shown. Some speculations on the current level of predictability based on these results may be advanced.

ICE AND CLIMATE (Continued)

0920

ANDREJ SAULESLEJA
Hydrometeorology Division
Atmospheric Environment Service
4905 Dufferin Street
Downsview, Ontario, Canada M3H 5T4

Impacts of CO_2 Warming on the Great Lakes

Energy balance calculations of increases in lake surface temperatures and evaporation are performed using results from climate models with doubled CO_2 atmospheric content (3°C mean air temperature change, various assumptions on seasonal distribution and a 4 w/m^2 increase in net radiation). Calculated water temperature increases are typically one degree greater than air temperature in summer and one degree less than air temperature in winter for Lake Superior, but from near zero (spring) to near one degree (fall) for Lake Erie. Annual evaporation is increased by 99 mm or 20% for Lake Superior and 117 mm or 13% for Lake Erie. Modelled patterns of precipitation (Manabe et al.) are compared to present day patterns and amounts. Increased precipitation may offset an 8% reduction in outflows from the Great Lakes system resulting from increased evaporation. More frequent severe weather is likely in the summer season.

0940

ALFRED J. STAMM , PETER CAPLAN, and ROGER A. HINRICHS; State University of New York, College at Oswego, Oswego, New York 13126 Examination of Rain under the Plume from an oil-fired power Plant

Rain was sampled near an oil-fired power plant in Oswego, N.Y. This plant burns high-sulfur oil (up to 2.8% sulfur) with MgO added to protect the stack, so it was of interest to investigate the net change in pH under the plume. Closely-spaced rainwater samples were taken from 3 rows perpendicular to the plume at roughly 2, 3, and 4 km from the stack, with the plume in low stratus clouds. Analysis showed that the rain was less acidic under the plume in the first row and comparable to background by the third row. A strong increase in magnesium and some increase in sulfate was measured under the plume, but no increase in nitrate was seen. Vanadium was found to be a good indicator of plume presence.

CONTAMINANTS

0920–1200 Room 105

Moderator: Murray Charlton

0920

V. ELLIOTT SMITH, Cranbrook Institute of Science, P.O. Box 801, Bloomfield Hills, MI 48013. Bioaccumulation of Sediment Polychlorinated Biphenyls (PCBs) Traced Through Isomer Ratios.

Unknown quantities of polychlorinated biphenyls (PCBs) stored in polluted sediments are re-introduced to the food chain directly through bottom foraging by certain fish and waterfowl. Estimation of this uptake as distinct from other routes of biocontamination is difficult because contaminant mixtures in organisms are often complex and variable. Selective storage, metabolism and excretion of PCB isomers are possible causes of variability among these components.

Pair ratios of over 100 PCBs in Detroit River sediments were compared with such ratios in bottom-feeding benthos, fish and ducks from the same site. Isomer pairs yielding the most consistent ratios were identified by capillary gas chromatographic comparison with some 200 synthetic PCB standards.

These isomers are considered the best indicators of sediment-derived PCBs in fauna. Total PCB uptake from local sediments was inferred from the fractional quantity of indicator isomers in sediment PCBs. These results suggest possible use of selected isomers to identify sources of bioaccumulated PCBs and to estimate relative contributions from local sediments.

0940

SWIATOSLAW KACZMAR, MATTHEW J. ZABIK , FRANK D'ITRI, Pesticide Research Center, Michigan State University, East Lansing, Michigan 48824

The Extent and Geographical Distribution of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Residues in Michigan

Samples of Carp and Sucker were collected from each of the major rivers in Michigan and analyzed for residues of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Residues ranging from 17 to 586 parts per trillion were detected in samples originating at various sites throughout southern lower Michigan indicating that 2,3,7,8-TCDD is more widely distributed in Michigan than previously thought.

1020
PAUL W. RODGERS, PAUL L. FREEDMAN, DAVID L. HEIDTKE, Limno-Tech, Inc., Environmental Consultants, 15 Research Drive, Ann Arbor, MI 48103
CLIFFORD P. RICE, Great Lakes Research Division, University of Michigan, Ann Arbor, MI 48109
PCB distribution in Saginaw River and model forecasts.

The Saginaw River was monitored in 1980-81 for PCB levels in water, sediments, fish and other biota. Sediment distribution showed heterogeneity, with elevated levels adjacent to the municipalities of Saginaw and Bay City. These recent values of PCBs showed a decline in concentrations when compared to historical data. In particular, fish concentrations indicated values that were predominantly below the temporary threshold value for human consumption of 5 mg/kg. Model simulation of the system indicates that water concentrations are now driven by atmospheric contributions and that the sediment response time to changing PCB loads is on the order of eight years. Model output also indicates that much of the PCBs introduced to the Saginaw River is ultimately transported to Saginaw Bay.

1040
S.W. EFFLER , S.P. DEVAN, P. RODGERS and C.T. DRISCOLL, Upstate Freshwater Institute, Inc., Syracuse, NY 13214, Allied Corp., Jamesville, NY 13078, Limno-Tech, Inc., Ann Arbor, Mich., Syracuse Univ., Syracuse, NY 13210. The Recent History (1970-1982) and Nature of Chloride Loading to Lake Ontario from Onondaga Lake, NY.†

Onondaga Lake is a small urban lake located within Metropolitan Syracuse, NY, which receives chloride enriched waste from an adjoining chlor-alkali manufacturer. Releases from the lake reach Lake Ontario via the Oswego River. Onondaga Lake represents the single largest source of chloride to Lake Ontario. The percent contribution of the lake's releases to published estimates of the total (including the upstream Great Lakes) and tributary (to Lake Ontario only) loadings ranged from 8-27% and 28-96%, respectively, since 1970. Time scales of substantial variability in loading from the lake range from daily to yearly. Daily variations result from the rather unusual hydraulic conditions at the lake outlet. Yearly variations are due to changes in production at the chlor-alkali manufacturer. The impact the expected closing of chlor-alkali manufaturing in Syracuse will have on the future chloride concentration of Lake Ontario is evaluated through application of a long term integrated chloride model for the Great Lakes.

†A contribution of the Upstate Freshwater Institute, Inc.

1100
W.H. HYATT , J.D. FITZSIMONS and D.M. WHITTLE, DFO, Great Lakes Fisheries Research Branch, P.O. Box 5050, Burlington, Ontario L7R 4A6. A Biological Tissue Archive for Retroactive Chlorinated Hydrocarbon Analysis of Great Lakes Biota.
The 1978 Canada-U.S. Water Quality Agreement describes the need for maintaining archives of all segments of the Great Lakes ecosystem. This study is intended to present appropriate preservation and storage conditions required for maintaining the integrity of chlorinated hydrocarbon residues for extended periods in a variety of biological tissues. Contaminant levels were measured in fish tissue homogenates, net plankton, zooplankton and a benthic invertebrate (Mysis relicta) after specific storage periods. Studies involved storage of samples at -20°, -40°, -80°and -196°C. Additional samples were preserved with 5% formalin and then frozen at -20°C, freeze-dried or oven-dried at 30°C or 60°C, with final storage at room temperature. Other samples, prefrozen in liquid nitrogen, were held at -20°C or -40°C. Some samples were acid digested and then solvent extracted. Some whole fish, fillet and liver homogenates were inoculated with C^{14}-PCB and stored at various temperatures. The efficiency of different extraction methods was subsequently compared for whole fish homogenates. Preliminary data on residue levels indicate that freeze-drying and oven-drying are inadequate preservation techniques for the archiving of biological tissues for retrospective residue analysis. Storage of a variety of tissues at -20°C or -40°C also results in losses of some residues.

1120
JEAN M. CZUCZWA AND RONALD A. HITES. School of Public and Environmental Affairs and Department of Chemistry, Indiana University, Bloomington, IN 47405. Polychlorinated Dibenzodioxins and Dibenzofurans in Sediments from Saginaw River and Bay and Lake Huron: Sources and Fates.

Polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) are formed by the combustion of municipal and chemical wastes. Indeed, it has been suggested that PCDD and PCDF have been ubiquitous in the environment since the origin of fire. We have addressed this question by measuring these compounds in ultimate environmental sinks such as lacustrine sediments. Several locations in the Saginaw River and Bay and southern Lake Huron were studied. Sediment cores, which preserved the historical input of materials were quantitated for PCDD and PCDF. The concentration ratios of various PCDD and PCDF were similar to each other and to fly ash from municipal incinerators. This suggests that combustion is the main source of the PCDD and PCDF at these locations. The depth-concentration profiles in these cores showed that PCDD and PCDF increased dramatically at a depth corresponding to approximately 1940 and remained high until the present time. This sedimentary historical record agrees well with the United States' production of chlorinated organic compounds and suggests that chlorinated precursors of PCDD and PCDF are present in combustion fuels and are the major source of PCDD and PCDF in the environment. Low or undetectable levels of PCDD and PCDF at depths corresponding to times before 1940 show that PCDD and PCDF were not with us since the advent of fire.

CONTAMINANTS (Continued)

1140

DONALD D. ADAMS', Center for Earth and Environmental Science, SUNY-Plattsburgh, NY 12901 and GEORGE G. HESS, Dept. Chemistry, NICHOLAS J. FENDINGER, DAVID A. DEIS, and DANIEL J. WAGEL, Brehm Laboratory, Wright State University, Dayton, OH 45435

Interstitial Water Geochemistry of Dissolved Organic Matter and Gases in the Recent Sediments of Lake Erie and Hamilton Harbour

Sediment cores were collected from four stations in Lake Erie's three basins and two stations in Hamilton Harbour. N_2, CH_4,CO_2 gases and DOC were measured at each station. Other lake and harbor cores were specially processed to identify the suite of dissolved organic compounds by GC/MS; these were separated into purgeables, base/neutral and acid extractable fractions. Gas and DOC composition of these cores were reported at previous meetings but will be briefly discussed. Purgeables identified in the cores were benzene, dichloromethane (?), ethylbenzene, hexane (?), toluene, xylene, indane or methylstyrene, and C_3, C_4 benzene. An unresolved hump in the harbor sample included aromatics and alkenes but not alkanes. Open lake interstitial water was relatively free of base/neutral and acid extractables, however, a wide variety of dissolved organic compounds were evident in the harbor samples. These were alkanes and heterocyclic and aromatic substances including polynuclear aromatics. Higher molecular weight PNA's and chlorinated compounds were not found. The harbor acid extract contained p-cresol and three phthalates. The identification of these compounds dissolved in mobile interstitial water phases presents environmental problems.

HYDROLOGY

1020-1140 Room 106

Moderator: Robert Sykes

1020

FRED BOGLIONE , LARRY SHERMAN and DAVE MELFI, U.S. Army Engineer District, Buffalo, 1776 Niagara Street, Buffalo, NY 14207 -

Owasco Lake management plan analysis.

Owasco Lake is located in the central part of the Oswego River Watershed which drains an area of approximately 5100 square miles in Central New York State. A control structure on Owasco Outlet affords regulation of lake levels and outflows: (1) to provide for flood protection and fish and wildlife management; (2) to insure adequate storage for municipal water supply and water-based recreation; and, (3) to provide flow for hydropower production and waste assimilation downstream. A study was performed to examine the feasibility of modifying the existing lake level management plan for the lake in order to more fully utilize the water resources of the area. A computer program developed by the U.S. Army Corps of Engineer's Hydrologic Engineering Center was used to simulate lake elevations and outflows over a fifty year period of known inflows under various management plans. Using these simulated elevations and outflows together with flood damage curves, condition-value functions for recreational boating and beaches, a hydropower production model, and environmental constraints, each plan was evaluated and analyzed for impacts. By altering the existing management plan, average annual flood damages can be reduced by $5,000 and average annual hydropower value can be increased by $10,000. This can be accomplished with negligible impacts to recreation or fish and wildlife. In addition, water supply and water quality releases are met at all times.

1040

HOLLY C. HARTMANN and THOMAS E. CROLEY II Great Lakes Environmental Research Laboratory, NOAA, 2300 Washtenaw Ave., Ann Arbor, MI 48104

Incorporation of Remotely-Sensed Snowpack Water Equivalent into the GLERL Large-Basin Runoff Model

The Great Lakes Environmental Research Laboratory (GLERL) Large-Basin Runoff Model is used to estimate Great Lakes inflows in operational hydrology studies. Snowpack, determined by a simple heat balance is the weakest part of the model although most runoff in some Great Lake basins comes from the snowpack. Explicit identification of snowpack in the model allows easy incorporation of areal snowpack water equivalent data provided by an airborne gamma radiation snow survey of the Lake Superior basin during the winter of 1982-1983. By using the survey data to update snowpack and ancillary storages in the model the goodness-of-fit between actual and model weekly outlfow volumes is improved for the Lake Superior subbasins. The improved model demonstrates the value of remotely-sensed snowpack water equivalent data for the GLERL Runoff Model in forecasting and simulation settings.

HYDROLOGY (Continued)

1100

THOMAS E. CROLEY II , Great Lakes Environmental Research Laboratory, NOAA, 2300 Washtenaw Ave., Ann Arbor, Michigan 48104

Lakes Ontario and Superior Basin Runoff Model Parameter Comparison

The Great Lakes Environmental Research Laboratory (GLERL) Large-Basin Runoff Model is applied to the subbasins about Lakes Ontario and Superior. It is an interdependent tank-cascade model of weekly runoff volumes coupled with linear reservoir concepts. Snowmelt and net supply are based on a simple heat balance while partial-area concepts are used to determine infiltration and surface runoff; evapotranspiration losses are determined from available energy and moisture in a complementary relationship between energy available and energy used. The parameters of the model are physically interpretable and their values reflect general basin characteristics readily observed from outside physical considerations. Physical parameter interpretations are made for all subbasins to indicate both inter-and intra-basin geophysical and climatic variations present for Lakes Ontario and Superior, and to provide insight into data needs for these areas.

1120

Jan A. Derecki
Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, Michigan 48104

Effect of Channel Changes in the St. Clair River During the Present Century

Periodic man-made changes in the outlet of Lake Huron through the St. Clair River date back to the middle of the last century. These artificial channel changes are well documented during the present century and consist of dredging for commercial gravel removal in the upper river during 1908-25 and uncompensated navigation improvements for the 25-ft and 27-ft projects completed in 1933 and 1962, respectively. The total effect of these changes on the levels of Lakes Michigan and Huron (hydraulically one lake) and on the upper St. Clair River profile was determined with dynamic flow models. The ultimate effect of the above dredging was a permanent lowering of the lake levels 0.27 m, which represents a tremendous loss of fresh water resource (32 km^3).

LEGAL ASPECTS OF GREAT LAKES USAGE

1020-1200 Room 102

Convenor and Moderator: Robert I. Reis

1020

ROBERT I. REIS, MILTON KAPLAN, LINDA REYNOLDS; Sea Grant Law Program, SUNY Buffalo. Port Development in the Great Lakes; Legal Aspects.

Port development in the Great Lakes has been a topic of discussion for many years. The Sea Grant Law Program is reviewing federal and state legislation and regulations directly impacting the port development process. The study focuses on the nature of ownership rights in shorelands, including incidental riparian or littoral rights, and governmental management of abutting subaqueous lands.

The findings indicate the existence of some unexpressed political and economic reasons for various features of existing New York state laws and regulations governing port development in the Great Lakes, and identify some jurisdictional conflicts and legislative ambiguities that should be addressed by federal, state and municipal lawmakers.

1040

ROBERT I. REIS, MILTON KAPLAN, LINDA REYNOLDS; Sea Grant Law Program, SUNY Buffalo. Regulation of Bulk Hazardous Cargo; Great Lakes.

A few years ago the Sea Grant Law Program undertook a study and published a preliminary report on federal regulation of the transportation of bulk hazardous cargo, mainly flammable and combustible bulk liquids, on the Great Lakes. The study identified several variables to be considered in the development of a system capable of keeping the hazards to a reasonably safe level, including the actual and purported hazards; threats posed to life, property, and the marine environment; manpower and technological resources; and the total costs of the system. The initial findings produced the recommendation that the Coast Guard, as principal architect of the regulatory system, be sensitive to the need to reconcile the concerns of carriers, environmentalists, industry, and members of the public at large. The study is presently being updated, in the light of interim legal developments, and any indicated policy changes stemming from shifts in the economy and technological advancements. We do not anticipate a more definitive conclusion but may recommend that stress be placed on different variables.

LEGAL ASPECTS OF GREAT LAKES USAGE (Continued)

1100

ROBERT I. REIS, MILTON KAPLAN, LINDA REYNOLDS; Sea Grant Law Program, SUNY Buffalo. Regulation of Erosion Control Structures.

Shoreline structures, particularly those for erosion control, have increasingly been subject to federal, state and municipal regulation of locations, construction features, size and appearance. Conflicts have arisen both among the different government entities concerned and between those who erect the structures and private owners of affected shorelands. The special problems of Long Island coastal lands led to a study by the Sea Grant Law Program. The methodology used for the research was traditional to baseline legal analysis, including a survey of relevant judicial decisions, state and local legislation and regulations, and legislative history. Local government officials were subsequently interviewed. Many of the findings are relevant to problems of coastal erosion along the Great Lakes. The results indicate that the recently enacted New York Coastal Erosion Hazard Areas Act, when implemented, may solve some of the problems, but create others to be addressed by the judiciary, legislature or concerned administrative officials.

1120

ROBERT I. REIS, MILTON KAPLAN, LINDA REYNOLDS; Sea Grant Law Program, SUNY Buffalo. Destruction of Ice Cover; Legal Implications.

Proposed measures for extending the navigation season of the St. Lawrence River would require the breaking of the ice cover between the mainland and the small islands that dot the region. We are informed that residents of the islands use the ice cover for the purpose of ingress and egress to the mainland during the winter months, as well as for recreational activities. The destruction of the ice cover, while it would further navigational interests, would have an obvious and serious impact on these residents. The SUNY Buffalo Law School's Sea Grant Law Program undertook a study of relevant federal and state legislation and regulations and pertinent case law. Among the matters considered were the possible implications of a past lack of exercise of federal navigational rights, the extent of private property rights of the residents, and the possible primacy of conflicting public navigational interests. The study concludes that the Federal navigational servitude is dominant and the courts would probably hold that the interests of the individuals on the islands are not constitutionally protected.

1140

ROBERT I. REIS, MILTON KAPLAN, LINDA REYNOLDS; Sea Grant Law Program, SUNY Buffalo. Floating Tire Breakwaters; Tort Liability.

Floating tire breakwaters may provide an effective and relatively inexpensive method of protecting small harbors and enclosures from the ravages of open waters of the Great Lakes. At the same time, these structures present some specific problems of potential civil liability by the responsible public or private owners for damage to vessels from collisions of vessels.
A study of the problem by the Sea Grant Law Program reviews applicable federal regulations of floating tire breakwaters in navigable waters, and the potential liabilities of developers or managers of the structures for damages to boaters arising from (a) the breaking free of parts of the structure, or (b) collisions of vessels with the structure while intact. In each instance, the required regulatory precautions are considered as they may or may not affect liability.

LAKE HURON SYMPOSIUM

1300-1700 Room 104

Moderator: Ronald Rossman

1300

Sheath, Robert G., University of Rhode Island
Burkholder, JoAnn M., Michigan State University

The benthic macroalgae of Lake Huron and its drainage basin.

Over 75 sites along the entire shoreline of Lake Huron and many input streams and rivers have been examined to determine the distribution of macroalgal communities. The drainage basin contains both hardwater and softwater lotic systems draining the Niagara Escarpment and Canadian Shield, respectively. Hence there is a wide range of pH values (6.6 to 9.0) and conductivities (40 to 550 µmhos cm^{-1}) in the watershed. While these factors affect the distribution of some species, clear-cutting and nutrient loading have had major impact on algal localization. Throughout the range, the benthic community of streams is dominated by filamentous Chlorophyta, with members of the Rhodophyta and Cyanochloronta accounting for much of the remaining diversity and abundance. In Lake Huron, filamentous Chlorophytes are also the most widespread group, particularly Cladophora glomerata, Chara globularis, and Ulothrix zonata. Wave exposure and nutrient inputs are major factors affecting their distribution.

1320

P.E. Ross , M. Munawar and I.F. Munawar
Dept. de Sci. biol., Univ. de Montreal, C.P. 6128, Succ. A, Montreal, Quebec, Canada H3C 3J7; Great Lakes Fisheries Research Branch, CCIW, Burlington, Ontario, Canada L7R 4A6

Utilization of phytoplankton production by Lake Huron zooplankton.

The feeding behaviour of three groups of zooplankton is examined for three algal size classes. Keratella cochlearis (Rotifera) fed primarily (85 percent) on the smallest size class, but assimilation could not be estimated. Bosmina longirostris (Crustacea: Cladocera) fed about equally on the smallest (45 percent) and on the intermediate (48 percent) size classes. Assimilation was almost entirely (93 percent) on the smallest class. Mixed copepod nauplii (Crustacea: Copepoda) fed mainly (72 percent) on the smallest class and assimilated only these cells.

