Atelier de 1989 / 1989 Workshop

Transport à Distance des Polluants Atmosphériques (TADPA)
Long Range Atmospheric Pollutants (LRTAP)

Rapport sommaire / Summary Report

Institut Maurice-Lamontagne /
Maurice Lamontagne Institute

Mont-Joli (Québec)

26-27 septembre 1989 / September 26-27, 1989

Pêches et Océans Fisheries and Oceans

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Ministère des Pêches et des Océans/
Department of Fisheries and Oceans

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PREFACE

La rédaction du présent rapport de même que l'enregistrement et la transcription ont été accordés en sous-traitance à Le Groupe Média Science Inc., en vertu de l'offre n° XKS 89 - 00046 - (305) /A, par le ministère des Pêches et des Océans de l'Institut Maurice-Lamontagne, Mont-Joli (Québec).

PREFACE

The writing of this summary report as well as the taping and transcribing was subcontracted to Le Groupe Média Science Inc., under the submission # XSK 89 - 00046 - (305) /A, by the Department of Fisheries and Oceans of the Institut Maurice-Lamontagne, Mont-Joli, Québec.

RESUME DE L'ATELIER

C'était le quatrième atelier sur le transport à distance des polluants atmosphériques (TADPA). Approximativement, 30 personnes se sont enregistrées (voir liste des participants en annexe). Deux représentants du bureau central du MPO étaient présents. Toutes les régions étaient représentées sauf la région du Golfe. Il y avait également des représentants du ministère de l'Environnement du Canada, des universités et d'organismes provinciaux.

L'atelier a débuté par la présentation de rapports régionaux résumant les récents résultats de recherche dans les domaines suivants:

a) Étude de cause et effet des précipitations acides;
b) Étude de mitigation;
c) Contaminants organiques;
d) Contaminants métalliques;
e) Paléoécologie.

Ces rapports furent suivis par les propositions de voies de recherche par les gestionnaires régionaux. Une synthèse des travaux sur l'aluminium fut également présentée par P.G.C. Campbell de l'INRS-Eau, Québec. Des résumés de ces présentations apparaissent à la partie I.

Lors de la deuxième journée, trois séances ont eu lieu:

a) Point de vue du CCRM sur le futur programme: lecture de la lettre de Tom Brydges par Iola Price;
b) Programme de Biomonitoring: réalisations et perspectives par Ian Davies;

WORKSHOP OVERVIEW

This was the fourth DFO LRTAP Workshop. There were approximately 30 registered full-time participants (see attendance list in appendix). Two DFO Headquarters staff attended and all DFO regions were represented except the Gulf Region. In addition, there was representation from Environment Canada, universities and provincial agencies.

The Workshop began with a series of reports which summarized recent research results under the categories of:

a) Cause and effect studies of acid precipitation;
b) Mitigation studies;
c) Organic contaminants;
d) Metallic contaminants;
e) Paleo-ecology.

These reports were followed by Regional manager proposals on research orientation. A synthesis of studies on aluminium was also presented by P.G.C. Campbell from INRS-Eau, Sainte-Foy, Québec. Summaries of presentations are found in part I.

During the second day there were three session:

a) RMCC point of view on the next program: reading of Tom Brydges' letter by Iola Price;
b) Biomonitoring Program: realisations and perspectives by Ian Davies;

c) Propositions socio-économiques par François Boulanger.

Puis une discussion générale a suivi sur ces trois sujets (voir partie II):

a) Orientations majeures du programme;
b) Nouvelles recommandations;
c) Points d'intérêt du TADPA.

Les thèmes principaux issus de la discussion finale furent:

- Garder en vue les recommandations de 87-88 (voir annexe 4);

- Soumettre les propositions de projet selon les orientations majeures suivantes: biomonitoring, atelier, coordination du bureau central, collaboration internationale, mitigation, études de cause et effet, paléoécologie, et contaminants organiques/toxiques (tout en ayant une vision nationale du programme);

- Instituer un programme gestionnaire de qualité pour les substances organiques et les métaux;

- Augmenter la coopération et la collaboration interrégionale ainsi que nationale lors de la présentation de projets en vue des subventions à venir. Ces projets devront également rencontrer les critères du sous-comité: l'excellence scientifique, le mandat, la relation au programme du TADPA ainsi que les points d'intérêt du TADPA.

c) Socioeconomic proposals by François Boulanger.

This was followed by a general discussion on these subjects, see part II,

a) Major headings;
b) New recommendations;
c) Focus points for LRTAP.

Topics / issues raised in the concluding discussion:

- Keep in view the 87-88 recommendations (see appendix 4);

- Consider the national scope of the program and submit the project proposals against the major headings which are: biomonitoring, Workshop, H.Q. coordination, international collaboration, mitigation, cause and effect studies, paleoecology and organics/toxics;

- Institute a quality management program for organics and metals;

- Increase inter-regional and national cooperation and collaboration to consider for fundings those projects which meet the Sub committee's criteria: scientific excellence, mandate relationship to the LRTAP program and also the focus points of LRTAP.

Les études réalisées dans chaque région seraient axées sur un ou plusieurs des grands domaines ou points d'intérêt général suivants:

1. Quelle est l'importance et la variation régionales, antérieures et actuelles, de l'apport de TADPA au Canada et comment ces valeurs s'intègrent-elles aux allures de la dispersion et de l'accumu- lation à l'échelle du globe?

   Charges intégrales (g/m^e)
   Flux ($g/m^e.an$)
   Effets de la variation du climat.

2. Quelle est la relation entre les taux d'apport du TADPA et la réaction des écosystèmes aquatiques?

   - Examen des publications;
   - Essais dose-réponse réalisés en laboratoire;
   - Mesure sur le terrain de la charge et du taux d'apport du TADPA en fonction de la bioaccumulation ou du stress chez les organismes et identification d'organismes indicateurs;
   - Essais sur le terrain: variation de la charge et observation de la réponse des écosystèmes et des organismes.

3. Quels sont les facteurs physiques et géographiques influant sur la disponibilité des polluants TADPA pour les écosystèmes?

   - Effets de la taille des lacs, du rapport Ad/Ao, du temps de séjour de l'eau, de la profondeur moyenne, de la température moyenne, du climat local;

Studies in each region would be focused on one or more of the five broad areas or questions described below:

1. What is the magnitude and regional variation in the history and current flux of LRTAP in Canada, and how does this fit into global patterns of dispersal and accumulation?

   Integral burdens (g/m^e)
   Flux ($g/m2.yr$)
   Effects of climate change

2. What is the relation between the rate of supply of LRTAP and the response of the aquatic ecosystems?

   - Literature review;
   - Laboratory dose-response experiments;
   - Field measurements of LRTAP burden and rate of supply related to bioaccumulation or stress response in organisms, index organism identification;
   - Field experiments: vary the load, observe response in ecosystem and organism components.

3. What are the physical and geographic controls on LRTAP availability to ecosystems?

   - Effect of lake size, Ad/Ao, water residence time, mean depth, mean temperature, local climate;

- Effets de la composition des sédiments, de la teneur en lipides, de l'origine terrestre ou lacustre des sédiments, du taux de sédimentation et de la couche de mélange, de la concentration sédimentaire...

- Effect of sediment composition, lipid content, terrestrial vs lake-produced sediment, sedimentation rate and mixed layer, sediment focusing...

4. Réduction des dommages: Que peut-on faire pour réduire les dommages déjà causés et comment peut-on prévenir que d'autres ne soient causés?

   Quels dommages ont déjà été causés?
   Quelles est l'évolution chronologique des dommages?
   Quelles sont les implications socio-économiques des dommages?
   Que faudra-t-il faire pour réparer les dommages déjà causés?

4. Mitigation: What can be done to alleviate the damage already done and how can we prevent future damage?

   How much damage has already been done?
   What is the time course of the damage?
   What is the socio-economic implication of the damage?
   What needs to be done to repair the damage?

5. Pouvons-nous fournir des données d'entrée pour les modèles généraux d'équilibre massique (p. ex.: Don Mackay) ou les modèles de gestion des risques (Minns)? Pouvons-nous collaborer à l'élaboration de modèles sur la dispersion et l'accumulation à l'échelle du globe?

5. Can we provide input to general mass balance models (e.g. Don Mackay) or risk management models (Minns)? Can we contribute to models of global dispersal and accumulation?

INTRODUCTION

Après une allocution de bienvenue au cours de laquelle le directeur de l'IML, M. Jean Boulva, a présenté l'institut ainsi que les grandes lignes de ses travaux, Madame Iola Price a exposé le programme du quatrième atelier annuel sur le Transport à Distance des Polluants Atmosphériques (TADPA) organisé par le MPO.

L'atelier était divisé en deux parties:

I) Revue des travaux exécutés afin de déterminer comment ceux-ci s'insèreront dans le futur TADPA V quand les fonds qui lui sont destinés auront été accordés.

II) Fixation des objectifs à venir et élaboration du cadre des travaux qui seront exécutés en vertu du TADPA V.

L'atelier a commencé par la présentation des rapports régionaux: état d'avancement des travaux et (ou) exposé sur la nécessité de prolonger certaines activités du TADPA IV dans le TADPA V.

Ensuite, les rapports des régions ont fait l'objet de discussions en profondeur, afin de déterminer ce qu'il serait nécessaire de faire dans l'avenir.

Cinq régions étaient représentées:

1. Région du Centre et de l'Arctique (quatre conférenciers).
   - Ray Hesslein
   - John Jelso
   - Greg Brunskill
   - Ken Minns

INTRODUCTION

After a welcoming address by MLI Director, Mr. Jean Boulva, saying a few words about the institute and a broad outline of their work, Mrs. Iola Price introduced the fourth annual DFO LRTAP Workshop.

This Workshop was organized into two parts:

I) Review of the past work in order to identify how the past work is going to fit into the future of LRTAP 5 when it gets funded.

II) Determine the future objectives and develop the framework for the work that will be done under LRTAP V.

The Workshop started with the presentation of Regional reports describing their respective progress and/or their need to carry over a particular activity of LRTAP IV into LRTAP V.

Then, in depth discussions of regional programs followed, to specify what would be the need to do for the future.

Five regions were represented:

1. Central and Arctic Region (four speakers)
   - Ray Hesslein
   - John Kelso
   - Greg Brunskill
   - Ken Minns

2. Région du Pacifique (pas de conférencier, mais un document écrit).

3. Région de Scotia-Fundy (un conférencier).
   - Gilles Lacroix

4. Région de Terre-Neuve (un conférencier).
   - Larry Coady

5. Région du Québec (un conférencier, exposé en français).
   - Gordon Walsh

2. Pacific Region (no speaker but a paper).

3. Scotia-Fundy Region (one speaker).
   - Gilles Lacroix

4. Newfoundland Region (one speaker).
   - Larry Coady

5. Québec Region (one speaker, french presentation).
   - Gordon Walsh

PARTIE I/PART I

1. RAPPORTS REGIONAUX SUR L'ETAT DE LA RECHERCHE/REGIONAL RESEARCH REPORTS

1.1. Région du Centre et de l'Arctique/Central and Arctic Region

RAY HESSLEIN

ELA LRTAP Update: 1989 season

The major components of the ELA program continued to be; biomonitoring, the acidification of Lake 302, the recovery from acidification of Lake 223, theacidification of and addition of ammonia to the wetland, and the whole lake cadmium study. The cadmium study is described separately by D. Malley and the biomonitoring by I. Davies. Some recent points of interest for these experiments follow.

The result of the comparison of the acidification caused by sulfuric and nitric acids in Lake 302 has been summarised in a manuscript by Rudd et al. The paper will be appearing in Limnology and Oceanography in the near future. Over the five year period of the addition to the two basins separated by a curtain, nitric acid proved to be 70 % as efficient as sulfuric acid at acidifying the epilimnia and 50 % as efficient on a whole basin basis. This was higher than originally expected. Algal uptake was limited in its response to remove nitrogen by the natural limitation of phosphorus. Denitrification in the sediment increased 40 fold but limited transport of the nitrate to the sites of denitrification prevented this process from removing a higher portion of the nitrate. Overall, in-lake processes removed 70 % of the nitric acid and 57 % of the sulfuric acid. Studies of whole lake nitrogen cycling are continuing in Lake 302N at pH 5.2, controlled by HC1 addition.

Lake 302S was held at pH 4.5 in 1989. The phytoplankton community continues to be dominated by dinoflagellates (80-90 % of cells), a characteristic of acidified systems. Diversity is very low with two species comprising most of the assemblage and only 18 species present so far this year. The trend of decreased phytoplankton photosynthesis noted in 1988 continued in 1989. There appears to be a significant trend toward increased light penetration but this has yet to be statistically confirmed. Periphyton communities continue to suffer considerably with the lowest coverage of epilithic communities yet seen and decreased photosynthesis and increased relative respiration rates. Metaphytic filamentous green algal growth was less dramatic in 1989 although still a very visible component. This was probably due to the very cool Spring and grazing pressure. Periods of significant decomposition were evidenced by oily slicks and strongly objectionable odour. Dace and Fathead minnow, both of which are sensitive to acidificaiton, have been shown to exert control over the filamenteous green algae through grazing. The chironomid emergence in Lake 302S increased in 1989 relative to other lakes. The emergence was characterized

by more large species which may be a response to decreased predation by small fishes which have been severely impacted by the acidification.

Lake 223 was held at pH 5.8 in 1989. The phytoplankton community was similar to that in 1988 with dinoflagellates still dominating and Cyanophytes and Chlorophytes representing about 30 % of the total. Cell counts continue to be at levels that have been relatively constant throughout the experiment. Annual areal phytoplankton photosynthesis has steadily increased (through 1988, 1989 not available yet) since the recovery was started in 1985. In 1988 photosynthesis was 30% higher than in 1978 when Lake 223 was at pH 5.93 during the acidification phase. Reference lakes have shown an increase of 6 % over this period. Light penetration has shown no appreciable change in Lake 223 during the last four years while control lakes have shown an increase. Lake 223 still has a higher light penetration than the average control lake.

Chironimid species lists show no recovery in the lake through 1987. Lists for 1988 and 1989 are in progress. Total emergence was slightly increased in 1989, probably due to favorable weather conditions and reduced grazing pressure by white sucker. Crayfish have not reinvaded the lake. The major fishing in the lake is being carried out as this report is being written. Preliminary catches show that fathead minnows are successfully reproducing in the lake. This has not happened since 1978.

Volatile sulfur studies have shown that concentrations are higher in shallow lakes. Dimethyl sulfide concentrations are as high as in the oceans and other volatile sulfur compounds are mmuch higher than oceanic values. Sediments appear to be the main source of these compounds. The production of organic sulfur compounds by sulfate reducing bacteria has been directly demonstrated for the first time. Identification of the organic sulfur compounds is under way.

Mercury methylation studies have shown that pH is the major factor controlling the rate. DOC also plays an important role in the rate control and the ratio of demethylation to methylation. This venue of research may lead to a better understanding of the accumulation of mercury in fish.

The methods for analyzing for the partial pressure of CO_2 have been incorporated in much of the routine sampling schedule of our lake studies. This is yielding very good data on the role of pCO_2 in regulating pH seasonally and the overall metabolism of carbon in lakes.

GREG BRUNSKILL

History & current flux of organic & metal lrtap in relation to fish stress in temperate, subarctic, and arctic lakes

G.J. Brunskill, D. Muir, L. Lockhart, P. Wilkinson, B. Billeck, R. Hunt, W. Burton.

A) Introduction

The objectives of our LRTAP research program are to test the following hypotheses:

1. The rate of supply of LRTAP organochlorines (OC), polycyclic aromatic hydrocarbons (PAH), and metals to remote lakes (as measured by their accumulation rate in sediment cores) causes increased bioaccumulation of OCs and metals, and increased stress indicator responses in fish.

2. Increased bioaccumulation and stress response to LRTAP adversely affects fish growth and reproduction.

3. Cold regions of the world should slowly condense out and retain volatile atmospheric pollutants from the temperate and tropical parts of the earth.

4. Sources (USSR, Asia, northern Europe, North America) of metal and organic atmospheric pollutants can be determined by ratios of metal to organic compnents, and by ratios to other natural atmospheric tracers (Pb-210, Cs-137, Be-7) that sorb to soils and lake sediments.

We are attempting to gather data to test these hypotheses by sampling remote, headwater lakes over a gradient in latitutes from the Experimental Lakes Area (ELA) in Ontario (49 30' N., to the high Arctic regions (Cornwallis Island, Ellesmere Island lakes, 82 N.). We are also considering possible lab and field experiments (whole lake spikes) and model simulations to test parts of these hypotheses.

B) Past studies

In order to obtain adequate sample weight for the determination of radionuclides, metals, OC, and PAH in thin sediment slices, we designed, built, and successfully tested a 3-man portable box corer. This corer yields 15-30 grams dry weight of sample per 1.3 cm horizontal slice of the sediment column. We also built an enlarged gravity corer for use in stiffer silty sediments. Without these inovations in sampling gear, we could not have done the following work. A more robust box corer is being built for the Hazen Lake work, in stiffer sediments at 260 meters water depth.

In 1987, 22 gravity corer and bulk surface sediment samples were taken from Lake 382 at ELA to estimate whole lake sedimentation and sediment characteristics. Detailed work on one box core from near maximum depth allowed the estimation of the history and current flux (ng/m2.yr) of the major OC (DDT, toxaphene, lindane, PCBs), PAHs, and the metals Pb, Hg, and Cd (See Tables 1 & 2). Radiochemical estimations of sedimentation rate and age utilize Pb-210, Cs-137, and Be-7 measurements. Lake trout have been obtained in summer and winter at ELA for measurements of mixed function oxidase enzyme activity, organochlorine and metal bioaccumulation (Table 3).

In 1988, we attempted to sample a bay of Southern Indian Lake in Northern Manitoba, but the sediments were too stiff for our coring apparatus. In April-May 1988, we were successful in obtaining duplicate box cores from two headwater lakes at meromictic estuarine basin nearby. Samples of the local lake trout and char populations were obtained by gill netting and angling. Radiochemical, geochemical, metal, and PAH and OC determinations are nearly complete for the lake cores (Tables 1 & 2). The historical profiles of the metals, OC and PAH are similar to the results from ELA, but the concentration and fluxes are about one quarter of those from ELA. We also collected large quantities of fresh snowfall that contained high concentrations of dust. This fine clay sediment from the snow has been analyzed for mineralogy, organochlorines, and other organic materials. It is not yet clear where it comes from, but the air mass carrying the dust originated in northern Asia.

In 1989, we tried to use a newly designed freeze corer to sample gas-rich, meromictic lakes at ELA that have laminated sediments. This was only partially successful, as the freeze corer does not yield enough sediment sample for all the determinations. A box core and a large gravity core was taken from Lake 375 at ELA, which will be the location of tube and possible a whole lake spike with organic pollutants. More fish were obtained to determine the variation of MFO activity with season.

In late May-early June of 1989, we were very successful in obtaining box cores and large gravity cores from Sophia and Amituk Lake, on the east coast of Cornwallis Island (75 N.). We also obtained aobut 30 land-locked char by gill netting. These samples have not yet been analyzed, due to shortage of funding. Polar Continental Shelf Project (PCSP) assisted us with aircraft and logistic support, and our work was done in collaboration with Dennis Gregor (DOE, Water Quality, snow & water organochlorines) and M. Retelle (Bates College, Maine, sedimentology of the laminated sediments of Sophia Lake). Interlaboratory calibration of measurements of low concentrations of organochlorines & PAHs were done in collaborations with Dr. Biddleman's lab at the University of South Carolina, and Dr. Hargrave's DFO-BIO lab in Dartmouth, N.S. Our metals lab recently participated in a quality assurance test sponsored by the International Joint Commission (Great Lakes Water Quality Board) on sediment samples, and these measurement included Pb, Cd, and Hg. Our

radiochemical laboratory is involved in ongoing calibration tests sponsored by the U.S. EPA Radiochemical Standards Branch.

Reports of this research program have been given at 6 scientific meetings, and a draft manuscript on the box core methodology is under review.

c) Proposed further work for 1990-91

We want to continue our northward transect into the very high Arctic, where over-the-pole transport of organic and metal LRTAP should be dominant. If PCSB and Parks Canada (DOE) will grant us support for aircraft and logistic services, it is feasible to sample Hazen Lake on the northern part of Ellesmere Island. This lake has a large population of char, and the sediments appear to be suitable for our work (the lake is very deep, 260 m, and sediment funneling should increase our time resolution for LRTAP histories). We have obtained permission from Borek Air to use their camp facilites on Hazen Lake.

We also propose to sample the large unnamed lake in the centre of Stefansson Island (of the NE coast of Victoria Island), where the furthest north population of lake trout is found. Both Lake Hazen and the lake on Stefansson Island are accessible from PCSP headquarters in Resolute by twin otter aircraft. Fish samples would be taken with gill nets. We now have access to Sea Star water sampling equipment, which will enable us to sample all four phases (air, water, sediment, & fish) of the systems. This kind of information on the volatile organic pollutants will allow tests of models created by Don McKay at the University of Toronto, that are pertinent to the "cold finger hypothesis". This work would be done in collaboration with Dennis Gregor of DOE, Fiona McLaughlin & Ed Carmack (Institute of Ocean Sciences, Sidney, B.C.), Jonathan Overpeck (Lamont-Doherty Geological Observatory, Columbia University, New York), and Mike Retelle (Bates College, Lewiston, Maine).

Cost Estimates for LRTAP 1990-91:

O & M:	Operating costs for 4 labs (Radiochemistry, Organochlorines, Metals, PAHs, fish work)	$ 40 K
	Arctic Sampling (travel, freight	30
	Instrument leases & service	29
	Personal service Contract (Radchem)	25
	Shop corer development, shipping cases	5
	Scientific meetings travel	4
	Total:	$ 123 K
Capital:	Freeze driers, balances, Sonar, Pinger, 300 meter winch	
	Portable ice auger, air sampling pumps	30

D) Long-term proposal, 1990-1995

The options below require discussions with other LRTAP researchers in DFO and elsewhere. Briefly, we propose to continue our geographic survey sampling as above, study LRTAP cycling and foodchain bioconcentration in a series of lakes at and near ELA, and do some critical experiments in the lab and in lakes at ELA to test several existing models of ecological and mass balance pathways of metal and organic LRTAP. We cannot do all of these things, of course, and we present several options for consideration.

1990-91: Lake Hazen, Stefansson Island
Continue work at ELA, Lake 375

1991-94: Core & collect fish for LRTAP FLUX study in the Mackenzie Valley, one meromictic lake near Inuvik, and a mountain lake on the Liard River above Fort Simpson. The Western Subarctic will have different histories and background levels of metals and organic atmospheric polutants. Fish communities are more diverse and abundant, compared to the high arctic. We would like to utilize stable isotopes of C, N, and sulfur to better characterize the sources of food (= contaminant source) for the fish populations.

Box core and collect fish from suitable lakes in northern Québec, wher PCB and other organochlorine pollutants have caused concern in wildlife, fish, and humans.

Box core and collect fish from suitable lakes in southern Ontario where LRTAP deposition rates and duration is much greater. We need some high LRTAP data points for sediments & fish to test the models of the relationships between rate of supply of LRTAP and response in fish populations. This work would be done in collaboration with Drs. Lean & Carey of DOE at CCIW in Burlington, who have studied PCBs in aquatic food chains in a series of lakes. There are also lakes which have received spills or intentional doses of organic contaminants (Toxaphene in B.C., PCBs in Ontario), which would be interesting test lakes for the models.

Box core and collect fish from a series of lakes in NW Ontario (ELA, Green, Orange, Linge, Musclow, Sydney, Trout, Nipigon) to augment ongoing foodchain studies by Drs. Rudd & Hecky (FWI), and to test the effect of limnological variables (Water residence time, drainage area, size of lake, sediment focusing factor, sediment type) on the estimate of metal and organic LRTAP flux, and the bioaccumulation & stress response in fish.

Begin detailed Mackay Model testing measurements of selected organic contaminants (present LRTAP &/or added organic compounds, with radioactive labels) in air, water, fish, and sediments of ELA lakes. Air & water measuremnts are feasible but require some new instrumetation (high volume air samplers, Sea Star water samplers). Similar measurements could be made on Arctic lakes to test the effect of climate or mean lake temperture on the retention of volatile organic pollutants in lakes.

Collaborate with climate change studies at ELA, to determine the effect of local climate changes (over 20-200 years) on atmospheric polutant supply rates, geochemical and biological changes in lake ecology. This would also involve determining the variation in LRTAP and natural (forest fire) PAH sedimentation over much longer lake histories than we are currently doing. Detailed analyses of annually laminated lake sediments form ELA would likely allow estimates of yearly variations in contaminants and natural parameters from the present to 500+ years ago.

1994-95: Analyze backlog of samples
Catch up on writing papers
Synthesis of larger scale view, latitudinal gradient, and participation in global flux models.

Budget: The costs of expeditions to remote Arctic lakes can now be estimated fairly well, and our experience in analyzing the box cores and fish samples allows us to know the time and cost of these operations. Detailed experimental studies at ELA will have a different range of problems & costs, but can be estimated from past experience with spike experiments for metals and mutrients.

Our current feeling is that we should continue the latitudinal LRTAP flux study to include Lake Hazen and perhaps the Western Arctic (Mackenzie Valley), and then move into the more detailes & experimental phase at ELA.

	89-90	90-91	91-92	92-93	93-94	94-95
O&M	$100K	120	120	120	120	100
Cap	30	30	10	30	30	10

Latitudinal LRTAP ....Model testing experiments

TABLE 1 LRTAP BURDEN IN REMOTE LAKES

Total Integral Burden of Anthropogenic Contaminent Minus Background

Region	Core	Integral ^{210}Pb + ^{137}Cs (kBq m^{-2})		Pb	Hg (mg m^{-2})	Cd	s-DDT	s-PCB (µg m^{-2})	s-PAH-perylene
ELA 49°30'N	L.382A	10.4	4.0	551	0.42	5.3	83	90	11,130
	L.375A	4.9							
SAQ 63°39'N	Far Lake A	4.4	0.33	39	0.59	1.3	10	28	400
	Hawk Lake A	4.7	0.19	36	0.63	2.4	8.6	22	716
Cornwallis Isld 75°07'N	Sophia Lake								
	Amituk Lake								
Stefansson Isld 74°N									
Ellesmere Isld 82°N	Lake Hazen								

TABLE 2 Current Rate of Supply of LRTAP to Remote Lakes (LRTAP Flux)

Region	Core	210Pb flux (βq m^{-2} yr^{-1})	Sedn rate (g m^{-2} yr^{-1})	Pb	Hg	Cd	s-DDT	s-PCB	s-PAH-perylene
				(μg m^{-2} yr^{-1})					
ELA 49°30'N	L.382A	324	563	24,000/5,630	21/56	338/112	0.6	0.7	28
	L.375A	152	123±17						
SAQ 63°39'N	Far Lake A	139	77±8	1,080/1,390	4.6/3.1	11/25	0.13	0.76	2.8
	Hawk Lake A	148	55±9	1,760/825	5.5/1.1	50/22	0.10	0.9	8.3
Cornwallis Isld 75°07'N	Sophia Lake A								
	Amituk Lake A								
Stafansson Isld 74°N									
Ellesmere Isld 82°N									

FIGURE 1

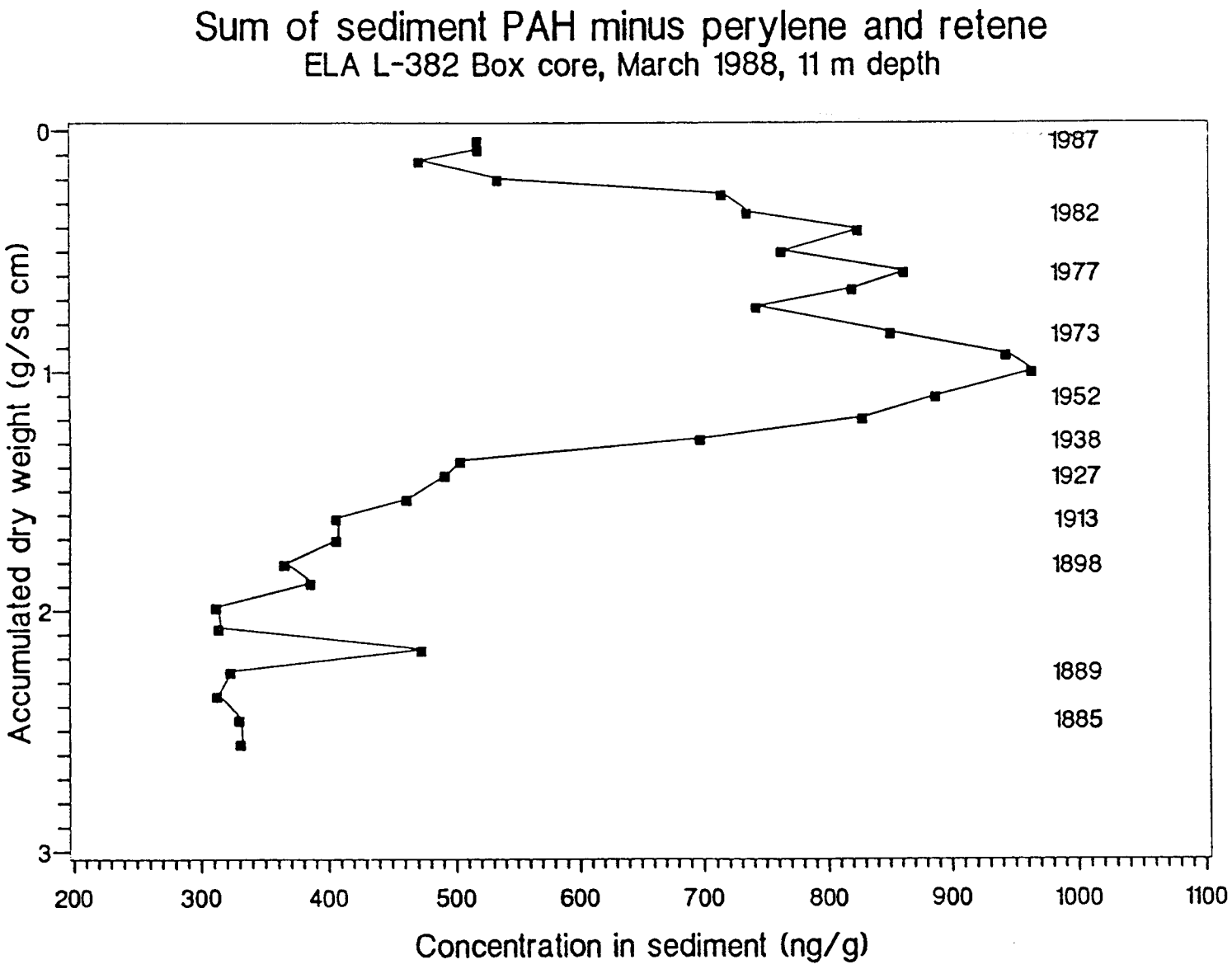

Sum of sediment PAH minus perylene and retene
ELA L-382 Box core, March 1988, 11 m depth
Accumulated dry weight (g/sq cm)
0
1
2
3
1987
1982
1977
1973
1952
1938
1927
1913
1898
1889
1885
200
300
400
500
600
700
800
900
1000
1100
Concentration in sediment (ng/g)

FIGURE 2

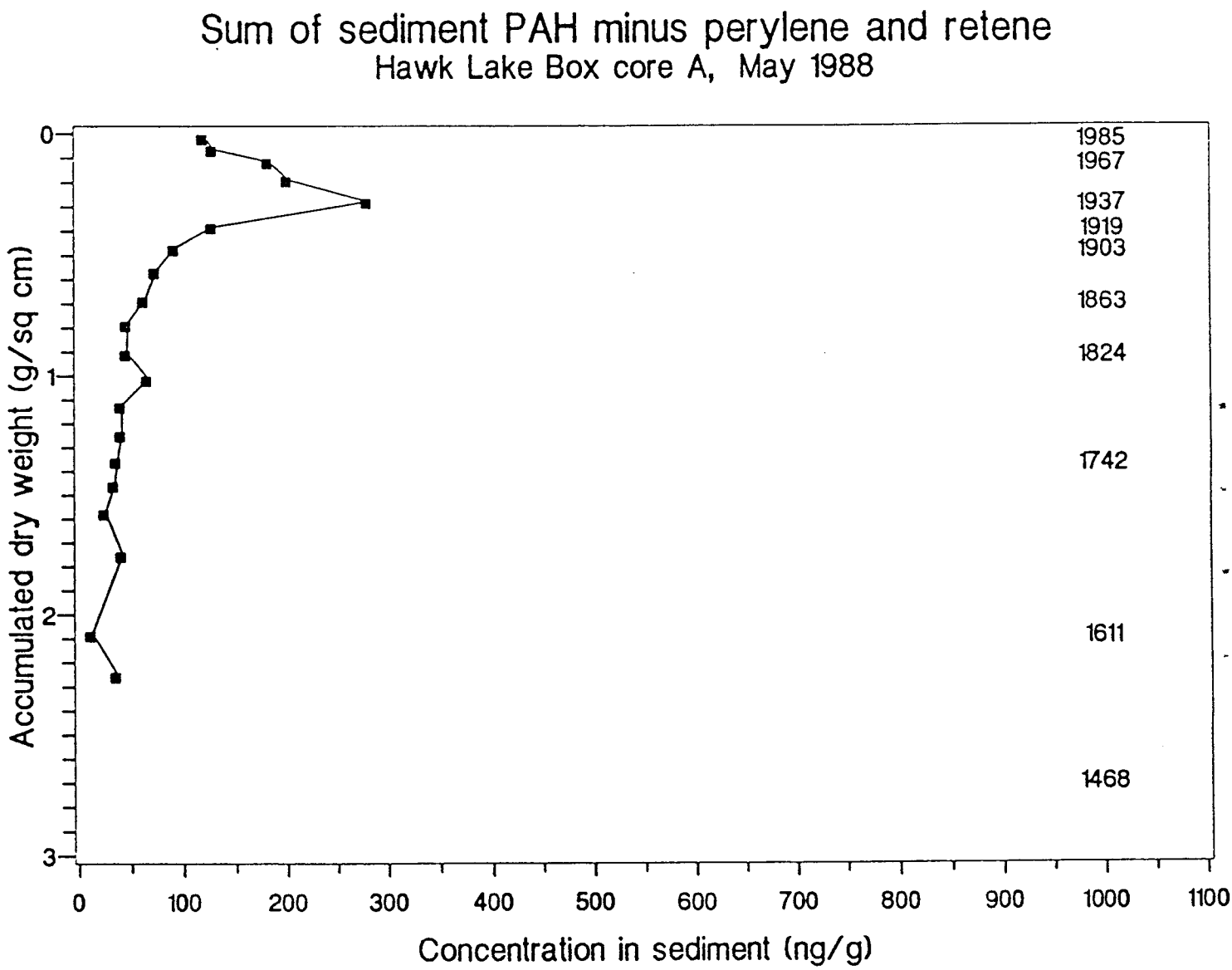

Sum of sediment PAH minus perylene and retene
Hawk Lake Box core A, May 1988
Accumulated dry weight (g/sq cm)
0
1
2
3
1985
1967
1937
1919
1903
1863
1824
1742
1611
1468
0
100
200
300
400
500
600
700
800
900
1000
1100
Concentration in sediment (ng/g)

FIGURE 3

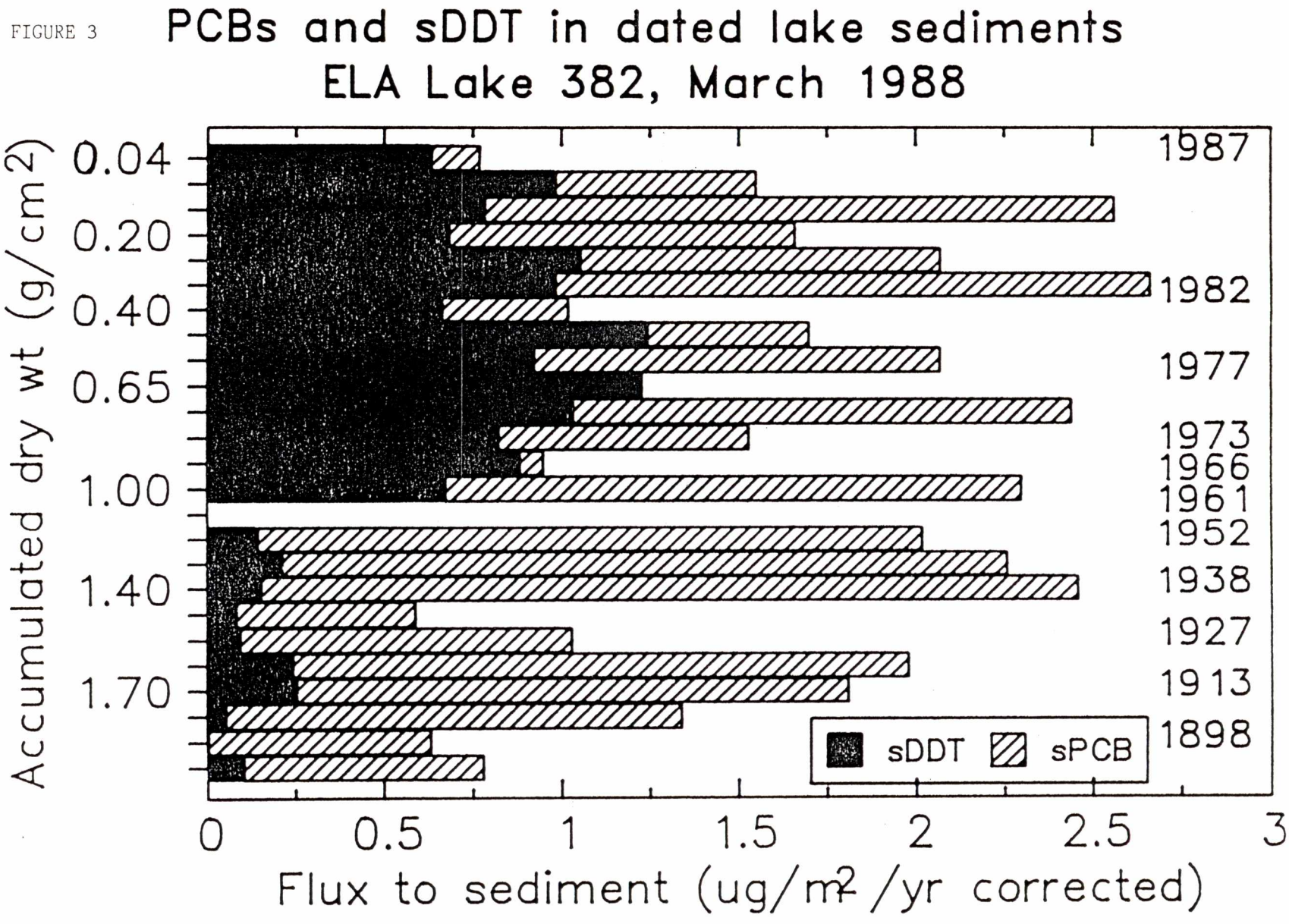
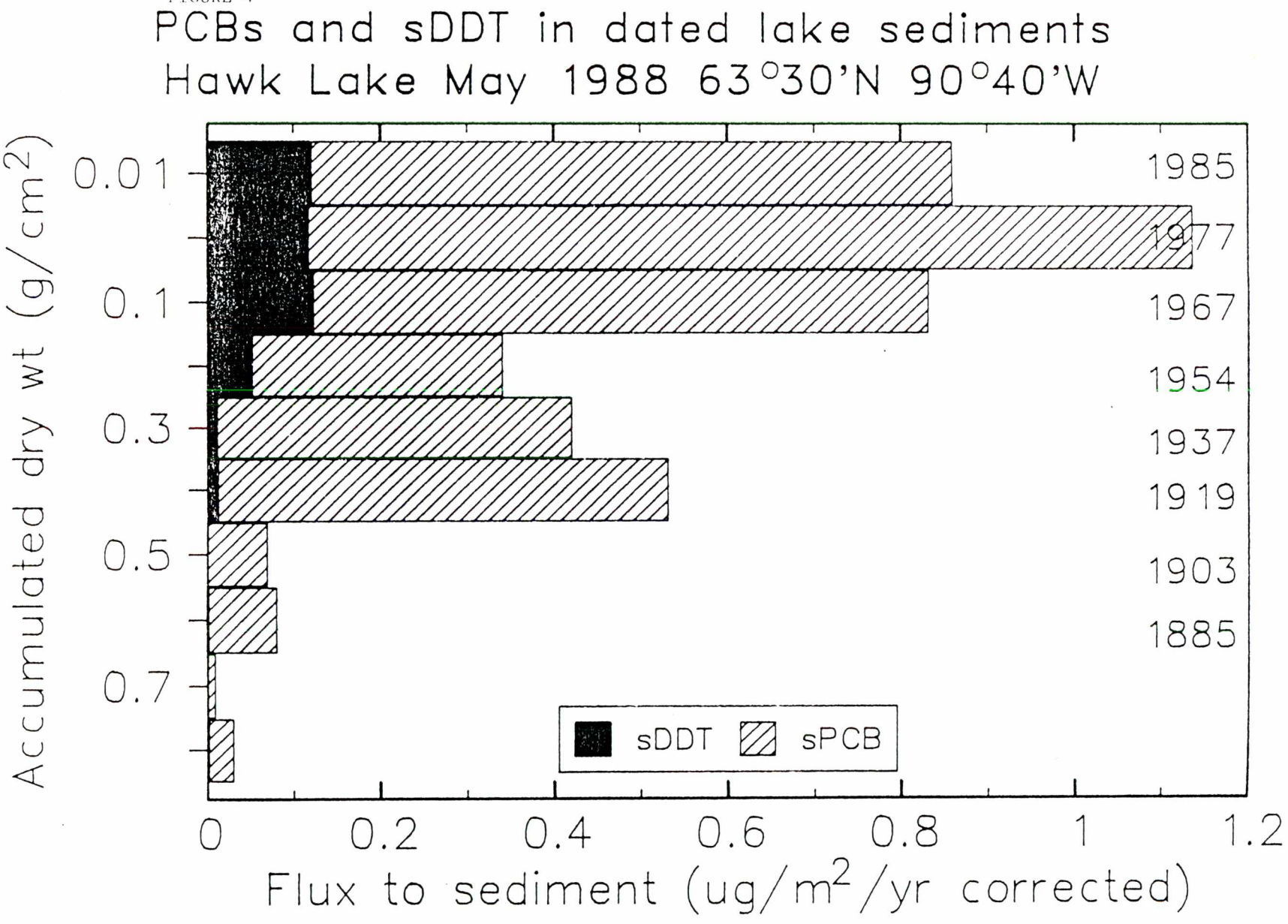

PCBs and sDDT in dated lake sediments
ELA Lake 382, March 1988
Accumulated dry wt (g/cm2)
0.04
0.20
0.40
0.65
1.00
1.40
1.70
1987
1982
1977
1973
1966
1961
1952
1938
1927
1913
1898
sDDT
sPCB
0
0.5
1
1.5
2
2.5
3
Flux to sediment (ug/m2/yr corrected)

FIGURE 4


PCBs and sDDT in dated lake sediments
Hawk Lake May 1988 63°30'N 90°40'W
Accumulated dry wt (g/cm2)
0.01
0.1
0.3
0.5
0.7
1985
1977
1967
1954
1937
1919
1903
1885
sDDT
sPCB
0
0.2
0.4
0.6
0.8
1
1.2
Flux to sediment (ug/m2/yr corrected)

JOHN KELSO

Research summary for the turkey lakes calibrated watershed

The initial stimulus for research in the TLW originated from concern over the loss of fishstocks and other aquatic biota due to acidic atmospheric deposition. The TLW was an ideal candidate for such research as these lakes are situated on the Canadian Shield and thus are sensitive to the high amounts of wet sulphate deposition they receive (frequently > 30 $kg \cdot ha^{-1} \cdot yr^{-1}$).

These lakes have been shown to be very responsive chemically to changes in acid deposition. A general trend of increasing pH and alkalinity since 1979 has been documented concurrent with decreases in sulphate loadings. Stocked brook trout in the most sensitive (and previously fishless) headwater lake have been shown to be capable of reproducing, although blood analyses and in situ bioassays suggest that the population is subjected to stress during spring pH depressions.

Research into fish and invertebrate communities in the TLW indicate that factors such as lake morphometry, physical habitat and predator density are more important in limiting production and species composition than are water chemistry factors such as nutrient loading and pH. The brook trout stocking experiment in Batchewana Lake will ensable us to test hypotheses regarding the importance of such factors in regulating aquatic communities.

Studies have also been conducted in the TLW to examine the atmospheric loadings and fate of LRTAP organics and trace metals in aquatic systems. Planned research in conjunction with FWI in L382 will provide us with a unique opportunity to assess whether present water quality guidelines for a toxic LRTAP metal (cadmium) are sufficient to protect aquatic communities.

The TLW provided us with the opportunity to conduct research not only on LRTAP issues, but to examine the role of factors responsible for inducing natural variability as opposed to directed change due to anthropogenic causes. The nine years of data from these lakes represents a unique data base which would enable us to assess and monitor any possible effects on aquatic communities due to climate warming.

Multi-disciplinary research in the calibrated watershed produced 114 publications since the work started in 1982. Research addressed a large number of physical/chemical/ biological issues associated with atmospheric deposition. A list of GLLFAS publications and a brief summary is appended.

