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Distribution of Chlorinated Hydrocarbon Pesticides and PCBs in the Arctic Ocean

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April 1989

Canadian Technical Report of Fisheries and Aquatic Sciences
No. 1644

Fisheries and Oceans
Pêches et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

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DISTRIBUTION OF CHLORINATED HYDROCARBON PESTICIDES AND PCBs IN THE ARCTIC OCEAN

by

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Cat. No. Fs 97-6/1644E 0706-6457

Correct citation for this publication:

Hargrave, B.T., W.P. Vass, P.E. Erickson, and B.R. Fowler. 1989. Distribution of chlorinated hydrocarbon pesticides and PCBs in the Arctic Ocean. Can. Tech. Rep. Fish. Aquat. Sci. 1644: ix + 224 p.

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ABSTRACT

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Organochlorine pesticides and PCBs were analyzed in air, snow, ice, seawater, sediment, plankton and benthic amphipods collected north of Axel Heiberg Island (81^0N). Sampling was carried out through first year ice adjacent to an ice island on which the polar Continental Shelf project has established a permanent camp. Samples were collected in May and late August, early September 1986 and again in June 1987.

Although present at concentrations that are among the lowest reported anywhere in the world, organochlorine pesticides were detectable and quantifiable in most samples. The most abundant compounds in air, snow, ice and seawater were alpha and gamma hexachlorocyclohexanes (HCH). Total HCH levels ranged from 500 pg/m^3 in air to 5000 pg/L in surface (0-50 m) seawater. Hexachlorobenzene (HCB) was the next most abundant compound in air (100 pg/m^3) but because of its low solubility, was much less abundant in ice or water (<20 pg/L). Cyclodiene pesticides (chlordane, dieldrin, α endosulfan, heptachlor), DDT, DDE, methoxychlor and PCBs were present at trace levels in air and water (<10 pg/m^3 air; <10 pg/L water) but were relatively abundant in melted snow (up to 100 pg/L) indicating efficient scavenging from air. Three types of compounds, PCBs, DDE and cis-chlordane were detected in surface sediments. Concentrations were less that 50 pg/g.

DDT, DDE, PCBs and cyclodiene pesticides (chlordane, dieldrin) were preferentially concentrated in biota. These compounds were the most abundant organochlorines in plankton and pelagic amphipods. DDT, DDE and PCBs were concentrated by a further factor of 10-50 in benthic amphipods compared to samples of plankton or pelagic amphipods from under the ice.

The distribution and abundance of organochlorines in seawater indicates the major source to be at the surface. Concentrations of all organochlorines were highest in the well mixed low salinity surface layer (0-50 m) and decreased with depth through the halocline. Atmospheric concentrations and levels in snow and ice along with available data for inflowing Bering Sea and river water indicate that atmospheric transport is the major source of organochlorines to the Arctic Basin. Atlantic water below the halocline by extrapolation appears to have very low organochlorine concentrations. The volume of inflowing North Pacific and river water and concentrations of organochlorines in these waters is insufficient to produce the observed surface seawater concentrations.

RÉSUMÉ

Hargrave, B.T., W.P. Vass, P.E. Erickson, and B.R. Fowler. 1989. Distribution of chlorinated hydrocarbon pesticides and PCBs in the Arctic Ocean. Can. Tech. Rep. Fish. Aquat. Sci. 1644: ix + 224 p.

On a dosé des pesticides organochlorés et des PCB dans de l'air, de la neige, de la glace, de l'eau de mer, des sédiments, du plancton et des amphipodes benthiques recueillis au nord de l'île Axel Heiberg (81° N). Les échantillons ont été prélevés dans de la glace de l'année près d'une île de glace sur laquelle le groupe d'étude du plateau continental polaire a établi un camp permanent. Le prélèvement des échantillons a eu lieu au mois de mai, à la fin du mois d'août et au début du mois de septembre 1986 ainsi qu'au mois de juin 1987.

Bien que les concentrations des pesticides organochlorés relevées soient parmi les plus faibles qui aient été signalées ailleurs dans le monde, la plupart des échantillons renfermaient des quantités décelables et quantifiables de ces composés. Les composés les plus abondants dans l'air, la neige, la glace et l'eau de mer étaient les alpha-hexachlorocyclohexanes et les gamma-hexachlorocyclohexanes (HCH). Les concentrations totales de HCH variaient de 500 pg/m^3 dans l'air à 5000 pg/L dans l'eau de mer superficielle (0-50 m). L'hexachlorobenzène était le deuxième composé le plus abondant dans l'air (100 pg/m^3), mais en raison de sa faible solubilité, il était beaucoup moins abondant dans la glace ou dans l'eau (< 20 pg/L). Les pesticides cyclodiéniques (chlordane, dieldrine, α-endosulfan, heptachlore), le DDT, le DDE, le méthoxychlore et les PCB étaient présents à l'état de traces dans l'air et dans l'eau (< 10 pg/m^3 dans l'air; < 10 pg/L dans l'eau), mais ils étaient relativement abondants dans la neige fondue (jusqu'à 100 pg/L), ce qui indique qu'ils y sont efficacement piégés à partir de l'air. Trois composés, PCB, DDE et cis-chlordane, ont été décelés dans des sédiments superficiels. Leurs concentrations étaient inférieures à 50 pg/g.

Le DDT, le DDE, les PCB et les pesticides cyclodiéniques (chlordane, dieldrine) étaient préférentiellement concentrés dans le biote. Ces produits étaient les composés organochlorés les plus abondants chez le plancton et chez les amphipodes pélagiques. Le DDT, le DDE et les PCB étaient 10 à 50 fois plus abondants chez les amphipodes benthiques que dans les échantillons de plancton ou d'amphipodes pélagiques prélevés au-dessous de la glace.

La répartition et l'abondance des composés organochlorés dans l'eau de mer montrent que leur source principale se trouve à la surface. Les concentrations de tous les composés organochlorés étaient maximales dans la couche superficielle bien agitée et de faible salinité (0-50 m) et elles diminuaient au fur et à mesure de la profondeur, dans l'halocline. Les concentrations atmosphériques et les concentrations mesurées dans la neige et dans la glace, ainsi que les données existantes relatives à la venue d'eau de la mer de Béring et d'eau de rivière, indiquent que le transport atmosphérique est la principale source de composés organochlorés dans le bassin Arctique. Les concentrations de composés organochlorés dans l'eau de l'Atlantique, sous l'halocline, calculées par extrapolation, semblent très faibles. Le volume des eaux provenant du Pacifique Nord et de l'eau de rivière et les concentrations de composés organochlorés dans ces eaux sont insuffisants pour produire les concentrations observées dans l'eau de mer superficielle.

INUKTITUT SUMMARY

Hargrave, B.T., W.P. Vass, P.E. Erickson, and B.R. Fowler. 1989. Distribution of chlorinated hydrocarbon pesticides and PCBs in the Arctic Ocean. Can. Tech. Rep. Fish. Aquat. Sci. 1644: ix + 224 p.

ᐆᒪᔪᐊᕈᓯᕐᓄᑦ ᑐᕐᑯᑎᕈᑎᑦ ᐊᒻᒪᓗ PCB ᖃᐅᔨᓴᖅᑕᐅᓚᐅᕐᑐᑦ ᓯᓚᒥ, ᐊᐳᑎᒥᓗ, ᓯᑯᒥᓗ, ᑕᕆᐅᒥᓗ, ᑭᓂᖅᑕᖅᓂᒃᓗ, ᐃᒪᕐᒥᐅᑕᐃᑦ ᓅᒍᓐᓇᖕᒋᑐᑦᓗ ᓇᖕᒥᓂᖅ ᐊᒻᒪᓗ ᐃᖅᑲᒥᐅᑕᐃᑦ ᑲᑎᖅᓱᖅᑕᐅᓯᒪᓪᓗᑎᒃ ᐅᒥᖕᒪᑦ ᓄᓈ ᑲᓇᖕᓈᓂᑦ. ᐆᒃᑐᕋᖅᑕᐅᓪᓗᑎᒃ ᓯᕗᓪᓚᖅᐹᖅ ᐅᑭᐅᖕᒐᓂᑦ ᓯᑯ ᐱᖃᓗᔭᐅᑉ ᖃᓂᖕᒐᓂᑦ ᐅᑭᐅᖅᑕᖅᑐᒥ ᓄᓇᓂᒃ ᖃᐅᔨᓴᖅᑎᒃᑯᑦ ᓯᓂᒃᑕᕐᕕᒃᓴᓕᐅᓚᐅᕐᑐᑦ. ᐆᒃᑐᕋᐅᑎᑦ ᑲᑎᖅᓱᖅᑕᐅᓚᐅᕐᑐᑦ ᒪᐃ ᐊᒻᒪᓗ ᐊᒍᔅᑎ ᓅᖕᒍᐊᓂ, ᓴᑕᐸ ᐱᒋᐊᓚᓵᖅᑎᓪᓗᒍ 1986-ᒥ ᐊᒻᒪᓗ ᔫᓐ 1987-ᒥ.

ᑕᐃᑲᓃᒐᓗᐊᕐᑎᓪᓗᒋᑦ ᐅᔾᔨᕆᔭᐅᓯᒪᓗᒃᑕᑦᓯᐊᕐᑐᑦ ᐊᑦᓯᓂᖅᐹᖕᒍᒐᓗᐊᕐᒪᑦ ᐅᓂᒃᑲᓕᐅᒐᐅᓯᒪᓂᖕᒐ ᓇᒥᓗᒃᑖᖅ ᓄᓇᕐᔪᐊᓕᒫᓂᑦ, ᐆᒪᔪᐊᕈᓯᕐᓄᑦ ᑐᕐᑯᑎᕈᑎᓂᑦ ᐊᒻᒪᓗ PCB-ᓂᑦ ᐆᑐᕋᐅᑕᐅᓪᓗᑎᒃ ᐆᑐᑎᒋᔭᒥᖕᓂᑦ. ᑕᒃᑯᐊ PCB-ᖕᒍᓂᕋᖅᑕᐅᔪᑦ ᐊᒻᒪᓗ ᑕᒪᒃᑯᐊᕋᓗᔭᑦ ᐆᒪᔪᐊᕈᓯᕐᓄᑦ ᑐᕐᑯᑎᕈᑎᑦ (DDT-ᖕᒍᓂᕋᖅᑕᐅᔪᑦ, DDE-ᖕᒍᓂᕋᖅᑕᐅᔪᓪᓗ, Chlordane-ᖕᒍᓂᕋᖅᑕᐅᔪᓪᓗ ᐊᒻᒪᓗ dieldrin-ᖕᒍᓂᕋᖅᑕᐅᔪᑦᑕᐅᖅ) ᐅᔾᔨᕆᔭᐅᓯᒪᔪᑦ ᓱᓇᑐᐃᓐᓇᕐᓂᑦ ᐆᒪᔪᓕᒪᕐ. ᑕᒪᒃᑯᐊ ᐊᒥᓱᓂᖕᒋᑦ ᓱᕋᖅᑕᐅᓯᒪᔪᑦ ᐃᒪᕐᒥᐅᑕᐃᑦ ᓅᒍᓐᓇᖕᒋᑐᑦ ᓇᖕᒥᓂᖅ ᐊᒻᒪᓗ ᐃᑭᐊᖕᒐ ᐃᒪᐅᑉ, DDT-ᓂᑦ, DDE-ᓂᑦ, PCB-ᓂᑦ ᐅᔾᔨᕆᔭᐅᓯᒪᓪᓗᑎᒃ 10-ᖕᒍᔪᐃᑦ 50-ᖕᒍᓗᒃᑕᖅᓱᑎᐅᒐᓗᐊᖅ ᐃᖅᑲᒥᐅᑕᐃᑦ ᐆᑐᑕᐅᓪᓗᑎᒃ ᐃᒪᕐᒥᐅᑕ ᓅᒍᓐᓇᖕᒋᑐᑦ ᓇᖕᒥᓂᖅ ᓯᑰᑉ ᐊᑖᓂᑦ.

ᐆᒪᔪᐊᕈᓯᕐᓄᑦ ᑐᕐᑯᑎᕈᑎᑦ PCB-ᓪᓗ ᓇᓂᔭᐅᓚᐅᕐᑐᑦ ᖁᑦᓯᓂᖅᐹᖕᒍᓪᓗᑎᒃ ᐅᔾᔨᕆᔭᐅᓯᒪᓂᖕᒐᑦ ᑕᕆᐅᑭᓐᓃᖅᐸᖕᒍᔪᒥ ᐃᒫᓂᑦ (0-50 ᒦᑕᓂᑦ) ᐊᒻᒪᓗ ᐊᒃᓯᓪᓗᐊᕐᓂᖅᓴᐅᓕᖅᓗᓂ. ᐊᕙᑖᓂᑦ ᐅᔾᔨᕆᔭᐅᓯᒪᓂᖕᒐ ᐊᒻᒪᓗ ᐊᒃᓯᓂᖕᒋᓄᑦ ᐊᐳᑏᑦ ᐊᒻᒪᓗ ᓯᑯᑦ ᖃᐅᔨᓴᖅᑕᐅᓐᓂᑯᔪᑦ ᐃᖕᒋᕐᕋᓂᖕᒐ ᑕᕆᐅᒥ ᑰᒥᓗ ᐃᒪᐃᓕᖕᒐᓄᑦ ᐊᕙᑖᓂᑐᑦ ᐃᖕᒋᕐᕋᕈᑕᐅᔪᒃᓴᑦ ᓱᕋᖅᓯᒪᓗᐊᓕᖅᓯᒪᓕᕐᓂᖕᒋᑦ ᐅᑭᐅᖅᑕᖅᑐᒥ. ᐊᒃᓯᒃᑐᒥ ᐃᒪᕐᒥ ᑕᐃᑲᖕᒐᑦ ᑭᑖᓂᑦ ᑕᕆᐅᕐᑯᑎᖕᒐᓂᑦ ᓱᕋᓗᐊᖅᓯᒪᓗᐊᖕᒋᓂᖕᒐᓄᓕ ᐅᔾᔨᕆᔭᐅᓯᒪᓂᐅᔪᖅ.

1. INTRODUCTION

The Department of Energy, Mines and Resources, through the Polar Continental Shelf Project (PCSP) set up a camp in 1985 on an ice-island presently off the north-west coast of Axel Heiberg Island (near 81°N, 97°W, see Figure 1.1). The island is an approximately 4 x 7 km oval shaped piece of ice, 45 m thick that was calved from an ice shelf off the north coast of Ellesmere Island in 1983. A similar island (Fletcher's Ice Island T-3) was occupied by American scientists from 1952 until 1974 during which time the island drifted in the Beaufort Gyre along the north coast of the Canadian Archipelago into the Beaufort Sea and subsequently made two revolutions of the Canada Basin. It is hoped that this new island will follow a similar course. The island and camp offers a unique opportunity to carry out scientific studies along Canada's most northerly coast over an extended time period.

Chlorinated hydrocarbon pesticides and polychlorinated biphenyls (PCBs) are semi-volatile, lipophilic industrial compounds which have environmental significance because of their stability, toxicity and tendency to concentrate in organisms. Although produced and used principally in the mid-latitudes and tropics, long range transport via the atmosphere (Oehm and Ottar, 1984; Barrie, 1986) as well as surface ocean currents and river drainage has introduced these compounds into the Arctic Ocean Basin. PCBs and chlorinated hydrocarbon pesticides have been detected in the Arctic, although the available data base is small and restricted primarily to atmospheric concentrations and tissues from large mammals. The present distribution and the mechanisms for the transfer of these compounds between various compartments of the arctic marine environment is poorly understood. Very little is known about rates of biological production in offshore areas, food web linkages and most importantly, the sensitivity of arctic organisms to these potentially toxic compounds. It is known that productivity and levels of organic matter (particulate and dissolved) in the

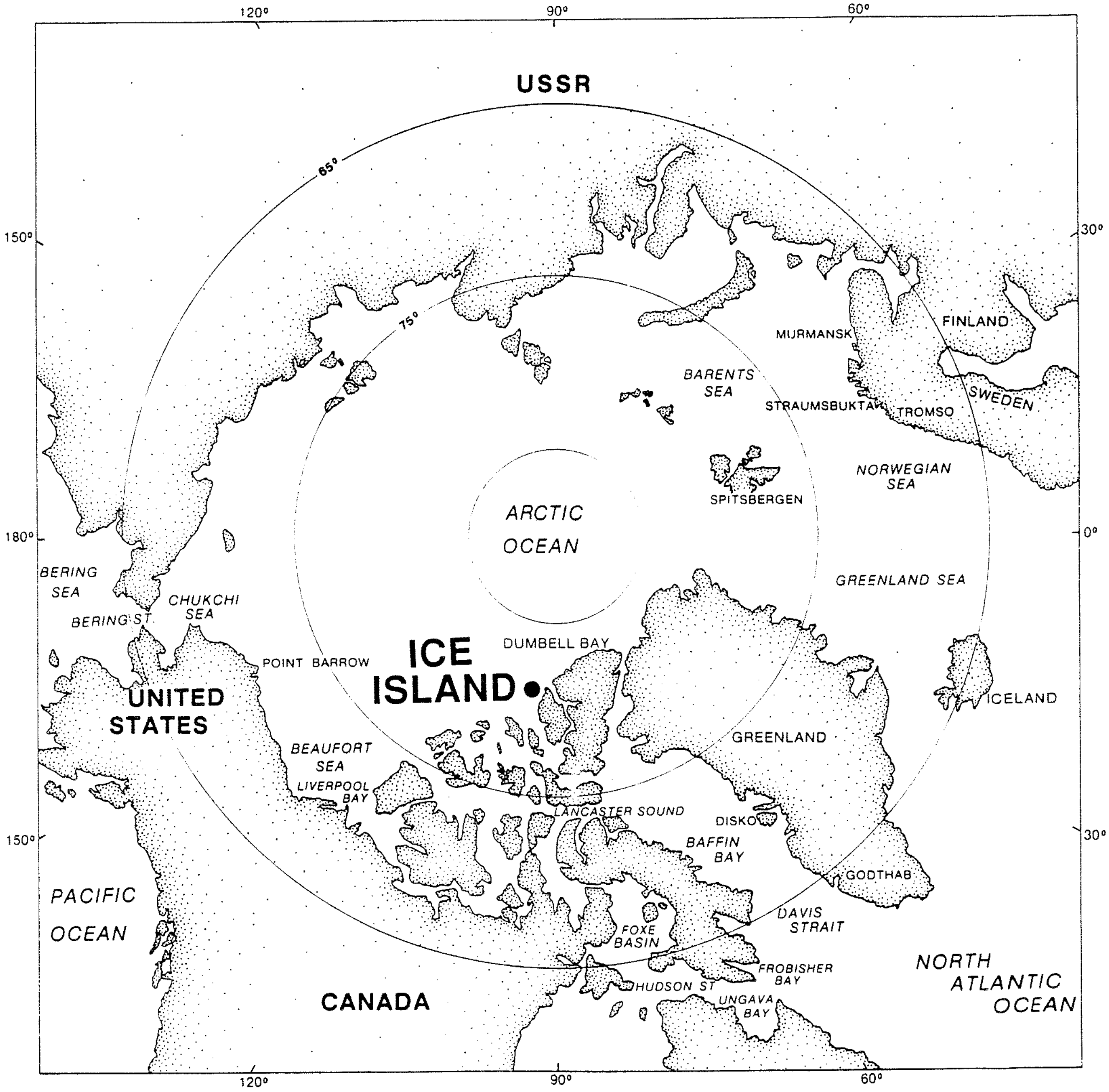


Figure 1.1 Approximate location of the ice island in 1986-1987.

Arctic Ocean are extremely low (Gordon and Cranford, 1985). Since there is insufficient light for photosynthesis for many months of the year, the supply of organic matter is very seasonal. The necessity for organisms in this environment to be able to store energy-rich substances may make them more susceptible to contaminants than organisms in more temperate regions. This in turn may lead to a more efficient transfer of contaminants to the higher trophic levels including arctic consumer organisms.

Relatively high levels of PCBs and chlorinated hydrocarbon pesticide residues have been found in arctic marine mammal and fish tissues in several recent studies (Nordstrom et al., 1985; Thomas and Hamilton, 1988). This has direct relevance to Canadian arctic regions where native people still rely on marine mammals and fish for a large portion of their protein and caloric intake. Observations of PCBs and chlorinated hydrocarbon pesticide residues in blood samples from many Inuit from the community of Broughton Island on Baffin Island (Kinloch and Kuhnlein, 1987) that exceed tolerable concentration limits set by Health and Welfare Canada emphasize this point.

The present study used the opportunity provided by the Canadian Ice Island Station to expand the available data base for these compounds in the high Arctic with the objective of examining the distribution of chlorinated hydrocarbon pesticides and PCBs in various compartments of the Arctic marine environment and food web.

1.1 Objectives

The terms of reference for the work carried out were to:

1) determine ambient concentrations of selected chlorinated hydrocarbon pesticides and PCBs in the water and bottom sediment off Canada's northern outer coast;

2) measure concentrations of these compounds in marine biota at various trophic levels to determine whether biomagnification occurs; and

3) evaluate the importance of the atmospheric contribution of these contaminants.

There are a large number of chlorinated hydrocarbon pesticides that have been or are presently in use. Because of concerns over their environmental effects, the use of many of the more persistent pesticides has been banned in the United States, Canada and western Europe. However, banned compounds are still being used in large tonnages in other countries particularly in the tropics and the ban on the use of many others has only been in effect during the past few years. A summary of recent FAO 'reported' worldwide usage of organochlorine pesticides whose use or production has been halted in the United States is given in Table 1.1 (from Bidleman, 1987). As pointed out by Bidleman, these figures likely grossly underestimate the total amount of pesticide used as reporting of these figures to the FAO is voluntary.

A total of 20 organochlorine pesticides were monitored in this study. PCBs in this study were defined in terms of a particular technical mixture, Arochlor 1254. Since reference to these compounds will be made throughout the text and since most have short form or common names different from their actual chemical nomenclature, a list is given in Table 1.2 of the target compounds in this study and the corresponding short form name that will be used in the text. Some of the pesticides have several stable isomers and others are metabolites or degradation products or are present in the same technical mixtures and hence share common origins and have similar physical and chemical properties. On this basis the target compounds can be grouped into 5 classes: hexachlorocyclohexanes (HCH), hexachlorobenzene (HCB), Cyclodienes, DDT, and PCBs. This grouping of compounds has been used in the discussion of the data.

Table 1.1.

FAO Reported Usage of Organochlorine Pesticides, Tonnes
(Taken from Bidleman; 1987)

	DDT	Technical HCH	Lindane	Toxaphene	Cyclodienes[a]	Other
Mexico 1983 + 84	600	500	55	2,400		1,175
Kenya 1983 + 84	225	14	18		339	
Gambia 1983	120					
Argentina 1983	1	6	146		638	48
India 1983	887	24,293			80	148
Turkey 1982	379	2,552	77			63
Italy 1983			1,398			484
Hungary 1984				55		146
Poland 1984			166	41		1,280

a) Listed as "aldrin and similar insecticides".

Table 1.2 Target Chlorinated hydrocarbon Pesticides and PCBs

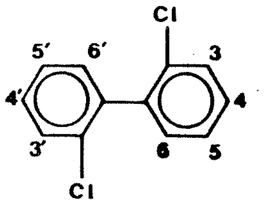
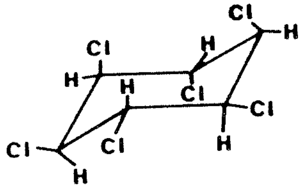
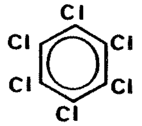
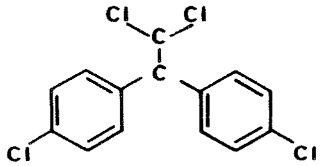
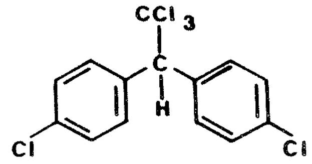
Compound Common Name	Chemical Name	Molecular Form	Structure
PCBs defined as Aroclor 1254	mainly contains isomersof chlorinated biphenyls of the composition $C_{12}H_6Cl_4$, $C_{12}H_5Cl_5$ and $C_{12}H_4Cl_6$		
γ HCH or BHC (lindane)	Cyclohexane, 1,2,3,4,5,6 hexachloro	$C_6H_6Cl_2$	
α HCH or BHC	Cyclohexane, 1,2,3,4,5,6 hexachloro	$C_6H_6Cl_2$	
HCB (hexachlorobenzene)	Benzene, hexachloro	C_6Cl_6	
p,p'-DDE	Benzene, 1,1'-(dichloroethenylidene)bis(4-chloro-	$C_{14}H_8Cl_4$	
p,p'-DDT	1,1,1-Trichloro-2,2-bis(4-chlorophenyl)-ethane		

Table 1.2 (cont'd)

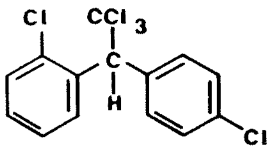
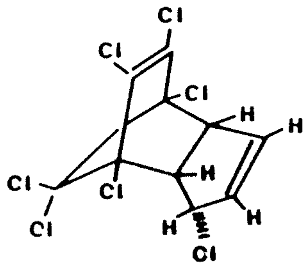
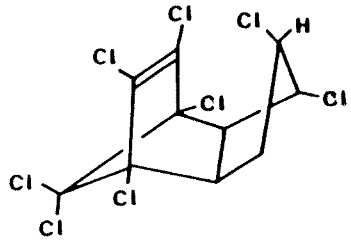
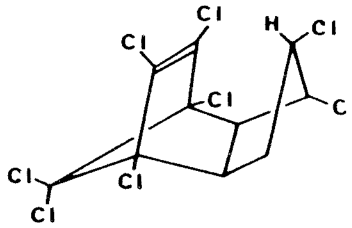
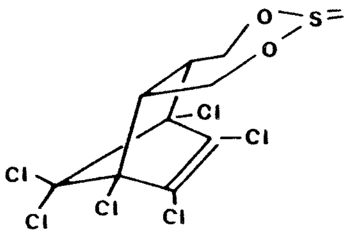
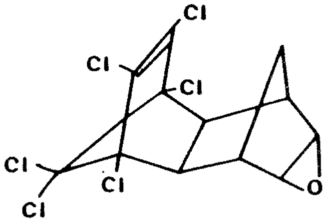
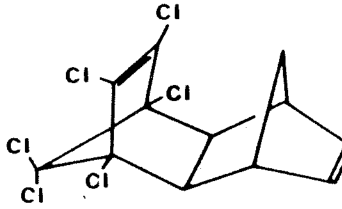
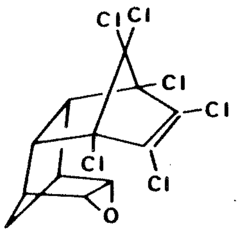
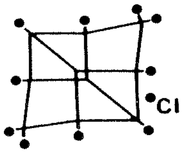
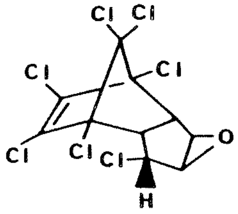
o,p'-DDT	1,1,1-Trichloro-2-(2-chlorophenyl)-2-(4-chlorophenyl)ethane		
heptachlor	4,7-Methane-1H-indene,1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro	$C_{10}H_{10}Cl_7$	
trans chlordane (γchlordane)	4,7-Methano-1H-indene,1,2,4,5,6,7,8,8-octochloro-2,3,3a,4,7,7a-hexahydro-	$C_{10}H_6Cl_8$	
cis chlordane (βchlordane)	4,7-Methano-1H-indene,1,2,4,5,6,7,8,8-octochloro-2,3,3a,4,7,7a-hexahydro-	$C_{10}H_6Cl_8$	
α endosulfan (Thiodan)	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,7,9a-hexahydro-e-oxide	$C_9H_6Cl_6O_3S$	

Table 1.2 (cont'd)

Dieldrin	2,7:3,6-Dimethanonaphth(2,3-b)oxirene,3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,	$C_{12}H_8Cl_6O$	
Aldrin	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanonaphthalene		
Endrin	2,7:3,6-Dimethanonaphth(2,3-b)oxirene,3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octhydro-	$C_{12}H_8Cl_6O$	
Mirex (dechlorane)	1,3,4,-Metheno-1H-cyclobuta(cd)pentalene, 1,1a,2,2,3,3a,4,5,5a,5b,6-dodecachloro octahydro-	$C_{10}Cl_{12}$	
Heptachlor epoxide	4,7-Methanoindan-1,4,5,6,7,8,8-heptachlor-2, 3-epoxy-3a4, 7, 7a-tetrahydro		

2. SAMPLING METHODS

Three trips were made to the island:

1) May 19 - 31, 1986
2) August 25 - September 8, 1986
3) June 5 - 16, 1987

The first trip was made as soon as possible after the start of the study in March, 1986. It was hoped that sampling would overlap with the period of elevated atmospheric contaminant levels associated with the "arctic haze" phenomenom. The second trip was at the end of the brief summer period and was expected to coincide with the period of higher productivity. The final trip was scheduled in June in the hope that there would be increased under-ice algae production and a greater likelihood of catching fish. Some additional air samples were obtained in April 1987 from Mould Bay on Broughton Island through the Institute of Ocean Sciences, Chemical Oceanography Division, Pat Bay. These samples were collected to provide a better estimate of the range in atmospheric concentrations. Peak annual concentrations are from March through May (Barrie, 1986).

The problem of contamination in sampling was especially critical in this study because of the expected low levels of pesticides. All sampling was therefore away from the main camp off the edge of the island on first year ice in May, 1986 and June 1987 or at the edge of the island on the second sampling trip in August. A list of the types and number of samples collected on each trip is given in Table 2.1. Equipment and supplies for both trips were sent to the Polar Continental Shelf Project (PCSP) Base in Resolute. A snowmobile was rented in Resolute for use on the island. A four hour trip by Twin Otter was required to transport equipment and personnel from Resolute to the Ice Island.

Accommodation, meals, fuel, lab space and an extra snowmobile were supplied by the PCSP base on the island.

TABLE 2.1
List of Samples Collected

Substrate	Method	Analyte	Samples Collected May 1986	 Aug 1986	 June 1987
Water	In-situ sampler	dissolved and particulate chlorinated hydrocarbons	17	14	8
	In-situ sampler	particulate organic carbon particulate nitrogen	8	14	8
	NBS drop sampler	dissolved and particulate chlorinated hydrocarbons	-	3	3
	3L PVC Niskin type bottle	nutrients salinity	40	40	21
Sea ice Cores	Hot water ice corer, melting tank	dissolved and particulate chlorinated hydrocarbons	3	-	6
	Hot water ice corer	epontic algae	3	-	3
Snow	Melting tank	dissolved and particulate chlorinated hydrocarbons	4	3	3
Sediments	Ponar grab or corer	particulate chlorinated hydrocarbons	8	7	2 cores
		grain size analysis	3	3	-
		metal analysis (archived)	-	3	-
Biota	minnow trap	tissue chlorinated hydrocarbons	total 20 samples all trips >20 g material		
	plankton net	tissue chlorinated hydrocarbons	30	30	8
Air	High volume particulate air sampler	particulate chlorinated hydrocarbons	6	4	+2
	Arctic Labs air sampler	vapour phase and particulate chlorinated hydrocarbons	6	4	3 +2 from Mould Bay

The island moved a few km on the first trip; for most of the time, however, it was stationary. On the second trip, movement in a northeast direction was more frequent and substantive. On both trips, the island remained over the shelf in water depths of less than 300 m just north of Axel Heiberg Island. In June 1987, the island was also stationary for most of the time, although some large leads opened up around the island near the middle of the month. Movement of the island during 1986 and 1987 is shown in Figure 2.1.

In August, sampling was from the edge of the island and sampling in May, 1986 and June 1987 was carried out at a site just off the island on an area of 1.4 m thick first year ice. A large diameter hole (1.5 m) was made using a portable hot water ice melter. The melter uses a 450,000 BTU oil burner to heat water which is circulated through a heating chamber then pumped o a perforated copper ring. Melt water is pumped back through the heating chamber. The design is based on a unit developed by the Frozen Sea Research Group at the Institute of Ocean Sciences in Patricia Bay, B.C. The hole was melted about 50 m from the edge of the island. A 4.6 m x 2.4 m Hansen Weatherport (R) insulated tent was erected over the hole. In August, a tent was erected as a heated shelter close to the ice edge. One tent was left on the island between trips and served as a storage shed for equipment. A Coleman oil heater was used to heat the tent in May 1986, an electric heater was used in August and a propane heater in June 1987. The main ice hole was used principally for plankton collections. Prior to net tows, CTD and bottle casts were made to collect samples for nutrients and salinity. After plankton sampling was complete, some bottom grabs were also taken from the hole.

A number of smaller diameter holes (0.6 m) were melted near the tent away from the island to obtain ice cores. One of these holes was used exclusively to deploy the in-situ samplers, while another hole was used to deploy baited traps and a grab sampler.

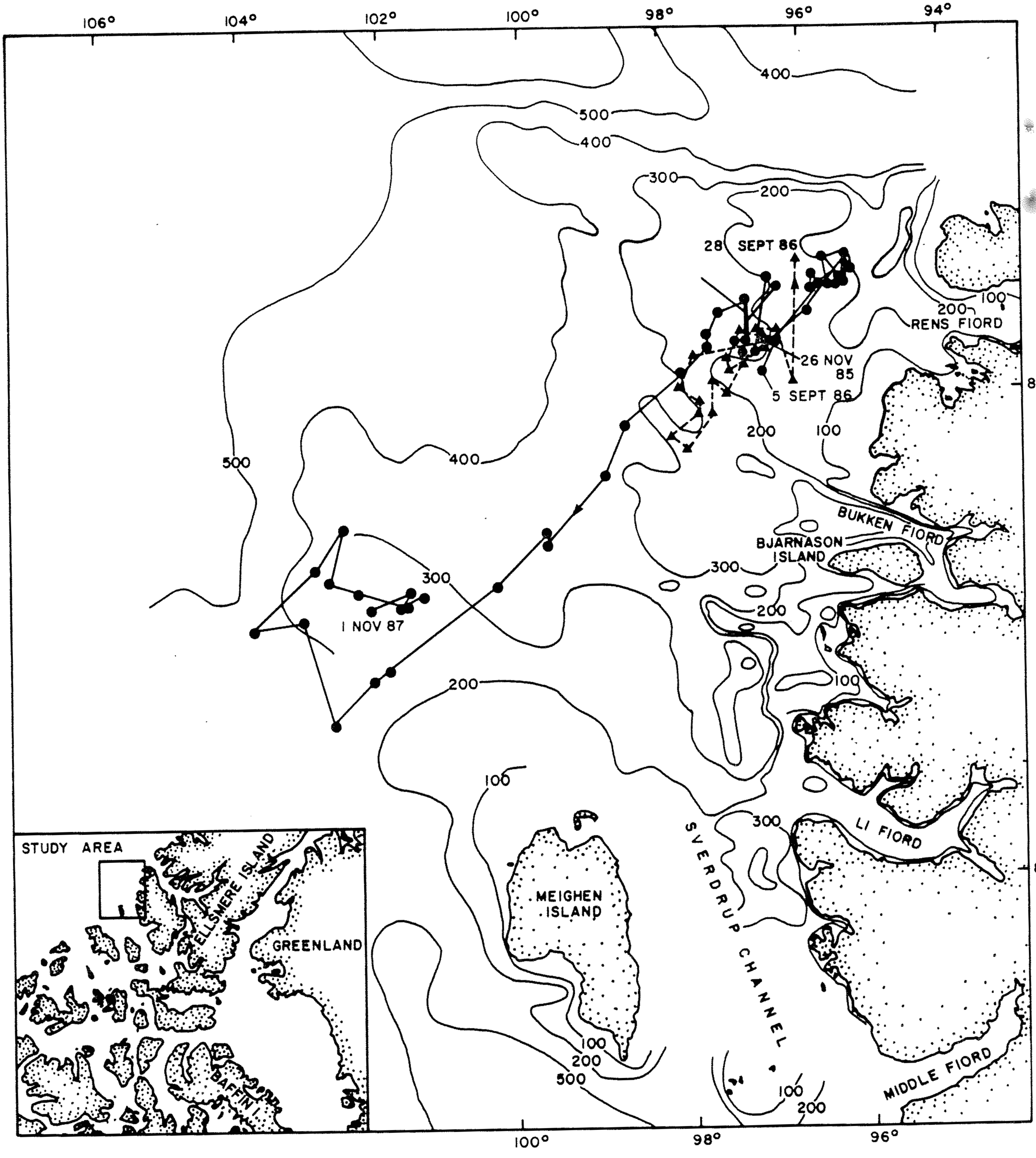


Figure 2.1 Drift pattern of the ice island in 1986 and 1987.

2.1 Chlorinated Hydrocarbons in Water with In-situ Pumps

Chlorinated hydrocarbons and other non-polar components in sea water were extracted in-situ using Seastar water samplers onto Amberlite XAD-2 columns. The sampler is a microprocessor controlled battery powered pumping device which draws water at a preset flow rate through a filter unit and extraction column, and measures and displays the volume pumped. Samples were taken in the surface layer (0 - 50 m), 75 m, 100 m, 125 m, 175 m, 225 m and 280 m in May and at 10, 40, 60, 90, 125, 150 and 175 m in August. Triplicate samples were taken at some depths to obtain a measure of sampling precision.

2.1.1 Preparation

Prior to each sampler deployment, the samplers were prepared and checked in the heated tent and cleaned with detergent, acetone and dichloromethane when necessary. The pressure cases were opened, an inlet and outlet hose fitted to allow methanol recirculation from a methanol bottle, then pump and microprocessor battery voltages measured under load at a flow rate of 150 mL/min. Batteries were replaced when the pump and CPU power supplies fell below 11.0 V and 4.0 v respectively. Pressure cases were resealed and methanol recirculation lines removed. A glass fiber filter (142 mm Gelman AE, 1 μm nominal pore size) was installed in the filter unit using pre-extracted tongs and pre-baked aluminum foil. The XAD-2 column, filter unit and inlet lines precleaned with hexane were installed, the water inlet tube capped with cleaned aluminum foil, and the sampler kept above freezing until deployment. Column plugs were wrapped in cleaned foil and stored in a prebaked screw capped bottle.

2.1.2 Deployment and Recovery

A clean Kevlar mooring line was marked at the required deployment depth and laid out over the ice surface away from the ice hole. The samplers were operated using continuous pumping at 150 mL/min with a 6 second start delay. The appropriate modes were selected and the line secured to the sampler which was passed rapidly through the surface, minimizing contact to the surface microlayer. With the top plate at the surface, the sampler was started and the volume display verified for the first 100 mL or so after the methanol had eluted. The sampler was rapidly lowered to the selected depth and allowed to pump a large volume sample of 180 to 400 L over a period of 20 to 44 hours, after which it was recovered. Upon reaching the surface the sampler was quickly pulled out and allowed to pump for approximately 1 minute to draw out most of the water present in the filter unit. Using the sample mode switch, the sampler pump was switched off, the volume noted, and the sampler taken into the heated tent to remove the column and filter.

Using solvent cleaned the forceps, the glass fibre filter was folded to retain the collected particulates, placed into a precleaned aluminum foil pouch, and stored frozen. With the column held in place in the sampler clamps, column end fittings were replaced with plugs, the column labelled, and then stored at ambient temperature wapped in aluminum foil.

To protect the sampler from internal damage by freezing, water was flushed out of the system with methanol.

2.2 Chlorinated Hydrocarbons in Water Using Discrete Bottle Sampling

2.2.1 Preparation and Sampling

An NBS type drop sampler was used to collect discrete samples on the second and third trips to serve as a comparison with in-situ samples in the near surface (<10 m) water. The drop sampler and lines were nominally cleaned with detergent in the tent and the teflon sample bottle plug-lid rinsed with acetone and dichloromethane, and covered with cleaned aluminum foil until use. The sampler and line were transported out to the remote sampling site and used from a cleaned cooler. At the sampling site on the edge of the island, a cleaned pre-labelled 4 L sample bottle was installed in the sampler which was lowered rapidly to 10 metres, held open for approximately one minute, closed and recovered. Bottle caps lined with cleaned FEP teflon sheet were installed and the bottle stored in an insulated box for transportation back to the lab. Three replicate samples, nominally 8 L each, were collected for chlorinated hydrocarbon analysis. Each sample consisted of two 4 L bottles. Three additional samples were collected for filtration for particulate organic carbon analysis on the second trip.

2.2.2 Filtration and Extraction

Sample bottles were shaken to resuspend settled particulate and gravity filtered through a glass fibre filter (142 mm Gelman AE) in a solvent rinsed (acetone then dichloromethane) 4L separatory funnel. The filter was removed with cleaned forceps, folded to retain particulates and stored frozen in a cleaned aluminum foil pouch. The filtrate was serially extracted with glass distilled hexane (10 mL then 2 x 100 mL) and the extracts combined in a 500 mL stoppered flask. This was repeated for the remaining sample bottle and the combined extracts dried by standing over anhydrous sodium sulphate for 10 minutes. The extract was taken down by vacuum rotary evaporation at 20°C to 3 mL and quantitatively transferred by pipette to a 10 mL ampoule with 3 x 1 mL hexane sample flask rinses. After cooling and solvent vapour removal, the ampoule was sealed off for shipment and analysis. Procedural blanks were carried through the extraction using pre-extracted sea water as a sample.

2.3 Chlorinated Hydrocarbons in Sea-Ice (May 1986, June 1987)

A core of first year sea ice was melted out using the hot water ice drill with a 60 cm diameter melting ring. The ice cores, approximately 1.4 m in length, were lifted out, placed inverted onto the ice surface and the top 10 cm, which had originally been at the bottom of the core, was cut off with a hand saw and stored in a polyethylene bag for analysis for epontic algae. The remaining ice core was cut down with a solvent cleaned carbon steel blade to fit a solvent cleaned, dry aluminum melting tank (35 x 30 x 90 cm) placed over it. The tank and ice core were then turned over and the core cut off at the top of the tank leaving a cleanly collected ice block in the melting tank. A lid was secured to the tank which was taken back to the lab. Using this procedure, a large (50 - 55 kg) ice sample could be cleanly collected, contacting only solvent cleaned metal and teflon surfaces.

2.3.1 Filtration and Extraction

A teflon and glass stopcock was installed into a fitting on the tank bottom and the tank heated with two 6000 BTU/h stoves until most of the ice had been melted. The melt water was not allowed to exceed 5°C during processing. A 142 mm filter with a Gelman AE glass fibre filter and an Amberlite XAD-2 extraction column were connected to the stopcock and the melt water run out through the column at a flow rate of less than 100 mL/min.

2.4 Chlorinated Hydrocarbons in Snow

On the initial two trips, snow was collected using a solvent cleaned aluminum scoop. A cleaned aluminum melting tank (30 x 35 x 90 cm) was filled with surface snow (upper 5 cm) collected from locations at least 1.5 km and up wind from the main camp and away from any likely source of contamination. The contents of the tank were compressed to increase sample weight. The tank was capped, taken back to the lab, fitted with a teflon in glass stopcock and the snow sample melted using two 6000 BTU/h camp stoves. To increase sample volume, the tank and melted contents were taken back to the sample site and refilled with fresh snow which, when melted, provided a sample of 45 - 55 L.

In June 1987, solvent extracted 40 L Teflon bags supplied by Denis Gregor of Environment Canada were filled with snow and used to briefly store samples until they could be melted in the aluminum melting tank.

2.4.1 Filtration and Extraction

A 142 mm filter with a Gelman AE glass fibre filter and an Amberlite XAD-2 extraction column were connected to the stopcock and the melt water run out through the column at a flow rate of less than 100 mL/min.

2.5 Collection of Plankton

Nets used for plankton collection were fabricated with four different mesh sizes of Nitex(R) monofilament nylon cloth. These include a 0.75 m diameter by 4 m long net with 20 μm mesh, a 1 m diameter by 4 m long net with a 73 μm mesh, a 1 m diameter by 4 m long net with a 253 μm mesh and a 1 m diameter by 4 m long net with a 460 μm mesh.

Mesh sizes were chosen in an attempt to adequately filter the water column for the normal range of plankton size groups. The nets were cleaned during the first sampling period by rinsing with glass-distilled acetone and hexane prior to deployment. This cleaning method was found to be impractical given the difficulties encountered in shipping large volumes of restricted cargo by air.

A more convenient method of net cleaning was used for the second sampling trip. An alumnium net container, 30 cm in diameter and 60 high with a bolt-on top and teflon O-ring seal, was fabricated for the August trip. This cylinder was sandblasted and solvent rinsed, then used as a net cleaning container. The freshly cleaned nets were sealed in the cylinder and shipped to the Ice Island. The cylinder was then used for net storage during the sampling period.