When feeding data are compared with phytoplankton production data for the same size classes, it is clear that only production from the smallest size class is utilized to any extent. This utilization however, cannot explain the estimated loss rates for these algal populations.

1340

D.C. MCNAUGHT, D. GRIESMER, R. LARSON; and J.E. GANNON, R.S. STEMBERGER. Department of Ecology, Univ. of Minnesota, Minneapolis 55455 and Research Center, SUNY Oswego 13126.

Changes in the Zooplankton Community in Response to Reductions in Nutrient Loading to Saginaw Bay (Lake Huron).

A significant reduction in phosphorus loading to Saginaw Bay between 1975 and 1978 led to pronounced changes in the Bay's zooplankton community. Fluvial inputs of phosphorus were reduced 50%, resulting in a 24% decrease in orthophosphate for phytoplankton growth. The crustacean zooplankton were reduced 37%, from 155700m^{-3} in 1974 to 97800m^{-3} in 1980. The eutrophic indicator Bosmina longirostris remained constant at 38% while the oligotrophic Diaptomus sicilis increased. Rotifer populations responded to nutrient diversion dramatically. Total rotifers decreased 3-fold, while predatory rotifers decreased 4-fold, with these invertebrate apex predators responding as predicted by reductions in energy flow. These changes are evidence of an improvement in the Bay's water quality (supported by US-EPA).

1400

DAVID M. DOLAN, IJC, 100 Ouellette Avenue, Windsor, Ontario, Canada N9A 6T3; DAVID A. GRIESMER, and DONALD C. McNAUGHT, Department of Ecology, University of Minnesota, Minneapolis, Minnesota 55455.

Nutrient, Phytoplankton and Zooplankton Interrelationships in Saginaw Bay, 1974-1980.

The response of the Saginaw Bay ecosystem in terms of nutrient concentrations and phytoplankton and zooplankton components, to the 50% external phosphorus load reduction over the period 1974-1980, has been examined. Special emphasis has been given to traditional predictions made in the literature about the response of a eutrophic water body when a nutrient source is removed or reduced. For nutrients, the decrease in water column phosphorus is discussed as well as secondary changes in silica and nitrogen parameters. For phytoplankton, the observed favorable species shift towards more desirable forms is illustrated as well as secondary effects on rotifers and herbivorous crustaceans. For zooplankton, the decreases in crustaceans and total rotifers are examined in light of the changes in phytoplankton and nutrients and the composition of the zooplankton community. Finally, the response of the three dominant trophic components is considered at high and low nutrient levels with special attention to classical predator (zooplankton) - prey (algal) interactions. Due to phosphorus removal prior to 1980, populations of predator and prey converged toward a stable joint equilibrium and exhibited self damping, as theory predicted.

LAKE HURON SYMPOSIUM (Continued)

1420

DR. J. JAMES TIBBLES, Dept. of Fisheries & Oceans, Sea Lamprey Control Centre, Huron St., Ship Canal P. O., Sault Ste. Marie, Ontario, Canada P6A 1P0. Sea Lamprey Control in Lake Huron.

The sea lamprey gained access to the upper Great Lakes from Lake Ontario in the mid-1930's. The first lamprey reported from Lake Huron was in 1937. The tributary streams were ideally suited for lamprey production and the lamprey population flourished. The commercial lake trout production from Lake Huron dropped from more than 2268t in 1938 to 76 t in 1954 and continued to decline until the fishery collapsed in 1959. In a few short years lake trout were eliminated from Lake Huron.

Sea lamprey control with toxicants has been performed on an annual basis since 1966 in both Canada and the United States. Sea lamprey ammocoete populations have been established in only 102 streams tributary to Lake Huron in both Canada and the U.S. The lamprey program has been extremely successful in Lake Huron with effective control being achieved in all tributaries with the exception of the St. Marys River.

As lamprey control progressed from lake to lake, a program of stocking large "desirable" salmonids (lake trout and salmon) was initiated by the fishery management agencies around the Great Lakes. The resultant fishery, both commercial and sport in Canada and the United States, from all lakes, is reported as having an economic value in excess of a billion dollars.

1440

DONALD J. WILLIAMS Inland Waters Directorate, Ontario Region, Dept. of Environment, Canada Centre for Inland Waters, 867 Lakeshore Rd., Burlington, Ontario, L7R 4A6.

Lake Huron - Overview of Environmental Quality Past, Present and Future

Two major intensive investigations have been conducted on Lake Huron within the last decade. Both were joint, co-ordinated studies between Canada and the United States. The first in 1973 was conducted as part of the Upper Lakes Reference Study under the 1972 Great Lakes Water Quality Agreement. The second was conducted in 1980 as part of the intensive studies of each of the Great Lakes according to the Great Lakes International Surveillance Plan (GLISP) referenced in the revised 1978 Agreement. In addition to these intensive co-ordinated efforts on behalf of both countries, numerous studies of the physics, chemistry and biology of the Lake have been ongoing by individual investigators over the last number of years. Results from many of the above investigations were presented at the Lake Huron Symposium held at the IAGLR Conference in May, 1983. This paper summarizes these findings in an attempt to provide a perspective on the present status of the Lake, what changes have occurred over the last decade and some possible future needs for research and monitoring.

1520

PANEL DISCUSSION

Moderator: Mohudin Munawar

BIOFOULING SYMPOSIUM

1300-1620 Room 102

Convenor and Moderator: Daniel Pope

1300

DANIEL H. POPE , DAVID J. DUQUETTE , ARLAND H. JOHANNES , AND PETER C. WAYNER . Fresh Water Institute, Department of Materials Engineering and Department of Chemical and Environmental Engineering, Rensselaer Polytechnic Institute, Troy, NY 12181. Microbiologically Influenced Corrosion of Industrial Alloys.

A multidisciplinary group of scientists at Rensselaer Polytechnic Institute was asked by the Materials Technology Institute of the Chemical Process Industries to survey the available literature on Microbiologically Influenced Corrosion (MIC) and to report their findings relative to the evidence for MIC of iron and mild steels, stainless steels, copper alloys, aluminum and its aluminum alloys, nickel-chrome alloys, and titanium. The group was asked to report the state of the information relating to the mechanism(s) whereby MIC of each material occurs, methods of study in the laboratory and detection and prevention in the practical applications. They were also requested to develop a prioritized list of research areas.

This group found evidence in the literature for MIC of all alloy groups except nickel-chrome and titanium. They found that the detailed mechanisms for MIC are generally unknown, and the protection from MIC and reliable methods of detecting it are not generally available. Sulfate reducing bacteria were reported to be involved in MIC of many alloy groups. Formation of films, oxygen and ion concentration cells, acids, NH_3, O_2, H_2S, and CO_2 were all implicated in MIC of the alloys studied.

1330

ROBERT E. TATNALL
E. I. du Pont de Nemours & Co. Inc.
Engineering Department, L13E57
Wilmington, DE 19898

Examples of Biocorrosion in Industry

Biocorrosion in the process industries is most often found in three areas:

1. Cooling water systems,
2. Aqueous waste treatment, and
3. Ground water left in new equipment after testing.

Examples of all three are presented. One case is discussed wherein corrosion of carbon steel was successfully controlled by judicious use of a non-oxidizing biocide plus chlorine. In another case, corrosion of mild steel and stainless steels continues even with high levels of chemical treatment.

Emphasis is on physical evidence at corrosion sites: local pH, appearance and makeup of deposits and types of corrosion observed.

1400

W. G. CHARACKLIS
College of Engineering
Montana State University
Bozeman, MT 59717

Biofouling: Processes, Problems and Monitoring

Biofouling is the net result of several fundamental processes including transport, adsorption, microbial reactions, and detachment. The contribution of these processes and factors affecting their rate will be presented. Biofouling results on several problems of concern to industry including increased fluid frictional resistance, increased heat transfer resistance, and enhanced corrosion. Mechanisms by which biofouling deposits effect these changes will be discussed. Finally, methods for continuously monitoring fouling deposition (not only biofouling) will be presented.

1430

MARIANNE WALCH and RALPH MITCHELL. Laboratory of Microbial Ecology, Division of Applied Sciences, Harvard University, Cambridge, MA 02138. Microorganisms and the hydrogen embrittlement of metals.

Failure of metals due to the absorption of atomic hydrogen has been widely recognized as an important phenomenon, but the role of bacteria in this corrosion process is not understood. We are using biochemical and electrochemical methods to investigate several mechanisms by which fouling microorganisms may be involved in hydrogen embrittlement of metals. These mechanisms include: (1) production of molecular hydrogen, which may be dissociated into atomic hydrogen and absorbed into the metal; (2) production of hydrogen ions, which may be reduced to form hydrogen atoms at cathodic areas of corroding metals; (3) formation of hydrogen sulfide, which may stimulate the absorption of atomic hydrogen into metals by preventing its recombination into molecular hydrogen; (4) destabilization of surface films, which, depending upon conditions at the metal/water interface, may either stimulate or inhibit the embrittlement process. Bacteria may also sometimes suppress absorption of hydrogen by removing it from the metal surface. The microbial processes and environmental conditions controlling hydrogen production and consumption by microorganisms on metal surfaces are being studied.

1520

TIMOTHY I. LADD and J.W. COSTERTON. Department of Biology, University of Calgary, Calgary, Alberta, Canada, T2N 1N4. Development and Control of Bacterial Biofilms on Submerged Surfaces in Aquatic Systems.

The numerically and metabolically predominant bacterial population of aquatic systems containing submerged surfaces grows as an adherent biofilm within which the bacteria are surrounded by their own exopolysaccharide glycocalyces. This thick accretion of cells and exopolysaccharide acts as an ion-exchange resin (predominantly anionic) that traps soluble nutrients and makes them available to even the innermost organisms so that the heterotrophic potentials of cells within biofilms are generally higher than that of their planktonic (floating) counterparts. This adherent mode of growth protects biofilm bacteria against environmental antibacterial agents such as amoebae and bacteriophage, and against commercial chemical biocides. We have developed a biofilm sampling device to monitor the development of sessile populations in aquatic systems, and to assess the concentrations of biocides necessary to kill these biofilm bacteria. This Robbins Device is now in wide use in industrial systems using cooling water, and in pipelines carrying oil and water mixtures or injection water for secondary oil recovery, and its use has led to the development of our newly patented "ice nucleation" method for biofilm removal, and to several systems for the evaluation of biofilm removal in oil recovery systems.

1550

REGINALD J. SORACCO AND DANIEL H. POPE. Fresh Water Institute, Rensselaer Polytechnic Institute, Troy, NY 12181. Results of Studies on Biofouling, Microbiologically Influenced Corrosion, Pathogens, and Their Control in Heat Rejection Systems.

Research in our laboratory has been concerned with the formation of, problems related to, and control of microbial communities in a variety of cooling devices. We have shown that Legionella pneumophila are harbored and proliferated in cooling system sediments and slimes. Field tests of organic biocides demonstrated them to be ineffective in control of L. pneumophila and resulted in a "bloom" of Pseudomonas aeruginosa. Ozone was however effective in controlling general (total plate count), L. pneumophila and P. aeruginosa populations. In other studies, material fouling heat exchangers was shown to be primarily inorganic (80-90%) (major components: Fe, Mn, Al and Si) with the biological components composed of bacteria with varied physiological characteristics. Several laboratory and side-stream test systems have been developed and used to monitor fouling and to test methods of controlling the accumulation of biofilm and the effects of these microbial communities on the corrosion of metals. The efficacy of chlorine, chlorine dioxide, bromicide, and organic biocides were tested. Results show that low-level continuous treatment with oxidizing biocides are most effective in such control.

FISHERY BIOLOGY

1300-1700 Room 103

Moderator: Stephen Brandt

1300

OLSON, R.A., J.D. WINTER, D.C. NETTLES, K.M. PARNELL, and J.M. HAYNES. SUNY Colleges at Fredonia and Brockport. Environmental Resources Center, Fredonia, N.Y 14063. Distribution and Habitat Preferences of Lake Ontario Salmonids.

During summer 1981 and spring and summer 1982, vertical gill nets were used to study distribution and habitat preferences of lake trout (Salvelinus namaycush), brown trout (Salmo trutta), steelhead (Salmo gairdnerii), chinook (Oncorhynchus tshawytscha) and coho (O. kisutch) along the southern shoreline of Lake Ontario.

Catches revealed movements of salmonids to areas ≥ 30 m in depth as water became progressively warmer during summer. Brown trout were highly associated with the thermocline. Lake trout predominated in and below the thermocline and chinook predominated in and above the thermocline. All salmonid species ranged widely from bottom substrate. Mean temperatures occupied were: lake trout 10.1 ± 3.9 C, brown trout 13.6 ± 4.1 C, and chinook 15.6 ± 3.6 C. High catch per unit effort 2 - 5 km offshore as compared to much lower CPUE 5 - 24 km offshore suggests the salmonids are more highly concentrated closer to shore.

Stomach contents indicated brown trout preferred alewife (Alosa pseudoharengus), lake trout consumed alewife and smelt (Osmerus mordax) and chinook preferred smelt. During 1982, smaller meshed nets (25 - 50 mm stretch) were set concurrently with larger mesh sizes (114 - 127 mm stretch) to correlate prey species distribution with salmonid abundance.

Only four coho and four steelhead were caught during the study suggesting low densities of coho and solitary nature of steelhead.

1320

Parnell, K.M., D.C. Nettles, J.M. Haynes, R.A. Olson, and J.D. Winter. SUNY Colleges at Brockport and Fredonia. Dept. of Biol. Brockport, N.Y. 14420. Steelhead/Rainbow Trout Movements in Lake Ontario.

During 1981-82, movements of radiotagged steelhead were monitored in Lake Ontario and a tributary. In '82, nine fish were tracked ascending Sandy Creek, one as far as 25km. Five, two of which had spawned between release and recovery, were caught by anglers, indicating normal feeding and reproductive behavior. The remaining fish entered the lake and were tracked as far east as Oswego, N.Y. and as far west as the Niagara River. Two were later caught by anglers in Canadian waters. In '81 fish dispersed to open waters as water temps. rose to 10°C in mid-May. After a late spring in '82, this same dispersal phenomenon and temperature relationship was observed in mid-June, indicating 10°C is an important transition temperature for Lake Ontario steelhead. Offshore movements were strongly associated with the migration of the thermal bar.

In 1982, the longer tracking season revealed a general westward migration (62%) which was determined to be temperature related. A melting ice cap in the western basin created a temporary east/west temperature gradient. Tagged fish returned eastward toward colder waters after the ice cap melted.

1340

Nettles, D.C., J.M. Haynes, R.A. Olson, and J.D. Winter. SUNY Colleges at Brockport and Fredonia, Biol. Sci. Dept. Brockport, N.Y. 14420. Seasonal Movements and Habitat Preferences of Lake Ontario Brown Trout.

Radio telemetry and vertical gill netting were utilized to study Lake Ontario brown trout in 1980-82. Eight externally and 25 surgically radio-tagged brown trout were tracked during periods of near-shore occupancy (spring and fall). Transmitter attachment related mortality was 0 and 32%, respectively. During spawning seasons females exhibited significantly faster and longer movements ($P < .0001$) than males. No radio-tagged brown trout reached suitable spawning habitat although homing behavior was pronounced in fall 1980. Brown trout showed preference for Hamlin Beach, Lyons Point, and natural and artificial outflow areas. Correlation analyses revealed inverse relationships between near-shore turbidity levels and tracking success ($P < .01$) during two of three tracking periods. As indicated by temperature sensitive transmitters, brown trout occupied temperatures ranging from 3.6 to 19.1°C during near-shore occupancy. Vertical gill netting during summer showed brown trout to prefer thermoclinal areas of the water column within 5km of shore, regardless of absolute thermocline depth or temperature. Mean summer temperature preferences were 12.7±4.7°C and 11.4±4.1°C for 1981 and 1982, respectively.

1400

ROBERT O'GORMAN, USFWS, Oswego Biological Station, 17 Lake, Oswego, NY 13126
CLIFFORD P. SCHNEIDER, NYDEC, Cape Vincent Fisheries Station, Cape Vincent, NY 13618

Dynamics of Lake Ontario Alewives after a Die-off

As U.S. and Canadian agencies began programs to reestablish lake trout and to establish other piscivorous salmonids in Lake Ontario, current knowledge of forage fish stocks was needed to formulate management strategy. To provide information on alewives we jointly surveyed this resource during 1976-82 using bottom trawls. Alewives were very abundant in 1976, but during the 1976-77 winter a die-off greatly reduced their numbers. The population quickly recovered, however, with adult abundance increasing fourfold from 1978 to 1981, remaining high in 1982. Abundance of mature alewives affected recruitment of age II fish to the stock in two ways: (1) numbers of yearlings produced was directly related to adult abundance at low population levels but, inversely related at high population levels and (2) survival of yearlings to age II was inversely related to adult abundance. Growth in 1977 was exceptional, leaving a wide, unmistakable band on scales of the previously slow-growing adults. As abundance returned to pre die-off levels we used this growth band as a marker to identify survivors of the die-off and to document that each year after 1978 a successively larger proportion of these survivors were failing to grow and form an annulus (54% in 1979, 96% in 1980, and 100% in 1981). There was no marker on scales of alewives spawned after the die-off, but the age composition of our catches strongly suggests that during 1981 most of them also failed to grow.

1420

ROGER A. BERGSTEDT, USFWS, Oswego Biological Station, 17 Lake, Oswego, NY 13126

Seasonal Distribution of Alewives and Rainbow Smelt in Southeastern Lake Ontario

Alewifes and rainbow smelt are the major prey species of the various salmonids stocked into Lake Ontario. Essential to understanding the impact of predator on prey is knowledge of when and where the various species interact. Due to a lack of pelagic sampling, however, information on seasonal distribution of both predators and prey was limited. During 1978-82 I used a combination of acoustic sampling, bottom trawling and midwater trawling to examine the seasonal distributions of alewives and rainbow smelt.

Three aspects of the seasonal distribution appear notably different from that reported on the upper Great Lakes. First most smelt and alewives were midwater between 50 and 80 m deep and as far as 17 km offshore, based on observations with acoustics and trawls on 10/27-29/81 and again with acoustics on 11/20/81, 12/14/81, and 3/24/82. While sampling was not conducted during winter, it seems likely the midwater distribution persisted between December and March. Second, echograms made on 3/24/82 showed alewives were not near bottom where temperatures of 3-4°C were available but were midwater at temperatures of 1.0-1.5°C. Third, after spawning in early summer, alewives remained in the eplimnion until fall. Strong thermal stratification in summer effectively segragates alewives from any potential predators such as immature lake trout which reside in the hypolimnion. Alewives are in fact absent from the diet of immature lake trout in summer.

1440

WILLIAM J. ABRAHAM, N.Y.S.D.E.C., Fisheries Management, Avon, New York 14414

Assessment of the 1982 Year Class of Yellow Perch Associated with Sodus Bay, Lake Ontario

Sampling in 1982 verified that Sodus Bay, Wayne County, is an important yellow perch (Perca flavescens) spawning area and produces a substantial number of fry. Bottom sled trawling and limited gill netting indicated that perch spawning peaked within the bay about May 1. Subsequent trawling with half-meter nets during mid-May indicated that many yellow perch were produced in Sodus Bay and that many had been transported to the open lake, presumably by currents since the observed sac fry were incapable of directed swimming. The samples could not have been the product of open lake spawning since cold temperatures (<6.7°C, 44°F) in that environment would have precluded spawning and/or egg development. It is likely that the extremely cold temperature regime characteristic of this nearshore area of Lake Ontario would obviate yellow perch production in most years. Trawling bay and lake transects with identical gear on May 27 resulted in the capture of one larval yellow perch. This catastrophic mortality coincided with the annual inshore migration of alewives (Alosa pseudoharengus). Seining bay and lake nearshore areas during late July further supported the contention that the 1982 cohort was a complete failure, at least in the vicinity of Sodus Bay. This suggests that alewife predation on yellow perch fry may be responsible for that species' year class failures from 1979 - 1982 in the south central waters of Lake Ontario.

1520

ROBERT J. DANEHY
Research Center
SUNY at Oswego
Oswego, NY 13126

Seasonal Diets of Smallmouth Bass, Yellow Perch and White Perch at Nearshore Sand and Cobble Substrates in Mexico Bay, Lake Ontario

Natural shoals in the near shore zone of the Great Lakes have received little attention, partially because of the dynamic nature of the habitat. Fish populations were studied in a shoal area of Mexico Bay in eastern Lake Ontario during 1981. Samples were taken at four sites: two cobble shoals that were at depths of 10' and 20' and two sand substrates at 10' and 20'. Smallmouth Bass, Yellow Perch and White Perch were collected with bottom experimental gill net sets. Diets of 1,075 individuals were examined. Amphipods (primarily Gammarus spp.) were the major prey item of the Yellow Perch and White Perch at all sites. Alewife contributed to the diets of all three species. Adults were preyed on by Smallmouth Bass and larger Yellow Perch in the spring, the eggs were the most important prey item for the White Perch in midsummer and the YOY were important to all three species in the fall. Only the diet of the Smallmouth Bass appeared to change with respect to substrate.