Gillfas publications from the turkey lakes watershed study

84-04 Dermott, R.M. The benthic fauna in the lakes of the Turkey Lakes Watershed. Turkey Lakes Watershed Unpublished Report No. 84-04, 15 pp. (+ Tables and Figures), 1984.

Summary:
Report presents results of an examination of the benthic fauna in each lake of the TLW. Although there was a slight reduction in the number of taxa present in the lake of lowest pH (e.g. Bartchawana L.), there was little overall relation between fauna abundance or biomass and lake pH or alkalinity. High littoral biomass in Batchawana L. is related to a lack of fish predation.

85-11 Dermott, R.M. Benthic fauna in a series of lakes displaying a gradient of pH. Hydrobiologia 128: 31-38, 1985.

Summary:
Benthic fauna (presence and abundance) were examined in the TLW and related to pH. There was little relation between pH or ANC and the abundance and biomass of benthic fauna at depths > 3 m. High littoral biomass in the lake with lowest pH (Batchawana) is related to the lack of fish predation.

86-21 Dermott, R., J.R.M. Kelso, and A. Douglas. The benthic fauna of 41 acid sensitive headwater lakes in north central Ontario. Wat. Air. Soil Pollut. 28: 283-292, 1986.

Summary:
The abundance and composition of benthic fauna in 41 lakes of central Ontario (including those in the TLW) was evaluated. No correlation with pH or ANC was observed. Other factors such as lake depth and sediment nature appear to be important factors governing benthos distribution.

88-08 Dermott, R.M. Zoobenthic distribution and biomass in Turkey Lakes. Can. J. Fish. Aquat. Sci. 45(Suppl 1): 108-114, 1988.

Summary:
The composition of benthic fauna in the 4 lakes of the TLW is dependent on absence of fish, depth, and hypolimnetic oxygen concentrations, rather than the chemical gradient in the watershed. Details of species composition and biomass are presented and evaluated.

86-08 Johnson, M.G., L.R. Culp, and S.E. George. Temporal and spatial trends in metal loadings to sediments of the Turkey Lakes, Ontario. Can. J. Fish. Aquat. Sci. 43(4): 754-762, 1986.

Summary:
Metal concentrations in lake sediment cores were evaluated to assess their source. Variations in the profile of Pb, Cd, Hg and Zn concentrations (evaluated relative to ^{210}Pb activity) showed that these metals had a significant anthropogenic origin. The inferred metal loadings to the sediments was compared to atmospheric loadings.

88-20 Johnson, M.G. and D.B. McNeil. Fossil midge associations in relation to trophic and acidic state of the Turkey Lakes. Can. J. Fish. Aquat. Sci. 45(Suppl 1): 136-144, 1988.

Summary:
Analysis of sediment cores suggest that all the lakes except Wishart L have been progressing to more oligotrophic conditions; trophic status of Wishart L has been relatively stable. There is little evidence of lake acidification except in the most recent sediments of the headwater (Batchawana L). There has likely never been a fish community in Batchawana L.

82-11 Kelso, J.R.M., R.J. Love, J.H. Lipsit, and R. Dermott. Chemical and biological status of headwater lakes in the Sault Ste. Marie District, Ontario. In: R.M. D'itri (ed.), Acid precipitation, effects on ecological systems, Ann Arbor Science Publishers, ann Arbor, Michigan, 165-207, 1982.

Summary:
Report presents results of a survey of 85 headwater lakes in which an attempt is made to recognize relationships which may exist between the wellbeing of biological communities and chemical status. Biological communities reflected to varying degrees the acidic status of their aquatic habitat. Compared to plankton and benthic organisms, fish provide the most blatant response to changes in their habitat.

83-01 Collins, R.H., R.J. Love, J.R.M. Kelso, J.H. Lipsit, and J.E. Moore. Phytoplankton production, as estimated by the ^{14}C technique, and populations contributing to production 1980/81 in the Turkey Lakes Watershed. Can. Tech. Rep. Fish. and Aquat. Sci., No. 1191, 23 pp, 1983.

Summary:
Phytoplankton production was estimated for the ice-free seasons of 1980 and 1981 in each of the lakes in the TLW. Production was observed to increase downstream. Species contributing to production were identified. Highest summer production generally followed the shift of Cyanophyte species.

84-06 Lam, D.C.L., A.G. Bobba, D.S. Jeffries, and J.R.M. Kelso. Relationship of spatial gradients of production, buffering capacity, and hydrology in Turkey Lakes Watershed. ASTM STP 928: 42-53, 1986.

Summary:
The carbon uptake rate of phytoplankton was observed to increase from the poorly buffered headwater lake to the better buffered lakes downstream. Water pH, alkalinity, and dissolved inorganic carbon also increased in a parallel fashion and the report discusses the relationships among these observations. In particular, a hydrological model predicts that a greater groundwater component is present in the downstream waters and this can account for the above observations.

84-16 Kelso, J.R.M. and J.M. Gunn. Responses of fish communities to acidic waters in Ontario. In: Hendry, G.R. (ed.), Early biotic responses to advancing lake acidification, Butterworth Publishers, Boston, Mass, 105-115, 1984.

Summary:
Information is presented on observed symptoms and responses of fish communities in low pH lakes of Ontario. Topics covered include: community and population changes, changes in abundance, cases of lakes in terminal stage of fish loss, species tolerance, mixed community and recruitment failure, and contaminant levels in fish. Emphasis is placed on presentation of new material.

85-13 Kelso, J.R.M. Standing stock and production of fish in a cascading system on the Canadian Shield, Can. J. Fish. Aquat. Sci. 42(7): 1315-1320, 1985.

Summary:
Fish biomass and productions is examined for the lowest 3 lakes in the TLW using mark-recapture techniques. Total fish biomass decreases downstream and with increasing lake depth. Salmonid flesh production is of greater relative significance downstream. Results were compared with observations from other N. American lakes.

86-09 Kelso, J.R.M., C.K. Minns, J.H. Lipsit and D.S. Jeffries. Headwater lake chemistry during the spring freshet in north-central Ontario. Wat. Air Soil Pollut. 29: 245-259, 1986.

Summary:
Paper presents an analysis of the reductions in ANC, base cations, and SO_4 in lakewaters that occur during spring melt using a 30-lake survey conducted within and around the TLW. A simple model is developed that predicts changes in lake chemistry during spring melt given a few chemical and morphometric variables.

88-02 Kelso, J.R.M., and D.S. Jeffries. Response of headwater lakes to varying atmospheric deposition in north-central Ontario, 1979-1985. Can. J. Fish. Aquat. Sci., 45: 1905-1911, 1988.

Summary:
Paper discusses the causes of variations in chemistry observed for 54 Algoma lakes (including some of the Turkey Lakes) between 1979 and 1985. Lakes were surveyed on a 3 year cycle. Changes in pH, ANC and Ca were related to either changing atmospheric deposition or terrestrial basin response. Two fishless lakes (in 1979) developed white sucker populations by 1986 through invasion into a more hospitable chemical environment. Water quality "recovery" in central Ontario extends beyond that observed near Sudbury.

88-06 Jeffries, D.S., I.K. Morrison, and J.R.M. Kelso. The Turkey Lakes Watershed Study. Proc. Can. Hydrol. Symp., Banff, Alta., (in press).

Summary:
Rationale for the study basin selection criteria, general basin description, research topics, and difficulties encountered are all presented. This is perhaps the most complete and concise review of why and how the TLW study has been conducted.

88-07 Kelso, J.R.M. Fish community structure, biomass, and production in the Turkey Lakes Watershed, Ontario. Can. J. Fish. Aquat. Sci. 45(Suppl 1): 115-120, 1988.

Summary:
Report summaries fisheries community, biomass, and production studies in the TLW. Only the 3 downstream lakes support a native, reproducing fish stock. Biomass varied 3.3-fold but fish flesh production by only 1.5-fold. Both were strongly influenced by lake depth and also related to ANC and phytoplankton C assimilation. These conditions might be related to acidification and/or biogeographic factors.

88-18 Kelso, J.R.M. and J.H. Lipsit. Young-of-the-year fish community in nine lakes, varying in pH, on the Canadian Shield. Can. J. Fish. Aquat. Sci. 45(Suppl 1): 121-126, 1988.

Summary:
Larval fish populations were sampled from lakes in the TLW and others near Sudbury to assess the impact of the rapid water quality changes that accompany spring runoff. Abundance was not strongly linked to lake pH or ANC; however, diversity was related. Monitoring of the larval fish community is proposed as an inexpensive, responsive, and reproducible measure of change in fish communities that are sensitive to acidification.

88-19 Kwain, W. and J.R.M. Kelso*. Risk to salmonids of water quality in the Turkey Lakes watershed as determined by bioassay. Can. J. Fish. Aquat. Sci. 45(Suppl 1): 127-135, 1988. (*author of correspondence).

Summary:
Report presents results of in-situ bioassy studies conducted to address the reason for the fishless state of Batchawana L. Spring pH depressions did not induce consistent mortality in caged fish. Whole-body ion concentrations were generally similar for fish caged in Batchawana L. compared to those in the other 3 lakes; Pb and Hg levels were higher however. Factors beyond pH and trace metals likely contribute to the fishless condition of Batchawana L.

88-21 Johnson, M.G., J.R.M. Kelso, and S.E. George. Loadings of organochlorine contaminants and trace elements to two Ontario lake systems and their concentrations in fish. Can. J. Fish. Aquat. Sci. 45(Suppl 1): 170-178, 1988.

Summary:
Report presents assessment of the inputs of various organic contaminants and trace metals on 3 lakes in the TLW (and 2 others) and their incorporation into fish. Atmospheric deposition was determined for several OC's and pesticides. Lake loading and/or lipophilicity could account for most of the variability of these substances in fish. Lead concentrations were proportional to loadings and Hg exhibited the greatest biomagnification.

88-27 Jeffries, D.S., J.R.M. Kelso, and I.K. Morrison. Physical, chemical, and biological characteristics of the Turkey Lakes watershed, central Ontario, Canada. Can. J. Fish. Aquat. Sci. 45(Suppl 1): 3-12, 1988.

Summary:
Report summarizes the characteristics of the TLW and compares them to other calibrated basins in North America. It acts as the introductory paper to the TLW Special Volume. Additional information on the rationale for the TLW study may be found in the preceding forward to the Special Volume (i.e. Kelso, J.R.M., CJFAS, 45(Suppl 1): 2, 1988.

C.K. MINNS

LRTAP large-scale risk assessment - progress report

C.K. Minns, J.E. Moore, B. Kilgour.

Acid rain

Regional Modelling: Two MSS describing the DFO-ESSA model have been accepted and are expected to appear in CJFAS Jan 1990. A MS describing the linking of the DFO-ESSA model to a biological damage model is in review with CJFAS. A fourth MS describing a Monte Carlo analysis of key uncertainties in the model is nearing completion. Another MS describing a fish species richness model for Ontario has been accepted by TAFS and will appear in 1990. Recently the DFO-ESSA model has been used to examine the consequences of the US's emission control program. The results will be used by the Royal Society of Canada in an upcoming analysis of the potential of proposed emission controls to protect Canadian freshwater resources. Even with full implementation of the Canadian and proposed US emission controls, large areas are predicted to continue receiving levels of deposition damaging to biota. In Table 1 we have presented estimates of the number of fish species populations lost (compared to original conditions) under a range of emission control scenarios. The models predict that 1980 levels of deposition caused a loss of 244 000 species populations and that 133 000 will remain lost after the completion of emissions reductions envisaged for Canada and the US. We have also continued to provide components and advice for the DOE 1990 Assessment activities which includes regional modelling.

Validation of DFO-ESSA model: We have begun compiling data from lakes where paleoecological diatom (or other biota) reconstructions have been performed. So far, results for a number of lakes in eastern Canada show reasonable agreement on predicted original pH values and excellent agreement on predicted delta pH values (original minus current) (Figure 1). Smol is helping us pinpoint lakes where sufficient data are available. Once a sufficient number of lakes have been examined, these results will be combined with results of validation studies using lake time-series data to prepare a MS describing validation of the DFO-ESSA site model.

Predictions for Biomonitoring lakes: We have compiled a set of predictions for all biomonitoring lakes where we had sufficient input data. While the site model performs less well when predicting current pH (because of (i) the difficulty of aligning lake chemistry and deposition in time, (ii) the lack of inclusion of colour/DOC for some lakes, (iii) the average nature of the alkalinity-pH curve used.), we have good reason (see above) to consider predicted changes in pH under different control scenarios. The results suggest that very few of the biomonitoring lakes will show any chemical response to large changes in sulphur emissions (Table 2). Lakes in the Parry Sound, Muskoka-Haliburton, and La Mauricie areas are predicted to show the greatest response, lakes in Newfoundland and Northwest Ontario the least. As improved and/or expanded data sets become available for the biomonitoring sites, further refined predictions will be prepared. Once biological summaries are prepared, the biological damage model 1 will be used to predict biological responses.

Climate change

Geographic Information System (GIS): We have acquired the SPANS GIS of Tydac Technologies, the main GIS vehicle for DOE. Minns and Moore have taken the basic training course. There is a steep and long learning curve to be followed but it is expected that the system will be immediately applicable to display predictions from the DFO-ESSA regional model of acidification.

Database assembly: We have begun the task of creating a SPANS universe (database) describing the watershed, topographic, and long-term mean climate conditions (mean annual air temp, mean annual precipitation - 30 year mean 1951 - 1980) for eastern Canada. So far, the databases for watersheds and elevation have been completed. We are examining methods of translating point observations of fish species distribution into range maps in order to exploit the presence-absence database already compiled.

Initial modelling: We plan to use a simple model of fish yield vs mean annual air temperature compiled for four commercial fish species as the first application of the GIS-based approach paying special attention to the assessment of uncertainty in predictions.

Contaminants

No progress in 1989-90: No activities have been undertaken in this area since no resources were made available for the activity.

Summary and prospectus

The focus in 1989 has been on consolidation including publication, application, and validation. A number of additional requirements to expand confidence in the DFO-ESSA model have been identified and can only be addressed over an extended period in the future. As the work on climate

change modelling develops and our facility with GIS expand will be able to link the acidification model to a model of climate change and examine the consequences of interactions. Once regional contaminant modelling is undertaken, the three areas of modelling can be joined to provide a basis for regional cumulative impact assessment. We have provided regional representatives with program outlines for the period 1990-1994 along with estimates of the resources needed to support such activities.

Table 1. Numbers of fish species populations potentially lost, by secondary watershed, for all emission control scenarios plus the current condition. The number of lakes in a secondary watershed was multiplied by an average fish species or cyprinid fish species richness per lake (6.3,4.9, and 3.5 for Ontario, Quebec and Maritimes respectively) to estimate the number of species-populations and that number was multiplied by the model-estimated percent loss of potential richness to estimate the number of species-populations lost.

Wshed	1980 Base	Canada 50%	Canada US 2	Canada US 2+5	Canada US 2+10	Zero	Current
East.Canada	244047	192313	182041	158178	132722	51730	191036
Ontario	59867	47897	45170	37680	30591	10428	44367
1/2A	0	0	0	0	0	0	0
1/2B	2049	1790	1515	1153	878	189	1515
1/2C	23716	20865	19850	17012	14353	7595	25361
1/2D	9444	6784	6321	5027	3798	403	9716
1/2E	8393	5896	5547	4430	3342	312	3149
1/2H	4557	3776	3652	3234	2814	772	909
1/2J	2666	1709	1569	1175	821	68	2156
1/2K	7960	6097	5817	4897	3903	766	1429
1/4G	0	0	0	0	0	0	0
1/4J	0	0	0	0	0	0	0
1/4L	361	297	297	244	234	42	42
1/4M	141	116	95	91	70	0	17
1/4N	69	54	19	13	13	0	13
1/5P	512	512	488	402	366	280	61
1/5Q	0	0	0	0	0	0	0
1/5R	0	0	0	0	0	0	0
Quebec	120198	90537	85728	73084	59983	19764	87231
2/2J	2804	1285	1097	825	459	0	3179
2/2K	3337	1849	1645	1155	775	67	1611
2/2L	5451	4070	3746	3111	2390	722	2912
2/2N	7821	5517	5208	4255	3125	627	3557
2/2O	348	225	208	151	125	50	322
2/2P	2597	1904	1798	1482	1157	441	2368
2/2R	6365	4753	4377	3571	2752	653	6240
2/2S	16375	13382	12766	11482	9568	4611	9221
2/2T	16911	13265	12738	11069	8719	2416	16099
2/2U	14001	10545	10158	9157	8123	2665	11837
2/2V	13874	10487	10054	8213	6852	2088	7687
2/2W	12881	10272	9710	8439	7316	2824	8207
2/2X	7352	5733	5423	4702	4124	1650	5124
2/3A	6624	4647	4357	3353	2608	373	4533
2/3B	3457	2602	2441	2118	1890	579	4331
Maritimes	63982	53879	51143	47414	42148	21538	59438
3/1A	6072	5368	5156	4539	3958	2020	4102
3/1B	4830	4118	3957	3399	2808	1352	4772
3/1D	514	411	376	298	223	24	750
3/1E	3970	3254	3106	2550	1945	198	7115
3/1F	377	327	323	293	254	154	705
3/2Y	26836	22575	20710	20244	17980	10988	10122
3/2Z	21382	17826	17515	16092	14981	6801	31873

Scenarios: 1) 1980 Base - the no-control scenario 2) Canada 50% - a 50% proportional reduction at the 13 Canadian sources east of Saskatchewan 3) Canada US 2 - Canada 50% plus a proportional reduction at all 25 US sources totalling 2 million metric tonnes 4) Canada US 2+5 - the same with an additional 5 million tonnes per year reduction distributed among US sources to simulate the first phase of the proposed US control program 5) Canada US 2+10 - the same with a further 5 million tonnes per year reduction to simulate the second phase 6) Zero - emissions all at 40 North American sources reduced to zero.

Table 2. Steady state pH values for 33 lakes under different SO_4 deposition scenarios: 1) SO_4 deposition same as 1980 levels; 2) SO_4 emissions reduced in Canada by 42%; 3) SO_4 emissions reduced in Canada and the U.S. by 42%; 4) SO_4 emissions increased by 10%; and 5) SO_4 emissions reduced to nil.

Lake	Actual pH	Scenario				
		1	2	3	4	5
Quebec						
Eclair	6.33	5.96	6.18	6.26	6.02	6.54
Francine	6.03	6.27	6.38	6.43	6.30	6.62
Hamel	5.21	6.19	6.30	6.35	6.22	6.56
Theode	6.02	6.44	6.51	6.54	6.46	6.67
Newfoundland						
Lake 608	5.50	6.13	6.15	6.16	6.13	6.23
Spruce Pond	6.30	6.90	6.90	6.90	6.90	6.90
Lake 206	5.80	6.28	6.31	6.32	6.29	6.40
Ontario						
Orange	6.95	7.13	7.13	7.14	7.13	7.14
Crow	6.18	6.59	6.64	6.67	6.57	6.76
K7	4.49	4.00	4.01	4.17	4.00	6.12
Raven	4.76	4.00	4.09	4.28	4.00	6.22
Carruthers	5.91	6.14	6.14	6.14	6.14	6.13
Lady	5.21	4.38	4.88	5.64	4.29	6.47
Pender	6.30	6.20	6.37	6.47	6.13	6.66
Cochrane	6.62	6.77	6.79	6.80	6.76	6.83
Lane	6.09	5.35	6.02	6.23	5.02	6.58
Batchawana Lake North	6.00	6.41	6.44	6.48	6.39	6.61
Batchawana Lake South	6.10	6.47	6.49	6.53	6.45	6.64
Wishart	6.70	6.76	6.76	6.77	6.75	6.80
Little Turkey	6.60	6.86	6.87	6.87	6.86	6.87
Turkey	6.70	6.94	6.94	6.94	6.94	6.94
Blue Chalk	-------	6.40	6.51	6.56	6.35	6.71
Crosson	-------	4.81	5.77	6.12	4.61	6.57
Harp	-------	6.46	6.54	6.58	6.43	6.71
Plastic	5.80	4.58	5.37	5.94	4.44	6.52
Lake 111	-------	6.70	6.70	6.71	6.70	6.71
Lake 224	-------	6.67	6.68	6.68	6.67	6.71
Lake 262	-------	6.85	6.86	6.86	6.85	6.85
Lake 373	-------	6.93	6.93	6.93	6.93	6.92
Nova Scotia						
Big Dam West	-------	5.95	5.99	6.01	5.96	6.07
Big Dam East	-------	5.97	6.02	6.06	5.98	6.14
Coblielle	-------	5.19	5.36	5.49	5.24	5.76

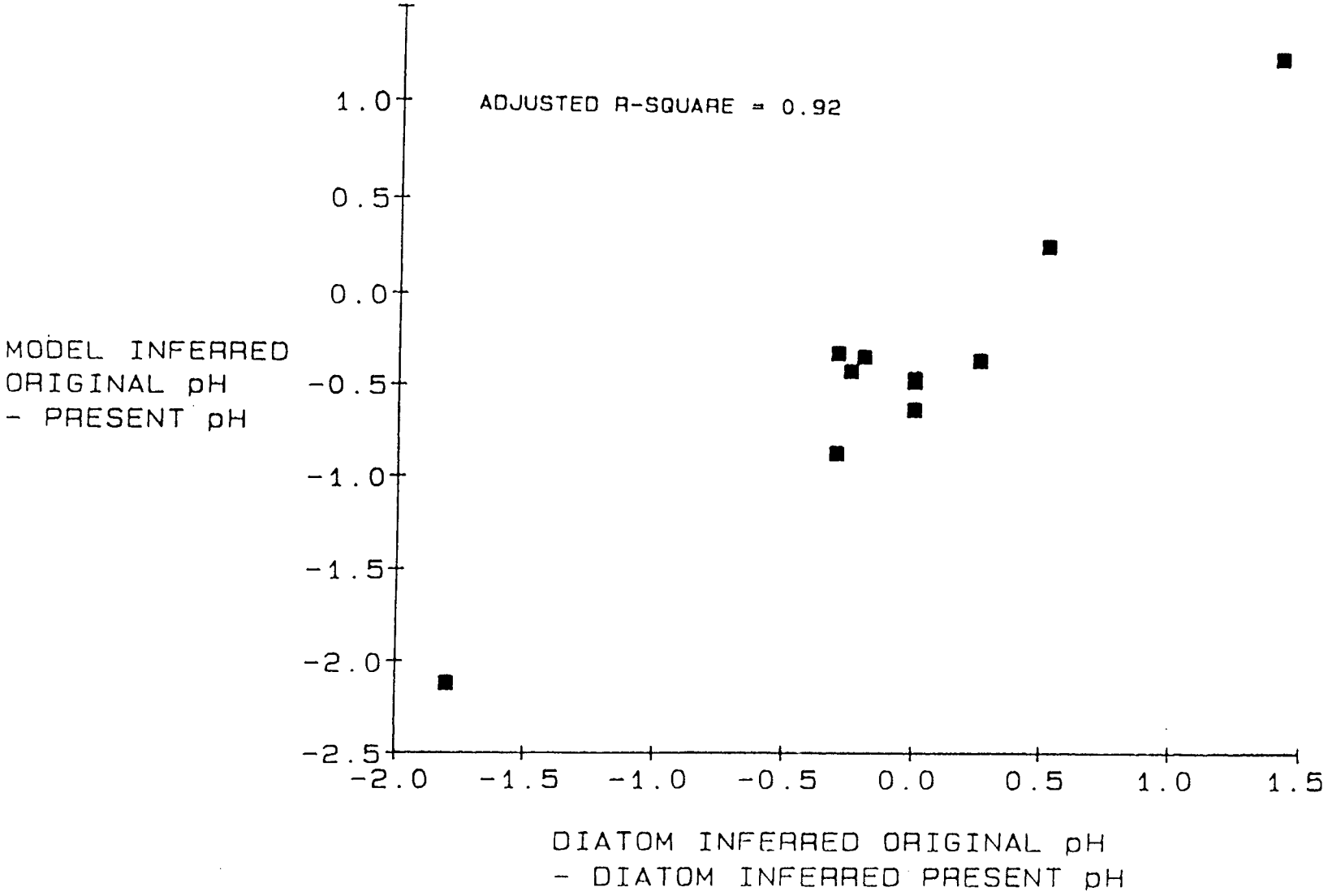


Figure 1. Relationship between diatom inferred original pH - diatom inferred present pH, and model inferred original pH - present pH, for 11 lakes in eastern Canada.

CADMIUM WHOLE LAKE EXPERIMENT AT THE EXPERIMENTAL LAKES AREA: SECOND AND THIRD YEARS

Freshwater Institute, Central and Arctic Region, DFO.

Prepared for the DFO Workshop on Long Range Transport of Atmospheric Pollutants, 26-28 September 1989, Maurice Lamontagne Institute, Mont-Joli, Québec by D.F. Malley, J.F. Klaverkamp, S.B. Brown, P.S.S. Chang, E.R. DeBruyn, R. Evans, D. Findlay,
S. Harrison, M. Holoka, R.V. Hunt, S.G. Lawrence, D. Majewski, H. Majewski, R. McNicol, E. Scherer and L. Wesson.

Introduction

Cadmium is released to the environment from anthropogenic activities in amounts which may equal or exceed those of natural sources. The environmental concentrations of Cd in a number of Canadian lakes are approaching the Canadian Water Quality Guideline (CWQG) of 200 ng Cd/L. There is concern that in very soft waters found in those parts of Canada having metal smelters, this concentration is likely too high to protect aquatic life.

A whole lake experimental addition of Cd to Lake 382 in the Experimental Lakes Area on the Precambrian Shield in northwestern Ontario was described by Malley and Brown (1989). This experiment began in 1987 to test the effects of [Cd] below and gradually increasing over a few years to the CWQG of 200 ng/L. Cadmium, together with its radiotracer, ^{109}Cd, is being added to observe its fate, distribution, accumulation, routes of uptake and effects on a whole lake ecosystem. A further goal is the development and validation of early warning biochemical, histological, physiological or behavioural indicators of impending ecosystem damage which can be employed to identify stressed aquatic ecosystems.

The Lake 382 experiment and associated laboratory studies are being conducted primarily by staff of the Fish Habitat Research and Contaminants and Toxicology Research Divisions of Canada's Department of Fisheries and Oceans Freshwater Institute.

Method

Starting on 23 June 1987 and continuing until fall turnover, Cd and ^{109}Cd were added twice a week to the epilimnion of 37 ha Lake 382. A total of 900 g Cd and 89 mCi ^{109}Cd were added in 1987. During 1988, the epilimnetic additions were continuous over the ice-free season, amounting to 640 g Cd and 62 mCi ^{109}Cd. Target water concentration during these years was 100 ng/L Cd or 50% of the CWQG. During 1989, beginning on 31 May, Cd and ^{109}Cd are being added by continuous addition. The target concentration is 120 ng/L Cd.

Results

Water Chemistry

Prior to the Cd additions in 1987, the background [Cd] in the epilimnion was about 1.6 ng/L. As previously reported, the [Cd] in the epilimnetic water of Lake 382 in the ice-free season averaged 83 ng/L in 1987 and 51 ng/L in 1988. By 14 June 1989, the additions increased the epilimnetic [Cd] to 110 ng/L and it averaged about 100 to 105 ng/L between then and early September.

Phytoplankton and Primary Production

There was a noticable decline in the abundance of phytoplankton (cells/L) in the epilimnion in the spring and summer of 1989 compared with 1988. The fall biomass appeared to be about the same in the two years possibly due to fall mixing and entrainment of the metalimnetic phytoplankton populations. The epilimnetic species composition shifted from chrysophyte dominance to a co-dominance of cyanophytes, chlorophytes and chrysophytes. More detailed comparison with reference lakes in 1989 is required to judge whether this is an effect due to Cd or to year-to-year variability.

Over 1987, 1988 and 1989 there has been approximately a 43% increase in annual mean epilimnetic chlorophyll *a* concentration as compared to the four years from 1983 through 1986. Both production per unit biomass and photosynthetic efficiency (alpha) annual means showed declines from 1987 through 1989. Overall, areal production rates for Lake 382 showed a significant increase in late 1988 and it appears that there was a similar but smaller trend in late 1989. Reference lake basins did not show these trends over the same period.

From 1987 through 1989 reference lake basins showed a small general increase in light transparency. The light transparency of Lake 382, on the other hand, remained relatively constant from 1987 through 1989 despite the near doubling in chlorophyll concentrations from 1987 to 1988 and a 31% increase in areal primary production. Analysis of the 1989 data is expected to provide more information on whether Lake 382 continues to deviate from reference lake basins, which may be an indication of effect of Cd.

Zooplankton

Zooplankton were sampled biweekly during the ice-free season in the three thermal layers. Most zooplankton species in Lake 382 tolerated the [Cd] in Lake 382 in 1987 and 1988 with no adverse effects on population sizes or reproductive capacity. However, the contribution of some cladoceran species to the total zooplankton abundance was somewhat lower in 1987 and 1988 than before the Cd addition in 1985 and 1986. Also the proportions of the cladoceran, *Daphnia galeata mendotae* and of cladoceran eggs in the epilimnion compared with that in the entire water column were less in 1987 and 1988 than in 1985 and 1986. These may be early indications of adverse

and 1988 than in 1985 and 1986. These may be early indications of adverse effects of Cd on cladocerans. For measurement of ^{109}Cd in the plankton, 200 L of lake water from each of the three thermal layers were filtered through 54 um and then through 20 um mesh. In 1988, as had been reported in 1987, the cpm of ^{109}Cd in the >54 um fraction were consistently highest in the plankton from the metalimnion until the fall, when the counts from the plankton in the epilimnion were higher. This probably indicates migration of organisms between the metalimnion and the epilimnion since little of the ^{109}Cd is in the water of the metalimnion until turnover. The ^{109}Cd activity in the plankton of the hypolimnion was low during most of the 1987 sampling season, but showed a slight rise in the fall prior to turnover. This was apparently due to settling of seston.

Zooplankton were exposed experimentally to several concentrations of Cd and of dissolved organic carbon (DOC) in a continuous-flow impoundment system in Lake 382 prior to the 1987 Cd additions and in Lake 240 thereafter. Holopedium gibberum was virtually eliminated at 400 ng/L Cd and was reduced in abundance by about 30% in 200 ng/L Cd. Abundance of Daphnia galeata mendotae was 22% and 61% of the controls (impoundment vessels without added Cd) at 400 and 200 ng/L Cd, respectively. There was evidence that [DOC] of greater than 500 u mol/L counteracted some of the toxic effects of Cd.

Benthos

Exposure of the floater mussel, Anodonta grandis grandis, in the laboratory during January 1988 to Cd concentrations ranging from nominal 0 to 50000 ng/L for 22 days showed that these organisms produce metallothionein (MTN). Concentrations of this metal-binding protein, which may reflect the onset of acclimation to Cd toxicity, increased with increase in external [Cd] in the mantle, gill and visceral mass but did not increase in the foot. Although MTN concentrations increased in the kidney, the increases were not statistically significant due to the high variability. Gills of mussels collected from Lake 382 in September 1988 contained 37.8 ug/g wet weight of MTN compared with 11.4 ug/g in gills of mussels from reference Lake 377. Thus, this species responds to elevated [Cd] by the production of MTN. In July 1988, Anodonta were exposed in the laboratory to lake water enriched with particles >10 um or to water from which the particles had been removed, both containing the same [^{109}Cd], to compare rates of uptake of Cd. Unexpectedly, the mussels in the particle-free (food-free) water accumulated ^{109}Cd at a faster rate than the mussels in the water containing food. This was presumably due to increased ventilation (feeding) effort by the mussels in the particle-free water. Although uptake from food vs water was not quantified it is evident that the uptake of Cd directly from the water is a very important route in mussels.

Macrophytes

Monitoring of accumulation of ^{109}Cd by macrophytes continued in 1989 with similar results as in the previous two years. Accumulation of ^{109}Cd was

highest in water lily, Potamogeton and Myriophyllum. In July, total live biomass of about 15 species of macrophytes in Lake 382 was measured by Margo Shaw, DFO, Sault Ste. Marie Laboratory, in order to estimate the proportion of ^{109}Cd added to Lake 382 which is tied up in each macrophyte species.

Fish

The effects of Cd in fish are being monitored in species from several trophic levels and at four levels of biological organization:

a. tissue uptake and distribution of Cd;
b. biochemical and histological responses;
c. whole animal behavioural responses;
d. population effects.

In 1988, [^{109}Cd] in whole white sucker, Catostomus commersoni, remained approximately at 1987 levels, whereas [^{109}Cd] in lake trout, Salvelinus namaycush, increased over the 1987/88 winter and in the summer of 1988 exceeded that in sucker. [^{109}Cd] in gill of both species increased over the 1987/88 winter, then decreased through 1988, probably due to the lower ambient levels in 1988. [^{109}Cd] in the liver of both species remained constant over the 1987/88 winter and remained constant in white sucker over 1988. In the liver of lake trout, [^{109}Cd] rose by 4 to 5 times in 1988. The [^{109}Cd] in liver in 1988 were 4 times higher than background for trout and 7 times higher than background for white sucker. The highest [^{109}Cd] in any tissue was measured in the posterior kidney. [^{109}Cd] in the posterior kidney rose in both sucker and trout over the winter. These increases were accompanied by increased kidney [MTN] in both species. In 1988, [^{109}Cd] in trout kidney surpassed [^{109}Cd] in sucker kidney. These 1988 [^{109}Cd] in kidney were 3 times background for trout and 4 times background for sucker. ^{109}Cd did not accumulate in muscle. [^{109}Cd] in fathead minnows and pearl dace over the 1987/88 winter remained approximately at late 1987 levels. [^{109}Cd] decreased in both species during 1988 probably because of the lower ambient levels. Concentrations of MTN in liver from both of these littoral-zone fish species were considerably elevated, however, in relation to [MTN] found in these species from two reference lakes. Feeding experiments with Cd-contaminated amphipods, Hyalella azteca, and Cd-spiked trout food, showed that rainbow trout fingerlings accumulate Cd from the live food at a faster rate than from trout pellets. These data will be useful in modelling uptake of Cd by fish in Lake 382.

Three histological parameters, oocyte differential counts, oocyte size profiles and gonado-somatic indices (GSI), were determined for lake trout ovaries from Lake 382 and reference Lake 468 for 1987 and 1988. Whereas these parameters in fish were very similar between lakes in 1987, and between years for Lake 468, in 1988 there were differences between Lakes 382 and 468. In June, 1988, the vitellogenic or yolk-sequestering oocytes were 30% smaller in size in the Lake 382 fish compared with those from Lake 468. In September, 1988, these oocytes were 40% smaller in size and comprised 18% of the total oocytes in the ovary of Lake 382 fish compared with 33% of the

total in the Lake 468 fish. Also in September, 1988, the mean GSI for 7 female trout form Lake 382 was 3% compared with 16% in the Lake 468 females. Although these results are consistent with anticipated effects of Cd on fish ovaries, other explanations such as sampling bias and natural variability in, e.g. food supply, have not been ruled out.

Plasma thyroid hormones (T3 and T4) and thyroid epithelial cell height (TECH) were measured along with growth rate and gonad development in lake trout from Lake 468 and Lake 382. In fish from each lake, plasma T3 concentrations exceeded those of plasma T4. The indices of the thyroid function showed pronounced changes during the ice-free season only in fish from Lake 468. Fish from Lake 468 grew rapidly and had T3 concentrations and TECH which varied little during the ice-free season. Elevated T3 and TECH appeared to be associated with active somatic growth and subsequent normal gonad development, whereas reduced plasma T3 and TECH appeared to be associated with slow growth and subsequent poor gonad development.

Initial decreases in glycogen content of liver from lake trout in Lake 382 were followed by a rebounding overproduction of this energy reserve. These initial responses correlated with decreased protein concentration and increased sodium concentration in muscle. These observations are consistent with Cd-induced starvation in these trout. The rebound in liver glycogen concentrations likely protects muscle protein reserves and serves as the principal source of glucose in blood.

Preference-avoidance testing of lake whitefish (Coregonus clupeaformis) to Cd was continued in the laboratory using a computerized method for data acquisition and analysis. A total of 27 response parameters were computed on the behavioural responses of these fish to [Cd] ranging from 200 to 256000 ng/L. While most fish showed avoidance of Cd at most concentrations tested, a significant number of fish displayed a preference for Cd, i.e. they spent time on the Cd-dosed side of the trough. However, when the magnitude of the response and not the direction was considered, a bimodal dose-response relationship was evident. The fish responded strongly to [Cd] <1000 ng/L and >8000 ng/L but showed little reaction to concentrations in between. Thus, lake whitefish detect and avoid water containing [Cd] as low as 200 ng/L, the CWQG.

Lake trout exposed in the laboratory for 12 weeks to [Cd] of 1000, 2000 and 6500 ng/L had [MTN] in kidney, gill and liver above those in control fish. There appeared to be a positive correlation between liver [MTN] and blood osmolality in these fish.

Analysis of gut contents from Lake 382 lake trout so far indicates that these fish rely more heavily on invertebrates as food than do lake trout from reference Lakes 468 and 305. This could mean that the trout in Lake 382 are more susceptible to Cd stress than those in the other lakes, if the Cd reduces populations of their invertebrate prey.

PUBLICATIONS AND ABSTRACTS REPORTING ON THE WHOLE LAKE CD EXPERIMENT AND ASSOCIATED CD WORK

Primary Publications:

Harrison, S.E. and J.F. Klaverkamp. 1989. Uptake, elimination and tissue distribution of dietary and aqueous cadmium by rainbow trout (Salmo gairdneri Richardson) and lake whitefish (Coregonus clupeaformis Mitchell). Environ. Toxicol. Chemistry 8:87-97.

Lawrence, S.G. and M.H. Holoka. Response of crustacean zooplankton impounded in situ to cadmium at low environmental concentrations. Verh. Internat. Verein. Limnol. 24 (in press).

Lawrence, S.G., M.H. Holoka and R.D. Hamilton. Effects of cadmium on a microbial food chain, Chlamydomonas reinhardii and Tetrahymena vorax. Sci. Total Environ. (in press).

Malley, D.F. and P.S.S. Chang. Response of the zooplankton community of a Precambrian Shield lake to the experimental addition of cadmium. Verh. Internat. Verein. Limnol. 24 (in press).

Malley, D.F., P.S.S. Chang and R.H. Hesslein. Whole-lake addition of ^{109}Cd: Radiotracer accumulation in the mussel population in the first season. Sci. Tot. Environ. (in press)

Technical Reports:

Scherer, E., R.V. Hunt and R.E. McNicol. 1989. Computerized preference-avoidance quantification and analysis: A rapid, high-resolution method. Can. Tech. Rep. Fish. Aquat. Sci. 1672:iv + 9p.

Unpublished Reports:

Malley, D.F. and S.Brown. 1989. Cadmium whole lake experiment at the Experimental Lakes Area, northwestern Ontario. pp 49-52.

In Canada. Department of Fisheries and Oceans. Report of the Department of Fisheries and Oceans LRTAP Workshop, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, 15-17 November 1988. (Unpublished report available from D.C. Gordon, Bedford Institute of Oceanography).

Abstracts:

Brown, S.B., R.E. Evans, K.H. Mills and T.J. Hara. Thyroid activity, gonad development and growth rates in two populations of lake char. Abstract of paper presented at the First International Symposium on Fish Endocrinology, June 12-17, 1988, Edmonton.

Chang, P.S.S., D.F. Malley and J.F. Klaverkamp. Metallothionein in mussels Anodonta grandis exposed to cadmium in the laboratory.

Abstract prepared for the 16th Annual Aquatic Toxicity Workshop, 6-8 November 1989, Winnipeg.

Holoka, M.H. and S.G. Lawrence. Accumulation by plankton of cadmium added to a Precambrian Shield lake. Abstract prepared for the 16th Annual Aquatic Toxicity Workshop, 6-8 November 1989, Winnipeg.

Malley, D.F., D. Huebert and R.V. Hunt. Accumulation of ^{109}Cd by submerged and emergent macrophytes in a lake subject to experimental addition of cadmium and its radiotracer. Abstract prepared for the 16th Annual Aquatic Toxicity Workshop, 6-8 November 1989, Winnipeg.

Malley, D.F. and S.G. Lawrence. In situ impoundments as tools in whole-lake ecotoxicology. Abstract of paper presented at the meeting of the American Society of Limnology and Oceanography in conjunction with the Society of Canadian Limnologists at the University of Alaska-Fairbanks, June 18-22, 1989.

McNicol, R.E. and E. Scherer. Preference-avoidance responses of lake whitefish (Coregonus clupeaformis) to cadmium solutions. Abstract prepared for the Society of Environmental Toxicology and Chemistry 10th Annual Meeting, 28 October - 2 November 1989, Toronto.

Stephenson, M. and M.A. Turner. Cadmium dynamics in epilithic periphyton and a grazer, Hyalella azteca (Amphipoda). Abstract of poster presented at the meeting of the American Society of Limnology and Oceanography in conjunction with the Society of Canadian Limnologists at the University of Alaska - Fairbanks, June 18-22, 1989.

1.2 Région du Pacifique/Pacific Region
(pas de conférencier, mais un document écrit/no speaker but a paper)

Pacific Region's activities during the year were limited to pursuing the two LRTAP-funded projects, meeting attendance, and a review of the planning documents for LRTAP V. The project to determine sensitivity of B.C. streams to acidification has been completed, and bioassays to determine the effects of pH on blood chemistry of two west coast salmon stocks will shortly be written up.

LRTAP input of trace organics

After reviewing the literature it was decided to concentrate organochlorine compounds on small volumes of Tenax. The material so concentrated will be thermally desorbed directly onto a gas chromatography column held at -50 C; quantification will normally be by electron capture detector. Positive identification of peaks will be done through the use of GC/MS and by

collecting duplicate samples which will be run on different columns. This method was chosen because it is possible to do with the equipment available and because relatively low sample volume is required. Development of the analytical method suffered some delays but standards are being run at the present time.

An automated organic precipitation collector has been leased for rain collection. It has been adapted to match the concentrator columns and it is expected that it will be tested soon.

It is expected that routine rain collection will commence in the near future and that snow collection will go as planned in the spring.

Pacific region habitat management division acid rain program

Background: Between 1981 and 1986 the Pacific Region Habitat Management Division (HMD) conducted water chemistry surveys in selected salmon streams in B.C. and the Yukon to assess sensitivity to acidification (see Technical Reports 1388, 1389 and 1599). Many coastal streams exhibited low buffering capacity and low pH and a more limited number of interior streams were identified as sensitive to acidification.

In 1987, DOE studies showed that episodic pH depression exceeded one pH unit in a Lower Mainland salmon stream during storm events (Kanaka Creek, Whitfield and Dalley 1987). In another study by DOE, a statistically significant pH depression in Vancouver's drinking water (Capilano, Seymour and Coquitlam rivers) was documented over a 26-year period beginning in 1959 (Whitfield 1987). Provincial data indicated that wet sulphate depositions on the B.C. Lower Mainland exceeded 20 Kg/ha/yr and average rainfall pH was 4.7.

Pilot fish impact studies were initiated by HMD in 1987/88, with the focus on Lower Mainland streams. The HMD project was conducted in cooperation with Science (Freshwater Institute, FWI), SEP staff and DOE. Micro-techniques for blood and tissue sampling used by Jack Klaverkamp (FWI) were adapted for use with underyearling coho fry.

In 1988/89, coho blood chemistry and stream water sampling were conducted at the Kanaka Creek hatchery (lower Fraser River tributary) over a series of storm episodes in conjunction with a laboratory acidification experiment at Simon Fraser University managed by Dr. Brian McKeown. Coho blood from both experiments were analyzed by FWI staff. In the field (hatchery) study and the laboratory (SFU) simulation of episodic pH change, the following parameters were analyzed in coho blood: osmolality, sodium, chloride, potassium, calcium, glucose and serum protein. (Data from the field experiment has not yet been interpreted.)

The laboratory bioassays are detailed below:

1. Single pH reduction: Exposure: Four days
   Treatments: Control (pH 6.5);
   pH 5.5;
   pH 5.0;
   pH 4.5.

Coho blood sampling on Day o; Day 1; Day 2 and Day 4. Two distinct fish stocks were used: Capilano and Kanaka.

2. Stepwise pH reduction: Exposure: One day at each pH
   Treatments: Day 1: Starting pH 6.5;
   Day 2: pH reduced to 5.5;
   Day 3: pH reduced to 5.0;
   Day 4: pH reduced to 4.5.

Coho blood was sampled daily. Two distinct fish stocks were used: Capilano and Kanaka.

In discussions with FWI staff, the following trends in the data have been noted.

1. The Capilano coho exhibited a "typical" response to acid exposure. Blood ions and glucose were apparently altered by pH change.

2. Kanaka fish appeared to respond differently than Capilano fish to the same acid exposures. Blood glucose changed, blood ions did not.

The Capilano River Hatchery is lake fed, whereas Kanaka Creek is not. The Capilano River pH is usually near 6.4 with alkalinity between 2 and 3 mg/L. Kanaka Creek water has a pH taht fluctuates more widely, often between 6.2 and 7.0, with alkalinity commonly varying between 3 and 9 mg/L.