The other components of the plankton nets, including the stainless steel net rings, nylon rope, flowmeter (T.S.K. model 1201), brass cod ends with stainless steel mesh, cables, turnbuckle and shackles were all precleaned with glass-distilled solvents and wrapped for shipment in washed aluminum foil. The aluminum frame designed to support a plankton net during a vertical haul (Conover - Paranjape "Crossbow", unpublished), was also solvent rinsed and foil wrapped prior to shipment.

A skimmer was devised to minimize the contamination of the plankton net by the surface film found in any hydrohole. A Little Giant(R) submersible pump was placed in a clean stainless steel pail which was floating, semi-tipped, in the 1.5 m diameter hydrohole. The submersible pump removed the surface layer water as fast as it flowed into the tipped pail.

A Hawboldt(R) oceanographic winch, driven by a separate 14 h.p. gasoline- powered hydraulic pumping unit, and containing 2400 m of 5 mm diameter Kevlar(R) cable, was used for plankton collections. The winch was placed inside the Weatherport(R) shelter for the plankton collections in May 1986 and June 1987. Cable from the winch was passed through a meter block which hung from an aluminum davit erected over the hydrohole. In August 1986 the winch was secured to a large Komatik style sled which was positioned at the edge of the Island. The meter block was suspended from a boom which extended over a 2 m diameter hole in a lead adjacent to the Island.

Consecutive vertical hauls over full water column depth to within 10 m of the bottom (150 - 290 m) with each net were pooled to obtain a sufficient sample size for organochlorine analysis. The number of vertical hauls pooled varied between 5 and 30 depending on the size of the mesh and the time of year (Table 2.2).

Flowmeter readings were taken after each tow and one additional haul with each net provided a sample for species composition analysis. This sample was preserved in 5% formalin in seawater. Table 2.3 summarizes the size separation of pooled samples prior to storage.

Table 2.2

Total Vertical Hauls in Pooled Samples for Zooplankton

Net Mesh (μm)	Sampling Period May 24-29, 1986	Sampling Period August 28-30, 1986	Sampling Period June 5-16, 1987
20	10	10	-
73	15	10	7
250	20	15	6
450	30	5	6
Total	**75**	**40**	**19**

The pooled zooplankton samples were divided into standard size fractions using precleaned all-stainless testing sieves (Table 2.3).

Table 2.3

Separation of Pooled Net Hauls into Standard Size Fractions

Net Mesh	Test Sieve Mesh
20 µm	125 µm
	63 µm
	25 µm
73 µm	250 µm
	125 µm
	63 µm
250 µm	1 mm
	500 µm
	259 µm
450 µm	2 mm
	1 mm
	500 µm

The size-fractioned samples were transferred from the test sieves to glass jars and frozen. The jars were precleaned in the following sequence: soap and water wash, hot water rinse, distilled water rinse, acetone rinse, glass-distilled hexane rinse, and drying for 1 hour followed by baking for 12 hours at 350°C. The mouth of each jar was covered with aluminum foil which also had been solvent rinsed and baked.

2.6 Collection of Benthos

A Ponar grab (0.06 m^2 bite) was used to collect surface sediments and benthic infauna at bottom depths between 285 and 309 m in June and between 150 and 185 m in August 1986. The grab was precleaned by thorough washing and rinsing with glass distilled hexane. It was wrapped in hexane washed aluminum foil for shipment to the Ice Island.

The coarse gravel sediment was poorly sorted. It was washed through solvent-cleaned Endicott sieves (305 and 500 μm mesh) immediately after collection using water pumped by a "Little Giant" submersible pump from the hydrohole. No metazoan fauna were visible on sieves. Subzero air temperatures caused seawater and sediment remaining in sieves to freeze and a thorough examination for fauna was not possible in the field. Rinse water was emptied onto the snow and ice or allowed to run into a small hole prepared for this purpose by the ice melter. Subsamples of surficial sediment taken by spatula to 3 cm depth were preserved in 5% formalin for later examination.

Mobile scavenging animals were collected near the seabed by exposing baited traps. Several galvanized minnow traps, with entrances at each end enlarged to 2 cm diameter, were precleaned and shipped as described for the Ponar grab. Whole frozen Rainbow trout (Salmo gairdneri) were obtained from the Ice Island food stores. These small trout were probably pond reared in Europe or Japan. Sections (approximately 2 cm transverse pieces) were thawed and placed in Nitex covered plastic holders (Toby Teaboys). This protected bait in traps which would attract scavengers but not be consumed.

Several traps were clamped to the hydrowire to be suspended at 5 - 10 m heights up to 100 m above bottom. An 8 kg lead weight to give tension on the line was used to indicate when the lower-most trap was on bottom. Traps were exposed from approximately 2300 to 0700 on five to seven occasions during each trip in 1986. Attempts to collect non-crustacean scavengers at the sediment surface and at various depths in the water column were unsuccessful. Fish hooks or nylon leaders were baited with pieces of trout and fastened to the hydrowire. No bait was eaten during five deployments of up to 8 hours each. A cod jig was used on several occasions in unsuccessful attempts to catch fish under the ice and near the bottom.

2.6.1 Fyke Net Deployment

No fish were caught on the first two sampling trips using baited hooks and bottom traps. It was decided on the final trip to use a Fyke net to attempt to catch any fish which might be feeding on the underside of the ice. A net was constructed by Research Nets Inc. in Bothnell, Washington with four, 50 x 1 m "wings" extending outward from a 1 m^2 central trap. The net was deployed approximately 75 m from the main hydrohole with the four arms stretched out along the underside of the ice away from the central baited trap in an "x" pattern. The contents of the trap were checked every few days during the ten day deployment. Many amphipods were obtained feeding on the bait but no fish were caught.

2.7 Suspended Particulate Matter

Suspended particles in the water column were collected by in situ pumping of water through precombusted and preweighed silver filters (Selas Flotronics, 0.8 μm pore diameter). Seastar pumps, at a flow rate of 150 mL min-1 sampled between 14 and 133 liters at various depths. Millipore Swinnex (R) holders (45 mm dia) were loaded with precombusted (600° C, 3 hr), preweighed, silver filters which were connected to the sampler intake with a small piece of teflon tubing held in place by hose clamps.

Results from sampling in May showed lower concentrations of particulate organic carbon than expected from earlier published data (see Section 4.4). These differences made it desirable to obtain water bottle samples for comparison with samples obtained by in situ pump. A NBS drop sampler (volume 4 L) was used for this purpose in August. Triplicate samples (12 liters) were collected at 10 m depth for comparison with replicate (n = 6) in situ pump samples at the same depth.

The sample intake on the pump was also modified for this comparison. An aluminum cylinder (30 cm high. 4 cm inside diameter) open at the upper end was fastened to the pump with the sampler intake tube at the bottom. Particles, presumably of all sizes of aggregation, would settle in the cylinder and be susceptible to collection. With longer deployments, the cylinder could function as a sediment trap. However, the exposure period was short (several hours) and the constant removal of water by pumping would prevent particle accumulation. It was thought that particles obtained with the collector tube attached to the inlet would be representative of the total particle population in suspension and thus comparable to particulate matter collected by the drop sampler. This method was also used in June 1987.

2.8 Air Sampling

Air samples were collected at sites remote from the main camp and at a distance from the water sampling sites to minimise air contamination problems. The first few samples were collected at a location approximately 2 km north of the main camp and about 5 km from the remote site. The location then was moved so that it could be more conveniently serviced from the remote camp. The electrically driven samplers were powered by one or two portable generators (4 or 5 Kw) situated 60 m from the samplers. Efforts were made to keep the generators downwind of the samplers.

2.8.1 High Volume Particulate Air Sampling

Particulates in air were sampled using a United Metals high volume air sampler. Before use in the field, the filter clamping gasket, a potential source of contamination in this sampler, was sealed in cleaned aluminum foil, and other parts of the sampler which would come into contact with the filter were solvent cleaned. Samples were collected on 8 cm. x 11 cm. teflon reinforced glass fibre (May, 1986, solvent rinsed) or cellulose (August, 1986, soxhlet extracted with acetone) filters. Flow rates were measured and recorded on a clock driven rotating card recorder which also provided a record of the length of the sampling period.

Air samples were collected for a period of from 30 to 52 h at a flow rate of from 1.62 to 1.67 $m^3 \cdot min^{-1}$. During operation, the sampler was approached from the downwind direction and, when necessary, the power generator relocated to be downwind of the sampler. At the end of the sampling period, the filter was folded using solvent clean tongs so as to retain collected particulates. It was found necessary to do this while the filter remained in the sampler with the pump in operation to avoid loss of the filter due to the wind. The filters were stored in prebaked aluminum foil pouches and were stored frozen.

2.8.2 Vapour Phase Sampling

Two independent but similar systems, the Arctic Labs High Volume Sampler (AHVS) and Terry Bidleman High Volume Sampler (TBHVS) were used to collect vapour phase chlorinated organics. Both employed polyurethane foam plugs to retain the sample, but differed in mechanical details.

The results of the 1986 air sampling with the AHVS indicated that some channeling around the front polyurethane plug had occured, presumably due to shrinkage during sampling. Subsequently , in 1987 a redesigned one piece filter/plug holder was used similar to that used in the TBHVS air sampler.

The AHVS is shown in Figure 2.2 and consisted of a 142 mm stainless steel filter unit, a pair of poly-urethane foam plugs (15 cm x 7.8 cm) in a holder, a calibrated flowmeter and high capacity oil-less vane pump (Gast, 270 L/minute) driven by a brushless motor. The sampler was situated 4 m up wind of the air pump and was approached from down wind when in use.

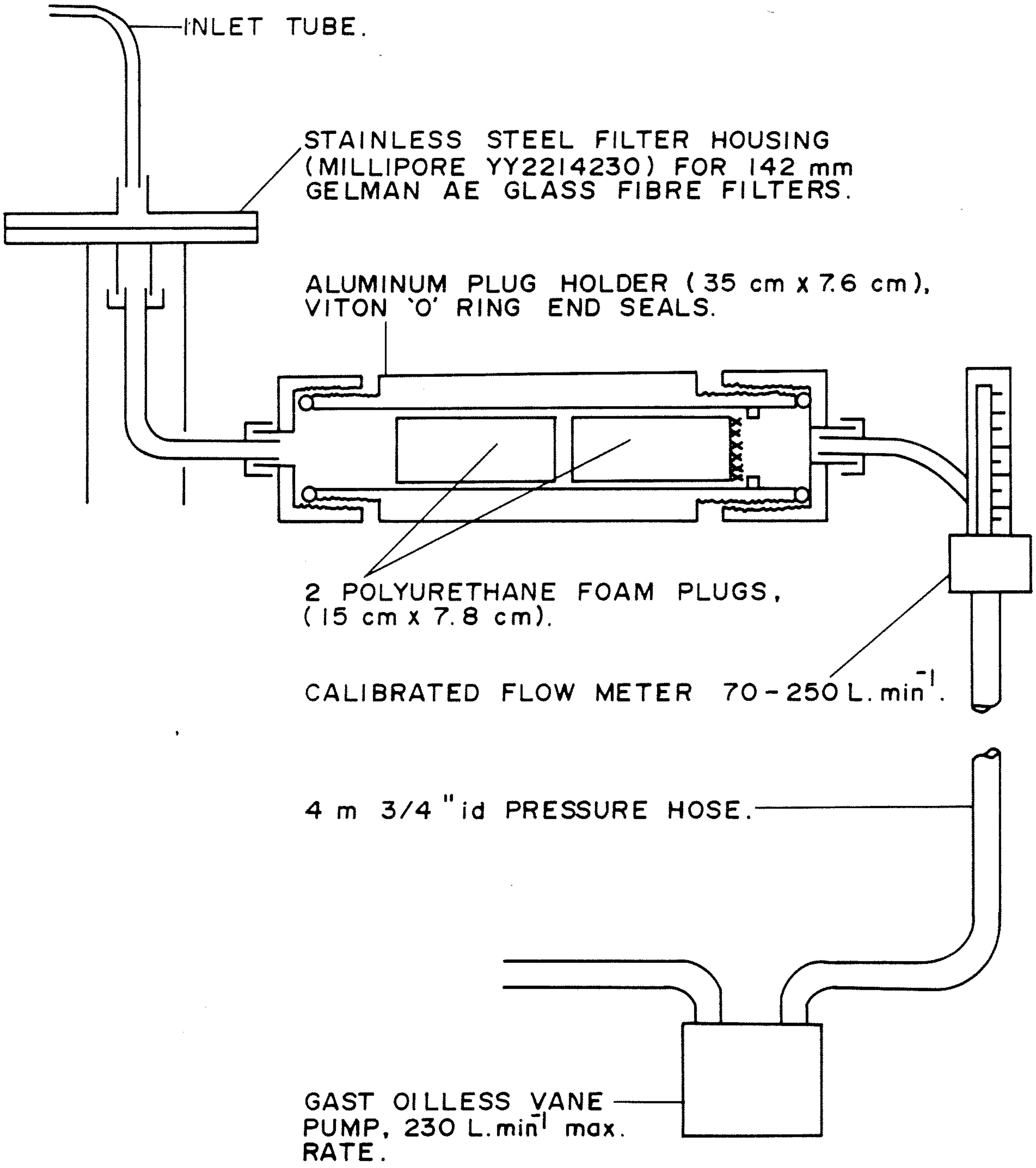


Figure 2.2 Schematic Diagram of the Arctic Laboratories Ltd. Vapour Phase Sampler (AHVS).

Air samples were collected with the AHVS for periods of from 30 to 53 h at flow rates of from 120 to 160 L.min-1 which gave sampled volumes of 200 to 600 m3. After collection, filters were folded and stored in baked aluminum foil pouches and polyurethane foam plugs were returned to screw capped sample jars, and stored at -20°C.

The Bidleman sampler consisted of a 20 x 25 cm glass fibre filter followed by two polyurethane foam plugs (7.6 cm x 7.6 cm) connected to a Rotron DR-313 brushless airpump by a 5 m flexible hose. Details of the sampler construction are given in Bidleman et al. (1980).

2.9 Sediment Sampling

Sediment samples for organochlorines were collected with a Ponar grab (0.06 m^2 bite) with hinged stainless steel flaps which allowed access to the surface of the sample while the jaws of the grab were still closed. Approximately 50 g of the upper 1 - 2 cm of sediment from a central undisturbed section of three separate grabs was removed with a solvent cleaned aluminum scoop and stored for analysis in cleaned glass jars. Grab samples were collected on the first two trips in May and August 1986. In June 1987, three cores were collected to obtain samples from different depth horizons. This was done to provide a control for surface samples on the assumption that deeper sediment would have no organochlorines present. Cores were obtained with a gravity corer composed of an aluminum body, a 10 cm diameter acrylic core barrel (75 cm long) and stainless steel cutting head. Cores were collected from an ice hole outside of and away from the heated tent and processed in the open. After recovery, surface water was carefully siphoned off, then the core extruded onto aluminum foil. The extruded core was measured and then sectioned with a stainless steel knife. The outer sediment that had been in contact with the core barrel was skimmed off and discarded. Three depth horizons (0 - 1 cm; 10 - 1 cm and >20 cm) were transferred to cleaned jars for analysis.

2.10 Miscellaneous Sampling for Chlorinated Hydrocarbons

A number of items on the Ice Island which presented possibilities for interference were collected for potential analysis. These included shot-hole antifreeze diesel/trichloroethylene mixture, hydraulic fluid, Kelvar line, vermiculite, Geogel explosive, Geogel residues, nitex netting and hydro-winch paint.

2.11 Water Properties

2.11.1 CTD Profiles

An Applied Microsystems CTD-12 was used to obtain conductivity, temperature, depth profiles. These were taken at the beginning of each trip. The CTD-12 measures conductivity with an equivalent salinity accuracy of ±0.03 PPT within a range of 0 PPT to 41 PPT. Temperature is measured with an accuracy of ±0.02C within a range of -2°to 30°C. Depth is measured with an accuracy of ±0.3 m within a range of 0 m to 345 m. The data transmitted from the CTD-12 was collected via an RS232 interface with a TANDY Model 100 computer. Salinity was calculated from conductivity, temperature and pressure by the "UNESCO 1978 PRACTICAL SALINITY SCALE". A cable problem did not allow a direct readout in May 1986, but data was stored internally on magnetic tape.

Discrete samples for salinity were obtained from bottle casts with 3L PVC Niskin type samplers in 300 mL flint glass bottles. Samples were analyzed on the island in May and returned to Sidney, B.C. for analysis after the second trip.

2.11.2 Nutrients

Samples for dissolved nutrients (reactive silicate, nitrate and orthophosphate) were collected from the main hydrohole using

3L PVC Niskin type water samplers. Samples were drawn in triplicate into cleaned Pyrex glass (phosphate, nitrate) and plastic (silicate) tubes. In June 1987, samples were collected in duplicate in 125 ml polyethylene bottles. All samples were stored frozen (-18°C). On the first trip, samples were analyzed by F. Zemlyak (Chemical Oceanography BIO) on the island approximately one week after collection. On subsequent trips, samples were returned to Sidney, B.C. and kept frozen until analysis approximately 2 months later.

3. ANALYTICAL METHODS

3.1 Chlorinated Hydrocarbons

3.1.1 Materials

Solvents used were pesticide grade, distilled in glass (hexane and pentane supplied by Burdick and Jackson; dichloromethane and acetone supplied by BDH Omnisolve; methanol supplied by Caledon). Acetonitrile (Burdick and Jackson) was redistilled through a 90 cm burle packed column at 5 mL min^{-1} before use. Diethylether (Caledon) was fractionally redistilled before use and stored in the refrigerator. A solvent blank was determined for each new solvent by rotary evaporation of the amount used in procedure to 100 μl and analysis of a 1 μL injection into the GC/ECS using standard conditions. Solvents were used only if blank gas chromatograms were free of interfering peaks.

Florisil (Baker, 60 - 100 mesh) was washed with acetone and hexane, dried at 80°C for 48 h and then activated at 500°C for 24 h. After cooling, the florisil was deactivated with 3% (by weight) distilled water, and allowed to stand 48 h in a stoppered flask before use.

Florisil (Baker, 60 - 100 mesh) used for samples from the third trip was prepared by washing with acetone and hexane and drying at 80°C for 48 h. The florisil was then activated at 600°C for 6 h, slowly cooled to 100°C, transferred while warm to a nitrogen flushed flask, and then cooled in the stoppered flask. After cooling, the florisil was deactivated with distilled water (1.2% by weight) and allowed to equilibrate for 48 h.

Glassware was washed in laboratory detergent, rinsed with tap water, then distilled water, air dried, and baked overnight at 340°C in a forced air oven. After baking glassware was wrapped in aluminum foil for storage. Metal and teflon items were washed with laboratory detergent, rinsed with distilled water, dried with acetone, and then cleaned with dichloromethane and hexane immediately before use.

Glass fibre filters (Whatman, 47 mm) and Gelman AE filters (142 mm) were baked at 300 °C for 18 h and 340°C for 12 h respecively and stored in baked aluminum foil pouches.

FEP teflon cap liners were cleaned overnight in chromic acid, washed and rinsed in tap water and distilled water, rinsed with acetone and dichloromethane and stored in clean aluminum foil pouches.

Copper turnings were activated before use by standing in 2M HCl for 15 min, rinsed with solvent extracted distilled water, methanol, acetone, and dichloromethane.

Internal standard (decachlorobiphenyl; Aldrich) and calibration standards (hexachlorobenzene, (BDH); alpha-HCH (alpha-BHC); beta-HCH (beta-BHC) and gamma-HCH (gamma-BHC); heptachlor, heptachlor epoxide, trans-chlordane, cis-chlordane, alpha endosulphan, dieldrin, endrin, o,p′ and pp′-DDE, p,p′-DDD (Mandel Scientific); Aroclor 1254 and 1260 (Ultra Scientific); oxychlordane and cis-nonachlor (E.P.A.)) were used as received.

3.1.2 Blanks and Standardization

Procedural blanks were determined initially for each sample type and a routine procedural blank was carried through the analysis with each suite of approximately six samples.

A GC/ECD baseline and solvent baseline was run initially each working day, followed by calibration standards for PCB′s and two standards containing 20 selected chlorinated hydrocarbons.

3.1.3 In-Situ Sampler Column Analysis

Columns were eluted using a Seastar elution system which provided vertical elution from the bottom of the column up. Prior to daily use, the glass and teflon system was scrupulously cleaned by a series of solvent rinses using acetone (150 mL), hexane (150 mL) and dichloromethane (250 mL).

A resin extraction column was installed and eluted at 2 to 4 mL/min with methanol (200 mL) then dichloromethane (250 mL) and the eluate spiked with internal standard (1.00 mL containing 22.96 ng decachlorobiphenyl in hexane). The dichloromethane eluate was taken down by rotary evaporation at 35°C to residual methanol, combined with the methanol eluate, to which was added saturated sodium chloride solution (25 mL). The aqueous methanol was extracted with pentane (3 x 100 mL), the pentane layer separated, taken down to approximately 50 mL by rotary evaporation, dried over anhydrous sodium sulphate for 30 minutes then rotary evaporated down to 2 mL. The extract was stored in 15 mL centrifuge tube in the fridge for florisil column separation.

3.1.4 Polyurethane Foam Plugs (Air Samples) Analysis

The polyurethane foam plugs were spiked with internal standard solution (1.00 mL 22.96 ng decachlorobiphenyl in hexane) then serially extracted by repeated compression in an all glass plunger and cylinder system with 3 x 150 mL 1:1 hexane/acetone. The extracts were combined, taken down to 50 mL by rotary evaporation, dried by standing over anhydrous sodium sulphate, taken down to 2 mL and transferred to a 15 mL centrifuge tube for florisil column separation.

3.1.5 Particulate Filters and Sediment Extractions

Particulate samples collected on glass fibre filters were extracted by a method based closely upon the Inland Waters Directorate method (Analytical Methods Manual, 1979) initially using a Virtis homogenizer then an ultrasonic bath which was found to give improved procedural blanks with comparable extraction efficency. Sediments were extracted by the ultrasonic method.

The filter sample was placed in a fluted glass Virtis homogenization flask or a ground glass stoppered Erlenmeyer flask (for ultrasonic extraction) to which acetonitrile (120 mL) and internal standard (1.00 mL 22.96 ng decachlorobiphenyl in hexane) was added. The filter was extracted by homogenization or ultrasonic agetation for 10 minutes after which the supernatant was decanted through a GF/A filter into 1 L separately funnel. The filter residue was further serially extracted by the same procedure by homogenization with 160 mL 3:1 acetonitrile-water (filters) or 120 mL acetonitrile (sediments 60 mL mL acetonitrile, then the sample residue rinsed with two additional 20 mL aliquots of acetonitrile. The water content of the extract was adjusted to 20% by the addition of pre-extracted water (30 mL) to the separatory funnel, then the aqueous acetonitrile back-extracted with hexane (150 mL 2 x 100 mL). The combined extracts were taken down to 50 mL by vacuum rotary evaporation at 35°C. dried over anhydrous sodium sulphate (5 g) then taken down to 2 mL. Sulphur was removed from sediment extracts by shaking vigorously with 1 g activated copper turnings, then standing for 1 hour. The sediment and filter extracts were transferred to 15 mL centrifuge tubes, sealed and stored cool for florisil column separation.

3.1.6 Extraction of Biological Tissue Samples

Biological tissue samples were extracted using the current method of Norstrom and Muir (1985) of the National Wildlife Research Centre, Canadian Wildlife Service, Ottawa. This method has been used extensively for the analysis of chlorinated hydrocarbons in biological samples from the Canadian Arctic.

A tissue sample (5 g - 10 g) was homogenised in a Virtis homogeniser and a subsample (up to 6 g) weighed into a glass mortar with 30 g anhydrous sodium sulphate then ground with a glass pestle to a free-flowing powder. The ground sample was quantitatively transferred to a 5 mL sintered glass soxhlet thimble and soxhlet extracted with hexane(300 mL) for two hours. The extract was reduced to 2 mL by rotary evaporation at 33°C, quantitatively transferred to a 15 mL centrifuge tube and reduced to 1 mL in an N_2 stream. 1 mL dichloromethane was added to prepare the extract for gel permeation column clean-up.

The extract was placed on a calibrated Biobeads SX-3 gel permeation column (60 g 3.0 cm x 50 cm) and eluted with 1:1 dichloromethane/hexane at 5 mL/min. The 150 - 300 mL fraction was collected and evaporated down for florisil column separation.

3.1.7 Sample Clean-Up and Separation

Extracts from the first and second sampling trips (86 samples) were cleaned up and separated by the following procedure.

Florisil (8 g deactivated with 3% w/w water) was slurried in hexane, packed with tapping into a hexane filled 10 mm x 200 mm column, and capped with a 10 mm layer of sodium sulphate. The column was flushed with 50 mL hexane and the solvent level run down to the top of sodium sulphate layer.

Sample extracts were blown down to 1 mL with nitrogen and quantitatively transferred to the florisil column and eluted with hexane (37 mL), 6% diethyl ether in hexane (37 mL) and 15% diethyl ether in hexane (37 mL). The first 27 mL was collected as fraction 1, the next 47 mL as fraction 2 and the last 37 mL as fraction 3. Aliquots of internal standard (1.0 mL 22.96 ng decachlorobiphenyl) was added to fractions 2 and 3 and all were taken down by vacuum rotary evaporation to 2 mL for GC/EC analysis. (Additional activated copper treatment of sediment contract fraction 1 was necessary to remove residual sulphur.)

The column cut points, determined for each prepared batch of florisil was typically as below:

Fraction 1:	polychlorinated biphenyls, hexachlorobenzene, o,p'-DDE, pp'-DDE, alpha-HCH (40%), heptachlor, aldrin, pp'-DDT (70%), Mirex.

Fraction 2: beta-HCH, alpha-HCH (60%), gamma-HCH, dieldrin, endrin, o,p'-DDT, o,p'-DDD and p,p'-DDD, alpha-endosulphan, heptachlor epoxide, methoxychlor, cis- and trans-chlorane.

Fraction 3: methoxychlor (10%), dieldrin (5%).

Two composite pesticide standards and PCB standards (Aroclor 1254 and/or 1:1 Aroclor 1254/Aroclor 1260) were run daily to verify instrument performance, establish current retention times and determine current response factors.

Each sample fraction was injected in duplicate, and when necessary co-injected with a pesticide composite standard mixture.

Extracts from the third sampling trip were separated using the following procedure as per Nordstrum and Muir (1985).

A glass column (10 mm x 240 mm) was filled with hexane and slurry packed with florisil (8 g 1.2% water deactivated), capped with a 10 mm layer of anhydrous sodium sulphate and flushed with 40 mL hexane. Fraction 2 from the gel permeation column was quantitatively transferred to the column followed by a series of rinses with 3 x 1 mL hexane. The column was eluted with 35 mL hexane (fraction 1), 34 mL 15% dichloromethane in hexane (fraction 2) and 52 mL 50% dichloromethane in hexane (fraction 3). Each fraction was taken down to 2 mL by rotary evaporation for analysis by GC/ECD.

Cut points for this procedure gave the following separation:

Fraction 1: hexachlorobenzene, heptachlor, aldrin, o,p'-DDE, p,p'-DDE, Mirex, decachlorobiphenyl (I.S.)

Fraction 2: alpha-, beta-, and gamma-hexachlorocyclohexane, oxychlordane, trans- and cis-chlordane, o,p'-DDD, p,p'-DDD, p,p'-DDT, cis-nonachlor

Fraction 3: heptachlor epoxide, alpha-endosulphan, dieldrin, endrin, methoxychlor

Each sample fraction for samples from the third trip was injected only once.

3.1.8 Instrumental Analysis

a) Instrumental Conditions

Chlorinated hydrocarbons were determined using a Hewlett Packard 5830A gas chromatograph, with a ^{63}Ni electron capture detector and a 15 m x .25, 0.25 µm film mm DB5 Durabond Fused Silica capillary column or a 60 m x 0.22 mm, 0.1 µ film DB-5 Durabond Fused Silica Column (J & W Scientific). The following conditions were used:

15 m column

Carrier gas:	Hydrogen: 60 mL/min through injector approximate 40:1 split ratio
Make-up Gas:	Argon with 5% methane; 30 mL/min
Injector Temperature:	250°C
Detector Temperature:	320°C
Oven Program:	Held 100°C for one minute, then programmed 100°C to 180°C at 20 C° min^{-1} then 10 C° min^{-1} to 270 °C, and held for 5 min
Syringe:	Hamilton 10 µL 701RN syringe
Injection Mode:	Gröb splitless injection, carrier splitting resumed after three minutes
Injector Pressure;	15 psi (split), 40 psi (splitless)

60 m column

Conditions used were the same as those used for the 15 m column with the following exceptions:

Oven Program:	initial temperature 100°C; hold for 2 min, then program at 10°C min^{-1} to 300°C and hold 5 min.
Injection Mode:	Gröb splitless injection carrier splitting resumed after 1 min.

A baseline and injection blank (i.e., solvent injected) and calibration standard were run at the start of each daily use of the gc.

b) Assignment Criteria of CG/ECD Chromatograms

A peak was assigned to a given chlorinated compound only if all of the following criteria were satisfied:

i) The corrected retention time was within ±0.02 minutes of that expected.

ii) Upon co-injection with the authentic material, the sample and standard compounds co-eluted as one peak.

iii) The compound was expected in the florisil column fraction injected.

iv) The GC peak shape resembled that of the authentic compound.

c) Quantitation

Response was measured by peak height (1986 samples, trips one and two) or by peak areas (1987 samples and all biota samples). All compound peaks were quantitated against the internal standard, decachlorobiphenyl, using the formula,

$$m_i = A_i \times W_{is}/(A_{is} \times RRF_i)$$

where m_i = quantity of compound i found (in nanograms)

A_i = peak area or height found for compound i

W_{is} = quantity of internal standard, in nanograms, added to the sample (F1) or fraction (F2 or F3)

A_{is} = peak area or height for the internal standard

RRF_i = relative response factor for compound i with respect to the internal standard.

3.1.9 Detection and Quantitation Limits

Detection and quantitation limits throughout this work are defined as three and ten standard deviations, respectively, above the mean procedural blank. These limits were determined specifically for each substrate (i.e XAD-2 columns, 142mm glass fibre filters, polyurethane plugs, and particulate high volume air (PHVS) filters) and procedural variants (i.e column elution, filter homogenation, polyurethane air plug extaction, tissue and sediment homogenisation, extraction and separation). For each sample type, the following protocol was used;

1) the quantity of each compound of interest (tabulated in nanograms) was blank corrected by subtraction of the mean blank for that compound from the sample value.

2) if the blank corrected value was less three standard deviations of the procedural blank, it was replaced by the value (in nanograms) corresponding to three blank standard deviations and preceded with the '<' symbol denoting the

value is less than the procedural detection limit for that compound.

3) if the blank corrected value was less than ten blank standard deviations, it was replaced by the value coresponding to ten blank standard deviations and preceded with the letter 'Q', denoting that the compound was detected but the determined value was less than the quantitation limit.

4) the resulting blank corrected quantities or the detection and quantitation limits were converted to concentrations and reported in the following units;

water - $pg.L^{-1}$ ($pg = 10^{-12}g$)

snow - $pg.L^{-1}$ in melt water

ice - $pg.L^{-1}$ in melt water

sediment - $ng.g^{-1}$, dry weight ($ng = 10^{-9}g$)

biota - $ng.g^{-1}$, dry weight (also reported as wet weight and lipid weight

air - $pg.m^{-3}$

3.2 Quality Control and Quality Assurance in Organochlorine Analyses.

Throughout the program, from sampling to GC analysis, steps were included to monitor the quality of the data. The quality control included scrutiny of instrument calibration, blanks and replicates. As part of the quality assurance program, various 'reference' materials such as, standard reference samples, exchanged extracts, concensus samples, homogenates or independantly prepared standards were analysed to determine analytical accuracy. Samples of air, snow and water were collected simultaneously and analysed by two other laboratories. This section describes the important elements of the quality control and quality assurance procedures.

3.2.1 Instrument Calibration

Analytical balances were calibrated regulary using a set of standard weights and deviations noted in a balance log. The electrobalance was calibrated daily with a certified 100mg standard weight prior to use. All balances are checked and serviced annually by a balance maintenance specialist. The GC/ECDs were calibrated daily by injection of two low level standards containing 5 to 50 pg of the chlorinated pesticides and the internal standard, and a PCB standard containing Aroclor 1254 and the internal standard. These calibration runs provided retention times and relative response factors for all the compounds of interest and were not used unless the following conditions were satisfied:

(a) adequate resolution of compounds of interest
(b) acceptable peak shape
(c) relative response factors within 20% of the average over the previous five days of operation.

Relative response data from acceptable daily calibration runs were used for calculation of samples analysed on the same day. Relative response factors with respect to decachlorobiphenyl and the response factor of the internal standard were logged daily to monitor trends.

All compounds determined were within the ECD linear response range, and peaks exceding the linear range were rerun at a lower concentration.

3.2.2 Blanks

Procedural blanks (i.e. the analysis performed without the introduction of a sample) were used to determine the detection and quantification limits (section 3.1.9). For each of the substrate types (XAD columns, glass fibre filters, polyurethane plugs, extracts or biota), consistent and minimal procedural blanks were required before samples could be analysed. Routine solvent and reagent blanks were run to check for interferences and monitor contamination. Field blanks were performed on substrates (i.e. filters, polyurethane plugs and XAD columns) prepared with the sample substrates, transported to and from the field with the samples.

3.2.3 Replicates

Replicates or duplicates were included at all stages of the analyses, including replicate sampling, extraction and GC analysis. The precision estimated from these replicates is specific to the sample type and stage of replication and is discussed for each sample type in the following section.

3.2.4 Quality Assurance

Where available, standard reference materials or intercalibration homogenates were analysed to verify analytical procedures. Intercalibration samples were also collected for independant analysis by two other laboratories specialising in sampling air and snow for trace level chlorinated hydrocarbons.

Other quality assurance and quality control measures which were specific to each type of analysis are described in the following sections.

a) XAD Water Sampling Validation

Overall column efficiency (defined as percent extraction efficiency multiplied by percent recovery) was determined by comparison of concentrations determined by in-situ sampling onto XAD-2 at 10 m with concentrations from hexane extraction of 10 m samples collected with a water bottle. The extraction procedure was carried out in triplicate on 8L aliquots of a sea water sample collected at 10m depth from the remote hydrohole. Three 8L samples were filtered through a glass fibre filter (142mm Gelman AE) into two 4L separatory funnels, spiked with internal standard (decachlorobiphenyl), then serially extracted with hexane (150mL then 2 x 100mL). The combined extracts were taken down to 6 mL by vacuum rotary evaporation and sealed into ampoules for GC/ECD analysis.

The results of the first field XAD validation experiment carried out August, 1986 in the laboratory on the Ice Island, indicated extraction of these relatively small sample volumes (8L), provided useful data only for the most abundant compounds, (HCHs) , other compounds being below the detection or quantification limit. The experiment was run in triplicate (appendix C) but the volatile HCHs were partially lost from one extract (sample 2-NBS-X2, fraction 2) which had been taken to dryness during work-up. This sample was not included in the summary table (Table 3.1) for the calculation of column efficiency. HCH isomers were quantifiable with a mean α-HCH concentration of 7050 pg/L, significantly higher than for the in-situ sampler HCH concentrations (mean α-HCH 4400pg/L) collected from the same depth. Based on these compounds, column efficiency of the α- and gamma- HCHs was 62% and 66%,respectively compared with hexane liquid-liquid extraction. This contrasts with column efficency values for gamma-HCH of 89 to 100% determined for these columns in spiked sea water (Green and Kowalski,1984) and <90% extraction reported from natural and tap waters by others (Coburn,*et al*,1977, LeBel and Williams,1980). To confirm this result, the experiment was repeated in triplicate in June 1987,

Table 3.1
Comparison of HCHs by XAD and hexane extraction (pg/L)

Date	Sample	Sampler	Extraction Method	α-HCH	β-HCH	g-HCH
1) Trip 2 Validation Experiment						
02 Sept 86	2-NBS-1X	NBS	L-L hexane	7600	nm	1100
02 Sept 86	2-NBS-3X	NBS	L-L hexane	6500	nm	850
			Mean	7050	nm	970
27 Aug 86	2-ISS-01C	ISS	XAD	5000	nm	710
25 Aug 86	2-ISS-02C	ISS	XAD	3700	nm	570
01 Sept 86	2-ISS-11C	ISS	XAD	4400	nm	650
			Mean	4400	-	640
			% (XAD/Hx)[a]	69%	-	66%
2) Trip 3 Validation Experiment						
14 Jun 87	3-NL-1	NBS	L-L Hexane	4500	93	600
14 Jun 87	3-NL-2	NBS	L-L Hexane	4000	150	550
14 Jun 87	3-NL-3	NBS	L-L Hexane	4800	150	650
			Mean	4400	130	600
07 Jun 87	3-ISS-1C	ISS	XAD	2600	37	480
07 Jun 87	3-ISS-2C	ISS	XAD	3000	30	510
13 Jun 87	3-ISS-3C	ISS	XAD	2800	57	570
			Mean	2800	50	520
			% (XAD/Hx)[a]	64%	38%	86%
14 Jun 87	3-NX-1	NBS	XAD	7000	110	620
14 Jun 87	3-NX-2	NBS	XAD	6900	110	600
14 jun 87	3-NX-3	NBS	XAD	6200	110	570
			Mean	6700	110	600
			% (XAD/Hx)[b]	152%	85%	100%
14 Jun 87	3-NXL-1	XAD eluant	L-L Hexane	46	<10	25
14 Jun 87	3-NXL-2	XAD eluant	L-L Hexane	88	<10	12
14 Jun 87	3-NXL-3	XAD eluant	L-L Hexane	37	<10	20
			Mean	57	-	19
			% (XAD eluant/ L-L Hx)[c]	1.3%	-	3.2%

(a) In-Situ sampler XAD value as % of HCH found by hexane liquid-liquid extraction .

(b) NBS sampler XAD value as % of HCH found by hexane liquid-liquid extraction.

(c) NBS sampler XAD eluant extracted by hexane as % of hexane liquid-liquid extraction.

(d) All samples collected at 10m depth

and the analyses expanded to include elution of the filtered water through an XAD column followed by hexane extraction of the eluate. This allowed the column retention and efficiency to be determined directly for surface sea water.

The results of the second XAD validation experiment, which are summarised for the HCHs in Table 3.1 and presented in full in Appendix C , indicate similar results to the first validation experiment of a 64% column efficiency for α-HCH for the in-situ sampler extraction. However, only 1.3% alpha and 3.2 % gamma - HCH were found in the column output indicating an extraction efficiency of > 96%. The XAD column efficency from water sampled by NBS drop sampler agreed well for beta and gamma HCH but was substantially higher for alpha HCH than for the in-situ sampler (6700 pg/L vs 4400 pg/L). This would suggest some alteration of the sample during storage and lab processing to change the availability of the alpha HCH to the XAD resin.

Surface seawater was also analysed during June 1987 by Greg Patton of the University of South Carolina (Patton et al, 1987). Sea water samples (2 -3L) were collected from 10m by NBS drop sampler, filtered in the Ice Island laboratory (Gelman 47mm binderless glass fiber filters), extracted onto bonded octyl silica gel cartridges (500mg, J.T.Baker C_8-SPE) and analysed independantly at USC. The HCHs were the only organochlorines detected in extracts from these cartridges (Table 3.2) and are compared to the in-situ sampler and XAD validation results in Table 3.3.

HCH concentrations sampled by NBS and extracted by XAD or bonded n-octyl silica are comparable and are similar to NBS sampled-hexane extracted samples collected August 86. The reason for the lower values in 1987 by in-situ sampler and NBS/hexane extraction is not clear.

There has been no correction of the XAD tabulated data for column extraction/recovery efficency. The USC data includes a uniform recovery efficiency factor of 78% which has been applied to all organochlorine concentrations to compensate for method losses.

Table 3.2.
HCH Concentrations in Surface Seawater by Patton and Biddleman, U.S.C.a,b

Collection date	Sample	Depth (m)	α-HCH (pg/L)	g-HCH (pg/L)
9 June 1987	1	10m	6400	830
9 June 1987	2a	10m	8900	1000
9 June 1987	2b	10m	6600	720
10 June 1987	3	10m	7000	610
11 June 1987	4a	10m	8100	650
11 June 1987	4b	10m	6000	790
12 June 1987	5	1m	7000	1100
		Mean	7100±1.0	810±180

(a) Samples collected by NBS drop sampler from remote hydrohole, except sample 5, which was collected from a lead.

(b) From Patton <u>et al</u>, 1988.

Table 3.3.

Comparison of HCH concentrations in surface seawater by different sampling methods.

Date	Method[a]	Mean Concentration (pg/L)		
		α-HCH	g-HCH	
May 86	ISS/XAD	4700 ±340	640 ±41	(n=2)
Aug 86	ISS/XAD	4400 ±640	640 ±65	(n=3)
Jun 87	ISS/XAD	2800 ±200	520 ±46	(n=3)
Aug 86	NBS/Hexane extraction	7050 ±780	970 ±180	(n=3)
Jun 87	NBS/Hexane extraction	4400 ±400	600 ±50	(n=3)
Jun 87	NBS/XAD	6700 ±430	600 ±25	(n=3)
Jun 87	NBS/C_8silica	7100 ±1000	810 ±180	(n=7)

(a) ISS - *in-situ* sampler
NBS - NBS drop sampler

b) In-situ Particulate Sampling

Replicate samples were taken with the in-situ samplers on all sampling trips at three depths to determine sampling and analytical precision.

The filters were uniformly very low, which is consistent with the low SPM and POC values found (Table 4.4), and few organochlorine values were above the detection limits, although samples were run at the highest sensitivity with clean and consistent procedural blanks. Consequently, precision for the compounds not detected could not be determined, but were consistently below the detection limits. The detection limits for 1986 and 1987 filter samples based on several filter procedural blanks from each suite are listed in Table 3.4 in picograms per filter and picograms/litre for typical sample volumes.

The most abundant compounds found, HCB, α-HCH and trans-chlordane, were present at concentrations close to the limits of detection or quantitation, and consequently are of low precision. Typical ISS filter replicates are presented in Table 3.5.

Replicate samples with the in-situ sampler were taken on all sampling trips at various depths (Appendix C). These samples give a measure of the sum of the analytical, sampling and natural water variability as samples were taken over a period of several days. Natural water variability over the whole water column is assumed to be slight in the time period of a few days or weeks. Analyses for all compounds were least variable in June 1987. Results for the first and second trips were similar and more variable than the June data. For α-HCH, at concentrations of >4000 pg/L, a relative standard deviation of 12 - 15% was obtained in May and August samples; 6% in June. At concentrations of less than 500 pg/L corresponding values were 41% in May and 7% in June. For gamma-HCH, variability was less; typically better than 10% at concentrations of about 500 pg/L and 15 - 30% at concentrations less than 100 pg/L. Precision of replicates for the less abundant compounds was generally ±50% and as much as

Table 3.4.

Detection limits for *in-situ* sampler filters.

Compound	Detection limit 1986 samples pg/filter	 pg/L[a]	 1987 samples pg/filter	 pg/L[b]
Aroclor 1254	410	1.7	20	0.04
HCB	60	0.25	3	0.007
heptachlor	90	0.37	20	0.04
aldrin	5	0.02	4	0.009
o,p'-DDE	9	0.04	20	0.04
p,p'-DDE	30	0.12	6	0.01
Mirex	13	0.5	20	0.04
alpha-HCH	30	0.12	20	0.04
beta-HCH	11	0.04	70	0.16
gamma-HCH	20	0.08	30	0.07
oxychlordane	-	-	20	0.04
trans-chlordane	20	0.08	20	0.04
cis-chlordane	80	0.08	20	0.04
p,p'-DDT	85	0.35	60	0.14
cis-nonachlor	-	-	30	0.07
heptachlor epoxide	5	0.02	30	0.07
α-endosulphan	10	0.04	20	0.04
dieldrin	100	0.4	60	0.14
endrin	5	0.02	110	0.25
methoxychlor	33	0.14	1500	3.4

(a) Calculated for an average 1986 sample volume of 240L.
(b) Calculated for an average 1987 sample volume of 440L.

Table 3.5.