1540

MARY D. BALCER. CLSES, University of Wisconsin, Superior, WI 54880 and Zoology Dept., U. of Wisconsin, Madison, WI 53706. The Planktivorous Feeding Behavior of Young Rainbow Smelt in Western Lake Superior.

Previous field studies have demonstrated that young rainbow smelt (Osmerus mordax) in Lake Superior feed selectively. A strong preference is shown for copepods, while the equally abundant cladocerans are seldom found in the diet. During the summer of 1982 field and laboratory studies were conducted to discover the mechanisms of this selective predation and its impact on the zooplankton community.

Visual observations revealed that young smelt are particulate feeders and employ the "darting" mode of feeding described by Janssen for alewives. The fish stop swimming and assume an S posture when potential prey items are detected. Young smelt detect cladocerans as readily as copepods, but strike at very few of the spined forms. When spined Daphnia are attacked, the fish experience difficulty in manipulating and consuming the prey. In contrast, soft bodied cladocerans such as Diaphanosoma and Leptodora are readily consumed.

Feeding trials show that the total number of prey consumed per day is dependent on total prey abundance. Analysis of stomach contents and fecal remains from the smelt were found to be better indicators of daily prey consumption than analysis of the remaining prey population.

1600

J. H. HARTIG and D. J. JUDE. Great Lakes Institute, Univ. Windsor, Windsor, Ont. N9B 3P4, Canada and Great Lakes Research Division, Univ. Michigan, Ann Arbor, Mi 48109, U.S.A.

Opportunistic Cyclopoid Predation on Fish Larvae

Adult Diacyclops thomasi and Acanthocyclops vernalis are capable of opportunistic predation on certain, newly hatched fish larvae. Although alewife, yellow perch, spottail shiner, and rainbow smelt are seasonally abundant in eastern Lake Michigan and an inland coastal lake, most predation in this study, as evidenced by cyclopoids attached to fish larvae in field collections, occurred on yellow perch larvae (83%). Exceptional spring spawning of yellow perch in the inland coastal lake resulted in very high larval fish densities (41,837/1000 m^3) and facultative predation by D. thomasi on newly hatched larvae (max. predation: 8,735/1000 m^3). Cyclopoid predation on alewife and crappie (Pomoxis spp.) larvae accounted for 7 and 5% of the total predation, respectively. Ninety-seven percent of all predation occurred in night collections. This predation suggests that larval fish mortality and possibly cyclopoid population growth are strongly affected. Opportunistic cyclopoid predation on fish larvae may also disrupt zooplankton community structure by changing the feeding pattern of cyclopoids. Lack of significant predation on other species of fish larvae is probably due to temporal and spatial asynchrony of predator and prey, low probability of encounter, robust nature of certain species, and effective swimming and escape ability.

1620

STEPHEN J. EDWARDS , JOHN DEMBECK, THOMAS E. PEASE, MICHAEL J. SKELLY, LMS Engineers, One Blue Hill Plaza, Pearl River, New York 10965.

Evaluation of Fish Residency within an Angled Screen Diversion System

A preliminary study conducted for Niagara Mohawk Power Corp to evaluate the effectiveness of an angled screen fish diversion system at their Oswego Steam Station suggested that residency of specific fish species in the screenwell may affect their ability to divert. A program was initiated to evaluate fish residency within the screenwell and its effect on system efficiency.

Results indicated that fish residence was species-specific. Typically, salmonids and bass remained in the screenwell for significant periods of time (30 days), yellow perch passed directly through and alewife and gizzard shad residency was variable. To evaluate the effect residency has on specific species, the screenwell was described as a habitat in terms of current, light, shelter and food. The typical niche occupied by each fish species was described relative to the habitat offered by the screenwell. These findings were then compared to the empirical results of survival, condition factor and feeding habits of fish residing within the screenwell.

Predators adapt well in the screenwell and residence is not a detriment to their ultimate diversion and survival. However, residency of schooling planktivores does appear to reduce their potential for safe diversion.

1640

BERKES, F. , J. DENNIS, P. HAYES and R. MORRIS Institute of Urban and Environmental Studies, Brock University, St. Catharines, Ont. L2S 3A1

Motives and Expectations of Recreational Fishermen, with Reference to Pollution

Questionnaire studies were carried out (April-Sept. 1982) in eastern Lake Erie and western Lake Ontario to investigate fishermen's motives for going fishing and to what extent they were affected by environmental problems. The number of fishermen who indicated non-fishing-oriented motives (relaxation, nature-oriented, companionship) exceeded the number of fishermen who indicated fishing-oriented motives (experience of a catch, competition, fishing for food) by about three to two. A larger number of L. Erie fishermen said they considered the environment "acceptable as is" as compared to L. Ontario fishermen, and ate their fish, but the differences were not statistically significant. However, a significantly higher number of L. Ontario fishermen's eating habits had changed in 1982, as compared to L. Erie fishermen. Of L. Ontario fishermen, 7% had stopped eating fish in 1982. This percentage was highest (20%) among small boat fishermen interviewed in spring 1982, immediately after the much publicized dioxin problem.

CONTAMINANT TRANSPORT

1300-1700 Room 105

Moderator: Paul Rodgers

1300

A.G.BOBBA, R.W.DURHAM,D.C.L.LAM AND S.R.JOSHI
National Water Research Institute, Canada Centre for Inland Waters, Burlington, Ontario L7R 4A6.

Simulation of Contaminant Transport to Lake Ontario Through Groundwater Flow System: Port Granby Study.

Port Granby radioactive waste disposal site is a 10 hectare area located on a bluff 35 m above lake level, on the north shore of Lake Ontario, approximately 15 km west of Port Hope, Ontario, Canada. Hydrogeologically, the strata in descending order are:(i) a moderately permeable unit of upper sandy clay silt,(ii) a low permeable unit of glacial till, (iii) a moderate permeable unit of lower sands and silts, (iv)a low permeable unit of glacial till, and (v) a moderate permeable unit of fractured bed rock aquifer. The site is bounded on three sides by groundwater drains: east creek, west creek and Lake Ontario. A two-dimensional finite element method was used to simulate groundwater flow patterns along several north-south geological cross sections through the site. The calibrated model simulates the water table, including the location of a groundwater divide, the hydraulic head distribution and the velocity flow field. The groundwater divide indicates that all of the recharging water is flowing to the deeper formations and discharging to Lake Ontario. Springs were also observed along the contact between the glacial till unit and upper sandy clay silt strata. Sensitivity analysis of the locations of hydraulic heads will be presented. Contaminant plumes of radium-226, uranium and nitrate, computed by the model will be compared with field data.

1320

DAVID B. BAKER', KENNETH A. KRIEGER and JACK W. KRAMER. Water Quality Laboratory, Heidelberg College, Tiffin, Ohio 44883.

Some characteristics of pesticide transport in Lake Erie tributaries.

Relatively high concentrations of many currently used herbicides and insecticides are present in rivers draining agricultural watersheds. In 1982 we studied the transport of pesticides in the Raisin, Maumee, Sandusky and Cuyahoga basins. Analyses included Linuron, EPTC, Butylate, Ethoprop, Trifluralin, Phorate, Simazine, Atrazine, Terbufos, Fonofos, Cyanazine, Metribuzin, Alachlor, Metolachlor and Chlorpyrifos. For most compounds peak concentrations occurred during the first runoff event following the spring planting period. Concentrations decreased rapidly during subsequent runoff events. Among the agricultural watersheds, peak concentrations decreased with increasing basin size. Lower concentrations persisted for longer times in the larger river basins. The pattern of pesticide concentrations in the Cuyahoga differed greatly from the other rivers. The Cuyahoga had very low atrazine, metolachlor, metribuzin and alachlor concentrations but had high simazine and linuron concentrations. During the periods of pesticide runoff, concentrations exceeded levels which in laboratory tests are inhibitory to various components of aquatic communities. Many of these compounds are not removed by conventional water treatment so that tap water concentrations are similar to stream concentrations.

1340

DEBORAH L. SWACKHAMER', DAVID E. ARMSTRONG
Water Chemistry Program, University of Wisconsin, Madison, Wisconsin 53706 Sources of PCBs to Wisconsin Lakes and Lake Michigan.

The accumulation of polychlorinated biphenyls (PCBs) in Great Lakes fishes have focused attention on the sources of PCBs to the Great Lakes. PCBs are transported by air, but the relative importance of atmospheric as compared to tributary and industrial sources is uncertain. Direct measurement of PCB inputs to the Great Lakes is problematic and complex, making efforts to model atmospheric input difficult. The importance of atmospheric vs. non-atmospheric sources of PCBs to Lake Michigan was evaluated by comparing Lake Michigan with lakes located in remote areas receiving no point source PCB input. PCB concentrations in the surface sediments of Lake Michigan ranged from 1-200 µg/g (dry wt.) and could be related to depositional zones. PCB concentrations of sediment cores taken in depositional zones from Lake Michigan and several pristine Wisconsin lakes were corrected for vertical mixing and sedimentation rate and compared for concentration and net accumulation. Results show Lake Michigan to have significantly higher PCB content than the other lakes, suggesting that areal loading is higher for Lake Michigan and that non-atmospheric sources to Lake Michigan may be substantial.

1400

S. J. EISENREICH , P. D. CAPEL , R. A. BOURBONNIERE , J. A. ROBBINS , B. J. EADIE .
Environmental Engineering Program, University of Minnesota, Minneapolis, MN 55455; [2]Canada Centre for Inland Waters, Burlington, Ontario L7R 4A6; [3]GLERL, NOAA, 2300 Washtenaw Avenue, Ann Arbor, MI 48104.

Chlorinated Hydrocarbon Concentrations and Fluxes in Sediment Cores from Eastern Lake Ontario.

Two sediment box cores taken in eastern Lake Ontario in 1981 were sectioned into 1 or 2 cm depth increments and analyzed for radionuclides, nutrient, metal, and natural and synthetic organics. This paper will present the concentration profiles of selected chlorinated hydrocarbons (CH) in the two cores having sedimentation rates of ∿0.2 cm/yr and ∿0.1 cm/yr, as determined by Pb-210 and Cs-137 dating. CH profiles to be presented include t-PCBs, PCB congeners, t-DDT, DDE, DDD, mirex, Lindane and HCB. CH profiles are similar in both cores for all species. For t-PCBs, concentrations were lower in the uppermost 1-cm fraction, peaked at the bottom of the mixed depth (∿5-6 cm, and ∿3 cm for the two cores), and decreased to non-detectable at depth. Several other CH profiles were similar. Recent t-PCB fluxes were ∿11 to 16 $ng/cm^2/yr$. While mirex profiles could be predicted assuming a "slug" input in ∿1970, PCB profiles could not be predicted based on the PCB production/consumption function. There is significant evidence that some CHs including PCB congeners are mobile in the sediment pore water.

1420

ROBERT C. McCREA , JOHN D. FISCHER AND KEN W. KUNTZ
WATER QUALITY BRANCH
CANADA CENTRE FOR INLAND WATERS
867 LAKESHORE RD., BURLINGTON, ONTARIO, L7R 4A6.

Partitioning of organochlorine pesticides and PCB's in the Lower Great Lakes Region

Considerable attention has been paid to trace organic contaminants associated with suspended sediment in natural waters. The aqueous phase, however, has been largely ignored since ambient concentrations of trace organics in water are generally below the analytical detection limit of gas chromatographic systems when traditional (2L) samples are analyzed. A large volume (200L) Aqueous Phase Liquid-Liquid Extractor (APLE) was developed to determine whether concentrations of organochlorine pesticides and PCB's are significant in the aqueous phase. Suspended sediment and (200L) aqueous phase samples were collected simultaneously at eleven locations in Lower Great Lakes Region. Results indicate that the partitioning of pesticides and PCB's vary greatly between these river and lake systems. Although Mirex and p, p-DDE were predominantly found in the suspended sediment samples, they were relatively insignificant in terms of total organochlorine loading. Organochlorines present in the aqueous phase of the Niagara River, St. Lawrence River and Lake Ontario samples accounted for 58-95%, 98% and 99% of the total organochlorine concentrations respectively.

1440

PHILIP A. MEYERS·, Department of Atmospheric and Oceanic Science, The University of Michigan, Ann Arbor, Michigan 48109. Extractable Organic Matter in Rain from the Great Lakes Region.

Solvent-extractable organic compounds have been compared in rain samples collected during the spring of 1980 at three locations in the Great Lakes region. Rain samples from two one-week periods at Beaver Island in Lake Michigan and from one period at Hemlock Lake, New York, represent rural samples. Two urban samples were collected in Rochester, New York. All samples contain large amounts of long chainlength n-alkanoic acids and n-alkanes. Important amounts of plant wax components are present, as well as indicators of microbial contributions. Most of the solvent-extractable material appears to have a recent biological origin, but evidence of petroleum hydrocarbons exists in one of the urban Rochester samples.

1520

A. G. BOBBA, D. C. L. LAM AND R. P. BUKATA
National Water Research Institute, Canada Centre for Inland Waters, Burlington, Ontario, Canada, L7R 4A6

Simulation of Contaminant Transports Through Lake Sediments

A variable grid finite element method was used to simulate the two-dimensional transient movement of contaminants in lake sediments. The model includes the effects of sedimentation and resuspension, molecular diffusion, bioturbation, hydrodynamic dispersion, porosity of sediments, chemical adsorption and radioactive decay. The model has been applied to some Great Lakes sediment data such as Cs-137 and Sr-90. The relative significance of the various physical, biological and chemical components will be discussed.

1540

FRANK J. HORVATH and WILLIAM S. CREAL.
Michigan Department of Natural Resources, PO Box 30028, Lansing, Michigan 48909. Organochlorine contaminants in the Kalamazoo River with implications of transport to Lake Michigan.

The Kalamazoo River, a southwest lower Michigan tributary to Lake Michigan, is contaminated with relic PCB-laden paper mill wastes. An advisory against eating fish from the City of Kalamazoo to the mouth has been in effect since 1977. Although there are presently no known active point sources of contaminants to the river, PCBs are translocating to Lake Michigan. From 12-liter whole water depth integrated samples at the mouth, we predict that between 15 and 395 kg/yr total PCBs are transported to Lake Michigan via water. Additional loadings may occur from bed load transport. Sediment concentrations as high as 85 mg/kg were found within the City of Kalamazoo in 1982. In Kalamazoo Lake (at Saugatuck) 1.7 mg/kg were found. Sediment deposits will continue as a source of contamination to fish and the Great Lakes for many years.

1600

R. PETER RICHARDS, Water Quality Laboratory, Heidelberg College, Tiffin, Ohio 44883.

Pesticide concentrations in Sandusky Bay and the lower Sandusky River following a spring storm.

In the rivers of northwestern Ohio, many non-point derived pollutants reach maximum concentrations in runoff following storms in spring and early summer. This pattern also characterizes many agricultural herbicides and insecticides. Concentrations of three pesticides (Atrazine, Alachlor, Metolachlor) measured during May and June 1982 exceeded 40 µg/L in the upper Sandusky River basin (Melmore, Ohio), and exceeded 15 µg/L in the lower reaches of the river (Fremont, Ohio) and in the upper portion of Sandusky Bay. By comparison, 5 µg/L is often taken as a concentration sufficient to inhibit photosynthesis in algae. In the bay, pesticide concentrations are well correlated with nitrate + nitrite, indicating that the pesticides are dissolved in the water, rather than adsorbed to suspended sediments.

1620

RONALD J. SCRUDATO
DIXON H. LANDERS
SUSAN A. GANNON
State University Research Center
SUNY, Oswego
Oswego, NY 13126

Oswego River Mirex Contributions to Lake Ontario

The Oswego River is one of two major mirex sources to Lake Ontario. Mirex-contaminated bottom sediments extend from the Oswego River mouth 15 km upstream where concentrations in excess of 1800 ng/gm have been identified. Preliminary analyses of Oswego River suspended sediment samples extracted from large volume water samples (60 l) indicate a suspended sediment mirex flux of greater than four kilograms mirex yr^{-} to the eastern Lake Ontario basin. Based on large volume analyses of "soluble" Oswego River mirex concentrations, the suspended (sorbed) to soluble ratio is about 120:1. Spring and Fall discharges exceed annual mean values by a factor of three causing seasonal mirex fluxes to the Eastern Lake Ontario basin.

1640

PAMELA LOW
JOHN E. GANNON
Research Center
King Hall
SUNY Oswego
Oswego, NY 13126

Upstream Migration of the Lake Ontario Contaminant, Mirex

Mirex is a toxic organochlorine compound and widespread contaminant of Lake Ontario sediments and fishes. Most of the concern and research has focused on mirex in the lake. However, we assessed the magnitude and pathways of transfer of mirex into upstream environments by anadromous lake salmonids. Study sites were located on two tributaries of the Salmon River, Oswego Co., NY. Sampling occurred during the fall, 1981 salmon run, and included Pacific salmon, resident brown trout, benthic invertebrates, blowfly larvae from decomposing carcasses, and stream sediments. A third stream, inaccessible to spawning salmonids was similarly sampled (excepting migratory species) for use as a control. Mirex incorporation into stream resident species has been the result of egg deposition and carcass decomposition. Brown trout are particularly susceptible to mirex loading as they feed heavily on salmon eggs during the spawning season, as well as blowfly larvae washed from decomposing carcasses and crayfish which scavenge submerged carcasses. Since the number of streamside decomposing carcasses has greatly diminished in the last several years, mirex-laden eggs probably are currently the major source of input of the contaminant into upstream systems.

PHYSICAL LIMNOLOGY

1300-1500 Room 106

Moderator: Eugene Chermack

1300

VERDUIN, J. BOTANY, SO. IL. UNIV. CARBONDALE, IL. 62901

A comparison of transmissometer data with submersible photometer data.

When transmissometer data are graphed vs submersible photometer data from the same station a wide scatter of data points is obtained. It seems likely that the small sample examined by the transmissometer contributes considerably to the scatter. But calibration of the transmissometer presents troublesome problems. When working in clear water transmittance may exceed 100%.

Graphs of α (transmissometer) vs k (submersible photometer) show that a conversion factor of $\alpha/2.5 = k$ is fairly reliable above α-values of 5. But between α-values of 0.5 - 5 a conversion factor of $\alpha/5 = k$ is more nearly valid. The most useful application of the transmissometer lies in sampling waters deeper than the bottom of the euphotic zone, and averaging several samples at a given depth and station may overcome some of the scatter introduced by small sample size.

1320

JAMES S. BONNER, JOSEPH V. DEPINTO, Department of Civil and Environmental Engineering, Clarkson College of Technology, Potsdam, NY 13676.

Vertical Transport of Aquatic Particles.

Recent studies have indicated that the fate of many aquatic pollutants is closely linked to the vertical transport of particles. Many settling rates as measured with inverted microscopes, spectrophotometers, and fluorometers have been reported. The settling velocities reported from these laboratory analyses are actually the result of two mechanisms, gravity and eddy dispersion. In order to account for these two effects in laboratory settling columns, a one-dimensional, time-dependent, convective-diffusive transport model was constructed. The model was calibrated to simulate the vertical transport in a settling column. Data used to calibrate the model were obtained by measuring the apparent settling velocities of standard particles in a fluorometer. The Stokes velocity was input into the model and the dispersion coefficient was adjusted until the model output agreed with observed data. The dispersion coefficient (cm^2/sec) was thus obtained independently for each particle and ranged from 1.0×10^{-6} to 0.5×10^{-6} (mean = 0.76×10^{-6}). This approach has been used to account for the discrepancy between the measured apparent settling velocity and the true settling velocity for various phytoplankton and tributary suspended sediments.

1340

T. KEILTY, E. F. STOERMER, Great Lakes Research Division, University of Michigan, Ann Arbor, MI 48109 and J. A. ROBBINS, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104. *Cyclotella Comensis* from Lake Huron in Lake Erie Sediments: Evidence for Near-Bottom Transport?