Références

Sullivan, M.A., S.C. Samis, J.A. Servizi and R.W. Gordon. 1985. Survey of selected British Columbia and Yukon salmon streams for sensitivity to acidification from precipitation. Ca. Tech. Rep. Fish. Aquat. Sci. 1388: ix + 105 p.

Servizi, J.A., R.W. gordon, S.C. Samis, L.G. Pella, M.A. Sullivan and M.D. Nassichuk. 1985. Survey of selected streams for sensitivity to acidification from the proposed Hat Creek coal development. Can. Tech. Rep. Fish. Aquat. Sci. 1389: vi + 76 p.

Sullivan, M.A. and S.C. Samis. 1988. Assessment of the acidification potential of selected Lower Mainland and Vancouver Island, British Columbia streams. Can. Tech. Rep. Fish. Aquat. Sci. 1599: vii + 113 p.

Whitfield, P. and N. Dalley. 1987. Rainfall driven pH depressions in a British Columbia coastal stream. In: Monitoring, Modeling and Mediating Water Quality. S.J. Nix (ed.). American Water Res. Assoc. Bethesda, Md.

Whitfield, P. 1987. Spectral analysis of long-term water quality records. In: Developments in Water Science 27: Statistical Aspects of Water Quality Monitoring. Eds: El-Shaarawi, A. and R. Kwiatkowski.

1.3 Région de Scotia-Fundy/Scotia-Fundy Region

GILLES LACROIX

LRTAP Project review - 1989/90

A number of separate projects were continued or completed in 1989/90. These included a demonstration liming study started in 1986, ecological studies of salmon populations and of fish distribution in relation to pH and other factors, and toxicological and physiological studies of salmonids in situ in acidic rivers and in controlled laboratory conditions. Research related to deposition of organic contaminants and accumulation in the marine environment recently started was also continued. A brief summary of recent activities conducted under each major project funded in 1989-90 follows. Biomonitoring initiated in the region is reviewed under the National Biomonitoring Program.

1. Mitigation of acidification impacts on Atlantic salmon in Nova Scotia (Watt)

   Liming and biological and chemical monitoring of the demonstration deacidified refuge initiated in 1986 for the preservation of the Atlantic salmon run in the East Branch of East River, Nova Scotia, was continued. The objective is genetic salvage; to demonstrate the practicality (technical, social, and bureaucratic) of preserving a native wild Atlantic salmon stock within a deacidified refuge. As in previous years, approximately 400 tonnes of powdered calcite limestone was spread over the ice of four headwater lakes on the East Branch. The mean annual pH of the stream has risen from a preliming level of 5.3 to about 6.6 at present. Salmon fry densities in the East Branch have increased since first liming and again in 1989 which is presumed to be the progeny of 1986 parr. The distribution and densities of brook trout and American eel have not changed significantly with liming. Lake chub, white sucker, and banded killifish densities have also not changed significantly, but the species have increased their range.

The starch-gel electrophoresis study of Nova Scotia Atlantic salmon parr tissues from Atlantic coast rivers threatened by acid rain was also continued (PDF, Steele). Electrophoretic analysis of fish from 22 rivers identified 10 polymorphic enzymes in juvenile salmon, and some between river genetic variation is apparent. There appears to be separate populations of Atlantic salmon within the study area, but inter-year variation has also been observed and may reduce the statistical significance of the findings.

2. Biomonitoring and toxicological study on Atlantic salmon (Uthe)

The investigation of materials effective as counter agents for all observed pathological effects of acid rain on adult Atlantic salmon, particularly those observed in limed acidic water, was continued. These effects include poor growth, non-synchronicity of spawning readiness, increased egg mortality, severe stress, abnormal hormone metabolism, vertebral fragility, and abnormal thyroxine levels. The effects of liming Westfield River water were investigated in 1986, and those of calcium disodium ethylenediamine tetraacetate (EDTA) by itself were examined in 1987 and 1988. In 1989, an experiment is being conducted combining liming and EDTA (chelation and pH adjustment) to treat the Westfield River water. The condition of the post-spawned fish from the various holding conditions will be investigated as in previous years. EDTA has shown itself to be partially effective at low dosage (10^{-6} M) in preventing or delaying many acidic water-induced deleterious effects without affecting the pH of the acidic water.

3. Impacts of acid rain on salmonid ecology (Lacroix)

Studies of the ecological and physiological responses of salmonids and other fish to toxic factors in acidified rivers of Scotia-Fundy and to temporal changes in water chemistry were continued. An examination of the morphology and histology of the gills of salmon parr and brook trout from feral populations in acidic rivers of Nova Scotia was completed and revealed none of the chronic effects of Al at low pH. An experiment was completed to determine the toxicological and physiological responses of salmon parr and smolts, and of brook trout during spring flow episodes in a small acidic brook and in sections downstream of limestone gravel bars. To further depict the responses of salmonids to acid stress, a field experiment was initiated where blood gas and blood pH analyses will be used in addition to other parameters during in situ exposures to chronic and acute levels of acidity. This will further differentiate between respiratory effects and ionoregulatory effects, and separate more definitely between effects of Al at low pH and those of low pH alone.

The long-term measurements of densities of juvenile salmon and of other fish communities in a range of acidic streams was continued in Nova Scotia to provide an evaluation of responses to temporal changes in water chemistry. A spring and fall survey of chemical conditions in the salmon

rivers of New Brunswick which drain in the Bay of Fundy was also initiated to assess the potential for acidification effects in those rivers. The study of salmon and brook trout densities in relation to a pH gradient established by limestone application on gravel bars in a small brook in Nova Scotia was continued, and the movements and microhabitat preference of these fish were also documented. The evaluation of the importance of the limestone gravel bars as spawning substrate for wild Atlantic salmon was continued. The chemical evaluation of the effects of this application of limestone gravel in riffle areas of a small brook, including its effects on the speciation of Al, was also continued.

4. Effects of low pH on early development of Atlantic salmon (Peterson)

Studies on the influence of organic acids on Al accumulation by salmon alevins and on Al toxicity were continued. Accumulation of Al on salmon fry gills was investigated in relation to the concentrations of organic acid (citric acid was used as a surrogate organic acid). The model developed by Peterson et al. (Water Air Soil Pollut., in press) was used to determine the relative amount of Al and A^- (organic anions) in the experiments. In a first experiment, Al minus A^- values of +10,0 and -10 were used. The time course of Al accumulation on gills, and of pathological changes in gill histology are being investigated. In a second experiment, the gills were "loaded" with Al for 15 d, and the influence of organic ions in clearing Al from the gills are being investigated.

5. Invertebrate and fish distribution as affected by pH (Peterson)

As a follow up to the benthic invertebrate distribution study conducted in previous years, riffle habitat was electrofished at 56 sites in 3 stream systems (St. Croix River, N.B., and Medway and Gold rivers, N.S.), and multivariate analyses are being performed on the data. Twinspan cluster analysis indicated 8 distinct fish species assemblage clusters: 1) sites with no fish present - intermittent rivulets; 2) brook trout only streams - cold brooks with sites from all 3 stream systems; 3) sites with a brook trout/eel assemblage - slightly larger streams than in cluster 2, these were all acid sites, as blacknose dace also occupied these sites in the St. Croix system; 4) a diverse assemblage featuring salmon and eels - these were mostly large streams; 5) a salmon, eel, and fallfish assemblage - large river sites in the St. Croix system; 6) trout/eel/salmon/blacknose dace - larger brooks in the St. Croix system; 7) eel only - mostly larger streams in the Medway system; 8) a diverse cyprinid assemblage - larger brooks and small streams in the St. Croix system. The main difference between the St. Croix (circumneutral) and the two acidic N.S. systems was in the distribution of cyprinids - a consequence of interaction between zoogeographic and acidity factors.

6. Long range atmospheric transport of organic contaminants and trace metals to Canadian Atlantic and eastern Arctic marine systems (Addison, Harding, Yeats, Hargrave)

Identification of organochlorine (OC) contaminants present in the atmosphere of Canadian Atlantic marine areas was approached by sampling and analyzing air and rainfall ("washout" from the atmosphere). Air sampled at Sable Is. contained hexachlorobenzene (HCB), hexachlorocyclohexanes (HCH), some polychlorinated biphenyl (PCB) components, members of the DDT-group of insecticides and their metabolites, and occasionally chlordane and toxaphene components. The HCB, HCH, PCB, and DDT components are part of the "background" contamination throughout the northern hemisphere, but chlordane and toxaphene components could be traced back to the southwestern U.S. Rainfall sampled at a site in the southern Gulf of St. Lawrence produced similar results. HCH was the most common OC in rainfall and PCB and DDT components were obseved occasionally.

The fluxes of OCs from the atmosphere to the marine environment were examined by sampling rainfall year-round in the southern Gulf of St. Lawrence. HCH, the main OC in rainfall remained fairly constant at 6 ng/L with no seasonal variation in concentration, and it reflects the northern hemisphere "background" contamination. DDT-group and PCB components were detected occasionally. Samples of St. Lawrence River water at intervals downstream of Québec City contained HCH (1-2 ng/L) as the major OC component, with traces of DDT and PCB. HCH input to the Gulf was calculated to be about 10^{e} g/yr by rainfall and about 0.8 x 10^{e} g/yr from river flow. Input from atmospheric sources accounts for about half of the HCH, and OC in general, which enters the Gulf of St. Lawrence. Similar analyses of metal contaminants in rainfall and river water showed that riverine input accounts for most of the metal supply to the Gulf of St. Lawrence, and rainfall input is small. The possibility of a correlation between OC concentrations in phytoplankton from the southern Gulf of St. Lawrence and OC fluxes via rainfall in the area was examined. Results to date have shown that PCB concentrations in rainfall have fallen by about 10 to 100-fold between the mid 1970's and the late 1980's, and that there is a concomitant 100 to 1000-fold decrease in PCB concentrations in small phytoplankton over that period. This reflects the limitations on PCB use imposed in the early 1970's in most western countries.

Work was also continued to provide information about the seasonal variation of OC transport into the Arctic Ocean ecosystem. This includes attention to both atmospheric vapour and particulate phase transport, water transport, and accumulation in benthic amphipods. The high lipid content of lysianassid species makes them useful for monitoring year-to-year variations in OC concentrations. The comparison of atmospheric deposition in Arctic areas with fall-out in other marine areas is meant to provide a perspective on the relative magnitude of the introduction of atmospherically transported contaminants to the Arctic. HCH, HCB, several cyclodienes, compounds of the DDT group, toxaphene, and PCBs have been

detected in all samples from air over the Arctic Ocean, from snow on the ice cap, in water, and in planktonic and benthic crustaceans at the Canadian Ice Island in 1986, 1987, and 1988. OCs were transferred to the ocean, accumulated, and concentrated in zooplankton and benthic amphipods during the summer melt. Additional samples were collected in September 1989 when "Arctic haze" effects are expected to be minimal and OCs, in the vapour phase and adsorbed to atmospheric particles, should be at minimum seasonal concentrations.

7. Paleoecological reconstruction of the historical long range atmospheric transport of contaminants into Atlantic Canada (Keizer)

The paleoecological study was to obtain calibrated pH records for a number of remote lakes in Scotia-Fundy and to calculate atmospheric deposition rates for organic contaminant inputs to the same lakes. A scoping exercise in 1988/89 indicated that there were major difficulties associated with definitive dating of sediments in cores from 3 lakes in Kejimkujik National Park because of bioturbation. Sampling of additional lakes in New Brunswick and Nova Scotia, dating, pH reconstruction, and analysis of core sections for polycyclic aromatic hydrocarbons and organochlorines was planned for 1989/90. This work, to be done primarily by Aquatic Research Limited as part of an unsolicited proposal, had to be mostly cancelled because of non-renewal of the UP. Only a small portion of the planned study was, therefore, carried out. Cores from a number of lakes in southern New Brunswick were collected, some have been dated, and the remainder of analyses will be completed over the next year. However, the diatom fossil analyses and pH reconstruction will not be done because of lack of available expertise in house.

1.4 Région de Terre-Neuve/Newfoundland Region

LARRY COADY

Report to the 1989 DFO Workshop on Long-Range Transport of Airborne Pollutants (LRTAP)

Contributors:

L.W. Coady, P.M. Ryan, J.F. Payne, J.W. Kiceniuk.

There were six LRTAP projects undertaken by Newfoundland Region researchers in 1989:

1. Biological monitoring for LRTAP effects (Ryan)

In 1988, monitoring was discontinued in the Experimental Ponds Area and limited to two sites, Grandy Brook and Isle aux Morts River. During the

1988 LRTAP Workshop it was recommended that the Region give special attention to establishing a minimum of three biomonitoring sites. It was also recognized that the Isle aux Morts site would need to be discontinued due to mining and development in the area. The biomonitoring project was reviewed in December 1988 and it was agreed investigations should take place at three sites in 1989. Grandy Brook would continue, the Experimental Ponds Area was reinstated, and a site was selected in Gros Morne National Park as a replacement for Isle aux Morts River. These three systems (Figure 1) were monitored using national biomonitoring protocols with appropriate modifications for Newfoundland species.

- Stephensons Pond and its tributaries on Grandy Brook

This site is located on the south coast of Newfoundland and has been monitored since 1985. The 1985 and 1986 studies provided fish population and water chemistry data. Since 1987 additional information on benthic invertebrates and plankton has been collected. Previous paleoecological reconstructions were undertaken at three sites and water chemistry monitored by Environment Canada.

- Harding Pond and its tributaries at the headwaters of the Humber River in Gros Morne National Park

The 1989 field studies were undertaken in cooperation with Parks Canada which supplied helicopter transportation, field accomodation and manpower support. Paleoecological reconstructions are available from one site in the system, water chemistry is monitored by Environment Canada and upwind rainfall is monitored by the Atmospheric Environment Service at Rocky Harbour. Fish population and water chemistry data for this watershed are available from 1975 to 1978.

- Experimental Ponds Area

The site consists of Spruce and Headwater Ponds and their tributaries at the headwaters of the Gander River in central Newfoundland. Biological and ancillary data were collected in the area from 1977 to 1986 as part of a study of factors affecting production of salmonids in standing waters. Biomonitoring in 1987 and 1989 followed national protocols with field investigations undertaken under contract with Dr. R. Knoechel, Memorial University. Water chemistry continues to be monitored by Environment Canada and the Newfoundland Department of Environment, vegetation and soil conditions by the Canadian Forestry Service, and upwind precipitation at Bay d'Espoir by the Atmospheric Environment Service.

Significant progress has been made at biomonitoring sites in 1989. The Canadian Wildlife Service has verbally committed to monitor bird populations at all three sites. It is noteworthy that alkalinity deficits at the Experimental Ponds Area have decreased concurrently with reduced sulfate deposition. Preliminary results in the Gros Morne site also indicate a reduced rate of metal deposition. Findings are to be

published. As monitoring continues, the historic data base should enable a regional assessment of change, should recovery continue.

2. Paleoecological reconstructions of ecosystem productivity (Ryan)

Four Newfoundland lakes were sediment-core sampled in 1988 for the reconstruction of lake histories. These sites were on the southwest and west coast (see locations in previous LRTAP DFO reports) and included two of the current biomonitoring river systems.

This work was funded under the Unsolicited Proposal fund as part of a joint eastern Canada analysis of 16 lakes in four provinces (Newfoundland, Nova Scotia, New Brunswick, Québec). Investigations include reconstruction of lake pH, metal and plant pigment concentrations, and concentrations of PAH (see report by Payne-Ryan) and PCB.

Publication of results of this project is currently in progress and, so far, are indicative of reduced rates of metal deposition, at least in Newfoundland. Publication of previous paleoecological reconstructions (i.e. prior to 1989) is continuing.

No coring has been done thus far in 1989. Planned paleoecological work includes the core sampling of the Experimental Ponds Area.

3. Episodic acidification and long-term water quality monitoring (Ryan)

General emphasis in 1989 has been on the analysis and publication of data.

Weekly water sampling was undertaken at 14 river systems from July 1987 to June 1988 (see previous Workshop reports) and a publication has been completed. May-to-October sampling results from the Experimental Ponds Area provide conservative estimates of acidification. Results from previous years have indicate some improvement in water quality with increasing pH and decreasing alkalinity deficit (Figure 23). These changes were concurrent with reduced precipitation and resultant reduced sulphate deposition at the downwind Bay d'Espoir CAPMON site (Figure 3).

Long-term water quality sampling at the biological monitoring sites is continuing with water sampling during site visits (spring and fall with summer visits at the Experimental Ponds Area). Future work and collaborative studies with Environment Canada, Canadian Wildlife Service and Parks Canada should provide seasonal (spring, summer and fall) data records.

Planned work in 1989 includes water chemistry sampling and stream gauging at the biological monitoring sites. Analyses are conducted by Environment Canada in St. John's.

4. Analysis and publication of previously-completed lake and river surveys (Ryan)

In the past year, this included a published report on Gros Morne Park fishes, based on 1975 to 1980 data. This serve as a baseline for biomonitoring. A paper on relative abundance estimators for fish has been published which documents lesser fish abundance associated with lesser pH at that biomonitoring site.

Future work includes the continuing analyses and publication of data from biological monitoring sites and previous lake and river surveys. Particular attention will be given to the Experimental Ponds Area.

5. Aromatic hydrocarbons in invertebrates of select Newfoundland lakes (Kiceniuk)

Artificial substrates (consisting of drilled plastic pans filled with stones) were placed in pond outflows at the three LRTAP biomonitoring sites in Newfoundland. These were placed in May and are being removed in September. Invertebrates taken will be transported alive to the lab for identification species by M. Colbo, Memorial University. Large individuals will be frozen pending analysis. Total species counts will be done on all invertebrates from each site. An extraction method has been chosen and extraction efficiency completed for selected aromatic compounds. Class analysis of aromatic will be done in-house and halogenated compounds will be by contract.

6. Reconstruction of the history of LRTAP mediated PAH deposition in Newfoundland (Payne, Ryan)

Polycyclic aromatic hydrocarbons have generated considerable attention because of their mutagenic and carcinogenic properties and Environment Canada has recently placed PAH compounds as the number one priority on its list of environmental chemicals of concern. Within the past few years a number of studies have reported aromatic hydrocarbons in fish tissues and sediments in regions far removed from industrial sources including the Arctic. The primary source of these compounds would seem to be atmospheric transport of fossil fuel derived material. The fact that such compounds can be readily detected in the Arctic environment has drawn further attention to the general problem of long range transport of pollutants, beyond the more familiar and main concern connected with sulfur dioxide.

In a previous study (Investigation of Possible Relationships between Sulfate Deposition and Polycyclic Aromatic Hydrocarbon levels in Fish and Sediments on Newfoundland Lakes by J.F. Payne, J. Kiceniuk, D. Scruton, and P. Ryan) we analyzed muscle tissues of fish archived from the EIS surveys in Newfoundland. Traces of PAH were detected in most of over 100 fish extracts. Since this study used a class analysis technique and there

is possibility of interference by "natural" aromatic compounds, any future studies of PAH in tissues and sediments will involve individual compound identification by mass spectrometry as well as class analysis by HPLC.

The purpose of the present study was to provide information on the history of PAH deposition in Newfoundland. Specific objectives are to (a) document the history of PAH deposition in Newfoundland, (b) establish the present baseline from which further PAH impacts can be assessed, (c) provide information to relate any historical ecosystem change (e.g. algal assemblages) to PAH levels in sediments, and (d) provide information on the types and levels of combustion PAH found in sediments so that environmentally meaningful dose-response studies on the toxicity potential of PAH can be assigned. Cores are being analyzed by gas-chromatography-mass spectrometry from Candle-Stick Pond in the Long Range Mountains, a lake designated for long term biomonitoring.

As indicated in Figure 4, striking differences have been observed in PAH concentrations in surface sediments in comparison with deeper sediments from a "stable" core. The alkyl substituted PAH followed a similar pattern and this is consistent with hydrocarbons of combustion origin such as from LRTAP sources of the burning of petroleum and coal. Historical deposition rates are indicated to be quite low (and fairly constant) but cultural enrichment factors as high as 30-40 fold are noted for the surface sediment. The naturally derived PAH, perylene, was elevated in deeper sediments indicating an anaerobic origin. The toxicity of PAH is largely associated with lower molecular weight compounds. In this regard, it is worth noting (and somewhat surprising because of it's volatility) that naphthalene was readily detected and highly elevated in the surface sediment.

Overall this study is providing important information on the historical deposition of PAH in the Long-Range Mountains area of Newfoundland, but it is difficult to attribute the rapid elevation in surface sediments to LRTAP sources. Could it be from the occasional use of outboard motors in the pond in the summer by Park personnel or the occasional hunter's plane which may be using the pond? If this is the case, this study demonstrated that LRTAP could be a relatively unimportant source of PAH in the aquatic environment.

To put the situation in perspective: Is one "outboard motor day" equivalent to 50 years of atmospheric deposition? This is obviously an important question for LRTAP interests.

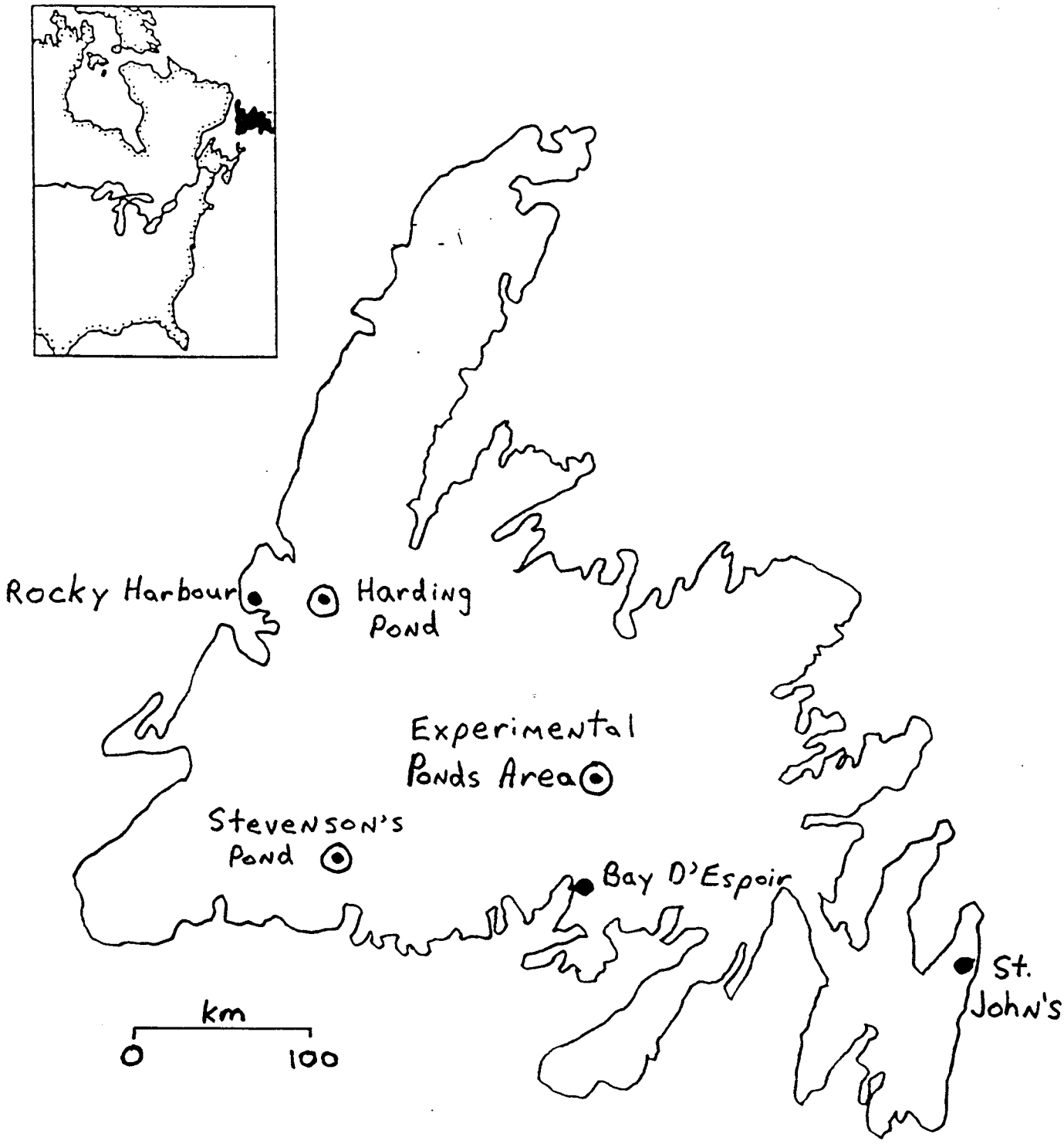


Figure 1. Location of 3 1989 LRTAP biomonitoring sites.

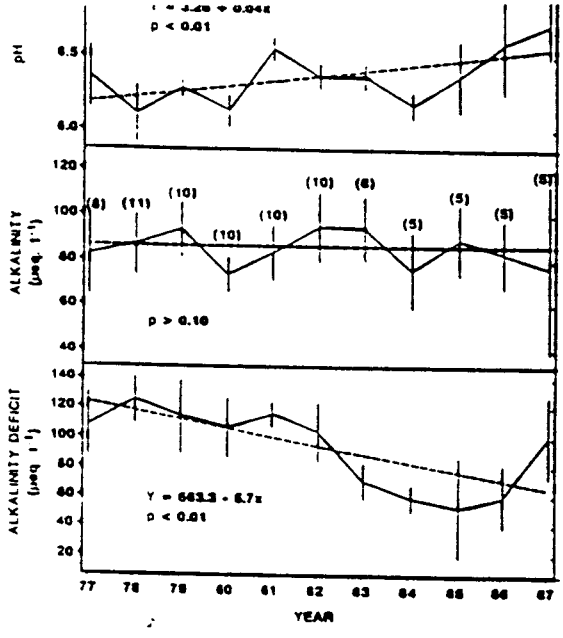
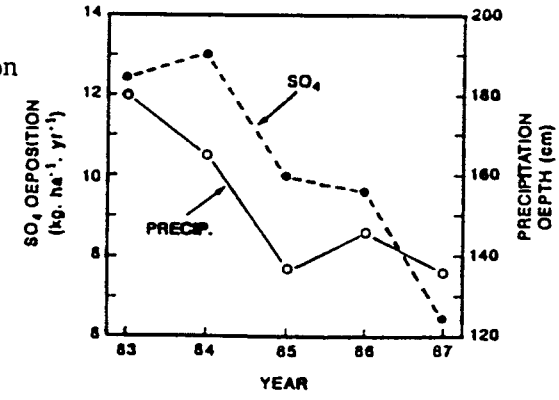


Fig. 2. Long-term variations in pH, alkalinity, and alkalinity deficits in Spruce Pond's outlet in the Experimental Ponds Area, 1977 to 1987. Vertical bars indicate two standard errors about the annual means and the dotted lines represent linear regressions with time of all (N=87) values. Significant regressions and levels of significance (P) are given. Number of samples each year is indicated (N) in center panel. Figure is from Ryan et al. (1991). See publication listing.

Fig. 3. Annual deposition of excess sulphate and annual precipitation at the Bay D'Espoir precipitation chemistry monitoring site (CAPMoN). The two variables can be related by the regression equation: SO_4 = -8.62+0.14 Precip; r = 0.901; p <0.05. Figure is from Ryan et al. (1991). See publication listing.



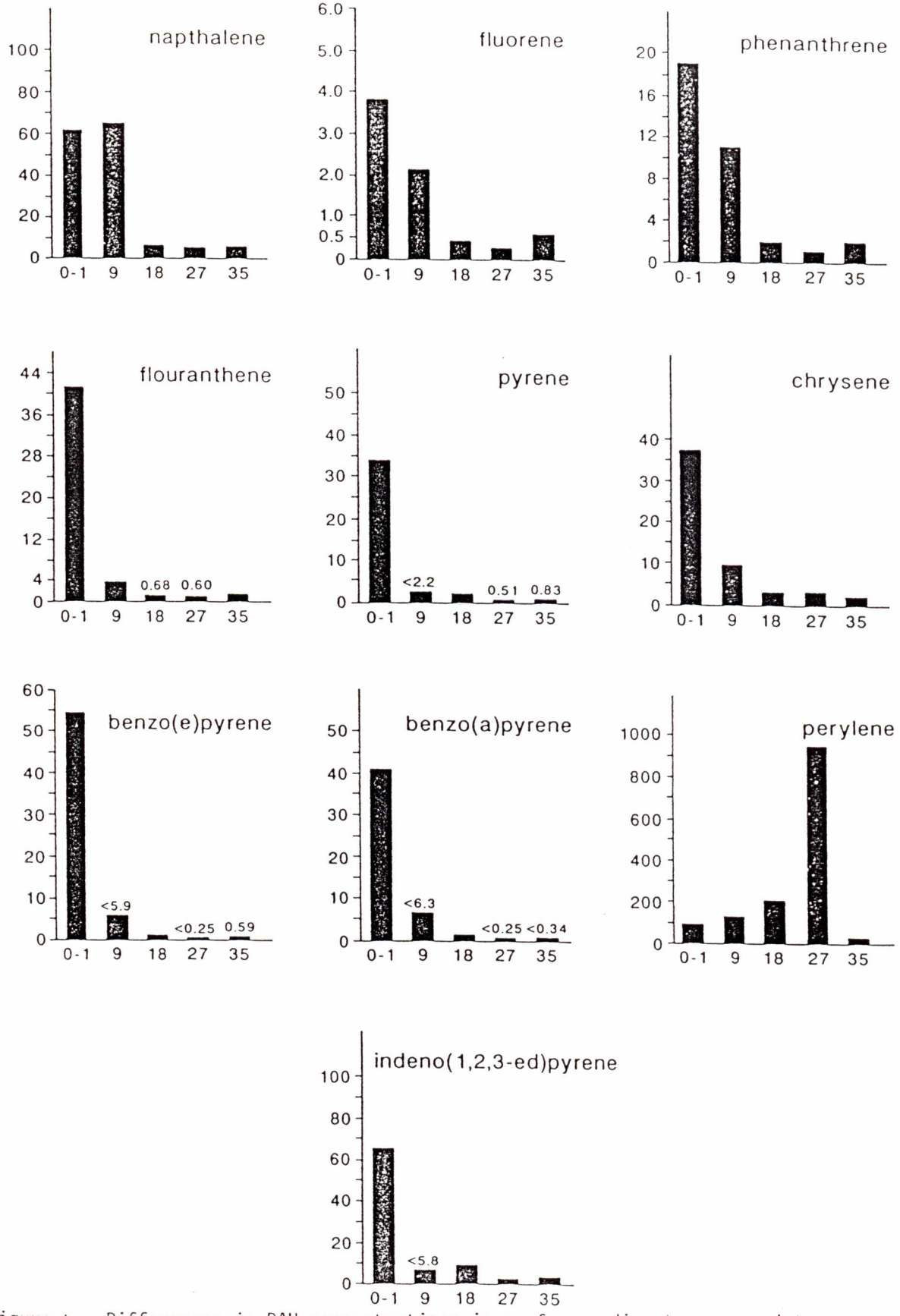
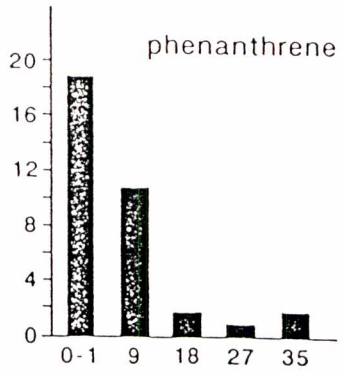
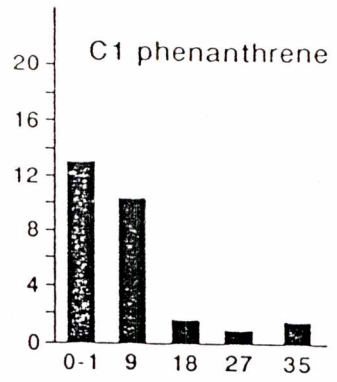
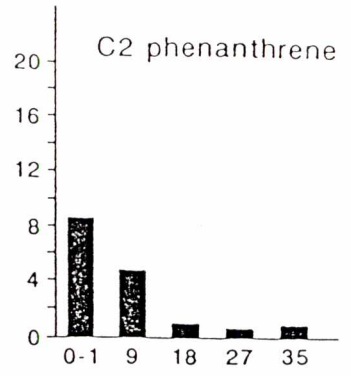
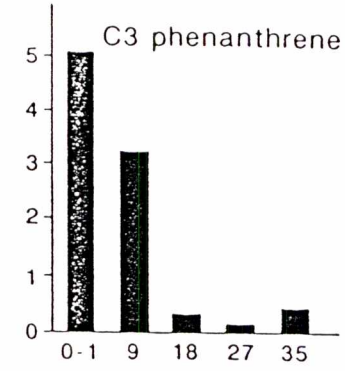


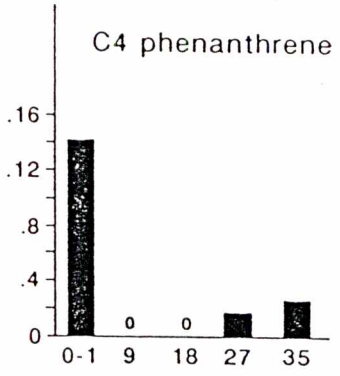
Figure 4. Differences in PAH concentrations in surface sediments compared to deeper sediments.

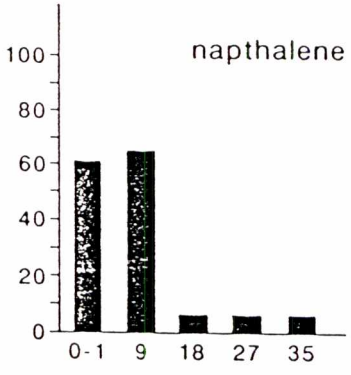


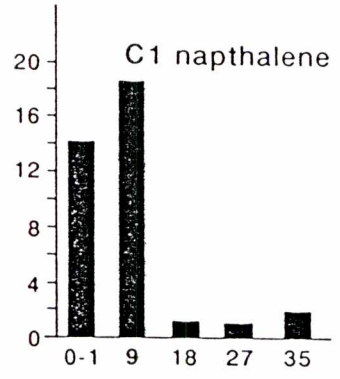


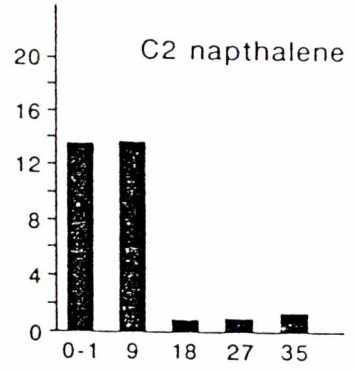


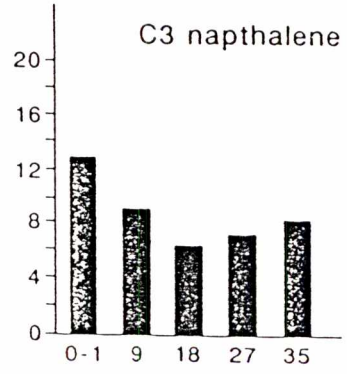












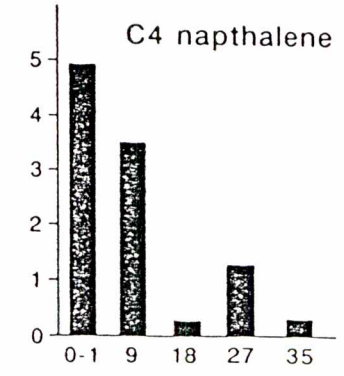


Figure 4 (cont'd)

1.5 Région du Québec/Québec Region

GORDON WALSH

Le programme TADPA 89-90 dans la région du Québec

1. Introduction

En 89-90, le programme TADPA de la Région du Québec comprenait les activités suivantes:

- Paléo-écologie dans l'est du Canada;
- Programme national de biomonitoring incluant des bio-essais sur la Côte-Nord avec des juvéniles de saumon atlantique;
- Évaluation des habitats à saumon vulnérables à l'acidification;
- Effets de l'acidification sur la boucle alimentaire microbienne;
- Poursuite de l'étude de la spéciation de l'aluminium et étude de la toxicité des fluoro-complexes sur le saumon atlantique juvénile et caractérisation de la matière organique dans le bouclier canadien.

Ce document présente brièvement l'état d'avancement des projets. Les résultats des travaux sur l'aluminium sont présentés par P.G.C. Campbell, lors de cet atelier.

2. Paléo-écologie de l'acidification dans l'est du Canada

L'étude paléo-écologique entreprise en 88-89 s'est poursuivie en 89-90. Cette étude vise notamment à répondre aux objectifs généraux suivants:

- documenter l'évolution de l'acidification et de la contamination par les métaux lourds provenant du transport atmosphérique dans l'est du Canada depuis environ 250 ans;
- établir la relation entre le taux d'acidification et la réponse biologique;

Méthodes:

Des carottes de sédiments ont été prélevées dans 4 lacs des provinces du N.-B., de la N.-É., du Qc et de T.-N. (Fig. 1).

En laboratoire, on a effectué les analyses suivantes: a) analyse des tranches de carottes (au 0.5 cm pour les 10 premiers cm, au cm ensuite) pour les métaux lourds (Absorption atomique sauf pour le mercure qui est analysé par la méthode des vapeurs froides); b) datation des tranches à l'aide du ^{210}Pb; c) au moins 10% des échantillons ont fait l'objet de duplicatas et des standards de références ont été dosés au hasard; d) analyse des assemblages de diatomés à chacune des époques; e) évaluation des pigments fossiles. Les assemblages de diatomés permettent de

reconstruire l'histoire du pH. Les pigments fossiles constituent un indice de la productivité des écosystèmes.

Les flux de métaux ont été calculés de façon à distinguer ceux provenant de processus naturels de ceux d'origines anthropogéniques en se basant sur les niveaux de référence de l'aluminium avant le début de la contamination atmosphérique (e.g. Bourton 1979; Dick & Peel 1985; Johnson & Nicholls 1988; Livett 1988).

La concentration du métal lourd M en excès est donc calculée comme suit:

$$M_{excès} = M_{total} - M_{roche\text{-}mère}$$

où

$$M_{roche\text{-}mère} = [Al]_{roche\text{-}mère} * [M/Al]_{roche\text{-}mère}$$

Compte tenu que les lacs échantillonnés ne sont pas soumis à des perturbations locales, on assume que les métaux en excès proviennent du transport atmosphérique.

Résultats préliminaires:

Plomb (Fig. 2):

Début de la contamination:

- les premières contaminations dans l'est du Canada se retrouvent au N.-B. aux environs des années 1800, ce qui correspond aux premiers développements industriels basés sur le charbon dans cette province;
- il s'agit de la première mention en Amérique du Nord d'une contamination aussi ancienne;
- le début de la contamination par le plomb dans les autres provinces s'est produit quelques dizaines d'années plus tard;
- les premières dépositions de plomb sont de l'ordre de 0.01-0.02 µg/cm^2/an;

19ième siècle:

- la déposition s'est accrue au 19e siècle par un facteur 2-5 fois;
- les lacs plus isolés (e.g. T.-N. et Qc occidental) ont subi une contamination par le plomb moins importante;
- le taux d'augmentation de la déposition est plus faible au Qc;

20ième siècle:

- les taux de déposition de plomb atteignent des maximum (N.-B. 0.5-0.7; N.-É. 0.1-0.5 µg/cm^2/an) vers les années cinquante;

- on observe cependant des diminutions ou des stabilisations des dépôts lors des récentes années;
- on observe une augmentation rapide des dépôts de plomb d'un facteur 24 dans la province de Québec;

Autres métaux (Fig. 3):

Début de la contamination:

- les métaux tels que Cu, Ni, Zn, Hg, et As sont apparus quelque 20 ans après le plomb (sauf le mercure en N.-É., 1879);
- il y a accroissement de la déposition partout sauf au Québec où la déposition augmente rapidement au début du 20ième siècle;

19ième siècle:

- la déposition s'est accrue au 19e siècle par un facteur 2-5 fois;
- les lacs plus isolés (e.g. T.-N. et Qc occidental) ont subis une contamination par les métaux moins importante;
- la variabilité des résultats est plus grande que pour le plomb;

20ième siècle:

- en général, les contaminations ont atteint des plateaux ou ont diminué;
- ce phénomène a déjà été noté dans d'autres études (e.g. Grands Lacs, Kemp et Thomas 1976; Lake Muskoka, Rybak et al. 1989a; Newfoundland, Rybak et al. 1989b, Scruton et al. 1989);
- ces tendances coïncident avec la diminution générale des émissions atmosphériques du souffre (Martin & Brydges 1986) depuis le milieu des années '70;

Le problème de remobilisation de métaux dans les lacs acidifiés reste à approfondir. Bien qu'il soit difficile de distinguer les métaux provenant de l'atmosphère de ceux remis en circulation par l'acidification, la relation avec la contamination atmosphérique demeure valide puisque les deux sources découlent de phénomènes d'origine atmosphérique.

Une autre problème surviendra lors de l'interprétation des assemblages de diatomés. En effet, il n'existe aucune fonction de transfert permettant cette interprétation en N.-É. La reconstruction des pH historiques dans cette province sera par conséquent limitée.

En conclusion, la contamination des métaux lourds dans l'est du Canada coïncide avec la colonisation et le développement du pays. Le plomb est apparu d'abord, suivi quelque 20 ans plus tard par les autres métaux. Le 19ième siècle a été marqué par une augmentation rapide de la

contamination (sauf au Québec). Au 20ième siècle, on assiste plutôt à une stabilisation et même à une diminution sauf au Québec où la tendance semble toujours à la hausse. La présence en quantité assez importante du plomb dans des régions isolées montre bien que le transport à grande distance affecte les milieux aquatiques (Fig. 4) .

Les analyses des assemblages de diatomés et de pigments fossiles se poursuivent. Le projet se terminera en mars 1990.

3. Biomonitoring

La Région du Québec participe au Programme national de biomonitoring. Quatre lacs (Éclair, Françina, Hamel et Théode; Fig. 5) du Parc national de La Mauricie et 5 rivières à saumon de la Côte-Nord (aux Rochers, de la Trinité, Godbout, Jupitagon et Matamek; Fig. 6) constituent les sites étudiés. En 89-90, nous avons effectué les activités prévues par le Programme. Il est à noter que nous réalisons une étude d'émergence des insectes adultes, s'étendant de mai à Novembre, afin de compléter et de valider les identifications à l'espèce des organismes des communautés benthiques. Une perspective nationale du programme est présentée par Ian Davies à ce même atelier. On présente ci-après des résultats préliminaires des bio-essais 88-89 et 89-90.

4. Bio-essais sur la Côte-Nord

Dans le cadre du Programme de Biomonitoring, des bio-essais ont été réalisés dans 4 rivières de la Côte-Nord selon un protocole développé par G. Lacroix (MPO, St.Andrews) adapté aux rivières et aux conditions climatiques de la Côte-Nord.

Ces bio-essais consistent à exposer des tacons de saumon atlantique 2^+ en stade de pré-smoltification à la chute de pH printanière.

Méthodes:

La durée des expériences se termine environ 45 jours après le pic d'acidité qui survient au début du mois de mai. L'expérience commence quelques semaines avant le choc acide, i.e. qu'elle se prolonge d'avril jusqu'à la mi-juin.

A chaque semaine, la mortalité est notée, et des prélèvement biologiques sont effectués. Ceux-ci comprennent: a) le plasma pour la mesure de l'hématocrite, des protéines plasmatiques totales, de l'osmolalité, du sodium et du chlorure; b) les branchies pour étude histologique (Epon en 1988 et métacrylate en 1989); et c) les branchies pour le dosage de l'aluminium. En 1989, trois paramètres plasmatiques additionnels sont analysés: le glucose, le cortisol, et les formes T_3 et T_4 de la thyroxine.

En 1988, des bio-essais ont eu lieu dans les rivières de la Trinité et aux Rochers et, en 1989, dans les rivières Matamek et Jupitagon (Fig. 6); des poissons des mêmes lots gardés dans les piscicultures du gouvernement provincial de Gaspé (1988) et de l'Anse-Pleureuse (1989) ont servis de contrôle.

Résultats:

Lors de la fonte printanière, le pH est tombé sous 5.0 (Fig. 7) pour 3 des 4 rivières, le minimum observée étant 4.7. Dans les rivières Trinité et aux Rochers, le pH est revenu à la normale après quelque 40 jours; le pic d'acidité lui-même n'a duré qu'une dizaine de jours. Dans les rivières Matamek et Jupitagon, la variation de pH a été moins grande; le pH s'est maintenu cependant sous 6.0 pendant toute la durée de l'expérience. Il y a eu très peu de variation du pH dans les deux contrôles. La conductivité suit le même patron que le pH, les eaux étant diluées par les eaux de fonte très peu minéralisées (Fig. 8). Le COD n'a pas montré de tendance particulière (Fig.9).

En ce qui concerne l'aluminium (Fig. 10 et 11), les résultats sont variables d'une année à l'autre. Il est à signaler cependant les niveaux d'aluminium inorganique en 1989, les teneurs dépassant parfois la valeur de 100 µg L^{-1}, ce qui constituent des niveaux très élevés.

En 1988, aucune mortalité n'a été causée par le choc printanier (Fig. 12, 1988) et presque tous les tacons survivants se sont smoltifiés. Par contre, en 1989, des taux de mortalité élevés ont été observés (Fig. 12, 1989) atteignant 95% dans la rivière Matamek.