In-situ Sampler Filter Replicates.

a) August 1986, 10m replicates

Compound	**2-ISS-01F**	**2-ISS-11F**
HCB	0.59	<0.28
α-HCH	0.71	1.6
trans-chlordane	<0.06	0.42

b) June 1987, 10m replicates

Compound	**3-ISS-02F**	**3-ISS-08F**
HCB	0.06	0.10
α-HCH	<0.05	Q0.11

c) August 1986, 90m replicates

Compound	**2-ISS-03F**	**2-ISS-06F**	**2-ISS-08F**	**2-ISS-13F**	**2-ISS-14F**
HCB	<0.22	<0.27	Q1.2	<0.15	<0.15
α-HCH	<0.11	<0.14	0.62	0.3	Q0.25
trans-chlordane	<0.07	<0.09	0.42	0.25	Q0.17

±100% at quantifiable concentrations less than 5 pg/L (Table 4.5).

c) Air Sampling and Analyses

The air sampling system was designed with two sequential polyurethane plugs to provide a procedural blank and check for breakthrough with each sample. Channelling around the front plug due to shrinkage during sampling invalidated this approach and the two plugs were combined and analysed. Plugs cleaned and transported with the sample plugs were used as blanks. For the 1987 sampling, modifications were made to the Arctic Labs high volume air sampler. The body of the air sampler and separate filter holder were replaced with a single unit plug and filter holder. Modifications in the plug preparation procedure and the sampler design changes eliminated the channelling problem. Also, the position of the air flowmeter was moved to the pump outlet to minimise pressure changes at the flowmeter. For consistency with the May and August 1986 analyses, separate field blank plugs were used for June 1987 procedural blanks and detection limit determination.

An interlab calibration was carried out with Dr. Terry Bidleman's group at the Department of Chemistry, University of South Carolina. The intercalibration was made at three levels:

1) calibration standards were exchanged and instrumental calibration accuracy compared,

2) air sample extracts were exchanged and quantitation accuracy compared and

3) air samples were simulaneously collected from adjecent air samplers on the Ice Island in August 1986 and June 1987.

Instrumental calibration was compared by exchange and analysis of GC/ECD calibration standards. The results (Table 3.6) indicate good agreement between labs for these compounds with no systematic differences. Four polyurethane plug extracts were exchanged after initial analysis; the results (Table 3.7) indicate reasonable agreement between labs for the limited number of compounds compared.

Air samples were collected simultaneously in August 1986 and June 1987 by Arctic Labs and U.S.C. then analysed independantly as part of the intercalibration excersise and accuracy check. The mean values and standard deviations during each sampling trip for the two labs are compared in Table 3.8 for those compounds reported by both laboratories. The results are generally comparable and means are within two standard deviations, although HCB and alpha-HCH in August 1986 show greater differences. The low 1986 value found by Arctic Labs is believed due to breakthrough as a result of the channelling arround the front plug. The air sampler modification in 1987 minimised this tendancy and consequently the 1987 concentration values are more comparable. For all compounds the average difference of means for AL compared to USC were 77% and 102% for 1986 and 1987 respectively.

d) Snow Samples

Snow sampling and analyses were intercalibrated with Denis Gregor of Surveys and Interpretation Division, Water Quality Branch, Inland Waters Directorate, Environment Canada with analytical support by the National Water Quality Lab (N.W.Q.L), Burlington, Ontario. Initial comparison was done with a snow sample collected by Denis Gregor from adjacent to the air strip in early May 1986 three weeks prior to the Arctic Labs samples, collected from a remote site. The snow sample was collected, transported and allowed to melt in solvent cleaned 40L FEP teflon bags. The melted snow was dichloromethane extracted without filtration in the field lab in Resolute Bay using a

Table 3.6.

Comparison of Instrument Calibration Standards Between Arctic Labs and Universiy of South Carolina.

	Determined Concentration of Standard (pg/μL)					
Standard	USC 403		USC 408		AL VS2	
Origin of std.	USC		USC		ALL	
Laboratory	USC	ALL	USC	ALL	USC	ALL
HCB	-	-	23	22	69	75
alpha-HCH	35	31	35	35	112	126
beta-HCH	31	31	41	47	-	-
gamma-HCH	35	31	35	35	122	132
heptachlor	34	31	-	-	125	138
trans-chlordane	38	33	-	-	119	132
cis-chlordane	38	34	-	-	-	-
trans-nonachlor	38	29	-	-	-	-
p,p’-DDE	42	45	-	-	-	-
o,p’-DDT	43	56	-	-	-	-
p,p’-DDT	43	54	-	-	-	-

Table 3.7.

Results of Analysis of Exchanged Air Sample Extracts

Determined concentrations (pg/m^3)

Sample	1-AHVS-3P		1-AHVS-2P		IIA#3		IIA#4	
Origin	ALL		ALL		USC		USC	
Laboratory	USC	AL	USC	AL	USC	AL	USC	AL
alpha-HCH	474	607	256	234	307	220	251	170
gamma-HCH	110	120	22	16	39	40	26	28
HCB	152	108	128	71	88	60	53	34
trans-chlordane	0.8	5.6	(nd)	nd				
cis-chlordane	8	2.3	4	1.1				

Table 3.8

Intercalibration of organochlorine pesticides in air measured at the Ice Island by Arctic Laboratories (AL) and the University of South Carolina (U.S.C.) (pg/m^3)

Compound	August 1986		June 1987	
	A.L.	U.S.C.	A.L.	U.S.C.
Aroclor 1254	11 ±5	6.0 ±3.5	14 ±4	7.1 ±2.8
HCB	63 ±16	189 ±37	110 ±38	146 ±13
p,p'-DDE	<0.2	1.0 ±0.2	1.0 ±0.2	2.9 ±2.1
alpha-HCH	250 ±50	540 ±110	190 ±70	340 ±35
gamma-HCH	16 ±4	31 ±5	53 ±26	45 ±7
trans-chlordane	<0.6	1.1 ±0.4	1.8 ±0.2	2.3 ±0.6
cis-chlordane	0.8 ±0.2	2.8 ±0.7	3.3 ±1.3	4.0 ±0.9
p,p'-DDT	<0.4	0.9 ±0.4	1.0 ±0.4	2.1 ±1.5
cis-nonachlor	nm	0.4 ±0.26	0.8 ±0.3	0.7 ±0.2
heptachlor epoxide	2.1 ±0.6	1.5 ±0.5	3.0 ±1.1	3.7 ±1.2
alpha-endosulphan	3.8 ±1.0	7.1 ±2.3	7.9 ±1.9	3.4 ±2.3
dieldrin	<8.6	1.9 ±1.8	<10	0.6 ±0.6

N.W.Q.L. continuous large volume extractor and analysed by N.Q.W.L. in Burlington. The 1986 results indicated reasonable agreement between labs despite differences in timing location and analytical methods.

A more rigorous intercalibration was undertaken in June 1987. Triplicate snow samples (3 x 200L, 5 x 40L samples in teflon bags) were collected by Arctic Labs upon arrival at the Ice Island on 6 June and returned to Resolute Bay for extraction. Snow (3 x 150-300L in a cleaned aluminum melting tank and 40L teflon bags) was collected from the same depth and general location by Arctic Labs on 8, 9, and 15 June, melted and eluted through XAD-2 columns in the Ice Island field lab. Columns were extracted and analysed in the Seakem labs in Sidney, B.C.

The results of this intercalibration, given in Appendix C and summarised in Table 3.9., indicate reasonable agreement. Mean concentrations generally within one standard deviation for most of the compounds of interest except alpha endosulphan. The mean percentage difference of Arctic Labs from NWQL data for eleven compounds detected by both labs was 94% (103% excluding alpha endosulphan).

An additional snow intercalibration for the HCHs was done in June 1987 with Greg Patton of U.S.C. who collected 15-20L samples in an cleaned aluminum tank, thawed the sample in the Ice Island field lab. The melted snow sample (2-3L) was aspirated through a filter (Gelman 47mm binderless glass fiber) and a pair of bonded n-octyl silica gel cartridges (J.T.Baker C_8-SPE) in series and the cartridge sealed in a vial, and later extracted and analysed at U.S.C. Due to the smaller sample size only the HCHs were detected and the results of these analyses and the individual sample HCH values found by Arctic Labs and N.W.Q.L. are compared in Table 3.10. The mean HCH values are comparable but considerable variation is evident between individual samples for these compounds. The ratio of alpha to gamma is lower for the Arctic Labs data compared to the other laboratories.

Table 3.9.

Intercalibration of Organochlorine residues in Snow; Comparison of Arctic Laboratories and National Water Quality Laboratory data from samples collected June 1987.

	Concentrations in Melted Snow (pg/L)			
Compound	**Arctic Labs**[a] mean	sd	**N.W.Q.L.**[b] mean	sd
Aroclor 1254	185	160	260	20
HCB	12	3.0	50	30
heptachlor	6	3	20	20
aldrin	0.5	0.5	int	int
o,p'-DDE	2.8	2.4	nd	-
p,p'-DDE	20	14	nd	-
Mirex	<4.0	-	nd	-
alpha-HCH	240	160	140	20
beta-HCH	15	8.3	nm	-
gamma-HCH	190	120	320	390
oxychlordane	8.1	4.7	nm	-
trans-chlordane	20	15	8	1
cis-chlordane	25	18	20	-
p,p'-DDT	<47	26	20	20
heptachlor epoxide	46	26	28	11
alpha-endosulphan	97	58	1410	430
dieldrin	<140	55	50	6
endrin	27	11	30	15
methoxychlor	37	26	90	60

(a) Sum of dissolved (XAD) plus particulate components. Mean of three samples.
(b) Preliminary data; melted snow not filtered prior to extraction. Mean of three samples.
(c) nd = below NQWL detection limit.
(d) '<' = below Arctic Laboratories detection limit.
(d) nm = not measured.

Table 3.10.

Intercalibration of HCHs in snow; Comparison of samples collected June 1987 by Arctic Laboratories, U.S.C. and N.W.Q.L. (pg/L in melted snow)

	Arctic Labs[a]				N.W.Q.L.[b]				U.S.C.[c]			
Sampling Date	8/06	9/06	15/06	mean	06/06	06/06	06/06	mean	07/06	09/06	13/06	mean[d]
alpha-HCH	230	470	170	290	170	130	130	140	340	290	1900	212
gamma-HCH	190	310	75	190	110	80	780	320	350	380	670	470

(a) Filtered and extracted on to XAD-2.

(b) Preliminary data from Gregor (1988).
Not filtered, extracted with dichloromethane.

(c) Patton el al(1987).
Filtered, extracted onto bonded n-octyl silica gel.

(d) sample from June 13, 1987 from newly fallen snow not included in mean

e) Biota Samples

Analytical precision for biological samples containing low concentrations of organochlorines was determined by triplicate analysis of a homogenised Ice Island plankton sample. Also, several replicates of seal blubber and Arctic char liver homogenates were analysed as part of an interlab calibration with two government labs to determine accuracy and precision at higher concentrations. A larger plankton sample (73μm net haul, <500μm size class, sample i.d. 1-Jar-86-119), collected in May 1986 was homogenised and triplicate samples (0.47-0.54g, dry weight) taken for organochlorine residue analysis. The results are given in Table 3.11. The mean relative standard deviation for the 18 quantifiable compounds in this homogenate was 17%.

Arctic Labs has recently partipated in an interlab calibration with Canadian Wildlife Service (C.W.S.), Hull, Quebec (Henry Won and Richard Turle) and Department of Fisheries and Oceans (D.F.O.) at the Fresh Water Institute, Winnipeg (Bert Grift and Denis Muir) as part of a project monitoring chlorinated hydrocarbons in arctic biota samples (Thomas and Hamilton,1988). The analytical methods used for the intercalibration were the same as for the 1987 Ice Island biota analyses and the results are useful for Ice Island method evaluation.

Homogenates of ringed seal blubber and arctic char liver from Iqaluit and Pangnirtung, N.W.T. were prepared and shipped to the participating laboratories. The results for compounds monitored in this project for triplicate samples analysed by D.F.O. and C.W.S.and by Arctic Labs on two occasions and is summarised in Tables 3.12.(a) and 3.12.(b). PCBs were determined on the basis of individual congeners and consequently concentrations of PCBs as Aroclor 1254 were not reported. The Arctic Labs results are in good agreement with and comparable to the other particating labs. No significant systematic error is evident and the results appear to be of acceptable quality.

Table 3.11.

Replicate Analysis of Plankton Homogenate[a] for Organo Chlorines (ng/g, dry weight)

Compound	Concentration of organochlorines (ng/g, dry weight)					
	Replicate					
	1	2	3	mean	sd	rsd
Arochlor 1254	12.9	14.6	15.6	14.4	1.4	9.5
HCB	2.9	2.2	0.66	1.9	1.1	60.
aldrin	0.6	0.11	0.10	0.09	0.03	29.
o,p'-DDE	0.32	0.41	0.61	4.5	0.15	3.3
p,p'-DDE	1.6	1.7	2.2	1.8	0.32	18.
Mirex	0.17	0.15	0.29	0.20	0.08	38.
alpha-HCH	11.2	10.6	11.2	11.0	0.35	3.0
beta-HCH	0.98	0.98	1.0	0.98	0.01	1.2
gamma-HCH	1.4	1.2	1.3	1.3	0.1	7.7
oxychlordane	0.87	0.85	1.0	0.91	0.08	8.9
trans-chlordane	1.7	1.6	2.1	1.8	0.26	15.
cis-chlordane	4.1	3.6	4.7	4.1	0.55	13.
p,p'-DDT	3.2	3.2	4.1	3.5	0.52	15.
cis-nonachlor	3.2	2.8	3.7	3.2	0.45	14.
heptachlor epoxide	0.70	0.74	0.92	0.79	0.12	15.
dieldrin	2.5	2.8	3.6	3.0	0.57	19.
endrin	2.8	1.9	1.9	2.2	0.52	24.
methoxychlor	0.94	1.1	1.2	1.1	0.13	12.

Mean relative standard deviation 17%

(a) Plankton sample 1-Jar-86-119, <500μm size class collected with a 73μm vertical net haul, May 1986.

Table 3.12

Summary of Triplicate Analyses of Arctic Biota Intercalibration Samples

(a) Ringed Seal Blubber (ng/g, wet weight)

	D.F.O.[a]		C.W.S.[b]		Arctic Labs 1[c]	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
HCB	14.91	0.60	0.00	0.16	6.93	5.55
p,p'-DDE	372.92	10.30	248.07	15.47	183.33	5.77
Mirex	1.37	0.02	1.00	0.21	1.77	0.31
alpha-HCH	102.77	7.13	99.99	4.39	144.33	53.35
beta-HCH	22.70	2.27	11.13	0.18	0.00	1.00
gamma-HCH	3.20	0.19	2.81	0.25	3.33	0.00
oxychlordane	75.01	2.89	81.68	2.99	105.67	26.76
trans-chlordane	0.37	0.21	n.a.	n.a.	3.30	0.20
cis-chlordane	3.66	0.33	3.52	0.10	7.33	2.31
p'p'-DDD	5.91	0.44	6.52	0.28	11.67	0.58
p'p'-DDT	70.48	4.50	67.68	2.56	130.00	17.32
o'p'-DDT	0.23	0.39				
cis-nonachlor	6.12	0.35	3.52	0.10	5.77	0.32
heptachlor epoxide	23.77	1.27	52.43	1.38	37.67	2.08
dieldrin	35.12	1.63	33.12	0.19	53.00	1.00
endrin					1.27	0.21
methoxychlor						

(a)Department of Fisheries and Oceans, Freshwater Institute, Winnipeg.

(b)Canadian Wildlife Services, Hull, Quebec.

(c)Analysed on two occasions, Arctic Labs 1 in April 1987 and Arctic Labs 2 in June 1987.

Table 3.12, cont'd.

Summary of Triplicate Analyses of Arctic Biota Intercalibration Samples

(b) Arctic Char Liver (ng/g, wet weight)

	D.F.O.[a]		C.W.S.[b]		Arct
	MEAN	S.D.	MEAN	S.D.	MEAN
HCB	5.38	1.05	6.90	0.39	6.2
p,p'-DDE	5.35	1.40	4.67	0.26	6.6
alpha-HCH	9.23	1.25	8.58	0.38	15.6
beta-HCH	1.88	0.32		n.a.	1.3
gamma-HCH	1.30	0.20	0.74	0.05	1.6
oxychlordane	1.29	0.09	1.29	0.10	3.0
trans-chlordane	0.96	0.12	0.72	0.08	
cis-chlordane	3.43	0.42	3.82	0.36	4.7
p'p'-DDD	0.77	0.11	1.30	0.25	3.5
p'p'-DDT	0.60	0.07	6.28	0.52	14.6
cis-nonachlor	2.03	0.29	1.85	0.15	2.5
heptachlor epoxide	2.13	0.34	3.37	0.12	2.5
dieldrin	6.52	1.11	4.98	0.10	9.1
endrin					1.2
methoxychlor					

(a)Department of Fisheries and Oceans, Freshwater Institute, Winnipeg.

(b)Canadian Wildlife Services, Hull, Quebec.

(c)Analysed on two occasions, Arctic Labs 1 in April 1987 and Arctic Labs 2 in June 1987.

f) Sediment samples

Precision of chlorinated pesticide analyses and accuracy of PCB analyses were determined by six replicate analyses of the standard reference sediment CS-1, a coastal marine sediment reference sample supplied by the National Research Council of Canada, Marine Analytical Chemistry Standards Progam (NRCC/MACSP) certified at 1.2 ±0.6 ng/g PCB quantitated as Aroclor 1254. This SRM is certified only for PCBs as Aroclor 1254 determined by packed column GC methods,and no data is available on the levels of chlorinated pesticides. Consequently, the SRM allows a method validation only for PCBs. The analyses of the SRM were carried through with several sediment sample batches to monitor batch to batch variation in extraction efficiency and the results given in Table 3.13. The mean concentration of Aroclor 1254 from six determinations of the SRM was 0.75 ±0.05 ng/g, lower than but within the uncertainty of the certified concentration of 1.2 ±0.6ng/g. The lower values found by Arctic Labs are attributed to the analysis by capillary GC which is has higher resolution and specificity than the packed column technique used for the SRM certification. The results for other chlorinated compounds found in CS-1 are given in Table 3.13 and indicate the precision at this level.

The extraction efficiency of the sediment method was verified by exhaustive Soxhlet extraction (25h with 1:1 acetone/hexane) of the SRM sediment after analysis by the standard method. The results indicate that for those compounds found and quantified in the SRM, the standard method extracted 92-99% of the organochlorines present, and an additional 1-8% could be extracted by soxhlet from the SRM sample residue. The residual levels extracted by soxhlet are close to or below detection and quantification limits and no correction for extraction efficiency to the sediment concentrations was made.

Table 3.13 Replicate analyses of Standard Reference Material CS-1

Compound	Replicate							
	1	2	3	4	5	6	Mean	S.D.
Aroclor 1254	0.77	0.76	0.76	0.73	0.81	0.65	0.75	±0.05
HCB	0.059	0.056	0.049	0.063	0.066	0.065	0.063	±0.006
p,p′-DDE	0.13	0.13	0.11	0.11	0.17	0.10	0.13	±0.03
alpha-HCH	0.088	0.084	0.062	0.077	0.070	0.070	0.075	±0.01
gamma-HCH	0.054	0.05	0.05	0.076	0.075	0.060	0.061	±0.06
heptachlor epoxide	0.050	0.048	0.018	0.031	0.038	0.057	0.040	±0.02

3.3 POC/PON

When samples were retrieved, silver filters were removed by forceps, stored in disposable plastic Petri dishes and kept frozen until analysis (within two months). Filters were fumed (30 min) over concentrated HCl prior to drying (80°C overnight) to remove carbonates. Dry weight of filters was compared with original filter weight to measure total dry mass of particles collected. Filters were combusted in a Perkin Elmer Elemental Analyzer (Model 240) for determination of organic carbon and nitrogen. Absolute sensitivity (twice blank value) was approximately 5 μg for carbon and nitrogen.

3.4 Lipids

Lipids were extracted from 100 mg of the pulverized dry tissue by homogenisation with 80 ml of 2:1 chloroform:methanol in a Virtis homogenizer for five minutes (Barnes and Blackstock, 1973). The solution was maintained at 55°C for ten minutes and then filtered through a No. 1 chloroform:methanol washed Whatman filter into a 100 ml volumetric flask. The solid residue was washed with small aliquots of which chloroform/methanol. On the final washing it was poured into the filter. The solution was made up to 100 mL and then transferred to a 250 mL separatory funnel, shaken with 20 ml of 0.9% NaCl, and then stored overnight stoppered and taped with teflon tape in the refrigerator to separate. After separation, the lower organic layer was collected in a 100 mL volumetric, and made to volume with 2:1 chloroform:methanol at room temperature.

Lipid concentration was quantified colorimetrically using the sulphophosphovanillin method of Barnes and Blackstock (1973). A 0.5 mL aliquot of lipid extract was evaporated under nitrogen and 0.5 mL of concentrated sulphuric acid added to the residue. The tube was stoppered with non-absorbent cotton wool and heated ten minutes in a boiling water bath. After cooling. 0.1 mL from each tube was transferred to a clean, dry test tube and 2.5 mL of the phosphovanillin reagent added. After thirty minutes, the absorbance was measured at 530 nm against a procedural blank. A cholesterol standard was used to derive a calibration curve and a calculation made for total lipid concentration using the conversion factor given in Barnes and Blackstock which equates 80 mg cholesterol standard to 100 mg total lipid.

The quantity of extract containing less than 200 mg of lipid was initially determined gravimetrically by the following procedure. Duplicate 2.5 mL aliquots of the soxhlet extract were placed on tared (± 0.02 mg) aluminum weighing boats which were then dried at 105°C for 10 minutes, cooled in a dessicator and reweighed to ± 0.02 mg. The lipid content of the sample was calculated. The volume containing 200 mg or less lipid was determined and this volume taken and evaporated down to 1 mL for gel permeation column clean-up.

Procedural blanks were run with every suite of samples. True replicates were analyzed by subsampling a homogenized sample. The precision of the method (relative standard deviation) was +/- 7% at lipid concentrations of 5.7 and 24.7 % dry weight.

3.5 Reactive Nutrients

Samples from the trip in May were analyzed on the island by F. Zemlyak from the Chemical Oceanography Section of Bedford Institute of Oceanography. Samples from the second and third trips in August and June were analyzed at the Institute of Ocean Sciences, Pat Bay. In both cases, nutrients were determined with Technicon autoanalyzer II methods (Strickland and Parsons, 1968) calibrated by Sagami Research Institute reference standards. Nitrate refers to nitrate + nitrite. Accuracy of the methods used at the Institute of Ocean Sciences was nitrate +/- 4% at 15 mM; silicate +/- 5% at 30 mM and phosphate +/- 5% at 2 mM.

3.6 Sediment Grain Size

Samples from bottom sediments were analyzed for grain size under sub-contract to Thurber Consultants of Victoria. Standard wet sieve analysis was performed for gravel and sand and hydrometer sedimentation tests for silt and clay (ASTM D422). Precision of the method based on triplicate analysis of the same sample was better than 3% for each size fraction (% sand, silt, clay). Sand was defined as > 63.5 um; silt 2 - 63 um; and clay < 2 um.

4. RESULTS

Results are presented in the following sections for each type of sample collected. Quantifiable concentrations of organochlorines were found in all types of samples with the exception of particulates from ice melt and sea water as a result of the very low quantities of particulates in these samples. Detailed data for all compounds monitored are given in Appendices A - F.

4.1 Air

4.1.1 Vapour Phase

A summary of quantifiable or detectable organochlorines in the vapour phase for all three sampling trips is given in Table 4.1 and detailed in Appendix A. The alpha and gamma isomers of HCH and HCB were the most abundant compounds. Total HCH concentrations were between 250 - 500 pg/m3. HCB concentrations were 70 - 100 pg/m3 while all other compounds were at concentrations of less than 10 pg/m3. Seasonally, concentrations of alpha HCH, cis and trans chlordane and DDE were lowest in August/September. Concentrations of other compounds did not display any significant seasonal variation. Ratios of alpha and gamma HCH and trans and cis chlordane were variable. Concentrations of gamma HCH (lindane) were significantly lower in August/September. As a result, mean alpha:gamma ratios were increased to 16 from a value of 6 in May and 3.5 in June. The ratio of trans:cis chlordane was 0.5 in June 1987, the only data set where concentrations of trans and cis chlordane were quantifiable in all samples. Data collected in August gave ratios of less than 1 but trans chlordane levels were all below detection. In May 1986, for the few samples with quantifiable levels, trans chlordane concentrations were the same as in June but the concentration of the cis isomer was 3 times lower giving a trans:cis ratio of 1.5.

Table 4.1.

Summary of Organochlorines in Air Vapour (pg/m^3)

Compound	May 19–31, 1986	Aug. 25 – Sept. 8, 1986	June 5–16, 1987
Arochlor 1254	5.1*	9.1 ± 5.5 (4)	14 ± 4 (3)
HCB	74 ± 17 (6)	63 ± 16 (4)	109 ± 39 (3)
α HCH	451 ± 115 (6)	251 ± 49 (4)	187 ± 71 (3)
HCH	71 ± 28 (6)	16 ± 4 (4)	53 ± 26 (3)
trans chlordane	1.8 ± 0.8 (5)	<0.6	1.8 ± 0.2 (3)
cis chlordane	1.2 ± 0.8 (5)	0.8 ± 0.2 (4)	3.3 ± 1.3 (3)
heptachlor epoxide	4 ± 1 (6)	2 ± 1 (4)	3 ± 1 (3)
alpha-endosulphan	3 ± 2 (6)	4 ± 1 (4)	8 ± 2 (3)
pp'DDT	<0.4	<0.4	<0.6
PP'DDE	2.0 ± 0.8 (6)	<0.3	1. ± 0.2 (3)

* single quantifiable value

Concentrations are mean ± std. deviation (n).

4.1.2 Air Particulates

Quantifiable concentrations of a few residues were found in air particulate samples obtained with the particulate high volume air sampler in May, none in August and 12 in June (detection limits were lower for June samples because of use of a 60 m GC column with resulting better resolution; see section 3.18). PCBs were the most abundant compounds in May and June particulates at 1.5 pg/m3. All other detectable compounds in June samples were less than 1 pg/m^3. Levels in May samples were slightly higher but were below quantitation and are not as reliable. A summary of detectable compounds in June 1987 samples is given below:

Compound	**Concentration (pg/m^3)**
PCB as Arochlor 1254	1.5
HCB	0.15
o'p' DDE	0.3
p'p' DDE	0.7
p'p' DDT	0.2
alpha HCH	0.1
gamma HCH	0.04
trans chlordane	0.05
cis chlordane	0.12
heptachlor epoxide	0.1
alpha endosulphan	0.4
dieldrin	0.2

4.2 Snow

Concentrations of dissolved and particulate organochlorines in melted snow are summarized for all three trips in Table 4.2 and detailed in Appendix B. Compounds of all classes of organochlorines (HCH, HCB, DDT, PCBs and cyclodienes) were quantifiable in filtered snow melt. The alpha and gamma isomers of HCH were the most abundant dissolved compounds. There were however, very large differences in the amount of HCH present on each trip and differences in the ratios of the alpha:gamma isomers. Total HCH decreased from 2100 ng/L in May to 1250 ng/L in August/September. In June 1987, sample concentrations were 480 ng/L, principally as a result of lower α HCH levels. The ratio of alpha:gamma isomers varied from 2.3 to 5.5 to 1.5 respectively over the three trips. Concentrations of HCH associated with particulates were less than 1.0 ng/L in all samples.

PCBs (as Arochlor 1254) were the next most abundant dissolved component. Seasonally, concentrations were lower in August/September relative to May and June (79 ng/L vs 125 and 177 ng/L respectively). PCBs were quantifiable on particulates in May and June (54 and 7 ng/L respectively) and below detection (<15 ng/L) in August.

The cyclodiene insecticides were also relatively abundant in melted snow samples. Total chlordane (sum of cis and trans isomers) decreased from 88 ng/L in May to <10 in August/September. Concentrations in June were 45 ng/L. The ratio trans:cis chlordane also was variable. A ratio of 2 was found in May samples; in August the ratio was >1 while in June 1987, the ratio had decreased to 0.8. Particulate chlordane concentrations were detectable but not quantifiable in some May samples but below detection (<0.5 ng/L) in August and June.

Heptachlor epoxide, dieldrin, endrin and α endosulfan were also present in the dissolved melt water. All appear to be lowest in August samples although variability was high. This trend was most evident comparing May and August samples. Heptachlor epoxide was the only cyclodiene for which concentrations were quantifiable in all samples. Levels

Table 4.2.

Summary of Organochlorines in Melted Snow Samples
(pg/L)

Compound	May, 1986		August 25 - Sept. 8, 1986		June 1987	
	Dissolved (n = 4)	Particulate (n = 4)	Dissolved (n = 3)	Particulate (n = 3)	Dissolved (n = 3)	Particulate (n = 2) range
α HCH	1490 ±180	<0.7	1070 ± 120	<0.7	294 ± 160	<0.3
HCH	640 ± 90	<0.5	193 ± 22	<0.5	192 ± 118	0.4
p'p'DDT	14 ± 9	1.9	<1 - 7	2	22 - Q25	<1.7 - 3.5
p'p'DDE	Q3- 6	Q0.5 - 2.2	<5	0.6	Q5 - 36	<0.6 - 2.6
Methoxychlor	71 - Q6	<0.7 - Q2	43 ± 44	<0.8	67 - Q10	<22
transchlordane	58 ± 30	<0.5 - 7	<0.9 - 10	Q0.2 - Q0.9	20 ± 16	<0.3
cis chlordane	30 ± 12	<0.5 - 6	<0.5 - Q0.9	<0.5	25 ± 18	<0.3
heptachlor epoxide	110 ± 29	<0.1 - 1.6	37 ± 9	<0.1	46 ± 26	<0.4
α endosulfan	206 - Q96	<0.2 - 2	Q72 - Q125	<0.4	97 ± 58	<0.3
dieldrin	290 ± 100	<7	92 ± 11	<2	108	<0.9
Endrin	12 ± 8	<0.3	<1 - Q3	<0.1	<21	<3
PCB	125 ± 58	54 ± 26	79 ± 21	<15	177 ± 160	7 ± 5
HCB	<1.8 - 41	4 - Q2	<2 - 11	<1	Q3 - Q8	2 ± 1

< less than detection limit

Q indicates a value below the quantification limit varied from 110 ng/L in May to 37 in August and 46 in June 1987. Particulate concentrations for all cyclodienes were below detection (<1 ng/L).

Dissolved HCB concentrations were highly variable (perhaps as a result of contamination) ranging from below detection (<2 ng/L) in some samples to quantifiable values of 40 ng/L in others. No seasonal trend was apparent as a result of this variability. Particulate HCB was quantifiable in May and June samples (4 and 2 ng/L respectively) and <1 ng/L in August.

DDT, DDE and methoxychlor were all present in May and June samples in quantifiable amounts. Dissolved DDT and the sum of DDE isomers were lower in August (below detection). Particulate DDT was below detection. Particulate DDE concentrations were between 0.5 and 2.6 ng/L, or up to 50% of dissolved levels. No seasonal trend was evident for dissolved methoxychlor. Methoxychlor was found only in the dissolved phase; particulate concentrations of methoxychlor were below detection on all trips.

4.3 Ice

Ice cores from first year ice were collected in May 1986 and June 1987. Data is summarized in Table 4.3 and Appendix C. Dissolved organochlorine concentrations in melted ice were lower then underlying surface seawater, but in the same relative proportions. The ratios of alpha and gamma isomers of HCH were approximately 7, the same as water column ratios: ratios of trans:cis chlordane were less than one although uncertainty is high due to the low concentrations (most samples were below quantitation limits).

Concentrations of PCB, HCB, DDE, DDT and cis-chlordane were all at quantifiable concentrations in particulates matter collected from the bottom 10 cm of ice in June. In contrast only PCBs were quantifiable in May samples; PCB levels in June were 3 - 10 times higher than in May. There

Table 4.3.

Summary of Organochlorines in First Year Melted Ice (pg/L)

(results given as mean ± std. deviation;
n = 3 when all values quantifiable;
otherwise a range is indicated)

Compound	**May, 1986**		**June, 1987**	**June 1987**	
Depth (m)	**Dissolved 0.6 - 1.2**	**Particulate 0.6 - 1.2**	**Dissolved 0.8 - 1.4**	**Dissolved 1.4 - 1.6**	**Particulate 1.4 - 1.6**
alpha HCH	1310 ± 290	0.6 - Q1.8	690 ± 82	580 ± 130	1.3 - 2.3
gamma HCH	183 ± 47	<0.4 - Q1.4	77 ± 11	85 ± 27	<2
p'p'DDT	<1.8 - 12	<2	62 ± 2	<33 - <103	Q14 - 75
Sum DDE	<3	<0.6 - 0.9	<10 - 39	Q10	9 - 39
methoxychlor	<3 - 31	<0.6 - Q1.2	<16	<27	<100
trans chlordane	4.5 - Q1.7	<0.4 - Q1.4	<4	<7	<1 - 3.6
cis chlordane	4.8 - Q1.0	<0.4 - Q1.6	<4	<7	Q3 - 5
heptachlor epoxide	<5 - Q13	<0.1 - 1.6	<3	Q6 - 10	<0.7
alpha endosulfan	<60	<0.2 - 1.2	<4	Q6 - 21	<1 - 3
dieldrin	6 ± 1	<2 - Q4.4	<290	<160	<4 - 7
endrin	<1 - 5.8	<0.1 - Q0.3	<59	<95	<7
PCB	Q22 - Q24	9 ± 5	<35 - 111	28 ± 5	32 - 98
HCB	<2	<1.2	<6 - Q20	<10 - 14	5 - 8

a) Bottom of ice core, including ice algae.

Q indicates value less than quantification limit.

were visible epontic algae in the June samples so that higher organochlorine levels in particulates in June samples likely reflect organochlorines associated with these organisms.

4.4 Water Properties

4.4.1 Water Structure

Water depths during the course of the study varied between 150 and 340 m. This depth range encompasses the Arctic surface water (0 - 200 m) and the upper part of the Arctic intermediate water (200 - 900 m) (Coachman, 1969; Kinney et al., 1970). Salinity and temperature profiles for each trip are shown in Figures 4.1 - 4.2. The general features of the water column are fairly typical of those observed elsewhere in the Polar Basin (Jones and Anderson, 1987). The upper 50 m is well mixed and has a low salinity and temperatures near freezing. The low salinity of this layer is due to river run-off, North Pacific influx through Bering Strait and the seasonal melting and freezing of ice (Aagaard et al, 1981). In August, 1986 surface water was slightly fresher (S= 31.9 ppt vs 32.2 ppt in May) with the upper 5m noticeably fresher and warmer presumably as a result of ice melt. Since sampling was from the edge of the island in August, the upper 45 m will have been influenced by the proximity of the island and may not be representative of general water properties elsewhere in this depth range. Below the well mixed low salinity surface layer is a broad halocline between the surface layer and warmer, more saline intermediate water of Atlantic origin which has its core over much of the Arctic Basin between 400 - 500 m (temperature maximum). Temperatures increased with depth below about 100 m with water below approximately 280 m having temperatures above 0°C.

Nutrient concentrations were uniform in the upper 50 m in both May and June. Concentrations of inorganic nitrate,

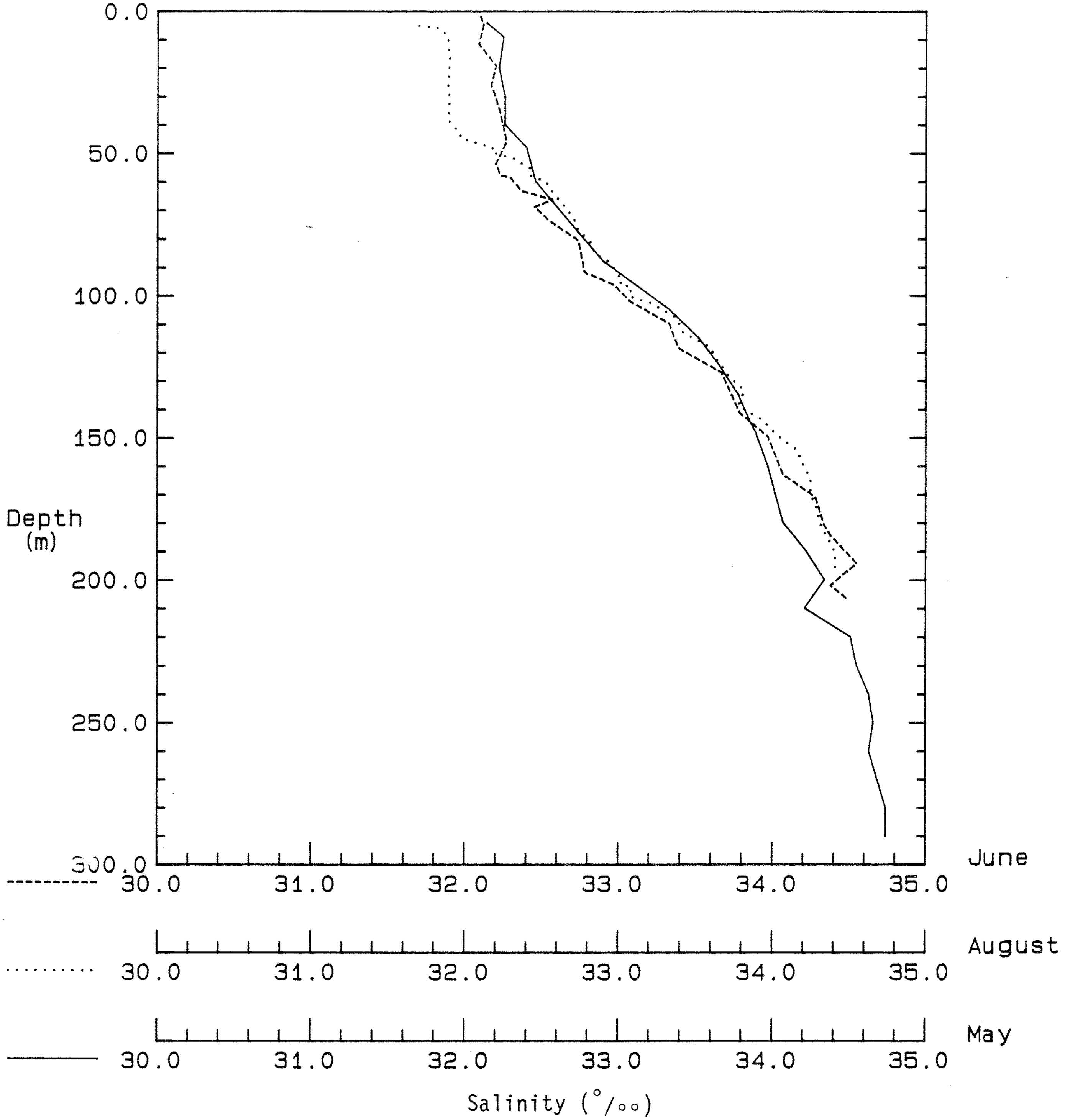


Figure 4.1 Water column depth profiles of salinity at the Ice Island on all three sampling trips.

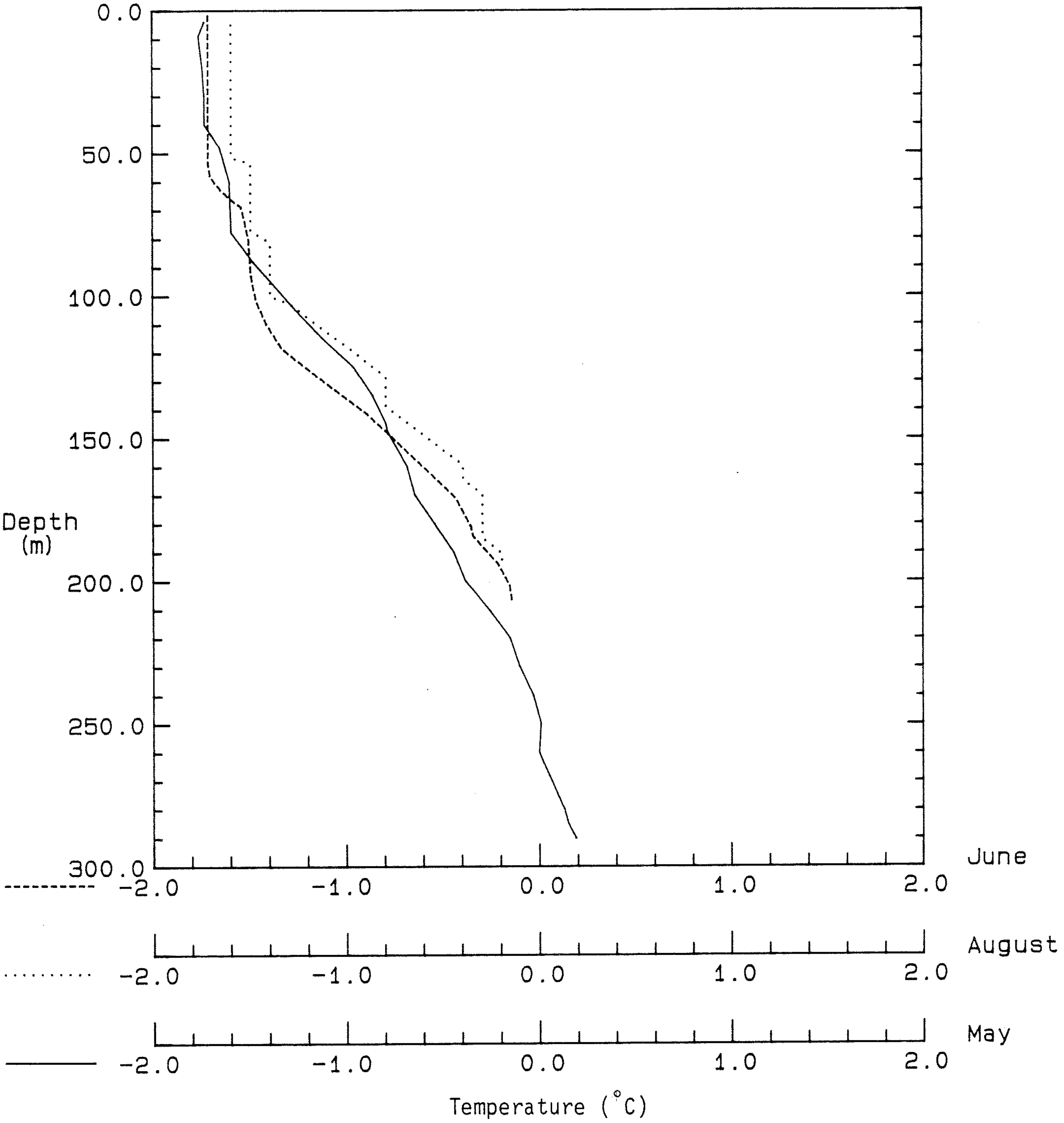


Figure 4.2 Water column depth profiles of temperature at the Ice Island on all three sampling trips.

silicate and orthophosphate were approximately 6, 15 and 1.4 μM respectively on both occasions. Phosphate concentrations in the upper 50 m decreased to 1 μm in August. All nutrient concentrations were dramatically lower during August in the upper 5 m. The very low phosphate (0.3 μm), silicate (6 μm) and nitrate (1 μm) concentrations observed in this water is likely a result of ice melt and run-off from the island. Increased concentrations of suspended particulate organic carbon in August (Table 4.4) and reduced nutrient concentrations in the upper well mixed layer reflect the net increase in suspended particulate matter due to primary production by phytoplankton and ice algae. Within the upper part of the halocline, a distinct nutrient maximum was observed on all three sampling trips at a depth of between 100 - 120 m and a salinity of 33.1 ppt. Concentrations of dissolved silicate, nitrate and orthophosphate reached levels of 38, 17 and 2.2 μM respectively in June. Maximum phosphate was lower in August (1.8 μM) and nitrate lower in May (15 μM). This maximum is a distinctive feature of the Central Arctic Ocean which has been postulated in recent publications to have its origins within the Arctic Basin rather than with intruding Bering Sea water. The mechanism suggested is brine formation and drainage from the large continental shelves (Jones and Anderson, 1987; Melling and Lewis, 1982; Aagaard et al., 1981, 1985). Nutrient depth profiles for all three trips are shown in Figures 4.3 - 4.5.