The species composition and density of algal remains have been determined in surface sediments (0-1 cm) in a series of radiometrically dated cores taken along an east-west transect spanning the three main depositional basins of Lake Erie. Of 62 species identified, dominant member densities were generally high in the western (WB) and eastern (EB) basins and lowest in the central basin (CB). Total valve fluxes (=dens. x sed. rate) show similar patterns ranging from a 2×10^4 to 10^6 valves/cm^2/yr (EB). The second highest flux (7×10^5 valves/cm^2/yr) occurred ca. 16 Km south of the mouth of the Detroit River. *Cyclotella comensis*, a species prevalent in Lake Huron but not in Lake Erie, comprises 20% of the total numbers in the core near the source (Detroit River) and decreases across the Lake (as shown in order of west to east): WB(20%,6%,1.4%);CB(0.5%,0.4%,0.6%);EB(1%,3%). A similar pattern is seen in the rate of deposition: ($10^3/cm^2/yr$): WB(150,16,1.3);CB(1.7,0.2,0.1);EB(12, 73). The appearance of *C.comensis* remains in the eastern basin shows that mechanisms exist by which a point source of tracer particles with a short residence time in the water column may contribute to a remote depositional basin. As this species has not been observed in waters of L. Erie, its transport apparently involves near-bottom transport of resuspended materials.

1400

R.L. PICKETT, J.E. CAMPBELL, and A.H. CLITES. Great Lakes Environmental Research Laboratory/ NOAA, 2300 Washtenaw Ave., Ann Arbor, MI. 48104.

Note - Satellite-Tracked Current Drifters in Lake Michigan.

Satellite-tracked current drifters are being used to monitor near-surface currents in Lake Michigan. These drifters are now commercially available, and preliminary tests show their satellite-determined positions to be within 0.5 km. The drifters appear to be ideal for monitoring near-surface lake currents and testing hydrodynamic lake models.

PHYSICAL LIMNOLOGY (Continued)

1420

JOHN A. KENNEDY, 3232 S. 10th St., Sheboygan, WI, 53081, and CLIFFORD H. MORTIMER, University of Wisconsin-Milwaukee, Zoology Dept., Milwaukee, WI, 53201. Water-mass structures and exchanges in Green Bay, Lake Michigan.

Vertical depth-profiles of temperature, dissolved oxygen, electrical conductivity, and water transparency were recorded at 16 stations spaced along two cross-sections in central Green Bay, Lake Michigan, during monthly 5-day cruises, June through October, 1980.

The results show a high degree of variability of the monitored parameters, responding to wind stress on the Bay surface, to influxes from Lake Michigan, and to internal physiolimnological processes. Strong cross-basin isoline tilting is used to interpret water mass motion and direction, for example southward incursions of Lake Michigan water. While southerly intrusions of Lake Michigan and Outer Bay waters were often seen along the western shore, and northerly flow of Inner Bay water was occasionally seen along the eastern side of Section I, basin morphology and local meteorological forces probably prevent the establishment of a permanent counter-clockwise current pattern in the Bay as a whole.

Water quality was seen to increase significantly between Sections II and I, indicating that northward movement of polluted water from the Inner Bay.

1440

ALAA E. ELZAWAHRY AND WILLIAM JAMES
Civil Eng. Dept. McMaster University, Hamilton,Ontario,L8S-4L7,(416) 527-6944
"Lake Erie flow structure in the vicinity of Cleveland Ohio"

The structure of the nearshore flow in the vicinity of Cleveland, Lake Erie has been analyzed in some detail. From early May to the end of December, time series flow data were collected from a net-work of current-meters placed in a coastal chain perpendicular to the shoreline. The time series flow data have been analyzed to reveal the characteristics of the flow.

Filtering, spectrum and statistical analyses have been used to find horizontal turbulence and kinetic energy properities. An episode during which a strong shore-parallel current persisted has been chosen to find the variability of these parameters. The results showed an inner boundary layer dominated by bottom and shore friction (FBL) extending 12 km from the shore where the velocity and the kinetic energy attain maximum values. The ratio between the inertial kinetic energy and the total kinetic energy in the energy spectra did not exceed 0.2 up to 31 km from shore. Thus the entire central basin of Lake Erie can be considered as a coastal boundary layer (CBL).

LAKE CHAMPLAIN SYMPOSIUM

0800-1200 Room 104

Convenors: Allen Cassell, Donald Adams *Moderator:* Allen Cassell

0800

DAWSON, JAMES C. , Center for Earth and Environmental Science, State University of New York, Plattsburgh, NY, 12901.

Lake Champlain: Retrospect and Prospect

Great Lakes researchers have sometimes neglected the "sixth" great lake in their colloquia and symposia. The Lake Champlain Symposium attempts some redress by describing some of the current research on Lake Champlain. This broad overview of recent research will provide a context for the more detailed papers that follow. The author sketches Lake Champlain's geologic evolution, physical setting, sedimentologic character, chemistry and biologic activity. The detailed inventories and analyses of the Lake Champlain Basin Study of the New England River Basins Commission will provide the basis for this overview.

A variety of international, federal, state, local, academic and private institutional arrangements have been and continue to be involved in studying and managing the Lake Champlain resource. A retrospective overview of the relationships, conflicts and successes of these arrangements will be outlined. The paper will conclude with a brief review of contemporary resource management activities and the author's view of research agenda priorities for Lake Champlain.

0840

MILTON POTASH AND E. B. HENSON. Zoology Department, University of Vermont, Burlington, Vermont 05405.
The limnology of Lake Champlain: an historical overview.

The first recorded study of Lake Champlain, 1905, reports about a pollution survey of river mouths. The New York Conservation Department carried out a biological survey (1930), concentrating on fish. Beginning in 1965, a ten-year detailed limnological study was carried out by the authors. The first major goal was to establish base-line data; the second was to evaluate the total watershed, to determine the influence of inflowing streams and rivers on the lake ecosystem.

Limnological parameters measured regularly included temperature profiles, transparency, pH, specific conductance, total alkalinity, dissolved oxygen, potassium, sodium, calcium and magnesium. Using these data, five major water masses were identified within the overall basin. Chemical concentrations were greatest in the southern basin, decreasing significantly in the northern major lake basin. Water flowing westerly from the eastern regions of the lake appeared to produce a dilution effect. However, it was found that the main lake exhibited a linear decrease in most chemical parameters, the decrease beginning well south of the entrances of westerly flowing waters. Some indication of increasing nutrient concentration and decreasing dissolved oxygen was apparent during this ten-year period. Overall results indicate that the lake should continue to be monitored because the potential for continued eutrophication exists.

0900

G.E. MYER , A.L. DERRICK, D. LARSON, and D. HULBERT, Department of Physics, State University of New York, Plattsburgh, New York, 12901. Circulation and Current Patterns Within the Major Basins of Lake Champlain.

Lake Champlain is divided into several distinct basins which are interconnected by narrow and shallow passageways. During the past ten years an ongoing study has resulted in the mapping of major summer current systems within the major basins. The Main Lake's currents are dominated by a 4 day internal seiche with a typical amplitude of 10 meters. The currents at depths below 5 meters generally agree with a baroclinic geostrophic flow pattern. The near surface water often approximates an Ekmandrift pattern. The shallow regions of the Lake have current patterns which respond to short term wind patterns and bottom drag. The current patterns of the Northeast Arm of the Lake are nearly independent from those of the Main Lake except near the connecting passages.

0920

A.L. DERRICK and G.E. MYER, Department of Earth and Environmental Sciences, State University of New York, Plattsburgh, New York, 12901. Water Mass Exchange Between the Northeast Arm and Main Basin of Lake Champlain.

In the evaluation of trophic status and phosphorus loadings a continuing problem has been obtaining a realistic evaluation of the exchange of water between the interconnected basins of Lake Champlain. Using both Eularian and Lagrangian methods the water exchanges between Missisquoi Bay, the Northeast Arm and the Main Lake were measured. These were compared with wind, water level, and turbidity measurements. The short term current patterns were found to be greatly influenced by differential wind tides and seiche, the longer term exchanges largely follow the mean relative water levels with a mixing related to long term wind patterns. It was found that the use of water level records and secchi measurements allowed the actual measured exchanges to be closely approximated by calculation.

0940

JEFFREY P. LAIBLE. Department of Civil and Mechanical Engineering, University of Vermont, Burlington, Vermont 05405. Circulation and Pollution Transport in St. Albans Bay Vermont.

St. Albans Bay, on Lake Champlain, Vermont is the focus of a comprehensive watershed study designed to identify and quantitatively assess the sources of pollution affecting the Bay. A significant factor affecting conditions in the Bay is the exchange with the main lake. In order to assess this exchange, a numerical model (finite element analysis) and a series of field studies are being conducted. The finite element analysis defines depth varying flow fields from which flux values and bulk diffusion coefficients can be obtained for use in a multi cell pollution transport model. The field studies include simultaneous measurement of currents at multiple points and depths at the boundary between the bay and the lake. The measured reverse currents which exist due to wind loading have been modeled by the finite element procedure. Both theoretical and experimental results reveal reverse currents which reach 10-15 cm/sec for surface flows and 5-10 cm/sec reverse flows in regions of the bay-lake interface. A preliminary estimate of the exchange rates at the boundary under a prevailing south west wind was found to be approximately 1/4 of the bay volume per day. Wind data is also being collected to be used in conjunction with the flow data/analysis in developing a statistical statement of the bay-lake exchange rates as a function of meteorological conditions. Both theoretical and experimental results provide a comprehensive analysis tool for assessing the transport of phosphorous throughout the Bay.

1020

ERIC SMELTZER and SUSAN WARREN
Vermont Department of Water Resources & Environmental Engineering
Montpelier, Vermont 05602

The Use of Water Quality Data on Lake Champlain for Lake Protection and Management.

Four years of total phosphorus, chlorophyll, and transparency data collected at 26 stations throughout the lake by citizen volunteers through the Vermont Lay Monitoring Program has been used to quantify trophic state conditions in the lake. Regression relationships linking phosphorus, chlorophyll, and transparency developed solely from Lake Champlain data are statistically significant but have relatively low predictive precision. Phosphorus sampling conducted primarily on Lake Champlain and its tributaries before and after the implementation of the Vermont Phosphorus Detergent Ban revealed a marginally significant improvement in phosphorus levels at stations most affected by point source inputs, relative to control areas. Applications of simple phosphorus models for embayments to Shelburne Bay and to St. Albans Bay showed for both cases the dominating influence on bay water quality of water exchange with the broad lake. However, contrasting conclusions for the two bays were reached with regard to the potential water quality improvements expected from point source phosphorus controls. Shelburne Bay should respond only slightly to controls while St. Albans Bay should improve dramatically with phosphorus removal at the St. Albans Municipal Treatment Plant.

1040

ALPHONSE H. GILBERT
JOHN J. LINDSAY
ROBERT E. MANNING

School of Natural Resources, Aiken Ctr., University of Vermont, Burlington, VT 05405

Allocation and management of Lake Champlain for outdoor recreation

Research was initiated in the summer of 1980 to assess the status of boating activity on Lake Champlain. Objectives were to determine the nature and extent of boating-related problems and to develop recommendations for resolution. Study methods included aerial photography of boating activity, surveys of lake boaters, shoreline owners and marina operators, and a literature review of water-based recreation management alternatives. Major issues were found to be lack of access and berthing capacity, insufficient holding tank pump-out facilities, conflicts between boaters and shoreline residents, and the special importance of "near-shore" waters. Major recommendations include development of a more active information program for boaters, state registration of non-power boats, additional reliance on the Shoreland Zoning Act and Mooring Management Act, state requirements for pump-out facilities, and development of several different types of public access areas.

1100

CLAUSEN, J.C. , D.W. MEALS, JR., E.A. CASSELL, AND R.C. FURBUSH. Vermont Water Resources Research Center. School of Natural Resources, University of Vermont. Burlington, Vermont 05405. Studies of Agricultural Non-Point Pollution of St. Albans and Shelburne Bays in Lake Champlain.

Lake Champlain is a phosphorus limited lake which is undergoing accelerated eutrophication. Two bays on the Vermont shores, St. Albans and Shelburne Bays, show pronounced water quality deteoriation in recent years and have prompted studies of the effects of Agricultural Best Management Practices on water quality. Water quality monitoring of watershed point sources, subwatersheds, edge-of-fields, a wetland, and one of the bays began in 1979 and will continue for 10 years. Shorter-term studies have included biological monitoring and analysis of bay circulation and bay sediments. Current results indicate that the LaPlatte River is exporting about ten times more phosphorus to Shelburne Bay than average phosphorus loadings from agricultural watersheds in the northeastern U.S. The seasonal variability in nutrient concentrations and exports in streamflow make the evaluation of the effectiveness of best management practices in improving water quality difficult until long-term trends are observed.

1120

LINDSAY W. WOOD, Ph.D., NYS Department of Health, Center for Laboratories & Research, Empire State Plaza, Albany, New York 12201.

The use of internal parameters to determine relative phosphorus loading across a lake's surface

Phosphorus loadings to Lake Champlain were estimated for many sections through the use of data on spring phosphorus concentrations, mean summer phosphorus concentrations and mean growing season chlorophyll a concentrations. Areas included in the study were Cumberland Bay (1978), Bulwagga Bay (1979), both South Lake and Kings Bay (1980), and Willsboro Bay - Burlington Bay (1981). These internal parameter estimates show good agreement to those for the South Lake or Total Lake estimates of Henson and Gruendling (1977). Turbidity apparently reduced the chlorophyll a estimations in the South Lake area (Crown Point southward). The Main Lake areas showed good agreement amongst internal parameter and the more traditional methods used by Henson and Gruendling to estimate phosphorus loadings.

This approach also provided a general picture of overall water circulations in the sections studied. These circulations were at variance with some of these hypothesized by Henson and Gruendling in their loading model.

1140

E.B. HENSON AND MILTON POTASH, Zoology Dept., University of Vermont, Burlington, VT 05405

Lake Champlain: the interaction of the lake with its drainage basin.

It would be expected that Lake Champlain, with 300 tributary streams, a morphometric shore development index of 7.9, an insularity of 12.6%, a ratio of mean depth to maximum depth of 0.23, a watershed to lake area ratio of 18:1, and a renewal rate of less than three years, would be highly influenced by the runoff from the drainage basin.

The major basins of the lake are examined individually with regard to morphometry, hydrology and the contrast of water quality characteristics of residual lake water with influent runoff. Tributary input is examined with respect to concentrations and loading of major ions.

Since large amounts of annual loading enters the lake during the short period of spring melt-off, the climatological and hydrological factors that can result in maximal runoff with variable lake levels could be a factor in controlling the quality of the lake.

In most instances the concentrations of ions in the influent streams are higher than in the part of the lake. Some of this reduction in concentration can be accounted for by sedimentation, loss through wetlands, and biological incorporation. An important factor is that the concentration of many of the ions are less during periods of high runoff.

EUTROPHICATION

0800-1200 Room 102

Moderator: William Sonzogni

0800

MARGARET SUMMERFIELD , Center for Great Lakes Studies and Department of Zoology, University of Wisconsin-Milwaukee, Milwaukee, WI 53211. Chemical and Physical Data for Three Bays in NW Lake Michigan.

Samples were collected from three bays along the northwest shore of Lake Michigan during the summer of 1981. These were analyzed for the major nutrients, specific conductivity, temperature, and several other factors. Preliminary results indicate that the nutrient levels compare favorably with those reported by Bartone and Schelske for the northern lake stations during 1976, with the exception that dissolved NO_3 and NO_2 for the bays was significantly lower and potassium had a wider range but the mean value was similar. These bays, Rowleys Bay, North Bay, and Moonlight Bay, are still relatively free from the enrichment found in certain other nearshore waters of Lake Michigan which have been categorized as "secondary eutrophic."

0820

S.W. EFFLER , M.T. AUER and D.L. JOHNSON , Upstate Freshwater Institute, Inc., Syracuse, New York, 13210, Michigan Technological University, Houghton, Michigan, 49931, SUNY CESF, Syracuse, New York, 13210. "Carbonate Equilibria and the Distribution of Inorganic Carbon in Green Bay".

The spatial and temporal distribution of selected inorganic carbon equilibrium species is presented for twelve locations, representing the near surface waters of Green Bay during the spring to fall period of 1982. Carbon dioxide and calcite equilibrium conditions were determined through solution of temperature and ionic strength adjusted equilbria and evaluated with respect to suitability as indicators of physical conditions and biological activity in the waters of Green Bay. Substantial temporal variation in these equilibrium conditions occurred throughout most of the bay. The magnitude of variation was greatest in the more productive areas of the bay, where extensive calcite supersaturation and carbon dioxide undersaturation occurred. The variations were mediated mostly through changes in pH. Calcite saturation conditions suggest that calcite precipitated within the inner bay. This prediction is evaluated through analysis of settling particles collected in sediment traps deployed during the same period.

[4]A contribution of the Upstate Freshwater Institute, Inc.

0840

S.W. EFFLER , M.G. PERKINS , and M.T. AUER , Upstate Freshwater Institute, Inc., Syracuse, NY, 13214, South Hampton College, South Hampton, NY, Michigan Technological University, Houghton, MI, 49931. "Absorption by Gelbstoff in Green Bay."

The spatial and temporal distribution of absorption by Gelbstoff (yellow dissolved substance) is presented for a productive six month period of 1982 for twelve locations representing the near surface waters of Green Bay. Filtered (0.45 μm) samples were scanned with a spectrophotometer (4 cm path length) from 400-700 cm. Fluvial discharges to the bay were enriched in Gelbstoff, with absorbances as high as 4.0 m^{-1}. Rather strong longitudinal gradients in absorbance were noted within the bay, with the highest values (0.65 m^{-1}) in the inner bay and the lowest in the outer bay. This spatial distribution was consistent with both the position of the fluvial discharges and the distribution of phytoplankton biomass. The relative importance these two potential influences have on the distribution of Gelbstoff will be evaluated, as will the role Gelbstoff plays in light attenuation in the productive layers of the bay.

[4]A contribution of the Upstate Freshwater Institute, Inc.

0900

MARTIN T. AUER , RAYMOND P. CANALE , and JAMES H. WIERSMA , Departments of Civil Engineering, Michigan Technological University , Houghton, Michigan 49931 and The University of Michigan , Ann Arbor, Michigan 48109, and Department of Science and Environmental Change, U. Wisconsin-Green Bay , Green Bay, Wisconsin 54302. "Dissolved Oxygen Depletion in Green Bay 1980-82."

Bottom waters in Green Bay experience dissolved oxygen depletion in the summer months. The extent and severity of depletion vary as a function of seasonal and short-term meteorological phenomena. Shallow waters near the Fox River mouth experience oxygen depletion only during periods of extended quiescence. Dissolved oxygen concentrations less than 2 mg/ℓ have been reported from thermally stratified waters as far as 80 km from the Fox River mouth. Preliminary calculations indicate that the impacts of allochthanous loading of BOD are less important to oxygen dynamics in the deep, stratified waters of the bay than are internal production and endogenous respiration. Phytoplankton populations in the turbid, eutrophic waters of the inner bay may be characterized as nutrient saturated and light-limited. Nitrogen-depletion and the associated proliferation of cyanobacteria are routinely observed. It is suggested that phytoplankton growth is promoted by improved water clarity in the mid-bay region. Internally-produced organic carbon then settles in the deeper waters of the bay leading to oxygen depletion.

0920

SUSAN T. BAGLEY , ROBERT D. GARDINER , MARTIN T. AUER , and RAYMOND P. CANALE . Departments of Biological Sciences and Civil Engineering , Michigan Technological University, Houghton, Michigan 49931 and Department of Civil Engineering , University of Michigan, Ann Arbor, Michigan 48109.
"Seasonal and Spatial Variation in Biochemical Oxygen Demand in Green Bay (Lake Michigan)."

Biochemical oxygen demand was measured for the surface and bottom waters of Green Bay at 26 stations on 18 occasions over the period 25 May to 6 October 1982. Highest concentrations of BOD-5 were measured at the mouth of the Fox River (midsummer mean, 11 mg/ℓ). A distinct spatial gradient in levels of BOD-5 was detected with distance from the mouth of the Fox River. Lake water concentrations dropped to less than 50% of river mouth levels at a distance of 20 km and approached background levels of < 1 mg/ℓ at a distance of 90 km. Concentrations of BOD-5 increased over the summer with peak levels occurring in late July and early August. Seasonality was most pronounced for stations near the Fox River mouth. Bottom water levels of BOD-5 were generally 0.5 to 1.5 mg/ℓ less than corresponding surface water concentrations. Preliminary experiments indicate that algal respiration contributes significantly to long-term BOD. Also, oxygen demand associated with the soluble organic carbon component is much greater than that of the particulate fraction.

0940

RAYMOND P. CANALE and MARTIN T. AUER , Departments of Civil Engineering, The University of Michigan , Ann Arbor, Michigan 48109 and Michigan Technological University , Houghton, Michigan 49931.
"Steady-State Material Balances for Green Bay (Lake Michigan)."