Le stress qui a causé la mortalité se reflète dans les paramètres plasmatiques. En 1989, les valeurs d'osmolalité, de sodium, de chlorure, et d'hématocrite (Fig. 13, 14, 15, 16) chez les survivants se rapprochaient des valeurs observées chez des saumons juvéniles moribonds (e.g. voir Lacroix et Townsend 1987).

On suspecte que le pH ou l'aluminium ne soient pas les seuls facteurs de mortalité en cause. En effet, la fonte printanière est un événement hydrologique important caractérisé non seulement par des variations chimiques mais aussi par des élévations du niveau d'eau, du débit, ainsi que de la température (Fig. 18 et 19). Il est possible que les stress combinés de ces divers facteurs aient causé la mortalité observée.

Les dosages de l'aluminium dans les branchies de même que les observations histologiques, qui sont en cours, permettront sans doute d'établir des relations plus claires. Quoiqu'il en soit, les expériences devraient être reproduites l'an prochain sur les rivières Jupitagon et Matamek ainsi que dans la rivière Godbout, qui montre des chocs acides beaucoup moins prononcés.

5. Évaluation des habitats à saumon vulnérables à l'acidification

Depuis 1981, le MPO effectue un suivi de la qualité physico-chimique des rivières à saumon de la Côte-Nord 4 fois par année. Ces rivières sont situées sur le bouclier canadien dans une zone dont la nature du sous-sol confère aux eaux une très faible capacité tampon.

Seize rivières sont échantillonnées chaque année mais des données existent pour 33 rivières. Ces rivières sont extrêmement sensibles aux précipitations acides (conductivité en général entre 15 et 25 µS/cm) en raison de la nature géologique de la région. Bien que les sources de polluants atmosphériques soient relativement éloignées, les dépôts sont de l'ordre de 15-22 kg $SO_4^=$-/ha/an, soit très près du seuil recommandé pour la protection des milieux aquatiques modérément sensibles. D'ailleurs, des calculs d'exportation des $SO_4^=$-montrent que les rivières sont affectées par les sulfates d'origines atmosphériques (Fig. 20); Lachance et al. 1988) et que les niveaux de protection sont probablement dépassés à l'occasion.

On n'observe pas d'acidification chronique comme en N.-É. (pH < 5.0); par contre, la fonte printanière engendre des épisodes de pH < 5.0 pendant des périodes variant de quelques jours à quelques semaines.

Une autre problématique particulière est celle de l'aluminium. Lorsque le pH si situe dans la fourchette 5.0-5.5, notamment lors de la fonte printanière, les concentrations des formes toxiques de l'aluminium prennent une importance parfois inquiétante (≥ 100 µg L^{-1} Al inorganique; voir e.g. la Fig. 11).

Dernièrement, le Conseil International pour l'Exploration de la Mer a produit un document discutant des habitats à saumon du Canada qui étaient vulnérables à l'acidification et ceux qui étaient perdus (ICES 1987). Les superficies d'habitats de la province de Québec ont toutefois été fortement sous-estimées à 3 km^2 (Tableau 1). L'analyse des données physico-chimiques disponibles montre en effet que la superficie est de l'ordre de quelques 110 km^2. Puisqu'il s'agissait de données incomplètes et que le statut chimique d'un grand nombre de rivières était inconnu, un échantillonnage des 51 rivières à saumon de la Côte-Nord a été entrepris en 89-90. De son côté, le ministère provincial du Loisir, de la Chasse et de la Pêche actualise et collige présentement les superficies de tous les habitats à saumon disponibles sur la Côte-Nord.

Les données disponibles permettent de croire que la superficie vulnérable à l'acidification (selon le critère de vulnérabilité du CIEM de 50 µéq/l $CaCO_3$ pondéré par le débit), sera supérieure à 100 km^2 (Walsh, en prép.).

Aussitôt qu'ils seront disponibles, les résultats seront transmis au Comité scientifique canadien sur les pêches de l'Atlantique (CSCPCA) qui verra à les acheminer.

6. Boucle alimentaire microbienne dans un lac oligotrophe perturbé

Il s'agit d'un projet conjoint MPO/Univ. Laval en collaboration avec des chercheurs du MPO à Vancouver (Dr Stockner) et à l'Institut des eaux douces à Winnipeg (Drs J. Rudd, C. Kelly, E. Fee, J. Shearer, H. Kling, A. Furutani et E. DeBruyn).

Ce projet a pour but de quantifier le transfert du flux énergétique au sein du réseau alimentaire afin de modéliser la productivité d'un écosystème lacustre acide. Ce projet est fondé sur le nouveau concept trophique mettant en évidence la contribution des nanoautotrophes à la production primaire, et la grande activité respiratoire des micro-organismes. Les travaux progressent comme prévu. Cependant, aucune donnée préliminaire n'est disponible en ce moment.

7. Comportement géochimique, spéciation et toxicité de l'aluminium et relations avec la matière organique

Ces dernières années, la Région du Québec a investi plusieurs efforts dans la problématique de l'aluminium. Ces travaux ont été en partie réalisés par Dr P.G.C. Campbell de l'INRS-Eau à Québec. Celui-ci présente une synthèse des connaissances sur l'aluminium en rapport avec l'acidification dans le cadre de cet atelier.

Tableau 1. Habitat accessible pour le saumon atlantique dans l'est du Canada et superficie vulnérable à l'acidification selon ICES (1987) et Walsh (en prép.).

Région	Habitat accessible (km^2)	Habitat vulnérable (km^2)
T.-N./Labrador	211.1	25.6
Qué.	562.3	3.0
N.-B.	134.9	0.0
I.P.-É	2.8	0.0
N.-É.	38.7	20.5
Total	949.8	49.1

Source: ICES Acid Rain Study Group (1987)

Qué. Côte-Nord	319	113

Source: Walsh (en prép.)

Références

Bourton, C. 1979. Trace element content of greenland snows along an east-west transect. Geochim. Cosmochim. Acta 43: 1253-1258.

Dick, A.L., & D.A. Peel. 1985. Trace elements in Antartic air and smnowfall. Ann. Glaciol. 7: 12-19.

ICES. 1987. Report of the Acid Rain Study Group, Copenhagen, 4-6 March 1987. C.M. 1987/M:3., 33 p.

Johnson, M.G., & K.H. Nicholls. 1988. Temporal and special trends in metal loads to sediments in Lake Simcoe, Ontario. Water Air Soil Pollut. 5: 469-490.

Kemp, A.L.W., et R.L. Thomas. 1976. Impact of man's activities on the chemical composition in the sediments of Lakes Ontario, Erie and Huron. Water Air Soil pollut. 5: 469-490.

Lachance, M., D. Brouard, et G. Walsh. 1988. Airborne Transport of Sulphur: Impacts on chemical composition of rivers on North Shore of the St. Lawrence River (Québec). Water, Air, Soil Pollut. 39: 311-322.

Lacroix, G.L., et D.R. Townsend. 1987. Responses of juvenile Atlantic salmon (Salmo salar) to episodic increases in acidity of Nova Scotia rivers. Can. J. Fish. Aquat. Sci. 44: 1475-1484.

Livett, E.A. 1988. Geochemical Monitoring of Atmospheric Heavy Metal Pollution: Theory and Applications. Adv. Ecol. Res. 18: 65-177.

Martin, H.C., & T.G. Brydges. 1986. Stress factors: trends and recovery. International Conference on Acidification and its Policy Implications, Amsterdam, The Netherlands, 17 p.

Rybak, M., I. Rybak, et D. Scruton. 1989b. The impact of atmospheric deposition on the aquatic ecosystem with special emphasis on lake productivity, Newfoundland, Canada. Hydrobiologia, in press.

Rybak, M., I. Rybak, et K. Nicholls. 1989a. Recent trends and historical changes in water quality of Lake Muskoka. Proc. Tech. Transfer Conf. 1988, Toronto, Canada: BP-10:349-353.

Scruton, D., J.K.Elner, et M. Rybak. 1989. Regional calibration of fossil diatom - contemporary pH relationships for insular Newfoundland, canada, including historical pH reconstruction for five lakes and assessment of paleo-inferred productivity changes in one lake. p. 457-464, In Acid rain: Scientific and Technical Advance, Selper Ltd., London.

Liste des figures

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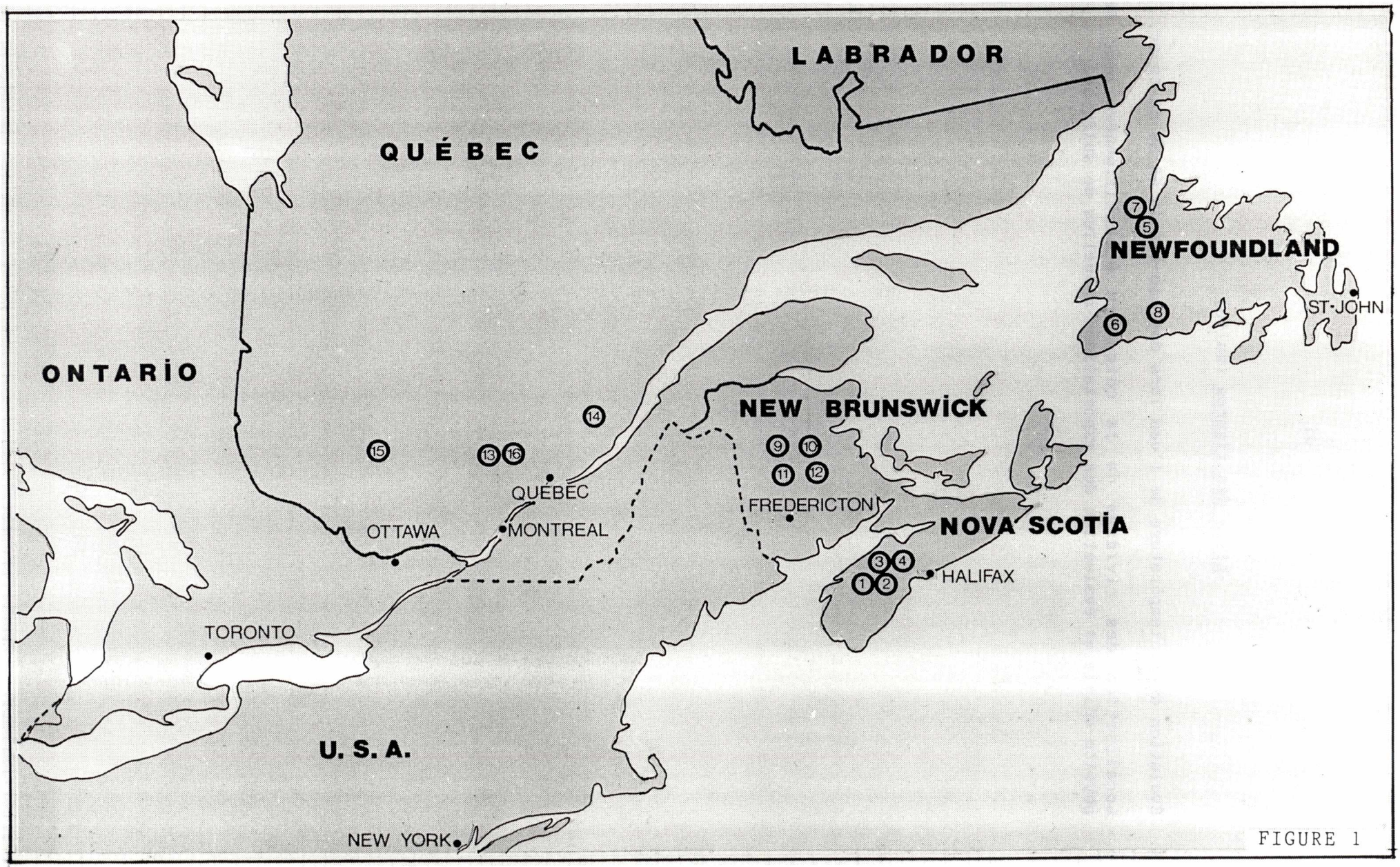

LABRADOR
QUÉBEC
NEWFOUNDLAND
ST-JOHN
ONTARIO
NEW BRUNSWICK
QUEBEC
FREDERICTON
OTTAWA
MONTREAL
NOVA SCOTIA
HALIFAX
TORONTO
U. S. A.
NEW YORK
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

FIGURE 1

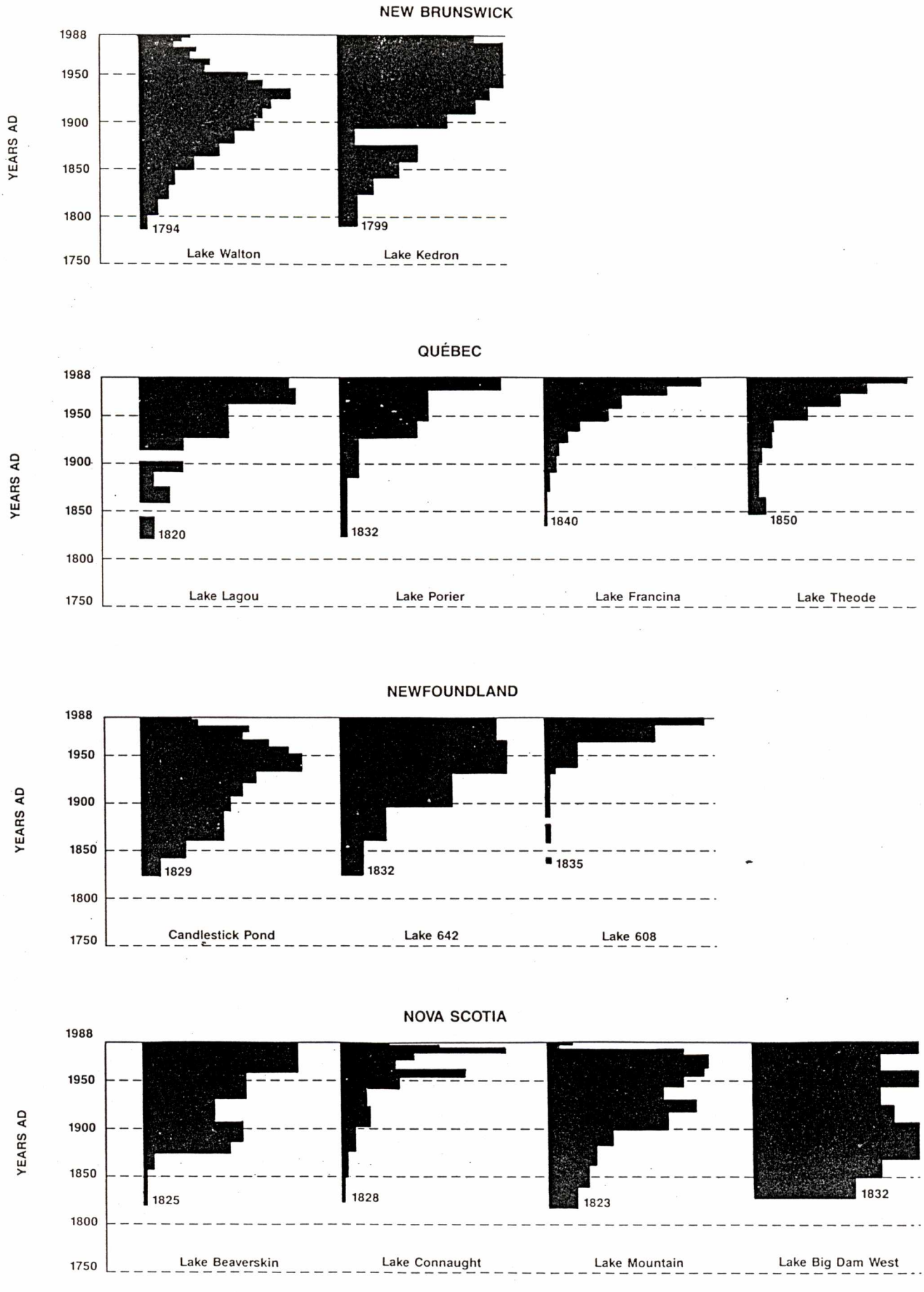

NEW BRUNSWICK
YEARS AD
1988
1950
1900
1850
1800
1750
1794
1799
Lake Walton
Lake Kedron
QUÉBEC
YEARS AD
1988
1950
1900
1850
1800
1750
1820
1832
1840
1850
Lake Lagou
Lake Porier
Lake Francina
Lake Theode
NEWFOUNDLAND
YEARS AD
1988
1950
1900
1850
1800
1750
1829
1832
1835
Candlestick Pond
Lake 642
Lake 608
NOVA SCOTIA
YEARS AD
1988
1950
1900
1850
1800
1750
1825
1828
1823
1832
Lake Beaverskin
Lake Connaught
Lake Mountain
Lake Big Dam West

FIGURE 2

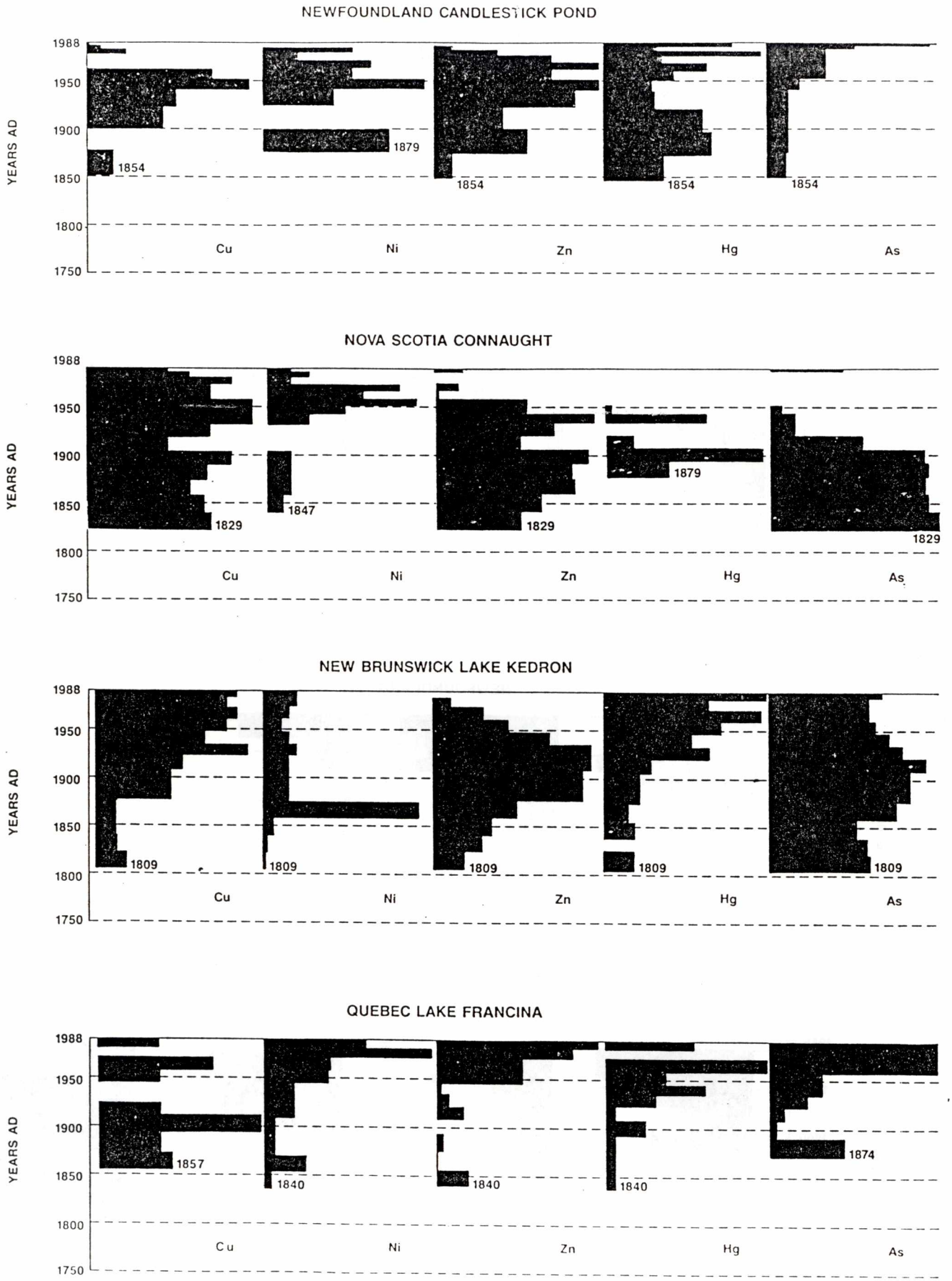

NEWFOUNDLAND CANDLESTICK POND
NOVA SCOTIA CONNAUGHT
NEW BRUNSWICK LAKE KEDRON
QUEBEC LAKE FRANCINA
YEARS AD
1988
1950
1900
1850
1800
1750
Cu
Ni
Zn
Hg
As
1854
1879
1854
1854
1854
1829
1847
1829
1879
1829
1809
1809
1809
1809
1809
1857
1840
1840
1874

FIGURE 3

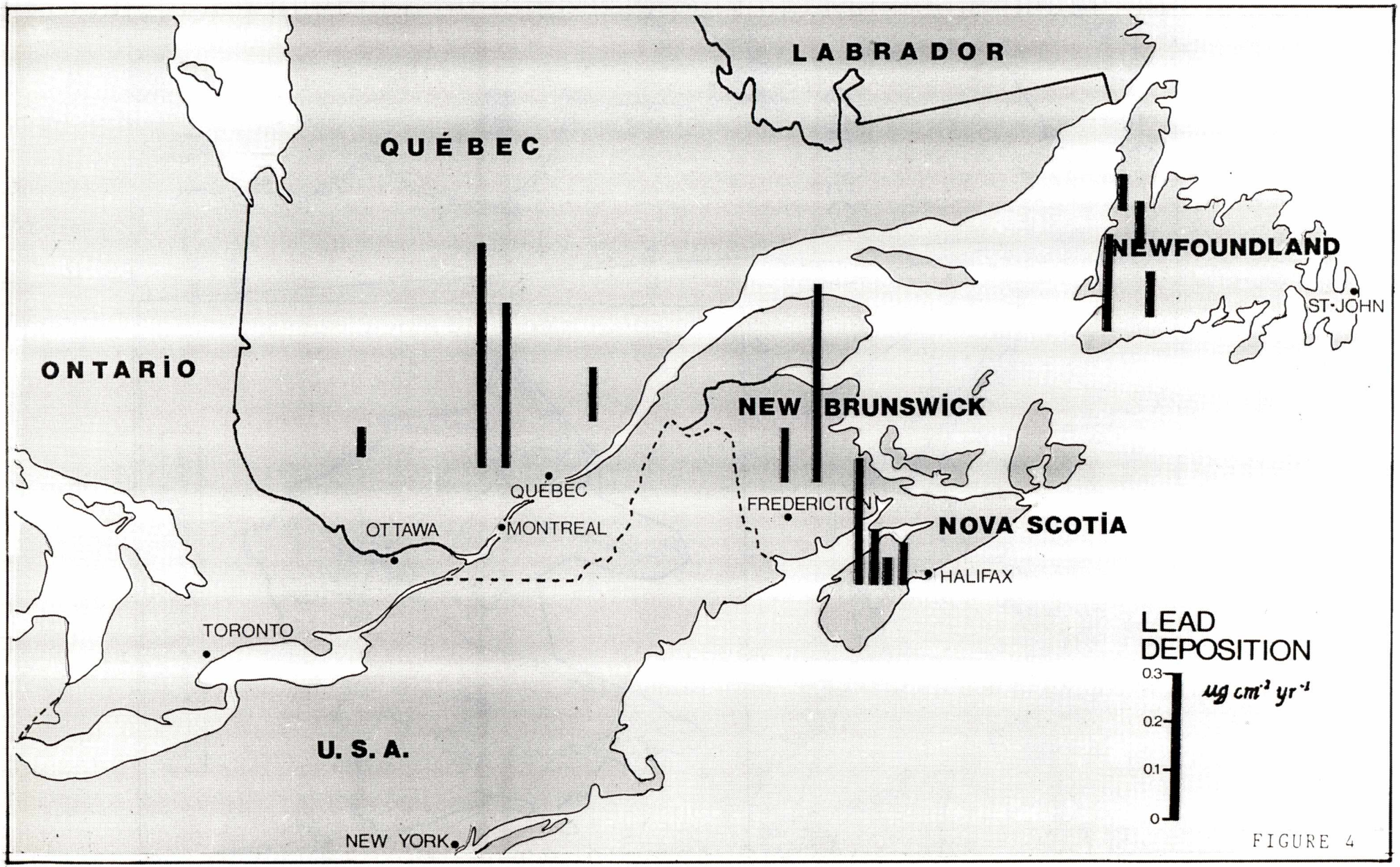

LABRADOR
QUÉBEC
NEWFOUNDLAND
ST-JOHN
ONTARIO
NEW BRUNSWICK
QUÉBEC
FREDERICTON
OTTAWA
MONTREAL
NOVA SCOTIA
HALIFAX
TORONTO
U. S. A.
NEW YORK
LEAD DEPOSITION
0.3
0.2
0.1
0
µg cm⁻² yr⁻¹

FIGURE 4

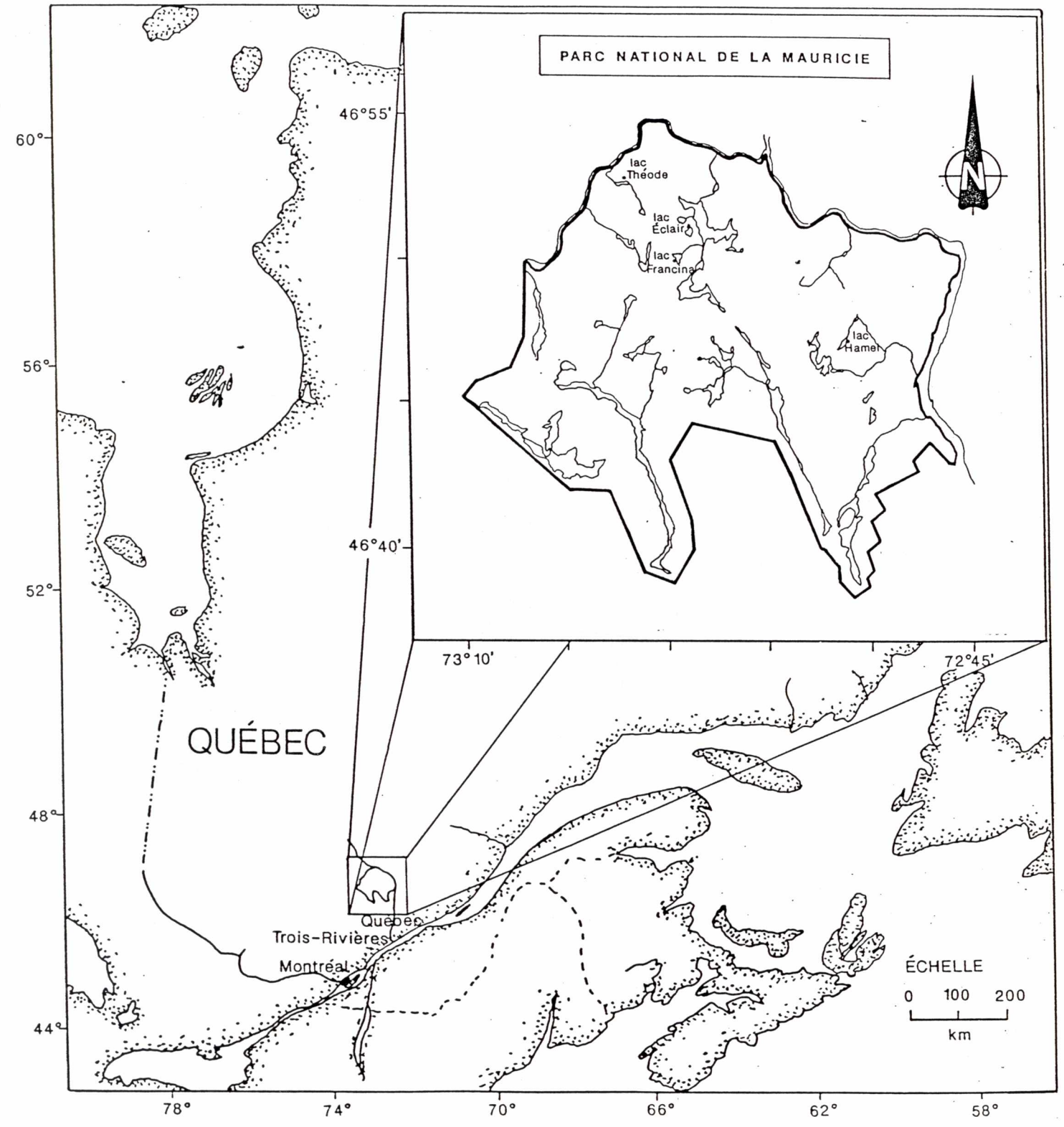

PARC NATIONAL DE LA MAURICIE
lac Théode
lac Éclair
lac Francina
lac Hamel
N
46°55'
46°40'
73°10'
72°45'
60°
56°
52°
48°
44°
78°
74°
70°
66°
62°
58°
QUÉBEC
Québec
Trois-Rivières
Montréal
ÉCHELLE
0 100 200
km

FIGURE 5

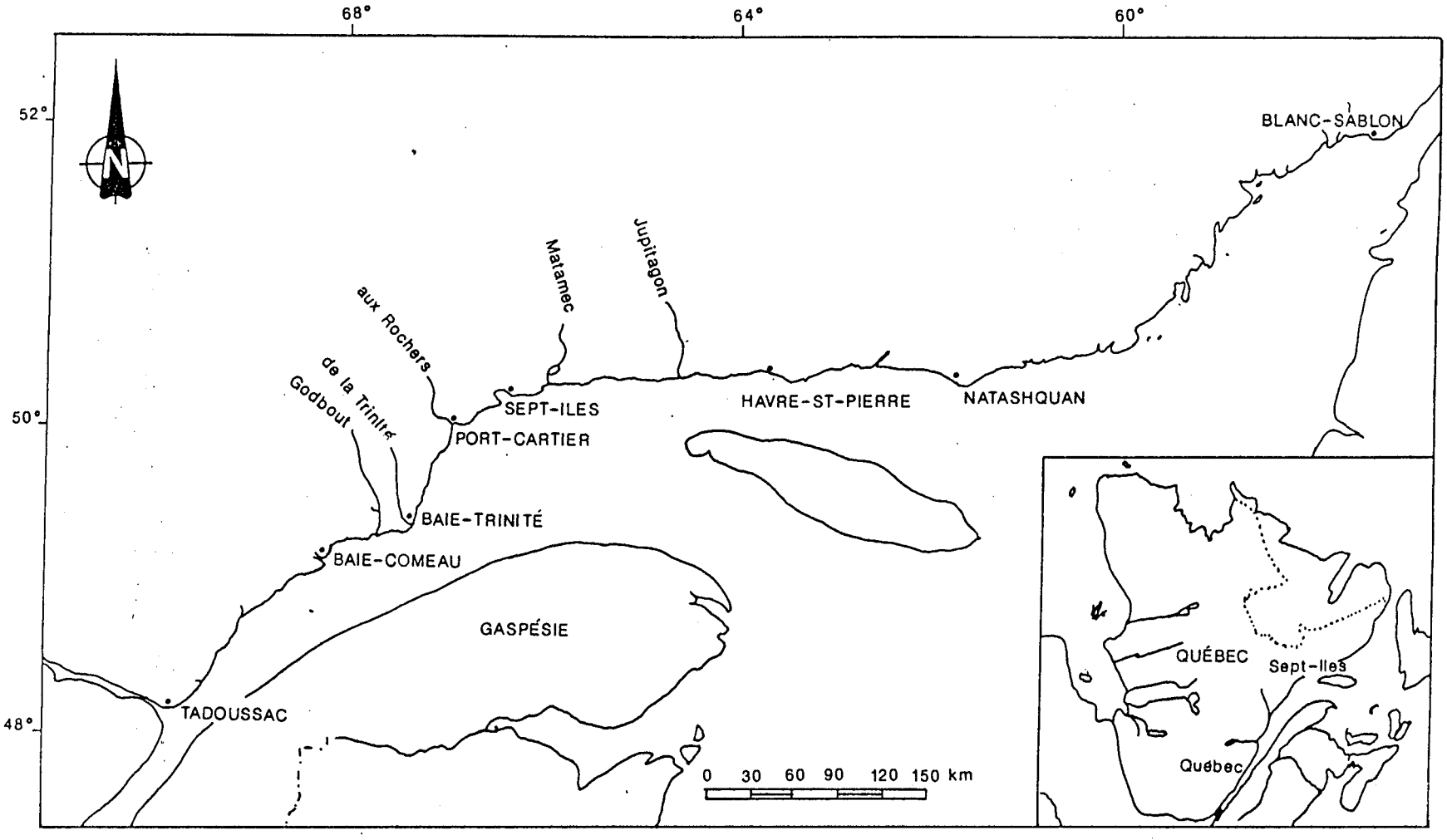


Figure 6. Localisation des rivières à saumon de la Côte-Nord intégrées au réseau de surveillance biologique.

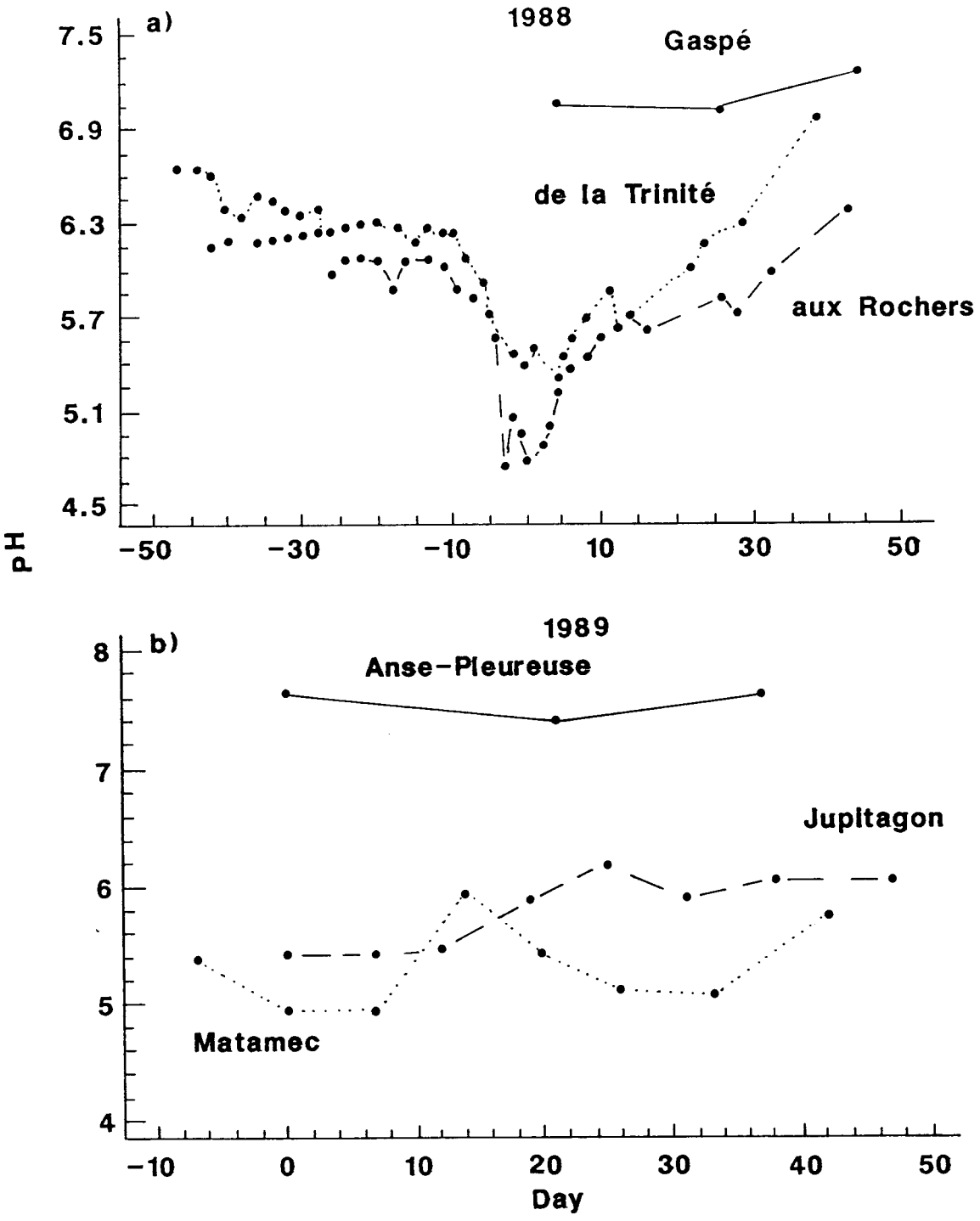

a)
1988
Gaspé
de la Trinité
aux Rochers
7.5
6.9
6.3
5.7
5.1
4.5
pH
-50
-30
-10
10
30
50
b)
1989
Anse-Pleureuse
Jupitagon
Matamec
8
7
6
5
4
-10
0
10
20
30
40
50
Day

FIGURE 7

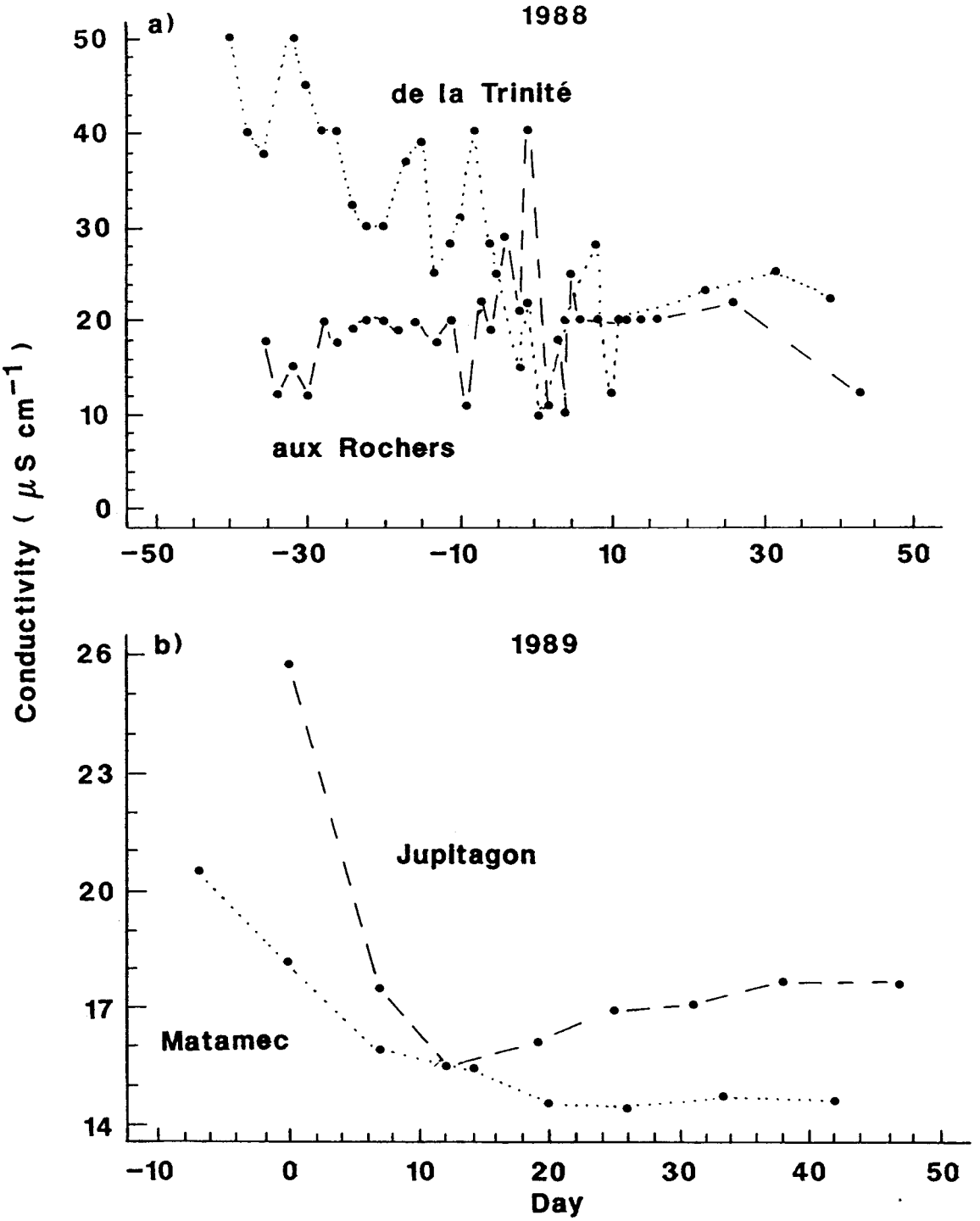

a)
1988
de la Trinité
aux Rochers
50
40
30
20
10
0
−50
−30
−10
10
30
50
b)
1989
Jupitagon
Matamec
26
23
20
17
14
−10
0
10
20
30
40
50
Day
Conductivity (μS cm⁻¹)

FIGURE 8

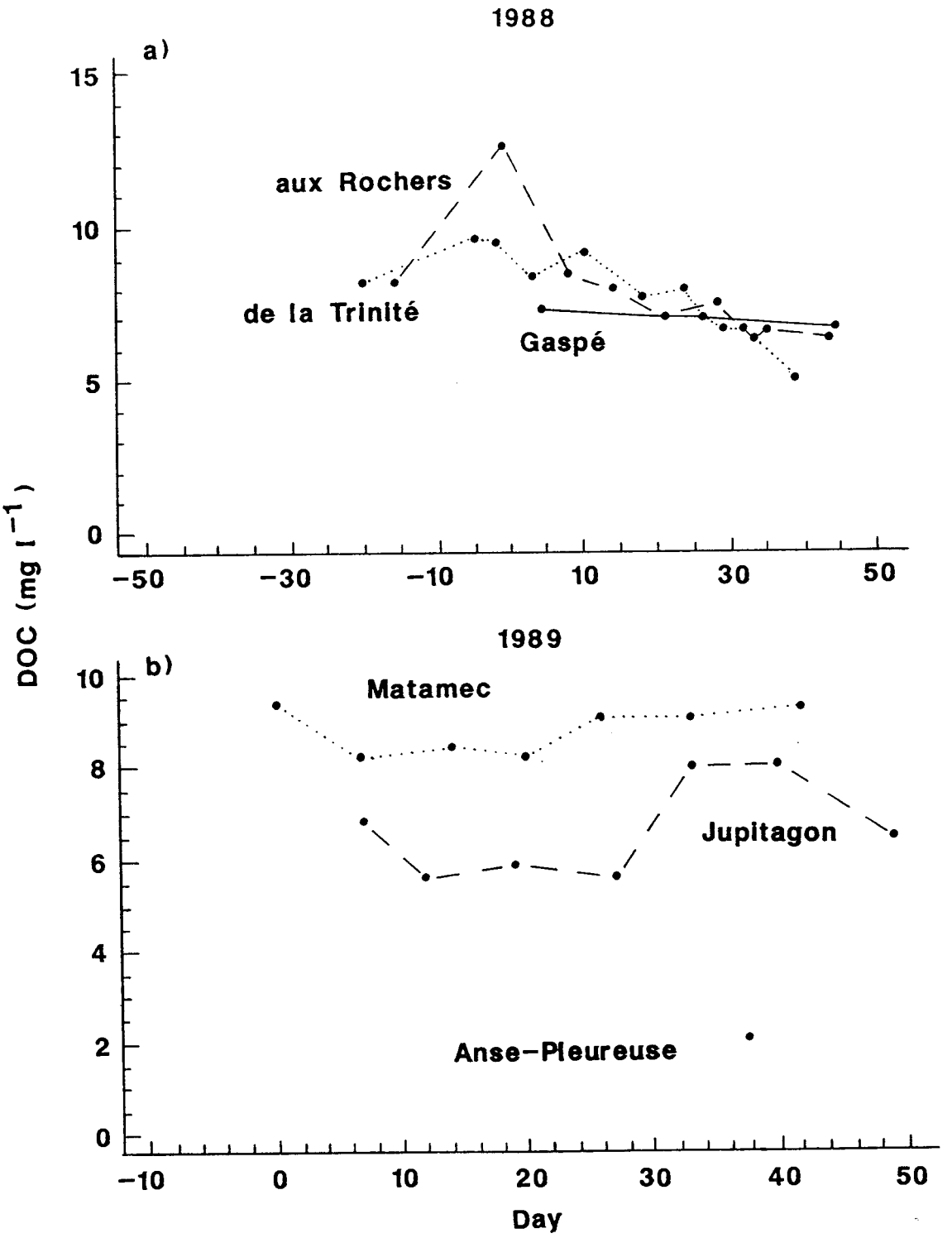

1988
a)
15
10
5
0
aux Rochers
de la Trinité
Gaspé
−50
−30
−10
10
30
50
1989
b)
10
8
6
4
2
0
Matamec
Jupitagon
Anse-Pleureuse
−10
0
10
20
30
40
50
Day
DOC (mg l⁻¹)