4.4.2 Particulate Organic Carbon and Nitrogen

The suspended matter, particulate organic carbon (POC) and particulate organic nitrogen (PON) concentrations for all three trips are summarized in Table 4.4. Values at all depths (except 125 m) were generally lower than concentrations measured by Gordon and Cranford (1985) at a deep water sampling site (85°N, 2000 m) in the Canada Basin where concentrations of suspended particles might be

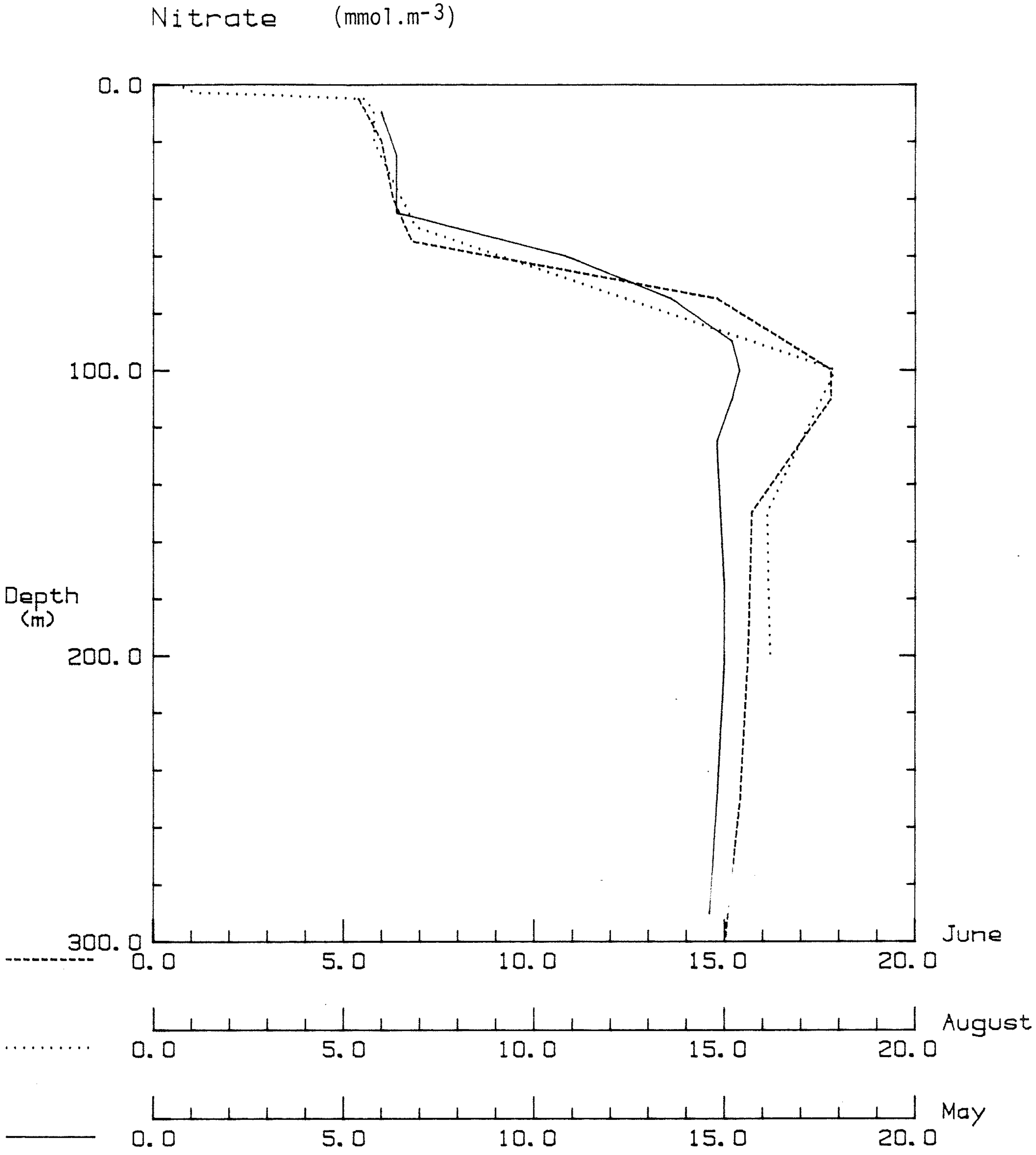


Figure 4.3 Water column depth profiles of nitrate (and nitrite) at the Ice Island on all three sampling trips.

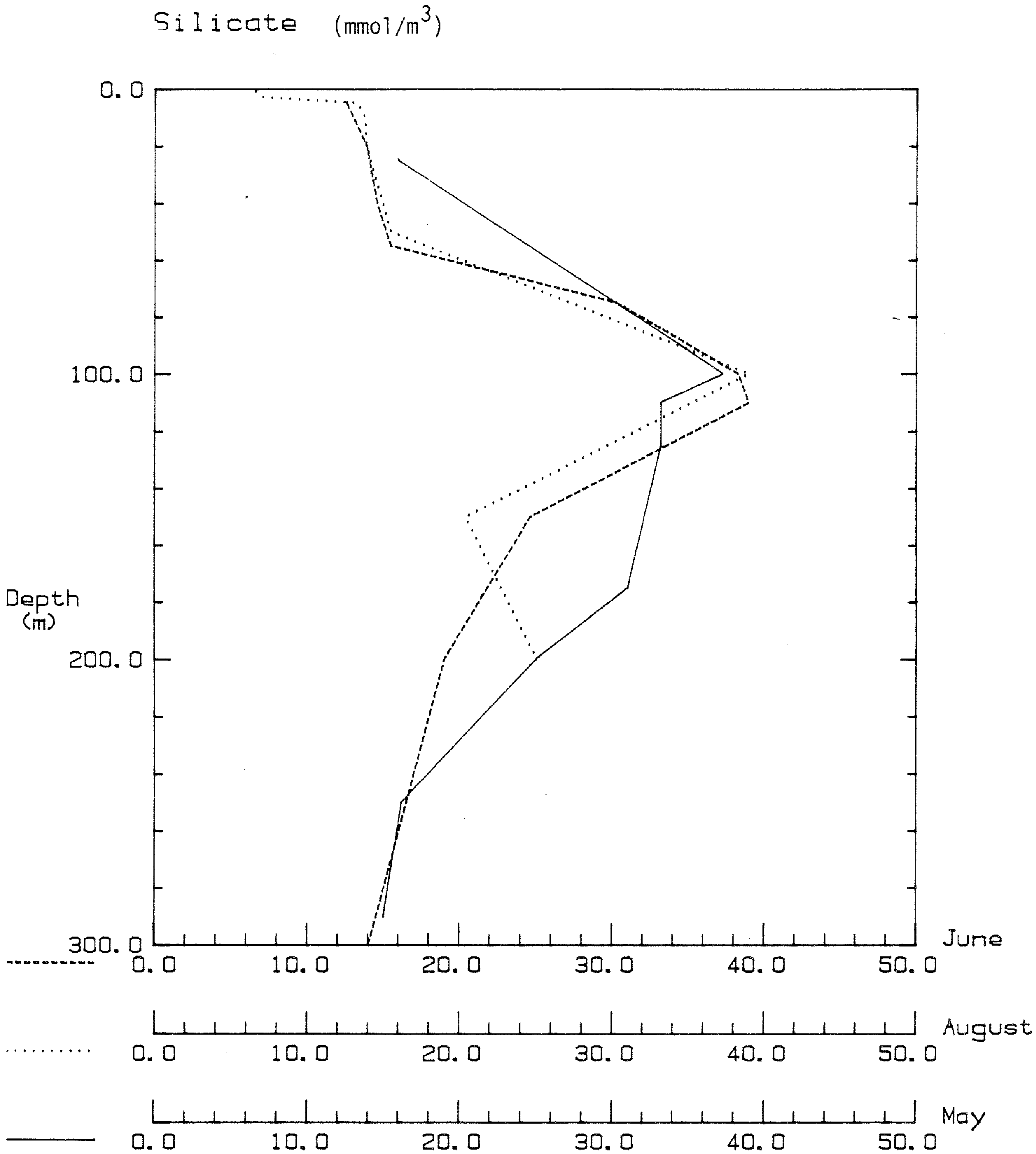


Figure 4.4 Water column depth profiles of silicate at the Ice Island on all three sampling trips.

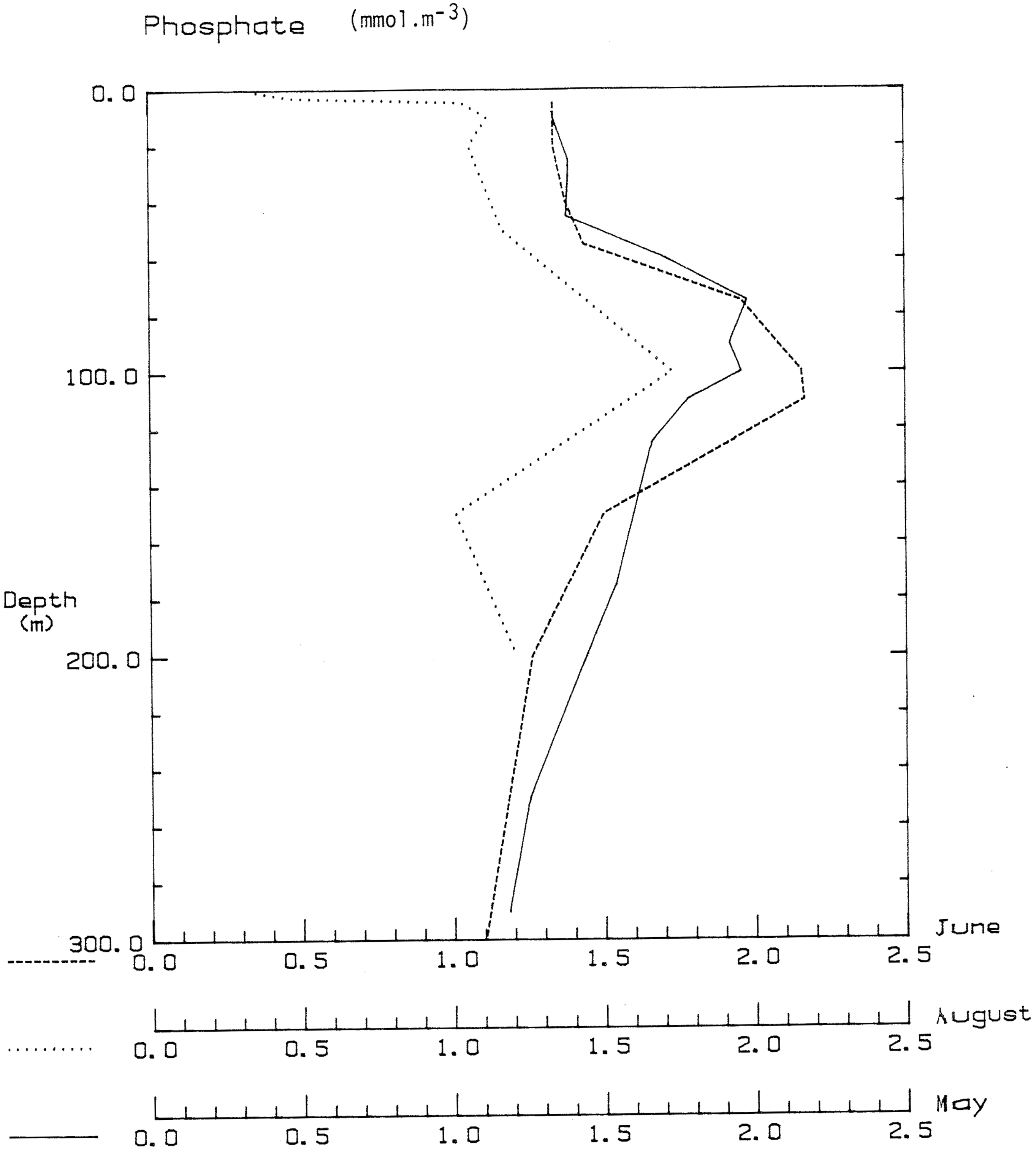


Figure 4.5 Water column depth profiles of phosphate at the Ice Island on all three sampling trips.

Table 4.4

Summary of Particulate Organic Carbon (POC), Particulate Nitrogen (PN) and Suspended Particulate Concentrations in the Water Column on All Three Sampling Trips

Date	Depth (M)	Vol. Filt. (L)	Suspended Dry Wt. (ug/L)	Particulate Org. Carbon (ug/L)	Particulate Nitrogen (ug/L)	% Carbon	% Nitrogen	C:N
May 1986	10	* 102.3	7	1.69	.29	24.1	4.1	5.8
	45	* 40.5	47	2.36	.41	5	.9	5.8
	60	* 25.6	19	4.07	.58	21.4	3.1	7
	75	* 36.2	9	2.65	.35	29.4	3.9	7.6
	100	* 30.1	14	2.85	.14	20.4	1	20.4
	125	* 25.3	18	8.53	1.78	47.4	9.9	4.8
	175	* 49.1	20	.81	.45	4.1	2.3	1.8
	242	* 95.8	5	1.36	.18	27.2	3.6	7.6
August 1986	10	aNBS 8.03	42	22.9	2.96	54.5	7	7.7
	10	aNBS 8.14	121	9.05	1.72	7.5	1.4	5.3
	10	aNBS 8.84	157	1.89	.59	1.2	.4	3.2
	10	38	14	7.1	1.18	50.7	8.4	6
	10	20.3	50	9.05	1.33	18.1	2.7	6.8
	10	19.9	17	6.81	1.06	40.1	16.2	6.4
	10	21.9	33	4.97	.73	15.1	2.2	6.8
	10	* 40.0	33	4.29	.83	13	2.5	5.2
	10	* 23.2	no weight	5.4	.93	-	-	5.9
	40	34.4	47	5.76	.9	12.3	1.9	6.4
	60	98.4	19	2.37	.46	12.5	2.4	5.2
	90	14.2	15	no sample	no sample	-	-	-
	125	61.2	9	2.14	.31	23.8	3.4	6.8
	150	128.5	12	.5	.21	5.4	1.8	3.1
	175	133.4	8	no sample	no sample	-	-	-
June 1987	10	106.3	33	.98	.09	3	.3	11
	10	107.9	1	1.52	.15	10.9	1.1	9.9
	10	73.5	56	.52	.05	9.3	.09	10.4
	10	71.2	23	1.94	.28	8.4	1.2	6.9
	110	155.7	7	1.23	.11	17.6	1.6	11.9
	110	104.4	26	2.69	.37	10.3	1.4	7.3
	270	67.1	18	1.43	.16	7.9	.9	8.8
	270	63.5	4	1.87	.21	46.8	5.3	8.7

* no collector tube above filter holder

a NBS = National Bureau of Standards Drop Sampler expected to be lower than at our sampling location over the shelf. An average (upper 100 m) value of suspended particulate organic carbon of 9 ug C L^{-1} was measured by Gordon and Cranford compared to average concentrations in this study of 2.7 and 5.7 ug C L-1 in the upper 50 m in May and August (Table 4.4).

Gordon and Cranford collected water in 12 L bottles and gravity filtered it through similar Selas Flotronics silver filters used in this study. One possible explanation for the lower than expected concentrations in our samples is that the Seastar sampler pumps at a low flow rate and even though large volumes were sampled, only part of the population of suspended particles was collected. The 4 mm diameter opening on the Swinnex filter holders might not allow particle aggregates to enter the filter holders. Alternatively, concentrations of aggreagtes could be low and the probability of collection would be small with the pumping rate used. Tests carried out at B.I.O. in the summer of 1987 after the final sampling trip showed that the low results might also have been a result of cracking of the filters in the field with subsequent loss of some particulate material. June samples taken with a collector tube in place gave low suspended particle mass and particulate organic carbon concentrations comparable to those found in May 1986 taken without the collector tube. The effect of the tube appears to be minor.

Concentrations of suspended particulate material under the Ice Island are as low as those observed in the deep sea. The dry weight of suspended solids in pump samples ranged from 50 ug/L in the upper 50 m in August to less than 20 ug/L in the deeper water on all three trips. Suspended solid concentrations in August were about 3 times higher in the NBS drop sampler collections than in pump collected samples even with the collector tube in place.

Suspended solids and POC content were highest in the upper 50 m in August and lowest in June. Mean C:N ratios on a weight:weight basis on all three trips show no depth gradient. There was a suggestion of a maximum in percent POC and PON content of suspended matter in samples at the depth of the nutrient maximum (100 - 120 m) on all three trips. This might be expected if flocculent, organic rich particles were concentrated in the pycnocline. This may also reflect the continental shelf origins of this water (see section 4.4.1).

4.4.3 Dissolved Pesticide and PCB Concentrations

Data for all compounds and all depths for each sampling trip are given in Appendix D. Alpha and gamma isomers of HCH, trans and cis chlordane, dieldrin, heptachlor epoxide, HCB and PCBs were all present at quantifiable concentrations. A summary of individual compounds that were above detection limits and their variation with depth is given in Table 4.5. The most abundant compounds were the alpha and gamma isomers of HCH. Concentrations of alpha HCH were 4 - 5 ng/L while gamma HCH levels were 6 to 7 times lower. Concentrations of all detectable compounds with the exception of dieldrin were highest in the upper 0 - 50 m well mixed surface layer and decreased with depth through the halocline. Concentrations of dieldrin did not exhibit any depth related trend perhaps as a result of the low concentrations (less than 5 pg/L).

Ratios of the alpha to gamma HCH isomers (5 -7.5) did not vary significantly with depth despite the more than 20 fold decrease in concentrations from the surface to deep water. Ratios of trans and cis chlordane did change with depth however, from values of about 2 in the surface water to less than 1 in the deep water of the halocline.

There were no significant seasonal differences in the concentrations of organochlorines in the upper low salinity water despite lower salinities in August 1986 at the end of the period of maximum ice melt.

Table 4.5.

Summary of Quantifiable Dissolved Organochlorines in Seawater
(concentrations in pg/L; mean ± std. deviation)

Compound	May 1986 Depth (m) 0 - 60 (n = 60	75 - 200 (n = 6)	>200 (n = 4)	August 1986 Depth (m) 0 - 60 (n = 5)	75 - 175 (n = 6)	> 200	June 1987 Depth (n = 3) 10 m	110 m*	270 m
α HCH	4240 ± 630	2030 ± 1010	320 ± 130	4530 ± 550	2230 ± 940	no samples	2820 ± 180	1440 - 1480	150 ± 10
HCH	570 ± 18	290 ± 150	59 ± 17	650 ± 55	320 ± 130		520 ± 45	298 - 300	28 ± 4
trans chlordane	2.6 ± 1.0	1.9 ± 0.7	0.6 ± 0.3	2.7	3.0		<0.04 - 0.4	<0.3 - Q0.9	<0.3 - Q0.6
cis-chlordane	1.3 ± 0.8	1.3 ± 1.0	3.9 ± 0.3	2.1 ± 2	3.7 ± 1.5		2.1 ± 0.5	2.4 ± 2.7	2.1 ± 0.4
dieldrin	15.3 ± 1.9	10.8 ± 4.8	7.8 ± 0.9	14 ± 3	12 ± 3		<19	<18	<19
heptachlor-epoxide	<2.6 ± 11	3.0 - 8.6	3.3 ± 0.5	10.3 ± 1.2	6.8 ± 2.9		11 ± 2	5 - 7	1 ± 1
HCB	18 ± 6	13 ± 4	8 ± 4	22 ± 7	16 ± 5		17 ± 5	12	6 ± 1
Arochlor 1254	Q13 ± 3	<4 - Q13	<2 - Q7	<4 - Q16	<4 - Q13		<2.2	<2.1	<2.2
DDT	6.9 ± 5	4.2 ± 4	4.4 ± 4	1.6 ± 0.3	1.5 ± 0.5		<4	<4 - 8.2	<4.0

* range of 2 samples
Q = below quantification limit

4.4.4 Particulate Pesticide and PCB Concentrations

Data for all compounds and all depths for each sampling trip are given in Appendix D. Concentrations of most pesticides were at or below detection. This was not surprising given the very low levels of particulate material in the water column (1 - 56 ug/L, Table 4.4). Sample sizes from volumes pumped (180-400L) were therefore 20 mg or less. Despite this, there were detectable concentrations of PCBs (defined in terms of arochlor 1254), HCB, heptachlor, chlordane and dieldrin.

4.5 Zooplankton and Benthos

4.5 1 Organism Identification

a) Zooplankton

Preserved samples in 10% formalin (12 samples in total) were identified to species where possible by examination with a binocular microscope (Mr. J.S. Wilson - Department of Oceanography, Dalhousie University). Results are detailed in Appendix G. Biomass of organisms was not determined although data exists for flow meters readings from individual tows which would allow this calculation.

The 460 um mesh net samples were dominated by the largest copepod species present in the water column - Calanus hyperboreus (copepodite stages IV and V and adults). C. glacialis and Metridia longa were also present but in smaller numbers. These three species, because of their relatively large body size dominated the biomass of the plankton samples. One exception was the sample collected with the 20 um mesh net in August 1986. This was the only sample with an abundance of phytoplankton (tentatively identified as the dinoflagellate Gonyaulax catenata and the centric diatom Coscinodiscus sp.). Only a few cells of these species were observed in the May 1986 20 um and 73 um mesh samples. Nauplii and early copepodite stages comprised a higher percentage of individuals in the August 1986 collection as would be expected if adults produced eggs during July and August.

The broad seasonal pattern of changes in zooplankton abundance and biomass were that large bodied copepods dominated samples collected in May and June (>50% of the numbers of individuals and biomass). In August there was a shift to smaller sized species (mostly < 1mm) such as <u>Oithona similis</u>, <u>Oncaea borealis</u>, <u>Microcalanus sp</u>. and unidentified copepod nauplii and copepodites. The abundance of phytoplankton in the August 1986 samples made seperation and identification of small copepods difficult.

b) Benthic Fauna

The most abundant amphipod species attracted to bait was <u>Tmetonyx cicada</u>. Individuals were 3 - 5 cm total body length. They were obtained alive and it was possible to hold individuals at - 1.0°C in seawater in a container surrounded by snow. Bait was protected in Nitex mesh holders to prevent ingestion to avoid contamination of tissue samples to be used for organochlorine analyses. However, amphipods held for several days egested very little material. It was assumed that animals separated for analyses had empty guts. Subsequent microscopic examination of preserved individuals showed that amphorous material partially filled the guts of more than 50% of the amphipods (n=35).

<u>Andaniexis spp</u> was the second most abundant lysianassid species collected with almost equivalent numbers of <u>Anonyx nugax</u> (maximum length 3.5 cm). Other smaller species (<u>Orchomene spp</u>. and <u>Menigrates spp</u>.; 1-2 mm length) were present but abundance was low in all samples.

Other non-crustacean benthic species attracted to bait included unidentified brittle stars, shrimp, gasteropod observed in the May 1986 20 um and 73 um mesh samples. Nauplii and early copepodite stages comprised a higher percentage of individuals in the August 1986 collection as would be expected if adults produced eggs during July and August.

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b) Benthic Fauna

The most abundant amphipod species attracted to bait was Tmetonyx cicada. Individuals were 3 - 5 cm total body length. They were obtained alive and it was possible to hold individuals at - 1.0°C in seawater in a container surrounded by snow. Bait was protected in Nitex mesh holders to prevent ingestion to avoid contamination of tissue samples to be used for organochlorine analyses. However, amphipods held for several days egested very little material. It was assumed that animals separated for analyses had empty guts. Subsequent microscopic examination of preserved individuals showed that amphorous material partially filled the guts of more than 50% of the amphipods (n=35).

Andaniexis spp was the second most abundant lysianassid species collected with almost equivalent numbers of Anonyx nugax (maximum length 3.5 cm). Other smaller species (Orchomene spp. and Menigrates spp.; 1-2 mm length) were present but abundance was low in all samples.

Other non-crustacean benthic species attracted to bait included unidentified brittle stars, shrimp, gasteropod molluscs and holthurians. Individuals were not numerous (1 to 4 animals per collection) and their small size provided insufficient biomass for both identification and chemical analyses.

4.5.2 Organochlorines

a) Zooplankton

Results for all plankton samples are summarized on a wet weight basis for different size fractions in Table 4.6. Detailed data for individual samples on a wet, dry and lipid weight basis are included as Appendix E. All data in Table 4.6 have been pooled to give mean values as no significant ($p = 0.5$) difference was found in concentrations as a function of sampling trip. Lipid content of plankton ranged from less than 1 to 7 % wet weight. Although there was no significant seasonal trend, the limited lipid data available for the August/September samples does suggest that there was a lower lipid content in zooplankton at that time relative to May/June.

PCBs, DDT and its DDE metabolites as well as alpha HCH were the most abundant organochlorines. PCBs were as high as 10 ng/g in some samples while alpha HCH and DDT levels were generally 1 - 3 ng/g. All other organochlorines had concentrations of less than 1 ng/g. Concentrations were highest in the >250 um and >125 um size range samples for PCBs and alpha HCH although variability was high.

b) Amphipods and Brittlestars

Organochlorine levels in the major benthic amphipod species are summarized in Table 4.7 along with data for the pelagic amphipod Pseudalibrotus litoralis captured from just under the ice in June 1987 and some brittle stars obtained in August 1986. Concentrations in benthis amphipods were higher

Table 4.6.

Organochlorines in Plankton
(ng/g wet weight)
(all data mean ± std. deviation (n)

	Size Fraction (μm) (greater than)						
Compound	**2000**	**1000**	**500**	**250**	**125**	**63**	**25 (1 sample)**
Arochlor 1254	1.7 (4) ±0.9	1.9 (6) ±1.4	1.3 (3) ±0.5	6.7 (8) ±5	7 (5) ±5	2.4 (3) ±2	0.5 (1)
HCB	0.14 (4) ±0.11	0.3 (6) ±0.2	0.89 (6) 1.2	0.7 (6) ±0.4	0.4 (3) ±0.2	0.5 (3) 0.4	0.08 (1)
Σ DDE	0.2 (4) ±0.2	0.2 (7) ±0.2	0.4 (3) ±3	0.7 (7) ±0.8	0.7 (3) ±0.6	<0.3	<0.3
DDT	0.5 (4) ±0.5	0.6 (7) ±0.4	2.3 (6) ±1.7	1.5 (6) ±1.0	1.5 (3) ±1.2	1.8 (3) ±0.8	0.5
α HCH	0.4 (4) ±0.2	1.4 (l7) ±1.0	1.9 (5) ±0.9	2.2 (8) ±0.9	2.3 (4) ±1.2	1.8 (3) ±0.6	0.8
HCH	0.09 (1)	0.3 (7) ±0.1	0.16 (3) 0.07	0.2 (2)	0.4 (4) ±0.3	<0.3	Q0.1
trans chlordane	0.14 (4) ±0.07	0.2 (7) ±0.08	0.4 (6) ±0.2	0.3 (7) ±0.2	0.3 (3) ±0.2	0.2 (3) ±0.2	0.6
cis chlordane	0.35 (4) ±0.14	0.5 (6) ±0.2	1.0 (7) ±0.5	0.8 (7) ±0.4	0.8 (4) 0.4	2.3 (4) ±3.3	0.1
dieldrin	0.24 (4) ±0.07	0.39 (7) ±0.2	0.7 (7) ±0.5	0.6 (7) ±0.4	0.7 (3) ±0.5	0.7 (3) ±0.3	0.3
Mean Lipid: wet weight %	2.48 (4) ±0.46	4.6 (7) ±2.3	3.53 (5) ±0.97	4.05 (7) ±1.52	(1.33-7.18)	1.36 (3) ±1.08	-

Q indicates value below quantification limit

Table 4.7.

Summary of Quantifiable and Detectable Organochlorines in Under Ice Pelagic and Benthic Amphipods and Brittlestars (conc. ng/g wet weight)

Compound	A. nugax	T. cicada (2 pooled samples)	Andaniexas spp. (1 pooled sample)	Brittle Star (3 pooled samples)	Pseudalibrotus litoralis (under ice) (1 pooled sample)
Arochlor 1254	182 (9)* ±68	608	166	20* ±6	3
HCB	5 (9) ±2	8.0	4.4 ±0.6	2.4	2.6
Σ DDE	28 (9) ±18	111	34	3.8 ±0.6	0.3
Mirex	1.5 (11) ±0.4	5.1	1.4	0.2 ±0.1	<0.04
α HCH	0.6 (11) ±0.3	0.6	0.7	0.5 ±0.8	0.7
HCH	0.6 (11) ±0.3	0.6	0.7	0.5 ±0.3	0.7
trans-chlordane	2.7 (12) ±1.4	6.0	1.5	1.8 0.8	1.0
cis-chlordane	11 (12) ±5	21	8.2	5.3 ±1.9	2.3
DDT	25 (12) ±12	41	24	14 ±6	3
Dieldrin	2.2 (12) ±1.5	6.0	2.4	8.1 ±5	3
Mean Lipid Content, % wet weight	4.4% (10)	5.8%	5.3%	1.4%	1.5%

* Concentrations are mean ± 1 std deviation **n** is in brackets.

than in the pelagic amphipod and brittle stars. PCBs, DDT and DDE were by far the most abundant compounds. PCBs (as Arochlor 1254) ranged from 182 ng/g in A. nugax to 608 ng/g in T. cicada, the most abundant species. Mean concentrations in brittlestars were 20 ng/g while concentrations in pelagic amphipods were similar to zooplankton (3 ng/g). Lipid content (wet weight) was similar in all benthic species (4 - 6 %), and higher than in pelagic amphipods (1.5 %) or brittle stars (1.4 %). Detailed data for each pooled sample is given in Appendix E-1.

4.6 Sediments

Concentrations of most pesticides and PCBs were below detection in surficial sediments. On the basis of the core samples taken in June 1987, only two compounds, PCBs (as arochlor 1254) and cis chlordane, were present in detectable or quantifiable levels in surface sediments. Traces of several other organochlorines, notably HCB were found in surface sediments from grab samples (Appendix F). However, analysis of deeper sections of the cores indicated that surface values were equal to or even less than concentrations in deeper sections where no organochlorines should be present. Concentrations of both arochlor 1254 and cis chlordane were less than 0.1 ng/g. The mean concentrations (all data) of PCBs and cis chlordane in the upper cm of sediments were 0.05 ng/g and 0.02 ng/g respectively.

Sediment texture in May grab samples was a mixture of gravel (1 - 9%), sand (15- 26%), silt (28 - 33%) and clay (42 - 47%) sized particles. Samples taken in August and June were finer and contained no gravel and smaller quantities (5 - 10%) sand (Appendix H).

5. DISCUSSION

The results indicate that organochlorines are present in quantifiable concentrations in all compartments of the arctic marine environment. Although concentrations of organochlorines found in this study are among the lowest reported anywhere in the world, the ubiquitous presence of these compounds in an oceanic region well removed from immediate sources and the obvious biomagnification in the food chain serves to emphasize the global nature of organochlorine pollution and the importance of atmospheric transport in the global distribution of these compounds.

The results for the different classes of organochlorine compounds foundin this study are discussed in the following sections in terms of their observed distribution and relationship to other published data. A discussion is also provided of the biomagnification of the most abundant organochlorines and the relative importance of various transport mechanisms and sources of organochlorines to the Arctic Basin.

5.1 Organochlorines in Air, Water, Snow Ice and Sediment

The distribution of organochlorines in different compartments of the physical environment will be related to their relative abundance, vapour pressure, solubility, affinity for particles, environmental stability and susceptibility to metabolic transformation by organisms. The vapour pressure and water solubility of the organochlorines monitored in this study are compared in Table 5.1. HCHs are used in large quantities throughout the world and this factor in combination with a relatively high vapour pressure and the highest water solubility of all the organochlorines is reflected in the relative abundance of these compounds in arctic air and water. DDT and its analogs containing 2 aromatic rings conversely have a low abundance in arctic air and sea water reflecting the more restricted use of

Table 5.1

Comparison of Physical Properties of the Major Organochlorine Pesticides and PCBs Monitored in this Study (from Callahan *et al*, 1979)

Compound	Vapour Pressure (torr @ 20-25°C)	Solubility, ppb (water, neutral pH, 20-25°C)
PCBs (Arochlor 1254)	77.7×10^{-5}	12 - 50
Cyclodienes:		
aldrin	2.3×10^{-5} (20°C)	17 - 100
dieldrin	$1.8 \times 10^{-7} - 2.8 \times 10^{-6}$	186 - 200
chlordane (cis & trans)	1×10^{-5}	56 - 1850
α endosulphan	1×10^{-5}	150 - 600
endrin	2×10^{-7}	260
heptachlor	3×10^{-4}	56 - 180
heptachlor epoxide	-	100 - 350
Hexachlorocyclohexane		
alpha	2.5×10^{-5}	1200 - 2000
gamma	$1 - 1.5 \times 10^{-5}$	2000 - 12000
Hexachlorobenzene	1.1×10^{-5}	< 20
p,p'-DDT	1.7×10^{-7}	< 1 - 25
p,p'-DDE	6.2×10^{-6}	1 - 140

these compounds (Table 1.1) and much lower water solubility. These compounds however have a high affinity for particles

5.1.1 Hexachlorocyclohexanes and Hexachlorobenzene

Hexachlorocyclohexanes quantified in samples collected from the Ice Island are commonly observed atmospheric pollutants in Arctic air masses (Oehme and Stray, 1982; Oehme and Ottar, 1984; Oehme and Mano, 1984), snow (Gregor, 1987) and tissues of Arctic marine mammals and fish (Norstrom et al., 1985; Wong, 1985). Concentrations of alpha and gamma-HCH measured seasonally in air vapour off the northern coast of Norway varied from 160 to 1300 and 10 to 50 pg m^{-3} respectively with highest levels during summer (Oehme and Mano, 1984). In contrast, Tanabe and Tatsukawa (1980) reported concentrations of total HCH to be approximately an order-of-magnitude greater in air samples from the Northwest Pacific and Bering Sea. Values over the Ice Island are comparable to the lowest of the Norwegian concentrations and similar to levels reported by Bidleman et al. (1987) over southern Sweden during winter.

Ratios of alpha:gamma-HCH measured in air off the coast of Norway (12 - 28) and in southern Sweden (2 - 6) in these earlier studies span the range of values measured from the Ice Island in May (6.3), August (15.7) and June (3.5) (Table 4.1). Lower values, due to enrichment of gamma-HCH, may indicate supply through long range atmospheric transport to high latitudes during winter when the cold high-pressure center is located over Asia (Oehme and Mano, 1984; Barrie, 1986). We observed lower ratios in snow (1.5 to 5.5) which are comparable to values measured by Gregor (1987) for sites throughout the Northwest Territories, including the Ice Island in May 1986.

Tanabe and Tatsukawa (1983) described latitudinal differences in proportions of HCH isomers due to an historic tendency for use of purified gamma HCH (lindane) in the southern hemisphere. However, there has also been an increasing use of purified lindane in the U.S. since 1978 (Bidleman et al., 1987).

Technical mixtures used previously in the northern hemisphere contained approximately 50 to 80% alpha-HCH (the inactive and stable isomer) with 8 to 15% lindane giving a ratio of alpha:gamma 5 to 6. Besides the source of HCH, ratios of alpha:gamma isomers may be altered by transformation of lindane to the more stable α isomer on exposure to UV radiation and in aerated water (Oehme and Mano, 1984). High ratios in air vapour in August/September and in August snow could reflect the loss of the gamma isomer by UV induced transformation. The ratios for the HCH isomers in seawater did not vary significantly between sampling trips, reflecting stability of the large reservoir of HCH's dissolved in surface seawater.

HCB concentrations in air vapour measured over the Ice Island (63 - 109 pg m^{-3}) (Table 4.1) are similar to the lowest values reported during summer off the Norwegian Arctic coast (Oehme and Stray, 1982; Oehme and Ottar, 1984), but they are an order-of-magnitude less than concentrations measured in air over the continental U.S. and North Atlantic (Bidleman et al., 1987). Simultaneous measurements on the Ice Island in August and June by staff from Bidleman's lab at USC were 3 times higher in August 1986 and about 50% higher in June 1987 (Table 3.8, Section 3.2.2). Levels measured in both air and seawater in our study were similar for the three sampling periods but values in snow were lower in August/September. Although HCB has a vapour pressure which is low compared to many other organochlorines (Table 5.1), it is a semi-volatile organic compound. Decreases in concentrations dissolved in snow could arise from volatilization after deposition in the early spring.

In general, our values for most organochlorine residues in snow in 1987 are in agreement with both USC and the National Water Quality Laboratory. Patton et al.'s (1988) collected freshly fallen snow on the Ice Island in June 1987 and showed that levels of total HCH were two to six times higher than concentrations present in "old" subsurface snow. Sublimation of previously deposited hexachlorocyclo-hexanes could have depleted concentrations in snow, especially during summer when air temperatures rose above 0°C. Our values of HCH in melted snow samples in June were similar to Patton et al.'s (1988) values for "old" snow. The ratio of alpha:gamma-HCH was 1.5 in June. Lindane (gamma-HCH) values in June were the same as in the previous August/September samples while alpha-HCH, concentrations were 3 times lower. Reported vapour pressures for the two isomers are similar and an increase in the alpha isomer relative to the gamma isomer would be expected on the basis of the UV induced transformation of lindane to alpha-HCH. The lower concentration of alpha-HCH therefore indicates a mechanism which produces a more rapid loss of alpha-HCH than transformation of lindane or is indicative of a difference in source material in 1987. Gregor (personal communication) indicated that values for organochlorines in snow samples throughout the Canadian Arctic were lower in 1987 compared to 1986.

HCH concentrations are lower in ice than in seawater probably as a result of loss through brine explusion during the winter.

Concentrations of HCH's measured in coastal and oceanic waters have been reviewed by Harding (1986). HCH isomers are the most water soluble of the organochlorines monitored (Table 5.1) and this property along with their abundance in air is reflected in high levels of these compounds in seawater. Levels of alpha and gamma-HCH > 10 ng L^{-1} occur in some coastal waters near urban areas but values for oceanic surface waters are up to an order-of-magnitude lower. Concentrations for Σ-HCH in the NW Pacific and Bering Sea (1.3 and 7.3 ng L^{-1}) span the range of values observed at the Ice Island (5.1 ± 0.5 ng L^{-1}) (Table 4.5). Concentrations of alpha-HCH and gamma-HCH of 7.1 and 0.8 ng L^{-1} reported from 10 m depth in samples collected from the Ice Island in June 1987 (Patton et al. 1988) are about 40% higher than average values for the mixed layer we measured in June 1986 (Table 4.5). Differences in extraction methods used in each study must account for this variance.

There is a large reservoir of HCH in Arctic surface water. Assuming a surface area of 1.3 x $10^{13}m^2$ and an average 5

$\mu g/m^3$ in the upper 50 m, the total HCH dissolved in surface seawater is approximately 3250 metric tonnes. This relatively large amount of HCH reflects its longer residence time due to relatively high solubility and serves to buffer any seasonal fluctuations in concentrations or in ratios of the two most abundant isomers.

HCH isomers have a much lower affinity for particles than PCBs, DDT or many cyclodienes. No detectable HCH was found in surface sediments or in particles from melted snow despite their abundance in seawater and air vapour. HCH isomers are not concentrated in plankton and benthos to the same degree as the more hydrophobic and lipophilic PCBs, DDT and cyclodiene compounds (Section 5.2).

HCB concentrations in surface seawater observed in this study are about 100 times less than α HCH. HCB has a water solubility at least two orders of magnitude less than HCH, which is about the magnitude of the relative decrease in HCB:αHCH ratios between air vapour and dissolved seawater. Despite the relative abundance in air vapour and low solubility, HCB was not present in surface sediments nor in measurable quantities in snow or ice particulates. HCB was quantifiable in plankton and amphipods. However, as noted for HCH, HCB does not accumulate in organisms to the same degree as other compounds such as PCBs, DDT and cyclodienes (Section 5.2).

5.1.2 Cyclodienes

The principal cyclodiene insecticides measured in air over the Ice Island were present at a few pg m^{-3} typical of atmospheric samples from oceanic areas (Tanabe and Tatsukawa, 1980; Kawano et al., 1985). Concentrations of trans and cis-chlordane in air vapour during summer at 76° N at a land-based sampling site (Mould Bay) on Melville Island (Hoff and Chan, 1986) were comparable to our values. Oehme and Mano (1984) measured similar amounts of cis-chlordane in air vapour during late summer off the Arctic coast of Norway, but concentrations at more southern latitudes in both hemispheres, summarized by Kawano _et al_. (1985), are an order-of-magnitude higher. Bidleman _et_ _al_. (1987) reported high chlordane concentrations (140 pg m^{-3}) over the North Atlantic at 32° N with lower values (31 pg m^{-3}) at 45° N and in Barbados (8 pg m^{-3}) implying that the U.S. is a major source for chlordane to the atmosphere over the North Atlantic. As noted for hexachlorocyclohexanes in air vapour, Patton _et_ _al_. (1988) measured average concentrations of _cis_ and _trans_ chlordane in August (1986) and June 1987 that were higher than levels we reported (Table 3.8, section 3.2.2). Mean concentrations in June, were higher in both studies.

Hoff and Chan (1986) reported that the ratio of _trans_:_cis_-chlordane for technical chlordane is 1.26. Ratios of 1.3 and 1.8 in air vapour and snow collected in our study in May 1986 and also observed in snow from the Ice Island (1.0 to 1.6) by Gregor (1987) are similar to technical chlordane and those in air samples over southern Sweden (Bidleman _et_ _al_.,1987). However lower ratios (0.2 - 0.7) were measured in both August 1988 and June 1987 air samples in agreement with ratios (0.3 - 0.7) measured by Hoff and Chan (1986) at Mould Bay and by Patton _et_ _al_. (1988) on the Ice Island in August 1986 and June 1987.

Different _trans_:_cis_ chlordane ratios may indicate different sources. Hoff and Chan (1986) suggested that a low trans:cis ratio could indicate the source to be volatilized chlordane from soils in areas of application since the trans isomer has been shown to be lost in soils in the production of oxychlordane. Low ratios were also present in the water column below 100 m depth (Figure 5.1). Chlordane isomers dissolved in seawater below 100 m could have a different origin from those in the air, snow and upper water column (Section 5.3) or the composition of isomers could reflect the loss of the trans isomer through metabolic transformation (Suprock _et_ _al_.,1980).

The group of cyclodienes, chlordane, heptachlor epoxide, α endosulfan and dieldrin were all relatively abundant in snow samples relative to the other organochlorines. Significant decreases in concentrations of all quantifiable cyclodienes

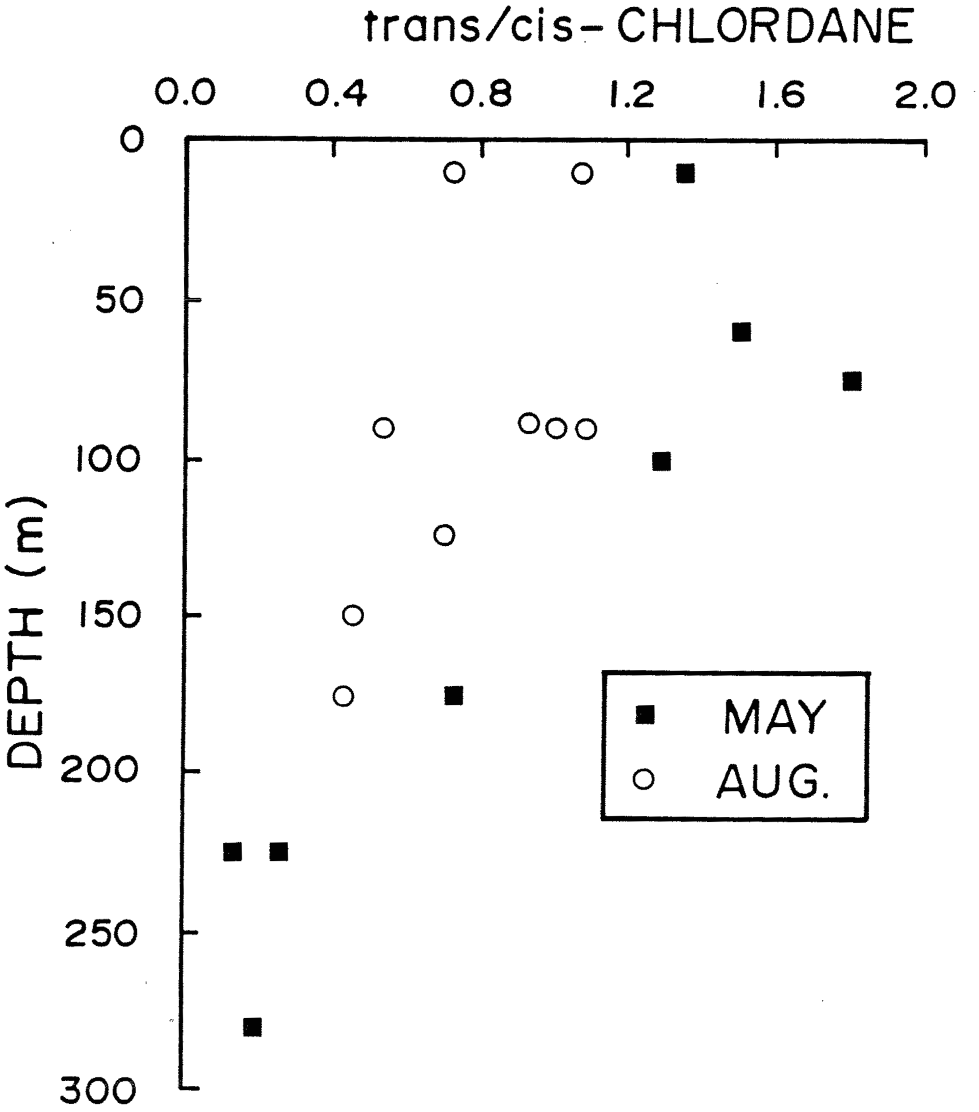

Figure 5.1 Depth profiles of the ratio of trans:cis chlordane, May and August, 1986.

occurred in snow collected from the Ice Island between May and August with the greatest difference observed for <u>cis</u> + <u>trans</u>-chlordane (88 ± 42pg/L to <10 pg/L) and α endosulfan. Vapour pressures of chlordane and α endosulfan are among the highest of the cyclodiene compounds and the decrease in August/September may partly be due to the warmer temperatures. Decreases also occurred in air vapour concentrations but these were much reduced in comparison.