A three-year program is currently under way to quantify the relative contribution by tributary loading, sediment oxygen demand, and internal production to the total system oxygen demand for Green Bay. A mathematical model will be used to examine the impact of changes in carbon and nutrient loading on dissolved oxygen dynamics in Green Bay. As a first cut, a 12-cell, steady-state mass balance model has been constructed. Material balances of increasing complexity have been calculated for chloride, total phosphorus, and total organic carbon. The chloride budget considers only loading and mass transport, while the total phosphorus budget includes net settling and sediment release; a term for primary production is added for the total organic carbon budget. Model calculations of spatial variation in these parameters match field measurements using literature estimates and direct determination of model coefficients. Model output points to the importance of internal production of organic carbon in regulating dissolved oxygen dynamics in Green Bay.

1020

EARL E. SHANNON,
President and Technical Director
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Effect of Conventional and Advanced Wastewater Treatment Processes on the Algal Availability of Phosphorus

In order to develop additional technical information on the algal availability of phosphorus in municipal wastewaters and the effect of wastewater treatment on algal available phosphorus, a 13 month sampling program was carried out at 10 Ontario treatment plants with and without phosphorus removal. Processes monitored encompassed lagoons and primary, secondary and advanced treatment facilities. Algal assays, utilizing a dual culture diffusion apparatus (DCDA) were run on the soluble and particulate wastewater fractions. Both routine (14 day) and long term (up to 90 days) assays were carried out. The particulate fraction was further characterized via a sequential chemical extraction technique. The algal available P in the treatment plant effluents varied from <0.1 to 2.7 mg/L. The portion of the total-P that was algal available ranged from 19 to 91%. It was concluded that the control of available-P should be focused on the soluble fraction of wastewater effluents. Extrapolation of the results to Ontario treatment plant discharges to the Lower Great Lakes, indicated that the existing algal available loadings of 824 metric tonnes/year could be reduced to 372 tonnes/year if an across-the-board-effluent total-P requirement of 0.5 mg/L were implemented.

1040

Thomas C. Young , Joseph V. Depinto, and John P. McAuliffe, Department of Civil and Environmental Engineering, Clarkson College of Technology, Potsdam, New York 13676 Effects of anaerobic conditions on algal-availability of particulate phosphorus in lower Great Lakes tributaries.

After deposition, sediments are often exposed to a period of anoxia, followed by resuspension. In order to determine the effect of anoxia on the bioavailability of P associated with suspended sediments, samples from four Lake Erie tributaries were subjected to a period of anaerobic incubation, reaerated, and bioassayed for available P. The available P released from the post-incubation bioassays was compared to the release from aliquots of the same samples but which were not exposed to the anaerobic period. Sequential chemical fractionation of the sediment P was done concurrently to identify changes in particulate P resulting from the treatments and bioassays. Bioassays on anaerobically incubated sediments consistently showed less available P release to algae than did bioassays in parallel on control sediments. In contrast, however, a comparison of changes in the total sediment-bound P between the two groups of bioassays indicated that algal-available P from the anaerobically incubated sediments was similar to that of the controls. Together, the bioassay and P fractionation data indicate that after deposition and exposure to anaerobic conditions, tributary suspended solids will release no more available P than if they were to remain in suspension.

1100

DAVID M. DOLAN , IJC, 100 Ouellette Ave., Windsor, Ontario and VICTOR J. BIERMAN, JR., EPA, Environmental Research Lab., South Ferry Rd., Narragansett, Rhode Island 02882. The Effect of Sediment - Water Interactions on Phosphorus Concentrations in Saginaw Bay, 1974-1980.

During the period 1974-1980, Saginaw Bay was studied intensively for eutrophication related parameters, including phosphorus. Although the phosphorus loading from the Saginaw River decreased approximately 50% during this period, the total phosphorus concentrations in the bay did not respond in a similar fashion. In fact, substantial decreases in water column total phosphorus were not observed until 1980, even though significant removal of point source phosphorus in the Saginaw Basin was underway by 1976. This apparent lag in response was not due to the retention time in Saginaw Bay, since this is of the order of two to four months. A spatially segmented, dynamic mass balance model was developed to describe concentrations of phosphorus and suspended solids over the time period. A wind-driven resuspension mechanism was used to describe the sediment - water interactions. Model output was calibrated to field data for total phosphorus and suspended solids. It was found that the bottom sediment in depositional zones in Saginaw Bay acted as a reservoir of phosphorus and caused the apparent lag in response of the system.

1120

DOUGLAS K. SALISBURY , JOSEPH V. DEPINTO and THOMAS C. YOUNG, Department of Civil and Environmental Engineering, Clarkson College of Technology, Potsdam, NY 13676. Phosphorus Bioavailability of Loads to Lake Erie for 1970-1980.

Total phosphorus loading data for Lake Erie from 1970-1980 (U.S. Army Corps of Engineers, Buffalo District) have been catagorized into three forms, based on phosphorus bioavailability studies. The three forms are soluble reactive phosphorus (SRP) (immediately available for algal uptake), external unavailable phosphorus (EUP) (not immediately available but converted to an available form at a specific rate), and external refractory phosphorus, (ERP) (never available for algal uptake). In 1970, the total phosphorus load to the western basin was 14,418.4 MT, of which 40.5% was SRP, 13.7% was EUP, and 45.8% was ERP. In contrast, the 1980 total phosphorus load was 7,761.5 MT of which 49.0% was SRP, 11.6% was EUP, and 39.4% was ERP. This phosphorus loading data set should allow more accurate calibration of phosphorus dynamics in nutrient/phytoplankton models. The significance of the phosphorus proportioning technique was ascertained using a multi-nutrient phytoplankton model (DiToro and Connolly, 1980) with the 1970 phosphorus loading data. The results of a simulation with four phosphorus systems (SRP, EUP, ERP, and autochthonous unavailable phosphorus) was compared to results of a simulation that used two phosphorus systems (SRP and unavailable phosphorus). Significant changes in the phosphorus and nitrogen dynamics and in the phosphorus-limited fall phytoplankton peak were observed.

1140

WAYNE S. GARDNER , THOMAS P. NALEPA, DAVID R. SLAVENS, AND GWENYTH A. LAIRD, Great Lakes Environmental Research Laboratory, 2300 Washtenaw Avenue, Ann Arbor, MI 48104. Patterns and Rates of Nitrogen Release by Benthic Chironomids and Tubificids.

Metabolic mineralization of ammonium by tubificid worms and chironomid larvae appears to be an important mechanism contributing to nitrogen regeneration from aerobic lake sediments. Mean weight [ash free dry weight (AFDW)] - specific ammonium release rates ranged from 3 to 15 nmol NH_4 (mg AFDW)$^{-1}h^{-1}$ for chironomid and tubificid species collected in the summer from nearshore Lake Michigan sediments. Although mean rates of nitrogen release were similar for the two groups of benthic invertebrates, the patterns of release were different. Tubificids released nitrogen (ammonium plus primary amines) continuously, whereas chironomids released it in spurts several times per hour. Mean ammonium-release rates were generally constant with time after the animals were removed from food for both species. This implies that ammonium regeneration for these benthic animals is primarily an endogenous process. Conversely, primary amine nitrogen release often decreased with time after food removal and may reflect either egestion of partially digested materials from the animals' guts or a decrease in the metabolic pool size of free amino acids. Based on previous meansurements of phosphorus release, mean molar NH_4:PO_4 ratios in excreted materials were calculated to be 15:1 for chironomids and 35:1 for tubificids.

CONTAMINANT METHODS

0800-0940 Room 105

Moderator: Augustine Silveira, Jr.

0800

ROBERT JOHNSON , Varian Instrument Group
83 Second Avenue
Burlington, MA 01803
Technical Support Specialist

Applications of Gas Chromatography to Environmental Analysis.

Specific detectors and dual capillary columns as aids in component identification and quantitation have become quite popular in environmental analyses. Analyses using tandem photoionization and hall electrolytic conductivity detectors will be described as well as dual capillary column analyses of environmental samples.

0820

JOHN J. ROBINSON , Varian Instrument Group
25 Hanover Road
Florham Park, NJ 07932
Technical Support Specialist

Applications of HPLC to Environmental Analysis.

High performance liquid chromatography (HPLC) is an extremely versatile and selective separation technique, but its application to environmental analysis is often limited by the sensivity and selectivity of the available detectors. This limitation can be overcome by the application of inherently more selective detectors, but also by more creative use of existing hardware. Examples of both approaches will be illustrated in the analysis of PNA's, phenols, carbamotes, and other environmentally important compound classes.

0840

PETER DOMINSKI , Varian Instrument Group
25 Hanover Road
Florham Park, NJ 07932
Technical Support Chemist

The Reduction of Chemical Interferences Using Chemical Matrix Modification in Graphite Furnace AAS - by: T.N. McKerryie, P.S. Diodye, M.W. Rouch and P.C. Dominski

The problem of interferences in graphite furnace AAS is a difficult one. Many different techniques must be utilized, such as matrix modification, background correction and judicious temperature programming in order to reduce these interferences. Other considerations for the development of furnace methods include analysis requirements, sample preparation requirements and analyte instrumental requirements.

A large number of analytes in samples of both natural and treated origins when analyzed by furnace AAS are present in high salt matrices, usually sodium chloride. These samples can pose formidable problems as the analyte can be atomized as a volatile chloride which can lead to the reduction of the atomic absorption signal. Matrix modification can be used to reduce the effect of the parent matrix by either reducing the interfering species or changing the characteristics of the analyte to give complete resolution of atomic and background signals. Effectiveness of ammonium oxalate diammonium hydrogen citrate and ammonium dehydrogen phosphate as chemical modifiers will be assessed in the analysis of Pb, Zn, Cd, Al and Mn in high salt matrices.

0900

ANAND R. MUDAMBI
JOHN P. HASSETT
Chemistry Department
State University of New York
College of Environmental Science & Forestry
Syracuse, NY 13210
RONALD J. SCRUDATO
Research Center
State University of New York
Oswego, NY 13126

Mirex in Oswego River and Lake Ontario Water Columns

Water samples from Oswego Harbor, the plume of the Oswego River and a Lake Ontario site outside of the plume (Mexico Bay) were collected in spring, summer and fall 1982 and analyzed for dissolved and particulate mirex. Samples (40-60 l) were passed through a continuous flow centrifuge to remove particles and then through an XAD-8 column to adsorb dissolved mirex. Particles were extracted with hexane and the XAD-8 columns were extracted with acetone. After concentration and fractionation on a Florisil column, mirex was identified and quantified by packed column gas chromotography with an electron capture detector. Dissolved mirex (i.e. that not retained by the centrifuge but adsorbed by XAD-8) was detected in most samples from all sites at concentrations ranging from below detection limits (~5 pg/l) to 130 pg/l.

CONTAMINANT METHODS (Continued)

0920

EDWIN C. TIFFT, JR.
WILLIAM C. BECKER

O'Brien & Gere Engineers, Inc.
1304 Buckley Road
Syracuse, New York 13221

Chlorinated Hydrocarbons in Lake Ontario

The finding of DDT, PCBs, mirex and dioxin in Lake Ontario's sediments, fish and foul have led to concern over the safety of the Lake as a drinking water supply. As a result, the Metropolitan Water Board (MWB) of Onondaga County, New York has initiated the most comprehensive monitoring program for chlorinated hydrocarbons ever conducted on a single supply from Lake Ontario. Since 1976 the MWB has collected samples of raw water at its intake at Oswego, New York on a monthly basis to evaluate the presence of chlorinated hydrocarbons. To date, 94 samples have been analyzed for 16 chlorinated hydrocarbons including several PCBs and CHPs, such as mirex and DDT. The analytical procedures consisted of liquid-liquid extraction with hexane, concentration and electron capture gas chromatography. In addition, a sample was analyzed for 2,3,7,8-TCDD, an extremely toxic organic. The 2,3,7,8-TCDD sample was prepared according to EPA Method 613 and then analyzed by GC/MS. The monitoring results show that none of the samples collected have ever revealed the presence of any chlorinated hydrocarbon compounds at a general detection level of 0.01 ppb. In addition, the dioxin sample showed no presence of 2,3,7,8-TCDD at a detection level of 0.01 ppb. The results clearly show that Lake Ontario is an excellent source of drinking water.

GENERAL BIOLOGY

0800-1000 Room 103

Moderator: Jacob Verduin

0800

HERMAN S. FOREST State University of New York College at Geneseo, N.Y. 14454 -

Diversity of submersed macrophytes in glacial lakes of Europe and North America: relationship to water quality.

Studies in eight lakes and bays of western New York revealed two patterns in the submersed macrophyte flora. A regional flora was recognized, and the historical decline in species diversity of individual waters traced. Decline in diversity was related to richness of the initial flora and to man's influence, particularly nutrient enrichment. Some species were more sensitive to water quality decline than others. This study base was extended with data from published accounts and some field observations in eastern North America and in Finland, Poland, Scotland, Sweden, and Switzerland. Floral generalizations became much more uncertain in wider geographical applications, and only limited comparisons were possible between North American and European lakes. Nevertheless, it was possible to compare a flora of 10 species of Potamogeton and species of six other genera. Casualties in moderate decline included four species of Potamogeton, Myriophyllum exalbescens Fern., and Ranunculus spp. The most impoverished floras may include Potamogeton crispus L., P. pectinatus L., Ceratophyllum demersum L. and Myriophyllum spicatum L.

0820

CROWDER, A. A. and J. M. BRISTOW, Department of Biology, Queen's University, Kingston, Ontario, Canada, K7L 3N6 and Centro Agronomica Tropical de Investigacion y Ensenanza, Turrialba, Costa Rica.

Total Phosphorus in the Standing Crop of Aquatic Plants in the Bay of Quinté, Lake Ontario, in 1979.

During 1972-82 eutrophication of the Bay of Quinté decreased but submerged vegetation did not recover in extent or biomass. In 1979 an aerial survey was used to map submerged and emergent vegetation. Areas of both communities were measured. Biomass and P content were sampled and total P was calculated. In submerged plants the total P was estimated at 494 kg; in cattail marshes it was estimated at 89,892 kg. Turnover times in these communities are not known. Their possible roles in nutrient cycling are discussed.

0840

MAXINE A. HOLDER-FRANKLIN, Dept. of Biology and The Great Lakes Institute, U. of Windsor, Ont., Canada, N9B 3P4. Mathematical Modelling of Aquatic Bacterial Population Shifts.

Seasonal and diurnal river water samples were analysed for predominant bacterial types and nineteen chemical and physical parameters including temperature, O_2 concentration, pH, total organic carbon, nitrogen and phosphorus and several ions as well as specific conductance. The bacterial populations i.e. 1600 isolates were tested using 223 physiological and nutritional responses. These responses were factor analysed as were the chemical and physical parameters. Factor scores were regressed and analysed by path analysis to determine causal effects. It was demonstrated that the bacterial populations are primarily under the influence of the water temperature plus C and P followed by the O_2 concentration and the specific conductance. Secondary effects were attributed to CO_2 and nitrate concentrations. The basic path diagram of the chemical and physical parameters alone indicated that the most important variable was temperature linked with the nutrients carbon and phosphorous which directly influenced CO_2 and oxygen concentration. The pH was always linked with the oxygen factor as a negative loading. Oxygen and CO_2 both influenced the specific conductance. Thus the database for the model was the bacterial test responses which were factor analysed. The factors were interpreted and population was then described as physiological attributes. The high correlations of these factors with environmental parameters indicated that this is a superior method as compared with species counts for analysing bacterial population shifts.

0900

BARBARA L. STIVER. Department of Botany, Ohio State University, 1735 Neil Ave., Columbus, Ohio 43210
Phytoplankton distribution in central Lake Erie.

A study was undertaken in the summer of 1979 to examine the distribution of phytoplankton at a station in the central basin of Lake Erie. Two surveys of plankton were studied, one in mid-July and one in mid-August. During both surveys the central basin was thermally stratified. Samples collected from six depths were analyzed chemically and microscopically. The major phyla found included Cyanophyta, Chlorophyta, Chrysophyta Pyrrophyta, and Cryptophyta. A large population of the cyanophyte Oscillatoria was found in the metalimnion in July but very low populations of the algae were found in August. Metalimnetic populations of Ceratium were large. Some genera of algae were concentrated in the metalimnion where other genera were distributed throughout the water column. The distributions of the most common genera will be described as well as the contribution of each phyla to the total phytoplankton biomass.

0920

KENNETH J. WAGNER
Department of Natural Resources
Cornell University
Ithaca, New York 14853

The influence of natural phytoplankton assemblages on Daphnia reproduction in Oneida Lake, New York.

An analysis of seven years of data collected from Oneida Lake indicates that defined phytoplankton assemblages exert differential effects on Daphnia pulex reproduction. Assemblages dominated by flagellates and diatoms appeared most beneficial to the reproductive process, although associated low temperatures reduced corresponding birthrates. Assemblages dominated by flagellates alone were least beneficial, due to quantitative deficiencies. Cyanophyte dominated assemblages produced highly variable effects as a result of qualitative differences in assemblage components. The results of enclosure experiments support the above observations. Implications for the management of lentic systems are discussed. Where increased production of Daphnia as a food resource for planktivorous fish is desired, strategies that maximize algal biomass are recommended over management actions that potentially improve phytoplankton quality while reducing algal biomass.

0940

H. A. VANDERPLOEG, J. R. LIEBIG, B. J. EADIE AND R. GLOVER, Great Lakes Environmental Research Laboratory, Ann Arbor, MI 48104; Hunter College, N. Y., N. Y. Interaction between Calcite Whitings and Zooplankton in Lake Michigan.

Calcite is a significant contributor to the total particle-size spectrum of Lake Michigan seston from mid-August to mid-October. Both herbivorous copepods and cladoceran ingest calcite along with other seston. To determine if the calcite had an effect on zooplankton feeding, feeding was compared for 0.8 $mm^3 \cdot l^{-1}$ Cyclotella and for 0.8 $mm^3 \cdot l^{-1}$ Cyclotella plus 0.8 $mm^3 \cdot l^{-1}$ calcite. The size of the calcite used and the concentration of calcite plus Cyclotella approximated typical annual maximum concentrations found in Lake Michigan. Special Coulter-counter methods allowed measurement of feeding rate on algae in the presence of calcite and the impact of feeding on the calcite. For Daphnia pulex, the presence of calcite lowered feeding rates on Cyclotella to values 30.5% of those for Cyclotella alone. Diaptomus sicilis was unaffected by the calcite. Neither zooplankter had any effect on calcite concentration. The difference between Daphnia and Diaptomus is probably related to their feeding methods.

Fecal pellets collected from different seasons in Lake Michigan were examined for carbonate content and pellet dimensions. During September, calcite constituted approximately 70% of the volume of the pellet. Calculated sinking rates showed that the presence of the calcite increased pellet sinking rates from 2 $m \cdot d^{-1}$ to 32 $m \cdot d^{-1}$. Potential effects of calcite on zooplankton succession and other ecological effects are detailed.

PALEOLIMNOLOGY

1020-1140 Room 103

Moderator: Jacob Verdiun

1020

DORA BARLAZ, Department of Geology and Geophysics, University of Minnesota, Minneapolis, MN 55455.

Physical Characteristics of Sediments and Holocene Geological History of the Duluth-Superior Harbor, Lake Superior

Surface sediments in the Duluth-Superior Harbor and lower St. Louis River were characterized by means of grains size, total organic carbon (TOC), and mineralogical analyses. The sediments are predominantly silt, with sand along the shorelines and gravel in the high-traffic ship channels. TOC varies from 0.06-5% dry wt., and is highest in the fine grained sediment. Mineralogy of the harbor sediments is relatively uniform. The medium sand fraction is dominated by lithic fragments; opaque minerals, amphiboles, and pyroxenes constitute the majority of fine sand grains. Relative abundance of smectite, illite, kaolinite, and chlorite in the clay-size fraction was determined and varies systematically with sediment texture. Engineering borehole data and 3.5 kHz seismic reflectin profiles were used to reconstruct stratigraphy and Holocene history of the area. Boreholes, 10-60 meters in length, contain 6 lithologic units: glacial outwash sand, glaciolacustrine clay, and post-glacial peat, silt, clay and nearshore sand. Seismic profiles contain 3 main reflectors which roughly correspond to the lithologic changes seen in boreholes. Variation of sediment types are the record of changing water levels and environments in western Lake Superior. The spits that bound the harbor are Holocene features, possibly formed by spit progradation by longshore currents or "self generation", submergence of coastline ridges, or emergence of offshore bars.

1040

T. KEILTY , J. A. ROBBINS, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104, and D. S. WHITE, University of Michigan, Ann Arbor, MI.

Relations Between Organism Densities, Organic Carbon and Sediment Accumulation Rates in Lake Michigan.