FIGURE 9

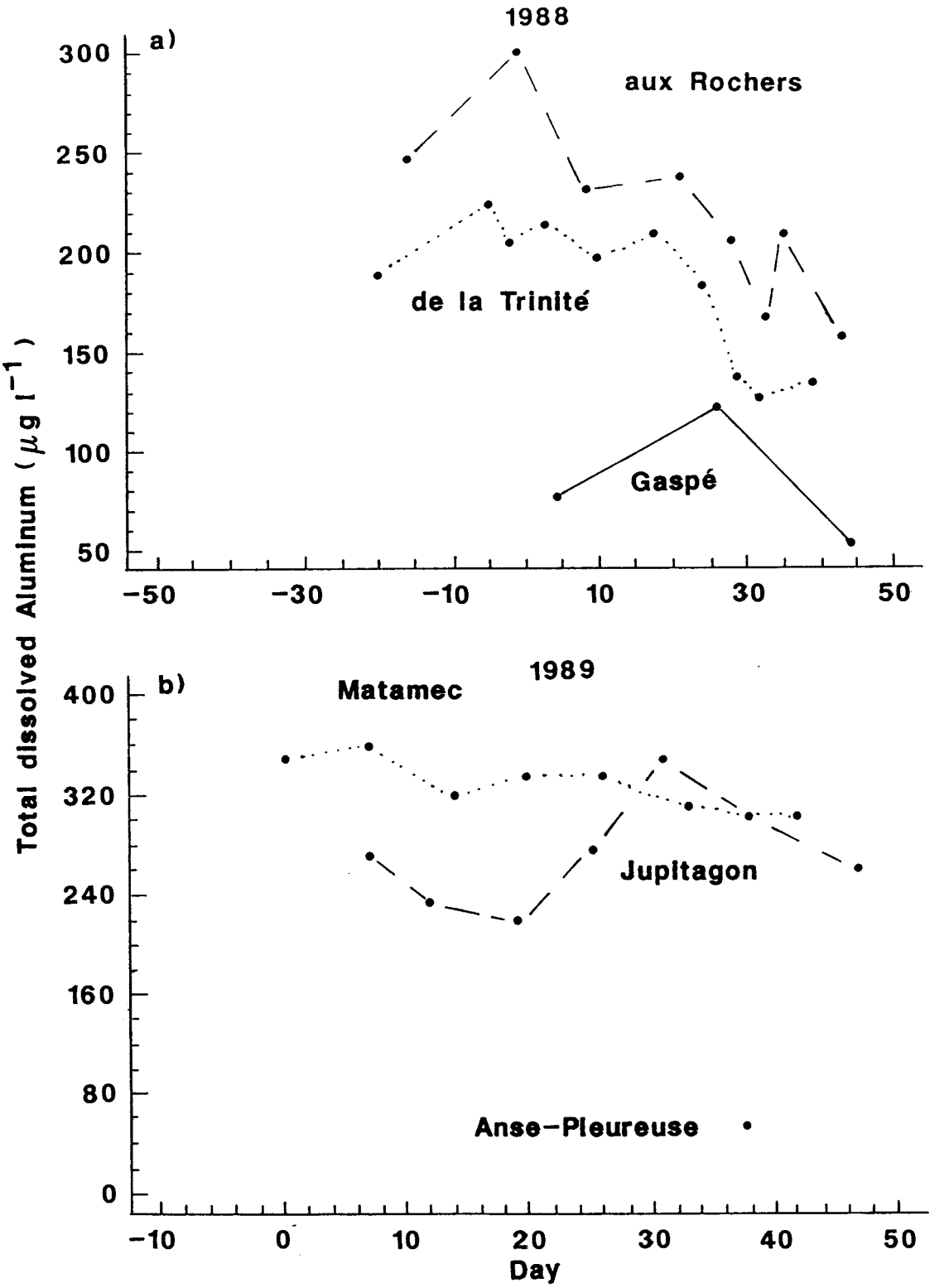

1988
a)
aux Rochers
de la Trinité
Gaspé
300
250
200
150
100
50
−50
−30
−10
10
30
50
Total dissolved Aluminum ($\mu g\ l^{-1}$)
1989
b)
Matamec
Jupitagon
Anse-Pleureuse
400
320
240
160
80
0
−10
0
10
20
30
40
50
Day

FIGURE 10

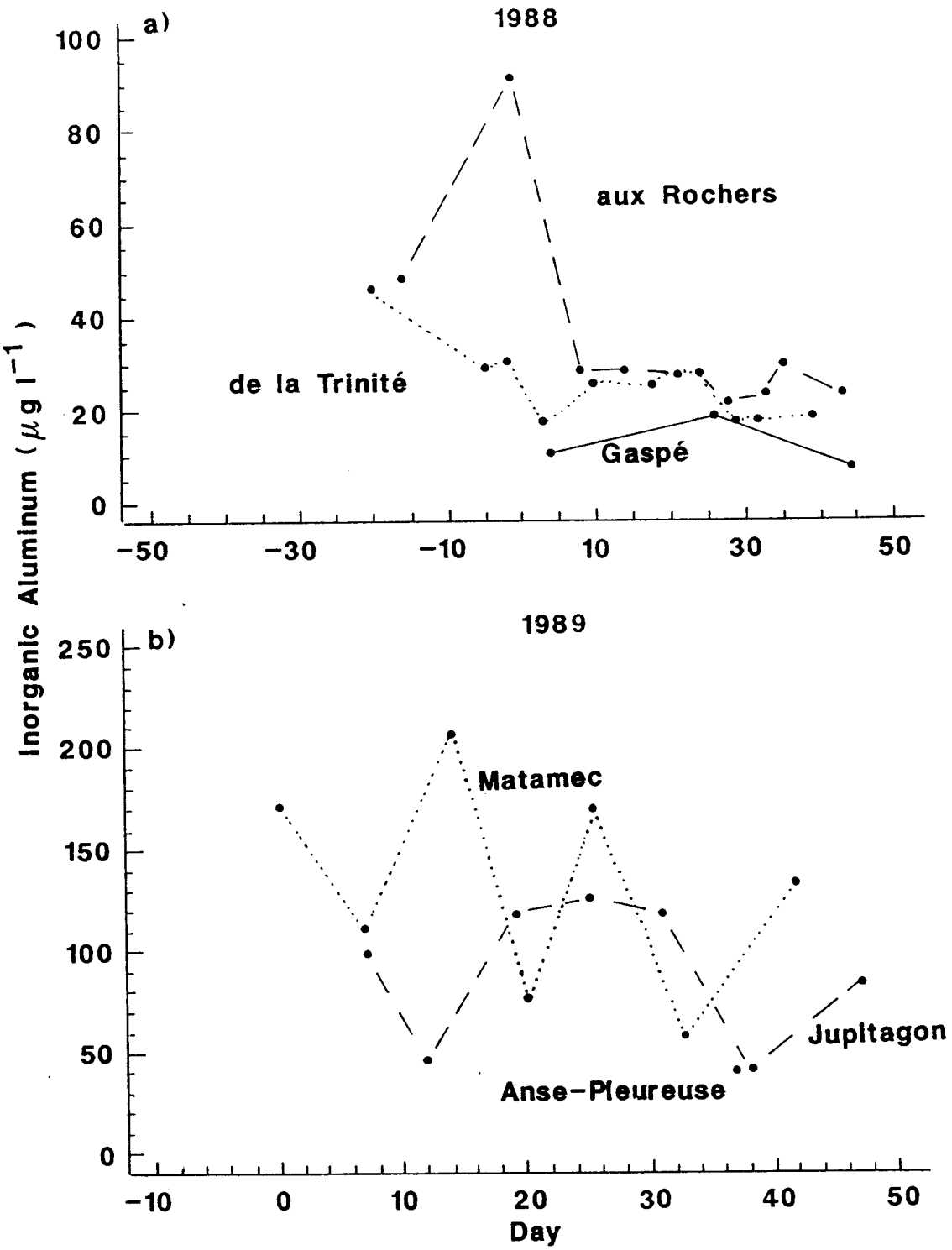

a)
1988
100
80
60
40
20
0
aux Rochers
de la Trinité
Gaspé
−50
−30
−10
10
30
50
Inorganic Aluminum (μg l^{-1})
b)
1989
250
200
150
100
50
0
Matamec
Jupitagon
Anse-Pleureuse
−10
0
10
20
30
40
50
Day

FIGURE 11

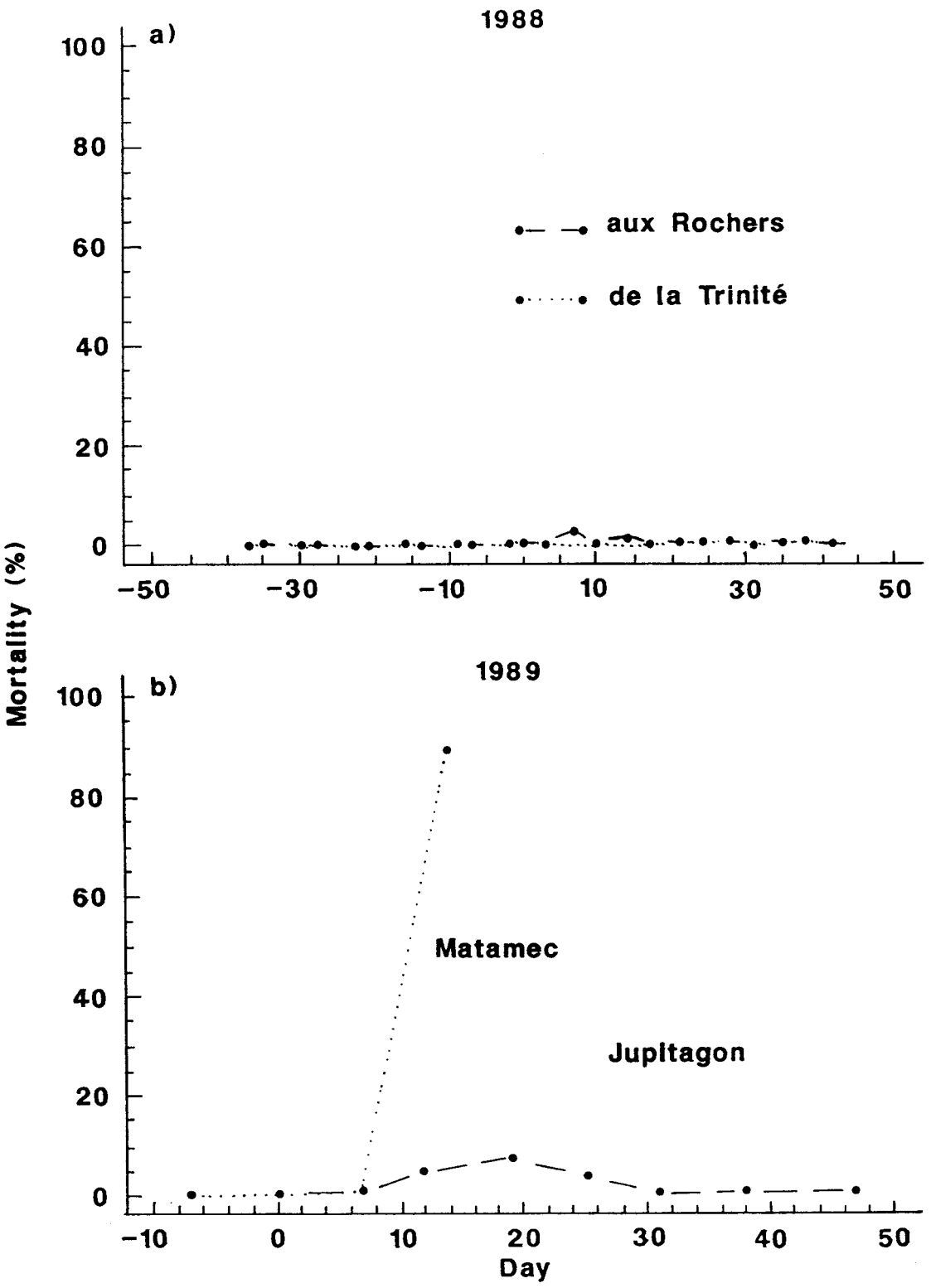

1988
a)
100
80
60
40
20
0
aux Rochers
de la Trinité
-50
-30
-10
10
30
50
1989
b)
100
80
60
40
20
0
Matamec
Jupitagon
-10
0
10
20
30
40
50
Day
Mortality (%)

FIGURE 12

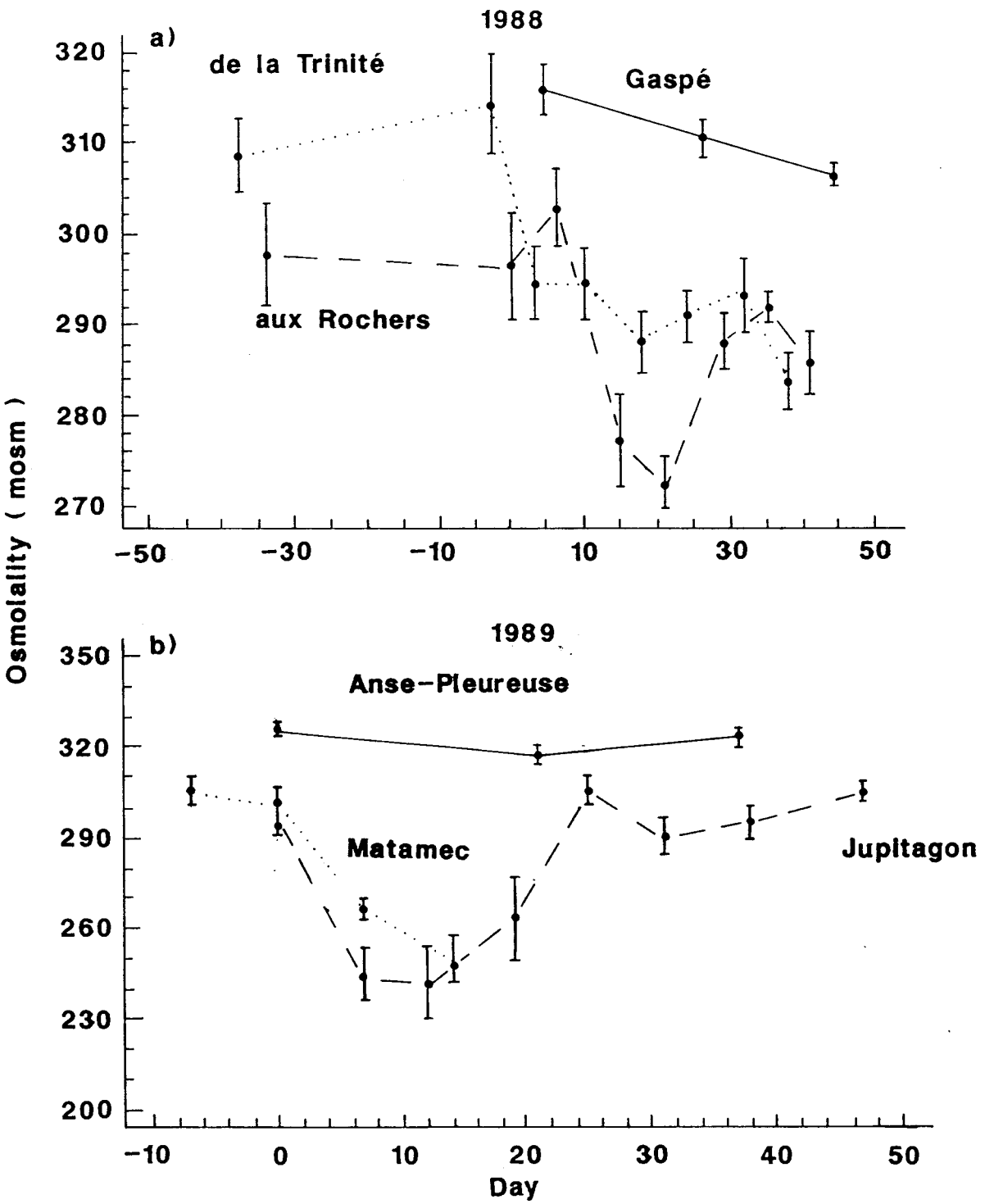

1988
a)
de la Trinité
Gaspé
aux Rochers
320
310
300
290
280
270
-50
-30
-10
10
30
50
1989
b)
Anse-Pleureuse
Matamec
Jupitagon
350
320
290
260
230
200
-10
0
10
20
30
40
50
Day
Osmolality (mosm)

FIGURE 13

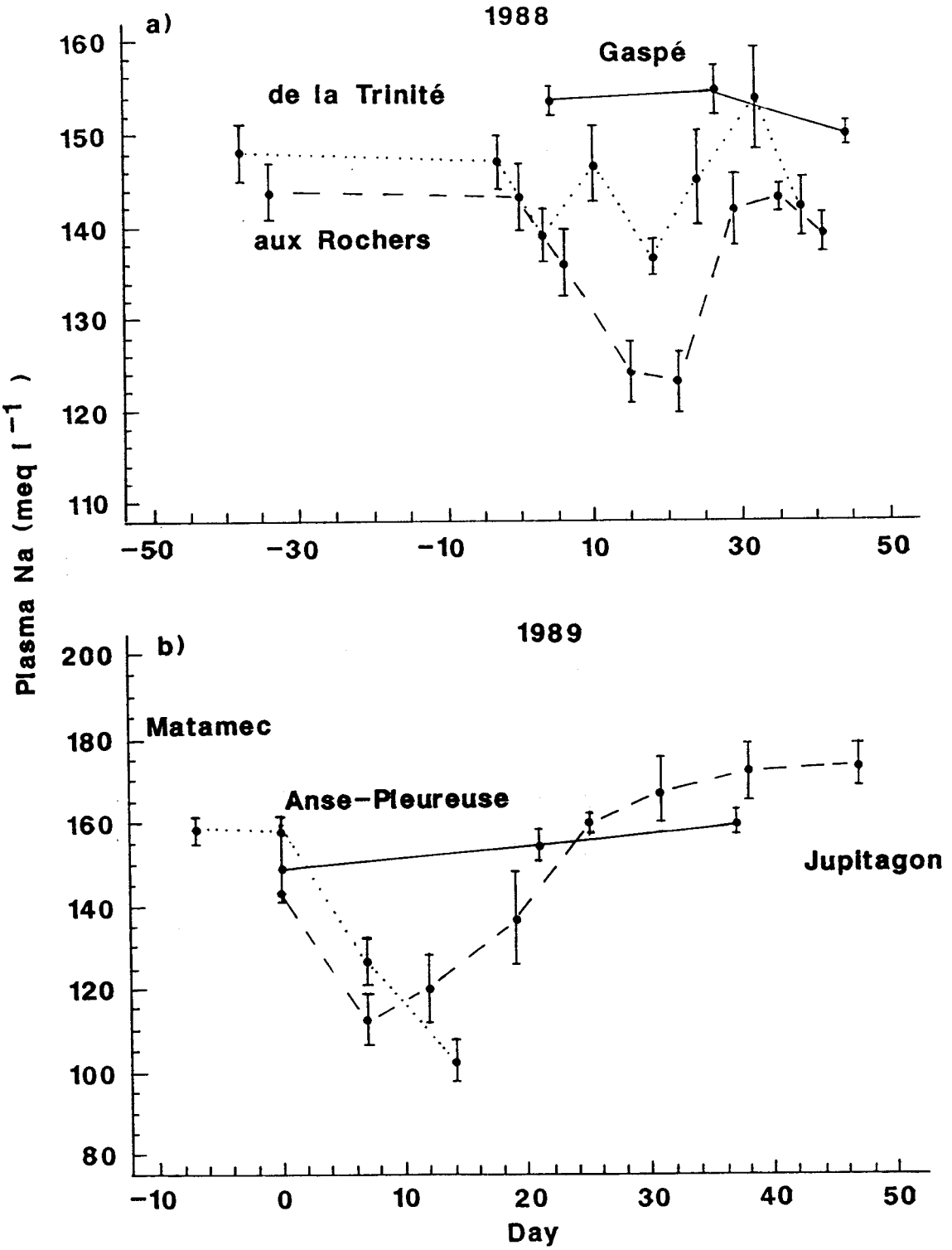

a)
1988
Gaspé
de la Trinité
aux Rochers
160
150
140
130
120
110
−50
−30
−10
10
30
50
b)
1989
Matamec
Anse-Pleureuse
Jupitagon
200
180
160
140
120
100
80
−10
0
10
20
30
40
50
Day
Plasma Na (meq l⁻¹)

FIGURE 14

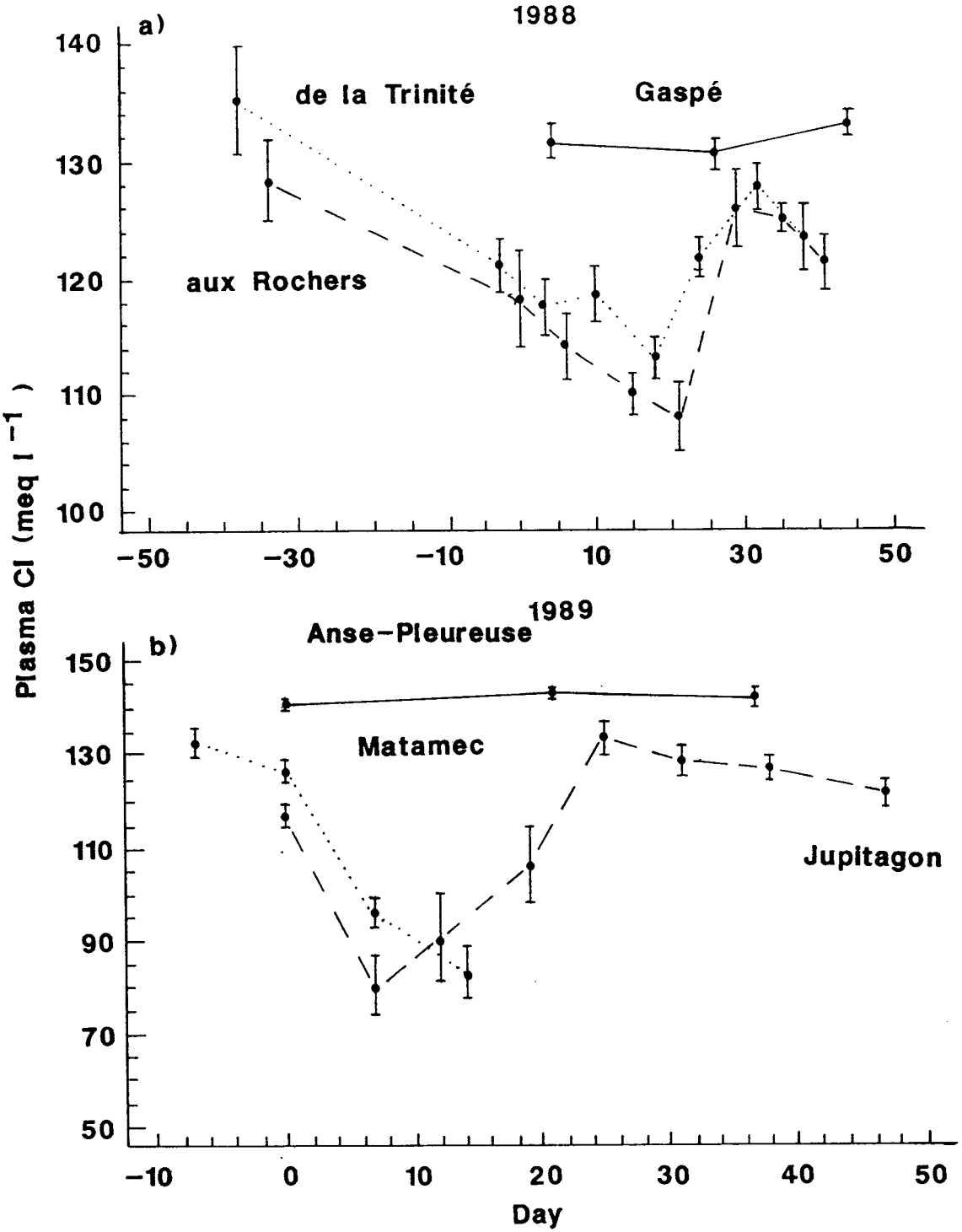

a)
1988
de la Trinité
Gaspé
aux Rochers
140
130
120
110
100
−50
−30
−10
10
30
50
Plasma Cl (meq l⁻¹)
b)
1989
Anse-Pleureuse
Matamec
Jupitagon
150
130
110
90
70
50
−10
0
10
20
30
40
50
Day

FIGURE 15

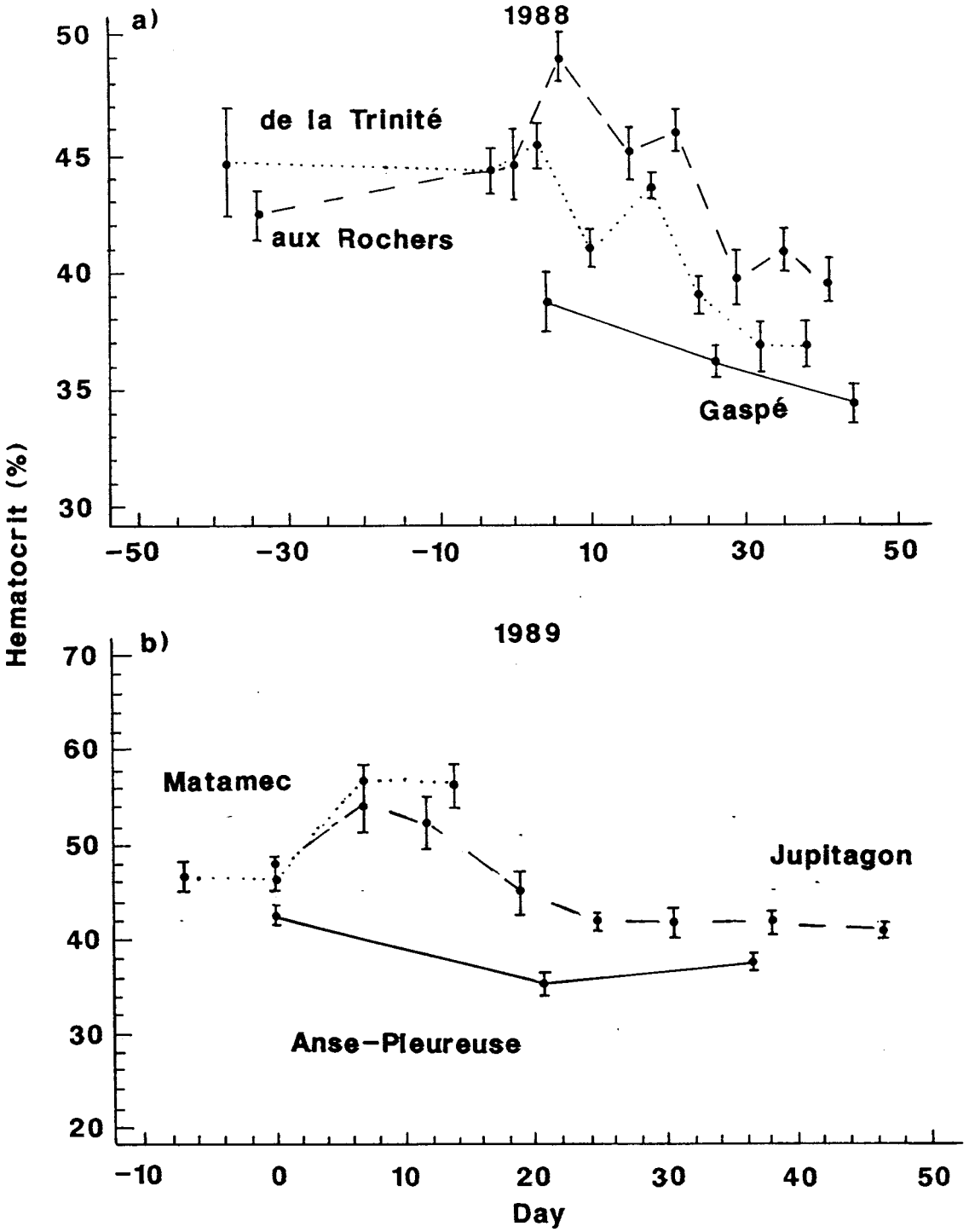

a)
1988
de la Trinité
aux Rochers
Gaspé
b)
1989
Matamec
Jupitagon
Anse-Pleureuse
Hematocrit (%)
Day

FIGURE 16

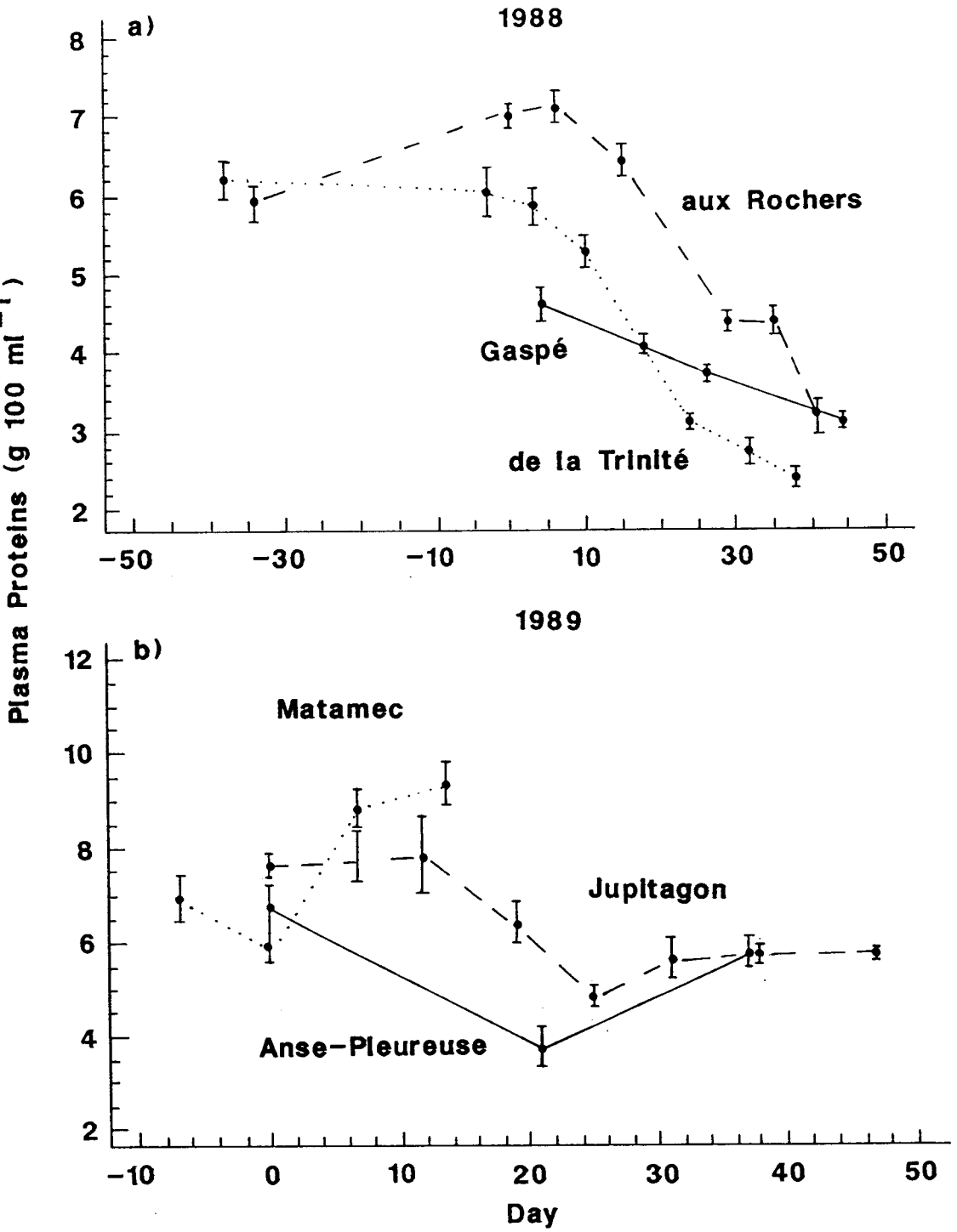

a)
1988
aux Rochers
Gaspé
de la Trinité
b)
1989
Matamec
Jupitagon
Anse-Pleureuse
Plasma Proteins (g 100 ml^{-1})
Day

FIGURE 17

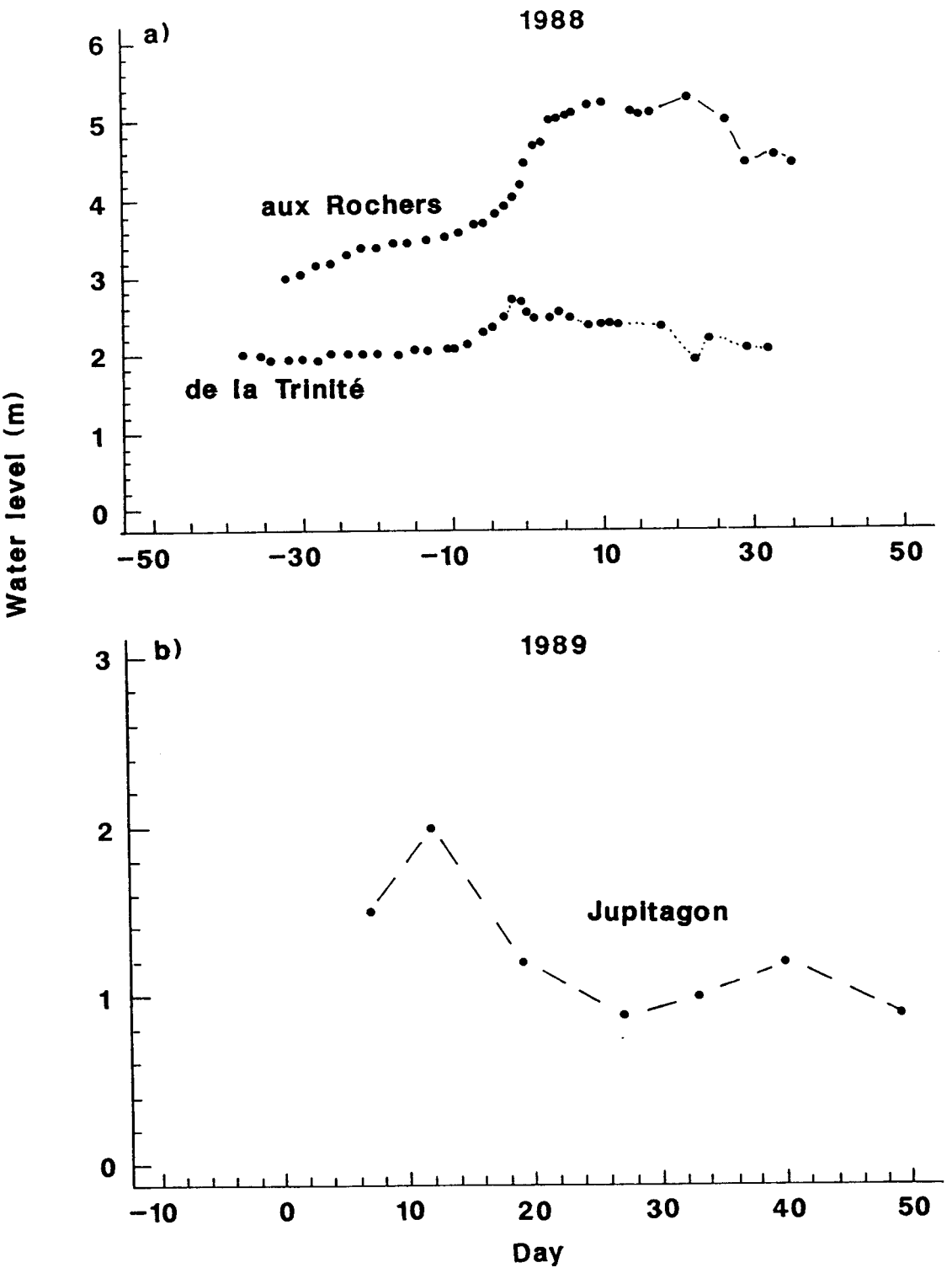

a)
1988
aux Rochers
de la Trinité
Water level (m)
6
5
4
3
2
1
0
-50
-30
-10
10
30
50
b)
1989
Jupitagon
3
2
1
0
-10
0
10
20
30
40
50
Day

FIGURE 18

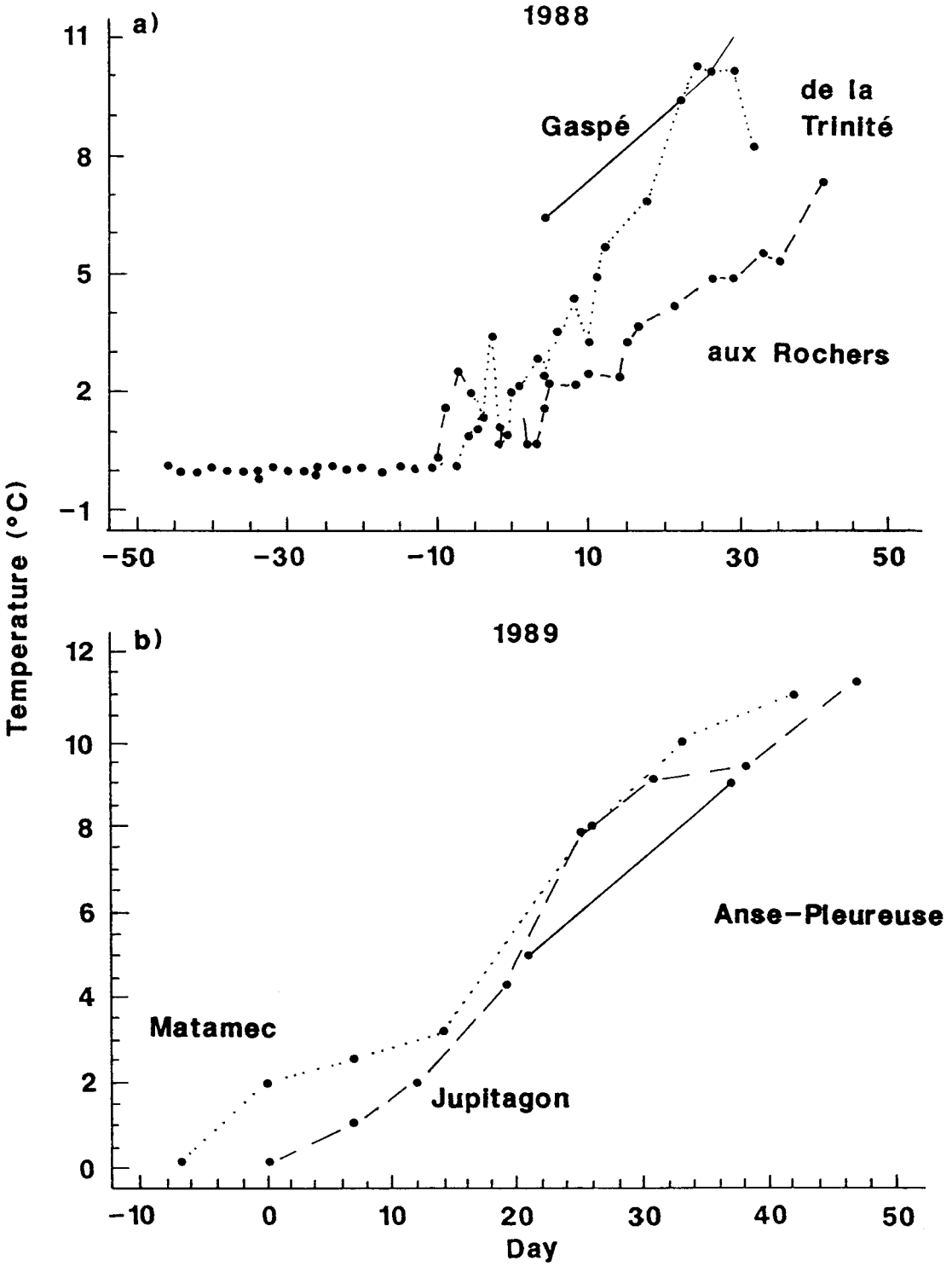

a)
1988
11
8
5
2
-1
Gaspé
de la
Trinité
aux Rochers
-50
-30
-10
10
30
50
b)
1989
12
10
8
6
4
2
0
Anse-Pleureuse
Matamec
Jupitagon
-10
0
10
20
30
40
50
Day
Temperature (°C)

FIGURE 19

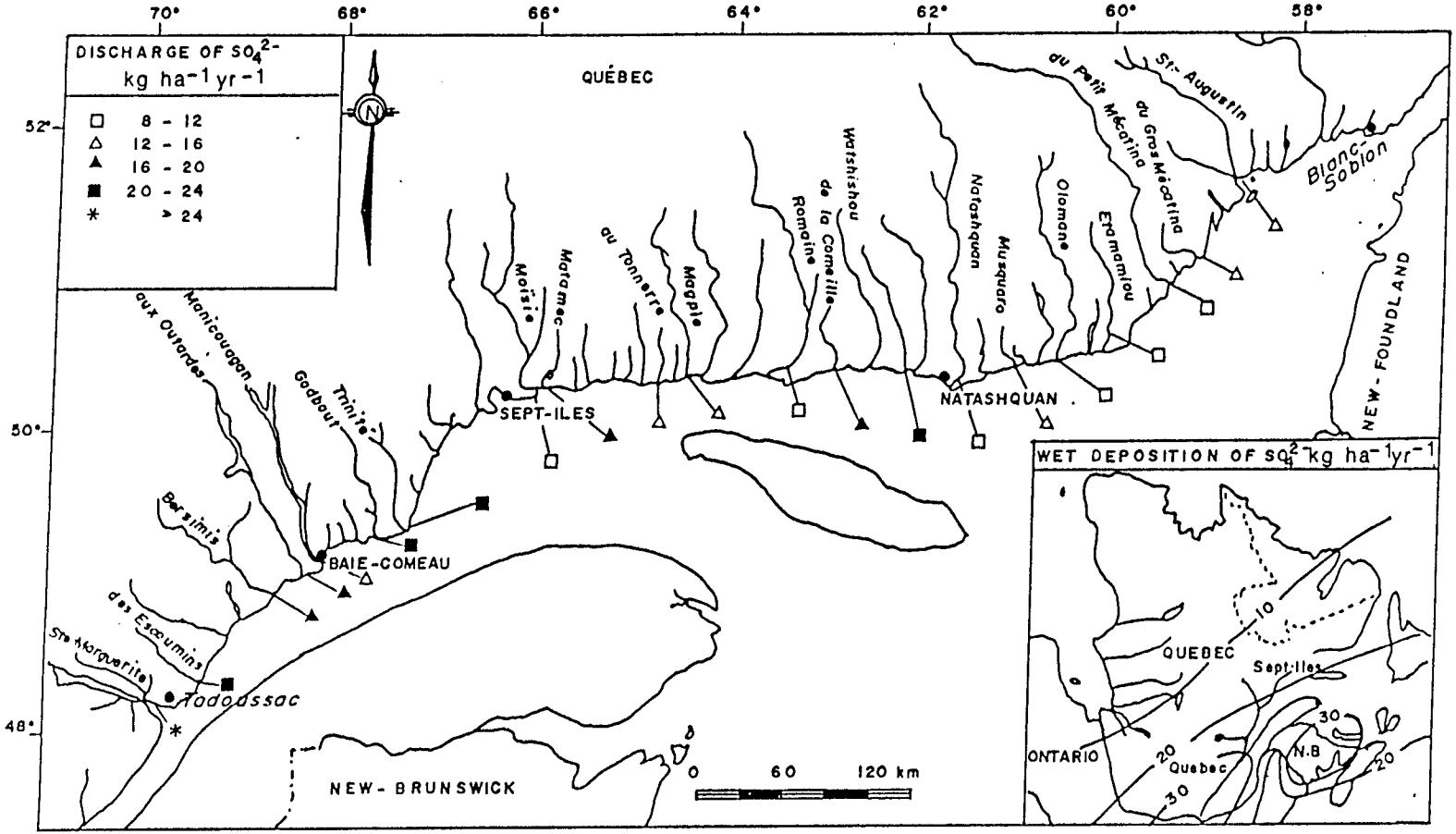

70°
68°
66°
64°
62°
60°
58°
52°
50°
48°
DISCHARGE OF SO_4^{2-}
kg ha⁻¹ yr⁻¹
8 - 12
12 - 16
16 - 20
20 - 24
> 24
QUÉBEC
Manicouagan
aux Outardes
Godbout
Trinité
Moisie
Matamec
au Tonnerre
Magpie
Romaine
de la Corneille
Watshishou
Natashquan
Musquaro
Olomane
Eromamiou
du Petit Mécatina
du Gros Mécatina
Ste-Augustin
Blanc-Sablon
NEW-FOUNDLAND
SEPT-ILES
NATASHQUAN
BAIE-COMEAU
Bersimis
des Escoumins
Ste Marguerite
Tadoussac
NEW-BRUNSWICK
0
60
120 km
WET DEPOSITION OF SO_4^{2-} kg ha⁻¹yr⁻¹
10
QUEBEC
Sept-Iles
30
ONTARIO
20
Quebec
N.B
20
30

FIGURE 20

2. PROPOSITIONS DE VOIES DE RECHERCHE PAR LES GESTIONNAIRES REGIONAUX POUR LE PROCHAIN PROGRAMME QUINQUENNAL

2.1 Région du Centre et de l'Arctique

RAY HESSLEIN

Les divers groupes de la région du Centre et de l'Arctique désireraient:

1) Maintenir le Programme de Biomonitoring à trois endroits (ELA, Algoma, Parry Sound).