Concentrations of some cyclodienes were higher in melted snow relative to HCH or HCB based on levels in air vapour. All cyclodienes concentrations were two orders of magnitude less than total HCH levels in air vapour and an order of magnitude less than HCB. In snow, however, cyclodienes such as chlordane, heptachlor epoxide and α endosulfan had concentrations that were more than an order of magnitude higher than HCB and only a factor of 5 - 10 less than total HCH. Evidently, these compounds are more efficiently scavenged by snow from air vapour or are not lost as rapidly through revolatilization. All have vapour pressures, however, which are similar to both HCH and HCB (Table 5.1) and solubilities less than HCH so that other factors or combination of factors, must be responsible for their concentration in snow.

The lower concentrations of cyclodienes relative to hexachlorcyclohexanes in the vapour phase and their lower water solubility is reflected in their reduced concentrations in seawater relative to HCH (three orders-of-magnitude less than those for Σ-HCH) (Table 4.5). Vertical profiles of dissolved cyclodienes in seawater also showed small vertical gradients. Dissolved concentrations of chlordane and dieldrin between 50 and 100 m were not significantly different despite sharp gradients in salinity, temperature and dissolved nutrients. On the other hand, despite variability in concentration profiles, the ratios of <u>trans</u>-chlordane relative to the <u>cis</u> isomer were increased at depths near 100 m (Figure 5.1). Recent studies have suggested that the widespread occurrence of the nutrient maximum near this depth in the Arctic Ocean is not due to intrusion of Bering Sea water, as previously thought, but due to brine formation and drainage from the large continental shelves into the central basin (Melling and Lewis, 1982; Jones and Anderson, 1986; Macdonald et al., 1987). Organochlorines in this water could also reflect input form coastal drainage and atmospheric exchange during the summer when coastal water are ice free. The change in relative proportion of isomers may therefore be an indication of a different source of organochlorines at this depth.

5.1.3 DDT, DDE and PCBs

PCBs and DDE were present in air vapour at low concentrations. DDT was below detection (<0.5 pg/m^3) on all trips. DDE concentrations showed a seasonal trend with lowest levels in August/September. PCB concentrations were higher (10 pg/m^3 vs 1 pg/m^3 DDE). May 1986 results were highly variable so that no seasonal trend was evident. Unlike other organochlorines, PCB concentrations were higher by a factor of 2 compared to samples taken simultaneously by Bidleman's lab at USC (Table 3.8, section 3.2.2). DDE concentrations were however one third of USC concentrations in June 1987 (1 vs 2.9 pg/m^3).

Organochlorines such as isomers of DDT and DDE and congeners of PCB's have volatilzation transfer coefficients from water to air that are two to three times greater than HCH (Table 5.1) (Oehme and Mano, 1984). These organochlorines may therefore be more readily released back into the atmosphere following precipitation in snow as described for HCB. This could explain the lower concentrations of PCBs and ΣDDT found in snow on the Ice Island compared to cyclodienes and also be responsible for the lower levels during August compared to values in May and June.

Much higher concentrations (1.7 ng/L) of total PCB were reported for snow collected from the Ice Island in May 1986 by Gregor (1987). Although differences in extraction techniques preclude direct comparison, the discrepancy could arise from contamination. Gregor collected snow three weeks earlier at a site on the Ice Island close to the base camp and landing strip. Teflon bags were used to contain water form melted snow prior to solvent extraction without separation of particulate and dissolved phases as in our study. This extraction method may be more efficient than we achieved using XAD-2 resin columns. However, blanks from the teflon bags showed that PCBs were present (Gregor, 1987) and sample values were not blank corrected. Other studies of organochlorine distribution in oceanic environments have commented on problems of contamination. McNeeley and Gummer (1984) concluded that PCBs measured in snow from sites on Ellesmere Island were unreliable due to contamination. Harding (1986) pointed out that reported values for PCBs and isomers of DDT dissolved in seawater may be vastly overestimated due to their hydrophobic nature.

The presence of detectable concentrations of organochlorines such as DDT, DDE and PCBs in seawater is greatly affected by the availability and concentration of suspended particles. All isomers and congeners of these compounds have estimated water solubilities of 10^{-8} to 10^{-10} g/L, two to three orders-of-magnitude lower than values for HCH isomers of 10^{-5} to 10^{-7} (Tanabe and Tatsukawa, 1983). These authors observed that a high percentage of DDT and PCBs in seawater was adsorbed to suspended particles at high latitudes. Concentrations in vertical profiles were highest where concentrations of suspended particles were also greatest. A higher percentage of PCB, DDT,and DDE concentrations in snow samples were in the particulate phase than any other organochlorines in agreement with these observations.

Concentrations of suspended particulate matter under the Ice Island are as low as those observed in the deep sea. An average (upper 100 m) value for suspended particulate organic carbon (9 μg C 1^{-1}) measured by Gordon and Cranford (1985) in samples collected by 12 L Niskin bottles at a station over the Alpha Ridge (85° N) was higher than concentrations in our study (average values of 2.7 and 5.7 μg C L^{-1} in the upper 60 m layer in May and August) (Table 4.4). The very low levels of dissolved and particulate PCBs and DDT in the water column reflects their low abundance in air, their low water solubility and concentrations of suspended particulate matter under the Ice

Island that are equivalent to those observed in the deep sea (Table 4.4). Low concentrations of suspended particulate matter at all depths, but especially below the upper mixed layer in the Arctic ocean should lead to low rates of sedimentation and increased residence time of particle-reactive organochlorines in the water column. Tanabe and Tatsukama (1983), estimated a much shorter residence time for DDT and PCBs (0.2 - 0.4 yr) in the mixed layer than for the more soluble HCHs (5 - 10 yr). Organochlorines adsorbed to suspended particles are available for consumption by grazing zooplankton, and rapid removal from the water column can occur as aggregated particles sediment (Osterroht and Smetacek 1980, Iseki et al., 1981). The impact of these biological processes for transfer of organochlorines through the water column may be enhanced by the low concentration of suspended particles and low sedimentation rates in the Arctic ocean.

The association of these compounds with particulates and their accumulation in biota (Section 5.2) is reflected in the presence of PCBs and DDT (one sample) in surface sediments despite their low abundance in seawater.

5.2 Biomagnification of Organochlorines

Concentrations of organochlorines in plankton from the Ice Island are compared with recent published plankton data for other oceanic regimes in Table 5.2. Concentrations in plankton in the Arctic Ocean are among the lower range of values reported for oceanic plankton. Plankton data were also compared with under ice and benthic amphipods from the Ice Island and with fish, seal and Polar Bear tissue from the eastern Canadian Archipelago in Table 5.3. There were higher concentrations of all compounds in tissues of amphipods relative to zooplankton with benthic amphipods, in particular, T. cicada, having higher concentrations than P. litoralis captured under ice. Not all compounds are concentrated to the same extent however. PCB and DDT concentrations were almost two orders of magnitude higher in benthic amphipods than in zooplankton while the concentration in under-ice animals was only

Table 5.2.

Comparision of Organochlorine Levels in Marine Plankton
(wet weight ng·g^{-1})

Compound	This Study (bulk plankton)	Compiled Data (from Harding, 1986)	Sample	Area
PCBs	0.5 - 7	0.1 - 21	bulk plankton >250 µm	Gulf of St. Lawrence Nova Scotia Coastal
		100 - 190	copepods	N. Pacific
		20	bulk plankton >300 µm	North Sea off Holland
		1.8	bulk plankton >300 µm	N.W. Pacific
		<3	bulk plankton >300 µm	Antarctic, Ross Sea
DDT	0.5 - 2.3	2.7 - 20.4	copepods	Mediterranean Sea
		<0.8	plankton >300 µm	Antarctic, Ross Sea
		1.7	plankton >300 µm	N.W. Pacific
		1.3	bulk plankton >300 µm	North Sea off Holland
Dieldrin	0.2 - 0.7	<76	bulk plankton >300 µm	Antarctic, Ross Sea
		1.5	bulk plankton >300 µm	North Sea off Holland

Table 5.3.

Concentrations of Abundant Organochlorines in Ice Island Biota
Compared with Data for Fish and Marine Mammals from the Central and Eastern Canadian Arctic

	Zooplankton	**Peragic[4] Amphipods**	**Benthic[5] Amphipods**	**Arctic Cod[6] (muscle) Resolute**	**Lycodes[7] Liver**	**Ringed Seal[8] (blubber) Male-Pond Inlet**	**Polar Bear[9] Liver Resolute**
DDT[1]	0.7 - 2.8	3.3	60 - 150	2.4	423	870	201 ± 198
Chlordane[2]	0.5 - 3.0	5	10 - 30	3.1	49.8	300	1658 ± 866
α HCH	0.4 - 2.2	6.5	5.8	1.8	1.6	62	31 ± 25
Dieldrin	0.2 - 0.7	3	2.2 - 6	0.8	3.1	54	214 ± 91
PCB[3]	1 - 7	3	166 - 608	3.7	608	627	649 - 439
HCB	0.1 - 0.9	2.6	4 - 8	2.5	5	27	8 ± 4

1. Sum of DDT, DDE and DDD.
2. Sum of cis and trans chlordane for Ice Island; for other samples includes cis and trans nonachlor, oxychlordane and heptachlor epoxide as well.
3. Ice Island and lycodes data in arochlor 1254 equivalents; other data in 1260 or sums of different congeners.
4. Pseudalibrotus litoralis.
5. Primarily Tmetonyx cicada, Andaniexis spp. and Anonyx nugax.
6. From Muir et al., 1985.
7. Analyzed with this data. Lycodes frigidus caught April 6, 1983, 85°48'N; 110°43'W at a depth of 2075 m on a soft mud bottom. (Prouse and McAllister, 1986).
8. From Thomas and Hamilton, 1988. PCBs on a congener basis: DDT includes DDT and pp'DDE only.
9. From Norstrom et al. 1985: PCBS in 1260 equivalents.

slightly higher. Hexachlorocyclohexanes HCB and dieldrin concentrations, in benthic and under ice amphipod however, were not significantly different between amphipod species and only slightly higher than in zooplankton (an order of magnitude or less). Concentration increases for chlordane isomers were intermediate, with higher levels in benthic animals and concentrations between 10 and 30 times concentrations in zooplankton.

Published fish muscle tissue data (Norstrom et al., 1985) indicates that concentrations are very similar to levels in amphipods captured under the ice. The results for a sample of liver from the Arctic eel pout Lycodes frigicus caught in the Arctic Ocean (85°N) in 1983 from the CESAR camp at a depth of 2075 m and analyzed with our data indicate that DDT, chlordane and PCBs may be concentrated in fish liver by factors of 10 - 100 over levels in muscle tissue (Table 5.3). The DDT and PCB levels in this liver sample are very similar to the levels reported for seal blubber and polar bear liver. These latter samples however, have higher concentrations of chlordane, HCH, dieldrin, and to a lesser extent, HCB. Overall concentration factors for the major organaochlorines are summarized in Table 5.4 for air, seawater, zooplankton, pelagic and benthic amphipods, seal and polar bear tissues. Concentrations have been normalized to HCB which has arbitrarily been set to 1. The most abundant compounds in marine mammalian tissues are present in very small amounts in air and seawater, the source of these materials to the Arctic Basin. PCBs, DDTs and chlordanes are thus magnified through the food chain to a far greater degree than more abundant compounds such as HCH and HCB.

TABLE 5.4.

Relative Concentration Factors for Organochlorines Through Various Compartments of the Arctic Environment
(normalized to HCB = 1)

Compound	Air (vapour)	Seawater (0-50 m)	Zooplankton (>250 µm)	Pelagic Amphipods *P. litroralis*	Benthic Amphipods *A. nugax*	Seal Blubber	Polar Bear Liver
HCB	1	1	1	1	1	1	1
αHCH	3	160	2.3	2.5	1	2.4	4
Σchlordane	0.05	1	1.5	1.9	5	12	175
dieldrin	0.01	1.3	0.8	1.2	0.4	2	2.5
ΣDDT	0.01	0.01	3	1.3	10	32	25
PCB	0.12	0.04	1.5	1.2	36	24	75

The particulate data for bottom ice cores in June 1987 gives evidence that concentration of PCBs and DDT in the food chain starts with ice algae. Concentration of PCBs, DDE and DDT in particulates from two samples of bottom ice in June 1987 containing abundant ice algae were much higher than any other organochlorines. These samples can be contrasted with ice samples taken the previous May when concentrations of epontic algae, inferred from discoloration of bottom ice, were lower. DDT concentrations were 2 orders of magnitude greater while PCBs about an order of magnitude greater in the June 1987 sample. In contrast, αHCH the most abundant dissolved compound in melted ice, is present at approximately the same levels in both May and June ice particulates and is present at 1 - 50 times lower concentrations than DDT or PCBs. (Table 4.3). The strong affinity of PCBs and DDT for particles has been noted by Tanabe and Tatsukawa (1983). These authors estimated an extremely short residence time of less than 20 days for productive surface waters.

The biota data clearly show a preferential enrichment of the cis isomer of chlordane. Trans/cis ratios in air and surface seawater are generally >1; ratios in plankton were generally 0.4

- 0.5; in benthic amphipods <0.3. Zitko (1978) and Kawano et al. (1985) found that fish and seal tissues were also depleted of trans relative to the cis isomer.

5.3 Sources of Organochlorines in Surface Seawater

The origins of organochlorines in the Arctic basin are outside the region. Introduction of these compounds into the Arctic marine environment may be by atmospheric, riverine as well as oceanic transport. It is has been well documented (Barrie, 1986) and is evident from the vapour and particulate phase air data from the ice island, that long range atmospheric transport does bring organochlorine compounds into the Arctic. The few measurements made in the Bering Sea indicate that inflowing Pacific water is also a source. Finally, the numerous large rivers draining into the Arctic, particularly on the Asian side, drain areas that receive inputs of these compounds by direct run-off and indirectly through atmospheric deposition.

The relative importance of each of these sources is difficult to assess. The observed vertical distribution of organochlorines indicates a source in the upper low-salinity surface layer. On the basis of the observed atmospheric levels, direct exchange between the ocean (and sea ice) and atmosphere will be important. Estimates by Patton et al. (1988) based on alpha HCH measurements on the Ice Island indicated that vapour phase and seawater concentrations were in approximate equilibrium. The concentrations of detectable compounds in seawater are related directly to their relative abundances in air and relative water solubility. HCH (both alpha and gamma isomers) have a water solubility at least 100 times that of HCB which is approximately the difference between the concentrations of these compounds in air (vapour phase) compared to seawater (Table 5.1). Similarly, higher concentrations of chlordane in seawater than air relative to HCB can be related to chlordane's higher solubility. Direct atmospheric input however, is restricted for most of the year over large areas because of ice cover. Maximum atmospheric concentrations occur in the April to May period (Barrie, 1986) when ice cover is at its maximum. Open water is greatest in the shallow shelf areas which are ice free for up to 3 -4 months of the year from July through October. Over most of the Arctic Basin direct atmospheric input will therefore be to the snow and ice.

Concentrations of HCH and the other most abundant organochlorines in the upper low-salinity surface layer are compared with concentrations in snow and ice in Table 5.5. Melted snow is obviously a source of most organochlorines. The exceptions are the isomers of HCH. The lower concentrations of HCH in melted ice and snow show that melt water from these sources will dilute the observed surface seawater organochlorine concentrations. Tanabe _et_ _al_. (1983) reported the opposite trend for HCH in the Antarctic. Concentrations were higher in snow than in the underlying surface seawater.

The accumulation of HCH in arctic surface seawater relative to concentrations in snow probably reflects its greater water solubility and residence time. Tanabe and Tatsukawa (1983), on the basis of open ocean dissolved and particulate HCH, PCBs and DDT derived approximate residence times for these compounds in the euphotic zone. Their estimates for HCH were 2 - 10 years, while residence times for PCBs and DDT were less than a year and in highly productive regions such as the Antarctic, 11 to 19 days. It is likely that the residence time of organochlorines in the Arctic upper low-salinity layer is longer than in other oceans because of the much lower particulate concentrations and slower rate of removal. Also, vertical transfer of dissolved material in the water column is restricted by the strong halocline. Organochlorines added to the surface layer through successive freeze-thaw cycles in the Arctic Ocean may therefore accumulate. This will be especially important for the more water soluble components such as HCH.

The limited river data (2 samples from the Mackenzie River in winter) and data for the Bering Sea (Table 5.6) indicate that these sources have concentrations very similar to those

Table 5.5.

Comparison of Concentrations
of the Most Abundant Organochlorines
in Surface Seawater, Snow and Ice
(concentrations in pg/L)

Compound	**Seawater**[a] **(0 - 60 m)**	**Snow**[b]	**Ice**[c]
α HCH	4230	294 - 1490	580 - 1300
HCH	620	190 - 642	84 - 183
Σ chlordane (trans + cis)	4	7 - 88	3 - 9
dieldrin	18	100 - 290	6
α endosulphan:	<0.1	93 - 154	6 - 21
HCB	20	<1 - 15	<2 - 14
heptachlor epoxide	11	40 - 109	<5 - 13
PCBs (Archlor 1254)	0.7 - 10	8 - 125 + up to 50 particlate)	23 - 28
DDT	<3	<4 - 24	<4 - 12
DDE	<0.2	<4 - 17	<3 - 10

a) mean of all data
b) range
c) ice is dissolved fraction only:

concentrations in pg/L

Table 5.6.

Published Data for Organochlorine Concentrations (pg/L) in the Antarctic and Surface Waters Bordering the Arctic Basin

Location	ΣHCH	PCBs	Σ DDT	Heptachlor Epoxide	Reference
This Study	3300 - 5200	10	<4	11	This study.
Mackenzie River (East Channel)	3700 - 5400	-	-	50	Erickson and Fowler 1987
Antarctic Ocean below Australia	210 - 930	35 - 72	1.3 - 21		Tanabe _et_ _al_. 1983
N.W. Pacific	3100 -14200	220 -380	20 - 1170		Tanabe & Tatsukawa 1980
Bering Sea	3200 - 4400	-	10 - 40		Tanabe & Tatsukawa 1980
Subarctic North Atlantic	300 - 800[a]	-	200 - 400		Orlova, 1983

a) α HCH

observed from the Ice Island in the upper well mixed surface layer. Aagaard and Coachman (1975) estimated that the total annual inflow to the Arctic basin from runoff and the Bering Sea was 5 x 10^{12} m^3 while the total volume of the upper 50 m of the Arctic Basin is about 4 x 10^{14} m^3. It is evident that these inflowing sources of water cannot account for the observed concentrations.

Extrapolation of organochlorine concentrations vs salinity through the halocline suggests that Atlantic core water has very low concentrations of all compounds monitored. Total HCH concentrations at the maximum depth sampled (280 m), for example, were less than 200 pg/L or about 50 times lower than concentrations in the surface layer.

The hypothesis that dense cold water formed on the shelves in winter, as a result of brine drainage, maintains the cold halocline separating the surface layer from Atlantic water (see for example Aagaard et al, 1981) suggests that there might be an organochlorine signature in this water assuming that water generated on the shelf has higher organochlorine levels. There was no corresponding concentration maximum detectable in any of the organochlorines monitored. Concentrations of HCH for instance, at the depth of the nutrient maximum, were in the range of values calculated on the basis of salinity assuming a conservative mixing of surface water and Atlantic core water. There was a change in the ratio of <u>cis</u>:<u>trans</u> chlordane (Section 5.1.2) however at a depth of 100 m which may be indicative of a continental shelf source of chlordane at that depth.

Although no single source or transport mechanism is responsible for the observed distribution and concentrations of all organochlorines in the surface waters of the Arctic Ocean, atmospheric input is clearly an important factor. Regional influences in the shelf areas as a result of the input of river water may result in local anomalies. However, the Ice Island was well removed from any direct influence of river drainage and concentrations probably reflect those over much of the Arctic Ocean. Direct and indirect atmospheric input with contributions from inflowing Bering Sea and river water, the isolation of the surface water from deeper water by the strong halocline and the extremely low levels of productivity and paucity of sinking particles are the principal contributing factors to the observed oceanic distribution of organochlorines in the Arctic Ocean.

6. RECOMMENDATIONS FOR FUTURE WORK

The results of this study have shown that organochlorine pesticides and PCB's are present in all compartments of the Arctic marine environment. The importance of atmospheric input as a source of organochlorines has been confirmed and concentrations of these compounds in marine biota were quantified. These results clearly point to the importance of continued monitoring of organochlorine concentrations in arctic air and biota to assess temporal trends. The ability of arctic biota to concentrate these compounds suggests that small changes in the annual input may be magnified to create much larger changes in tissues, particularly in lipid rich benthic amphipods, fish and mammals.

The Ice Island can be used as a base for future studies of organochlorine distribution in the Arctic Ocean if the Island enters the Beaufort Gyre and travels south-west into the Beaufort Sea. The Island base would then allow measurements to be made of seawater and biota over a greater water depth and distance from basin margins. Our observations show that soluble organochlorines such as HCH are accumulated in the surface mixed layer of the Arctic Ocean while more particle-reactive compounds (DDT and PCB's) are removed by sedimentation. If the origin of all of these compounds is atmospheric, with entry into the ocean through melting snow as our study implies, then the large reservoir of soluble organochlorines in the surface layer will integrate variable rates of supply over long periods of time. On the other hand, particle-reactive organochlorines will be removed from the surface layer by sedimentation and concentrated by lipid-rich benthic species. Observations of organochlorine concentrations in this fauna on an annual basis may detect long-term changes in rates of atmospheric supply.

Measurements could be made by sampling once a year over successive years as the Ice Island drifts clockwise around the Canada Basin. This would indicate the importance of regional differences in concentrations, indicate possible trajectories of supply and improve our understanding of how these compounds cycle and are stored within the marine environment of the Arctic Ocean. The Ice Island is the only practical means of obtaining this information off Canada's northernmost coastline and in the central and northern Beaufort Sea. Future studies of organochlorines in environmental samples taken using the Ice Island should be carried out by, or include intercalibrations with, laboratories that are involved with on-going organochlorine measurements in air and marine biota. This will be essential for meaningful comparisons of existing and future data sets.

Toxaphenes were not measured as part of this study. Several samples from the Ice Island were analyzed for toxaphenes, however, by T. Bidleman's laboratory at the University of South Carolina. Their results indicate that toxaphenes were present in air, snow and seawater and at concentrations that were comparable to hexachlorocyclohexanes in seawater. It is recommended therefore, that toxaphene concentrations be measured in any future studies and these compounds be included in any future analyses of arctic marine mammal, birds and fish tissues.

ACKNOWLEDGEMENTS

This study was carried out as a result of an Unsolicited Proposal to the Department of Supply and Services, Ottawa, Ontario. Funding was supplied by the Department of Supply and Services, the Department of Indian and Northern Affairs (DIAND), and the Department of Fisheries and Oceans. The Project Manager for the study was Dr. David Stone (DIAND, Northern Affairs Program, Ottawa). Mr. George Hobson and the Polar Continental Shelf Project staff in Resolute and on the Ice Island were extremely helpful in providing logistic support and assistance in the field. Organochlorine analyses were carried out by Ms. Val Scott. Ms. Georgina Phillips measured organic carbon and nitrogen in suspended particulate matter. Dr. Bernard Sainte-Marie identified amphipods collected with baited traps.

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Appendix A

Organochlorines in Air

MAY 1986
ARCTIC LABS HIGH VOLUME AIR SAMPLE (pg/cu m)
PLUGS

Sample I.D.	1-AHVS-1Pa+1Pb	1-AHVS-2Pa+2Pb	1-AHVS-3Pa+3Pb	1-AHVS-4Pa+4Pb	1-AHVS-5Pa+5Pb	1-AHVS-6Pa+6Pb
Volume (cu m)	203.800	363.500	412.300	585.600	459.400	446.500
Arochlor 1254	<2.80	<1.60	<1.40	<0.97	<1.20	<1.30
HCB	70.00	71.00	110.00	69.00	69.00	58.00
Heptachlor	<0.39	<0.22	<0.19	<0.14	<0.17	<0.18
Aldrin	<0.29	<0.17	<0.15	<0.10	<0.13	<0.13
o,p'-DDE	<0.88	<0.50	<0.44	<0.31	<0.39	<0.40
p,p'-DDE	<0.59	<0.33	Q 0.95	<0.20	<0.26	<0.27
Mirex	<0.54	<0.30	<0.27	<0.19	<0.24	<0.25
alpha-BHC	360.00	480.00	610.00	530.00	430.00	290.00
beta-BHC	<0.83	<0.47	<0.40	<0.29	<0.37	<0.38
gamma-BHC	51.00	79.00	120.00	79.00	49.00	46.00
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	<3.30	<1.90	Q 5.60	Q 3.90	<1.50	<1.50
cis-Chlordane	<0.83	Q 1.60	2.30	1.60	Q 1.30	Q 1.30
p,p'-DDT	<0.98	<0.52	<0.49	<0.34	Q 1.40	<0.45
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	2.70	4.20	5.70	4.50	2.30	2.70
alpha-Endosulfan	Q 2.70	3.60	6.20	4.30	2.00	2.40
Dieldrin	<22.00	<12.00	<11.00	<7.50	<9.60	<9.90
Endrin	<0.29	<0.17	<0.15	<0.10	<1.30	<0.13
Methoxychlor	<0.79	<0.44	<0.39	<0.27	<0.35	<0.36

NM = Not Monitored

MAY 1986
ARCTIC LABS HIGH VOLUME AIR SAMPLE (pg/cu m)
FILTERS

Sample I.D.	1-AHVS-1F	1-AHVS-2F	1-AHVS-4F	1-AHVS-5F	1-AHVS-6F
Volume (cu m)	203.800	363.500	585.600	459.400	446.500
Arochlor 1254	<10.00	<5.80	<3.60	<4.60	<4.70
HCB	<0.29	<0.17	<0.10	<0.13	<0.13
Heptachlor	<0.44	<0.25	<0.15	<0.20	<0.20
Aldrin	<0.02	<0.01	<0.01	<0.01	<0.01
o,p'-DDE	<0.04	<0.02	<0.02	<0.02	<0.02
p,p'-DDE	<0.15	<0.08	<0.05	<0.07	Q 0.18
Mirex	<0.06	<0.04	<0.02	<0.03	<0.03
alpha-BHC	<0.15	<0.08	<0.05	<0.07	<0.07
beta-BHC	<0.05	<0.03	<0.02	<0.02	<0.02
gamma-BHC	<0.10	<0.06	<0.03	<0.04	<0.04
Oxychlordane	NM	NM	NM	NM	NM
trans-Chlordane	<0.10	<0.06	<0.03	<0.04	<0.04
cis-Chlordane	<0.10	<0.06	<0.03	<0.04	<0.04
p,p'-DDT	<0.42	<0.23	<0.15	<0.19	<0.19
cis-Nonachlor	NM	NM	NM	NM	NM
Heptachlor Epoxide	<0.02	<0.01	<0.01	<0.01	<0.01
alpha-Endosulfan	<0.05	<0.03	<0.02	<0.02	<0.02
Dieldrin	<0.49	<0.28	<0.17	<0.22	<0.22
Endrin	<0.02	<0.01	<0.01	<0.01	<0.01
Methoxychlor	<0.16	<0.09	<0.06	<0.07	<0.07

NM =Not Monitored

MAY 1986
PARTICULATE HIGH VOLUME AIR SAMPLE (pg/cu m)

Sample I.D.	1-PHVS-1	1-PHVS-2	1-PHVS-3	1-PHVS-4	1-PHVS-5	1-PHVS-6
Volume (cu m)	3208.000	3014.000	3476.940	4921.820	5230.440	4901.780
Arochlor 1254	8.80	9.00	Q 7.50	Q 5.30	Q 5.00	Q 5.30
HCB	0.04	1.13	0.58	0.38	0.87	0.35
Heptachlor	<0.22	Q 0.76	<0.20	<0.14	Q 0.44	<0.14
Aldrin	<0.09	<0.09	<0.08	<0.06	<0.05	<0.06
o,p'-DDE	Q 1.10	<0.33	<0.29	<0.20	<0.19	<0.20
p,p'-DDE	<2.20	<2.30	<2.00	<1.40	<1.30	<1.40
Mirex	<0.04	<0.05	<0.04	<0.03	<0.03	<0.03
alpha-BHC	3.90	3.00	2.00	1.20	2.10	<1.10
beta-BHC	<0.10	<0.10	<0.09	<0.06	<0.06	<0.06
gamma-BHC	1.10	1.20	0.62	0.31	0.32	0.32
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	<0.24	0.87	Q 0.72	Q 0.51	<0.15	<0.16
cis-Chlordane	Q 0.87	Q 0.76	Q 0.66	Q 0.47	<0.13	<0.14
p,p'-DDT	<0.44	<0.46	<0.40	<0.29	<0.27	<0.29
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	7.90	2.90	0.54	0.29	0.18	Q 0.23
alpha-Endosulfan	Q 1.40	Q 1.50	Q 1.30	Q 0.94	<0.84	Q 0.94
Dieldrin	1.5	2.10	1.90	1.20	0.62	0.95
Endrin	<0.05	<0.05	<0.04	<0.31	<0.03	<0.03
Methoxychlor	<0.24	<0.26	<0.22	<0.16	<0.15	<0.16

NM = Not Monitored

	APRIL 1987 MOULD BAY AIR SAMPLE PLUGS (pg/cu m)		JUNE 1987 ARCTIC LABS HIGH VOLUME AIR SAMPLE (pg/cu m) PLUGS		
Sample I.D.	3-MBAS-1Pa+1Pb	3-MBAS-2Pa+2Pb	3-AHVS-1Pa+1Pb	3-AHVS-2Pa+2Pb	3-AHVS-5Pa+5Pb
Volume (cu m)	290.000	299.000	491.000	522.000	358.000
Arochlor 1254	<2.00	32.00	13.00	19.00	11.00
HCB	88.00	72.00	150.00	110.00	71.00
Heptachlor	5.80	2.40	<0.16	1.10	0.91
Aldrin	<0.21	<0.20	<0.12	<0.12	<0.17
o,p'-DDE	3.60	<0.60	<0.37	1.30	<0.50
p,p'-DDE	Q 1.30	3.30	0.81	1.10	Q 1.10
Mirex	<0.38	<0.39	<0.23	<0.20	<1.00
alpha-BHC	68.00	85.00	220.00	230.00	110.00
beta-BHC	<0.59	<0.57	Q 1.20	<0.33	<0.48
gamma-BHC	7.80	15.00	69.00	67.00	23.00
Oxychlordane	3.20	1.80	2.70	2.70	2.20
trans-Chlordane	<2.35	<2.30	Q 4.70	Q 4.41	<1.90
cis-Chlordane	<0.59	<0.57	3.90	4.20	1.90
p,p'-DDT	<0.69	<0.67	Q 1.30	Q 1.30	<0.56
cis-Nonachlor	<0.24	<0.23	0.67	1.20	Q 0.64
Heptachlor Epoxide	<0.24	<0.23	4.00	3.30	1.90
alpha-Endosulfan	<0.55	3.00	9.20	8.70	5.70
Dieldrin	<15.00	<15.00	<9.00	<8.40	<12.00
Endrin	<2.10	<0.20	1.20	1.10	4.80
Methoxychlor	<0.52	<0.54	<0.33	<0.31	<0.45

JUNE 1987
PARTICULATE HIGH VOLUME
AIR SAMPLE
(pg/cu m)

Sample I.D.	3-PHVS-1	3-PHVS-2
Volume (cu m)	4240.000	4951.000
Arochlor 1254	<1.90	<1.60
HCB	0.16	0.13
Heptachlor	<0.17	<0.14
Aldrin	<0.07	<0.06
o,p'-DDE	<0.24	<0.20
p,p'-DDE	<1.70	<1.40
Mirex	<0.03	<0.03
alpha-BHC	<0.38	<0.32
beta-BHC	<0.07	<0.06
gamma-BHC	<0.07	<0.06
Oxychlordane	<0.02	Q 0.05
trans-Chlordane	<0.18	<0.15
cis-Chlordane	Q 0.54	<0.14
p,p'-DDT	<0.33	<0.28
cis-Nonachlor	Q 0.07	Q 0.06
Heptachlor Epoxide	0.16	0.11
alpha-Endosulfan	Q 1.10	Q 0.93
Dieldrin	Q 0.66	<0.17
Endrin	<0.04	<0.03
Methoxychlor	<0.18	<0.16

AUGUST 1986
ARCTIC LABS HIGH VOLUME AIR SAMPLE (pg/cu m)
PLUGS

Sample I.D.	2-AHVS-1Pa+1Pb	2-AHVS-2Pa+2Pb	2-AHVS-3Pa+3Pb	2-AHVS-4Pa+4Pb
Volume (cu m)	384.100	500.400	471.800	800.800
Arochlor 1254	11.00	Q 3.80	16.00	5.50
HCB	62.00	72.00	40.00	77.00
Heptachlor	Q 0.73	<0.16	Q 0.59	Q 0.35
Aldrin	<0.16	<0.12	<0.13	<0.07
o,p'-DDE	<0.47	<0.36	<0.38	<0.22
p,p'-DDE	<0.31	<0.24	<0.25	<0.15
Mirex	<0.29	<0.22	<0.23	<0.14
alpha-BHC	240.00	230.00	210.00	320.00
beta-BHC	<0.44	<0.34	<0.36	<0.21
gamma-BHC	14.00	16.00	13.00	21.00
Oxychlordane	NM	NM	NM	NM
trans-Chlordane	<1.80	<1.40	<1.40	<0.85
cis-Chlordane	Q 1.50	Q 1.20	Q 1.20	0.99
p,p'-DDT	<0.52	<0.40	<0.42	<0.25
cis-Nonachlor	NM	NM	NM	NM
Heptachlor Epoxide	2.00	2.30	1.40	2.80
alpha-Endosulfan	3.20	3.80	3.00	5.20
Dieldrin	<11.00	<8.80	<9.30	<5.50
Endrin	<0.16	<0.12	<0.13	<0.08
Methoxychlor	<0.42	<0.32	<0.34	<0.20

NM = Not Monitored

AUGUST 1986
ARCTIC LABS HIGH VOLUME AIR SAMPLE (pg/cu m)
FILTERS

Sample I.D.	2-AHVS-1F	2-AHVS-2F	2-AHVS-3F	2-AHVS-4F
Volume (cu m)	384.100	500.400	471.800	800.800
Arochlor 1254	<5.50	<4.20	<4.50	<2.60
HCB	Q 0.55	<0.12	Q 0.45	Q 0.26
Heptachlor	0.49	<0.06	Q 0.21	Q 0.13
Aldrin	<0.06	<0.01	<0.01	<0.01
o,p'-DDE	<0.21	<0.16	1.90	<0.10
p,p'-DDE	<0.05	Q 0.16	Q 0.17	<0.02
Mirex	<0.02	<0.01	<0.01	<0.01
alpha-BHC	<0.83	<0.64	Q 2.30	<0.40
beta-BHC	<0.08	<0.06	<0.06	<0.04
gamma-BHC	Q 1.10	<0.26	Q 0.91	Q 0.54
Oxychlordane	NM	NM	NM	NM
trans-Chlordane	<0.31	<0.24	<0.25	Q 0.48
cis-Chlordane	<0.23	<0.18	<0.19	<0.11
p,p'-DDT	<0.08	<0.06	<0.06	<0.04
cis-Nonachlor	NM	NM	NM	NM
Heptachlor Epoxide	<0.08	<0.06	<0.06	<0.04
alpha-Endosulfan	<0.21	<0.16	<0.17	<0.10
Dieldrin	<0.86	<0.66	<0.70	Q 1.40
Endrin	<0.05	<0.04	<0.04	<0.02
Methoxychlor	<0.23	<0.18	<0.19	<0.11

NM = Not Monitored

AUGUST 1986
PARTICULATE HIGH VOLUME AIR SAMPLE (pg/cu m)

Sample I.D.	2-PHVS-1	2-PHVS-2	2-PHVS-3	2-PHVS-4
Volume (cu m)	3771.000	5047.000	4771.000	8292.000
Arochlor 1254	<2.10	<1.60	<1.70	<0.95
HCB	<0.03	<0.02	<0.03	0.06
Heptachlor	<0.19	<0.14	<0.15	<0.08
Aldrin	<0.07	<0.06	<0.06	<0.03
o,p'-DDE	<0.27	<0.20	<0.21	<0.12
p,p'-DDE	<1.90	<1.40	<1.50	<0.84
Mirex	<0.04	<0.03	<0.03	<0.02
alpha-BHC	<0.42	<0.32	<0.34	<0.19
beta-BHC	<0.08	<0.06	<0.06	<0.04
gamma-BHC	<0.08	Q 0.19	<0.06	<0.03
Oxychlordane	NM	NM	NM	NM
trans-Chlordane	<0.20	<0.15	<0.16	<0.09
cis-Chlordane	<0.19	Q 0.46	<0.15	<0.08
p,p'-DDT	0.14	<0.28	<0.29	<0.17
cis-Nonachlor	NM	NM	NM	NM
Heptachlor Epoxide	Q 0.12	0.19	Q 0.09	<0.06
alpha-Endosulfan	<0.37	<0.28	<0.29	<0.17
Dieldrin	<0.22	Q 0.56	<0.18	<0.10
Endrin	<0.04	<0.03	<0.03	<0.02
Methoxychlor	<0.20	<0.15	<0.16	<0.09

NM = Not Monitored

Appendix B

Dissolved and Particulate Organochlorines in Snow

MAY 1986
MELTED SNOW SAMPLE (pg/L)
COLUMNS

Sample I.D.	1-MSS-01C	1-MSS-02C	1-MSS-03C	1-MSS-04C
Volume (L)	55.340	49.550	53.590	44.570
Arochlor 1254	160.00	190.00	86.00	66.00
HCB	<1.80	27.00	<1.90	41.00
Heptachlor	<1.10	<1.20	<1.10	<1.40
Aldrin	<2.60	<2.90	<2.70	<3.20
o,p'-DDE	<2.90	<3.20	<3.00	<3.60
p,p'-DDE	Q 7.20	Q 8.10	Q 7.50	<2.70
Mirex	<4.20	<4.60	<4.30	<5.20
alpha-BHC	1600.00	1500.00	1200.00	1600.00
beta-BHC	<1.50	<1.70	<1.60	<1.90
gamma-BHC	740.00	680.00	520.00	630.00
Oxychlordane	NM	NM	NM	NM
trans-Chlordane	86.00	83.00	32.00	32.00
cis-Chlordane	42.00	39.00	19.00	21.00
p,p'-DDT	<1.60	<1.80	<1.70	<2.00
cis-Nonachlor	NM	NM	NM	NM
Heptachlor Epoxide	150.00	110.00	84.00	96.00
alpha-Endosulfan	210.00	Q 200.00	Q 190.00	Q 220.00
Dieldrin	400.00	360.00	190.00	220.00
Endrin	<1.10	23.00	6.50	5.20
Methoxychlor	<3.10	<3.40	<3.20	<3.80

NM = Not Monitored

MAY 1986
MELTED SNOW SAMPLE (pg/L)
FILTERS

Sample I.D.	1-MSS-01F	1-MSS-02F	1-MSS-03F	1-MSS-04F
Volume (L)	55.340	49.550	53.590	44.570
Arochlor 1254	87.00	61.00	55.00	14.00
HCB	Q 3.80	Q 4.20	4.20	Q 4.70
Heptachlor	<1.60	<1.80	<1.70	<2.00
Aldrin	<0.09	<0.10	<0.09	<0.11
o,p'-DDE	<0.16	2.20	1.60	0.88
p,p'-DDE	2.50	<0.61	<0.56	<0.67
Mirex	<0.24	<0.26	<0.24	<0.29
alpha-BHC	2.20	<0.61	<0.56	<0.67
beta-BHC	<0.20	<0.22	<0.21	<0.25
gamma-BHC	Q 1.40	<0.41	<0.37	<0.45
Oxychlordane	NM	NM	NM	NM
trans-Chlordane	7.10	1.80	Q 1.30	<0.45
cis-Chlordane	5.80	Q 1.60	Q 1.50	<0.45
p'p'-DDT	<1.50	<1.70	<1.60	<1.10
cis-Nonachlor	NM	NM	NM	NM
Heptachlor Epoxide	1.70	0.90	<0.09	<0.10
alpha-Endosulfan	1.90	Q 0.81	Q 0.75	<0.22
Dieldrin	Q 6.10	Q 6.90	<1.90	28.00
Endrin	<0.09	<0.10	<0.09	<0.11
Methoxychlor	<0.60	<0.67	<0.62	<0.74

NM = Not Monitored

AUGUST 1986
MELTED SNOW SAMPLE (pg/L)
COLUMNS

Sample I.D.	2-MSS-01C	2-MSS-02C	2-MSS-03C
Volume (L)	64.350	51.42	42.500
Arochlor 1254	59.00	78.00	100.00
HCB	11.00	<1.90	<2.40
Heptachlor	Q 3.30	4.40	Q 4.90
Aldrin	<2.30	<2.80	<3.40
o,p'-DDE	<2.50	<3.10	<3.80
p,p'-DDE	<1.90	Q 7.80	<2.80
Mirex	<3.60	<4.50	<5.40
alpha-BHC	860.00	1300.00	1100.00
beta-BHC	<1.30	<1.70	Q 6.60
gamma-BHC	170.00	210.00	200.00
Oxychlordane	NM	NM	NM
trans-Chlordane	3.70	10.00	<0.94
cis-Chlordane	<0.47	Q 1.90	Q 2.40
p,p'-DDT	<1.40	<1.80	6.90
cis-Nonachlor	NM	NM	NM
Heptachlor Epoxide	37.00	45.00	28.00
alpha-Endosulfan	Q 160.00	Q 190.00	Q 240.00
Dieldrin	86.00	110.00	85.00
Endrin	Q 3.10	<1.20	Q 4.70
Methoxychlor	19.00	94.00	15.00

AUGUST 1986
MELTED SNOW SAMPLE (pg/L)
FILTERS

Sample I.D.	2-MSS-01F	2-MSS-02F	2-MSS-03F
Volume (L)	64.350	51.420	42.500
Arochlor 1254	<16.00	<8.00	<9.60
HCB	<0.93	<1.20	<1.40
Heptachlor	<1.40	<1.80	<2.10
Aldrin	<0.08	<0.10	<0.12
o,p'-DDE	0.58	Q 0.57	Q 0.70
p,p'-DDE	<0.47	<0.58	<0.71
Mirex	<0.20	<0.25	<0.31
alpha-BHC	<0.47	<0.58	<0.71
beta-BHC	<0.17	<0.21	<0.26
gamma-BHC	<0.31	<0.39	<0.47
Oxychlordane	NM	NM	NM
trans-Chlordane	Q 1.10	Q 1.40	<0.47
cis-Chlordane	<0.31	<0.39	<0.47
p,p'-DDT	<1.30	<1.70	<2.00
cis-Nonachlor	NM	NM	NM
Heptachlor Epoxide	<0.07	<0.09	<0.11
alpha-Endosulfan	Q 0.62	Q 0.78	<0.24
Dieldrin	<1.60	<1.90	<2.40
Endrin	<0.08	<0.10	<0.12
Methoxychlor	<0.50	<0.64	<0.78