Zoobenthos densities and sedimentation rates (via Cs-137 and Pb-210) were determined in a set of replicate cores from Lake Michigan with contrasting rates of sediment accumulation but comparable sediment composition. As oligochaete densities tended to be linearly related to sedimentation rates, additional points were obtained (N=31) by comparing densities measured in a 1977 lake-wide survey (DSW) with sedimentation rates and organic carbon in surface sediments (JAR) at water depths greater than 50 m. Tubificid worm densities correlated well with the flux of organic carbon (r=0.74) but not with the organic carbon content alone. The results suggest that tubificid abundances in the fine grained sediments of the lake are limited by the supply of nutrients measured in terms of organic carbon rather than sediment composition. Stylodrilus heringianus occurs primarily at values of the organic carbon flux less than 0.8 mg $C/cm^2/yr$. Below this value their numbers correlate significantly with OC flux. At higher OC fluxes tubificids are the dominant oligochaete.

1100

JOHN C. KINGSTON . Department of Geology, University of Minnesota, Duluth, MN 55812.

A preliminary examination of the paleolimnology of the St. Louis River estuary based on the diatom record.

An effort to understand the past environment of the St. Louis River estuary at Lake Superior through the diatom record has begun. A 373-cm sediment core was obtained with a piston-corer from a shallow bay of the estuary at Superior, Wisconsin. Organic content of the core is generally high near the bottom and declines steadily toward the top, reflecting a change from peaty soils to fluvial deposits high in sand and silt. Some of the oldest sediment examined (352 cm) contains a soil diatom assemblage indicative of low water levels. Diatom assemblages at 277 cm and 152 cm contain high amounts of benthic forms that indicate good water transparency and oligotrophic to mesotrophic conditions. At the 52-cm depth, dominant plankton diatoms (Melosira spp.) indicate eutrophication and diminished transparency. Above 22-cm sediment depth several species that indicate chlorite contamination are present, and the assemblages are still dominated by eutrophic plankton. We hope to gain a better understanding of the postglacial and post-settlement ecology of this estuary using further analysis of diatoms in sediment cores.

1120

C. L. SCHELSKE , E. F. STOERMER, D. J. CONLEY, J. A. ROBBINS , and R. M. GLOVER . Great Lakes Research Division, University of Michigan, Ann Arbor, MI 48109, [1]Great Lakes Environmental Research Lab, NOAA, 2300 Washtenaw Ave., Ann Arbor, MI 48104, and [2]Biology Department, Hunter College, New York, NY 10021.

Sedimentary Evidence for Anthropogenic Modification of Silica Cycles in the Great Lakes.

Biogenic silica (BSi) analyses of dated sediment cores from Lake Ontario, Lake Erie and Lake Michigan showed peak periods of BSi storage at depth. However, BSi storage peaked at widely different times occurring about 1850 in Lake Ontario, 1880 in Lake Erie and 1970 in Lake Michigan. Our hypothesis for pulses of BSi storage in sediments is an initial increase in diatom production caused by nutrient (phosphorus) enrichment followed by a decrease in diatom production when Si becomes limiting for diatom growth in the water column. This is the sequence of events that has been described previously for Lake Michigan as the result of Si depletion in the water column. Our results show that Si depletion occurred in the 1800s in the lower lakes and suggest that the Si depletion sequence for these lakes was induced by relatively small increases in phosphorus concentrations or loadings during early settlement of the drainage basins. The phasing of Si depletion in the water column and BSi storage in the sediments will be related to total phosphorus and soluble reactive Si concentrations in the Great Lakes.

FISH CONTAMINANTS

1020-1200 Room 105

Moderator: Ronald Sloan

1020

PAUL W. RODGERS, Limno-Tech, Inc. Environmental Consultants, 15 Research Drive, Ann Arbor, MI, 48103.
WAYLAND R. SWAIN, U.S.E.P.A./ERL, 9311 Groh Road, Grosse Ile, MI, 48138.

Analysis of PCB loading trend in Lake Michigan

PCB concentrations of Bloaters collected from Lake Michigan from 1972-1980 are used to infer a loading trend in PCBs. The approach is to develop a mass balance describing the dynamics of PCBs by assuming that historical fish concentrations are proportional to concurrent water concentrations. Validity of this assumption is strengthened because the data represents a single fish species (a pelagic feeder), a specific age class, and the measurements were conducted by one laboratory. The results of the model analysis indicate that PCB loading to Lake Michigan during the period of observation can be described by a linear decrease. Forecasting lake and fish response to various loading scenarios is also an application of the model. These forecasts were compared to the temporary threshold value for human consumption of fish of 5 ppm, and the proposed value of 2 ppm. Results indicate likely compliance to both values within a 25 year period for Bloaters, Coho, and Trout. Forecast accuracy may be improved by precise measurements of proportionality coefficients.

1040

SUSAN H. MATHEWS , Cranbrook Institute of Science, Bloomfield Hills, MI 48013, and DAVID M. DOLAN, International Joint Commission, Windsor, Ontario. Polychlorinated Biphenyls (PCBs) in Saginaw Bay Yellow Perch, 1977-1980.

From 1977-80 yellow perch (Perca flavescens) were collected from Saginaw Bay and analyzed for polychlorinated biphenyls (PCBs) along with numerous samples of water, sediments, particulate matter and other fish species as part of a program to develop mass balance models of toxins at the EPA, Large Lakes Research Station, Grosse Ile, Michigan.

A total of 1368 individual yellow perch were gill-netted at 5 stations in Saginaw Bay in the course of 10 surveys, May-Nov., 1977-80. Homogenized, composited whole perch tissue samples of 20 gm (wet wgt.) were Soxhlet extracted and analyzed by packed column gas chromatography. Concentrations of PCBs ranged from 4.02 mg/kg in the inner bay to 0.84 mg/kg in the less polluted outer bay.

Regression-correlation analyses of Aroclors 1242, 1260 and total PCB with mean length, weight and % lipid content were carried out by station. Aroclor 1260 and total PCB were significantly correlated (α=.05) with both mean length and weight at all stations. Aroclor 1242 was correlated significantly only with mean length at two inner bay stations.

Analysis of co-variance indicated a gradient of PCB contamination in fish flesh from inner to outer bay, showing an overall decrease in PCB concentrations in all sizes of perch toward the outer bay. Bioconcentration factors were calculated for yellow perch at each station.

1100

CLIFFORD P. RICE , MARLENE S. EVANS and GEORGE E. NOGUCHI, Great Lakes Research Division, The University of Michigan, Ann Arbor, Michigan. Toxaphene and other chlorinated hydrocarbons in Lake Michigan Plankton and Fish.

Toxaphene was measured in sub-ppm concentrations in mysids, plankton and deepwater sculpin (a predator on mysids). The toxaphene concentrations for mysids collected in June 1982 ranged from 0.21 to 0.43 ppm dry weight with plankton concentrations ranging from 0.27 to 0.56 ppm. The PCB concentrations were 0.51 to 0.88 for mysids and 0.24 to 0.26 for plankton. A composite of seven deepwater sculpins were also analyzed and were found to contain 3.1 ppm toxaphene and 5.0 ppm total PCB on a dry weight basis. Other pesticides were also present in these samples including DDT residues, chlordane, dieldrin, etc. The toxaphene analyses were performed using electron capture gas-liquid chromatography with a fused silica capillary column. Toxaphene was identified by matching retention times of peaks in the samples with toxaphene standards. The number of matched peaks varied from 41 to 72% of the 39 peaks which were selected from the toxaphene standard. A subset of the matched peaks were used for quantitation. Our analyses have not included toxaphene previously. However PCB and other chlorinated hydrocarbons found in earlier collections (1979-81) were comparable to the values found in the 1982 collection.

1120

STEVEN A. SPIGARELLI, Center for Environmental Studies, Bemidji State University, Bemidji, MN 56601. Prediction of Xenobiotic Accumulations by Great Lakes Fishes.

Two methods were tested for estimation of bioaccumulation of lipophilic chemicals by Great Lakes fishes. Chemicals included a range of polarities (log P 4.4-6.9) and fish species included those commonly analysed in State monitoring programs.

One approach involved the development of "predictive" regressions between observed bioaccumulation factors (log BAF) and octanol-water partition coefficients (log P). Calculated maximum BAFs for a single chemical varied over 1-2 orders of magnitude among species within a lake, and 1-1.5 orders of magnitude among chemicals within a species. BAFs exceeded 10^7 for chemicals of log P>6 in long-lived, fatty fishes. For most species, BAFs increased linearly with increased log P, providing an empirical basis for the estimation of species- and chemical-specific uptake.

A bioenergetics model was used to project the size (age)-related accumulation of lipophilic chemicals, and the projections were compared with observed concentrations. The model gave very accurate projections of size-related concentrations, if metabolic and pollution-related parameters were estimated accurately. A metabolic parameter, γ, (the exponent on weight-related metabolism) determines the shape of the uptake curve over time (age) and controls the upper level of accumulation by each species. Thus, metabolic rate is a critical factor in projecting bioaccumulation of chemicals.

FISH CONTAMINANTS (Continued)

1140

P.V. Hodson, B.R. Blunt, P.T.S. Wong, O. Kramar, Y.K. Chau, D.M. Whittle

Great Lakes Fisheries Research Branch
Canada Centre for Inland Waters
Burlington, Ontario. L7R 4A6.

Alkyl lead contamination of fish from the St. Lawrence River.

Fish netted in 1980-82 from the St. Lawrence River near Maitland, Ontario, were heavily contaminated with lead. Concentrations of total lead in blood ranged from 10 to 57000 µg/L and in whole fish homogenates from 156 to 8300 µg/kg. Analysis of alkyl lead compounds in the same homogenates demonstrated 11 separate compounds at concentrations ranging from non-detectable to 68,600 µg/kg. The sum of alkyl lead concentrations ranged from 24 to 144,478 µg/kg. There were significant positive correlations between the sum of alkyl-lead and total lead concentrations. Carp had higher lead concentrations than white sucker and pike were the least contaminated. Contaminated fish were netted 8-10 km upstream of the suspected source and 16 km downstream. However, the proportion of fish in any sample that were contaminated was greatest at the suspected source, least upstream and intermediate downstream.

LAKE CHAMPLAIN SYMPOSIUM

1300-1500 Room 104

Moderator: Allen Cassell

1300

GRUENDLING, GERHARD K. Center for Earth and Environmental Science, State University of New York, Plattsburgh, New York 12901

The distribution and abundance of phytoplankton and the relationship to phosphorus concentrations in Lake Champlain.

Large scale studies were undertaken to determine the spatial and temporal distribution of phytoplankton and nutrients in Lake Champlain. Analyses of phytoplankton abundance and phosphorus concentrations were performed from as many as 20 stations in the lake. Results indicate significant geographical differences in phytoplankton abundance. Qualitative differences in phytoplankton are less apparent. Mean summer levels throughout the lake range from 3.5-10.1 ug/l chlorophyll A, 0.50-2.2 mg/l total phytoplankton biomass, and 1.2-6.5 x 10^6 cells/l total cell count. Quantitative differences in phytoplankton reflect the phosphorus concentrations within the lake. Mean total phosphorus values range from 0.012 mgP/l in the more oligotrophic portions of the lake to 0.050 mgP/l in the eutrophic bays. Algal bioassay analyses indicate that phosphorus is the chief limiting nutrient to phytoplankton growth in most regions of the lake except for areas that have extremely high phosphorus input. Phosphorus loadings in the various regions and the residence times of the water masses appear to be the most important factors determining the phytoplankton abundance in Lake Champlain.

1320

JACK McCARTHY
GARY S. SMITH
George D. Aiken Center for Natural Resources
The University of Vermont
Burlington, VT 05405

Emergent Aquatic Vegetation Mapping from CIR Aerial Photographs and Color Video Imagery

Two emergent aquatic plants, water chestnut (Trapa natans L.) and yellow floating heart (Nymphoides peltatum), have reached nuisance proportions in many of Lake Champlain's bays and near-shore zones where nutrient levels of natural processes and man's activities are high. Updating baseline data on the extent of infestation is an important component of weed control efforts. At the request of the State of Vermont's Department of Water Resources, vertical aerial imagery was acquired to map the emergent vegetation on Lake Champlain between Larrabees Point and an area just south of Benson Landing. 35mm color infrared photographs and color video imagery were used to record the study area's condition on September 21, 1982. The emergent aquatic vegetation was identified on the imagery and transferred to overlays of Vermont orthophoto base maps. Acreage calculations for the weed patches were obtained using a digitizer. The total acreage of surface aquatic vegetation was 61.91 acres.

1340

BOGUCKI, DONALD J. , GERHARD K. GRUENDLING and JOHN L. MALANCHUK. Center for Earth and Environmental Science, State University of New York, Plattsburgh, New York 12901. Response of wetland vegetation to naturally fluctuating water levels in Lake Champlain.

The effects of naturally fluctuating water levels on growth and abundance of selected wetland species were analyzed. Long-term analysis of forested wetlands was performed utilizing 1941-1978 sequential aerial imagery. Short-term analysis (3-yr. sequence) of selected emergent vegetation was conducted using specially flown large scale color and color infrared aerial photography. Results indicate that substantial differences exist amongst various wetland plants in response to different seasonal water levels. For example, a significant die-back in living green timber was recorded following extremely high water levels. The extent of recent die-back ranged from 7.4 to 64.6% of the forested area. In contrast, some vegetation (Typha angustifolia, Scirpus fluviatilis, Sparganium eurycarpum, Cephalanthus occidentalis) benefited from high water levels. Zizania aquatica was particularly responsive to low water levels and exhibited a 400-600 percent increase in extent during low water years. The naturally fluctuating water levels result in both long-term and short-term changes in the abundance extent and composition of the Lake Champlain wetlands vegetation.

1400

JOHN C. DRAKE , SPAFFORD ACKERLY, Dept. Geology, Univ. of Vermont, Burlington, VT 05405 Pore Water Investigations of Lake Champlain Sediments

Preliminary investigations of interstitial water from near surface sediments of Lake Champlain have been undertaken to ascertain the diagenetic remobilization of Cu, Pb, Fe, Mn and P. Sample locations include St. Albans Bay, Malletts Bay and Burlington Basin. Pb and Cu did not exhibit significant enrichment in the pore waters studied. Fe, Mn and P are far more concentrated in the interstitial waters than the overlying lake water. Fe generally increases with depth, Mn has a near surface maximum and P commonly exhibits more than one zone of enrichment. Pore water chemistry is highly variable among the different sites reflecting changes in sediment sources and rates of diagenetic reactions. Concentration gradients in undisturbed bottom sediments, stored anaerobically, were eliminated in 8 days. Homogenized bottom sediments incubated for 4 months developed gradients in the interstitial water concentrations in the interstitial water concentrations of Fe, Mn and P as well as P extractable from the sediment by NH_4OH-HOAc and HCl. Major differences exist between those incubated under aerobic conditions vs anaerobic conditions. These sediments represent a large repository of P capable of being recycled during periods of bottom anoxia or turbation.

1420

JOHN J. DOWLING, Marine Sciences Department, Univ. of Connecticut, Groton, CT 06340.
ALLEN S. HUNT, Department of Geology, Univ. of Vermont, Burlington, VT 05405-0122.
STEPHEN H. DANBOM, Continental Oil Co., Ponca City, OK 74601.
Porosity of Partially Saturated Sediments of Lake Champlain.

The sediments beneath Lake Champlain contain methane gas. Porosity for these sediments is underestimated unless the gas volume can be determined. Electrical resistivity logs of cores taken along a seven mile transect in the central part of the Lake reveal the presence of the gas. Analysis of these logs combined with standard laboratory techniques for determining water content have yielded estimates of true effective porosity and percent saturation. Lateral variation in these quantities are shown to be independent of depth and stratigraphy.

1440

ALLEN S. HUNT , ANTHONY E. RATHBURN, Geology Dept., Univ. Vermont, Burlington, VT 05405 Ostracodal and Foraminiferal Assemblages of the Champlain Sea, Lake Champlain

The association between foraminifera and ostracode faunal assemblages has been studied in eighteen 24-foot piston cores taken from central Lake Champlain. The oldest stratigraphic unit encountered consists of proglacial Lake Vermont sediments (ca. 13,200 to 12,500 yr.B.P. in age). This unit lacks foraminifera and ostracodes. A transitional zone, characterized by alternating appearance and disappearance of the fresh water ostracode Candona subtriangulata and the low salinity tolerant foraminifera Protelphidium orbiculare and Cassidulina reniforme, lies above the barren Lake Vermont sediments. Higher within the transitional zone, the ostracode species Cytheropteron macchesneyi appears in association with the dominant foraminifera Cassidulina reniforme & Islandella helenae. Above the transitional zone euhaline conditions prevailed and the diversity of both ostracodes and foraminifera increases. As the euhaline conditions changed to polyhaline, the diversity and number of foraminifera decrease until only P. orbiculare and E. excavatum remain. Low numbers of the ostracode Heterocyprideis sorbyana occur in association with these foraminifera species near the top of the Champlain Sea sequence. The boundary between Champlain Sea sediments and the overlying fresh water sediments of Lake Champlain is marked by the disappearance of marine species (ca. 10,000 yr.B.P.)

FISH/WILDLIFE CONTAMINANTS

1300-1500 Room 105

Moderator: Harvey Shear

1300

D.V. WESELOH , P. MINEAU * AND S.M. TEEPLE, CANADIAN WILDLIFE SERVICE, ONTARIO REGION, Canada Centre for Inland Waters, BOX 5050, BURLINGTON, ONTARIO L7R 4A6. Geographical Distribution of Productivity and Contaminant Measures in Great Lakes Herring Gulls. II. Lake Huron: 1980.

Colony size and location, eggshell thickness, reproductive success and egg residues (OCs) were determined for Herring Gulls nesting in Lake Huron, North Channel, Georgian Bay and the St. Marys River in 1980. The population of nesting Herring Gulls was approximately 33,000 pairs and was greatest in the North Channel and eastern Georgian Bay. The population appears to have increased approximately 33%, or 1.8% per year on average, between 1960-62 and 1980. Reproductive success (to 21 days) was normal, but ranged from 1.3 to 2.3 young per nest. Eggshell thinning ranged from 3.2-10.9% and eggshell quality has significantly improved on Double Island (North Channel) since 1978. Eggs from colonies in the North Channel had thicker shells and consistently lower residues than those from other colonies. Levels of DDE, HCB and PCBs were greatest in eggs from Saginaw Bay. Mirex was greatest in eggs from southern Georgian Bay.

1320

J. STRUGER , D.V. WESELOH, P. MINEAU AND D.J. HALLETT, CANADIAN WILDLIFE SERVICE, ONTARIO REGION, CANADA CENTRE FOR INLAND WATERS, P.O. BOX 5050, BURLINGTON, ONTARIO, CANADA L7R 4A6. Levels and Trends of Organochlorines in Herring Gulls in the Great Lakes, 1974-1981.

Levels of major organochlorine residues found in the eggs of Herring Gulls are reported for two colonies from each of Lakes Superior, Huron, Erie and Ontario from 1974 to 1981. Levels of DDE, DDT, HCB, Mirex and PCBs were greatest in Lake Ontario. Dieldrin levels were the highest in Lake Superior. Significant declines occurred in levels of DDT, Mirex, PCBs, DDE, Dieldrin and HCB for many colonies between 1974 and 1981. However, between 1980 and 1981 there were significant increases in levels of PCBs, Mirex, DDE and HCB on some colonies, especially Snake Island in Lake Ontario. During the same period none of these compounds decreased significantly on any of the monitor colonies. These figures may indicate that the declining residue levels in Herring Gulls during the last six years have begun to level off.

1340

ROSS J. NORSTROM , GLEN A. FOX and DEBORAH A. JEFFREY, Wildlife Toxicology Division, Canadian Wildlife Service, Ottawa, Ont., K1A 0E7, and ANDREW P. GILMAN, Environmental and Occupational Toxicology Division, Bureau of Chemical Hazards, Ottawa, Ont., K1A 0L2.

Dynamics of Organochlorine Compounds in Herring Gulls

Herring Gull (Larus argentatus) eggs have been collected annually since 1973 in all of the Great Lakes for monitoring organochlorine trends in the ecosystem. In order to make meaningful quantitative interpretation of these data, a knowledge of the pharmacodynamics of the compounds in female gulls is required. Whole-body clearance of p,p-DDE, one of the major residues in the Great Lakes, has been measured in wild gulls by dosing with ^{14}C-labelled DDE and recapturing one year later. Assuming first-order kinetics, a half-life of 220±30 d was determined. Preliminary data from analysis of plasma from dosed, caged gulls show that half-lives of photomirex, mirex and PCBs were similar to that of DDE. Half-lives of other compounds were in the range of 50-100 d for hexachlorobenzene, dieldrin, oxychlordane and octachlorostyrene, 25 d for p,p-DDD and <10 d for γ-hexachlorocyclohexane and t-chlordane. The consequence of these results to the interpretation of the egg monitoring data will be discussed.

1400

JODY J. JONES and JOHN C. FILKINS, Cranbrook Institute of Science. P.O. Box 801, Bloomfield Hills, Michigan 48013. The relationship between organochlorine concentrations and lipid levels on waterfowl wintering on the Detroit River.