2) Poursuivre les expériences sur l'acidification dans le lac 302 et sur le rétablissement du lac 223.

3) Examiner de plus près les effets de l'acidification sur les secteurs "Upland". (Participation assez importante du ministère de l'Environnement de l'Ontario.)

4) Procéder à d'autres études sur la relation entre la productivité du poisson et les effets de l'acidification.

5) Faire d'autres travaux sur les eaux brunes.

6) Procéder à une évaluation de l'impact acide en incluant les données sur les dépôts de nitrates dans le modèle.

2. REGIONAL MANAGERS' PROPOSALS ON RESEARCH ORIENTATION FOR THE NEXT FIVE-YEAR PROGRAM

2.1 Central and Arctic Region

RAY HESSLEIN

The various groups in the Central and Arctic Region would desire to:

1) Maintain the Biomonitoring Program at three sites (ELA, Algoma, Parry Sound).

2) Continue acidification experiment in Lake 302 and recovery of Lake 223.

3) Take a more serious look at the effects of acidification on Upland areas.(Fairly large participation from Ontario ministry of the Environment.)

4) Do more studies on the relationship between fish productivity and effects of acidification.

5) Do more work on brown water.

6) Carry on risk assessment acid with nitrate deposition put into that kind of a model.

7) Approfondir les études paléolimnologiques, physiologiques et biochimiques.

8) Passer aux études possibles sur les métaux, les composés organiques et le climat. (Effectuer l'expérience avec le cadmium pendant 2-3 ans, éventuellement avec un plan de rétablissement.)

9) Examiner l'addition de BPC et (ou) de HAP par des expériences sur les composés organiques, applicables à l'ensemble d'un lac.

10) Mettre davantage d'effort sur l'évaluation de l'impact des contaminants et du climat.

11) Faire passer la répartition de l'effort de 70 % - acide, 30 % - métal et composés organiques à 55 % et 45 %, respectivement. (Moyennant des conditions de financement optimales.)

Discussion

Iola Price a posé des questions concernant la contribution des services votés à ces chiffres (nouvelle répartition du % de l'effort). Comme ces chiffres ne reflétaient que le financement du programme TADPA V, Madame Price a suggéré à chaque région de réfléchir à la contribution qu'elle entendait apporter aux activités envisagées.

7) Add to paleolimnological studies, physiological and biochemical studies.

8) Move on to metals, organics and climate possibilities. (Hold the cadmium experiment for 2-3 years with a recovery plan eventually.)

9) Look at PCB and/or PAH addition to whole lake organic experiment.

10) Put more effort into risk assessment for contaminants issues and climate.

11) Move the ratio effort of 70 % acid, 30 % organic and metal to 55 % acid and 45 % organic and metal. (Under optimal funding conditions.)

Discussion

Questions were raised by Iola Price concerning the A-base contribution to these numbers (new % of ratio effort). As these numbers reflected only LRTAP V funding, Ms. Price suggested that each region think about what it is contributing for things that are intended to be done.

Au nom de la division de la Recherche sur l'Habitat du poisson, Ray Hesslein a dit que si le programme TADPA n'était plus financé, il faudrait fermer le secteur des lacs expérimentaux (ELA) parce que les services votés ne sont pas suffisants pour faire fonctionner le camp sans les fonds du TADPA; par ailleurs, les expériences à long terme sur le rétablissement de l'acidification et sur le cadmium en milieu humide ("Wetland") devraient toutes ralentir. Selon Vic Cairns, le financement du TADPA représente probablement 60 % du budget total et la contribution des services votés, probablement 20 %.

Ray Hesslein, speaking for the Fish Habitat Research division, said that if there was no further LRTAP funding, they would have to close the ELA because they don't have enough A-base to run the camp without LRTAP funding and also, all the long-term acidification recovery, cadmium, wetland experiments would go down. According to Vic Cairns, LRTAP funding represents probably 60 % of their total budget and their A-base contribution is probably 20 %.

2.2 Région de Scotia-Fundy

GILLES LACROIX

La région souhaite poursuivre ou amorcer des études dans les domaines suivants:

1) Le Programme de Biomonitoring des précipitations acides (1990-1995 et au-delà, 20 % des ressources).

2) Évaluation des techniques d'analyse des données concernant les changements spaciaux et temporels de la structure des populations (1990-1995).

3) Biomonitoring et étude toxicologique du saumon atlantique et chimie de l'eau dans des rivières du sud de la Nouvelle-Écosse touchées par le TADPA (1990-1995).

2.2 Scotia-Fundy Region

GILLES LACROIX

This region wish to continue or initiate a number of studies dealing with these topics:

1) Acid-rain Biomonitoring Program (1990-1995 and beyond 20 % of their resources).

2) Evaluation of techniques of data analysis pertaining to changes in community structure with time and space (1990-1995).

3) Biomonitoring and toxicological study on Atlantic salmon and water chemistry in LRTAP-impacted rivers of southwest Nova Scotia (1990-1995).

4) Mitigation de l'impact de l'acidification sur le saumon atlantique en Nouvelle-Écosse (1990-1993).

5) Mise au point d'une technologie pour la cryoconservation des ressources génétiques menacées par l'acidification (1990-1993).

6) Quantification de l'impact des contaminants TADPA et efficacité des mesures de mitigation (1990-1995).

7) Gestion du saumon atlantique dans les rivières acidifiées et impact de l'acidification sur les ressources disponibles (1990-1995).

8) Impacts de l'acidité sur l'écologie d'un salmonidé (1990-1995).

9) Écophysiologie comparée des salmonidés dans des cours d'eau acidifiés du Canada et de Scandinavie (1990-1993).

10) Relation entre les niveaux de Al et de Si dans les eaux naturelles de la région atlantique du Canada et de l'Écosse, et toxicité de ces eaux (1990-1992).

11) Effets, sur le saumon atlantique juvénile, de mélanges de métaux dans les eaux brunes (1991-1994).

4) Mitigation of acidification impacts on Atlantic Salmon in Nova Scotia (1990-1993).

5) Development of technology for cryopreservation of genetic resources threatened by acidification (1990-1993).

6) Quantification of LRTAP contaminants impacts and effectiveness of mitigation measures (1990-1995).

7) Atlantic salmon management in acidified rivers and impact of acidification on the resource base (1990-1995).

8) Impacts of acidity on a salmonid ecology (1990-1995).

9) Comparative ecophysiology of salmonids in acidified rivers of Canada and Scandinavia (1990-1993).

10) Relationship between Al and Si levels in natural waters of Atlantic Canada and Scotland and the toxicity of such waters (1990-1992).

11) Effects of metals mixtures in organic water on juvenile Atlantic salmon (1991-1994).

12) Efficacité du calcaire sur le lit des cours d'eau, comme refuge pour la reproduction du saumon atlantique dans les cours d'eau présentant une acidité chronique (1990-1995).

13) Le transport atmosphérique à distance de contaminants organiques vers les systèmes marins de la région atlantique du Canada et l'est de l'Arctique (1990-1994).

14) Reconstitution paléoécologique du transport atmosphérique à distance (actuel et historique) de contaminants vers la région atlantique du Canada (1990-1992).

12) Efficacy of limestone on streambeds as a refuge for reproduction of Atlantic salmon in chronically-acidic streams (1990-1995).

13) The long-range atmospheric transport of organic contaminants to the Canadian Atlantic and eastern Arctic marine systems (1990-1994).

14) Paleoecological reconstruction of the current and historical long range atmospheric transport of contaminants into Atlantic Canada (1990-1992).

Discussion

Selon Gilles Lacroix, 20 % des ressources vont au biomonitoring du Si, 20 %, à la recherche sur les causes et les effets, 20 %, à la quantification des impacts/du rétablissement de même qu'à la production du saumon/à la gestion, 20 % aux travaux sur la mitigation (chaulage et autres méthodes) et 20 %, aux composés organiques, aux contaminants et à la paléoécologie. Madame Price a mentionné qu'elle aimerait envisager une collaboration interrégionale dans certains de ces secteurs afin d'assurer une meilleure répartition des fonds dans l'avenir.

Discussion

According to Gilles Lacroix, 20 % of resources is going to the biomonitoring of Si, 20 % to cause-and-effect research, 20 % to quantification of impacts / recovery, and salmon production / management, 20 % to mitigation work (liming and other types) and 20 % to organics, contaminants and paleoecology. Ms. Price mentioned that she would like to think about cooperation inter-regionally on some of these things for a better distribution of funds in the future.

2.3 Région de Terre-Neuve

LARRY COADY

Aux termes du financement du TADPA V, sept projets sont prévus dans la région de Terre-Neuve. Trois de ceux-ci sont la continuation de projets entrepris en vertu du TADPA V, à savoir:

- monitoring biologique des effets du TADPA;
- acidification épisodique et monitoring de la qualité de l'eau à long terme;
- relevé des lacs et des rivières touchés par le TADPA.

Les quatre autres sont nouveaux:

- étude des sédiments lacustres au Labrador pour dégager les tendances historiques du TADPA;
- niveaux d'adduit ADN comme indicateurs biochimiques des HAP résultant du TADPA;
- rapport entre les doses et les effets, chez les poissons, des hydrocarbures aromatiques résultant du TADPA;
- biomonitoring à l'aide des branchies.

Le monitoring biologique et chimique doit se poursuivre afin de pouvoir faire le lien entre les changements qui surviennent dans les populations aquatiques et ceux qui se produisent dans les émissions TADPA.

2.3 Newfoundland Region

LARRY COADY

Seven projects are proposed for the Newfoundland Region under LRTAP V funding. Three of these are continuations of projects initiated under LRTAP V:

- biological monitoring for LRTAP effects;
- episodic acidification and long-term water quality monitoring;
- LRTAP-related lake and river surveys.

The remaining four are new:

- study of lake sediments in Labrador for historical trends in LRTAP;
- DNA-adduct levels as a biochemical indicator for LRTAP mediated PAH;
- dose response of fish to LRTAP aromatic hydrocarbons;
- fish gill biomonitoring.

Biological and chemical monitoring must continue in order that changes in aquatic communities can be linked to changes in LRTAP emissions.

Certaines preuves tendent à établir un lien entre les dépôts de SO_4 et une amélioration de la qualité de l'eau dans la partie insulaire de Terre-Neuve et ces travaux devraient se poursuivre. Les études sur le rétablissement et le biomonitoring sont par définition des travaux à long terme. Il est souhaitable de procéder à un monitoring intégré (processus aquatiques, terrestres et atmosphériques).

There is some evidence linking SO_4 deposition to improved water quality in insular Newfoundland and this work should continue. Biomonitoring and recovery studies are, of necessity, long-term. Integrated monitoring (aquatic, terrestrial and atmospheric processes) is desirable.

La région de Terre-Neuve aimerait mettre davantage l'accent sur la recherche organique qui a commencé à faire partie du programme TADPA du ministère en 1987. Les concentrations et la prévalence des composés organiques halogénés reliés au TADPA dans les sédiments et dans les tissus de poissons devraient être déterminées et les changements de ces concentrations, dans le temps, devraient faire l'objet d'études. Nous nous proposons de recueillir des poissons provenant de plusieurs régions du Labrador et de Terre-Neuve et d'en faire l'analyse pour déterminer les adduits ADN aromatiques. Les HAP peuvent réagir avec l'ADN, l'ARN et les protéines pour former divers adduits, dont certains, croit-on, sont liés au processus par lequel les produits chimiques deviennent mutagènes et cancérigènes. Nous nous proposons également d'exposer des poissons à une série de concentrations d'hydrocarbures aromatiques environnementaux et de mesurer la réaction de variables que l'on sait être affectées par les HA.

The Newfoundland Region would like to put more emphasis on organic research which became part of the departmental LRTAP program in 1987. The concentrations and prevalence of LRTAP-related halogenated organic compounds in sediment and fish tissue should be determined and changes in the concentration of these compounds with time should be investigated. We propose the collection of fish from several areas in Labrador and Newfoundland and analysis for aromatic-DNA adducts. PAH can react with DNA, RNA and proteins to form a variety of adducts, some of which are believed to be linked to the process whereby chemicals become mutagenic and carcinogenic. We also propose exposing fish to a series of concentrations of environmental aromatic hydrocarbons and measuring the response of variables known to be affected by AHs.

Une proposition de deux ans a été présentée, en vue de déterminer si l'histopathologie (des branchies) pourrait servir de méthode de biomonitoring pour l'étude des effets de l'acidification et des métaux chez les poissons.

A two-year proposal has been submitted to examine the possibility of histopathology (of fish gills) as a biomonitoring method to study the effects of acidification and metals on fish.

Les travaux de paléoécologie devraient être étendus au Labrador. On propose d'effectuer une étude de trois ans de carottes de sédiments provenant de quatre lacs du Labrador. On manque de données sur l'évolution de l'acidification au Labrador et ces études permettront de plus d'obtenir de l'information sur l'étendue et la nature des contaminants déposés par le TADPA.

Paleoecological work should be expanded into Labrador. A three-year study of downcore sediments from four lakes in Labrador is submitted. Data on the history of acidification in Labrador are lacking and these investigations will also provide data on the extent and nature of contaminants deposited by LRTAP.

2.4 Région du Québec

GORDON WALSH

M. Walsh a présenté ce tableau élaborant les grandes lignes des différentes priorités envisagées pour le futur avec le pourcentage des ressources qui devraient ou pourraient être allouées aux différentes orientations.

Il a terminé en mentionnant qu'il n'y a pas de ressource en base-A qui ont été allouées aux programmes dans la région du Québec sauf en ce qui a trait aux personnes-années. En général, une personne-année vient de la base-A.

2.4 Québec Region

GORDON WALSH

Mr. Walsh presented this table on the broad lines of the differents priorities foreseen for the future with the resources percentage that could be allocated to differents orientations.

He finished by mentionning that he has no resource in A-Base which were allocated to the Québec Region programs except the ones concerning the year-person. In general, one year-person comes from A-Base.

Région du Québec/Québec Region
Programme de TADPA 90-91/LRTAP Program 90-91
Priorités de recherche régionale/Regional research Priorities

Activité/Activity	% de ressources/ % of resources
Apports des composés organiques au golfe du St-Laurent/ Organics flux to the St. Lawrence Gulf	25
Programme de Biomonitoring/Biomonitoring Program	15
Indicateurs biochimiques et physiologiques - incluant les indicateurs énergétiques dans les populations de poisson/ Biochemical and physiological indicators - incl. Energetics in fish populations	30
Paléo-écologie (pH, métaux et composés organiques)/ Paleo-ecology (pH, metal and organics)	10
Boucle microbienne/Microbial food cycle	20

Discussion

Madame Price a alors demandé à M. Walsh s'il avait l'intention de proposer que tous ces projets se poursuivent pendant les cinq années.

Il a été répondu que la première, la deuxième et la troisième activités étaient proposées pour cinq ans, les travaux de paléoécologie, pour deux ans et les travaux sur la boucle alimentaire microbienne, pour une autre année.

Discussion

Ms. Price then asked to Mr. Walsh if he had the intention to propose that all these projects go for all five years.

It was answered of that, the first, the second and the third activities are proposed for five years, the paleo-ecology activity for two years and the microbial food cycle activity for one more year.

3. COMMENTAIRES GENERAUX SUR LES PROPOSITIONS DES GESTIONNAIRES REGIONAUX

Puis, il y a eu une discussion générale au cours de laquelle John Kelso a fait quelques observations au sujet de la perspective nationale à l'égard de l'orientation des programmes régionaux. Selon lui, il doit y avoir un mécanisme pour faire le pont et transposer les résultats de quelques systèmes aux ressources canadiennes.

Il a aussi fait remarquer qu'il y a un très grand nombre de programmes à caractère paléoécologique et de programmes portant sur les composés toxiques et que nombre d'autres organismes ont également entrepris des études semblables, ce qui fait ressortir l'impérieuse nécessité d'une coordination dans ces domaines.

Comme l'ont alors mentionné Ken Minns et Paul Keizer, John Smol assume déjà un rôle de coordination. Son service publie une liste de toutes les études paléoécologiques au Canada et identifie les programmes du MPO et des autres organismes. Cela aiderait le programme à conserver une certaine unité et à éliminer certains recoupements. Comme les régions avaient l'intention de proposer des travaux de paléoécologie à l'aide des paléodonnées sur le pH, Iola Price a ajouté qu'il faudrait peut-être choisir les régions qui fourniraient la plus grande quantité de données au meilleur coût.

3. GENERAL COMMENTS ON THESE REGIONAL MANAGER'S PROPOSALS

A general discussion then followed and John Kelso made a few observations concerning the national view of regional program's orientation. He said that there has to be a mechanism of bridging the scale from the results of a few systems to the Canadian resources.

He also pointed out that there are a very large number of paleoecology type programs and toxic material programs with a lot of other organizations involved in similar studies so there is a strong need for some coordination there.

As it was mentioned then by Ken Minns and Paul Keizer, a coordination role is already done by John Smol. His unit publishes a listing of all the paleo studies in Canada which identifies the DFO programs and other agencies. This would help to keep some unity to the program and cut down some overlap. As regions intended to propose paleoecology work with paleo pH data, Iola Price added that maybe there would be a need to pick those regions that would provide the greatest amount of data for the least of money.

D'autres participants ont aussi convenu de la nécessité d'une entente à un niveau assez élevé, ou d'un conseil de coordination, pour éviter le gaspillage de fonds.

Other participants have also agreed to the need of a fairly high-level agreement or a coordination board, otherwise a lot of money would be spent.

Greg Brunskill est d'accord avec les observations de John Kelso à l'effet qu'il y a des choses qui doivent être faites.

Greg Brunskill agreed with John Kelso's observations in saying that there are things that need to be done.

1) Déterminer les besoins à l'intérieur d'un programme.

1) Identify what are the needs to do as a program.

2) Nécessité d'obtenir de l'information des autres organismes. (Particulièrement les effets sur l'arène internationale et non pas seulement les processus atmosphériques du TADPA.)

2) Need of informations from other agencies. (Particularly the effect sides into the international arena and not only the atmospheric processes of LRTAP.)

3) Demander à l'organisme dirigeant de quoi il a besoin de la part du MPO.

3) Ask the lead agency what they need from DFO.

Iola Price a ensuite souligné le fait que le MPO devrait assumer sa représentation et la représentation du Canada et peut-être faire davantage pour s'assurer que les préoccupations des Pêches, les données des Pêches, les découvertes des Pêches soient incluses dans les documents d'information du Canada qui seront transmis à des personnes comme Tom Brydges du bureau de liaison du TADPA.

Iola Price then emphasized the fact that DFO should take up his representation and Canada's representation and perhaps make a greater attempt to ensure that Fisheries concerns, Fisheries data, Fisheries discoveries, are integrated into the Canadian briefing papers that go over with people like Tom Brydges from the LRTAP Liaison Office.

Jack Uthe conclut la discussion en disant qu'étant donné que toutes les régions envisagent de se lancer dans des études sur les substances organiques et comme cela suscitera un incroyable problème de précision des analyses, il proposait qu'on instaure à cette fin une gestion de la qualité et il a affirmé: "La gestion de la qualité, comme on la définit actuellement, se situe un échelon au-dessus de l'assurance de la qualité et de la précision."

Jack Uthe concluded this discussion by saying that, as every region talk about going into organics, and as it will bring about an incredible analytical accuracy problem, he suggested that a quality management be set up for this and he said: "Quality management as it's being defined now, which is one level above quality assurance and accuracy."

4. SYNTHESE DES ETUDES SUR L'ALUMINIUM/SYNTHESIS OF STUDIES ON ALUMINIUM

P.G.C. Campbell (INRS-Eau, Université du Québec, Sainte-Foy, Québec).

A synthesis of some of the recent work in the area of aluminium geochemistry and toxicology was presented. Mr. Campbell talked about two subjects:

1) Application of some of these speciation techniques to the study of the geochemistry of aluminium.

2) Some recent results on the toxicology of fluoral aluminium complexes.

The first part of his presentation, the geochemistry of some salmon rivers on Québec's North Shore having used the speciation technique is shortly described by this following abstract.

Campbell, P.G.C., B. Dubreuil et H.J. Hansen. 1989. Comportement géochimique de l'aluminium dans quelques rivières à saumon de la Côte-Nord (golfe du Saint-Laurent). Rapp. tech. can. sci. halieut. aquat. 1697: X + 63 p.

The roles of dissolved organic carbon (DOC) and ambient pH as factors determining aluminium speciation in three Atlantic salmon rivers (Québec North Shore: McDonald, aux Rochers and de la Trinité rivers) have been evaluated for 1986 winter low flows and during the subsequent spring runoff. During the initial period (early February to mid-April) river flows were low and stable, and river water quality (pH, DOC, colour, Ca^{+2}, F^-, NO_3^-, SO_4^{-2}, filterable Al) showed little fluctuation between sampling dates. With the onset of snowmelt, most solutes exhibited the expected dilution behaviour,

but several parameters demonstrated the opposite trend and attained maximum values during the peak flows ($[H^+]$; colour, DOC; filterable Al) (Figure 1). In effect, all three rivers experienced a marked pH depression during the snowmelt period; the coincident peaks in acidity, water colour and dissolved organic carbon suggest an important contribution by organic acids to the spring pH minima.

During the period of stable river flows that preceded the spring thaw, the distribution of filterable Al among the various operationally defined forms was reasonably constant (monomeric inorganic Al 10-15 %; monomeric organic Al 30-45 %; non-reactive Al 40-60 %). This distribution pattern was perturbed somewhat during the snowmelt period: both monomeric forms of aluminum contributed to the peak in filterable Al, whereas the non-reactive forms of aluminum (polynuclear species + non-reactive forms associated with fulvic or humic acids) declined in importance (-> 20-30 % filterable Al).

The distribution of aluminum among its various inorganic complexes, as calculated with a chemical equilibrium model, also showed marked fluctuations during the study period (Figure 2). The aluminate anion, $Al(OH)_4^-$, dominated the calculated speciation of dissolved inorganic aluminum for all three rivers during the winter low flows. With the advent of spring runoff, however, the pH depression led to the virtual disappearance of this species; the fluoro-Al complexes (AlF^{+2} and AlF_2^+) together with the cationic hydroxy-Al complexes ($AlOH^{+2}$ and $Al(OH)_2^+$) assumed much greater importance. Even during this period of low pH, however, the calculated proportion of the free Al^{+3} ion never exceeded 25 %. As the pH rose after the spring flood, $Al(OH)_4^-$ again became the dominant inorganic species in solution.

Multiple regression analyses were performed for the two study periods, before and during spring runoff, with monomeric organic aluminum as the dependent variable and DOC, filterable-Al, pH, and fluoride as predictors. Very different results were obtained within and outside the flood period: $[\text{organic Al}] = 0.48x[Al]_f - 0.89x\text{pH} + 4.57$ during the spring runoff; $[\text{organic Al}] = 0.34x\ [\text{DOC}] + 0.14$ outside the snowmelt period (Figure 3). In periods with stable water flow, DOC was the most important predictor; since the other variables were interrelated under these conditions, they could not be considered as independent variables in the development of a predictive equation. During spring runoff the predictors were not interrelated, but together they could only explain 50 % of the variance, suggesting that a predictive model may not be not feasible for this critical period.

The second part is concerning the effect of fluoride complexation on aluminum toxicity towards juvenile Atlantic salmon (Salmo Salar L.) described by this abstract.

Kevin J. Wilkinson, Peter G.C. Campbell and Pierre Couture
Université du Québec, INRS-Eau
C.P. 7500, Sainte-Foy, Québec, Canada G1V 4C7

In a series of semi-static experiments (duration 7 d), the effect of fluoride complexation on aluminum toxicity towards juvenile Atlantic salmon (Salmo salar L.; age 1+) was evaluated in synthetic media similar to the soft, acidic waters of the Canadian Shield. Major ion concentrations (∗cations = 0.25 mM), pH (4.5 or 4.9), O_2 content (10+ 2 mg. L^{-1}) and temperature (10+1 °C) were kept constant, while Al and F concentrations were varied, either individually or simultaneously. Monitored parameters included plasma Na levels, gill Al concentrations and fish mortality.

Fluoride complexation attenuated both the mortality of Atlantic salmon in the presence of aluminum and the accumulation of Al in gill tissue, but not to the extent predicted by the free-ion model of metal toxicity (Figure 4). Bioaccumulation and an important toxicity persisted even in the presence of an excess of the complexing ligand. An equilibrium model, involving the formation of a mixed ligand complex {F-Al-L-gill} at the gill surface, is proposed to explain this residual toxicity (Figure 5).

Exposure to Al, or to a combination of Al and F, led to a decrease in the plasma sodium levels even for sub-lethal conditions (Figure 6). At pH 4.5 and 4.9, the toxic action of aluminum in the presence of fluoride appears to be due to a perturbation of the osmoregulatory system. Aluminum concentrations as low as 2 ∗M adversely affected the salmon. The similarity of the osmoregulatory response to the H^+ - ion, to Al^{3+} and to $Al(F)_x$ suggested that the mechanism of toxicity in the presence of fluoride did not differ markedly from that observed by previous workers for salmonid species exposed to moderately acidic media containing Al but without added fluoride.

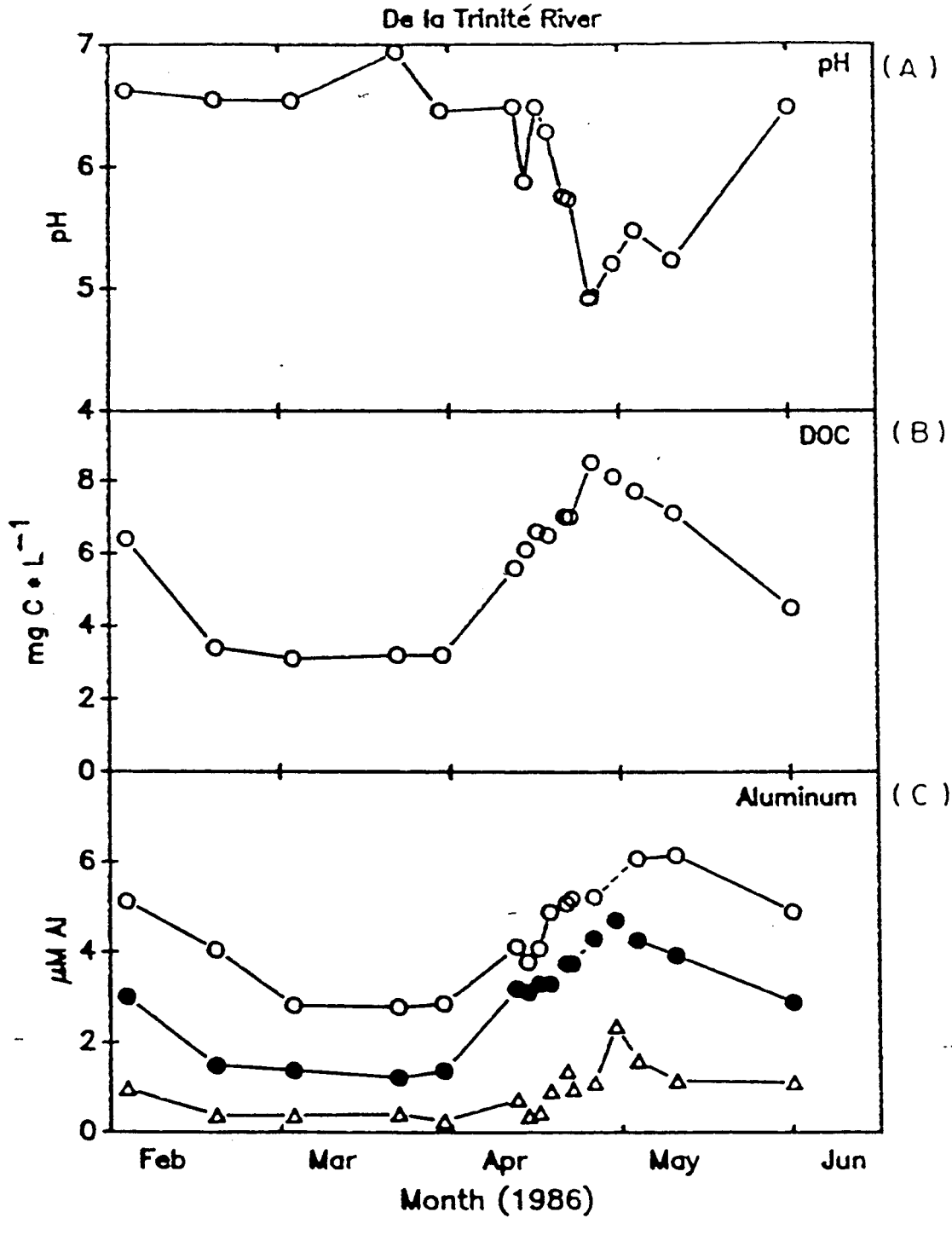


Figure 1: Temporal variation of water quality in the De la Trinité River. (A) pH; (B) Dissolved organic carbon; (C) Filterable aluminum - monomeric inorganic Al (Δ); total monomeric Al (•); total Al_f(o).

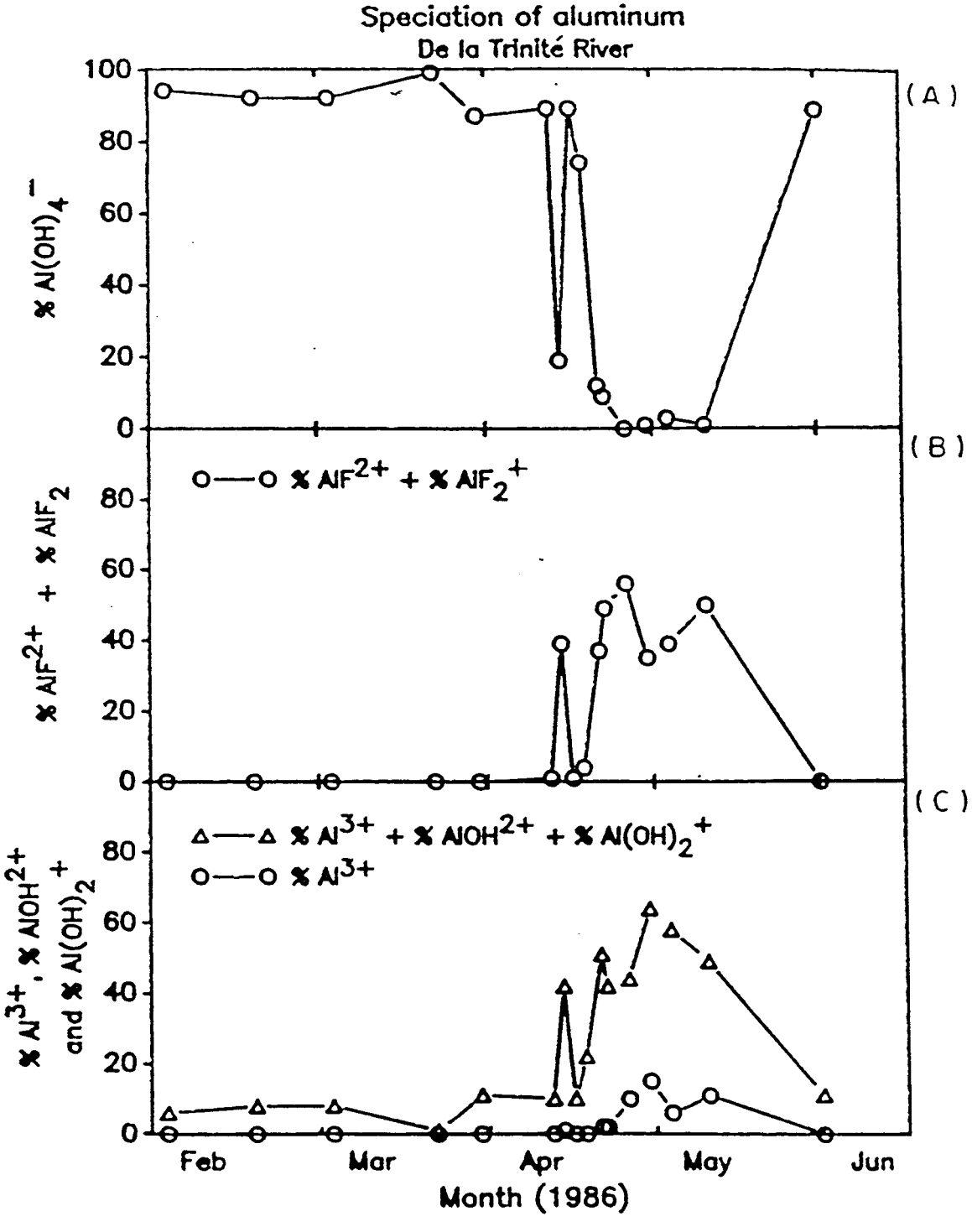


Figure 2: Temporal variation of the calculated speciation of inorganic monomeric aluminum in the De la Trinité River (%), (A) Aluminate anion; (B) Σ fluoro-Al complexes; (C) Σ cationic hydroxy-Al complexes + free Al^{3+} ion.

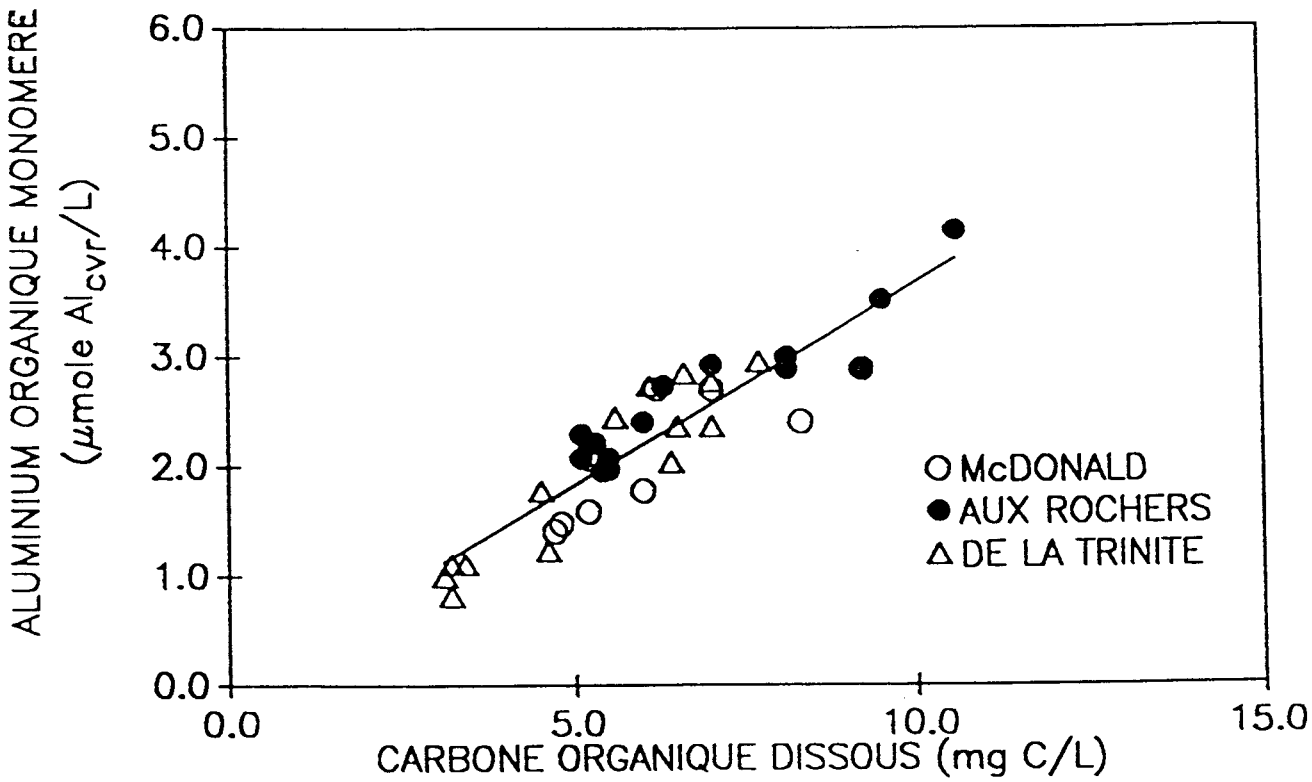


Figure 3. Correlation between monomeric organic Al and dissolved organic carbon: sampling dates outside the snowmelt period ([organic-Al] = 0.34 • [DOC] + 0.14).

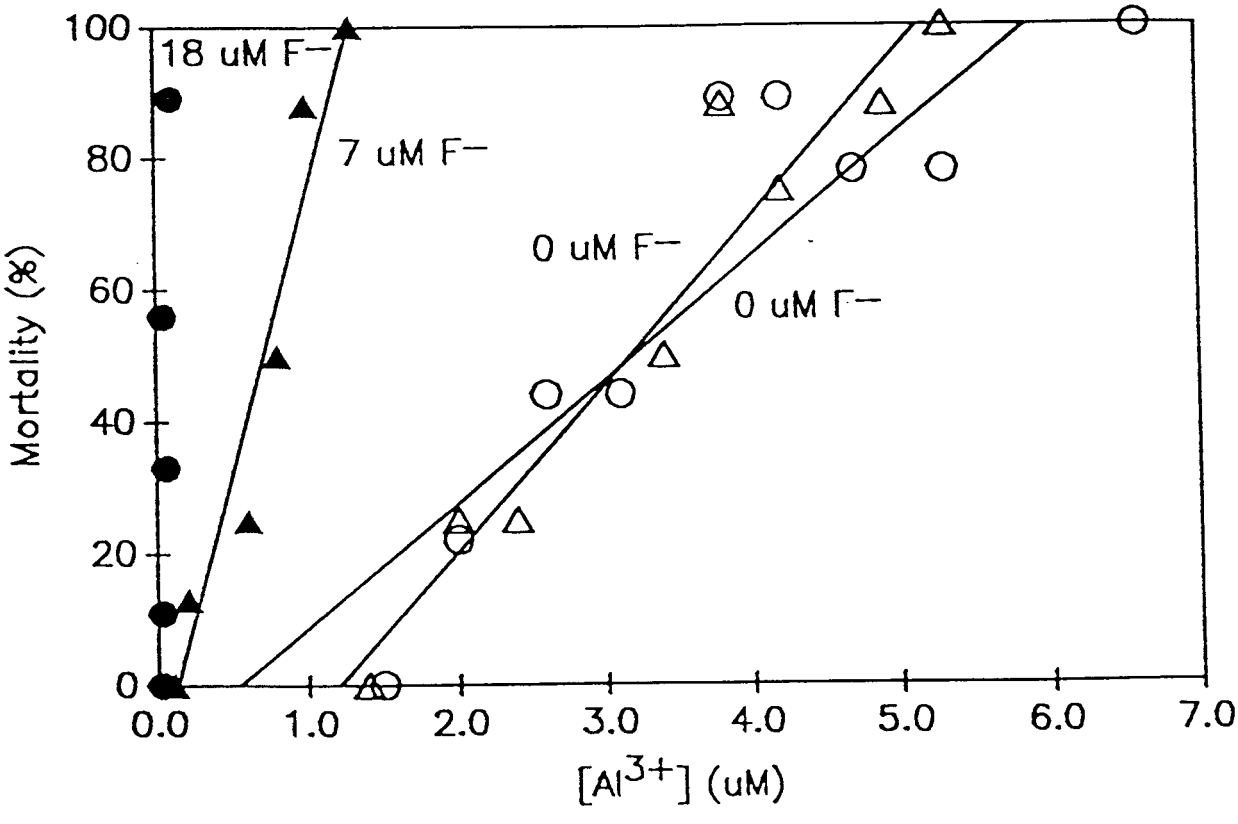


Figure 4. Mortality curves: Salmon mortality after 7 days as a function of free ion (Al^{3+}) concentrations. Open symbols represent experiments in which no fluoride was added. Closed triangles (▲) correspond to 7μM added fluoride whereas closed circles (●) correspond to 18 μM added fluoride.

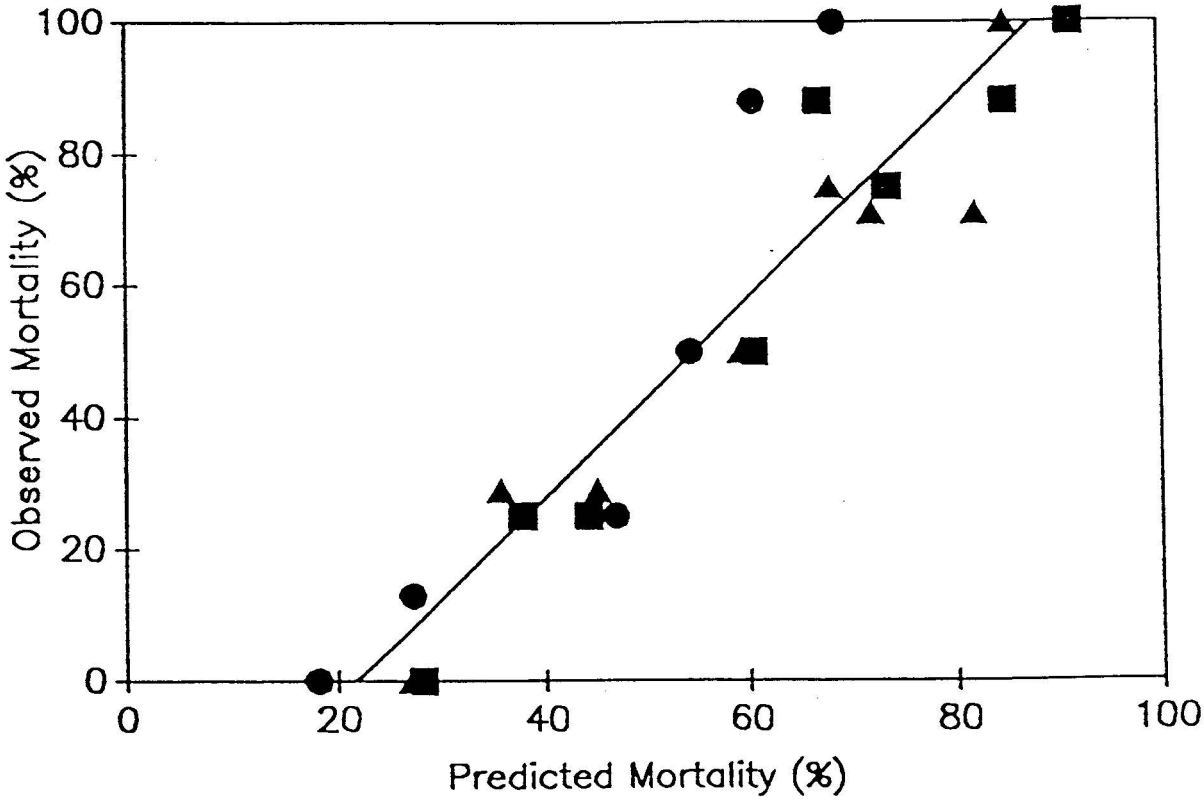


Figure 5. Observed versus predicted (7 d) mortality for experiments with salmon fry: Observed = 1.5 Predicted -33; r^2 =0.93. Predicted mortality was calculated from the equation 16.3{Al^{3+}} + 10.3{AlF^{2+}}, n=22, standard error of estimation = 17.6.

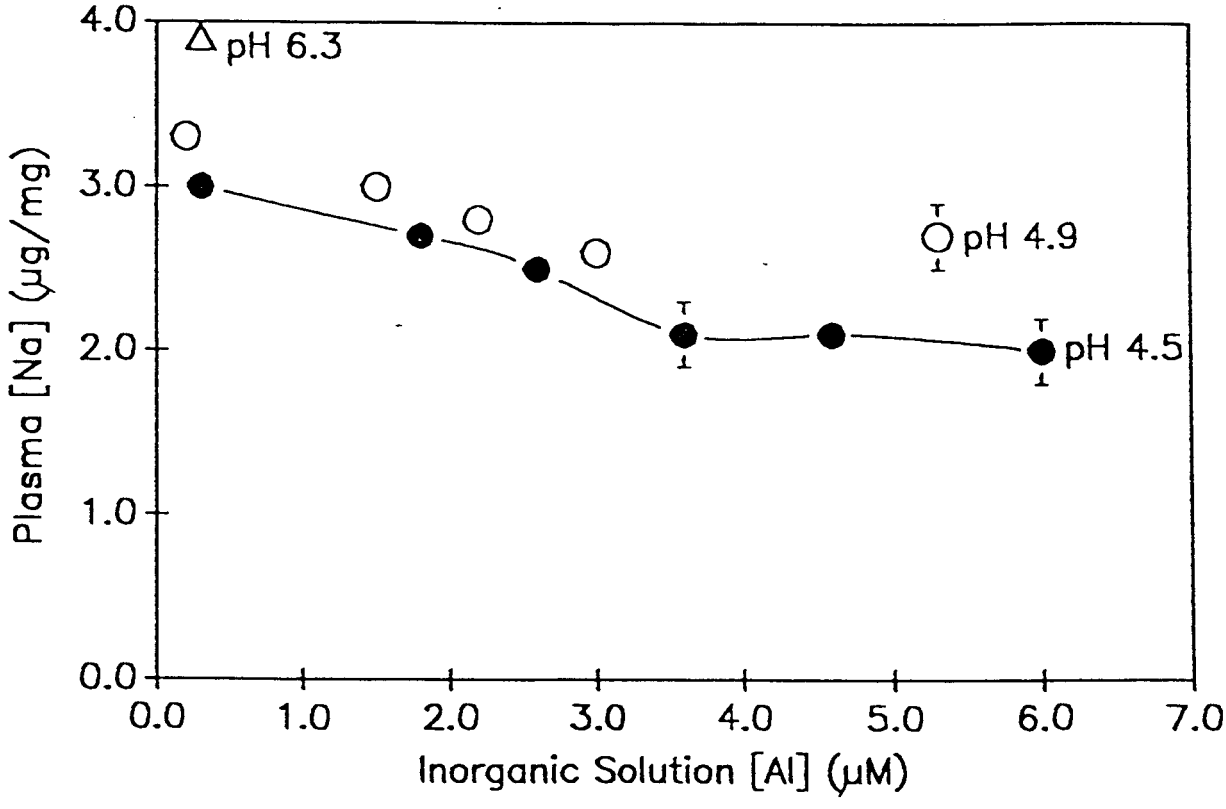


Figure 6. Variation of plasma sodium concentrations as a function of inorganic solution aluminum for experiments at pH 4.5 (●) pH 4.9 (○) as well as control fish (pH 6.3: △). Means ± standard errors are presented; n varies between 3 and 8.