NM = not monitored

JUNE 1987
MELTED SNOW SAMPLE (pg/L)
COLUMNS

Sample I.D.	3-MSS-1C	3-MSS-2C	3-MSS-3C
Volume (L)	35.930	67.540	68.460
Arochlor 1254	360.00	68.00	100.00
HCB	Q 14.00	Q 7.40	Q 7.30
Heptachlor	<5.60	<3.00	Q 9.50
Aldrin	<0.20	0.56	0.84
o,p'-DDE	<0.56	2.60	5.30
p,p'-DDE	36.00	Q 12.00	Q 12.00
Mirex	<5.90	<3.10	<3.10
alpha-BHC	230.00	470.00	170.00
beta-BHC	16.00	23.00	Q 6.40
gamma-BHC	190.00	310.00	75.00
Oxychlordane	8.26	13.00	Q 3.40
trans-Chlordane	18.00	37.00	5.00
cis-Chlordane	30.00	41.00	5.30
p,p'-DDT	<43.00	<23.00	Q 75.00
cis-Nonachlor	31.00	21.00	Q 15.00
Heptachlor Epoxide	57.00	65.00	16.00
alpha-Endosulfan	120.00	140.00	30.00
Dieldrin	<200.00	<110.00	<110.00
Endrin	<39.00	<21.00	<20.00
Methoxychlor	67.00	Q 19.00	25.00

JUNE 1987
MELTED SNOW SAMPLE (pg/L)
FILTERS

Sample I.D.	3-MSS-1F	3-MSS-2F	3-MSS-3F
Volume (L)	35.930	67.540	68.460
Arochlor 1254	3.50	13.00	4.50
HCB	1.20	2.70	2.50
Heptachlor	<0.56	<0.30	<0.29
Aldrin	<0.11	<0.06	<0.06
o,p'-DDE	<0.56	<0.30	<0.29
p,p'-DDE	0.56	2.70	1.20
Mirex	<0.56	<0.30	<0.29
alpha-BHC	<0.56	<0.30	<0.29
beta-BHC	<2.00	<1.00	<1.00
gamma-BHC	<0.84	<0.44	<0.44
Oxychlordane	<0.56	<0.30	<0.29
trans-Chlordane	<0.56	Q 0.89	<0.29
cis-Chlordane	<0.56	Q 0.89	<0.29
p,p'-DDT	<1.70	Q 1.30	Q 3.10
cis-Nonachlor	<0.84	<0.44	<0.44
Heptachlor Epoxide	<0.84	<0.30	<0.44
alpha-Endosulfan	<0.56	<0.89	<0.29
Dieldrin	<1.70	<1.60	<0.88
Endrin	<3.10	<0.59	<1.60
Methoxychlor	<42.00	<22.00	<22.00

Appendix C

Dissolved and Particulate Organochlorines in Seawater

MAY 1986
IN SITU WATER SAMPLE (pg/L)
COLUMNS

Sample I.D.	1-ISS-RES.	1-ISS-01C	1-ISS-02C	1-ISS-03C	1-ISS-04C	1-ISS-05C
Depth	5 meters	45 meters	10 meters	60 meters	75 meters	100 meters
Volume (L)	170.000	228.510	229.980	233.210	236.460	215.110
Arochlor 1254	Q 16.00	Q 12.00	Q 12.00	Q 12.00	Q 12.00	Q 13.00
HCB	<0.59	<0.35	<0.43	<0.43	<0.43	27.00
Heptachlor	<0.35	<0.50	<0.26	<0.26	<0.25	< 0.28
Aldrin	<0.84	<0.55	<0.63	<0.61	<0.61	<0.67
o,p'-DDE	Q 3.10	<0.55	Q 2.30	Q 2.20	Q 2.20	Q 2.40
p,p'-DDE	Q 2.40	<0.42	Q 1.70	Q 1.70	<0.51	<0.56
Mirex	<1.40	<0.80	Q 3.30	<0.99	<0.97	<1.10
alpha-BHC	4300.00	3500.00	4400.00	4200.00	3400.00	2000.00
beta-BHC	<0.50	<0.29	<0.37	<0.34	<0.36	<0.40
gamma-BHC	560.00	550.00	650.00	560.00	530.00	330.00
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	3.40	<0.14	2.70	3.70	3.20	1.80
cis-Chlordane	<0.18	<0.10	2.00	2.40	1.60	1.30
p,p'-DDT	10.00	<0.31	<0.39	<0.39	<0.38	<0.42
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	<1.50	<0.87	10.00	9.00	8.44	5.60
alpha-Endosulfan	<18.00	<13.00	<13.00	<13.00	<13.00	<14.00
Dieldrin	17.00	13.00	14.00	14.00	14.00	15.00
Endrin	<0.35	<0.21	3.50	5.20	5.20	3.20
Methoxychlor	<1.00	<0.59	<0.74	<0.73	<0.72	<0.79

NM = Not Monitored

MAY 1986
IN SITU WATER SAMPLES (pg/L)
COLUMNS

Sample I.D.	1-ISS-06C	1-ISS-07C	1-ISS-09C	1-ISS-10C	1-ISS-11C
Depth	280 meters	100 meters	175 meters	175 meters	125 meters
Volume (L)	214.790	200.010	202.450	202.770	202.690
Arochlor 1254	Q 13.00	Q 14.00	Q 14.00	<4.10	Q 14.00
HCB	7.60	<0.50	<0.49	9.00	<0.49
Heptachlor	<0.28	<0.30	<0.30	<0.30	<0.30
Aldrin	<0.67	<0.72	<0.71	<0.71	<0.71
o,p'-DDE	<0.75	<0.80	<0.79	<0.80	<0.80
p,p'-DDE	<0.56	<0.60	<0.59	Q 2.00	Q 2.00
Mirex	<1.10	<1.20	<1.10	<1.10	<1.10
alpha-BHC	180.00	2800.00	1300.00	400.00	1800.00
beta-BHC	<0.40	<0.42	<0.42	<0.42	<0.42
gamma-BHC	40.00	380.00	190.00	63.00	190.00
Oxychlordane	NM	NM	NM	NM	NM
trans-Chlordane	Q 0.70	2.00	1.30	<0.20	1.10
cis-Chlordane	3.70	Q 0.50	1.90	3.00	<0.15
p,p'-DDT	<0.42	<0.45	<0.44	<0.44	14.00
cis-Nonachlor	NM	NM	NM	NM	NM
Heptachlor Epoxide	4.00	6.00	Q1.10	Q 4.10	4.90
alpha-Endosulfan	<14.00	<15.00	<15.00	<15.00	<15.00
Dieldrin	7.10	12.00	11.00	7.50	10.00
Endrin	5.20	2.40	3.00	<0.30	<0.30
Methoxychlor	<0.79	<0.85	<0.84	<0.84	<0.84

NM = Not Monitored

MAY 1986
IN SITU WATER SAMPLES (pg/L)
COLUMNS

Sample I.D.	1-ISS-12C	1-ISS-13C	1-ISS-14C	1-ISS-15C	1-ISS-16C
Depth	10 meters	100 meters	225 meters	10 meters	225 meters
Volume (L)	199.180	196.600	201.480	198.150	350.460
Arochlor 1254	Q 14.00	Q 14.00	Q 14.00	Q 14.00	Q 7.90
HCB	<0.50	<0.51	11.00	<0.51	4.10
Heptachlor	<0.30	<0.31	<0.30	<0.30	<0.17
Aldrin	<0.72	<0.73	<0.71	<0.73	<0.41
o,p'-DDE	<0.80	Q 2.60	<0.80	<0.81	<0.47
p,p'-DDE	<0.62	Q 2.00	Q 2.00	<0.61	<0.34
Mirex	<1.20	<1.20	<1.10	<1.20	<0.66
alpha-BHC	5000.00	2600.00	440.00	4800.00	320.00
beta-BHC	<0.43	<0.43	<0.42	<0.43	<0.24
gamma-BHC	590.00	320.00	74.00	670.00	62.00
Oxychlordane	NM	NM	NM	NM	NM
trans-Chlordane	2.80	2.00	0.88	2.20	Q 0.43
cis-Chlordane	<0.15	<0.15	4.30	<0.15	3.80
p,p'-DDT	13.00	6.30	11.00	13.00	<0.26
cis-Nonachlor	NM	NM	NM	NM	NM
Heptachlor Epoxide	12.00	8.10	4.10	9.10	Q 2.40
alpha-Endosulfan	<15.00	<15.00	<15.00	<15.00	<8.60
Dieldrin	16.00	13.00	8.60	15.00	6.90
Endrin	<0.30	<0.31	<0.30	<0.30	<0.17
Methoxychlor	<0.85	<0.86	<0.84	<0.86	<0.49

NM = Not Monitored

MAY 1986
IN SITU WATER SAMPLE (pg/L)
FILTERS

Sample I.D.	1-ISS-01F	1-ISS-02F	1-ISS-03F	1-ISS-04F	1-ISS-05F
Depth	45 meters	10 meters	60 meters	75 meters	100 meters
Volume (L)	228.510	229.980	233.210	236.460	215.110
Arochlor 1254	<1.80	<1.80	<1.80	<1.70	<1.90
HCB	<0.26	<0.26	<0.26	<0.25	<0.28
Heptachlor	<0.39	<0.39	<0.39	<0.38	<0.42
Aldrin	<0.02	<0.02	<0.02	<0.02	<0.02
o,p'-DDE	<0.04	<0.04	<0.04	<0.04	<0.04
p,p'-DDE	<0.13	<0.13	<0.13	<0.13	<0.14
Mirex	<0.06	<0.06	<0.06	<0.05	<0.06
alpha-BHC	<0.10	<0.13	<0.13	<0.13	<0.14
beta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC	<0.07	<0.09	<0.09	<0.08	<0.09
Oxychlordane	NM	NM	NM	NM	NM
trans-Chlordane	<0.07	Q 0.30	Q 0.30	<0.08	Q 0.33
cis-Chlordane	<0.07	<0.09	<0.09	<0.08	<0.09
p,p'-DDT	<0.37	<0.37	<0.36	<0.36	<0.40
cis-Nonachlor	NM	NM	NM	NM	NM
Heptachlor Epoxide	<0.02	<0.02	<0.02	<0.02	Q 0.07
alpha-Endosulfan	<0.04	Q 0.11	Q 0.17	<0.04	<0.05
Dieldrin	<0.44	2.80	<0.43	<0.42	<0.46
Endrin	<0.02	<0.02	<0.02	<0.02	<0.02
Methoxychlor	<0.14	<0.14	<0.14	<0.14	<0.15

NM = Not Monitored

MAY 1986
IN SITU WATER SAMPLES (pg/L)
FILTERS

Sample I.D.	1-ISS-06F	1-ISS-07F	1-ISS-09F	1-ISS-10F	1-ISS-11F
Depth	280 meters	100 meters	175 meters	175 meters	125 meters
Volume (L)	214.790	200.010	202.450	202.770	202.690
Arochlor 1254	<1.90	<2.10	<2.00	<2.00	<2.00
HCB	<0.28	<0.30	<0.30	<0.30	<0.30
Heptachlor	<0.42	<0.45	<0.44	<0.44	<0.44
Aldrin	<0.02	<0.02	<0.02	<0.02	<0.02
o,p'-DDE	<0.04	<0.04	<0.04	<0.04	<0.04
p,p'-DDE	<0.14	<0.15	<0.15	<0.15	<0.15
Mirex	<0.06	<0.06	<0.06	<0.06	<0.06
alpha-BHC	<0.14	<0.15	<0.15	<0.15	<0.15
beta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC	<0.09	<0.10	<0.10	<0.10	<0.10
Oxychlordane	NM	NM	NM	NM	NM
trans-Chlordane	<0.09	<0.10	<0.10	<0.10	<0.10
cis-Chlordane	<0.09	<0.10	<0.10	<0.10	<0.10
p,p'-DDT	<0.40	<0.42	<0.42	<0.42	<0.42
cis-Nonachlor	NM	NM	NM	NM	NM
Heptachlor Epoxide	0.09	Q 0.08	<0.12	<0.44	<0.14
alpha-Endosulfan	<0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	<0.47	<0.50	<0.49	<0.49	<0.49
Endrin	<0.02	<0.02	<0.02	<0.02	<0.02
Methoxychlor	<0.15	<0.16	<0.16	<0.16	<0.16

NM = Not Monitored

MAY 1986
IN SITU WATER SAMPLES (pg/L)
FILTERS

Sample I.D.	1-ISS-12F	1-ISS-13F	1-ISS-14F	1-ISS-15F	1-ISS-16F
Depth	10 meters	100 meters	225 meters	10 meters	225 meters
Volume (L)	199.180	196.600	201.480	198.150	350.460
Arochlor 1254	Q 7.00	<2.10	<38.00	<2.10	<1.20
HCB	Q 1.10	<0.31	<0.30	<0.30	<0.17
Heptachlor	<0.45	<0.46	<0.45	<0.45	<0.26
Aldrin	<0.03	<0.03	0.09	<0.03	<0.01
o,p'-DDE	<0.05	<0.05	<0.04	<0.05	<0.03
p,p'-DDE	<0.15	<0.15	<0.15	<0.15	<0.09
Mirex	<0.07	<0.07	<0.07	<0.07	<0.04
alpha-BHC	Q 0.55	<0.15	<0.15	<0.15	0.63
beta-BHC	<0.06	<0.06	<0.05	<0.06	<0.03
gamma-BHC	<0.10	<0.10	<0.10	<0.10	<0.06
Oxychlordane	NM	NM	NM	NM	NM
trans-Chlordane	Q 0.35	<0.10	<0.10	Q 0.35	<0.06
cis-Chlordane	<0.10	<0.10	<0.10	<0.10	<0.06
p,p'-DDT	<0.43	<0.43	<0.42	<0.43	<0.24
cis-Nonachlor	NM	NM	NM	NM	NM
Heptachlor Epoxide	Q 0.08	0.10	Q 0.08	<0.02	<0.01
alpha-Endosulfan	<0.05	<0.05	<0.05	Q 0.21	<0.03
Dieldrin	<0.50	<0.51	<0.50	<0.50	<0.29
Endrin	<0.03	<0.03	<0.02	<0.03	<0.01
Methoxychlor	<0.17	<0.17	<0.16	<0.17	<0.09

NM = Not Monitored

AUGUST 1986
IN SITU WATER SAMPLE (pg/L)
COLUMNS

Sample I.D.	2-ISS-01C	2-ISS-02C	2-ISS-03C	2-ISS-05C	2-ISS-06C	2-ISS-07C
Depth	10 meters	10 meters	90 meters	40 meters	90 meters	60 meters
Volume (L)	355.800	344.000	277.050	211.350	221.350	172.160
Arochlor 1254	Q 7.80	Q 8.10	Q 10.00	Q 13.00	Q 13.00	Q 16.00
HCB	15.00	28.00	22.00	16.00	15.00	18.00
Heptachlor	2.30	Q 0.61	<0.22	<0.28	<0.27	1.30
Aldrin	<0.41	<0.42	<0.52	<0.68	<0.65	<0.84
o,p'-DDE	Q 1.50	Q 1.50	Q 1.90	<0.76	Q 2.30	Q 3.00
p,p'-DDE	<0.34	<0.35	<0.43	<0.57	<0.54	<0.70
Mirex	<0.65	<0.67	<0.83	<1.10	<1.00	<1.30
alpha-BHC	5000.00	3700.00	2800.00	4500.00	2700.00	5100.00
beta-BHC	<0.24	<0.25	<0.31	<0.40	<0.38	<0.49
gamma-BHC	710.00	580.00	411.00	620.00	360.00	700.00
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	4.30	3.60	4.80	3.50	2.90	3.70
cis-Chlordane	4.10	<0.09	4.50	<0.14	5.60	<0.17
p,p'-DDT	<0.25	<0.26	<0.32	<0.43	<0.41	<0.52
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	9.30	10.00	7.60	9.90	10.00	12.00
alpha-Endosulfan	<8.40	<8.70	<11.00	Q 47.00	<14.00	<17.00
Dieldrin	13.00	15.00	13.00	11.00	12.00	20.00
Endrin	<0.17	<0.17	6.20	4.40	7.30	3.00
Methoxychlor	<0.48	<0.49	<0.61	<0.80	<0.77	<0.99

NM = Not Monitored

AUGUST 1986
IN SITU WATER SAMPLE (pg/L)
COLUMNS

Sample I.D.	2-ISS-08C	2-ISS-09C	2-ISS-10C	2-ISS-11C	2-ISS-12C	2-ISS-13C	2-ISS-14C
Depth	90 meters	125 meters	175 meters	10 meters	150 meters	88 meters	90 meters
Volume (L)	180.010	206.230	215.640	217.480	227.070	399.440	409.560
Arochlor 1254	63.00	<4.00	Q 13.00	<3.80	Q 12.00	8.80	7.40
HCB	41.00	25.00	9.90	31.00	17.00	13.00	13.00
Heptachlor	2.90	Q 1.00	<0.28	<0.28	Q 0.93	0.57	Q 0.51
Aldrin	<0.80	<0.70	<0.67	<0.66	<0.63	<0.36	<0.35
o,p'-DDE	Q 2.90	Q 2.50	<0.74	Q 2.40	<0.71	Q 1.30	Q 1.30
p,p'-DDE	Q 2.20	<0.58	<0.56	<0.55	<0.53	<0.30	<0.29
Mirex	<1.30	<1.10	<1.10	<1.10	<1.00	<0.58	<0.56
alpha-BHC	3000.00	2600.00	600.00	4400.00	880.00	3000.00	2400.00
beta-BHC	<0.47	<0.41	<0.42	<0.39	<0.37	<0.21	<0.21
gamma-BHC	410.00	440.00	87.00	650.00	140.00	380.00	300.00
Oxychlordane	NM	NM	NM	NM	NM	NM	NM
trans-Chlordane	4.10	3.10	1.10	3.40	1.90	3.10	2.80
cis-Chlordane	<0.17	4.56	3.00	4.78	4.60	3.40	2.80
p,p'-DDT	<0.50	<0.44	<0.41	<0.41	<0.40	<0.22	<0.22
cis-Nonachlor	NM	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	5.00	9.70	Q 3.90	11.00	5.70	5.80	5.90
alpha-Endosulfan	Q 56.00	<15.00	<14.00	Q 46.00	Q 44.00	<7.50	<7.30
Dieldrin	9.60	17.00	7.50	17.00	9.00	12.00	11.00
Endrin	4.60	2.00	<0.28	2.40	<0.26	4.30	3.00
Methoxychlor	<0.94	<0.82	<0.79	<0.78	<0.75	<0.43	<0.42

NM = Not Monitored

AUGUST 1986
IN SITU WATER SAMPLE (pg/L)
FILTERS

Sample I.D.	2-ISS-01F	2-ISS-03F	2-ISS-05F	2-ISS-06F	2-ISS-07F	2-ISS-08F
Depth	10 meters	90 meters	40 meters	90 meters	60 meters	90 meters
Volume (L)	355.800	277.050	211.350	221.350	172.160	180.010
Arochlor 1254	<1.20	<1.50	<1.90	<1.80	<2.40	<2.30
HCB	Q 0.59	<0.22	<0.28	<0.27	<0.35	Q 1.20
Heptachlor	<0.25	<0.32	<0.43	<0.41	<0.52	<0.50
Aldrin	<0.01	<0.02	<0.02	<0.02	<0.03	<0.03
o,'p'-DDE	<0.03	<0.03	<0.04	<0.04	<0.05	<0.05
p,p'-DDE	<0.08	<0.11	<0.14	<0.14	<0.17	<0.17
Mirex	<0.04	<0.05	<0.06	<0.06	<0.08	<0.07
alpha-BHC	0.71	<0.11	1.40	<0.14	1.10	0.62
beta-BHC	<0.03	<0.04	<0.05	<0.05	<0.06	<0.06
gamma-BHC	<0.06	<0.07	<0.09	<0.09	<0.12	<0.11
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	<0.06	<0.07	Q 0.33	<0.09	Q 0.41	<0.41
cis-Chlordane	<0.06	<0.07	Q 0.38	<0.09	<0.12	<0.11
p,p'-DDT	<0.24	<0.31	<0.40	<0.38	<0.49	<0.47
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	<0.01	<0.02	<0.02	<0.02	<0.03	<0.03
alpha-Endosulfan	Q 0.11	<0.04	<0.26	<0.05	Q 0.23	Q 0.22
Dieldrin	<0.28	<0.36	<0.47	<0.45	<0.58	<0.56
Endrin	<0.01	<0.02	<0.02	<0.02	<0.03	<0.03
Methoxychlor	<0.09	<0.12	<0.16	<0.15	<0.19	<0.18

NM = Not Monitored

AUGUST 1986
IN SITU WATER SAMPLE (pg/L)
FILTERS

Sample I.D.	2-ISS-09F	2-ISS-10F	2-ISS-11F	2-ISS-12F	2-ISS-13F	2-ISS-14F
Data I.D.	125 meters	175 meters	10 meters	150 meters	88 meters	90 meters
Volume (L)	206.230	215.640	217.480	227.070	399.440	409.560
Arochlor 1254	<2.00	<1.90	<1.90	<1.80	<1.00	<1.00
HCB	<0.29	<0.28	<0.28	<0.26	<0.15	<0.15
Heptachlor	<0.44	<0.42	<0.41	<0.40	<0.23	<0.22
Aldrin	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01
o,p'-DDE	<0.04	<0.04	<0.04	<0.04	<0.02	<0.02
p,p'-DDE	<0.15	<0.14	<0.14	<0.13	Q 0.23	<0.07
Mirex	<0.06	<0.06	<0.06	<0.06	<0.03	<0.03
alpha-BHC	Q 0.53	Q 0.51	<1.60	Q 0.48	<0.31	Q 0.27
beta-BHC	<0.05	<0.05	<0.05	<0.05	<0.03	<0.03
gamma-BHC	<0.10	<0.09	<0.09	<0.09	<0.05	<0.05
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	Q 0.34	0.56	0.42	Q 0.31	0.26	Q 0.17
cis-Chlordane	<0.10	<0.09	<0.09	<0.09	<0.05	<0.05
p,p'-DDT	<0.41	<0.39	<0.39	<0.37	<0.21	<0.21
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01
alpha-Endosulfan	<0.05	<0.05	<0.05	<0.04	0.12	Q 0.10
Dieldrin	<0.48	<0.46	<0.46	<0.44	<0.25	<0.24
Endrin	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01
Methoxychlor	<0.16	<0.15	<0.15	<0.15	<0.08	<0.08

NM = Not Monitored

AUGUST 1986
NBS DROP SAMPLER (WATER) (pg/L)
COLUMN

Sample I.D.	2-NBS-1X	2-NBS-2X	2-NBS-3X
Volume (L)	8.000	8.700	8.900
Arochlor 1254	<65.00	<60.00	<58.00
HCB	<8.80	<8.00	<7.90
Heptachlor	<31.00	<29.00	<28.00
Aldrin	<0.25	<0.23	<0.22
o,p'-DDE	<7.50	<6.90	<6.70
p,p'-DDE	<10.00	<9.20	<8.90
Mirex	<8.80	<8.00	<7.90
alpha-BHC	7600.00	3000.00	6500.00
beta-BHC	<5.30	<4.80	<4.70
gamma-BHC	1100.00	320.00	850.00
Oxychlordane	NM	NM	NM
trans-Chlordane	Q 8.80	<2.30	<2.20
cis-Chlordane	<2.50	<2.30	<2.20
p,p'-DDT	<1.00	<0.90	<0.90
cis-Nonachlor	NM	NM	NM
Heptachlor Epoxide	11.00	Q 6.90	<2.20
alpha-Endosulfan	Q 7.50	<2.30	8.60
Dieldrin	<2.50	<2.30	<2.20
Endrin	<2.50	<2.30	<2.20
Methoxychlor	Q 65.00	<18.00	<18.00

AUGUST 1986
NBS DROP SAMPLER (WATER) (pg/L)
FILTER

Sample I.D.	2-NBS-1	2-NBS-2	2-NBS-3
Volume (L)	8.000	8.700	8.900
Arochlor 1254	<51.00	<47.00	<46.00
HCB	<7.50	<6.90	<6.70
Heptachlor	<11.00	<10.00	<10.00
Aldrin	<0.63	<0.57	<0.56
o,p'-DDE	4.40	3.50	5.00
p,p'-DDE	<3.80	<3.40	<3.40
Mirex	<1.60	<1.50	<1.50
alpha-BHC	26.00	<3.50	<1.00
beta-BHC	<1.40	<1.30	<1.20
gamma-BHC	<2.50	<2.30	<2.20
Oxychlordane	NM	NM	NM
trans-Chlordane	<2.50	<2.30	Q 7.90
cis-Chlordane	<2.50	<2.30	<2.20
p,p'-DDT	<11.00	<9.80	<9.60
cis-Nonachlor	NM	NM	NM
Heptachlor Epoxide	<0.58	<0.53	<0.52
alpha-Endosulfan	5.20	Q 4.1	<1.10
Dieldrin	170.00	130.00	110.00
Endrin	<0.63	<0.57	<0.56
Methoxychlor	<4.10	<3.80	<3.70

NM = Not Monitored

JUNE 1987
IN SITU WATER SAMPLE (pg/L)
COLUMNS

Sample I.D.	3-ISS-1C	3-ISS-2C	3-ISS-3C	3-ISS-4C
Depth	10 meters	10 meters	270 meters	270 meters
Volume (L)	377.900	433.100	379.320	377.650
Arochlor 1254	<2.20	<1.90	<2.20	53.00
HCB	18.00	20.00	6.40	7.80
Heptachlor	<0.53	Q 1.50	<0.53	2.30
Aldrin	<0.02	<0.02	<0.02	<0.02
o,p'-DDE	<0.05	0.31	Q 0.16	6.00
p,p'-DDE	<0.64	<0.55	<0.63	3.40
Mirex	<0.56	<0.48	<0.55	<0.56
alpha-BHC	2600.00	3000.00	150.00	140.00
beta-BHC	37.00	30.00	2.80	2.40
gamma-BHC	480.00	510.00	26.00	26.00
Oxychlordane	Q 0.61	0.75	<0.19	<0.19
trans-Chlordane	<0.27	Q 0.81	<0.26	<0.27
cis-Chlordane	1.60	2.50	2.00	1.80
p,p'-DDT	<4.10	<3.50	<4.00	<4.00
cis-Nonachlor	<0.82	<0.72	<0.82	<0.82
Heptachlor Epoxide	10.00	10.00	1.30	1.40
alpha-Endosulfan	<0.27	<0.23	<0.26	<0.27
Dieldrin	<19.00	<17.00	<19.00	<19.00
Endrin	<3.70	<3.20	<3.70	<3.70
Methoxychlor	<1.10	<0.92	<1.10	<9.00

JUNE 1987
IN SITU WATER SAMPLE (pg/L)
COLUMNS

Sample I.D.	3-ISS-5C	3-ISS-6C	3-ISS-7C	3-ISS-8C
Depth	110 meters	110 meters	270 meters	10 meters
Volume (L)	403.190	400.100	579.060	566.670
Arochlor 1254	<2.10	<2.10	<1.40	<1.50
HCB	12.00	12.00	5.30	11.00
Heptachlor	<0.50	<0.50	<0.35	<0.35
Aldrin	<0.02	<0.02	<0.01	<0.01
o,p'-DDE	<0.05	<0.05	<0.03	<0.04
p,p'-DDE	<0.60	<0.60	<0.41	<0.42
Mirex	<0.52	<0.52	<0.36	<0.37
alpha-BHC	1400.00	1500.00	160.00	2800.00
beta-BHC	25.00	19.00	4.20	56.00
gamma-BHC	300.00	300.00	33.00	560.00
Oxychlordane	0.86	Q 0.57	Q 0.40	0.70
trans-Chlordane	Q 0.87	<0.25	Q 0.60	<0.18
cis-Chlordane	2.70	2.40	2.50	2.10
p,p'-DDT	8.20	<3.80	<2.60	<2.70
cis-Nonachlor	Q 2.50	<0.77	<0.54	<0.55
Heptachlor Epoxide	5.40	6.40	1.10	13.00
alpha-Endosulfan	<0.25	<0.25	<0.17	<0.18
Dieldrin	<18.00	<18.00	<13.00	<13.00
Endrin	Q 11.00	<3.50	<2.40	<2.50
Methoxychlor	<0.99	<1.00	<0.69	<0.70

JUNE 1987
IN SITU WATER SAMPLE (pg/L)
FILTERS

Sample I.D.	3-ISS-2F	3-ISS-4F	3-ISS-6F	3-ISS-8F
Depth	10 meters	270 meters	110 meters	10 meters
Volume (L)	433.100	377.650	400.100	566.670
Arochlor 1254	<0.05	<0.05	<0.05	< 0.04
HCB	0.06	<0.01	0.04	0.10
Heptachlor	<0.05	<0.05	<0.05	<0.04
Aldrin	<0.01	<0.01	<0.01	<0.01
o,p'-DDE	<0.05	<0.05	<0.05	<0.04
p,p'-DDE	<0.01	<0.02	<0.01	<0.01
Mirex	<0.05	<0.05	<0.05	<0.04
alpha-BHC	<0.05	<0.05	<0.05	Q 0.11
beta-BHC	<0.16	<0.19	<0.17	<0.12
gamma-BHC	<0.07	<0.08	<0.07	<0.05
Oxychlordane	<0.05	<0.05	<0.05	<0.04
trans-Chlordane	<0.05	<0.05	<0.05	<0.04
cis-Chlordane	<0.05	<0.05	<0.05	<0.04
p,p'-DDT	<0.14	<0.16	<0.15	<0.11
cis-Nonachlor	<0.07	<0.08	<0.07	<0.05
Heptachlor Epoxide	<0.07	<0.08	<0.07	<0.05
alpha-Endosulfan	<0.05	<0.05	<0.05	<0.04
Dieldrin	<0.14	<0.16	<0.15	<0.11
Endrin	<0.25	<0.29	<0.27	<0.19
Methoxychlor	<3.50	<4.00	<3.80	<2.60

JUNE 1987
NBS WATER SAMPLER
EXTRACTED BY XAD (pg/L)

Sample I.D.	3-NX-1	3-NX-2	3-NX-3
Volume (L)	4.050	4.150	4.000
Arochlor 1254	<210.00	<200.00	<200.00
HCB	<37.00	<36.00	<38.00
Heptachlor	<49.00	<48.00	<50.00
Aldrin	<1.70	<1.70	<1.80
o'p'-DDE	<4.90	Q 14.00	<5.00
p'p'-DDE	<59.00	<58.00	<60.00
Mirex	<52.00	<51.00	<53.00
alpha-BHC	7000.00	6900.00	6200.00
beta-BHC	Q 110.00	Q 110.00	Q 110.00
gamma-BHC	620.00	600.00	560.00
Oxychlordane	<17.00	<17.00	<18.00
trans-Chlordane	<25.00	<24.00	<25.00
cis-Chlordane	<25.00	<24.00	<25.00
p'p'-DDT	<380.00	<370.00	<380.00
cis-Nonachlor	<77.00	<75.00	<78.00
Heptachlor Epoxide	<20.00	<19.00	<20.00
alpha-Endosulfan	<25.00	<24.00	<25.00
Dieldrin	<1800.00	<1800.00	<1800.00
Endrin	<350.00	<340.00	<350.00
Methoxychlor	<99.00	<96.00	<100.00

JUNE 1987
NBS WATER SAMPLER (pg/L)
COLUMN ELUATE
EXTRACTED BY HEXANE

	3-NXL-1	3-NXL-2	3-NXL-3
	4.05	4.150	4.000
Arochlor 1254	<130.00	2400.00	Q 430.00
HCB	<17.00	<17.00	<18.00
Heptachlor	<62.00	<60.00	<63.00
Aldrin	<0.49	<0.48	2.10
o,p'-DDE	<15.00	<14.00	<15.00
p,p'-DDE	<20.00	330.00	Q 70.00
Mirex	<17.00	<17.00	Q 60.00
alpha-BHC	46.00	88.00	37.00
beta-BHC	<10.00	<10.00	<11.00
gamma-BHC	25.00	12.00	20.00
Oxychlordane	9.50	14.00	12.00
trans-Chlordane	<4.90	0.48	<5.00
cis-Chlordane	<4.90	<4.80	<5.00
p,p'-DDT	Q 7.40	0.48	21.00
cis-Nonachlor	<1.50	<1.50	<1.50
Heptachlor Epoxide	<4.90	<4.80	<5.00
alpha-Endosulfan	<4.90	<4.80	<5.00
Dieldrin	<4.90	<4.80	<5.00
Endrin	<4.90	<4.80	<5.00
Methoxychlor	<40.00	<39.00	<40.00

JUNE 1987
NBS WATER SAMPLER (pg/L)
EXTRACTED BY HEXANE

Sample I.D.	3-NL-1	3-NL-2	3-NL-3
Volume (L)	3.960	3.960	3.960
Arochlor 1254	Q 430.00	<130.00	<130.00
HCB	Q 58.00	Q 58.00	Q 58.00
Heptachlor	<63.00	<63.00	<63.00
Aldrin	<0.51	<0.51	<0.51
o,p'-DDE	<15.00	<15.00	<15.00
p,p'-DDE	<20.00	<20.00	<20.00
Mirex	<18.00	<18.00	<18.08
alpha-BHC	4500.00	4000.00	4800.00
beta-BHC	93.00	150.00	150.00
gamma-BHC	600.00	550.00	650.00
Oxychlordane	15.00	9.70	9.70
trans-Chlordane	<5.00	<5.10	<5.10
cis-Chlordane	Q 18.00	Q 18.00	<5.10
p,p'-DDT	36.00	13.00	31.01
cis-Nonachlor	Q 5.10	<1.50	<1.50
Heptachlor Epoxide	<5.10	<5.10	<5.10
alpha-Endosulfan	<5.10	<5.10	<5.10
Dieldrin	29.00	<5.10	Q 15.00
Endrin	<5.10	<5.10	<5.10
Methoxychlor	<40.00	<40.00	<40.00

Appendix D

Dissolved and Particulate Organochlorines in Melted Ice

MAY 1986
MELTED ICE SAMPLE (pg/L)
COLUMNS

Sample I.D.	1-MIS-01C	1-MIS-02C	1-MIS-03C
Volume (L)	49.960	49.960	49.960
Arochlor 1254	Q 56.00	Q 56.00	Q 56.00
HCB	<2.00	<2.00	<2.00
Heptachlor	<1.20	<1.20	<1.20
Aldrin	<2.90	<2.90	<2.90
o,p'-DDE	<3.20	<3.20	<3.20
p,p'-DDE	<2.40	<2.40	<2.40
Mirex	<4.60	<4.60	<4.60
alpha-BHC	1100.00	1200.00	1700.00
beta-BHC	<1.70	<1.70	<1.70
gamma-BHC	150.00	160.00	240.00
Oxychlordane	NM	NM	NM
trans-Chlordane	<0.80	Q 3.00	Q 3.00
cis-Chlordane	<0.60	<0.60	4.80
p,p'-DDT	<1.80	<1.80	<1.80
cis-Nonachlor	NM	NM	NM
Heptachlor Epoxide	<5.00	Q 17.00	Q 17.00
alpha-Endosulfan	<60.00	<60.00	<60.00
Dieldrin	<0.80	6.80	7.50
Endrin	<1.20	<1.20	<1.20
Methoxychlor	<3.40	<3.40	<3.40

NM = Not Monitored

MAY 1986
MELTED ICE SAMPLE (pg/L)
FILTERS

Sample I.D.	1-MIS-01F	1-MIS-02F	1-MIS-03F
Volume (L)	49.960	49.960	49.960
Arochlor 1254	4.20	8.80	13.00
HCB	<1.20	<1.20	<1.20
Heptachlor	<1.80	<1.80	<1.80
Aldrin	<0.10	<0.10	<0.10
o,p'-DDE	<0.18	0.78	0.89
p,p'-DDE	<0.60	<0.60	<0.60
Mirex	<0.26	<0.26	<0.26
alpha-BHC	<0.60	<0.60	Q 2.20
beta-BHC	<0.22	<0.22	<0.22
gamma-BHC	<0.40	<0.40	<0.40
Oxychlordane	NM	NM	NM
trans-Chlordane	<0.40	<0.40	<0.40
cis-Chlordane	<0.40	<0.40	<0.40
p,p'-DDT	<1.70	<1.70	<1.70
cis-Nonachlor	NM	NM	NM
Heptachlor Epoxide	<0.09	<0.90	<0.09
alpha-Endosulfan	<0.20	1.20	<0.20
Dieldrin	<2.00	Q 6.80	Q 6.80
Endrin	<0.10	<0.10	<0.10
Methoxychlor	<0.66	<0.66	<0.66

NM = Not Monitored

JUNE 1987
MELTED ICE SAMPLE
(pg/L)

Sample I.D.	3-MIC-1	3-MIC-2
Volume (L)	25.220	23.990
Arochlor 1254	Q 110.00	<35.00
HCB	<5.90	Q 21.00
Heptachlor	<7.10	<8.30
Aldrin	1.50	<0.29
o,p'-DDE	7.30	<0.83
p,p'-DDE	Q 32.00	<10.00
Mirex	<8.30	<8.80
alpha-BHC	630.00	750.00
beta-BHC	<5.20	Q 18.00
gamma-BHC	69.00	85.00
Oxychlordane	<2.80	<2.90
trans-Chlordane	<4.00	<4.20
cis-Chlordane	<4.00	<4.20
p,p'-DDT	<61.00	<64.00
cis-Nonachlor	<12.00	<13.00
Heptachlor Epoxide	<3.20	<3.30
alpha-Endosulfan	<4.00	<4.20
Dieldrin	<290.00	<300.00
Endrin	<56.00	<58.00
Methoxychlor	<16.00	<17.00

JUNE 1987

MELTED EPONTIC ICE SAMPLE (pg/L)

COLUMNS

Sample I.D.	3-MEC-1	3-MEC-2	3-MEC-3
Volume (L)	45.610	25.370	14.720
Arochlor 1254	Q 61.00	<33.00	<57.00
HCB	14.00	Q 20.00	<10.00
Heptachlor	<4.40	<7.90	<14.00
Aldrin	<0.15	<0.28	<0.48
o,p'-DDE	Q 1.30	Q 2.40	6.30
p,p'-DDE	Q 18.00	<9.50	<16.00
Mirex	<4.60	<8.30	<14.00
alpha-BHC	590.00	710.00	440.00
beta-BHC	<2.90	<5.20	<8.80
gamma-BHC	67.00	120.00	70.00
Oxychlordane	Q 5.00	<2.80	<4.80
trans-Chlordane	<2.20	<3.90	<6.80
cis-Chlordane	<2.20	<3.90	<6.80
p,p'-DDT	<34.00	<60.00	<100.00
cis-Nonachlor	<3.80	<12.00	<21.00
Heptachlor Epoxide	9.50	Q 11.00	Q 19.00
alpha-Endosulfan	21.00	Q 13.00	Q 22.00
Dieldrin	<160.00	<290.00	<500.00
Endrin	<31.00	<55.00	<95.00
Methoxychlor	230.00	<16.00	<27.00

JUNE 1987

MELTED EPONTIC ICE SAMPLE (pg/L)

FILTERS

Sample I.D.	3-MEC-1F	3-MEC-3F
Volume (L)	45.610	14.720
Arochlor 1254	99.00	<1.40
HCB	5.40	7.70
Heptachlor	<0.44	<1.40
Aldrin	<0.09	<0.27
o,p'-DDE	2.40	<1.40
p,p'-DDE	37.00	<0.41
Mirex	<0.44	<1.40
alpha-BHC	2.30	<1.40
beta-BHC	<1.50	<4.80
gamma-BHC	<0.66	<2.00
Oxychlordane	<0.44	<1.40
trans-Chlordane	3.60	<1.40
cis-Chlordane	5.00	Q 4.10
p,p'-DDT	75.00	Q 14.00
cis-Nonachlor	7.00	<2.00
Heptachlor Epoxide	<0.66	<2.00
alpha-Endosulfan	2.70	<1.40
Dieldrin	7.10	<4.10
Endrin	Q 7.90	<4.50
Methoxychlor	<33.00	<100.00

Appendix E

Organochlorines in Biota

May 1986, Biota Sample
August 1986, Biota Sample
June 1986, Biota Sample
Miscellaneous Samples from Plankton Sampling

MAY 1986
BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	1-VIAL 8600102	1-VIAL 8600103	1-JAR 8600104	1-VIAL 8600105	1-VIAL 8600106
Sample Name	Benthic amph.	Benthic amph.	Benthic amph.	Benthic amph.	Benthic amph.
Species Name	A. nugax juv.	A. nugax	A. nugax	A. nugax juv.	A. nugax imm.
Collection Method	313 m trap	313 m trap	313 m trap	313 m trap	313 m trap
Comments	no b. ingested	no b. ingested	no b ingested	b. ingested	no b. ingested
Lipids - Dry Wt.	10.60 %	11.76 %	34.22 %	35.12 %	15.01 %
Lipids - Wet Wt.	2.02 %	2.34 %	2.22 %	10.67 %	3.00 %
Weight (g)	0.62	0.39	0.71	0.31	0.89
Arochlor 1254	800.00	1300.00	680.00	790.00	830.00
HCB	28.00	30.00	6.00	21.00	21.00
Heptachlor	<0.61	<0.97	Q 1.80	Q 4.10	<0.43
Aldrin	<0.11	<0.05	<0.03	0.40	<0.02
o,p'-DDE	Q 1.30	Q 2.00	1.40	Q 2.50	Q 0.88
p,p'-DDE	110.00	210.00	67.00	230.00	110.00
Mirex	5.60	11.00	11.00	4.70	7.50
alpha-BHC	14.00	16.90	16.00	11.00	16.00
beta-BHC	0.49	1.30	Q 0.20	Q 0.50	2.40
gamma-BHC	2.50	4.10	0.92	2.20	3.10
Oxychlordane	12.00	33.00	11.00	17.00	18.00
trans-Chlordane	11.00	24.00	8.60	14.00	17.00
cis-Chlordane	41.00	120.00	32.00	46.00	65.00
p,p'-DDT	72.00	140.00	130.00	130.00	89.00
cis-Nonachlor	38.00	98.00	44.00	39.00	54.00
Heptachlor Epoxide	2.00	1.40	0.31	3.90	1.90
alpha-Endosulfan	0.52	Q 0.17	<0.03	Q 0.22	0.45
Dieldrin	7.30	10.90	3.60	20.00	8.10
Endrin	1.60	0.52	0.23	0.79	3.90
Methoxychlor	4.40	2.50	2.80	<0.96	3.50

MAY 1986
BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	1-VIAL 8600108	1-VIAL 8600109
Sample Name	Trout (bait)	Benthic amph.
Species name		A. nugax
Collection method		297 m trap
Comments		no b. ingested
Lipids - Dry Wt.	12.59 %	4.81 %
Lipids - Wet Wt.	3.40 %	1.10 %
Weight (g)	3.09	0.37
Arochlor 1254	110.00	910.00
HCB	1.70	24.00
Heptachlor	0.96	<1.00
Aldrin	<0.01	<0.06
o,p'-DDE	1.50	<0.62
p,p'-DDE	54.00	100.00
Mirex	0.35	9.90
alpha-BHC	0.28	28.00
beta-BHC	<0.01	Q 0.38
gamma-BHC	<0.06	2.00
Oxychlordane	0.82	14.00
trans-Chlordane	2.70	14.00
cis-Chlordane	4.40	54.00
p,p'-DDT	9.00	100.00
cis-Nonachlor	2.00	56.00
Heptachlor Epoxide	2.80	0.57
alpha-Endosulfan	0.02	<0.05
Dieldrin	12.00	5.10
Endrin	0.47	0.33
Methoxychlor	<0.10	<0.81