Common goldeneye (Bucephala clangula) greater scaup (Aythya marila), and lesser scaup (A. affinis) were collected from the Detroit River during the winters of 1980 and 1981. PCB and other organochlorines were Soxhlet extracted from the defeathered eviscerated carcasses using methylene chloride and hexane. Organochlorine levels were quantified using high resolution capillary gas chromatography. Percent lipid was measured from the extract of each bird. Simple linear regression analysis of PCB/unit lipid on the %-lipid indicated a significant negative linear relationship between these two variables for some birds (α = .10).

Lower ambient temperatures during the winter resulted in thermal stress and increased lipid metabolism for maintenance energy. The increase in PCB/unit lipid as %lipid declined, can be attributed to the rate of lipid metabolism exceeding the rate of PCB excretion.

FISH/WILDLIFE CONTAMINANTS (Continued)

1420

CHRIS J. CAPPON University of Rochester Medical Center, Environmental Health Sciences Center, Box RBB, Rochester, NY 14642.

Chemical Form and Content of Mercury and Selenium in Lake Ontario Salmon and Trout.

The chemical form and content of mercury(Hg) and selenium(Se) were determined in the edible tissue of salmon (coho, chinook) and trout (lake, brown) taken from the Southern shore of Lake Ontario near Rochester, NY. This study was initiated to determine if elevated levels of Hg, especially the highly toxic methylmercury(CH_3Hg) exist in these fish species. Such levels could be potentially hazardous to human health upon regular consumption of contaminated fish. Se is of interest due to its role as a trace nutrient and its known protective effect against Hg toxicity in experimental animals. For all fish species, total Hg content ranged from 0.3 to 0.8 ppm(ug/g,fresh-weight), which is higher than the range of levels commonly found in canned tuna. Most of the Hg(greater than 70 percent) was present as CH_3Hg. Se was present as the tetravalent(IV) and hexavalent(VI) forms, the IV form predominating. On a molar basis, total Se content usually exceeded total Hg content. While the current Hg levels are within the recommended FDA guideline(1.0 ppm total Hg) for edible seafood, future monitoring of the total Hg and CH_3Hg levels, along with that of Se, in these fish species is necessary due to the ubiquity and persistence of Hg in the aquatic food chain of Lake Ontario.

1440

Mirex and Photomirex Concentrations Within Selected Tissue Sections of Lake Ontario Salmonids. Brian A. Kent and Joseph C. Makarewicz, Dept. of Biological Sciences, SUNY Brockport, Brockport, N.Y. 14420

Replicated analyses (n=6) were made for mirex and photomirex concentrations in whole fillets, skin, red muscle, belly flap, anterior dorsal loin, and caudal peduncle in twelve chinook (Oncorynchus tshawytscha) and Coho (O. kisutch) salmon collected from Lake Ontario in the summer and fall of 1982. Concentrations in red muscle (0.43 mg/kg mirex and 0.32 mg/kg photomirex) and skin (0.39 mg/kg mirex and 0.30 mg/kg photomirex) were observed to be the highest from the six tissue sections analyzed. Concentrations in belly flap (0.24 mg/kg mirex and 0.18 mg/kg photomirex), whole fillet (0.18 mg/kg mirex and 0.15 mg/kg photomirex), and anterior dorsal loin (0.12 mg/kg mirex and 0.10 mg/kg photomirex) were all observed to be above the 0.1 mg/kg action level set by New York State Officials. The concentrations in the caudal peduncle (0.09 mg/kg mirex and 0.09 mg/kg photomirex) were observed to be below the stated action level. The mean ratio of mirex to photomirex in all tissue sections except the caudal peduncle was found to be 1.29:1. In the caudal peduncle the concentration of mirex was found to be less than photomirex with a mirex to photomirex ratio of 0.97:1.

SEDIMENTOLOGY

1300-1500 Room 103

Moderator: Ronald Scrudato

1300

E. HUGEL AND J. A. ROBBINS, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104

Seasonal Variations in the Activity of Polonium-210 in Sediment Trap Samples from Lake Michigan.

The uranium series radionuclide, Po-210 ($t_{\frac{1}{2}}$=138 d), occurs in waters of the Great Lakes partly as a result of atmospheric loading of its parent, Pb-210 ($t_{\frac{1}{2}}$=22 y). The journey of these two isotopes through the water column and their interaction with particulate matter provides a means of characterizing transport processes on a seasonal time scale. The activity of Po-210 has been determined via α-spectroscopy in a series of trap samples (spaced about 20m apart vertically) collected at monthly intervals from April through September, 1982. Activities of bottom trap (95m) materials are essentially constant during the observation period and are comparable to activities of underlying surface sediments (32 dpm/g). Prior to stratification, activities are essentially the same in all samples indicating the rapid vertical mixing and the predominance of resuspended materials in the trap samples. As stratification develops the activity decreases monotonically (May-September) from ∿32 to ∿14 dpm/g in near-surface samples. This reduction is associated with the progressive decline of the resuspended component. Pre-stratification fluxes of Po-210 are ∿200 $dpm/m^2/d$ while post-stratification fluxes in near-surface waters are around 10 $dpm/m^2/d$. This latter value is comparable to the estimated atmospheric flux of 30 $dpm/m^2/d$.

1320

JOHN A. ROBBINS AND B. J. EADIE, Great Lakes Environmental Research Laboratory, Ann Arbor, MI 48104.

Seasonal Cycling of Beryllium-7 and Cesium-137 in the Benthic Nepheloid Layer of Lake Michigan.

The activity of beryllium-7 ($t_{\frac{1}{2}}$=53.4d) and cesium-137 ($t_{\frac{1}{2}}$=30 y) have been measured in a string of sediment traps located in open waters (100 m depth) in southern Lake Michigan. Traps collected materials in about monthly intervals from April through December. During the collection period atmospheric fluxes of Be-7 and Cs-137 were about 400 and 2.2 $dpm/m^2/d$ respectively. Prior to stratification, fluxes of both isotopes were uniform over most of the water column (increasing slightly within the lowest 10 m) and averaged 160 and 180 $dpm/m^2/d$ respectively. Thus, the Be-7 flux is roughly half the atmospheric flux while that of Cs-137 is about a factor of 80 higher. Nearly all of the Cs-137 entering the traps is from resuspension of bottom materials. With the onset of stratification, the Cs-137 activity in 20 m trap materials all but disppears while the Be-7 activity rises markedly owing to continued deposition of the isotope and markedly lower particle settling rates. In the deepest trap (95 m) activities of Be-7 decrease expoentially with a 53 d halflife during the stratified period. This decrease reflects the virtually complete isolation of the pool of resuspendible material from new inputs during that period.

1340

J. A. ROBBINS, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104, and K. A. JOHANSEN, University of Michigan, Ann Arbor, MI 48104.

Beryllium-7: A Tracer of Short-term Sediment Mixing Processes in the Great Lakes.

Distributions of beryllium-7 ($t_{½}$ = 53.5 d) cerium-144 ($t_{½}$ = 284 d) and cesium-137 ($t_{½}$ = 30 y) have been measured in box and open tube gravity cores from Lakes Erie and Michigan. Distributions of fallout Cs-137 do not conform well to the known history of deposition of the nuclide on the lake surface. Instead the activity is smeared downward as a result of biological mixing of surface sediments. Cs-137 profiles are quantatively described by a model in which time-varying inputs to the sediments are instantaneously mixed within a zone of well-defined thickness which moves upward at the sedimentation rate. For the short-lived nuclides this model doesn't work. Both Be-7 and Ce-144 fall off about expoentially with half-depths (0.5 and 1.5 cm respectively), far less than the depth of the mixed zone based on the cesium data. Evidently materials are homogenized on the time scales the order of decades but not over periods of months to a few years. A unified model proposed includes a diffusive component of range 1-2 cm and an advective component based on uniform conveyor-belt feeding and surface redeposition. This model, based partly on measured benthos abundances, accounts satisfactorily for the distributions of all three radionuclides.

1400

PETER G. SLY, Canada Centre Inland Waters, P.O.Box 5050, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6, Canada.— Sedimentology and Geochemistry of Modern Sediments in the Kingston Basin of Lake Ontario.

The accumulation of Modern mud is limited to deep water areas in the basin and thicknesses of more than 50cm are found only in the St. Lawrence Trough; elsewhere sands and silty sands are largely composed of reworked material. Modern muds are characterised by complex relationships between OC, sulphides, clays and hydrous Fe and Mn oxides, in which there are several forms of association with heavy metals. Heavy metal concentrations are lower than at Niagara, and close to lakewide means. Mercury values are above this mean, and closely related to the OC content.

1420

R. ROSSMANN, K. A. JOHANSEN, Great Lakes Res. Div., Univ. of Michigan, Ann Arbor, MI 48109, R. A. BOURBONNIERE, National Water Res. Inst., Canada Centre for Inland Waters, Burlington, Ontario L7R 4A6, and J. A. ROBBINS, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104 - Vertical Variation of Metals in Dated Lake Ontario Sediment Cores.

Box cores of Lake Ontario sediments were collected from two regions of the lake known to have differing sedimentation rates. At the time of collection, sub-cores of the box cores were sectioned at 1 cm intervals between 0 and 20 cm core depth and 2 cm intervals between 20 and 40 cm core depth. In addition to organic and inorganic carbon, sections of the cores were analyzed for Ca, Mg, Fe, Mn, As, Bi, Cr, Cu, Hg, Cd, Pb, Zn, Ni, K-40, Cs-137, and Pb-210. Based on Ca and inorganic carbon concentrations, calcium carbonate content decreased from a maximum of 12 to 22% near the surface to roughly 1% at the bottom of each core. Magnesium concentrations were nearly constant and low (1%) in each core. Organic carbon decreased from a maximum of 4 to 5% in surficial sediments to roughly 2% at 40 cm. Cd, Sb, Bi, Ca, Cr, Cu, Pb, Mn, Hg, and Zn concentrations peaked at depths of 2 to 12 cm below the surface. Bi, Ca, Cr, Cu, Hg, Mg, Mn, Pb, Sb, Zn, and Cd were correlated positively with both organic and inorganic carbon as well as with each other. These correlations may be an indication of a common source, flux controlling processes, or post-depositional alteration of phases with which these metals are associated.

1440

K. A. JOHANSEN, R. ROSSMANN, Great Lakes Res. Div., University of Michigan, Ann Arbor, MI 48109; J. A. ROBBINS, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104.
The History of Pb and Hg Deposition in Pb-210 and Cs-137 Dated Cores from Eastern Lake Ontario.

In 1980, box cores were obtained from eastern Lake Ontario in two adjacent areas having high sedimentation rates which differed by a factor of two. We tested the assumptions that 1) the time dependence of contaminant fluxes were essentially the same and 2) the difference between vertical contaminant profiles, in the absence of diagenesis, should scale with the sedimentation rate. Pb and Hg were measured in sub-cores dated by Cs-137 and Pb-210 techniques. The Pb-210 and Cs-137 sedimentation rates were essentially equal, 0.072 $g/cm^2/yr$ at the high sedimentation rate station (HS) and 0.036 $g/cm^2/yr$ at the low sedimentation rate station (LS). Stable Pb profiles at the HS and LS were similar and major inflections scaled with time. Recent reductions in use of lead fuel additives, which have resulted in lower atmospheric Pb emissions, were reflected in the cores. Although the temporal agreement was not as good as that for Pb, the Hg profiles also were similar. A steady-state mixing model applied to an atmospheric Pb source function based on coal and gasoline usage gave an excellent fit to both Pb profiles. Similarly, a Hg source function based on the HS sedimentation rate and Hg profile gave a good fit to the LS Hg profile. The good fit indicated temporal scaling with minimal diagenetic alteration of the sedimentary contaminant profiles.

EUTROPHICATION

1300-1500 Room 102

Moderator: Claire Schelske

1300

REBECCA L. NYSTROM and KENNETH E. MANTAI, Dept. Biol., SUNY Fredonia, Fredonia, NY 14063.

Nutrient interrelations between sediments, lake water, and *M. spicatum*.

Interrelationships between PO_4-P, K and N concentrations in bottom sediments, lake water and tissues of the rooted macrophyte *Myriophyllum spicatum* were studied at three sites in Chautauqua Lake, New York, during the summer of 1982.

Water levels of NO_3, PO_4-P and K fluctuated widely, but generally declined until mid-summer and then increased markedly. An early-summer decrease in sediment NH_3-N, exchangeable-K, and PO_4-P coincided with a similar decrease in tissue total organic N and K, while tissue PO_4-P declined slightly. In late summer, tissue N greatly increased, while tissue K concentrations increased somewhat, and tissue PO_4-P levels changed only slightly.

Substantial differences in nutrient concentrations in sediments and tissues were evident between sites but concentrations in the lake water were similar. Although the pattern of nutrient level changes was similar at all sites, the phasing appeared to be site-dependent. Sediment composition differences between sites may account for these observations. In general, tissue levels in *M. spicatum* roughly parallelled concentration trends in both sediments and lake water, especially during the active macrophyte growth period of early summer. It is apparent from these studies that *M. spicatum* tissue concentrations of N, PO_4-P and K are not static, but change markedly during the summer growing period and reflect N, K and PO_4-P levels in both lake water and sediments.

1320

RONALD ROSSMANN , Great Lakes Research Division, The University of Michigan, Ann Arbor, Michigan 48109 - Trends of Anions and Nutrients in Southeastern Lake Michigan between 1974 and 1982.

Southeastern Lake Michigan water samples were collected between April 1974 and April 1982. During the months of April, July, and October of most years, samples were collected from a depth of 1 m. Samples analyzed for orthophosphate, nitrate-nitrite, dissolved silica, sulfate, and chloride were filtered through 0.45 µm pore size membrane filters. Within the period of observation, orthophosphate concentrations decreased and nitrate, dissolved silica, sulfate, chloride, and total phosphorus concentrations increased. The time variation of total phosphorus is best described by a second order polynomial, that of dissolved silica by a third order polynomial, and those of orthophosphate, nitrate, sulfate, and chloride by fourth order polynomials (0.05 level of significance or better). Each parameter's variation with time is also described by a regression line (0.05 level of significance or better). For the period of 1974 through 1982, orthophosphate concentration decreased at the rate of 0.019 µg P/L/yr. For the period of 1979 through 1981, its concentration decreased at the rate of 0.23 µg P/L/yr. Nitrate, dissolved silica, sulfate, chloride, and total phosphorus concentrations increased at rates of 12 µg N/L/yr, 74 µg SiO_2/L/yr, 310 µg SO_4^{2-}/L/yr, 220 µg Cl^-/L/yr, and 0.29 µg P/L/yr, respectively.

1340

DAVID B. BAKER and JACK W. KRAMER. Water Quality Laboratory, Heidelberg College, Tiffin, Ohio 44883.

A comparison of bioavailable phosphorus loading in Lake Erie and Lake Ontario tributaries.

In 1982 storm runoff samples were collected from the Raisin, Maumee, Sandusky and Cuyahoga rivers in the Lake Erie Basin and the Genesee, Oswego and Black rivers of the Lake Ontario Basin. Approximately 40 storm samples from each river were analyzed for total phosphorus, soluble reactive phosphorus, total soluble phosphorus, soluble hydrolyzable phosphorus, and NaOH-extractable particulate phosphorus. The flux weighted concentrations of all of the above forms of phosphorus were much higher in the Lake Erie tributaries than in the Lake Ontario tributaries. The percentage of the particulate phosphorus that was extracted with NaOH was 39% for the Cuyahoga, 30% for the Raisin, Maumee and Sandusky and 17% for the Genesee. The particulate phosphorus concentrations in the Oswego and Black were so small that reliable NaOH extractible phosphorus measurements could not be made. Soluble reactive phosphorus formed from 55% to 75% of the total soluble phosphorus. Soluble hydrolyzable phosphorus formed from 81% to 96% of the total soluble phosphorus.

1400

THOMAS M. HEIDTKE , Department of Civil Engineering, Wayne State University, Detroit, MI 48202
WILLIAM C. SONZOGNI, State Laboratory of Hygiene, Univ. of Wisconsin-Madison, Madison, WI 53706
STEPHEN C. CHAPRA, Texas A&M Univ., Dept. of Civil Engineering, College Station, TX 77843

Optimizing Phosphorus Control Strategies for the Great Lakes Basin: A Linear Programming Approach

A systems analysis approach is used to derive the least-cost alternative for achieving water quality objectives for the Great Lakes. The study considers the Great Lakes as an interconnected system of eleven major basins and uses linear programming techniques to solve for the most cost-effective combination of point and nonpoint source controls to reach desired average whole-lake total phosphorus concentrations for each basin. The analysis examines how control measures in any single basin affect water quality in all other basins and demonstrates how changes in both system objectives and the assumed costs and maximum load reduction associated with various control measures affect the optimum alternative. The study reveals that the optimum alternative for achieving the desired system response is extremely sensitive to estimated costs and constraints on the maximum load reductions associated with point and nonpoint source control measures. In terms of identifying cost-effective water quality management programs, these results emphasize the importance of developing an accurate data base which reflects the most current technological state-of-the-art in controlling pollution from point sources and land runoff.

EUTROPHICATION (Continued)

1420

THOMAS M. HEIDTKE , Department of Civil Engineering, Wayne State University, Detroit, MI 48202
MARTIN T. AUER, Department of Civil Engineering, Michigan Technological Univ., Houghton, MI 49931
RAYMOND P. CANALE, Department of Civil Engineering, Univ. of Michigan, Ann Arbor, MI 48109

Optimal Cost Control Strategies for Attached Algae in the Great Lakes

Economic tradeoffs between alternative measures for controlling nuisance growth of Cladophora in nearshore waters of the Great Lakes are compared. A verified mathematical model is used to estimate the response of Cladophora growth to different combinations of phosphorus control for municipal wastewater discharges. Varying degrees of in-plant removal and offshore discharge are considered as strategies in achieving specified objectives for lakewater concentrations of soluble reactive phosphorus and concomitant reductions in nuisance growth of Cladophora.

The analysis demonstrates the sensitivity of the least-cost control strategy to the water quality criterion in effect. A "blended" control approach utilizing both in-plant phosphorus removal and offshore discharge achieves water quality objectives at a significantly lower annual cost than a "pure" control approach. The methodology is applied in a case study for Harbor Beach, MI. Results indicate that another important economic tradeoff exists between the cost of meeting nearshore water quality objectives (such as nuisance growth of Cladophora) and whole-lake water quality objectives for the Great Lakes.

1440

JOHN R. ADAMS , U.S. Army Corps of Engineers 1776 Niagara Street, Buffalo, NY 14207

Future Diffuse Source Total Phosphorus Loadings to Lake Erie

The U.S. Army Corps of Engineers, Buffalo District was charged by the Federal Water Pollution Control Act with the responsibility for developing "plans and specifications for the environmental repair and rehabilitation of Lake Erie". During Phase I of the Lake Erie Wastewater Management Study, it was determined that 44% of P loadings originated from diffuse sources, principally cropland. During Phase II, tributary sampling and detailed analysis of land resources led to the conclusion that conservation tillage measures could be employed in certain priority areas to achieve phosphorus transport reductions which when combined with point source reductions would achieve a loading reduction objective sufficient to eliminate most of the anoxia problem of the Central Basin of Lake Erie. During Phase III of the study it was concluded that a voluntary program emphasizing the adoption of conservation tillage and supported by adequate technical support could ultimately reduce the U.S. total diffuse source total phosphorus load by 32% to 4400 MT/YR.

NEW YORK INLAND LAKES

1520-1700 Room 104

Moderator: Kenton Stewart

1520

Ray T. Oglesby and William R. Schaffner. New York State College of Agriculture and Life Sciences, Cornell Univ., Dept. of Natural Resources, Ithaca, N.Y. 14853

A comparative evaluation of plankton in the New York Finger Lakes.

Despite many similarities between New York's Finger Lakes, substantial variation was noted in their water chemistry and their planktonic and fish communities. We have analyzed the structure (species composition and organism size) of the phytoplankton and zooplankton communities in the various lakes in an attempt to determine what factors are responsible for these variations.

1540

HERMAN S. FOREST State University of New York College at Geneseo, N.Y. 14454 -

Submersed macrophytes in the Finger Lakes as ecosystem indicators.