Exposé de P.G.C. Campbell
(Discussion)

Des questions ont été posées par Ray Hesslein à savoir si les autres ligands dans le système qui ont plus d'affinité pour Al réduiraient la toxicité. Al étant trivalent et ayant la capacité de former ces complexes à ligands multiples, il ne va pas suivre le modèle simple d'ion libre, non seulement parce qu'il faut tenir compte du lien Al, mais de Al qui est aussi lié en même temps au fluorure ou à un autre ligand.

Concernant le cadmium particulièrement, le pH plus bas assure une protection car le cadmium est un des métaux pour lesquels l'ion hydrogène semble jouer un rôle de concurrent efficace.

P.G.C. Campbell's Presentation
(Discussion)

Questions were raised by Ray Hesslein about other ligands in the system that had higher affinities for Al, if they would reduce the toxicity. Al being trivalent and having a capacity to form these mixed ligand complexes is not going to follow the simple free ion model, because not only the Al bound to be considered but the Al which is also bound at the same time to fluoride or another ligand.

Concerning the cadmium specifically, there is protection provided by lower pH because cadmium is one of the metals for which it did appear that hydrogen-ion is playing an effective role as a competitor.

5. POINT DE VUE DU CCRM SUR LE FUTUR PROGRAMME (lettre de Tom Brydges)

Madame Iola Price lit textuellement la lettre adressée à Gordon Walsh, du bureau de liaison du programme TADPA, par Tom Brydges dans laquelle celui-ci donne un aperçu des points que, selon lui, le nouveau programme devrait comprendre.

5. RMCC POINT OF VIEW ON THE NEXT PROGRAM (Tom Brydges' letter)

Ms. Iola Price then read, verbatum, Tom Brydges' letter from the LRTAP Liaison Office addressed to Gordon Walsh, that gives some idea of what he sees as the needs for the next LRTAP program. A copy of it follows:

Environment Canada | Environnement Canada
Atmospheric Environment Service | Service de l'environnement atmosphérique

4905 Dufferin Street
Downsview, Ontario
M3H 5T4

Your file / Votre référence

Our file / Notre référence

September 25, 1989

8305-4(ASCA)/A418

Gordon Walsh
Marie Ste. Montagne Institute
Department Fisheries and Ocean
P.O. Box 1000
Mont Joli, Quebec
G5H 3Z4

Dear Mr. Walsh:

We regret that staff from the Secretariat for the Changing Atmosphere (ASCA) are unable to attend your workshop. We do, however, have some ideas on the research priorities for the next stage of the program. There are four main areas that need to be considered by the LRTAP program as a whole. They are:

1. Chemical and biological monitoring of the effectiveness of the sulphur dioxide control program. The DFO biomonitoring program will be essential for addressing this issue.
2. Determination of the effects of nitrogen and related compounds on the environment and the establishment of critical loads for nitrogen. Reaching agreement on critical loads is part of the ECE NOx Protocol that Canada signed last year. DFO will have a role to play in resolving this issue.
3. Resolution of the causes of the forest decline.
4. Determination of the effects of transported air pollutants on human health.

Other emerging environmental issues relevant to the DFO LRTAP program include:

a) Assessment of the effects of metals, in particular mercury;
b) Assessment of the effects of toxic contaminants in the aquatic ecosystem;
c) Assessment of the effects of contaminants in the arctic; and
d) Assessment of the effects of climate change on the aquatic biological resource. ELA already has one of the longest, high quality, data sets on the effects of climate on water resources and wetlands.

We look forward to hearing of your plans in all of these area. Best of luck with your workshop.

Sincerely yours,

for Tom Brydges
A/Senior Advisor
ASCA

Canada

6 PROGRAMME DE BIOMONITORING: REALISATIONS ET PERSPECTIVES

IAN DAVIES

M. Davies commence son exposé en montrant une carte illustrant les sites actuels de surveillance biologique (biomonitoring) du MPO. Pour mieux décrire les points d'intérêt du programme, il expose de façon assez détaillée la philosophie de ce dernier, laquelle a été légèrement modifiée depuis la conception du programme, en 1986, sous l'égide du comité consultatif scientifique du TADPA.

A) Caractéristiques fondamentales du Programme de Biomonitoring

1) Le programme vise des ichtyofaunes constitués principalement de poissons et de benthos.

2) On a choisi des groupes de trois à cinq lacs à chacun des sept endroits et des groupes de cinq rivières à chacun des deux emplacements choisis dans l'est et le centre du Canada et dont le gradient de dépôts humides de sulphate varie de 5 kg $.ha^{-1}.an^{-1}$ à > 20 kg $.ha^{-1}.an^{-1}$.

3) Les systèmes à l'étude présentent un faible taux d'alcalinité, sont de taille réduite, sont soustraits aux influences locales de la pollution et, si possible, sont protégés contre toute perturbation à long terme.

6. BIOMONITORING PROGRAM: REALISATIONS AND PERSPECTIVES

IAN DAVIES

Mr. Davies started his presentation by showing a map representing the location of the DFO's biomonitoring sites as they exist now (see next). In order to give a better focus to the monitoring program, he laid out in some detail what the philosophy of the program is, since it changed slightly since the program's original design in 1986 under the LRTAP Scientific Advisory Committee.

A) Central characteristics of the biological monitoring program

1) Community based (largely fish and benthos).

2) Select groups of 3-5 lakes in each of 7 locations and 5 rivers in each of 2 locations in eastern and central Canada distributed across a gradient of wet sulphate deposition (= 5 kg $.ha^{-1}.yr^{-1}$ to > 20 kg $.ha^{-1}.yr^{-1}$).

3) Study systems are low alkalinity, small, free of local influences of pollution and where possible, secure against long-term disturbance.

Les sites de biomonitoring correspondent de préférence aux sites retenus par le ministère de l'Environnement.

Co-location with DOE sites is desirable.

4) Le programme se veut un programme de longue durée.

4) Designed to be a long-term program.

5) La priorité est accordée à la qualité des échantillonnages et non à la quantité.

5) Emphasis is on qualitative rather than quantitative sampling.

6) L'exécution du programme nécessitera neuf années-personnes et coûtera 500 000 $ par année.

6) Costs 9 PY's and $ 500,000 annually.

B) Points forts du Programme de Biomonitoring

B) Strengths of the Biomonitoring Program

1) Il fournit des études de référence pour étayer les changements observés.

1) Provide "case-book" studies to document change.

2) Le choix des systèmes et des ichtyofaunes-cibles potentiels rend le programme sensible à diverses perturbations environnementales.

2) Choice of systems and potential target communities makes the programme sensitive to a variety of environmental perturbations.

3) L'étude d'ichtyofaunes constitue une approche plus générale et plus valable que la simple utilisation d'un groupe d'espèces indicatrices.

3) Community approach is much broader and more robust than simply using a set of indicator species.

4) Le programme permet de déterminer dans une certaine mesure les limites de la variabilité naturelle.

4) Gives some expectation to the limits of natural variability.

5) Le programme fournit des données à l'appui de la recherche de cause à effet.

5) Provides support data for cause-effect research.

6) L'ichtyofaune constitue un facteur d'importance générale du programme tant sur le plan scientifique que pour l'intérêt public.

7) Le programme canadien est plus rentable que le programme européen et le programme proposé par la EPA aux États-Unis.

C) Contraintes fondamentales du Programme de Biomonitoring

1) Le programme permet d'observer les tendances dans le temps, mais il n'illustre pas le rapport de cause à effet.

2) Les données obtenues ne peuvent pas être extrapolées pour déterminer les tendances régionales sauf si l'on établit des rapports entre les données biologiques et chimiques.

3) Les comparaisons inter-régionales sont difficiles à effectuer sauf pour ce qui est des tendances communes.

4) Les résultats sont limités à deux régions seulement: l'est et le centre du Canada.

D) Problèmes d'exécution (solutions à ce jour)

1) Les stratégies d'échantillonnage sont inappropriées pour certains habitats (substrats artificiels, mise en commun des données).

6) Fish community occupies a position of general importance in the program. This has both scientific and public interest significance.

7) Canadian biomonitoring is more cost effective than the European programme and that proposed by the US EPA.

C) Basic limitations of the Biomonitoring Program

1) Yields trend-through-time information, not cause-effect information.

2) Results cannot be extrapolated to establish regional trends except through biological-chemical linkages.

3) Interregional comparisons difficult except in terms of common trends.

4) Results are limited to eastern and central Canada.

D) Operational weakness (solutions to date)

1) Sampling strategies are inadequate for some habitats (artificial substrates, data pooling).

2) Le contrôle et l'assurance de la qualité sont limités (nombre accru d'échantillonnages, listes communes des autorités taxonomiques, enregistrement magnétoscopique des habitats et des méthodes d'échantillonnage, assurance de la qualité des données à l'échelle régionale).

3) Incohérence sur le plan de la taxonomie (aucune solution, absence de service de consultation central).

4) Aucune banque centrale des données et aucun analyste (code ASCII commun en voie d'élaboration).

5) Base de financement incertaine (aucune solution).

6) Dépenses annuelles élevées compte tenu du budget global du programme (évaluation critique des techniques d'échantillonnage).

E) Objectifs de 1988-1989 (décrits à l'atelier de l'année dernière)

1) Rédiger un rapport technique et une version révisée du protocole.

2) Adopter une formule commune pour l'échange de données informatisées.

3) Examiner la méthodologie.

2) Limited QA/QC (extra effort sampling, common lists of taxonomic authorities, videotaping of habitat and sampling procedures, regional assurance of data quality).

3) Taxonomic consistency (none, no central curatorial facility).

4) Lack of central data bank and analyst (common ASCII format being developed).

5) Uncertain funding base (none).

6) High annual expense in terms of the total LRTAP allocation (critical evaluation of sampling techniques).

E) 1988/1989 Goals (outlined last year to the Workshop)

1) Produce a technical report and a revised version of the protocol.

2) Agree on a common format for computerized data exchange.

3) Examine methodology.

4) Prendre des décisions concernant les études paléolimnologiques à exécuter sur les lacs visés par le programme, à savoir indiquer les paramètres à mesurer et les responsables de ces mesures.

5) Améliorer l'assurance et le contrôle de la qualité.

6) Evaluer les techniques d'analyse des données.

7) Etablir des liens avec d'autres programmes.

8) Constituer des collections de référence à l'intention des musées.

9) Trouver des moyens d'assurer la sécurité des sites à long terme.

10) Revoir le choix des sites à Terre-Neuve.

11) Ajouter des lacs dans le district de Parry Sound en Ontario.

F) Etude des résultats obtenus en 1988-1989

1) Bioessai en cage sur deux rivières du Québec et trois rivières de la Nouvelle-Écosse.

2) Ajout d'un site à Terre-Neuve, rétablissement de la région des étangs expérimentaux, suppression d'un site à Algoma et modification d'un site de la région des lacs expérimentaux.

4) Resolve the need for paleolimnological studies on the monitoring lakes. What should be measured and by whom?

5) Improve QA/QC.

6) Evaluate techniques of data analysis.

7) Establish connections with other programs.

8) Create museum curated reference collections.

9) Investigate ways of achieving long-term site security.

10) Re-examine site choices in Newfoundland.

11) Add lakes in the Parry Sound District, Ontario

F) Review of 1988/1989 results

1) Cage Bioassay on 2 Québec rivers and 3 rivers in N.S.

2) Addition of 1 site in Newfoundland, restoration of EPA, cancellation of 1 site in Algoma and change of one ELA site.

3) Essai de substrats artificiels à quatre endroits.

4) Proposition de deux systèmes d'assurance et de contrôle de la qualité pour les invertébrés.

5) Essais méthodologiques.

6) Quelques indications de rétablissement chimique à Terre-Neuve.

G) Objectifs de 1989-1990

1) Rédiger un rapport technique et une version révisée du protocole.

2) Établir un modèle de base de données standard et un dépôt central des données.

3) Poursuivre l'évaluation critique de la méthodologie

4) Améliorer l'assurance et le contrôle de la qualité.

5) Évaluer les techniques d'analyse des données.

6) Continuer d'examiner les interrelations avec d'autres programmes.

7) Entreprendre les travaux en vue de la production d'un rapport d'activité annuel.

8) Effectuer un échantillonnage complet à tous les sites choisis.

3) Test of artificial substrates initiated at 4 locations.

4) 2 tier system of invertebrate QA/QC proposed.

5) Methodological tests.

6) Some indications of chemical recovery in Newfoundland.

G) 1989/1990 goals

1) Produce a technical report and revised version of the protocol.

2) Establish one standard database format and one central data repository.

3) Continue to critically evaluate methodology.

4) Improve QA/QC.

5) Evaluate techniques of data analysis.

6) Continue to explore interconnections with other programs.

7) Begin work on producing an annual data report.

8) Maintain full sampling at all sites.

H) Besoins pour 1990-1991

1) Une année-personne supplémentaire et un ordinateur pour l'analyste et gestionnaire de la base de données.

2) Une affectation supplémentaire de 3 000 $ E&E à Scotia-Fundy afin de permettre au Dr. R. Misra de mettre au point des techniques d'analyse des ichtyofaunes reposant sur des hypothèses générales de linéarité à variables multiples.

3) Augmentation de 10 % des crédits alloués à chaque participant du MPO afin d'améliorer l'identification taxonomique et d'absorber la TPS de 9 %.

4) Crédits supplémentaires de 10 000 $ E&E pour vérifier les collections de référence.

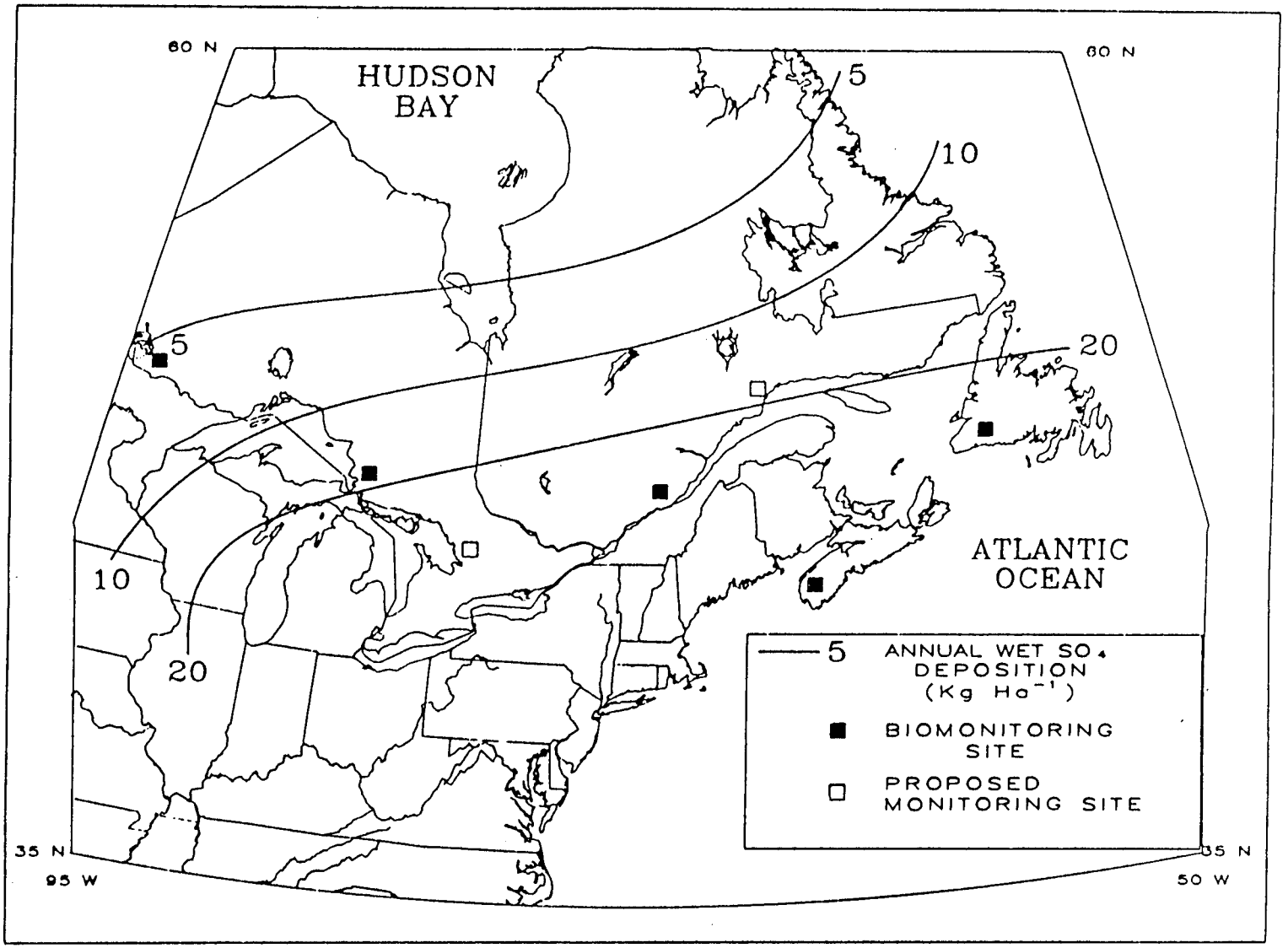
H) Requirement for 1990/1991

1) 1 additional PY and computer facility for a database manager data analyst.

2) $3,000 additional O&M to Scotia-Fundy to allow Dr. R. Misra to develop multivariate general linear hypothesis techniques for community analysis.

3) A 10 % increase in funding to each DFO participant to improve taxonomic identification and to effect the 9% GST.

4) $10,000 additional O&M overall to verify the reference collections.


60 N
60 N
HUDSON BAY
5
10
20
5
10
20
ATLANTIC OCEAN
5 ANNUAL WET SO4 DEPOSITION (Kg Ho⁻¹)
BIOMONITORING SITE
PROPOSED MONITORING SITE
35 N
95 W
35 N
50 W

Discussion

Se fondant sur les projections faites par Ken Minns, John Kelso affirme qu'on observera vraisemblablement aucun changement dans plus de 70 % des lacs visés par le Programme de Biomonitoring et soumis à diverses stratégies de contrôle des émissions.

D'après Ian Davies, l'absence de réaction signifie, dans certains cas, qu'aucune stratégie de contrôle des émissions ne produit de réaction chimique positive. On ne doit donc pas s'attendre à une réaction biologique. Il y a quelques systèmes dans ce cas. Prenons, par exemple, le lac K7 et les lacs Raven et Lady. Le pH de ces lacs n'excédera pas 5,6, seuil assez critique du point de vue biologique. Or, il y a un grand nombre d'espèces qui sont perturbées lorsque le pH atteint ce niveau.

On devrait enregistrer des réactions positives aux lacs Hamel et Plastic, par exemple, et peut-être aussi à un lac de la région de Parry Sound. Selon Ian Davies, cela ne veut pas dire que le Programme de Biomonitoring est inadéquat ou que les sites ont été mal choisis. Il estime que la répartition des sites est presque idéale pour la documentation de toute détérioration ou récupération. Il fait le lien avec la question des pluies acides. Au début, la disparition des poissons dans un seul et unique système aurait été vraiment utile dans les pourparlers avec l'administration américaine concernant ce dossier.

Discussion

Based on the projections that Ken Minns made, this comment was expressed by John Kelso: "Less than 30 % of the biomonitoring lakes are predicted to show any change under a variety of emission control strategies."

According to Ian Davies, it turns out that no response, in some case, means that all of the emission control strategies produce no chemical response in a positive way. So it's unlikely to see a biological response. There are a few systems in this case for instance, Lake K7, Raven and Lady, these lakes will remain at or below pH 5.6, a fairly critical pH from a biological point of view, at least, there's an awful lot of species that change around pH 5.6.

Hamel Lake and Plastic Lake for instance, should show positive responses and perhaps one of the lakes in the Parry Sound as well. Ian Davies doesn't think it's an inadequacy of the Biomonitoring Program or poor choice of the sites to begin with. He thinks that the Biomonitoring Program got close to an ideal distribution of the sites for documenting further damage or recovery. He related to the acid question at the early days where even a single system showing the disappearance of fish would have been really useful in arguing with the U.S Administration in the early years of the acid problem.

Ken Minns précise que pour régler ce type de problème, il faut absolument établir un lien plus solide entre l'évaluation des risques environnementaux et les données de surveillance. Il propose donc que la demande formulée par Ian Davies, soit une base de données et un analyste, fasse l'objet d'une proposition.

Ken Minns specified the necessity to build a stronger bond between the risk assessment and the monitoring information to clear up that kind of problem. Then he suggested that Ian Davies' requirement for a database and an analyst be the subject of a proposal.

7. PROPOSITIONS SOCIO-ECONOMIQUES

FRANCOIS BOULANGER

Madame Iola Price a invité M. Boulanger à parler des propositions socio-économiques dont le financement pour cette année est présentement à l'étude et qui seraient mises à exécution l'an prochain.

Il souligne l'importance d'établir un bon esprit de collaboration entre les principaux groupes compétents, les biologistes et les économistes, pour améliorer la qualité des communications. Il indique aussi qu'il faut établir une corrélation entre les données biologiques et économiques pour obtenir un tableau d'ensemble à jour, et peut-être plus valable, et ainsi prendre des décisions plus éclairées. Par exemple, la pêche du saumon est considérée comme une pêche très importante du point de vue économique et, dans ce cas précis, il importe d'utiliser les données émanant du MLCP du Québec pour mesurer l'impact de l'acidification.

7. SOCIO-ECONOMIC PROPOSALS

FRANCOIS BOULANGER

Mr. Boulanger was invited by Iola Price to talk about the socio-economic proposals that are currently under discussion for funding for this year and which would be carried over into next year.

He outlined the importance of developing a good cooperation between, biologists and economists to improve the quality of communication. He also mentioned the necessity of a link between the biological and the economic information to get something that will be up to date and maybe more valid when there is action to be taken. For example, the salmon fishing was pointed as a high-profile fishing from an economic point of view and in that case, it is important to use the information coming from the MLCP (Québec) to measure the impact of acidification.

Discussion

Dans le cadre de la discussion entre messieurs John Kelso, Gilles Lacroix, Ian Davies, Ray Hesslein et François Boulanger, John Kelso déclare qu'il apprécie toute information fournie par le MPO sur la valeur de la pêche sportive et sur l'économie de cette pêche en général. Toutefois, commi il est difficile de démontrer tout changement significatif dans les pêches sportives, il sera encore plus difficile d'y attribuer une perte économique aux différents scénarios d'acidification.

Discussion

There was a discussion between John Kelso, Gilles Lacroix, Ian Davies, Ray Hesslein and François Boulanger, John Kelso said that he strongly supports any information that DFO can get about the value of the sport fishery and whatever DFO can find out about the economics of the sport fishery. But he stated that the part he has problems with, like others, is to attribute an economic loss on the acidification scenarios.

PARTIE II/PART II

1. DISCUSSION SUR LE PROGRAMME FUTUR: PRIORITES ET FONCTIONNEMENT
(animée par I. Price)

Madame Price lance le débat en déclarant que le gouvernement et le ministère de l'Environnement élaborent ensemble une stratégie environnementale et que le niveau de financement n'a pas encore été établi pour 1990-1991 et les années subséquentes. Ils doivent tenir compte de plusieurs facteurs dont le programme d'étude sur le réchauffement de la planète, l'ozone stratosphérique, le plan d'action environnemental du ministère de l'Environnement et du gouvernement dans son ensemble.

Elle affirme que le gouvernement veut évaluer les perceptions que le public et les scientifiques ont de ces problèmes avant de prendre des décisions d'ordre politique. Il faut déterminer dans quelle mesure le gouvernement peut assumer le coût des recherches permettant de trouver des solutions aux problèmes cernés.

Si on mettait à exécution le TADPA V avec le niveau de financement privilégié, on disposerait d'un total de 3,2 millions de dollars tenant compte d'un taux d'inflation de 4 %, ce qui ne tient pas compte de la TPS de 9 %. Madame Price indique qu'on a aussi demandé 13 années-personnes et que celles-ci seraient ajoutées aux services votés.

1. DISCUSSION ABOUT THE NEXT PROGRAM: PRIORITIES AND FUNCTIONING
(chaired by I. Price)

Ms. Price opened the discussion on the next program by saying that the Department of Environment and the government as a whole is working on an environmental strategy and that funding is not set for the 1990-1991 year and beyond. There are a number of other considerations that have to be taken into account, one is the climate change program, stratospheric ozone, the whole Department of the Environment and the government's environmental agenda.

She said that the government as a whole want to evaluate the public and the scientists' perceptions of the problems before making their policy decisions. It depends on how the government can afford to pay for the kinds of research that will give the answers.

If LRTAP V goes ahead at the preferred level of funding, the total would be 3.2 million dollars increasing by a 4 % inflation factor which does not take into account the 9 % goods and services tax. She also mentioned that DFO is asking for 13 PYs and these PYs are to be added to the A-base.

La formule de financement du programme se comparera à la formule du GRDE (groupe de la recherche et du développement énergétiques), à savoir que les projets seront approuvés en principe pour la durée du TADPA V, mais le renouvellement du financement sera fonction de l'examen des projets, des rapports d'étape et des modifications proposées.

The LRTAP funding will be a kind of PERD-style funding, whereby projects are approved in principle for the duration of LRTAP V, but that renewal of the money will be based on a review of projects, of progress reports, of proposed changes.

Certains projets ne dureront probablement pas cinq ans, d'autres dureront un ou deux ans, à compter de la troisième année, et les crédits alloués seront rajustés en conséquence chaque année.

Some projects are not expected to take five years, some other will last one year, two years, starting year 3, and the monies will be adjusted to take that into account each year.

Madame Price demande donc aux participants d'examiner les recommandations de 1987 et 1988 et, pendant la discussion, de réfléchir aux recommandations qu'il conviendrait d'extraire de ces deux groupes de recommandations pour les mettre de l'avant. Elle rappelle les questions posées par John Kelso, à savoir comment devrait-on évaluer les populations de poissons et l'impact du programme TADPA? Nos recommandations devraient-elles porter sur ces points particuliers?

So, Ms. Price asked the participants to think about the 1987 and 1988 recommendations and during the discussion, to think about the recommendations that are going to be trying to extract from previous sets to forward as a whole. She recalled John Kelso's questions: how do we deal with stock assessment, what is the LRTAP impact, is this something that we should be focusing our recommendation on?

Des questions sont aussi posées sur les polluants organiques. Le gouvernement retiendra-t-il l'option 3 dans laquelle les polluants organiques constituent l'un des éléments du nouveau programme TADPA V et qu'adviendra-t-il de ces polluants organiques si l'option 2 est retenue?

Questions were also asked about organics. Will the government go for Option 3, in which organics are listed as one of the components of the new LRTAP V and what will happen to the organics package if the Option 2 is favoured?

Comme l'a précisé Richard Addison, la question des polluants organiques constitue un élément du programme simplement parce qu'il faut déterminer dans quelle mesure les contaminants organiques atmosphériques polluent les océans et, par conséquent, les poissons et ce, parce qu'il a été clairement établi que dans le golfe du Saint-Laurent et, assurément, dans l'Arctique, l'atmosphère représente la principale source d'organochlorés.

As it was clarified by Richard Addison, the focus of the organics component of the program is simply to decide what is the scale of organic input from the atmosphere to the sea and hence into fisheries. It has been already established that in the Gulf of St. Lawrence and certainly in the Arctic, the atmosphere represents the major source of organochlorines.

Madame Price affirme qu'on peut étirer les ressources pour répondre à certains de ces besoins et elle propose qu'on utilise à cette fin les ressources affectées au TADPA V et qu'on poursuive les travaux sur les polluants organiques déjà étudiés même si le programme TADPA a pour mandat d'examiner les polluants acides et plus particulièrement le sulphate et les oxydes d'azote.

Ms. Price said that the resources could be stretched to meet some of the dual needs and she proposed that this would be done under LRTAP V funding and continue the kind of LRTAP IV organics material that was done even if LRTAP has been given the mandate to address acidification issues, mostly the sulphate and the nitrous oxides.

1.1 Orientations majeures

Pour décider des orientations majeures du programme et en faire des recommandations à l'intention du sous-comité TADPA, on demande aux participants de réfléchir sur la façon dont le programme devrait être structuré pour les cinq prochaines années. On trace alors un tableau représentant les orientations majeures et les ressources que chaque région pourrait affecter soit en dollars, soit en pourcentage de leur contribution globale (il n'est pas fait mention des services votés à l'échelle régionale).

1.1 Major headings

In order to formulate the recommendation for the program which are the recommendations to the LRTAP Subcommittee, the participants were asked to think about how the program should be structured for the next five years. Then a chart was drawn representing the major headings and how much each region might spend either in total dollars or as a percentage of their total effort for the LRTAP monies allocated. (no mention of the regional A-base contribution).

ORIENTATIONS MAJEURES/ MAJOR HEADINGS	REGION				
	P C/A	Q	S.F.	T.N./ NF	AC/HQ (3 millions)
SURVEILLANCE BIOLOGIQUE/ BIOMONITORING (consultation et analyse des données/reference and analysis of data) 13-15 K une seule fois/ one time	15-20%	15-20%	20%	40-45%	
ATELIER/WORKSHOP					10 K
COORDINATION - AC/ H.Q. COORDINATION					10-12 K
COLLABORATION INTERNAT./ INTERNAT. COLLABORATION (L'AC paiera 50% des dépenses pour la participation du MPO à la prise de décisions/H.Q. will pay 50% of expenses for a DFO representation at decision making)					2 K
ATTENUATION/MITIGATION (évaluation des mesures d'atténuation/évaluation of mitigation)			20%		30% *
ETUDES SUR LES EFFETS ET QUANTIFICATION DE L'IMPACT/EFFECTS STUDIES QUANTIFY IMPACT	40%	40%	40%	30%	70% *
PALEOECOLOGIE/PALEO - micro-fossiles (évol.)/ historic-micro fossils - déposition de subst. org. et mét. (évol.)/ historic-depost org. met.	13-15%	15%	4%	10%	
CONTAMINANTS ORGAN., TOXIQUES/ORGANICS, TOXICS	25-30%	20-25%	16%	15-20%	

* Crédits affectés aux pluies acides - DGACC/Of Economic

1.2 Nouvelles recommandations au sous-comité TADPA

Iola Price demande alors aux participants de formuler de nouvelles recommandations à l'intention du sous-comité TADPA. Voici le fruit de leur réflexion:

1) Améliorer les communications et la coordination avec les organismes provinciaux, les autres ministères gouvernementaux et les ONG.

2) Améliorer les communications et la coordination entre le MPO et le ME concernant le Programme de Biomonitoring pour éviter la duplication.

3) Mettre en place un programme de gestion de la qualité pour les substances organiques et les métaux.

4) Formuler un nouvel ensemble de questions concernant:

   4.1 les orientations à long terme des programmes;
   4.2 les critères applicables à ces questions.

Tous les participants s'entendent sur ces quatre recommandations. Un débat s'ensuit sur l'importance des questions qui aboutiront à la formulation d'une politique.

1.2 New recommendations to the LRTAP Subcommittee

Iola Price then asked the participants to think about new recommendations. These following new recommendations to the LRTAP Subcommittee were issued.

1) Increase level of communication / coordination with provincial agencies, other government's departments and NGOs.

2) Increase level of commnunication / coordination between DOE and DFO for the Biomonitoring Program to avoid duplication.

3) Institute a quality management program for the organics and metals.

4) Devise a new set of "Questions" concerning:

   4.1) Long-term directions of programs.
   4.2) Criteria for the questions.

A consensus was made by all the participants concerning these four recommendations. A discussion then followed concerning the level of scale of questions that are going to lead to the formulation of policy.

Comme nombre de participants estiment que ces questions sont d'importance globale, Greg Brunskill propose de faire un résumé de quelques points sur les composantes non acides des dépôts TADPA et, bien sûr, à l'étape suivante, sur les autres composantes du TADPA. Cela devrait comporter à la fois le réchauffement global et les effets atmosphériques. L'ébauche suivante propose donc les orientations du programme TADPA V ainsi que les critères en vertu desquels les projets proposés dans le cadre de ce programme national pourraient être évalués.

As the level of scale was being seen as a global one by many of the participants, Greg Brunskill agreed summarize a few points about the focus for the non-acid components of LRTAP deposition and of course, in the next step for the other components of LRTAP. This would involve both climate change and atmospheric effects. Then, the following draft outline as the "Focus for LRTAP V" has been proposed, setting criteria for the national program under which, then, these could be addressed at a project level.

1.3 Points d'intérêt - TADPA

(Modifié subséquemment comme un résultat des commentaires des chercheurs de TADPA, MPO).

(Devait à l'origine s'intituler Points d'intérêt - polluants atmosphériques non acides).

1) Quelle est l'importance et la variation régionales, antérieures et actuelles, du flux TADPA au Canada et comment ces valeurs s'intègrent-elles aux allures de la dispersion et de l'accumulation à l'échelle du globe?

   - Charges intégrales (g/m^2).
   - Flux ($g/m^2.an$).
   - Effets de la variation du climat.

1.3 Proposed Focus point for LRTAP

(Subsequently modified as a result of comments by DFO LRTAP researchers)

(Originally intented to be "focus for non-acid LRTAP").

1) What is the magnitude and regional variation in the history and current flux of LRTAP in Canada, and how does this fit into global patterns of dispersal and accumulation?

   - Integral burdens (g/m2).
   - Flux (g/m2.yr).
   - Effects of climate change.

2) Quelle est la relation entre les taux d'apport du TADPA et la réaction des écosystèmes aquatiques?

- Examen des publications.
- Essais dose-réponse réalisés en laboratoire.
- Mesure sur le terrain de la charge et du taux d'apport du TADPA en fonction de la bioaccumulation ou du stress chez les organismes et identification d'organismes indicateurs.
- Essais sur le terrain: variation de la charge et observation de la réponse des écosystèmes et des organismes.

2) What is the relation between the rate of supply of LRTAP and the response of the aquatic ecosystems?

- Literature review.
- Laboratory dose-response experiments.
- Field measurements of LRTAP burden and rate of supply related to bioaccumulation or stress response in organisms, index organism identification.
- Field experiments: vary the load, observe response in ecosystem and organism components.

3) Quels sont les facteurs physiques et géographiques influant sur la disponibilité des polluants TADPA pour les écosystèmes?

- Effets de la taille des lacs, du rapport Ad/Ao, du temps de renouvellement de l'eau, de la profondeur moyenne, de la température moyenne, du climat local.
- Effets de la composition des sédiments, de la teneur en lipides, de l'origine terrestre ou lacustre des sédiments, du taux de sédimentation et de la couche de mélange...

3) What are the physical and geographic controls on LRTAP availability to ecosystems?

- Effect of lake size, AD/AO, water residence time, mean depth, mean temperature, local climate.
- Effect of sediment composition, lipid content, terrestrial vs lake produced sediment, sedimentation rate and mixed layer...

4) Réduction des dommages : Que peut-on faire pour réduire les dommages déjà causés et comment peut-on prévenir que d'autres ne soient causés?

- Quels dommages ont déjà été causés?

4) What can be done to alleviate the damage already done, and how can we prevent future damage?

- How much damage has already been done?

- Quelle est l'évolution chronologique des dommages?
- Quelles sont les implications socio-économiques des dommages?
- Que faudra-t-il faire pour réparer les dommages déjà causés?

5) Pouvons-nous fournir des données d'entrée pour les modèles généraux d'équilibre massique (par ex. : Don Mackay) ou les modèles de gestion des risques (Minns)? Pouvons-nous collaborer à l'élaboration de modèles pour la dispersion et l'accumulation à l'échelle du globe?

Après une discussion générale, on adopte ces orientations majeures qui présideront à l'établissement des objectifs des programmes TADPA, au lieu de faire des recommandations comme auparavant.

Cependant, comme ces cinq points sont jugés trop généraux et vraiment inacceptables par certains participants, exception faite des points soulevés à l'origine par Gregg Brunskill, en ce qui a trait aux substances organiques et aux métaux, madame Price consultera les membres du sous-comité de TADPA et leur demandera d'étudier ces énoncés et de proposer des améliorations, le cas échéant.

- What is the time course of the damage?
- What is the socio-economic implication of the damage?
- What needs to be done to repair the damage?

5) Can we provide input to general mass balance models (e.g. Don Mackay) or risk assessment models (Minns)? Can we contribute to models of global dispersal and accumulation?

After a general discussion, these focus points were favoured as a basis for regulating the objectives of the LRTAP programs, instead of the former way of making recommendations.

However, as these 5 points were considered too general and really not acceptable by some of the participants, except as originally intented by Gregg Brunskill, for the organic/metal part of the program Ms. Price will consult the members of the LRTAP Subcommittee and ask them to review these statements and provide her with comments on how they might be improved.

Dorénavant, quand une proposition régionale devra être rédigée, les représentants de la région en question devront s'efforcer de la formuler en indiquant comment ils entendent répondre à certains éléments des questions. Cela devra constituer des critères.

From now on, when a regional proposal is written, people in the region should try and frame it in the relation to how the region would be answering parts of portion of these questions. This should be treated as criteria.

Selon Michael Lawrence, les régions doivent s'attaquer à l'une de ces questions, à l'ensemble de celles-ci ou à une combinaison donnée, mais il s'agit là des lignes directrices du programme et il faudra répondre aussi à d'autres critères comme l'excellence scientifique, le mandat et le lien avec le programme TADPA.

Michael Lawrence said that regions should address one, some or all of these five questions, but these should be regarded as the programs guiding principles. There are other criteria that must also be met such as scientific excellence, mandate and relationship to the LRTAP program.

Iola Price précise que les gestionnaires régionaux doivent prendre des décisions à l'échelle régionale puis se préparer à défendre leurs projets devant le sous-comité TADPA de façon à ce qu'il y ait consensus sur les projets à réaliser au cours de la première année et sur les délais d'exécution.

Iola Price indicated that regional managers have to exercise a decision-making process at the regional level first, then come prepared to defend their region's projects to the Subcommittee so that a concensus be achieved on what will be done in year 1, with forecasts for the remaining four years.

Certes, il faudra que chaque proposition régionale soit distribuée à l'avance aux autres régions avant les réunions du sous-comité TADPA.

Of course every region's proposal will have been circulated in advance to every other region before the LRTAP Subcommittee meetings.

Madame Price ajoute que les régions obtiendront un accord de principe si le projet est financé pour la première année du TADPA V. Le financement des deux années suivantes sera fonction du

Ms. Price added that if a project is approved for year one of LRTAP V, the region will get approval in principle for funding for years two and three and transfert of money for year 2

rendement et cela suppose que les modifications aux priorités régionales et nationales seront examinées.

will be contingent upon performance. That also implies that regional and national priorities' changes could also be considered.

Le biomonitoring pourrait aussi faire l'objet d'un examen s'il ne donne pas les résultats escomptés. Cet examen se ferait à la réunion du sous-comité TADPA à l'occasion de laquelle celui-ci prend des décisions concernant le financement des projets de l'année suivante.

Even the biomonitoring could be the subject of a review if projects do not live up to expectations. This review would take place when the LRTAP Subcommittee meets, to make the decisions about the next year's funding.

Madame Price reconnaît qu'elle ignore pour le moment le niveau de financement. Elle déclare presque textuellement : "Nous ne connaissons pas encore la portée du programme et nous ne savons pas quels travaux seront financés dans le cadre du volet "variation du climat". Nous avançons à tâtons. Il s'agit d'un problème politique que nous ne pouvons pas régler à cette tribune. Tout ce que nous pouvons faire, c'est d'échanger le plus d'informations entre nous de sorte que lorsque les gestionnaires du programme TADPA s'amèneront, quand les membres du sous-comité se réuniront pour prendre les décisions finales, nous disposerons du plus grand nombre de renseignements possibles.

Ms. Price stated that the actual level of funding was unknown at the time. She said: " We don't know the exact dimensions of the program; we don't know exactly how much of the LRTAP-type work might be funded under the Climate Change program. We're operating in an area of great uncertainty. It's a political problem, one that we can't solve here. We can only try to exchange as much information among ourselves, so that the LRTAP program managers on the Subcommittee representative come in to make the final judgements, that we have as much information at our fingertips as it is possible."

Madame Price ajoute qu'elle-même, monsieur Lawrence et le sous-comité TADPA établiront ensemble des critères d'évaluation des projets mis de l'avant. A titre

In addition to this, Ms. Price said that she, Michael Lawrence and the LRTAP Subcommittee will work together to come up criteria, against which projects

d'exemple, elle mentionne l'excellence scientifique, le lien du projet avec le document au Cabinet dans sa forme actuelle (même si ce document sera probablement modifié avant d'être acheminé), le fait que le projet proposé permettra de répondre aux questions liées directement aux besoins régionaux et qu'il s'inscrit bien dans le programme. Cette liste de critères sera jointe à la formule de proposition de projet de façon à ce que tous les intéressés aient ces deux documents d'ici environ un mois.

will be judged, and that people will know what the project criteria are. As an example of one of those criteria, Iola Price specified scientific excellence, relation to the LRTAP Cabinet Document as it now stands, even though it may never go forward in that form, answering some of the kinds of questions that are sure to appear relating to regional needs and fitting into an overall program. These criteria will be added to the project proposal form to make sure everyone had them in approximately a month after the Workshop.

Elle ajoute que le sous-comité lancera peut-être un appel d'offres à l'extérieur du MPO si personne au sein du ministère n'est capable ou n'est intéressé. Il financera les travaux réalisés à l'externe.

Ms.Price said further that the Subcommittee might want to call for proposals outside DFO if there aren't people at DFO who are capable or interested, the Subcommittee may want to put some of the money in direct contracts outside.

Elle demande donc aux participants de garder en mémoire les recommandations de 1987 et 1988 puisqu'il s'agit d'énoncés d'intention, d'objectifs à atteindre. Certains des projets qui seront proposés pour le TADPA V seront de toute évidence le prolongement de travaux du TADPA IV.

She then asked to people to keep in mind the 87-88 recommendations because they are statements of purpose, of things that need to be done. Some of the projects that will be proposed for LRTAP V are undoubtedly going to be continuations of LRTAP IV work.

M. Gordon Walsh fait un dernier commentaire : il partage les opinions exprimées pendant la discussion et il privilégie les propositions visant à améliorer la collaboration et la coordination entre les régions et ayant une dimension nationale plutôt que régionale.

A last comment was made by Mr. Gordon Walsh saying that he agrees with the discussion and that he favours proposals that stimulate communication and collaboration between the regions and that have national scope instead of having a regional one.

CONCLUSION

Madame Price met fin à l'atelier en proposant que les gestionnaires régionaux et les chefs de projets individuels n'attendent pas l'intervention du comité TADPA pour proposer que les chefs de projets travaillent en collaboration et donnent cette dimension nationale au programme.

Elle rappelle aux gestionnaires régionaux de garder en mémoire les recommandations de 1987 et 1988 jointes en Annexe 4 lorsqu'ils étudient leurs propositions de projet. Elle leur rappelle aussi qu'ils devraient soumettre leurs propositions en fonction des orientations majeures du programme et préciser les délais d'exécution.

De plus, on recommande d'accroître la collaboration et la coordination quand il s'agit de financer les projets qui répondent aux critères susmentionnés. Le sous-comité essaiera de mettre en place un mécanisme permettant de s'assurer qu'en cette période de restrictions budgétaires que les ressources limitées seront affectées aux projets ayant la plus haute valeur scientifique possible.

Elle remercie tous les participants et les invite à assister à l'atelier de l'an prochain. La séance est ajournée à 17 h le 27 septembre.

CONCLUSION

Ms. Price then concluded the Workshop by suggesting that regional managers and individual project leaders not wait the step of LRTAP committee to propose that project leaders get together to work on something and seek that kind of national scope.

She recalled to the regional managers to keep in view the 1987-1988 recommendations (see Appendix 4) when they are considering their project proposals and that they should submit their project proposals as against those headings and specify the time frames.

Added to these recommendations, is one for increased interregional and/or interdepartmental cooperation and collaboration to consider for fundings those projects which meet criteria mentioned above. Then, the Subcommittee will try to institute some mechanism to ensure that in times of limited resources that the money is spent for the highest possible scientific values.