MAY 1986
BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	1-JAR 86-002	1-JAR 86-007	1-JAR 86-009	1-JAR 86-017	1-JAR 86-019	1-JAR 86-028
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	460 um net	20 um net	273 um net	20 um net	73 um net	20 um net
Size fraction	500 um	125 um	63 um	63 um	250 um	25 um
Comments	305-0 m	280-0 m	285-0 m	280-0 m	285-0 m	280-0 m
Lipids - Dry Wt.	20.93 %	(44.71%)	16.43 %	(16.43%)	35.20 %	(16.42%)
Lipids - Wet Wt.	3.84 %	(7.18%)	1.94 %	(1.49%)	4.51 %	(0.66%)
Weight (g)	0.11	0.094	0.13	0.025	0.25	0.037
Arochlor 1254	<4.80	Q 19.00	40.00	Q 71.00	53.00	<14.00
HCB	Q 3.80	Q 4.50	4.20	Q 17.00	9.70	<3.50
Heptachlor	<3.50	<4.00	<2.90	<15.00	<1.50	<10.00
Aldrin	Q 0.63	Q 0.74	Q 5.40	Q 2.80	Q 0.28	Q 1.90
o,p′-DDE	<2.10	<2.40	<1.80	<9.20	Q 3.10	<6.20
p,p′-DDE	Q 3.20	Q 3.70	Q 2.70	16.00	5.90	<2.70
Mirex	Q 0.63	Q 0.74	<0.16	Q 2.80	0.56	Q 1.90
alpha-BHC	9.40	25.00	20.00	17.00	25.00	9.20
beta-BHC	Q 1.30	1.60	1.70	<1.70	1.70	Q 3.80
gamma-BHC	<1.70	Q 6.80	Q 4.90	<7.60	Q 2.60	<5.10
Oxychlordane	2.60	2.30	4.20	2.70	1.80	4.90
trans-Chlordane	2.90	3.40	3.70	4.70	4.50	4.10
cis-Chlordane	7.80	9.00	8.30	7.30	11.00	6.90
p,p′-DDT	22.00	25.00	23.00	46.00	20.00	25.00
cis-Nonachlor	4.00	4.80	4.70	2.50	4.50	4.00
Heptachlor Epoxide	1.90	1.30	2.70	22.00	1.50	2.00
alpha-Endosulfan	1.60	Q 0.71	2.00	2.70	0.34	Q 1.50
Dieldrin	6.80	5.00	7.30	13.00	6.00	<0.57
Endrin	2.50	Q 1.10	Q 0.77	37.00	1.20	0.81
Methoxychlor	Q 9.00	<3.20	47.00	<12.00	11.00	<8.10

MAY 1986
BIOTA SAMPLE

(ng/g dry wt)

Sample I.D.	1-JAR 86-060	1-JAR 86-070	1-JAR 86-081	1-JAR 86-091	1-JAR 86-092	1-JAR 86-098	1-JAR 86-099
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	253 um net	253 um net	460 um net	20 um net	253 um net	73 um net	253 um net
Size fraction	500 um	250 um	1000 um	250+ um	1000+ um	125 um	1000+ um
Comments	305-0 m	305-0 m	305-0 m	280-0 m	305-0 m	285-0 m	305-0 m
Lipids - Dry Wt.	33.16 %	39.10 %	27.30 %	39.10 %	39.15 %	44.71 %	41.75 %
Lipids - Wet Wt.	4.00 %	6.29 %	4.10 %	4.70 %	3.75 %	7.18 %	4.20 %
Weight (g)	0.78	0.078	0.6	0.49	0.51	0.53	0.55
Arochlor 1254	34.00	50.00	10.00	14.00	9.00	15.00	8.10
HCB	4.00	6.70	1.10	3.10	<0.25	47.00	1.70
Heptachlor	<0.49	<4.90	<0.63	<0.77	<0.75	<0.72	<0.69
Aldrin	Q 0.09	Q 1.00	0.12	0.14	0.14	0.21	Q 0.13
o,p'-DDE	<1.00	<2.90	<0.38	Q 1.60	<0.45	5.30	<0.42
p,p'-DDE	3.20	4.60	1.20	2.00	1.40	30.00	1.70
Mirex	0.29	<0.27	Q 0.12	0.15	Q 0.14	1.70	Q 0.13
alpha-BHC	11.00	14.00	5.00	8.80	5.20	24.00	6.40
beta-BHC	0.44	<0.54	0.63	0.70	0.50	4.40	0.48
gamma-BHC	1.00	<2.40	Q 1.10	Q 1.30	Q 1.30	4.20	Q 1.20
Oxychlordane	1.40	1.80	0.54	0.80	0.96	2.20	1.20
trans-Chlordane	2.30	2.30	1.20	1.60	1.70	3.30	1.40
cis-Chlordane	5.80	7.00	2.80	3.50	3.80	8.10	4.20
p,p'-DDT	12.00	15.00	2.40	4.00	9.80	17.00	9.30
cis-Nonachlor	2.60	3.60	1.70	2.70	1.40	3.60	1.40
Heptachlor Epoxide	0.53	0.75	0.71	0.67	0.59	3.30	0.54
alpha-Endosulfan	Q 0.09	<0.26	<0.03	<0.04	<0.04	0.32	<0.04
Dieldrin	3.10	4.90	2.90	2.80	3.20	7.50	1.90
Endrin	0.78	0.51	0.05	<0.06	1.30	3.60	0.53
Methoxychlor	<0.38	<38.00	<0.50	<0.61	<0.59	2.30	<0.55

MAY 1986
BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	1-JAR 86-101	1-JAR 86-103	1-JAR 86-104	1-JAR 86-110	1-JAR 86-119
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	460 um net	460 um net	460 um net	460 um net	73 um net
Size fraction	1000+ um	2000+ um	2000+ um	2000+ um	500+ um
Comments	305-0 m	305-0 m	305-0 m	300-0 m	285-0 m
Lipids - Dry Wt.	57.10 %	26.50 %	36.30 %	27.40 %	33.70 %
Lipids - Wet Wt.	6.90 %	2.00 %	2.20 %	3.00 %	3.10 %
Weight (g)	0.58	0.42	0.62	0.74	0.5
Arochlor 1254	21.00	22.00	18.00	8.30	12.00
HCB	3.00	1.90	1.00	0.58	1.80
Heptachlor	<0.66	<0.90	<0.61	<0.51	<0.76
Aldrin	Q 0.12	Q 0.17	Q 0.11	Q 0.09	Q 0.14
o,p'-DDE	Q 1.30	Q 1.90	Q 1.30	Q 1.10	<0.46
p,p'-DDE	2.40	1.80	1.50	0.92	1.70
Mirex	0.27	0.21	0.15	Q 0.09	Q 0.14
alpha-BHC	5.90	5.90	3.70	2.90	11.00
beta-BHC	0.93	0.63	0.40	0.40	0.93
gamma-BHC	1.30	Q 1.50	Q 1.00	Q 0.09	1.00
Oxychlordane	0.92	0.83	0.45	0.59	0.87
trans-Chlordane	2.00	1.90	1.20	1.50	1.80
cis-Chlordane	4.40	4.30	2.80	3.30	4.10
p,p'-DDT	3.70	3.60	2.40	3.10	3.40
cis-Nonachlor	3.00	2.70	1.70	2.20	3.20
Heptachlor Epoxide	0.93	0.79	0.56	0.57	0.77
alpha-Endosulfan	<0.03	<0.05	<0.03	<0.03	<0.04
Dieldrin	3.90	3.30	2.20	2.70	2.90
Endrin	<0.05	<0.07	<0.05	<0.04	2.10
Methoxychlor	Q 1.70	Q 2.40	<0.48	Q 1.30	Q 2.00

MAY 1986
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	1-JAR 86-002	1-JAR 86-007*	1-JAR 86-009	1-JAR 86-017*	1-JAR 86-019	1-JAR 86-028*
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	460 um net	20 um net	273 um net	20 um net	73 um net	20 um net
Size fraction&a1554H500	um	125 um	63 um	63 um	250 um	25 um
Comments	305-0 m	280-0 m	285-0 m	280-0 m	285-0 m	280-0 m
Lipids - Dry Wt.	20.93 %	(44.71%)	16.43 %	(16.43%)	35.20 %	(16.42%)
Lipids - Wet Wt.	3.84 %	(7.18%)	1.94 %	(1.49%)	4.51 %	(0.66%)
Weight (g)	0.60	0.094	1.10	0.025	1.95	0.037
Arochlor 1254	<0.88	Q 19.00	4.70	Q 71.00	6.80	<14.00
HCB	Q 0.70	Q 4.50	0.50	Q 17.00	1.20	<3.50
Heptachlor	<0.63	<4.00	<0.35	<15.00	<0.19	<10.00
Aldrin	Q 0.12	Q 0.74	Q 0.06	Q 2.80	Q 0.04	Q 19.00
o,p'-DDE	<0.38	<2.40	<0.21	<9.20	Q 0.40	<6.20
p,p'-DDE	Q 0.58	Q 3.70	Q 0.32	16.00	0.75	<2.70
Mirex	Q 0.12	Q 0.74	<0.02	Q 2.80	0.07	Q 1.90
alpha-BHC	1.70	25.00	2.30	17.00	3.20	9.20
beta-BHC	Q 0.23	1.60	0.20	<1.70	0.22	Q 3.80
gamma-BHC	<0.32	Q 6.80	Q 0.58	<7.60	Q 0.33	<5.10
Oxychlordane	0.48	2.30	0.49	2.70	0.23	4.90
trans-Chlordane	0.53	3.40	0.43	4.70	0.58	4.10
cis-Chlordane	1.40	9.00	0.97	7.30	1.40	6.90
p,p'-DDT	4.00	25.00	2.70	46.00	2.50	25.00
cis-Nonachlor	0.74	4.80	0.55	2.50	0.58	4.00
Heptachlor Epoxide	0.35	1.30	0.32	22.00	0.19	2.00
alpha-Endosulfan	0.30	Q 0.71	0.23	2.70	0.03	Q 1.50
Dieldrin	1.20	5.10	0.87	13.00	0.76	<0.57
Endrin	0.46	Q 1.10	Q 0.09	37.00	0.15	<0.81
Methoxychlor	Q 1.70	<3.20	5.60	<12.00	1.40	<8.10

MAY 1986
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	1-JAR 86-060	1-JAR 86-070	1-JAR 86-081	1-JAR 86-091	1-JAR 86-092	1-JAR 86-098	1-JAR 86-099
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	253 um net	253 um net	460 um net	20 um net	253 um net	73 um net	253 um net
Size fraction	500 um	250 um	1000 um	250+ um	1000+ um	125 um	1000+ um
Comments	305-0 m	305-0 m	305-0 m	280-0 m	305-0 m	285-0 m	305-0 m
Lipids - Dry Wt.	33.16 %	39.10 %	27.30 %	39.10 %	39.15 %	44.71 %	41.75 %
Lipids - Wet Wt.	4.00 %	6.29 %	4.10 %	4.70 %	3.75 %	7.18 %	4.20 %
Weight (g)	6.47	0.485	4.01	4.11	5.33	3.30	5.49
Arochlor 1254	4.10	8.00	1.60	1.70	0.87	2.40	0.81
HCB	0.48	1.10	0.17	0.37	<0.02	7.60	0.17
Heptachlor	<0.06	<0.78	<0.10	<0.09	<0.07	<0.12	<0.07
Aldrin	Q 0.01	Q 0.14	Q 0.02	Q 0.02	Q 0.01	0.03	Q 0.01
o,p'-DDE	Q 0.12	<0.47	<0.06	Q 0.19	<0.04	0.85	<0.04
p,p'-DDE	0.39	0.74	0.18	0.24	0.13	4.80	0.17
Mirex	0.03	<0.04	Q 0.02	0.02	Q 0.01	0.28	Q 0.01
alpha-BHC	1.30	2.19	0.74	1.10	0.50	3.90	0.63
beta-BHC	0.05	<0.09	0.09	0.08	0.05	0.72	0.05
gamma-BHC	0.12	<0.39	Q 0.16	Q 0.16	Q 0.12	0.67	Q 0.12
Oxychlordane	0.16	0.30	0.08	0.10	0.09	0.35	0.12
trans-Chlordane	0.27	0.38	0.18	0.19	0.16	0.53	0.14
cis-Chlordane	0.69	1.10	0.42	0.41	0.36	1.30	0.42
p,p'-DDT	1.40	2.40	0.35	0.48	0.94	2.70	0.92
cis-Nonachlor	0.31	0.59	0.25	0.32	0.13	0.57	0.14
Heptachlor Epoxide	0.06	0.12	0.11	0.08	0.06	0.53	0.05
alpha-Endosulfan	Q 0.01	<0.04	<0.01	<0.01	<0.01	0.05	<0.01
Dieldrin	0.37	0.78	0.44	0.34	0.31	1.20	0.19
Endrin	0.09	0.08	<0.01	<0.01	0.13	0.59	0.05
Methoxychlor	<0.05	<0.61	<0.08	<0.07	<0.06	0.37	<0.06

MAY 1986
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	1-JAR 86-101	1-JAR 86-103	1-JAR 86-104	1-JAR 86-110	1-JAR 86-119
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	460 um net	460 um net	460 um net	460 um net	73 um net
Size fraction	1000+ um	2000+ um	2000+ um	2000+ um	500+ um
Comments	305-0 m	305-0 m	305-0 m	300-0 m	285-0 m
Lipids - Dry Wt.	57.10 %	26.50 %	36.30 %	27.40 %	33.70 %
Lipids - Wet Wt.	6.90 %	2.00 %	2.20 %	3.00 %	3.10 %
Weight (g)	4.82	5.42	10.28	6.72	5.38
Arochlor 1254	2.60	1.70	1.10	0.91	1.10
HCB	0.36	0.14	0.06	0.06	0.17
Heptachlor	<0.08	<0.07	<0.04	<0.06	<0.19
Aldrin	Q 0.02	Q 0.01	Q 0.01	Q 0.01	Q 0.01
o,p'-DDE	Q 0.16	Q 0.14	Q 0.08	Q 0.12	<0.04
p,p'-DDE	0.29	0.14	0.09	0.10	0.16
Mirex	0.03	0.02	0.01	Q 0.01	Q 0.01
alpha-BHC	0.70	0.46	0.22	0.31	1.00
beta-BHC	0.11	0.05	0.02	0.04	0.09
gamma-BHC	0.15	Q 0.12	Q 0.06	Q 0.10	0.10
Oxychlordane	0.11	0.06	0.03	0.07	0.08
trans-Chlordane	0.24	0.14	0.07	0.16	0.16
cis-Chlordane	0.52	0.33	0.17	0.36	0.38
p,p'-DDT	0.44	0.28	0.14	0.34	0.32
cis-Nonachlor	0.36	0.20	0.10	0.24	0.29
Heptachlor Epoxide	0.11	0.06	0.03	0.06	0.07
alpha-Endosulfan	<0.01	<0.01	<0.01	<0.01	<0.01
Dieldrin	0.47	0.26	0.13	0.29	0.27
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01
Methoxychlor	Q 0.20	Q 0.18	<0.03	Q 0.15	Q 0.18

MAY 1986
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	1-VIAL 8600102	1-VIAL 8600103	1-JAR 8600104	1-VIAL 8600105	1-VIAL 8600106
Sample Name	Benthic amph.	Benthic amph.	Benthic amph.	Benthic amph.	Benthic amph.
Species Name	A. nugax juv.	A. nugax	A. nugax	A. nugax juv.	A. nugax imm.
Collection Method	313 m trap	313 m trap	313 m trap	313 m trap	313 m trap
Comments	no b. ingested	no b. ingested	no b ingested	b. ingested	no b. ingested
Lipids - Dry Wt.	10.60 %	11.76 %	34.22 %	35.12 %	15.01 %
Lipids - Wet Wt.	2.02 %	2.34 %	2.22 %	10.67 %	3.00 %
Weight (g)	3.25	2.05	4.44	1.02	4.45
Arochlor 1254	150.00	250.00	110.00	240.00	170.00
HCB	5.30	6.30	0.95	6.30	4.20
Heptachlor	<0.12	<0.19	Q 0.29	Q 1.20	<0.09
Aldrin	<0.01	<0.01	Q 0.02	0.12	Q 0.02
o,p'-DDE	Q 0.24	Q 0.38	0.23	Q 0.76	Q 0.18
p,p'-DDE	21.00	40.00	11.00	70.00	22.00
Mirex	1.10	2.10	1.80	1.40	1.50
alpha-BHC	2.70	3.20	2.60	3.30	3.20
beta-BHC	0.09	0.25	Q 0.03	Q 0.15	0.47
gamma-BHC	0.48	0.78	0.15	0.67	0.61
Oxychlordane	2.30	6.30	1.80	5.20	3.60
trans-Chlordane	2.10	4.60	1.40	4.20	3.40
cis-Chlordane	7.80	23.00	5.10	14.00	13.00
p,p'-DDT	14.00	27.00	21.00	39.00	18.00
cis-Nonachlor	7.30	19.00	7.00	12.00	11.00
Heptachlor Epoxide	0.38	0.26	0.05	1.20	0.38
alpha-Endosulfan	0.10	Q 0.03	<0.01	0.07	0.09
Dieldrin	1.40	2.10	0.57	6.10	1.60
Endrin	0.30	0.10	0.04	0.24	0.77
Methoxychlor	0.84	0.48	0.44	<0.29	0.70

MAY 1986
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	1-VIAL 8600108	1-VIAL 8600109
Sample Name	Trout (bait)	Benthic amph.
Species name		A. nugax
Collection method		297 m trap
Comments		no b. ingested
Lipids - Dry Wt.	12.59 %	4.81 %
Lipids - Wet Wt.	3.40 %	1.10 %
Weight (g)	11.45	1.61
Arochlor 1254	30.00	210.00
HCB	0.45	5.50
Heptachlor	0.26	<0.24
Aldrin	<0.01	<0.01
o,p'-DDE	0.39	<0.14
p,p'-DDE	15.00	23.00
Mirex	0.09	2.30
alpha-BHC	0.08	6.40
beta-BHC	<0.01	Q 0.09
gamma-BHC	<0.02	0.45
Oxychlordane	0.22	3.20
trans-Chlordane	0.73	3.20
cis-Chlordane	1.20	12.00
p,p'-DDT	2.40	23.00
cis-Nonachlor	0.54	13.00
Heptachlor Epoxide	0.76	0.13
alpha-Endosulfan	0.01	0.01
Dieldrin	3.20	1.20
Endrin	0.13	0.08
Methoxychlor	<0.03	<0.19

MAY 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	1-VIAL 8600102	1-VIAL 8600103	1-JAR 8600104	1-VIAL 8600105	1-VIAL 8600106
Sample Name	Benthic amph.	Benthic amph.	Benthic amph.	Benthic amph.	Benthic amph.
Species Name	A. nugax juv.	A. nugax	A. nugax	A. nugax juv.	A. nugax imm.
Collection Method	313 m trap	313 m trap	313 m trap	313 m trap	313 m trap
Comments	no b. ingested	no b. ingested	no b ingested	b. ingested	no b. ingested
Lipids - Dry Wt.	10.60 %	11.76 %	34.22 %	35.12 %	15.01 %
Lipids - Wet Wt.	2.02 %	2.34 %	2.22 %	10.67 %	3.00 %
Arochlor 1254	7500.00	11000.00	2000.00	2200.00	5500.00
HCB	260.00	280.00	17.00	59.00	140.00
Heptachlor	<5.80	<8.30	Q 5.30	Q 12.00	<2.90
Aldrin	<1.00	<0.46	Q 0.09	1.10	Q 0.16
o,p'-DDE	Q 12.00	Q 17.00	4.20	Q 7.10	<5.90
p,p'-DDE	1000.00	1800.00	200.00	650.00	730.00
Mirex	53.00	93.00	32.00	13.00	50.00
alpha-BHC	130.00	140.00	47.00	31.00	110.00
beta-BHC	4.60	11.00	Q 0.58	Q 1.40	16.00
gamma-BHC	24.00	35.00	2.70	6.30	20.00
Oxychlordane	110.00	280.00	32.00	48.00	120.00
trans-Chlordane	100.00	200.00	25.00	40.00	110.00
cis-Chlordane	390.00	1000.00	93.00	130.00	430.00
p,p'-DDT	680.00	1200.00	380.00	370.00	590.00
cis-Nonachlor	360.00	830.00	130.00	110.00	360.00
Heptachlor Epoxide	19.00	12.00	0.89	11.00	13.00
alpha-Endosulfan	4.90	Q 1.50	<0.08	0.63	3.00
Dieldrin	69.00	93.00	10.00	57.00	54.00
Endrin	15.00	4.50	0.67	2.30	26.00
Methoxychlor	42.00	21.00	8.00	<2.70	23.00

MAY 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	1-VIAL 8600108	1-VIAL 8600109
Sample Name	Trout (bait)	Benthic amph.
Species name		A. nugax
Collection method		297 m trap
Comments		no b. ingested
Lipids - Dry Wt.	12.59 %	4.81 %
Lipids - Wet Wt.	3.40 %	1.10 %
Arochlor 1254	870.00	19000.00
HCB	13.00	500.00
Heptachlor	7.60	<21.00
Aldrin	<0.06	<1.20
o,p'-DDE	12.00	<13.00
p,p'-DDE	430.00	2100.00
Mirex	2.80	210.00
alpha-BHC	2.20	580.00
beta-BHC	<0.10	<7.90
gamma-BHC	<0.48	41.00
Oxychlordane	6.50	290.00
trans-Chlordane	21.00	290.00
cis-Chlordane	35.00	1100.00
p,p'-DDT	71.00	2100.00
cis-Nonachlor	16.00	1200.00
Heptachlor Epoxide	22.00	12.00
alpha-Endosulfan	0.19	1.10
Dieldrin	95.00	110.00
Endrin	3.70	6.80
Methoxychlor	<0.77	<17.00

MAY 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	1-JAR 86-002	1-JAR 86-007	1-JAR 86-009	1-JAR 86-017	1-JAR 86-019	1-JAR 86-028
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	460 um net	20 um net	273 um net	20 um net	73 um net	20 um net
Size fraction	500 um	125 um	63 um	63 um	250 um	25 um
Comments	305-0 m	280-0 m	285-0 m	280-0 m	285-0 m	280-0 m
Lipids - Dry Wt.	20.93 %	(44.71%)	16.43 %	(16.43%)	35.20 %	(16.42%)
Lipids - Wet Wt.	3.84 %	(7.18%)	1.94 %	(1.49%)	4.51 %	(0.66%)
Arochlor 1254	<23.00	Q 43.00	240.00	Q 430.00	150.00	<85.00
HCB	Q 18.00	Q 10.00	26.00	Q 100.00	28.00	<21.00
Heptachlor	<17.00	<9.00	<18.00	<91.00	<4.30	<61.00
Aldrin	Q 3.00	Q 1.70	Q 33.00	Q 17.00	Q 0.80	Q 12.00
o,p'-DDE	<10.00	<5.40	<11.00	<56.00	Q 8.80	<38.00
p,p'-DDE	Q 15.00	Q 8.40	Q 16.00	96.00	17.00	<16.00
Mirex	Q 3.00	Q 1.70	<0.97	Q 17.00	1.60	Q 12.00
alpha-BHC	45.00	56.00	120.00	100.00	71.00	56.00
beta-BHC	Q 6.20	3.60	10.00	<10.00	4.80	Q 23.00
gamma-BHC	<8.10	Q 15.00	Q 30.00	<46.00	Q 7.40	<31.00
Oxychlordane	13.00	5.20	25.00	16.00	5.20	30.00
trans-Chlordane	14.00	7.70	22.00	29.00	13.00	25.00
cis-Chlordane	37.00	20.00	50.00	44.00	31.00	42.00
p,p'-DDT	100.00	56.00	140.00	280.00	56.00	150.00
cis-Nonachlor	19.00	11.00	28.00	15.00	13.00	24.00
Heptachlor Epoxide	9.10	2.90	17.00	130.00	4.10	12.00
alpha-Endosulfan	7.70	Q 1.60	12.00	16.00	0.97	Q 9.10
Dieldrin	32.00	11.00	45.00	77.00	17.00	<3.50
Endrin	12.00	Q 2.50	Q 4.70	220.00	3.40	4.90
Methoxychlor	Q 43.00	<7.20	290.00	<73.00	30.00	<49.00

MAY 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	1-JAR 86-060	1-JAR 86-070	1-JAR 86-081	1-JAR 86-091	1-JAR 86-092	1-JAR 86-098	1-JAR 86-099
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	253 um net	253 um net	460 um net	20 um net	253 um net	73 um net	253 um net
Size fraction	500 um	250 um	1000 um	250+ um	1000+ um	125 um	1000+ um
Comments	305-0 m	305-0 m	305-0 m	280-0 m	305-0 m	285-0 m	305-0 m
Lipids - Dry Wt.	33.16 %	39.10 %	27.30 %	39.10 %	39.15 %	44.71 %	41.75 %
Lipids - Wet Wt.	4.00 %	6.29 %	4.10 %	4.70 %	3.75 %	7.18 %	4.20 %
Arochlor 1254	100.00	130.00	38.00	36.00	23.00	34.00	19.00
HCB	12.00	17.00	4.10	7.90	<0.64	100.00	4.10
Heptachlor	1.50	<13.00	<2.30	<2.00	<1.90	<1.60	<1.70
Aldrin	<0.27	Q 2.60	0.44	0.36	Q 0.36	0.48	Q 0.31
o,p'-DDE	Q 3.00	<7.40	<1.40	Q 4.10	<1.20	12.00	<1.00
p,p'-DDE	Q 9.70	12.00	4.40	5.10	3.60	67.00	4.10
Mirex	0.86	<0.69	Q 0.44	0.38	Q 0.36	3.90	Q 0.31
alpha-BHC	33.00	35.00	18.00	23.00	13.00	54.00	15.00
beta-BHC	1.30	<1.40	2.30	1.80	1.30	9.90	1.10
gamma-BHC	3.10	<6.10	Q 4.00	Q 3.30	Q 3.30	9.30	Q 2.90
Oxychlordane	4.10	4.70	2.00	2.00	2.50	4.80	2.80
trans-Chlordane	6.90	6.00	4.30	4.00	4.20	7.30	3.30
cis-Chlordane	17.00	18.00	10.00	8.90	9.60	18.00	10.00
p,p'-DDT	36.00	37.00	8.60	10.00	25.00	38.00	22.00
cis-Nonachlor	7.80	9.30	6.10	6.80	3.50	8.00	3.30
Heptachlor Epoxide	1.60	1.90	2.60	1.70	1.50	7.30	1.30
alpha-Endosulfan	Q 0.26	<0.66	<0.12	<0.10	<0.10	0.72	<0.09
Dieldrin	9.20	12.00	11.00	7.20	8.30	17.00	4.60
Endrin	2.40	1.30	0.18	<0.15	3.40	8.20	1.30
Methoxychlor	<1.20	<97.00	<1.80	<1.60	<1.50	5.10	<1.30

MAY 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	1-JAR 86-101	1-JAR 86-103	1-JAR 86-104	1-JAR 86-110	1-JAR 86-119
Sample Name	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	460 um net	460 um net	460 um net	460 um net	73 um net
Size fraction	1000+ um	2000+ um	2000+ um	2000+ um	500+ um
Comments	305-0 m	305-0 m	305-0 m	300-0 m	285-0 m
Lipids - Dry Wt.	57.10 %	26.50 %	36.30 %	27.40 %	33.70 %
Lipids - Wet Wt.	6.90 %	2.00 %	2.20 %	3.00 %	3.10 %
Arochlor 1254	37.00	82.00	51.00	30.00	36.00
HCB	5.30	7.10	2.80	2.10	5.30
Heptachlor	<1.20	<3.40	<1.70	<1.90	<2.30
Aldrin	Q 0.21	Q 0.64	Q 0.30	Q 0.33	Q 0.42
o,p'-DDE	Q 2.30	Q 7.20	Q 3.60	Q 4.00	<1.40
p,p'-DDE	4.20	6.70	4.20	3.30	5.00
Mirex	0.47	0.78	0.42	Q 0.33	Q 0.42
alpha-BHC	10.00	22.00	10.00	10.00	32.00
beta-BHC	1.60	2.40	1.10	1.50	2.80
gamma-BHC	2.30	Q 5.70	Q 2.80	0.31	3.10
Oxychlordane	1.60	3.10	1.20	2.20	2.60
trans-Chlordane	3.40	7.00	3.20	5.40	5.20
cis-Chlordane	7.70	16.00	7.60	12.00	12.00
p,p'-DDT	6.40	14.00	6.50	11.00	10.00
cis-Nonachlor	5.20	10.00	4.60	7.90	9.40
Heptachlor Epoxide	1.60	3.00	1.60	2.10	2.30
alpha-Endosulfan	<0.06	<0.18	<0.09	<0.10	<0.12
Dieldrin	6.90	13.00	6.20	9.70	8.70
Endrin	<0.09	<0.27	<0.13	<0.15	6.40
Methoxychlor	Q 3.00	Q 9.10	<1.30	Q 4.70	Q 5.90

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BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	2-JAR # 1004	2-JAR # 1008	2-JAR # 1011	2-JAR # 1015	2-JAR # 1020	2-JAR # 1023	2-JAR # 1025
Sample Name	Plankton	Snail,shrimp	Benthic amp.	Plankton	Brittle star	Plankton	Plankton
Collection method	20 um net	190 m trap	190 m trap	73 um net	190 m trap	450 um net	250 um net
Size fraction	125+ um		A. nugax	250+ um		total coll.	1000+ um
Comments	190-0 m	b. ingested	b. ingested		b. ingested		
Lipids - Dry Wt.	(24.70%)	12.20 %	29.19 %	28.80 %	4.75 %	49.00 %	37.70 %
Lipids - Wet Wt.	(2.10%)	3.60 %	6.13 %	2.10 %	1.04 %	2.80 %	3.40 %
Weight (g)	0.33	0.2	1.04	0.41	1.22	0.29	0.48
Arochlor 1254	28.00	24.00	1400.00	19.00	86.00	6.60	20.00
HCB	3.20	<0.65	37.00	3.30	14.00	1.60	3.40
Heptachlor	<1.20	<1.90	<0.37	<0.93	<0.31	<1.30	<0.79
Aldrin	<0.06	<0.11	Q 0.07	<0.05	<0.02	<0.07	<0.04
o,p'-DDE	<0.70	<1.20	0.89	Q 1.90	1.60	<0.79	<0.48
p,p'-DDE	1.60	<0.50	170.00	1.70	15.00	Q 1.20	1.50
Mirex	<0.06	<0.11	11.00	0.74	0.46	<0.79	Q 0.15
alpha-BHC	21.00	Q 0.50	58.00	22.00	24.00	17.00	30.00
beta-BHC	1.70	<0.21	0.36	1.60	6.00	1.30	1.90
gamma-BHC	2.10	<0.95	5.90	2.30	3.70	Q 2.20	3.10
Oxychlordane	0.85	0.47	36.00	0.68	6.50	0.45	0.92
trans-Chlordane	1.90	Q 0.34	19.00	1.50	8.70	0.90	2.20
cis-Chlordane	4.30	0.68	61.00	3.40	32.00	2.20	<0.04
p,p'-DDT	3.90	1.40	320.00	2.90	90.00	1.90	3.80
cis-Nonachlor	2.60	0.73	62.00	2.10	11.00	1.40	2.80
Heptachlor Epoxide	1.40	Q 0.17	6.20	1.50	10.00	0.83	1.20
alpha-Endosulfan	<0.06	<0.10	0.12	0.049	Q 0.04	<0.07	<0.04
Dieldrin	4.50	Q 0.35	18.00	4.40	34.00	2.70	3.50
Endrin	1.60	0.56	2.20	0.93	18.00	1.00	1.60
Methoxychlor	<0.91	<1.50	17.00	<0.73	0.91	<1.00	Q 2.10

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BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	2-JAR # 1030	2-JAR # 1037	2-JAR # 1100	2-JAR # 1101	2-JAR # 1102	2-MISC 4
Sample Name	Brittle star snail,shrimp	Benthic amp. Onisimus	Benthic amp. A. nugax	Benthic amp. Onisimus	Brittle star	Salmon bait
Collection method	190 m trap	190 m trap	201 m trap	201 m trap	201 m trap	
Comments	b. ingested	b. ingested	b. ingested	b. ingested	b. ingested	
Lipids - Dry Wt.	6.00 %	27.19 %	(29.19%)	22.26 %	10.30 %	
Lipids - Wet Wt.	1.00 %	10.19 %	(6.13%)	4.00 %	2.20 %	
Weight (g)	0.79	0.3	1.08	0.97	0.97	0.87
Arochlor 1254	170.00	370.00	480.00	1400.00	69.00	14.00
HCB	12.00	6.80	18.00	38.00	11.00	4.40
Heptachlor	<0.48	<1.30	<0.35	<0.39	<0.39	<0.44
Aldrin	<0.03	<0.07	<0.02	Q 0.72	<0.02	<0.02
o,p'-DDE	1.50	<0.77	Q 0.72	1.30	0.98	<0.26
p,p'-DDE	26.00	34.00	59.00	270.00	15.00	5.40
Mirex	2.00	2.20	6.20	8.80	0.35	Q 0.08
alpha-BHC	23.00	24.00	43.00	45.00	20.00	10.00
beta-BHC	1.06	2.00	Q 0.13	6.60	3.40	1.20
gamma-BHC	1.40	2.10	3.90	5.30	1.90	1.30
Oxychlordane	5.20	14.00	16.00	44.00	5.00	0.67
trans-Chlordane	6.07	3.00	12.00	17.00	12.00	0.82
cis-Chlordane	20.00	15.00	33.00	59.00	26.00	1.90
p,p'-DDT	48.00	60.00	130.00	170.00	70.00	2.00
cis-Nonachlor	14.00	16.00	38.00	52.00	1.80	1.30
Heptachlor Epoxide	4.60	1.40	1.80	8.80	17.00	0.83
alpha-Endosulfan	<0.03	Q 0.09	Q 0.03	0.13	2.70	<0.02
Dieldrin	23.00	4.50	11.00	14.00	61.00	1.70
Endrin	4.60	0.44	0.28	2.30	34.00	1.50
Methoxychlor	<0.38	2.50	Q 0.92	6.90	Q 1.00	<0.35

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BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	2-VIAL 1033	2-VIAL 1034	2-VIAL 1038	2-VIAL 1039	2-VIAL 1041
Sample Name	Plankton	Plankton	Benth. amp. Onisimus	Plankton	Plankton
Collection method	250 um net	73 um net	190 m trap	73 um net	20 um net
Size fraction	500 um	250+ um		63 um	25 um
Comments	180-0 m	180-0 m	b. ingested	180-0 m	180-0 m
Lipids - Dry Wt.	20.54 %	20.60 %	15.60 %	33.78 %	16.42 %
Lipids - Wet wt.	2.10 %	2.10 %	4.65 %	2.03 %	0.659 %
Weight (g)	0.14	0.31	0.82	0.12	0.22
Arochlor 1254	16.00	24.00	1400.00	25.00	12.00
HCB	3.40	8.00	19.00	16.00	2.00
Heptachlor	<2.70	<1.20	<0.46	<3.20	<1.70
Aldrin	<0.15	<0.07	Q 0.09	<0.18	<0.10
o,p'-DDE	<1.60	<0.75	Q 0.95	<1.90	<1.00
p,p'-DDE	1.60	2.00	330.00	Q 2.90	Q 1.60
Mirex	<0.15	Q 0.23	6.80	<0.18	<0.10
alpha-BHC	26.00	19.00	36.00	32.00	21.00
beta-BHC	2.40	1.20	1.10	3.60	1.30
gamma-BHC	Q 46.00	Q 21.0	28.00	Q 5.30	Q 2.90
Oxychlordane	2.80	0.68	61.00	3.20	0.82
trans-Chlordane	2.80	1.20	8.10	3.30	1.40
cis-Chlordane	7.70	2.90	39.00	9.80	3.30
p,p'-DDT	18.00	2.70	65.00	30.00	12.00
cis-Nonachlor	3.20	1.70	30.00	4.90	1.90
Heptachlor Epoxide	4.40	0.78	11.00	8.70	6.00
alpha-Endosulfan	1.70	<0.70	0.18	2.50	3.2
Dieldrin	5.20	2.50	11.00	13.00	6.30
Endrin	7.40	0.64	2.50	9.30	0.34
Methoxychlor	13.00	<0.97	20.00	35.00	<1.40

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BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	2-VIAL 1045	2-VIAL 1047*	2-VIAL 1049
Sample Name	Plankton	Plankton	Plankton
Collection method	450 um net	450 um net	250 um net
Size fraction	1000 um	500 um	250 um
Comments	200-0 m	200-0 m	180-0 m
Lipids - Dry Wt.	32.14 %	(34.77%)	41.88 %
Lipids - Wet Wt.	4.46 %	(2.45%)	3.86 %
Weight (g)	0.52	0.2	0.08
Arochlor 1254	6.10	Q 8.90	66.00
HCB	1.10	<0.65	Q 5.30
Heptachlor	<0.73	<1.90	<4.80
Aldrin	<0.04	<0.11	<0.26
o,p'-DDE	<0.44	<1.20	<2.90
p,p'-DDE	0.89	<0.50	Q 4.40
Mirex	<0.04	<0.11	<0.26
alpha-BHC	18.00	2.80	34.00
beta-BHC	2.20	<0.21	2.60
gamma-BHC	2.30	<0.10	Q 8.00
Oxychlordane	2.90	1.50	1.80
trans-Chlordane	1.80	0.74	3.20
cis-Chlordane	4.90	1.80	8.80
p,p'-DDT	8.70	5.00	24.00
cis-Nonachlor	2.40	0.90	3.60
Heptachlor Epoxide	1.70	0.11	2.50
alpha-Endosulfan	0.55	<0.10	Q 0.75
Dieldrin	3.60	Q 0.35	5.60
Endrin	1.80	0.35	1.40
Methoxychlor	2.10	<1.50	<3.80

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BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	2-JAR # 1004	2-JAR # 1008	2-JAR # 1011	2-JAR # 1015	2-JAR # 1020	2-JAR # 1023	2-JAR # 1025
Sample Name	Plankton	Snail,shrimp	Benthic amp.	Plankton	Brittle star	Plankton	Plankton
Collection method	20 um net	190 m trap	190 m trap	73 um net	190 m trap	450 um net	250 um net
Size fraction	125+ um		A. nugax	250+ um		total coll.	1000+ um
Comments	190-0 m	b. ingested	b. ingested		b. ingested		
Lipids - Dry Wt.	(24.70%)	12.20 %	29.19 %	28.80 %	4.75 %	49.00 %	37.70 %
Lipids - Wet Wt.	(2.10%)	3.60 %	6.13 %	2.10 %	1.04 %	2.80 %	3.40 %
Weight (g)	5.15	0.66	4.95	5.56	5.55	5.16	5.41
Arochlor 1254	1.80	7.30	290.00	1.40	19.00	0.37	1.80
HCB	0.20	<0.20	7.80	0.24	3.10	0.09	0.30
Heptachlor	<0.08	<0.58	<0.08	<0.07	0.07	<0.07	<0.07
Aldrin	<0.01	<0.03	Q 0.01	<0.01	<0.01	<0.01	<0.01
o,p'-DDE	<0.04	<0.36	0.19	Q 0.14	0.35	<0.04	<0.04
p,p'-DDE	0.10	<0.15	36.00	0.12	3.30	Q 0.07	0.13
Mirex	<0.01	<0.03	2.30	0.05	0.10	<0.04	Q 0.01
alpha-BHC	1.30	Q 0.15	12.00	1.60	5.30	0.95	2.70
beta-BHC	0.11	<0.06	0.08	0.12	1.30	0.07	0.17
gamma-BHC	0.14	<0.29	1.20	0.17	0.81	Q 0.12	0.28
Oxychlordane	0.05	0.14	7.60	0.05	1.40	0.03	0.08
trans-Chlordane	0.12	Q 0.10	4.00	0.11	1.90	0.05	0.19
cis-Chlordane	0.28	0.21	13.00	0.25	7.00	0.13	<0.01
p,p'-DDT	0.25	0.41	67.00	0.22	20.00	0.11	0.34
cis-Nonachlor	0.17	0.22	13.00	0.15	2.40	0.08	0.24
Heptachlor Epoxide	0.09	Q 0.05	1.30	0.11	2.20	0.05	0.10
alpha-Endosulfan	<0.01	<0.03	0.03	<0.01	Q 0.01	<0.01	<0.01
Dieldrin	0.29	Q 0.11	3.80	0.33	7.50	0.15	0.31
Endrin	0.10	0.17	0.46	0.07	4.00	0.06	0.15
Methoxychlor	<0.06	<0.45	3.60	<0.05	0.20	<0.06	Q 0.19

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BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	2-JAR # 1030	2-JAR # 1037	2-JAR # 1100	2-JAR # 1101	2-JAR # 1102	2-MISC 4
Sample Name	Brittle star snail,shrimp	Benthic amp. Onisimus	Benthic amp. A. nugax	Benthic amp. Onisimus	Brittle star	Salmon bait
Collection method	190 m trap	190 m trap	201 m trap	201 m trap	201 m trap	
Comments	b. ingested	b. ingested	b. ingested	b. ingested	b. ingested	
Lipids - Dry Wt.	6.00 %	27.19 %	(29.19%)	22.26 %	10.30 %	
Lipids - Wet Wt.	1.00 %	10.19 %	(6.13%)	4.00 %	2.20 %	
Weight (g)	4.94	0.80	5.13	5.40	4.60	5.46
Arochlor 1254	27.00	140.00	100.00	250.00	15.00	2.20
HCB	1.90	2.60	3.80	6.80	2.30	0.71
Heptachlor	<0.08	<0.49	<0.07	<0.07	<0.08	<0.07
Aldrin	<0.01	<0.03	<0.01	Q 0.13	<0.01	<0.01
o,p'-DDE	0.23	<0.29	Q 0.15	0.23	0.21	<0.04
p,p'-DDE	4.20	13.00	12.00	48.00	3.20	0.87
Mirex	0.31	0.82	1.30	1.60	0.07	Q 0.01
alpha-BHC	3.70	8.96	9.10	8.10	4.20	1.60
beta-BHC	0.17	0.75	Q 0.03	1.20	0.71	0.19
gamma-BHC	0.23	0.78	0.82	0.95	0.39	0.20
Oxychlordane	0.83	5.20	3.40	7.90	1.10	0.11
trans-Chlordane	0.97	1.10	2.50	3.10	2.50	0.13
cis-Chlordane	3.20	5.60	6.90	11.00	5.50	0.30
p,p'-DDT	7.70	22.00	27.00	31.00	15.00	0.31
cis-Nonachlor	2.20	6.00	8.00	9.30	0.38	0.20
Heptachlor Epoxide	0.73	0.51	0.38	1.60	3.60	0.13
alpha-Endosulfan	<0.01	Q 0.03	Q 0.01	0.02	0.57	<0.01
Dieldrin	3.70	1.70	2.30	2.50	13.00	0.26
Endrin	0.73	0.17	0.06	0.41	7.20	0.23
Methoxychlor	<0.06	0.95	Q 0.19	1.20	Q 0.21	<0.06

AUGUST 1986
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	2-VIAL 1033	2-VIAL 1034	2-VIAL 1038	2-VIAL 1039	2-VIAL 1041
Sample Name	Plankton	Plankton	Benth. amp. Onisimus	Plankton	Plankton
Collection method	250 um net	73 um net	190 m trap	73 um net	20 um net
Size fraction	500 um	250+ um		63 um	25 um
Comments	180-0 m	180-0 m	b. ingested	180-0 m	180-0 m
Lipids - Dry Wt.	20.54 %	20.60 %	15.60 %	33.78 %	16.42 %
Lipids - Wet wt.	2.10 %	2.10 %	4.65 %	2.03 %	0.659 %
Weight (g)	1.37	3.06	2.75	2.00	5.48
Arochlor 1254	1.60	2.40	420.00	1.50	0.46
HCB	0.35	0.81	5.70	0.94	0.08
Heptachlor	<0.28	<0.12	<0.14	<0.19	<0.07
Aldrin	<0.02	<0.01	Q 0.03	<0.01	<0.01
o,p'-DDE	<0.16	<0.08	Q 0.28	<0.11	<0.04
p,p'-DDE	0.16	0.20	98.00	Q 0.17	Q 0.06
Mirex	<0.02	Q 0.02	2.00	<0.01	<0.01
alpha-BHC	2.60	1.90	11.00	1.90	0.84
beta-BHC	0.24	0.12	0.32	0.21	0.05
gamma-BHC	Q 4.70	Q 0.21	8.30	Q 0.32	Q 0.12
Oxychlordane	0.28	0.07	18.00	0.19	0.03
trans-Chlordane	0.28	0.13	2.40	0.20	0.06
cis-Chlordane	0.78	0.30	12.00	0.59	0.13
p,p'-DDT	1.80	0.27	19.00	1.80	0.48
cis-Nonachlor	0.32	0.18	8.90	0.30	0.08
Heptachlor Epoxide	0.45	0.08	3.30	0.52	0.24
alpha-Endosulfan	0.17	<0.01	0.05	0.15	0.13
Dieldrin	0.53	0.25	3.30	0.76	0.25
Endrin	0.75	0.07	0.73	0.56	0.01
Methoxychlor	1.40	<0.10	5.90	2.10	<0.06