The present and past submersed macrophyte flora was investigated for Canandaigua, Honeoye, Canadice, Hemlock, Conesus and Silver Lakes, and Sodus and Irondequoit Bays of Lake Ontario. A number of findings have been illuminating or unexpected. Although the diversity of species has declined in all lakes generally in proportion to enrichment by man (as indexed by present phosphorus levels), some lakes were conspicuous losers, and some conserved high diversity. Initial diversity and the distribution of the potential plant zone are apparent contributing factors. The best conserved lakes turned out to be relatively fertile ones, Conesus and Honeoye. Conesus is both fertile and clear, and retained stability under an enormous increase in nutrient loading. In comparison, Hemlock Lake (with an impoverished flora) has been unstable and often turbid. An important factor in the stability of Honeoye Lake is occasional high flooding. In Canandaigua, the good quality of water in deeper areas was in contrast to severe losses of species in shallow waters. Finally, the most impoverished flora, that of Irondequoit Bay; is increasing in diversity since diversion of much of its human waste load.

1600

BERNARD A. MARCUS. Genesee Community College, Batavia, NY 14020. Notes on the distribution of Membranosorus heterantherae Ostenfeld and Peterson in Heteranthera dubia (Jacq.)MacM.

Membranosorus heterantherae Ostenfeld and Peterson (Sorodiscus heterantherae Wernham) is an endoparasite of the aquatic vascular plant Heteranthera dubia (Jacq.) MacM. and possibly of related species as well. It usually appears to infect the host at the basal node where a conspicuous gall that concentrates nitrogen forms. H. dubia, recently collected from Honeoye, Conesus and Silver Lakes in Western New York and from Sodus Bay of Lake Ontario, has been found to be infected, as have specimens in herbarium collections from Otsego, Canandaigua, and Chatauqua Lakes in New York. Older literature suggests that the distribution of the parasite is broad, but the parasite appears to have received little attention until recently.

1620

KRISTINE M. KUCHARSKI New York State Department of Transportation, 1530 Jefferson Road, Rochester NY 14623. Effects of dredging and dredge spoil disposal on fishery resources in the New York State Barge Canal.

The Department of Transportation initiated a study in the section of the Barge Canal from Knowlesville to Fairport, New York to survey fishery resources and to determine if there are any impacts on fish due to annual maintenance dredging. Four widewaters were sampled: three serve as spoil disposal sites; one was a control. Two dredge sites and six stations up and downstream of three of the widewaters were also examined. Gill nets, trap nets, electroshocking, and seines were used.

Widewaters appeared to provide the best habitat and indirect evidence suggested that they serve as spawning and nursery areas. During spoil disposal in widewaters, the number of game and panfish did not decrease nor did the numbers of forage species increase. The same trend was seen at dredge sites and at other main canal stations. There was a reduction in the abundance of forage fish species from July through September while the numbers of game and panfish became a more important component of the catch. These trends were seen at the control stations (Holley) which indicated a seasonal population change unrelated to dredging. Seasonal movement studies in the literature shed some light on reasons for the observed population changes although more study is needed to determine the factors operating in an artificial system.

1640

DAVID H. KOSCWSKI, N.Y.S.D.E.C. Fisheries Management, Avon, New York 14414

Update on Seneca Lake Sea Lamprey Control Program

In 1982, sea lamprey control was undertaken for the first time in the Seneca Lake system. On September 9, Bayluscide was applied to 111 acres of ammocoete infestations in the lake; 102 acres near the mouth of Keuka Lake Outlet at Dresden and 9 acres at Watkins Glen near the mouth of Catharine Creek. Treatment of Keuka Lake Outlet with TFM was completed on October 15. Catharine Creek treatment was aborted due to cold water temperatures and bioassay results which indicated that unacceptable mortalities of non-target fishes, including wild rainbow trout, were likely to occur. The Catharine Creek treatment has been scheduled for completion in 1983. Control operations followed a lengthy EIS process; formation and intensive training of a DEC sea lamprey control team; acquisition of special aquatic permits for use of TFM and Bayluscide; State registration of Bayluscide for sea lamprey control use at 100 lbs./acre; completion of cooperative arrangements with GLFC to acquire lampricides; completion of arrangements for use of Canadian advisors and equipment during TFM treatments and acquisition of key equipment items. An intensive research/monitoring program was conducted in connection with the Bayluscide treatment with follow up work to be accomplished during 1983. We will continue our long-standing monitoring program to determine status of salmonid populations and relative abundance of sea lamprey adults.

PHYTOPLANKTON

1520-1700 Room 102

Moderator: Thomas Storch

1520

RUSSELL A. MOLL and STEPHEN J. TARAPCHAK , Great Lakes Research Division, University of Michigan, Ann Arbor, MI 48109 and Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104.

Inorganic Phosphate Uptake by Phytoplankton and Bacteria in Lake Michigan.

The relative amounts of orthophosphate (PO_4-P) taken up by phytoplankton and bacteria remains an unresolved problem in aquatic ecology. Size fractionation experiments were conducted to determine if bacteria actually compete with algae for PO_4-P in Lake Michigan. Tracer studies showed that considerably less PO_4-P was taken up by microorganisms in small size fractions (< 1,3 and/or 7 µm) compared with whole water samples. Microalgae in the small size fractions had high photosynthetic rates, often accounting for a major portion of the overall primary productivity. Acridine Orange counts of bacteria showed that the small size fractions contained nearly the same concentration of bacteria as the whole water fraction. Since phosphate was required to support photosynthesis by microalgae, low PO_4-P uptake rates in small size fractions suggest that bacterial uptake of PO_4-P was negligible. Phytoplankton apparently represents the major pathway for biological removal of PO_4-P from lake water--bacteria therefore must be using primarily organic forms of PO_4-P.

1540

MICHAEL J. MC CORMICK AND STEPHEN J. TARAPCHAK, Great Lakes Environmental Research Laboratory, 2300 Washtenaw Avenue, Ann Arbor, MI 48104.

Error Analysis of Nutrient Regeneration Rates for a Station in Southern Lake Michigan.

Regeneration rates were calculated for phosphorus, silica and nitrogen in southern Lake Michigan during 1976. Error estimates of the calculated rates were made by first-order uncertainty analysis. Six terms were analyzed: (1) precision of measurement, (2) vertical eddy diffusivity, (3) atmospheric loading, (4) primary production, (5) nutrient/carbon ratio and (6) onshore-offshore transport. Results indicate high uncertainty in the calculated rates. (The 95% confidence interval includes zero in all cases). The major sources of error were identified to be onshore-offshore transport, nutrient/carbon ratio, and vertical eddy diffusivity. Approximately 83% of the variance estimates for phosphorus were due to uncertainty in the phosphorus/carbon ratio, and 95% of the variance estimates for silica and nitrogen were due to the onshore-offshore transport term. Results suggest nutrient regeneration rates can be meaningful only if uncertainty due to advection and cellular stoichiometry are minimized.

1600

STEPHEN J. TARAPCHAK AND LYNN HERCHE, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104 - Kinetics of Phosphate Uptake by Lake Michigan Phytoplankton: Estimating Michaelis-Menton Constants.

Kinetic parameters obtained from the substrate-dependent uptake of phosphate are often used to assess P limitation in natural phytoplankton assemblages. Uptake data normally are fitted to the Michaelis-Menton equation

$$\text{Velocity of uptake } (v) = \frac{V_{max}\ S}{K_t + S}$$

where V_{max} is the maximum velocity of uptake, K_t is the half-saturation constant, and S is the substrate concentration obtained after linear transformation of v vs. S. Analysis of phosphate uptake by Lake Michigan phytoplankton in over 30 experiments reveals that v at low concentrations (<5.0 µg P/L) often is an order of magnitude higher than predicted by the equation. This causes severe overestimate of K_t (i.e. underestimation of phytoplankton affinity to phosphate) and, therefore, leads to erroneous conclusions regarding the P-status of phytoplankton assemblages. Statistical Michaelis-Menton type uptake compartments are described. These procedures permit accurate estimation of kinetic constants.

1620

GLENN J. WARREN , MARTIN E. BORAAS, WILLIAM J. MONAGLE, DIANNE B. SEALE, and ARTHUR S. BROOKS. Center for Great Lakes Studies, Univ. Wis.-Milwaukee, Milwaukee, WI 53201. Responses of Lake Michigan phytoplankton to phosphorus and sodium enrichment in continuous culture.

Continuous cultures were run to determine the effects of added sodium and phosphorus on the Lake Michigan phytoplankton community. Lake Michigan water was used as the culture inoculum, and the dilution media was sterile filtered lakewater, with or without added Na or P. Experiments were performed to simulate seasonal temperatures in Lake Michigan. Enriched sodium levels were 6.9 mg/liter above ambient lakewater, and enriched phosphorus levels 100 ug/liter above ambient. Results at termination of the cultures (30-40 days) indicated that at low temperature (6°C), diatoms were numerically dominant in high and low P cultures, while at higher temperatures, bluegreen algae were dominant or co-dominant with diatoms in the high P cultures. Sodium levels had an insignificant effect on the results of the experiments. Median particle sizes of algae were measured at three culture temperatures. At temperatures of 12° and 16°C median particle (algal) size was larger in the high P cultures, while at 20°C there was no discernible P effect. These results are in agreement with observed algal sizes in lakes of differing trophic status. Results of continuous culture runs with respect to Si:P, and N:P ratios will be discussed.

PHYTOPLANKTON (Continued)

1640
STEPHEN J. TARAPCHAK AND M. QUIGLEY, Great Lakes Environmental Research Laboratory, NOAA, Ann Arbor, MI 48104 - Silica Interference in Phytoplankton Nutrient Enrichment Bioassays.

Conventional nutrient enrichment bioassays, conducted on water from Lake Michigan, were designed to evaluate the potential effects of extraneous silica (Si) release from the walls of Pyrex glass incubation containers on diatom growth. Tests revealed that (1) release of extraneous Si from 125-mL reagent bottles of 170-255 µg Si/L during short-term incubations (4-6 h) were coupled with twofold increases in photosynthetic rates, and (2) extraneous Si releases of 475-600 µg Si/L in long-term growth bioassays (7-d) performed in 1-L glass reagent bottles were coupled with 10-fold increases in phytoplankton growth rates and final biomass yield. Subsequent tests using lake water and Si-limited cultures of Cyclotella meneghiniana demonstrated that increases in growth were caused by Si release from containers, and that all or the major fraction of the extraneous Si was immediately available from growth. Chemically inert containers, e.g. polycarbonate flasks, should be used in bioassay tests.

SEDIMENT TRANSPORT

1520-1700 Room 103

Moderator: Ronald Scrudato

1520
THOMAS C. JOHNSON[1], BRUCE R. ROSENDAHL[1], JOHN D. HALFMAN[1]. 1-Department of Geology, University of Minnesota, Duluth, MN 55812. 2-Department of Geology, Duke University, Durham, NC 27708. Comparison of Side Scan SONAR Records from Lake Superior and Lake Tanganyika.

Lake Superior and Lake Tanganyika are the largest lakes on their respective continents, yet differ considerably in morphometry, age, tectonic and climatic setting, and origin. Side scan SONAR records from Lake Superior show that sediments accumulating in many offshore basins are influenced strongly by deep-water currents that probably are wind driven. The sediments also are dissected by large scale ring depressions that may be a manifestation of recent glaciation. We recently obtained side scan SONAR records from Lake Tanganyika, East Africa, and our preliminary analysis of these records show that sediments accumulating in offshore basins are affected more by turbidity currents and recent faulting than by wind-driven currents. No ring depressions are observed on the floor of Lake Tanganyika.

1540
DAVID L. JOHNSON,SUNY-CESF,Syracuse, NY 13210
STEVEN W. EFFLER,110 Hillsboro, Syracuse, NY 13210
Temporal Variations of St. Lawrence River Suspended Particles off Clayton, NY (#)

Individual suspended particle characterizations by automated SEM were performed on 11 samples (five dates) from the surface water of the main ship channel of the St. Lawrence near the Ellis International Laboratory. The purpose was to examine the temporal variation of inorganic particle types being discharged from the Great Lakes system. Particles were filtered on site for subsequent SAX analysis, wherein they were classified into one of 30 possible particle classes. Samples from 6/12 and 7/10 (1982) were dominated by "clays" and silica--each about 30% by weight. Ca and Ca-Si particles contributed about 5% each to the mass. However, on 7/18 and 8/8, the Ca rich class had risen to a 50% weight contribution, with the clays and silica making up only about 15% each. The pulse of Calcium particles is consistent with historical monitoring of "whitings" in the Great Lakes. An interpretation of the (5000) individual particle analysis results based on water column chemistry measures in eastern Lake Ontario is currently underway and will be presented. The rapid creation of a solid phase in the water column may have important consequences in pollutant transport. The present study has not yet indicated significant phosphorus transport with the Ca rich particles.

(#) A cooperative contribution of the Upstate Freshwater Institute, Inc.

1600

ARTHUR P. PINSAK and DAVID J. KAUNISTO, Great Lakes Environmental Research Laboratory, NOAA Ann Arbor, Mi 48104

Sediment transport in Lake St. Clair

Suspended sediment discharge from Lake St. Clair is about four times greater than the load carried by the St. Clair River. Shore erosion and tributary inputs do not account for this difference so sources within the lake contribute to the increase. A numerical model was developed to simulate resuspension and transport of sediment within the lake. Shallow water wave hindcasting techniques were used to calculate orbital velocities and the resulting bottom shear that initiates sediment resuspension was related to threshold velocities of three sediment classes to estimate space variable resuspension. The suspended sediment is transported by currents a distance related to gravitational settling. Lake circulation was simulated by vertically integrated time dependent hydrodynamic equations derived from the equation of motion and transport was simulated by a mass balance equation for 2-dimensional advection and diffusion. Using calculated orbital velocities, areas within the lake with a potential for sediment resuspension under given wind direction and velocity were identified and net sediment transport was determined. The eastern and northern areas of the lake are most susceptible to sediment resuspension and concentrations along the south and west shores are greater than the tributary inputs. Because sediment resuspension is sensitive to wind direction and velocity, long term model results with composite winds simulate available observations best and correlation with short term events is poor.

1640

A.J. Zeman, Hydraulics Division, National Water Research Institute, Burlington, Ontario L7R 4A6.
Relations between erosion resistance and geotechnical properties of cohesive sediments.

Available information on the erosion resistance of normally-consolidated and overconsolidated cohesive sediments of the lower Great Lakes is scarce. A laboratory research has been initiated at NWRI to test cohesive tills and glaciolacustrine clays under controlled and known values of applied shear stress. Undisturbed cylindrical samples are tested in a rotating-cylinder apparatus that includes a digital torque sensor, a 2400 rpm motor with digital speed control and transparent outer cylinders of different sizes. Both applied shear stresses and erosion rates are measured in the tests. Results obtained for samples of the Port Stanley till from the central Lake Erie north shore yielded critical shear stresses in the order of 20 Pa. Geotechnical properties investigated include the water content, the Atterberg limits, and the vane shear strength. Other factors influencing the erosion resistance include temperature of eroding fluid, sediment structure, and the formation of microfissures at low water contents. An extensive literature review of the subject, which was undertaken in connection with the study, indicates that both the water content and the mineralogical composition of the clay-sized fraction have to be taken into account. Generalized relations of the critical shear stress to the water content, the void ration, the plasticity index, and the shear strength will be discussed.

1620

TAYLOR, KENT , Department of Geology, Mercyhurst College, Erie, PA 16546. NUMMEDAL, DAG and SONNENFELD, DAVID, Department of Geology, Louisiana State University, Baton Rouge, LA 70803. Sediment Dispersal Patterns for a Barred Shoreface; Presque Isle, Pennsylvania.

Presque Isle is a 10km long recurved spit located on the southern shore of Lake Erie. Severe erosion along the northwest-facing neck of the spit continues, despite the construction of a groin field. The most recent proposal to stabilize the spit, is the construction of 56 detached breakwater segments. A multiphase study was undertaken to assess sediment dispersal patterns for the existing groin field bar system. Two bar systems, separated by a deep trough parallel the neck. During high wave energy conditions, inner bar sediments move lakeward into the trough system in response to groin cell associated rip currents. Outer bar sediments are also transported into the trough. The strong longshore trough current intermittently breaks through the outer bar forming "spill over lobes". Intermediate wave energy levels transport inner bar sediments lakeward, particularly adjacent to the groins. The velocity of the main trough current decreases and is too weak for net erosion. The outer bar is dominated by onshore, wave induced sediment movement. Low wave energy conditions produce onshore sediment transport over the entire shoreface. The outer bar migrates landward, the trough floor accretes, and the inner bar welds onto the beach.

CONTAMINANTS/NIAGARA RIVER

1520-1700 Room 105

Moderator: John Hassett

1520

RONALD A. HITES , RUDOLF JAFFE, AND RAY KAMINSKY. School of Public and Environmental Affairs and Department of Chemistry, Indiana University, Bloomington, IN 47405. The Impact of Organic Compounds from the Love Canal and 102nd Street Dumps on the Niagara River and Lake Ontario.

Sediment cores have been taken from nearshore sites along the Niagara River in the vicinity of the Love Canal and the 102nd Street dumps. Using GC/MS, a multitude of chlorinated organic compounds were identified and quantitated. On the basis of this analysis, the two sites were found to represent distinct sources of contamination to the Niagara River. In addition, sediment cores and grab samples from Lake Ontario have been analyzed using methane negative chemical ionization GC/MS in order to quantitate trace levels of organic compounds. A comparison of the compounds found in Lake Ontario sediment with those in Niagara River sediment reveals clear differences in the compounds which characterize these two systems. Although their compositions overlap, there are more differences than similarities. Our findings suggest that the Niagara River appears to be a major source of pollutants to Lake Ontario, but many of the compounds in the river do not accumulate to detectable levels in the lake.

1540

KLAUS L.E. KAISER and MICHAEL E. COMBA
National Water Research Institute, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario, L7R 4A6 - The Niagara River plume as determined from the dispersion of volatile halocarbons into Lake Ontario.

Our recent studies showed the Niagara River to be a significant source of some volatile halocarbons to Lake Ontario. We have now measured the concentrations of such compounds in each of the epilimnion, thermocline and hypolimnion at a more detailed station grid covering the Niagara River and Welland Canal mouths and nearshore Lake Ontario.

Results from this survey indicate that (i) there are volatile hydrocarbon plumes from both the Niagara River and Welland Canal, (ii) such plumes extend for several miles into Lake Ontario, (iii) there are noticeable differences of the contaminant patterns between surface and bottom waters of this nearshore area, and (iv) the Welland Canal appears to provide a significant loading of some compounds to Lake Ontario.

1600

GLENN C. MILLNER and ROBERT A. SWEENEY
Ecology and Environment, Inc.,
P.O. Box D Buffalo, NY 14225
Tracking dilution and dispersion of a discharge to the Lower Niagara River

The movement and rate of dilution of treated effluent discharged by SCA Chemical Services, Inc., (SCA) into Peggy's Eddy of the Lower Niagara River was successfully measured via flurometric quantifications of Rhodamine WT injected at a constant rate into the discharge stream. A three dimensional sampling array was employed to determine the 500:1 isopleth (dye dilution). The results indicated that the discharge stream moved in opposite direction to the main flow of the river and although the 500:1 isopleth did shift, it was confined to an area less than 250' from its discharge. There was no evidence of any build-up of treated wastewater in the eddy. The procedures provided real-time results and demonstrated that the discharge diffusor system performed satisfactorily. The fluorometric procedures used may have other applications in the Great Lakes and their tributaries.

1620

ROBERT A. SWEENEY and GLENN C. MILLNER
Ecology and Environment, Inc.,
P.O. Box D Buffalo, NY 14225
Ecosystem inventory in the vicinity of treated wastewater discharge, Peggy's Eddy, Lower Niagara River

Fish, aquatic vegetation, benthic macroinvertebrates, diatoms, and sediment were sampled upstream and downstream from the discharge of treated wastewater by SCA Chemical Services, Inc., (SCA). Nektonic surveys using a recording fine-line fathometer and experimental gill net were conducted during the discharge period. A comparison of upstream and downstream biota indicated that there was no evidence of toxicity or other abnormal behavior by organisms in the vicinity of or as a consequence of the discharge. No accumulation of heavy metals occurred in the sediment down current from the discharge.

1640

RICHARD P. LEONARD
U.S. Army Engineer District, Buffalo,
1776 Niagara Street, Buffalo, N.Y. 14207 -

Chemical and bioaccumulation studies at Times Beach dredge disposal area, Buffalo, N.Y.

The 46 acre Times Beach off-shore dredge disposal area, Buffalo, N.Y. was partially filled with dredge sediment in the early 1970's and left as a wild life area. About half of the area is shallow water (1-7 feet) with the remainder consisting of marsh wetland and upland shrubs and trees. Studies were conducted to ascertain if heavy metals and organics found in sediments are bioconcentrated in a wetland plant species (sedge) and in earthworms. In addition, water samples from the site were analyzed for the metals and organics found in the sediments. Results of the sediment, water, plant, and earthworm chemical analyses are presented and interpreted with respect to bioaccumulation and possible bioconcentration. Although metals and a few organics accumulated in vegetation and earthworms, bioconcentration is not evident. There were only traces of metals in water samples with no detection of organic contaminants.

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