She then closed the Workshop by thanking all participants and welcoming them to the next year Workshop. Adjourned at 5:00 on September 27.

ANNEXES / APPENDIXES

1. Liste des participants/List of participants.

2. Programme/Program.

3. Liste des documents distribués/List of distributed documents.

4. Recommandations des ateliers TADPA de 1987 à 1988/Recommendations of the 1987 and 1988 LRTAP Workshops.

ANNEXE / APPENDIX 1

LISTE DES PARTICIPANTS / LIST OF PARTICIPANTS

ADDISON R.F.
DFO - Bedford Institute of
Oceanography
Darmouth, N.S.
B2Y 4A2
(902) 426-3279

BARBOUR STEPHEN E.
DFO - Biological Sciences Branch
P.O. Box 550
Halifax, N.S.
B3J 2S7
(902) 426-2755

BLANCHER PETER
Canadian Wildlife Service
NWRC
100 Garelie Blvd.
Hull, Qc
K1A 0H3
(819) 997-6086

BOULANGER FRANÇOIS
DFO - Economics Branch
200 Kent Street
1162
Ottawa, Ontario
K1A 0E6
(613) 993-2280

BRUNSKILL GREGG J.
DFO - Freshwater Institute
501 University Crescent
Winnipeg, Manitoba
R3T 2N6
(204) 983-5252
983-5041

CAIRNS VICTOR
DFO - Bayfield Institute
P.O. Box 5050
867 Lakeshore Rd.
Burlington, Ont.
L7R 4A6
(416) 336-4862

CAMPBELL PETER
INRS-Eau
Université du Québec
C.P. 7500
Sainte-Foy, Qc
G1V 4C7
(418) 654-2538

COADY LARRY
DFO - Science Branch
Box 5667
St. John's, Nfld
A1C 5X1
(709) 772-5057

DAVIES IAN
DFO - Freshwater Institute
501 University Crescent
Winnipeg, Manitoba
R3T 2N6
(204) 983-5208

GEARING JUANITA
MPO
Institut Maurice-Lamontagne
C.P. 1000
Mont-Joli, Qc
G5H 3Z4
(418) 775-6590

HESSLEIN RAYMOND H.
DFO - Freshwater Institute
501 University Crescent
Winnipeg, Manitoba
R3T 2N6
(204) 983-5251

KEIZER PAUL
DFO - Bedford Institute of
Oceanographic
P.O. Box 1006
Darmouth, N.S.
B2Y 4A2
(902) 426-3843

KELSO JOHN R.M.
DFO
Canal Drive
Sault-Ste-Marie, Ontario
P6A 1P0
(705) 942-2848

KEMP ALAIN
MPO
Institut Maurice-Lamontagne
C.P. 1000
Mont-Joli, Qc
G5H 3Z4
(418) 775-6639

KHAN NUZRAT
DFO - Fish Habitat
Management Branch
Ottawa, Ontario
K1A 0E6
(613) 990-0199

KICENIUK JOE
DFO - Northwest Atlantic Fisheries
Centre
P.O. Box 5667
St. John's, Nfld
A1C 5X1
(709) 772-2087

LACROIX GILLES
DFO
Biological Station
St. Andrews, N.B.
E0G 2X0
(506) 529-8854

LAWRENCE MICHAEL
DFO
200 Kent Street
Ottawa, Ontario
K1A 0E6
(613) 990-0283

MACGREGOR LORNE
DFO - Institute of Oceans Sciences
Box 6000
Sidney, B.C.
V8L 4B2
(604) 356-6716

MINNS C.K.
DFO - GLLFAS
P.O. Box 5050
867 Lakeshore Road
Burlington, Ontario
L7R 4A6
(416) 336-4874

PAPINEAU MADELEINE
Environnement Canada
1141, route de l'Église
Sainte-Foy, Qc
G1V 4H5
(418) 648-3921

PRICE IOLA
DFO
200 Kent Street
Ottawa, Ontario
K1A 0E6
(613) 990-0275

RYAN PATRICK M.
DFO - Science Branch
P.O. Box 5667
St. John's, Nfld
A1C 5X1
(709) 772-4491

SANKAR RAY
DFO - Northwest Atlantic Fisheries Centre
P.O. Box 5667
St. John's, Nfld
A1C 5X1
(709) 772-2829

SHAW MARGO
DFO
Canal Drive
Sault-Ste-Marie, Ontario
P6A 1P0
(705) 942-2848

SUNDBY BJORN
MPO
Institut Maurice-Lamontagne
B.P. 1000
Mont-Joli, Qc
G5H 3Z4
(418) 775-6703

UTHE JOHN F.
DFO - Physical and Chemical Sciences Branch
P.O. Box 550
Halifax, N.S.
B3J 2S7
(902) 426-6277

WALSH GORDON
MPO
Institut Maurice-Lamontagne
C.P. 1000
Mont-Joli, Qc
G5H 3Z4
(418) 775-6577

WATSON NELSON
DFO - Freshwater Anadromous Division
P.O. Box 550
Halifax, N.S.
B3J 2S7
(902) 426-2755

WHITE WESLEY
DFO
P.O. Box 550
Halifax, N.S.
B3J 2S7
(902) 477-2933

ANNEXE / APPENDIX 2

PROGRAMME / PROGRAM

MARDI, 26 SEPTEMBRE 1989 TUESDAY, 26 SEPTEMBER 1989	AUDITORIUM
09:00 - 09:30	Mot de bienvenue du Directeur de l'IML / Welcoming address by MLI Director: J. Boulva Introduction et fonctionnement de l'atelier / Introduction and Workshop organization: I. Price
09:30 - 10:15	Rapports de recherche régionaux (45 minutes chacun) / Regional research reports (45 minutes each) - Région du Centre et de l'Arctique / Central and Arctic Region - Région du Pacifique / Pacific Region - Région de Scotia-Fundy / Scotia-Fundy Region - Région de Terre-Neuve / Newfoundland Region - Région du Québec / Québec Region
10:15 - 10:30	Pause-café / Coffee break
10:30 - 12:00	Rapports (suite) / Reports (continued)
12:00 - 13:30	DEJEUNER / LUNCH Visite de l'IML / MLI visit: 12:45 - 13:25
13:30 - 14:15	Synthèse des travaux sur l'aluminium / Synthesis of studies on aluminum P.G.C. Campbell (INRS-Eau, Québec)
14:15 - 15:00	Rapports (suite) / Reports (continued)
15:00 - 15:15	Pause-café / Coffee break
15:15 - 16:00	Rapports (suite) / Reports (continued)

16:00 - 17:15	Prochain programme: propositions de voies de recherche par les gestionnaires régionaux (15 minutes chacun) / Next Program: Regional manager proposals on research orientation (15 minutes each)
17:15	Ajournement / Adjourn

MERCREDI, 27 SEPTEMBRE 1989 — **AUDITORIUM**
WEDNESDAY, 27 SEPTEMBER 1989

09:00 - 09:30	Programme de Biomonitoring: réalisations et perspectives / Biomonitoring Program: realizations and perspectives: I. Davies
09:30 - 10:00	Point de vue du CCRM sur le futur programme / RMCC point of view on the next program: T. Brydges
10:00 - 10:15	Pause-café / Coffee break
10:15 - 10:45	Revue des recommandations des ateliers antérieurs / Review of previous Workshop recommendations: I. Price
10:45 - 12:00	Discussion du prochain programme: priorités et fonctionnement (présidée par I. Price) / Discussion on the next program: priorities and functioning (Chaired by I. Price)

Sujets à discuter / Subjects to be discussed:

- Structure du programme et fonctionnement / Functioning and structure of program
- Gestion nationale du programme / National management of program
- Mécanisme d'allocation des ressources / Mechanism of resources allocation
- Collaboration ministérielle inter-régionale / Inter-regional cooperation within DFO

- Coordination avec les autres ministères fédéraux et provinciaux / Coordination with the other federal and provincial departments
- Paléoécologie / Paleoecology
- Contaminants / Contaminants
- Recherche sur les composés organiques / Research on organic compounds
- Programme de Biomonitoring / Biomonitoring Program
- Recherche dans l'Arctique / Arctic research
- Quantification des impacts / Quantification of impacts
- Evaluation économique / Economic evaluation
- Recommandations / Recommendations

12:00 - 13:00	DEJEUNER / LUNCH
13:00 - 15:00	Discussion (suite / continued)
15:00 - 15:15	Pause-café / Coffee break
15:15 - 17:00	Discussion (suite / continued)
17:00	Ajournement / Adjourn

JEUDI, 28 SEPTEMBRE 1989 — **AUDITORIUM**
THURSDAY, 28 SEPTEMBER 1989

09:00 - 10:00	Discussion (suite / continued)
10:00 - 11:00	Pause-café / Coffee break
	Préparation du sommaire de l'atelier / Preparation of the Workshop summary
11:00 - 12:00	Sommaire des ateliers / Workshop summary: I. Price
12:00	Ajournement / Adjoun

ANNEXE / APPENDIX 3

LISTE DES DOCUMENTS DISTRIBUES / LIST OF DISTRIBUTED DOCUMENTS

- LRTAP Project Review - 1989/90, Scotia-Fundy Region.

- Percent of Scotia-Fundy resources under options 2 and 3 of the LRTAP 5 submission to be allocated to each of the identified research priorities projects.

- New LRTAP project proposal, Scotia-Fundy Region.

- Research summary for the Turkey lakes calibrated watershed.

- Acid-rain publications, Newfoundland Region (to September 1989).

- Long-Range Transport of Airborne Pollutants LRTAP IV and LRTAP V. The Newfoundland Region Perspective.

- CTR and FHR list of cadmium and lake 382 - Related publications and presentations.

ANNEXE / APPENDIX 4

RECOMMANDATIONS DES ATELIERS TADPA DE 1987 ET 1988

RECHERCHE

1. **Rétablissement des systèmes**

a) Evaluer le potentiel de rétablissement des systèmes acidifiés, déterminer s'ils seront aptes à s'adapter à une nouvelle colonisation par les espèces originelles. Dans la négative, envisager la possibilité d'une recolonisation artificielle.

Exécution

Centre et Arctique, Scotia-Fundy (étude sur le chaulage seulement).

Etat d'avancement

En cours.

b) Evaluer l'incidence de la durée de la période d'acidification du système et l'impact de ce facteur sur le potentiel de rétablissement du système acidifié.

Exécution

Centre et Arctique, Scotia-Fundy (étude sur le chaulage seulement).

Etat d'avancement

En cours.

RECOMMENDATIONS OF THE 1987 1988 LRTAP WORKSHOP

RESEARCH

1. **Recovery of Systems**

a) Assess the recovery potential of acidified systems, their ability, or lack thereof, to return to the original species to re-invade. Consider the possibility of stocking recovered systems where re-invasion of original species was unsuccessful.

Action by

Central & Arctic, Scotia-Fundy (liming study only).

Status

On going.

b) Assess the consequence of the duration over which a system is acidified and the degree to which recovery is limited by the length of time the system has been acidified.

Action by

Central & Arctic, Scotia-Fundy (liming study only).

Status

On going.

c) Chercher des moyens d'améliorer le rétablissement des écosystèmes (avec des contrôles d'émissions en Amérique du Nord, et sans contrôle d'émission).

Exécution

Centre et Arctique.

Etat d'avancement

En cours.

d) Faire des recherches sur les processus de rétablissement et déterminer la fréquence possible d'écarts importants dans les populations de poissons avant que le système redevienne stable. Les données réunies dans la région des lacs expérimentaux (ELA) indiquent que pendant le processus de rétablissement, les niveaux de population fluctuent.

Exécution

Centre et Arctique, Scotia-Fundy (étude sur le chaulage seulement).

Etat d'avancement

En cours.

e) Evaluer la possibilité de recourir au chaulage pour préserver les rivières à saumon de l'Atlantique ou pour ramener le pH à la normale. A cette fin:

- Poursuivre le projet de chaulage pendant au moins cinq ans (projet qui sera réévalué en 1991-92);

c) Investigate the options available to improve or enhance recovery of ecosystems (with North American emission controls and without North American emission controls).

Action by

Central & Arctic.

Status

On going.

d) Research the processes of recovery and the possible occurrence of large fluctuations in populations before the system reaches stability. Initial evidence from ELA indicates instability in population levels during recovery.

Action by

Central & Arctic, Scotia-Fundy (liming study only).

Status

On going.

e) Assess the practicality of liming as a strategy for the preservation or recovery of Atlantic salmon rivers by:

- Continuing the present liming project for at least five years (project to be re-evaluated in FY 1991-92);

- Déterminer si les estimations des prises possibles de saumon sont précises;

- Déterminer la précision des stratégies économiques et technologiques suédoises et leur applicabilité aux projets de chaulage au Canada;

- Evaluer la possibilité de recourir à la cryogénie et à l'aménagement de refuges comme méthodes de préservation génétique.

Exécution

Scotia-Fundy.

Etat d'avancement

En cours.

f) D'après les données réunies, le chaulage ne saurait à lui seul maintenir le saumon atlantique dans un état physiologique et reproductif normal. Pour aménager des refuges afin de maintenir à long terme la spécificité et la diversité de la nature génétique du poisson, on devrait poursuivre les recherches afin de trouver d'autres agents d'atténuation.

Exécution

Scotia-Fundy.

Etat d'avancement

En cours.

- Determining the accuracy of the estimates of potential salmon yields;

- Determining the accuracy and applicability of Swedish economics and technology for liming in Canada; and;

- Assessing the potential of cryogenics and the establishment of refugia as methods of genetic preservation.

Action by

Scotia-Fundy.

Status

On going.

f) Evidence indicated that liming alone may not sufficient in maintaining Atlantic salmon in a normal physiological and reproductive state. In order to create refuge areas for long-term maintenance of the uniqueness and diversity of the genetic nature of the salmon, research into other mitigative agents should continue.

Action by

Scotia-Fundy.

Status

On going.

2. Etudes paléolimnologiques

a) Tracer l'évolution chronologique dans les lacs visés par le Programme de Biomonitoring du MPO, ce qui permettra de comparer les données réunies dans le cadre du programme.

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique.

Etat d'avancement

En cours.

b) A l'échelle régionale, procéder à la reconstitution complète de l'histoire du pH et s'en servir pour comparer et valider les prévisions régionales de dommages faites à l'aide de modèle.

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique.

Etat d'avancement

En cours.

c) Etudier l'évolution et l'importance de la déposition et des émissions de contaminants organiques et métalliques au Canada (lecture des publications).

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique

Etat d'avancement

En cours.

2. Paleolimnologic studies

a) Establish a historic chronology in the lakes of the DFO Biomonitoring Program against which the monitoring results can be compared.

Action by

Newfoundland, Scotia-Fundy, Québec, Central & Arctic.

Status

On going.

b) Undertake a thorough reconstruction of pH history on a regional scale for use in comparing and validating regional model predictions of damage.

Action by

Newfoundland, Scotia-Fundy, Québec, Central & Arctic.

Status

On going.

c) Establish histories and magnitudes of organic and metal emissions and deposition in Canada as a result of worldwide use (literature review).

Action by

Newfoundland, Scotia-Fundy, Québec, Central & Arctic.

Status

On going.

d) Se servir des données paléoécologiques pour mieux saisir l'importance et les facteurs confusionnels de la variabilité naturelle ou non attribuable au TADPA observée dans les systèmes.

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique

Etat d'avancement

En cours.

d) Obtain assistance from paleo-evidence to help understand the range and confounding influences of natural or non-LRTAP variability in systems.

Action by

Newfoundland, Scotia-Fundy, Québec, Central & Arctic.

Status

On going.

e) Utiliser des systèmes expérimentaux pour l'étalonnage des méthodes de recherche paléoécologique.

Exécution

Centre et Arctique

Etat d'avancement

En cours

e) Use experimental systems to provide calibration for the paleo methods.

Action by

Central & Arctic

Status

On going

f) Mettre sur pied un groupe de travail qui coordonnera les études paléoécologiques menées dans toutes les régions du pays. Ce groupe s'assurera que des protocoles comme celui établi pour les PIRLA (Paleolimnological Investigations of Recent Lake Acidification) et des projets semblables soient adoptés et inscrits dans le programme du MPO.

Exécution

Participation de toutes les régions sous la direction de la région du Centre et de l'Arctique.

f) A groupe should be established to coordinate the paleoecological studies throughout the regions. This group should ensure that protocols such as those developed by PIRLA (Paleolimnological Investigations of Recent Lake Acidification) and similar projects be adopted and imposed on the DFO program.

Action by

Central & Arctic lead all Regions participate.

Etat d'avancement

En cours.

Status

On going.

3. **Indicateurs biochimiques et physiologiques**

a) Elargir la base de données permettant de comprendre et d'interpréter les indicateurs de stress dans les systèmes perturbés expérimentalement.

Exécution

Scotia-Fundy, Centre et Arctique.

Etat d'avancement

En cours.

b) Améliorer la précision des indicateurs et leur applicabilité à des types particuliers de stress, y compris l'importance de facteurs combinés (co-facteurs) tels que la température, les concentrations de CO_2, les concentrations de O_2, la variabilité saisonnière et des espèces, la méthode de prélèvement et autres.

Exécution

Scotia-Fundy, Centre et Arctique.

Etat d'avancement

En cours.

3. **Biochemical and physiological indicators**

a) Expand the base of data supporting the understanding and interpretation of stress indicators in perturbed experimentally manipulated ecosystems.

Action by

Scotia-Fundy, Central & Arctic.

Status

On going.

b) Refine the precision and applicability of indicators to specific types of stress including the importance of co-factors such as temperature, CO_2 concentrations, O_2 concentrations, seasonal and species variability, capture methodology etc.

Action by

Scotia-Fundy, Central & Arctic.

Status

On going.

c) Poursuivre le projet expérimental "vous échantillonnez, nous analysons" mis en oeuvre dans diverses régions (M. Klaverkamp et associés) pour ensuite l'évaluer en tant qu'outil de gestion et mieux déterminer la variabilité des indicateurs.

Exécution

Scotia-Fundy, Centre et Arctique, Pacifique

Etat d'avancement

En cours.

c) Continue the "you sample, we analyze" pilot project (Dr Klaverkamp *et al.*) from a variety of regions to assess this as a management tool and to better define variability of the indicators.

Action by

Scotia-Fundy, Central & Arctic, Pacific

Status

On going.

d) Essayer d'établir des liens entre les résultats des études sur les indicateurs de stress et la productivité des espèces ainsi que la survie de celles-ci.

Exécution

Toutes les régions.

Etat d'avancement

En cours.

d) Try to relate the results of stress indicator studies of individuals to species productivity as well as species survival.

Action by

All Regions.

Status

On going.

e) Examiner la durée de l'indication stress-effet, c'est-à-dire déterminer les raisons pour lesquelles certains indicateurs de stress acide reviennent à la normale après le chaulage tandis que d'autres demeurent anormalement élevés. Déterminer aussi si le rétablissement du poisson est complet ou seulement partiel.

e) Explore the duration of stress-effect indication; that is, determine the reasons for some acid-stress indicators returning to normal values following liming while other indicators remain abnormally high. Also investigate the recovery of fish; is it whole or only partial?

Exécution

Scotia-Fundy

Etat d'avancement

En cours.

Action by

Scotia-Fundy

Status

On going.

4. **Contaminants organiques et métalliques**

a) Evaluer les flux d'origine atmosphérique et ceux émanant des systèmes (lacs, rivières et régions côtières) afin d'évaluer les effets du TADPA. A cette fin, on peut procéder à des mesures directes et utiliser l'enveloppe globale en collaboration avec le ministère de l'Environnement et d'autres organismes, faire des études paléolimnologiques et étudier la distribution des concentrations dans le milieu aquatique.

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique, Pacifique.

Etat d'avancement

En cours.

b) Etablir le cheminement géochimique et le taux de transfert de l'eau aux particules et sédiments et évaluer les résultats sur des variables comme le facteur Kow (coefficient de partage octanol-eau) en tant que facteur déterminant de ces concentrations.

4. **Organics and Metals**

a) Determine fluxes to and from systems - lakes, rivers and coastal areas - in order to establish the scale of LRTAP influence. This can be accomplished by direct flux measurements and mass budgeting (in cooperation with DOE and other agencies), paleolimnologic studies and the distribution of concentrations in the aquatic environment.

Action by

Newfoundland, Scotia-Fundy, Central & Arctic, Pacific.

Status

On going.

b) Establish geochemical pathways and rates of transfer from water to particles and sediments and, evaluate results on variables such as Kow (octanol/water partition) as a major factor influencing these distributions.

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique.

Etat d'avancement

En cours.

c) Etablir le cheminement ainsi que les taux et les conditions d'accumulation chez les organismes.

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique.

Etat d'avancement

En cours.

d) Evaluer les effets sur la santé des organismes et des écosystèmes, et établir une corrélation avec les indicateurs de stress biochimiques et cellulaire et la productivité d'espèces importantes (par ex.: saumon, truite, etc.).

Exécution

Terre-Neuve, Scotia-Fundy, Québec, Centre et Arctique.

Etat d'avancement

En cours.

REMARQUE: Aux fins des études en eau douce prévues en b), c) et d), il vaut probablement mieux recourir à la manipulation à l'échelle du lac et à celle du mésocosme.

Action by

Newfoundland, Scotia-Fundy, Québec, Central & Arctic.

Status

On going.

c) Establish pathways to organisms, accumulation rates and conditions affecting uptake.

Action by

Newfoundland, Scotia-Fundy, Québec, Central & Arctic.

Status

On going.

d) Establish the effects on individuals and ecosystem health and relate those effects to biochemical and cellular stress indicators and to the productivity of important resource species (e.g. salmon, trout, etc.)

Action by

Newfoundland, Scotia-Fundy, Québec, Central & Arctic.

Status

On going.

NOTE: Topics 2), 3) and 4) for freshwater environments are probably best tackled through the use of mesocosm and whole-lake manipulation.

e) Etudier les effets des variations climatiques latitudinales sur la déposition et l'accumulation dans les organismes.

Exécution

Scotia-Fundy, Centre et Arctique.

Etat d'avancement

En cours.

e) Investigate the effects of latitudinal climate differences on both deposition and accumulation in organisms.

Action by

Scotia-Fundy, Central & Arctic.

Status

On going.

f) Etablir l'ordre de priorité des contaminants organiques devant faire l'objet de recherches vu l'impossibilité d'étudier toutes les substances.

Exécution

DGSPC (AC)

Etat d'avancement

A venir.

f) Priorize LRTAP organics for research because it will be impossible to evaluate all compounds.

Action by

PCSD (HQ)

Status

Needs to be done.

g) Mettre au point un modèle pour la distribution des substances organiques et des métaux et des traceurs historiques dans les sédiments afin de pouvoir interpréter les distributions verticales touchées par la mobilité.

Exécution

Toutes les régions.

Etat d'avancement

A venir.

g) A modelling approach to the distribution of organic and metal components and historic tracers in sediments should be developed to provide the capability to interpret the down-core distributions affected by mobility.

Action by

All regions.

Status

Needs to be done.

5. Variation climatique

a) La contribution du programme aux bases de données à long terme sur les écosystèmes du Canada devrait être maintenue et les données devraient être interprétées en fonction de la variation climatique potentielle. Cette variation est le fait des mêmes sources (combustion de carburants fossiles) qui produisent l'acidification et la déposition de contaminants organiques et métalliques. On prévoit présentement dans le Centre du pays une forte variation climatique qui pourrait avoir des effets radicaux sur les ressources aquatiques. Les régions côtières pourraient aussi être très affectées par les variations du niveau de la mer et des courants océaniques.

Exécution

Toutes les régions.

Etat d'avancement

A venir.

5. Climate Change:

a) Present contribution to long-term databases on whole ecosystems in Canada must be continued and interpreted with respect to potential climate change. Climate change is being forced by similar sources (fossil fuel burning) of atmospheric pollutants which produce acidification and organic/metal contamination. Present predictions for climate change in central Canada are large and will have potentially dramatic effects on aquatic resources. Coastal regions may be severely affected by changes in sea level and ocean currents.

Action by

All regions.

Status

On going.

EVALUATION DES RISQUES

1. La validité statistique des données réunies dans le cadre du programme national d'inventaire des lacs et d'autres ensembles de données a été contestée publiquement. Cela ne signifie pas que ces données ne sont pas utilisables, mais nous devons être capables de garantir dans une certaine mesure l'applicabilité de la régionalisation reposant sur les données existantes.

RISK ASSESSMENT

1. The statistical validity of the survey work within the NIS (National Inventory Survey) and other data sets have been publicly questioned. This does not mean that the data are not useable but we must be able to give some assurance as to the applicability of regionalization based on the data in hand.

Dans certains cas, il faudra peut-être réunir des données complémentaires pour certaines régions ou composantes.

Exécution

Centre et Arctique

Etat d'avancement

En cours.

2. Les données sur les dénombrements et les mesures dans les lacs et les régions de lacs du Canada sont méconnues ou reposent souvent sur des cartes très vieilles plus ou moins précises. On devrait améliorer cet aspect non seulement aux fins de l'évalua- tion des risques, mais pour fournir au gouvernement une évaluation des ressources dont la protection lui incombe. A cette fin, on pourrait d'abord estimer les coûts et les moyens techniques pour améliorer ces données et faciliter le suivi de la recommandation ci-dessus.

Exécution

Centre et Arctique, DBACC (AC).

Etat d'avancement

En cours.

3. Certains aspects du modèle chimique doivent être corrigés ou validés. Il faut faire le partage, associé à la pCO_2, des anions d'acide faible reliés au carbone organique dissous (COD) et des anions reliés au HCO_3. Le sous-comité TADPA a affecté des ressources à ce dossier. En outre, il faut évaluer l'utilité

It may be necessary to fill in with additional data for some regions or components.

Action by

Central & Arctic.

Status

On going.

2. Counts and Measures data for the number of lakes and lake areas for all of Canada are not well known or are based on very old maps of questionable accuracy. An effort should be made to improve this not only for Risk Assessment but also so that is Government has a firm estimate of resources under its protection. A first step in achieving this might be to estimate the costs and technical options for this kind of information upgrade. Improved Counts and Measures will assist in responding to recommendation (1) above.

Action by

Central & Arctic, ECAD (HQ).

Status

On going.

3. Some specific aspects of the chemical model need correction or validation. The partition of the weak acid anions between DOC (Dissolved Organic Carbon) - related anions and HCO_3 associated with pCO_2 must be resolved. The LRTAP Subcommittee allocated some funds to resolve the pCO_2 question. The utility

des données sur le COD dans la base de données. Le facteur F - libération de cations d'origine terrestre par suite de l'apport d'ions hydrogène - constitue un élément crucial du modèle et il n'est pas bien compris. La seule façon d'en apprendre davantage, c'est de procéder à des expériences d'acidification du bassin versant, ce qui est impossible dans le cadre du programme TADPA du MPO. On devrait peut-être continuer de travailler en collaboration avec le ministère de l'Environnement. Le ministère ontarien de l'Environnement est aussi intéressé à mener ce genre d'expérimentations.

of DOC data in the database must be assessed. The F factor, terrestrial cation release in response to hydrogen ion loading is a critical part of the model and it is not well understood. Probably the only way to resolve the uncertainty is by terrestrial acidification experiments. This has not been affordable within the present DFO LRTAP Program. Perhaps a cooperative effort with DOE should be pursued. Ontario Ministry of Environment is also interested in this kind of experiment.

Exécution

Centre et Arctique.

Etat d'avancement

En cours.

Action by

Central & Arctic.

Status

On going.

4. Il faut de toute urgence mener des travaux de recherche afin de quantifier l'impact des contaminants TADPA et de la détérioration physique et chimique des habitats sur la production d'espèces de poissons et d'invertébrés présentant un intérêt commercial. A cette fin, il faut:

a) élaborer, essayer et diffuser des modèles et des méthodes d'évaluation pour mesurer les effets de la dégradation des habitats sur la productivité des écosystèmes, en mettant l'accent sur les évaluations

4. Work on the quantification of the impact of LRTAP contaminants and physical and chemical habitat alterations on the production of fish and invertebrates of commercial interest is urgently required and should be conducted by:

a) developing, testing and publishing models and methods of assessment designed to guage the impacts of habitat alteration on production, placing emphasis on hindcasting and retrospective

rétrospectives et les prévisions à posteriori et sur l'acquisition de toute information historique existante, et;

b) à l'échelle des régions ou des zones, mettre sur pied des groupes de travail composés de spécialistes des habitats et des populations pertinents afin de mettre au point des méthodes pour mesurer l'impact sur les espèces d'importance dans la région ou la zone visée.

Exécution

Toutes les régions.

Etat d'avancement

A venir.

5. Examiner la possibilité de valider le modèle d'évaluation des risques et, à cette fin:

a) mettre le modèle à l'essai pour comparer les résultats avec les données de Sudbury où la charge a diminué;

b) utiliser les données paléolimnologiques sur le pH provenant d'autres régions.

Exécution

Centre et Arctique.

Etat d'avancement

En cours.

assessments and acquisition of all available historical information; and,

b) creating regional or zonal working groups composed of relevant habitat and population scientists concentrating on the development of methods to guage impacts on species of regional/or zonal importance.

Action by

All regions.

Status

Needs to be done.

5. Explore to possibility of validating the Risk Assessment model by:

a) testing it with Sudbury data where loading decreased;

b) using paleolimnologic back-calibration pH data from other areas.

Action by

Central & Arctic.

Status

On going.

6. Dans le modèle d'évaluation des risques, établir, si possible, un lien avec la productivité des écosystèmes après avoir étudié les effets de l'acidification sur la chaîne alimentaire.

Exécution

Centre et Arctique.

Etat d'avancement

En cours.

6. Attempt to develop a linkage in the Risk Assessment Model to ecosystem productivity following on our understanding of food chain effects of acidification.

Action by

Central & Arctic.

Status

On going.

7. Etudier l'incidence d'évènements épisodiques sur le modèle d'évaluation des risques.

Exécution

Centre et Arctique.

Etat d'avancement

En cours.

7. Consider the effects of episodic events on the Risk Assessment Model.

Action by

Central & Arctic.

Status

On going.

8. Publier, si possible, les résultats des études précitées.

Exécution

Centre et Arctique.

Etat d'avancement

En cours.

8. Results of the above investigations should be published where possible.

Action by

Central & Arctic.

Status

On going.

9. Continuer de participer aux travaux du groupe d'étude des pluies acides du CIEM.

Exécution

Scotia-Fundy, Québec et Terre-Neuve.

9. Continue involvement in the ICES Acid Rain Study Group.

Action by

Scotia-Fundy, Québec and Newfoundland.

Etat d'avancement

En cours.

Status

On going.

BIOMONITORING
(SURVEILLANCE BIOLOGIQUE)

1. Constituer une base de données et régler les problèmes éventuels d'assurance de la qualité des données intégrées.

   Exécution

   Groupe de travail sur le biomonitoring.

   Etat d'avancement

   En cours.

2. S'efforcer d'accroître l'intégration avec les programmes scandinaviens et américains et les autres programmes canadiens.

   Exécution

   Groupe de travail sur le biomonitoring.

   Etat d'avancement

   En cours.

3. Décider de l'intégration du zooplancton dans le programme.

   Exécution

   Groupe de travail sur le monitoring.

   Etat d'avancement

   Terminé.

BIOMONITORING

1. Set up a database and resolve potential problems of quality assurance in that database.

   Action by

   Biomonitoring Working Group.

   Status

   On going.

2. Maintain and expand integration with Scandinavian, U.S. and other Canadian programs.

   Action by

   Biomonitoring Working Group.

   Status

   On going.

3. Resolve the question of including zooplankton in the program.

   Action by

   Biomonitoring Working Group.

   Status

   Completed.

4. S'occuper des divers aspects de l'archivage des échantillons, outre l'identification des espèces. Déterminer quels types d'analyses peuvent être effectuées et à quel coût.

Exécution

Groupe de travail sur le monitoring.

Etat d'avancement

En cours.

5. Envisager la possibilité d'établir d'autres sites de monitoring (par ex. site du MPO dans la région de Parry Sound et faire des recommandations à cet égard.

Exécution

Groupe de travail sur le monitoring.

Etat d'avancement

Terminé.

6. Préparer un rapport d'examen sur le champ d'application et les résultats du programme et le présenter à l'atelier TADPA de 1989.

Exécution

Groupe de travail sur le monitoring.

Etat d'avancement

En cours.

4. Address the problem of sample archival other than for species identification. Determine what types of analyses are possible and at what costs.

Action by

Biomonitoring Working Group.

Status

On going.

5. Consider and make recommendations as to the possibility of additional biomonitoring sites (e.g. the DFO Parry Sound site).

Action by

Biomonitoring Working Group.

Status

Completed.

6. Prepare and present a review of the scope and results of the program at the 1989 LRTAP Workshop.

Action by

Biomonitoring Working Group.

Status

On going.

7. Elaborer une stratégie pour garantir la longévité du programme.

Exécution

DGSB (AC).

Etat d'avancement

En cours.

7. Develop a strategy to guarantee longevity of the program.

Action by

BSD (HQ).

Status

On going.

ASSURANCE DE LA QUALITE ET COORDINATION DU PROGRAMME

1. L'assurance de la qualité des données devrait faire l'objet de beaucoup plus d'efforts concertés. Cela vaut tout particulièrement pour le Programme de Biomonitoring, mais aussi pour tous les projets d'analyse chimique et biologique. De toute évidence, les données du programme national d'inventaire des lacs du MPO ne sont pas toutes de qualité et les données canadiennes ont fait l'objet de critiques dans des publications récentes, faute de contrôle adéquat de la qualité. Si nous voulons que nos données puissent souffrir tout examen, nous devons obtenir plus de ressources et appliquer des protocoles d'assurance de la qualité plus rigoureux et rationnels.

Exécution

Sous-comité TADPA
Toutes les régions.

Etat d'avancement

En cours.

QUALITY ASSURANCE AND PROGRAM COORDINATION

1. Much more coordinated effort must be placed on quality assurance of data. This is especially important for the Biomonitoring Program but true for all chemical and biological projects. The DFO NIS data certainly showed weakness in quality assurance. Canadian data have been criticized in recent publications for lack of quality assurance. If our results are to "stand up in court", more resources and more rigid, rational quality assurance protocols must be applied.

Action by

LRTAP Subcommittee
All regions.

Status

On going.

2. On devrait améliorer la coordination des projets entre les régions. Le comité consultatif scientifique organisait un forum à cette fin, mais l'atelier annuel TADPA ne suffit pas à cet égard. Une coordination accrue s'impose notamment pour l'évaluation des risques, car ainsi les résultats des recherches seront présentés de façon à améliorer les modèles.

Exécution

Sous-comité TADPA
Toutes les régions.

Etat d'avancement

En cours.

2. Coordination of projects among regions should be improved. The Scientific Advisory Committee used to provide a forum for this. The annual LRTAP Workshop is not sufficient for this purpose. Increased coordination would be of particular value to risk assessment by insuring that research output was formulated to contribute to improvement of models.

Action by

LRTAP Subcommittee
All regions.

Status

On going.

ECONOMIE

1. Publier et distribuer les évaluations économiques et les documents d'examen par des pairs produits à ce jour.

Exécution

DGAED (AC).

Etat d'avancement

En cours.

2. Envisager l'évaluation des travaux de recherche en fonction d'un nouveau critère, soit la valeur des ressources pour les non-utilisateurs. Toutes les évaluations actuelles sont axées sur les utilisateurs de ressources.

ECONOMICS

1. Publish and/or distribute economic assessments and peer review documents produced so far.

Action by

ECAD (HQ).

Status

On going.

2. Consider adding an assessment based on the value of resources to non-users. All present evaluations have focussed on the resource users.

Exécution

DGAED (AC).

Etat d'avancement

En cours.

Action by

ECAD (HQ).

Status

On going.

RECOMMANDATIONS A LA HAUTE DIRECTION

1. Les participants de l'atelier croyaient que la coordination et le contrôle scientifiques du programme avaient été approuvés depuis l'atelier TADPA de 1986. Cependant, ils se préoccupent grandement de l'absence apparente de soutien de la part de la haute direction et plus particulièrement du fait que le poste du gestionnaire du programme des pluies acides n'a pas été doté. Les participants jugent que cette attitude a abouti à l'affaiblissement de la coordination interministérielle à l'échelon supérieur. On ne saurait réaliser un programme efficace et solide sans les efforts concertés des ministères compétents.

Exécution

DGSB (AC).

Etat d'avancement

Terminé.

RECOMMENDATIONS TO SENIOR MANAGEMENT

1. The Workshop participants believed that the scientific coordination and control of the program has been approved since the 1986 LRTAP Workshop. However, there is great concern over the apparent lack of support from Senior Management, especially the lack of a strong commitment to the position of acid rain program manager. The participants considered that this has led to a weakening of interdepartmental coordination at the senior level. It will not be possible to put together a strong, successul program unless an interdepartmental effort can be mounted.

Action by

BSD (HQ).

Status

Completed.

2. Les dommages causés aux écosystèmes et aux ichtyofaunes des eaux canadiennes par les polluants atmosphériques n'ont pas été réparés même si l'on saisit beaucoup mieux le phénomène de l'acidification. Il

2. The problems of damage to Canadian aquatic ecosystems and fisheries through LRTAP have not been solved, although significant understanding of acidification has been achieved. The consequences of delays in imposing

faut évaluer l'incidence du report de la mise en oeuvre de mécanismes de contrôle et élaborer des stratégies pour protéger les ressources aquatiques. Par ailleurs, d'autres polluants comme les contaminants organiques et métalliques qui figuraient dans le premier projet de programme TADPA en 1978 sont encore présents. On a suspendu les travaux de recherche sur ces polluants en raison de l'urgence du dossier des pluies acides et des restrictions budgétaires. Ces questions doivent être étudiées dans le cadre du TADPA V.

controls must be studied and the strategies for protecting aquatic resources developed. Other LRTAP components (i.e. Organics and Metals) which have been identified since the first LRTAP submission in 1978 have not gone away. Research on these compounds was suppressed because of the urgency of the acid problems and budget limitations. These other LRTAP-related problems must now be studied as part or LRTAP-V.

Exécution

DGSB (AC), DGSPC (AC).

Etat d'avancement

En cours.

Action by

BSD (HQ), PCSD (QH).

Status

On going.

3. Par la suite de la réaffectation des services votés au sein du MPO et des compressions budgétaires, on ne pourra pas mener de grands travaux de recherche dans le cadre du programme à moins que:

   a) le programme ne reçoive de nouveaux crédits si la présentation du programme TADPA V est approuvée par le CT;

   b) les sommes présentement engagées ne soient considérées comme des services votés en reconnaissance du fait que le TADPA constituera encore une menace pour les ressources dont la protection incombe au MPO.

3. Because of the re-allocation of A-Base resources within DFO and budget reductions, it will be impossible to carry on important LRTAP research unless:

   a) the program received renewed support by approval of the LRTAP-V Submission by Treasury Board; or,

   b) present LRTAP commitments are regularized as A-base in acknowledgement of the fact that LRTAP will continue to be a potential problem for the resources under the Department's protection long into the future.

Exécution

DGSB (AC).

Etat d'avancement

En cours.

Action by

BSD (HQ).

Status

On going.

4. Il faut bien comprendre que les projets d'études sur les contaminants organiques et métalliques proposés dans le cadre du programme insistent sur le fait que le TADPA est un problème pan-canadien. La pêche dans l'Arctique, sur les côtes canadiennes et dans les eaux intérieures tempérées est touchée tout comme les consommateurs locaux. Même si le ministère de L'Environnement a participé aux travaux de recherche chimique dans les eaux côtières douces, ces études relèvent principalement du mandat du MPO. Le programme ne dispose pas des ressources voulues pour effectuer ces travaux complémentaires dans les eaux côtières, dont l'établissement des budgets pertinents.

4. It must be understood that the proposed LRTAP studies of organics and metals emphasize that LRTAP is a Canadian-wide problem. Arctic and coastal marine fisheries and the local consumers, as well as temperate inland ones, are involved. While DOE played a role in freshwater chemical work, in coastal waters, this work is primarily within DFO's mandate. The present LRTAP funding is insufficient to support this additional coastal effort including the determination of chemical budgets.

Exécution

DGSB (AC).

Etat d'avancement

En cours.

Action by

BSD (HQ).

Status

On going.

5. Les participants de l'atelier ont proposé que les démarches suivantes soient faites pour permettre le suivi de la recherche dans le cadre du programme:

5. The Workshop participants proposed the following steps to achieve continuance of LRTAP research:

Exécution

DGSB (AC).

Action by

BSD (HQ).

Etat d'avancement

En cours.

a) parallèlement au rapport d'évaluation du CCRM de 1990, préparer un résumé concis des réalisations antérieures et des défis à relever dans le cadre du programme du MPO et ce, en des termes familiers et à l'intention de la haute direction;

b) améliorer la coordination interministérielle aux échelons supérieurs du MPO, du ME, du SCF, du MAINC et de Santé et bien-être social aux fins de l'élaboration d'une stratégie concertée pour les futurs travaux de recherche du programme, stratégie qui donnera lieu à une présentation au Cabinet et au Conseil du Trésor. Cette stratégie devra être bien expliquée aux chercheurs afin qu'une proposition puisse être élaborée;

c) réaffirmer l'importance du poste de gestionnaire du programme des pluies acides (TADPA) si l'on veut donner suite aux recommandations précédentes et assurer la communication entre les services scientifiques et la haute direction;

Exécution

DGSB (AC).

Etat d'avancement

Terminé.

Status

On going.

a) a concise summary of past accomplishments and future challenges of the DFO LRTAP program should be prepared, using layman's language, for Senior Management in parallel with the RMCC 1990 Assessment Report;

b) interdepartmental cooperation in upper levels of DFO, DOE, CFS, DIAND and H&W be enhanced to unify a strategy for continued LRTAP research leading to a Cabinet/Treasury Board submission. This strategy should be made clear to researchers so the proposal can be prepared.

c) the strength of the Acid Rain (LRTAP) Program Manager's position be re-established if the above suggestions are to be implemented and to ensure that the scientific units are in communication with Senior Management;

Action by

BSD (HQ).

Status

Completed.

d) entreprendre dans les meilleurs délais le collationnement, l'intégration et la priorisation des propositions qui constitueront le volet scientifique de la présentation au Cabinet et au Conseil du Trésor puisque ces travaux sont assez longs. Ainsi, on indiquera clairement la façon de répondre aux besoins en recherche scientifique cernés à la faveur des ateliers du programme TADPA. En outre, on doit préparer un exposé clair des programmes qui prendront fin faute de financement à compter d'avril 1990;

Exécution

DGSB (AC).

Etat d'avancement

En cours.

d) collation, integration and priorization of specific proposals, for the scientific content of a Cabinet/Treasury Board submission must begin soon since this will take some time to complete. This will be the concrete expression of how to address specific research needs that were identified at the LRTAP Workshops. A clear statement of programs which collapse if funding is not in place by April, 1990 must be prepared as well;

Action by

BSD (HQ).

Status

On going.

e) le comité national des directeurs des Sciences doit étudier les répercussions, qu'auront sur leurs programmes régionaux de la poursuite des travaux actuels de surveillance biologique du TADPA au moyen des services votés, si le programme TADPA n'obtient pas de financement extérieur après 1990. Le Programme de Biomonitoring doit absolument se poursuivre encore 15 ou 20 ans.

Exécution

DGSB (AC).

Etat d'avancement

En cours.

e) the National Science Director's Committee consider the implications to their regional programs of continuing the present level of LRTAP Biomonitoring activity through A-base support should the LRTAP Program fail to get external funding beyond 1990. It is critical that the Biomonitoring Program continue for the next 15 to 20 years.

Action by

BSD (HQ).

Status

On going.

6. Le MPO prépare présentement un programme qui fait la synthèse des réalisations du programme TADPA et évalue l'ampleur et l'impact du problème de l'acification afin de trouver des solutions concrètes. Le présent document constitue une partie substantielle d'une vaste évaluation interministérielle du TADPA qui est coordonnée et dirigée par le CCRM. Il importe que les directeurs régionaux des Sciences et la haute direction de l'Administration centrale appuient cet exercice en encourageant leurs membres à y participer (examen de 1990).

Exécution

DGSB (AC)
Pour obtenir l'appui voulu de la haute direction de l'AC.

Etat d'avancement

En cours.

7. La région de Terre-Neuve devrait à tout le moins établir trois sites de biomonitoring.

Exécution

Terre-Neuve.

Etat d'avancement

Terminé.

8. La région du Pacifique devrait continuer de participer au programme TADPA.

6. A document is in preparation within DFO which will synthesize the accomplishments of the LRTAP Program and assess the status of the acidification problem and our understanding of consequences for solution. This document will form a substantial part of a large interdepartmental assessment of LRTAP being coordinated and led by RMCC. It is important that Regional Science Directors and Senior Headquarters Management ensure their support for this exercise by encouraging the participation of their staff. (1990 review).

Action by

BSD (HQ)
To ensure the necessary support from Senior Headquarters Management.

Status

On going.

7. The Newfoundland region should give special attention to establishing a minimum of three biomonitoring sites.

Action by

Newfoundland.

Status

Completed.

8. The Pacific Region should continue to be involved in the LRTAP Program.

Exécution

DGSB (AC), Pacifique.

Etat d'avancement

Terminé.

Action by

BSD (HQ), Pacific.

Status

Completed.