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BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	2-VIAL 1045	2-VIAL 1047	2-VIAL 1049	2-VIAL 1052
Sample Name	Plankton	Plankton	Plankton	Plankton
Collection method	450 um net	450 um net	250 um net	20 um net
Size fraction	1000 um	500 um	250 um	63 um
Comments	200-0 m	200-0 m	180-0 m	200-0 m
Lipids - Dry Wt.	32.14 %	(34.77%)	41.88 %	2.53 %
Lipids - Wet Wt.	4.46 %	(2.45%)	3.86 %	0.097 %
Weight (g)	3.75	0.2	0.87	3.67
Arochlor 1254	0.85	Q 8.90	6.10	0.99
HCB	0.15	<0.65	Q 0.49	0.15
Heptachlor	<0.10	<1.90	<0.44	<0.10
Aldrin	<0.01	<0.11	<0.02	<0.01
o,p'-DDE	<0.06	<1.20	<0.27	<0.06
p,p'-DDE	0.12	<0.50	Q 0.40	Q 0.10
Mirex	<0.01	<0.11	<0.02	<0.01
alpha-BHC	2.50	2.80	3.10	1.00
beta-BHC	0.31	<0.21	0.24	Q 0.04
gamma-BHC	0.31	<0.95	Q 0.74	Q 0.18
Oxychlordane	0.40	1.50	0.16	0.04
trans-Chlordane	0.24	0.74	0.29	0.09
cis-Chlordane	0.67	1.80	0.80	0.20
p,p'-DDT	1.20	5.00	2.20	0.68
cis-Nonachlor	0.33	0.90	0.33	0.10
Heptachlor Epoxide	0.23	0.11	0.23	0.04
alpha-Endosulfan	0.08	<0.10	Q 0.07	0.03
Dieldrin	0.50	Q 0.35	0.51	0.26
Endrin	0.26	0.35	0.13	0.03
Methoxychlor	0.29	<1.50	<0.35	<0.08

AUGUST 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	2-JAR # 1004	2-JAR # 1008	2-JAR # 1011	2-JAR # 1015	2-JAR # 1020	2-JAR # 1023	2-JAR # 1025
Sample Name	Plankton	Snail,shrimp	Benthic amp.	Plankton	Brittle star	Plankton	Plankton
Collection method	20 um net	190 m trap	190 m trap	73 um net	190 m trap	450 um net	250 um net
Size fraction	125+ um		A. nugax	250+ um		total coll.	1000+ um
Comments	190-0 m	b. ingested	b. ingested		b. ingested		
Lipids - Dry Wt.	(24.70%)	12.20 %	29.19 %	28.80 %	4.75 %	49.00 %	37.70 %
Lipids - Wet Wt.	(2.10%)	3.60 %	6.13 %	2.10 %	1.04 %	2.80 %	3.40 %
Arochlor 1254	110.00	200.00	4800.00	65.00	1800.00	14.00	53.00
HCB	13.00	<5.30	130.00	11.00	290.00	3.30	9.00
Heptachlor	<4.90	<16.00	<1.30	<3.20	<6.50	<2.70	<2.10
Aldrin	<0.26	<0.90	Q 0.22	<0.18	<0.36	<0.15	<0.11
o,p'-DDE	<2.80	<9.80	3.10	Q 6.60	34.00	<1.60	<1.30
p,p'-DDE	6.60	<4.10	580.00	5.80	310.00	Q 2.50	3.90
Mirex	<0.26	<0.90	38.00	2.60	9.70	<16.00	Q 0.40
alpha-BHC	85.00	Q 4.10	200.00	76.00	500.00	34.00	79.00
beta-BHC	6.90	<1.70	1.20	5.70	130.00	2.70	5.10
gamma-BHC	8.60	<7.80	20.00	8.00	78.00	Q 4.50	8.30
Oxychlordane	3.40	3.90	120.00	2.40	140.00	0.92	2.40
trans-Chlordane	7.90	Q 2.80	65.00	5.00	180.00	1.80	5.70
cis-Chlordane	18.00	5.60	210.00	12.00	670.00	4.60	<0.11
p,p'-DDT	16.00	11.00	1100.00	10.00	1900.00	3.90	10.00
cis-Nonachlor	11.00	6.00	210.00	7.10	230.00	2.90	7.30
Heptachlor Epoxide	5.60	Q 1.40	21.00	5.10	210.00	1.70	3.10
alpha-Endosulfan	<0.25	<0.82	0.41	0.17	Q 0.93	<0.14	<0.11
Dieldrin	18.00	Q 2.90	62.00	15.00	720.00	5.50	9.40
Endrin	6.50	4.60	7.40	3.20	380.00	2.00	4.30
Methoxychlor	<3.70	<12.00	58.00	<2.50	19.00	<2.00	Q 5.60

AUGUST 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	2-JAR # 1030	2-JAR # 1037	2-JAR # 1100	2-JAR # 1101	2-JAR # 1102	2-MISC 4*
Sample Name	Brittle star snail,shrimp	Benthic amp. Onisimus	Benthic amp. A. nugax	Benthic amp. Onisimus	Brittle star	Salmon bait
Collection method	190 m trap	190 m trap	201 m trap	201 m trap	201 m trap	
Comments	b. ingested	b. ingested	b. ingested	b. ingested	b. ingested	
Lipids - Dry Wt.	6.00 %	27.19 %	(29.19%)	22.26 %	10.30 %	
Lipids - Wet Wt.	1.00 %	10.19 %	(6.13%)	4.00 %	2.20 %	
Arochlor 1254	2800.00	1300.00	1600.00	6300.00	670.00	14.00
HCB	200.00	25.00	62.00	170.00	110.00	4.40
Heptachlor	<8.00	<4.80	<1.20	<1.80	<3.80	<0.44
Aldrin	<0.43	<0.26	<0.07	Q 3.20	<0.21	<0.02
o,p'-DDE	24.00	<2.80	Q 2.50	5.80	9.50	<0.26
p,p'-DDE	430.00	120.00	200.00	1200.00	150.00	5.40
Mirex	33.00	8.00	21.00	39.00	3.40	Q 0.08
alpha-BHC	380.00	88.00	150.00	200.00	190.00	10.00
beta-BHC	18.00	7.40	Q 0.45	30.00	33.00	1.20
gamma-BHC	24.00	7.70	13.00	24.00	18.00	1.30
Oxychlordane	86.00	51.00	55.00	200.00	48.00	0.67
trans-Chlordane	100.00	11.00	41.00	76.00	120.00	0.82
cis-Chlordane	330.00	55.00	113.00	260.00	250.00	1.90
p,p'-DDT	800.00	220.00	445.00	760.00	680.00	2.00
cis-Nonachlor	230.00	59.00	130.00	230.00	17.00	1.30
Heptachlor Epoxide	76.00	5.00	6.10	39.00	160.00	0.83
alpha-Endosulfan	<0.42	Q 0.34	Q 0.10	0.58	26.00	<0.02
Dieldrin	380.00	16.00	38.00	63.00	590.00	1.70
Endrin	76.00	1.60	0.96	10.00	330.00	1.50
Methoxychlor	<6.30	9.30	Q 3.10	31.00	Q 9.70	<0.35

AUGUST 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	2-VIAL 1033	2-VIAL 1034	2-VIAL 1038	2-VIAL 1039	2-VIAL 1041
Sample Name	Plankton	Plankton	Benth. amp. Onisimus	Plankton	Plankton
Collection method	250 um net	73 um net	190 m trap	73 um net	20 um net
Size fraction	500 um	250+ um		63 um	25 um
Comments	180-0 m	180-0 m	b. ingested	180-0 m	180-0 m
Lipids - Dry Wt.	20.54 %	20.60 %	15.60 %	33.78 %	16.42 %
Lipids - Wet wt.	2.10 %	2.10 %	4.65 %	2.03 %	0.659 %
Arochlor 1254	78.00	120.00	9000.00	74.00	70.00
HCB	17.00	39.00	120.00	46.00	12.00
Heptachlor	<13.00	<5.80	<2.90	<9.50	<10.00
Aldrin	<0.73	<0.33	Q 0.54	<0.53	<0.58
o,p'-DDE	<7.80	<3.60	Q 6.10	<5.60	<6.10
p,p'-DDE	7.80	9.80	2100.00	Q 8.60	Q 9.70
Mirex	<0.73	Q 1.10	43.00	<0.53	<0.58
alpha-BHC	130.00	92.00	230.00	94.00	130.00
beta-BHC	12.00	5.80	6.80	11.00	7.70
gamma-BHC	Q 220.00	Q 10.00	180.00	Q 16.00	Q 18.00
Oxychlordane	13.00	3.30	390.00	9.60	5.00
trans-Chlordane	13.00	6.00	52.00	9.90	8.60
cis-Chlordane	37.00	14.00	250.00	29.00	20.00
p,p'-DDT	87.00	13.00	420.00	88.00	72.00
cis-Nonachlor	15.00	8.00	190.00	15.00	12.00
Heptachlor Epoxide	22.00	3.80	70.00	26.00	36.00
alpha-Endosulfan	8.30	<0.32	1.20	7.40	19.00
Dieldrin	25.00	12.00	70.00	38.00	39.00
Endrin	36.00	3.10	16.00	27.00	2.10
Methoxychlor	64.00	<4.70	130.00	100.00	<8.50

AUGUST 1986
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	2-VIAL 1045	2-VIAL 1047	2-VIAL 1049	2-VIAL 1052
Sample Name	Plankton	Plankton	Plankton	Plankton
Collection method	450 um net	450 um net	250 um net	20 um net
Size fraction	1000 um	500 um	250 um	63 um
Comments	200-0 m	200-0 m	180-0 m	200-0 m
Lipids - Dry Wt.	32.14 %	(34.77%)	41.88 %	2.53 %
Lipids - Wet Wt.	4.46 %	(2.45%)	3.86 %	0.097 %
Arochlor 1254	19.00	Q 360.00	160.00	1000.00
HCB	3.40	<27.00	Q 13.00	160.00
Heptachlor	<2.30	<78.00	<11.00	110.00
Aldrin	<0.12	<4.50	<0.62	5.93
o,p'-DDE	<1.40	<49.00	<6.90	63.24
p,p'-DDE	<2.80	<20.00	Q 11.00	99.00
Mirex	0.12	<4.50	<0.62	5.90
alpha-BHC	56.00	110.00	80.00	1100.00
beta-BHC	7.00	<8.60	6.30	40.00
gamma-BHC	7.00	39.00	Q 19.00	180.00
Oxychlordane	8.90	61.00	4.20	42.00
trans-Chlordane	5.50	30.00	7.50	97.00
cis-Chlordane	15.00	73.00	21.00	210.00
p,p'-DDT	27.00	200.00	56.00	700.00
cis-Nonachlor	7.40	37.00	8.50	110.00
Heptachlor Epoxide	5.20	4.50	5.90	45.00
alpha-Endosulfan	1.70	<4.10	Q 1.80	34.00
Dieldrin	11.00	Q 14.00	13.00	270.00
Endrin	5.70	14.00	3.40	28.00
Methoxychlor	6.50	<61.00	<9.10	83.00

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BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	3-87-03	3-87-04	3-87-05	3-87-09	3-87-11	3-87-16	3-87-17
Sample Name	Plankton	Pelag. am.	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	250 um net	Bait trap	73 um net	73 um net	250 um net	450 um net	450 um net
Size fraction	250 um		125 um	125 um	500 um	500 um	1000 um
Comments	305-0 m	Under ice	305-0 m	305-0 m	305-0 m	305-0 m	305-0 m
Lipids - Dry Wt.	(33.99%)	16.74 %	(11.82%)	11.82 %	43.12 %	(43.12%)	32.52 %
Lipids - Wet Wt.	(4.78%)	1.51 %	(1.33%)	1.33 %	4.65 %	(4.65%)	8.22 %
Arochlor 1254	Q 2700.00	Q 440.00	Q 1300.00	500.00	Q 190.00	2600.00	54.00
HCB	Q 71.00	170.00	39.00	34.00	12.00	74.00	7.40
Heptachlor	<10.00	<1.60	8.80	Q 5.70	<0.70	31.00	<0.19
Aldrin	<0.69	1.00	<0.30	<0.11	<0.05	<0.60	0.01
o,p'-DDE	Q 48.00	Q 7.80	42.00	18.00	Q 3.30	59.00	1.60
p,p'-DDE	Q 71.00	19.00	58.00	38.00	12.00	270.00	6.60
Mirex	<71.00	<1.10	<3.50	Q 0.40	Q 1.70	<6.20	Q 0.46
alpha-BHC	<140.00	440.00	Q 220.00	160.00	44.00	Q 410.00	25.00
beta-BHC	<7.10	15.00	<3.50	10.00	<0.49	<6.20	0.63
gamma-BHC	<14.00	45.00	32.00	20.00	5.10	Q 41.00	4.30
Oxychlordane	5.50	39.00	17.00	12.00	2.70	48.00	2.80
trans-Chlordane	<54.00	63.00	<26.00	Q 30.00	Q 12.00	<47.00	3.40
cis-Chlordane	<65.00	150.00	<31.00	50.00	16.00	<58.00	11.00
p,p'-DDT	<590.00	Q 320.00	<280.00	Q 320.00	<39.00	<520.00	Q 37.00
cis-Nonachlor	<50.00	79.00	<24.00	32.00	Q 12.00	Q 150.00	4.70
Heptachlor Epoxide	<190.00	Q 100.00	<90.00	<31.00	<13.00	<170.00	<3.70
alpha-Endosulfan	<65.00	<10.00	<31.00	<11.00	<4.40	<56.00	<1.20
Dieldrin	<110.00	200.00	Q 180.00	46.00	<7.40	<95.00	9.00
Endrin	<440.00	<71.00	<210.00	<74.00	<30.00	<390.00	<8.30
Methoxychlor	<31.00	<4.90	<1.50	<5.10	<2.10	<28.00	<0.58

JUNE 1987
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	3-87-26	3-87-32	3-87-34	3-87-36	3-87-38	3-87-40	3-87-42
Sample Name	Plankton	Plankton	Plankton	Benth. am.	Benth. am.	Benth. am.	Benth. am.
Collection method	450 um net	250 um net	73 um net	310 m trap	310 m trap	310 m trap	310 m trap
Size fraction	2000+ um	1000+ um	250+ um	Psammonyx	Tmetonyx	juvenites	Ad. Anonyx
Comments	305-0 m	305-0 m	305-0 m	no b. ing.	no b. ing.	no b. ing.	no b. ing.
Lipids - Dry Wt.	25.03 %	20.32 %	33.99 %	(24.72%)	20.85 %	35.11 %	17.10 %
Lipids - Wet Wt.	2.73 %	1.31 %	4.78 %	(4.93%)	5.02 %	8.37 %	2.77 %
Arochlor 1254	110.00	88.00	190.00	3800.00	14000.00	2000.00	3800.00
HCB	9.70	9.00	1.50	52.00	120.00	54.00	140.00
Heptachlor	<0.24	<0.24	<0.08	<0.19	3.70	<0.11	Q 1.70
Aldrin	<0.02	0.74	<0.01	<0.01	19.00	0.04	0.43
o,p'-DDE	3.00	2.50	3.80	8.00	14.00	3.90	11.00
p,p'-DDE	13.00	11.00	9.40	530.00	2600.00	430.00	420.00
Mirex	1.70	0.98	1.30	25.00	110.00	17.00	48.00
alpha-BHC	23.00	31.00	19.00	72.00	150.00	82.00	170.00
beta-BHC	0.69	1.50	2.40	2.80	0.80	2.60	<0.36
gamma-BHC	3.40	3.70	2.40	7.40	12.00	7.80	12.00
Oxychlordane	4.80	4.70	2.80	81.00	580.00	77.00	88.00
trans-Chlordane	8.00	7.00	5.80	22.00	140.00	17.00	13.00
cis-Chlordane	19.00	18.00	13.00	121.00	460.00	94.00	130.00
p,p'-DDT	49.00	<45.00	28.00	300.00	860.00	210.00	510.00
cis-Nonachlor	14.00	8.70	6.90	140.00	480.00	100.00	230.00
Heptachlor Epoxide	<4.40	<4.40	<0.15	Q 13.00	57.00	10.00	<9.40
alpha-Endosulfan	<1.50	Q 4.90	<0.50	<1.30	Q 3.60	<0.68	<3.30
Dieldrin	9.80	16.00	11.00	27.00	130.00	17.00	33.00
Endrin	<10.00	<10.00	<3.50	<8.50	27.00	<4.80	<22.00
Methoxychlor	<0.72	<0.69	<0.24	Q 2.00	Q 1.70	<0.34	8.60

JUNE 1987
BIOTA SAMPLE
(ng/g lipid wt)

Sample I.D.	3-87-44	3-87-46*	3-87-48	3-87-50	3-87-52	3-LYCOD-F*
Sample Name	Salmon bt.	Bn. shrimp	Benth. am.	Benth. am.	Amphipods	Lycodes liver
Collection method		310 m trap	310 m trap	310 m trap	310 m trap	jig
Size fraction			Anonyx juv	Andaniexis	Tmetonyx	20 m deep
Comments		no b. ing.	no b. ing.	no b. ing.	no b. ing.	under ice
Lipids - Dry Wt.	17.32 %		24.72 %	26.50 %	25.62 %	
Lipids - Wet Wt.	2.94 %		4.93 %	5.30 %	6.64 %	
Arochlor 1254	200.00	Q 18.00	2400.00	3100.00	7400.00	610.00
HCB	53.00	0.85	89.00	83.00	<160.00	5.10
Heptachlor	Q 0.29	<0.07	<2.20	<0.17	<0.14	1.30
Aldrin	<0.01	<0.01	<0.02	0.04	0.05	0.65
o,p'-DDE	4.60	<0.09	5.10	4.00	5.80	4.00
p,p'-DDE	69.00	0.91	370.00	640.00	1300.00	120.00
Mirex	0.62	<0.05	24.00	27.00	66.00	8.40
alpha-BHC	127.00	<0.90	60.00	130.00	120.00	1.60
beta-BHC	13.00	<0.05	Q 0.53	5.40	2.60	Q 0.03
gamma-BHC	15.00	<0.09	4.50	13.00	9.10	1.10
Oxychlordane	7.50	0.13	69.00	110.00	160.00	8.40
trans-Chlordane	7.90	<0.35	72.00	29.00	70.00	4.10
cis-Chlordane	25.00	<0.42	270.00	150.00	280.00	14.00
p,p'-DDT	40.00	<3.80	440.00	450.00	580.00	260.00
cis-Nonachlor	9.00	<0.33	210.00	170.00	290.00	22.00
Heptachlor Epoxide	9.50	<1.20	Q 14.00	13.00	27.00	<0.24
alpha-Endosulfan	<0.55	<0.42	<1.40	<1.10	<0.90	<0.08
Dieldrin	19.00	<0.71	60.00	45.00	82.00	3.10
Endrin	<3.80	<2.90	<11.00	<7.20	<6.30	<0.56
Methoxychlor	<0.27	<0.20	31.00	<0.49	23.00	0.15

* Reported in wet weight only, no lipid values available

JUNE 1987
BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	3-87-03*	3-87-04	3-87-05*	3-87-09	3-87-11	3-87-16*	3-87-17
Sample Name	Plankton	Pelag. am.	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	250 um net	Bait trap	73 um net	73 um net	250 um net	450 um net	450 um net
Size fraction	250 um		125 um	125 um	500 um	500 um	1000 um
Comments	305-0 m	Under ice	305-0 m	305-0 m	305-0 m	305-0 m	305-0 m
Lipids - Dry Wt.	(33.99%)	16.74 %	(11.82%)	11.82 %	43.12 %	(43.12%)	32.52 %
Lipids - Wet Wt.	(4.78%)	1.51 %	(1.33%)	1.33 %	4.65 %	(4.65%)	8.22 %
Weight (g)	0.061	0.11	0.461	0.15	0.1	0.072	0.48
Arochlor 1254	Q 130.00	Q 73.00	Q 17.00	59.00	Q 80.00	120.00	17.00
HCB	Q 3.40	29.00	0.52	4.00	5.20	3.40	2.40
Heptachlor	<0.49	<0.27	0.12	Q 0.67	<0.30	1.40	<0.06
Aldrin	<0.03	0.17	<0.01	<0.01	<0.02	<0.03	<0.01
o,p'-DDE	Q 2.30	Q 1.30	0.56	2.20	Q 1.40	2.70	0.52
p,p'-DDE	Q 3.40	3.20	0.78	4.40	5.30	13.00	2.20
Mirex	<3.40	<0.19	<0.05	Q 0.05	Q 0.71	<0.29	Q 0.15
alpha-BHC	<6.60	73.00	Q 2.90	19.00	19.00	Q 19.00	8.30
beta-BHC	<0.34	2.50	<0.05	1.20	<0.21	<0.29	0.21
gamma-BHC	<0.66	7.60	0.42	2.40	2.20	Q 1.90	1.40
Oxychlordane	0.26	6.60	0.22	1.40	1.20	2.30	0.91
trans-Chlordane	<0.26	11.00	<0.34	Q 3.50	Q 5.20	<2.20	1.10
cis-Chlordane	<3.10	25.00	<0.41	5.90	6.90	<2.70	3.40
p,p'-DDT	<28.00	Q 53.00	<3.70	Q 38.00	<17.00	<24.00	Q 12.00
cis-Nonachlor	<2.40	13.00	<0.32	3.80	Q 5.00	Q 6.90	1.50
Heptachlor Epoxide	<9.20	Q 17.00	<1.20	<3.70	<5.60	<7.80	<1.20
alpha-Endosulfan	<3.10	<1.70	<0.41	<1.30	<1.90	<2.60	<0.40
Dieldrin	<5.20	34.00	Q 2.40	5.40	<3.20	<4.40	2.90
Endrin	<21.00	<12.00	<2.80	<8.70	<13.00	<18.00	<2.70
Methoxychlor	<1.50	<0.82	<0.02	<0.60	<0.90	<1.30	<0.19

* No dry weight available, reported as wet weight

JUNE 1987
BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	3-87-26	3-87-32	3-87-34	3-87-36	3-87-38	3-87-40	3-87-42
Sample Name	Plankton	Plankton	Plankton	Benth. am.	Benth. am.	Benth. am.	Benth. am.
Collection method	450 um net	250 um net	73 um net	310 m trap	310 m trap	310 m trap	310 m trap
Size fraction	2000+ um	1000+ um	250+ um	Psammonyx	Tmetonyx	juvenites	Ad. Anonyx
Comments	305-0 m	305-0 m	305-0 m	no b. ing.	no b. ing.	no b. ing.	no b. ing.
Lipids - Dry Wt.	25.03 %	20.32 %	33.99 %	(24.72%)	20.85 %	35.11 %	17.10 %
Lipids - Wet Wt.	2.73 %	1.31 %	4.78 %	(4.93%)	5.02 %	8.37 %	2.77 %
Weight (g)	0.51	0.63	1.13	0.62	0.86	0.78	0.34
Arochlor 1254	27.00	18.00	64.00	940.00	3000.00	720.00	660.00
HCB	2.40	1.80	0.52	13.00	26.00	19.00	24.00
Heptachlor	<0.06	<0.05	<0.03	<0.05	0.78	<0.04	Q 0.29
Aldrin	<0.04	0.15	<0.01	<0.01	4.00	0.01	0.07
o,p'-DDE	0.75	0.50	1.30	2.00	2.90	1.40	1.80
p,p'-DDE	3.20	2.20	3.20	130.00	540.00	150.00	72.00
Mirex	0.41	0.20	0.44	6.20	22.00	6.10	8.30
alpha-BHC	5.90	6.20	6.40	18.00	31.00	29.00	30.00
beta-BHC	0.17	0.30	0.82	0.70	0.17	0.92	<0.06
gamma-BHC	0.84	0.75	0.81	1.80	2.40	2.70	2.10
Oxychlordane	1.20	0.95	0.94	20.00	120.00	27.00	15.00
trans-Chlordane	2.00	1.40	2.00	5.50	30.00	5.90	2.30
cis-Chlordane	4.80	3.60	4.20	30.00	97.00	33.00	23.00
p,p'-DDT	12.00	Q 1.90	9.50	74.00	180.00	72.00	88.00
cis-Nonachlor	3.50	1.80	2.30	34.00	100.00	36.00	40.00
Heptachlor Epoxide	<1.10	<0.09	<0.05	Q 3.10	12.00	3.50	<1.60
alpha-Endosulfan	<0.37	Q 1.00	<0.17	<0.31	Q 0.74	<0.24	<0.56
Dieldrin	2.50	3.30	3.60	6.80	28.00	5.90	5.60
Endrin	<2.50	<2.10	<1.20	<2.10	5.60	<1.70	<3.80
Methoxychlor	<0.18	<0.14	<0.08	Q 0.48	Q 0.34	<0.12	1.50

JUNE 1987
BIOTA SAMPLE
(ng/g dry wt)

Sample I.D.	3-87-44	3-87-46*	3-87-48	3-87-50	3-87-52	3-LYCOD-F
Sample Name	Salmon bt.	Bn. shrimp	Benth. am.	Benth. am.	Amphipods	Lycodes liver
Collection method		310 m trap	310 m trap	310 m trap	310 m trap	jig
Size fraction			Anonyx juv	Andaniexis	Tmetonyx	20 m deep
Comments		no b. ing.	no b. ing.	no b. ing.	no b. ing.	under ice
Lipids - Dry Wt.	17.32 %		24.72 %	26.50 %	25.62 %	
Lipids - Wet Wt.	2.94 %		4.93 %	5.30 %	6.64 %	
Weight (g)	1.97	0.45	0.55	0.68	0.83	1.08
Arochlor 1254	35.00	Q 18.00	600.00	830.00	1900.00	1300.00
HCB	9.20	0.85	22.00	22.00	40.00	11.00
Heptachlor	Q 0.05	<0.07	<0.55	<0.04	<0.04	2.70
Aldrin	<0.01	<0.01	<0.01	0.01	0.01	1.40
o,p'-DDE	0.79	<0.09	1.30	1.10	1.50	8.50
p,p'-DDE	12.00	0.91	92.00	170.00	330.00	250.00
Mirex	0.11	<0.05	5.90	7.00	17.00	18.00
alpha-BHC	22.00	<0.90	15.00	35.00	31.00	3.40
beta-BHC	2.30	<0.05	Q 0.13	1.40	0.67	Q 0.07
gamma-BHC	2.70	<0.09	1.10	3.40	2.30	2.40
Oxychlordane	1.30	0.13	17.00	29.00	42.00	18.00
trans-Chlordane	1.40	<0.35	18.00	7.80	18.00	8.80
cis-Chlordane	4.30	<0.42	67.00	41.00	72.00	31.00
p,p'-DDT	7.00	<3.80	110.00	120.00	150.00	560.00
cis-Nonachlor	1.60	<0.33	52.00	44.00	75.00	46.00
Heptachlor Epoxide	1.60	<1.20	Q 3.50	3.50	6.90	<0.52
alpha-Endosulfan	<0.10	<0.42	<0.35	<0.28	<0.23	<0.18
Dieldrin	3.40	<0.71	15.00	12.00	21.00	6.50
Endrin	<0.66	<2.90	<2.70	<1.90	<1.60	<1.20
Methoxychlor	<0.05	<0.20	7.80	<0.13	6.00	0.33

* No dry weight available, reported as wet weight

JUNE 1987
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	3-87-03	3-87-04	3-87-05	3-87-09	3-87-11	3-87-16	3-87-17
Sample Name	Plankton	Pelag. am.	Plankton	Plankton	Plankton	Plankton	Plankton
Collection method	250 um net	Bait trap	73 um net	73 um net	250 um net	450 um net	450 um net
Size fraction	250 um		125 um	125 um	500 um	500 um	1000 um
Comments	305-0 m	Under ice	305-0 m	305-0 m	305-0 m	305-0 m	305-0 m
Lipids - Dry Wt.	(33.99%)	16.74 %	(11.82%)	11.82 %	43.12 %	(43.12%)	32.52 %
Lipids - Wet Wt.	(4.78%)	1.51 %	(1.33%)	1.33 %	4.65 %	(4.65%)	8.22 %
Weight (g)	0.061	1.22	0.461	1.33	0.927	0.072	1.90
Arochlor 1254	Q 130.00	Q 6.50	Q 17.00	6.10	Q 8.60	120.00	4.40
HCB	Q 3.40	2.60	0.52	0.46	0.56	3.40	0.61
Heptachlor	<0.49	<0.03	0.12	Q 0.08	<0.03	1.40	<0.02
Aldrin	<0.03	0.02	<0.01	<0.01	<0.01	<0.03	<0.01
o,p'-DDE	Q 2.30	Q 0.11	0.56	0.25	Q 0.15	2.70	0.13
p,p'-DDE	Q 3.40	0.29	0.78	0.50	0.57	13.00	0.54
Mirex	<3.40	<0.17	<0.46	Q 0.05	Q 0.08	<2.90	Q 1.00
alpha-BHC	<6.60	6.60	Q 2.90	2.20	2.00	Q 19.00	2.10
beta-BHC	<0.34	0.22	<0.05	0.14	<0.02	<0.29	0.05
gamma-BHC	<0.66	0.68	0.42	0.27	0.24	Q 2.00	0.35
Oxychlordane	0.26	0.59	0.22	0.16	0.13	2.30	0.23
trans-Chlordane	<2.60	0.95	<0.34	Q 0.39	Q 0.56	<2.20	0.28
cis-Chlordane	<3.10	2.30	<0.41	0.67	0.74	<2.70	0.87
p,p'-DDT	<28.00	Q 4.70	<3.70	Q 0.37	<1.90	<24.00	Q 81.00
cis-Nonachlor	<2.40	1.20	<0.32	0.42	Q 0.53	Q 6.90	0.39
Heptachlor Epoxide	<9.20	Q 1.60	<1.20	<0.42	<0.60	<7.80	<0.30
alpha-Endosulfan	<3.10	<0.16	<0.41	<0.14	<0.21	<2.60	<0.10
Dieldrin	<5.20	3.10	Q 2.40	0.61	<0.35	<4.40	0.75
Endrin	<21.00	<1.10	<2.80	<0.98	<1.40	<18.00	<0.68
Methoxychlor	<1.50	<0.07	<0.20	<0.07	<0.10	<1.30	<0.05

JUNE 1987
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	3-87-26	3-87-32	3-87-34	3-87-36	3-87-38	3-87-40	3-87-42
Sample Name	Plankton	Plankton	Plankton	Benth. am.	Benth. am.	Benth. am.	Benth. am.
Collection method	450 um net	250 um net	73 um net	310 m trap	310 m trap	310 m trap	310 m trap
Size fraction	2000+ um	1000+ um	250+ um	Psammonyx	Tmetonyx	juvenites	Ad. Anonyx
Comments	305-0 m	305-0 m	305-0 m	no b. ing.	no b. ing.	no b. ing.	no b. ing.
Lipids - Dry Wt.	25.03 %	20.32 %	33.99 %	(24.72%)	20.85 %	35.11 %	17.10 %
Lipids - Wet Wt.	2.73 %	1.31 %	4.78 %	(4.93%)	5.02 %	8.37 %	2.77 %
Weight (g)	4.67	9.80	8.04	2.80	3.57	3.27	2.10
Arochlor 1254	2.90	1.10	9.00	210.00	720.00	170.00	110.00
HCB	0.26	0.12	0.07	2.90	6.30	4.50	3.90
Heptachlor	<0.01	<0.01	<0.01	<0.01	0.19	<0.01	Q 0.48
Aldrin	<0.01	0.01	<0.01	<0.01	0.96	<0.01	0.01
o,p'-DDE	0.08	0.03	0.18	0.43	0.69	0.33	0.30
p,p'-DDE	0.34	0.14	0.44	29.00	130.00	36.00	12.00
Mirex	0.04	0.01	0.06	1.40	5.30	1.50	1.34
alpha-BHC	0.64	0.40	0.90	3.90	7.40	6.90	4.81
beta-BHC	0.02	0.02	0.11	0.15	0.04	0.22	<0.01
gamma-BHC	0.09	0.05	0.11	0.40	0.59	0.65	0.33
Oxychlordane	0.13	0.06	0.13	4.40	29.00	6.40	2.40
trans-Chlordane	0.22	0.09	0.27	1.20	7.20	1.40	0.36
cis-Chlordane	0.52	0.23	0.59	6.60	23.00	7.80	3.70
p,p'-DDT	1.30	Q 0.58	1.30	16.00	43.00	17.00	14.00
cis-Nonachlor	0.39	0.11	0.33	7.50	24.00	8.50	6.44
Heptachlor Epoxide	<0.12	<0.06	<0.07	Q 0.67	2.90	0.84	<0.27
alpha-Endosulfan	<0.04	Q 0.07	<0.02	<0.07	Q 0.18	<0.06	<0.09
Dieldrin	0.27	0.21	0.51	1.50	6.73	1.40	0.90
Endrin	<0.28	<0.13	<0.16	<0.46	1.40	<0.40	<0.62
Methoxychlor	<0.02	<0.01	<0.01	Q 0.10	Q 0.08	<0.03	0.24

JUNE 1987
BIOTA SAMPLE
(ng/g wet wt)

Sample I.D.	3-87-44	3-87-46	3-87-48	3-87-50	3-87-52	3-LYCOD-F
Sample Name	Salmon bt.	Bn. shrimp	Benth. am.	Benth. am.	Amphipods	Lycodes liver
Collection method		310 m trap	310 m trap	310 m trap	310 m trap	jig
Size fraction			Anonyx juv	Andaniexis	Tmetonyx	20 m deep
Comments		no b. ing.	no b. ing.	no b. ing.	no b. ing.	under ice
Lipids - Dry Wt.	17.32 %		24.72 %	26.50 %	25.62 %	
Lipids - Wet Wt.	2.94 %		4.93 %	5.30 %	6.64 %	
Weight (g)	11.60	0.45	2.76	3.40	3.20	2.307
Arochlor 1254	5.90	Q 18	120.00	170.00	490.00	610.00
HCB	1.60	0.85	4.40	4.40	10.00	5.10
Heptachlor	Q 0.01	<0.07	<0.01	<0.01	<0.01	1.30
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	0.65
o,p'-DDE	0.13	<0.09	0.25	0.21	0.38	4.00
p,p'-DDE	2.00	0.91	18.00	34.00	85.00	120.00
Mirex	0.02	<0.47	1.20	1.40	4.40	8.40
alpha-BHC	3.70	<0.90	2.90	7.00	8.00	1.60
beta-BHC	0.39	<0.05	Q 0.03	0.29	0.17	Q 0.03
gamma-BHC	0.45	<0.09	0.22	0.69	0.61	1.10
Oxychlordane	0.22	0.13	3.40	5.80	11.00	8.40
trans-Chlordane	0.23	<0.35	3.60	1.60	4.70	4.10
cis-Chlordane	0.72	<0.42	13.00	8.20	19.00	14.00
p,p'-DDT	1.20	<3.80	22.00	24.00	39.00	260.00
cis-Nonachlor	0.26	<0.33	10.00	8.80	19.00	21.00
Heptachlor Epoxide	0.28	<1.20	Q 0.67	0.70	1.80	<0.24
alpha-Endosulfan	<0.02	<0.42	<0.07	<0.06	<0.06	<0.08
Dieldrin	0.57	<0.71	3.00	2.40	5.40	3.10
Endrin	<0.11	<2.90	<0.47	<0.38	<0.41	<0.56
Methoxychlor	<0.01	<0.20	1.50	<0.03	1.60	0.15

Miscellaneous Samples from Plankton Sampling[a]

Sample I.D.	2-MISC 6	1-VIAL 8600111	1-VIAL 8600112	2-VIAL 1050
Sample Name	Paint chips (ng/g)	Winch cable (ng/L)[b]	Vermiculite (ng/g)	Geo gel (ng/g)
Comments	Winch Paint	Kevlar	Solvent Packaging	explosive (under-ice Seismic)
Lipids - Dry Wt.	-	-	-	-
Lipids - Wet Wt.	-	-	-	-
Weight (g)	0.003	1.0	0.03	0.06
Arochlor 1254	3800.00	<1.10	<18.00	<8.80
HCB	<43.00	<0.26	<4.30	<2.20
Heptachlor	<127.00	<0.78	<13.00	<6.30
Aldrin	Q 24.00	<0.04	<0.70	<0.35
o,p'-DDE	<77.00	<0.47	<7.70	<3.80
p,p'-DDE	1200.00	<0.21	<3.30	6.00
Mirex	<7.00	<0.04	<0.70	<0.35
alpha-BHC	56.00	2.40	<1.00	Q 1.60
beta-BHC	<14.00	0.34	<1.40	<0.70
gamma-BHC	<63.00	1.10	<6.30	<3.20
Oxychlordane	1.80	0.10	<0.67	6.20
trans-Chlordane	<6.70	0.05	<0.67	<0.33
cis-Chlordane	<6.70	0.05	<0.67	<0.33
p,p'-DDT	<14.00	0.55	<1.40	2.10
cis-Nonachlor	<6.70	0.10	<0.67	<0.33
Heptachlor Epoxide	22.00	0.03	<0.03	<0.17
alpha-Endosulfan	Q 17.00	0.11	<0.67	1.60
Dieldrin	Q 24.00	0.21	<0.70	2.10
Endrin	34.00	0.08	<1.00	3.00
Methoxychlor	180.00	1.50	<10.00	16.00

a) Materials present in or potentially in hydrohole or water column during sampling.

b) Equilibrium concentration (ng/L) of chlorinated hydrocarbons in 485 mL pre-extracted seawater fined with approximately 1 m kevlar cable.

Appendix F

Organochlorines in Surface Sediment

MAY 1986
SEDIMENT SAMPLE (pg/g)

Sample I.D.	1-S1	1-S2	1-S3	1-S4	1-S5	1-S6	1-S7
Weight (g)	30.79	26.64	28.34	21.51	21.03	23.01	26.13
Arochlor 1254	Q 45.00	Q 53.00	Q 49.00	65.00	67.00	Q 61.00	Q 54.00
HCB	16.00	18.00	17.00	33.00	19.00	32.00	32.00
Heptachlor	<0.97	<1.10	<1.10	<1.40	<1.40	<1.30	<1.20
Aldrin	<0.07	<0.08	<0.07	<0.09	<0.10	<0.09	<1.50
o,p'-DDE	<1.30	<1.50	Q 5.30	4.10	14.00	15.00	16.00
p,p'-DDE	Q 2.90	<1.10	<1.10	4.30	<1.40	5.00	5.10
Mirex	<0.19	<0.23	<0.21	<0.28	<0.29	<0.26	<0.23
alpha-BHC	<1.30	<1.50	<1.40	<1.90	<1.90	<1.70	<1.50
beta-BHC	<0.32	<0.38	<0.35	9.70	<0.48	94.00	14.00
gamma-BHC	17.00	16.00	21.00	30.00	21.00	<4.30	33.00
Oxychlordane	NM	NM	NM	NM	NM	NM	NM
trans-Chlordane	<0.97	<1.10	<1.10	<1.40	<1.40	<1.30	<1.20
cis-Chlordane	12.00	14.00	13.00	23.00	18.00	16.00	18.00
p,p'-DDT	32.00	41.00	39.00	54.00	39.00	54.00	60.00
cis-Nonachlor	NM	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	<0.97	<1.10	<1.10	<1.40	<1.40	<1.30	<1.20
alpha-Endosulfan	<0.65	5.60	5.20	13.00	9.90	18.00	15.00
Dieldrin	<5.50	<6.40	<6.00	Q 26.00	35.00	29.00	<17.00
Endrin	18.00	26.00	24.00	<0.05	<0.05	<0.04	72.00
Methoxychlor	<3.60	<4.10	<3.90	<5.10	<5.20	<4.80	<4.20

NM = Not Monitored

AUGUST 1986
SEDIMENT SAMPLE (pg/g)

Sample I.D.	2-S1	2-S2	2-S3	2-S4	2-S5	2-S6
Weight (g)	30.87	32.24	32.77	28.20	26.34	35.29
Arochlor 1254	Q 45.00	57.00	4.80	<1.50	55.00	66.00
HCB	24.00	19.00	1.20	2.60	22.00	30.00
Heptachlor	<0.97	<0.93	<0.09	<0.11	<1.10	<0.85
Aldrin	<0.07	<0.06	<0.01	<0.01	<0.08	<0.06
o'p'-DDE	<1.30	<1.20	<0.12	<0.14	<1.50	<2.60
p'p'-DDE	<0.97	Q 2.80	<0.09	Q 0.32	Q 3.40	Q 0.57
Mirex	<1.30	<0.19	<0.02	<0.02	<0.23	Q 0.42
alpha-BHC	240.00	<1.20	<1.20	<1.40	<1.50	<1.10
beta-BHC	35.00	<0.31	<0.31	1.20	<0.38	<0.28
gamma-BHC	13.00	11.00	Q 1.00	1.50	18.00	28.00
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	<0.97	5.40	<0.92	<0.11	<1.10	11.00
cis-Chlordane	12.00	11.00	0.81	1.90	22.00	21.00
p'p'-DDT	<0.13	22.00	<0.12	<0.14	<0.15	<0.11
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	<0.97	<0.93	<0.09	<0.11	<1.10	<0.85
alpha-Endosulfan	2.00	<0.62	<0.06	<0.07	3.80	2.80
Dieldrin	<5.50	<5.30	<0.52	<0.60	<6.50	<4.80
Endrin	<0.03	<0.03	<0.03	<0.04	<0.04	<0.03
Methoxychlor	<3.60	<3.40	<3.40	<3.90	<4.20	<3.10

NM = Not Monitored

JUNE 1987

CORE SEDIMENT SAMPLE (pg/g)

Sample I.D.	3S-1	3S-2	3S-3	3S-5	3S-6	3S-7
Depth	0-1 cm	10-11 cm	24-25 cm	0-1 cm	10-11 cm	25-26 cm
Weight (g)	9.3	33.3	31.4	21.3	28.4	28.6
Arochlor 1254	61.00	8.40	7.30	41.00	<1.40	5.20
HCB	12.00	26.00	57.00	9.90	17.00	28.00
Heptachlor	Q 8.60	Q 2.40	3.40	<0.94	<0.70	4.40
Aldrin	<0.43	<0.12	<0.13	<0.19	<0.14	<0.14
o'p'-DDE	<2.20	<0.60	<0.64	<0.94	<0.70	<0.70
p'p'-DDE	2.30	<0.60	Q 0.64	1.00	<0.21	<0.21
Mirex	<0.43	<0.18	<0.13	<0.19	<0.14	<0.14
alpha-BHC	<0.64	<0.12	<0.19	<0.29	<0.21	<0.21
beta-BHC	<7.50	<0.18	<2.23	<3.30	<2.50	<2.50
gamma-BHC	<3.20	<2.10	<0.96	<1.40	<1.10	<1.10
Oxychlordane	<0.22	Q 0.90	<0.06	<0.09	<7.80	<0.07
trans-Chlordane	<4.30	<1.20	<1.30	<1.90	<1.40	<1.40
cis-Chlordane	31.00	<0.90	<0.96	24.00	<1.10	<1.10
p'p'-DDT	<8.60	<2.40	<2.60	23.00	<2.80	<2.80
cis-Nonachlor	<3.20	<0.90	<0.96	<1.40	<1.10	<1.10
Heptachlor Epoxide	<0.86	Q 0.90	<0.25	2.20	<0.28	3.40
alpha-Endosulfan	<1.10	<0.30	<0.32	<0.47	<0.35	<0.35
Dieldrin	Q 7.50	4.75	12.00	<0.94	<0.70	<0.70
Endrin	5.80	3.10	<0.32	Q 2.40	<0.35	<0.35
Methoxychlor	<37.00	<10.00	<11.00	<16.00	<11.00	<12.00

1987
MARINE REFERENCE SEDIMENT SAMPLES (ng·g^{-1})

Sample I.D.	CS-1(a)	CS-1(b)	CS-1(c)	CS-1(d)	CS-1(e)	CS-1(f)
Arochlor 1254	<0.42	<0.42	<0.42	<0.42	<0.42	<0.42
HCB	<0.04	<0.04	Q 0.13	<0.04	<0.04	<0.04
Heptachlor	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
o'p'-DDE	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
p'p'-DDE	0.10	0.10	Q 0.09	Q 0.09	0.14	Q 0.09
Mirex	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
alpha-BHC	Q 0.12	Q 0.12	Q 0.12	Q 0.12	Q 0.12	Q 0.12
beta-BHC	0.51	0.51	0.31	0.36	0.50	0.55
gamma-BHC	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Oxychlordane	NM	NM	NM	NM	NM	NM
trans-Chlordane	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
cis-Chlordane	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
p'p'-DDT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
cis-Nonachlor	NM	NM	NM	NM	NM	NM
Heptachlor Epoxide	Q 0.10	Q 0.10	0.03	Q 0.10	Q 0.10	Q 0.10
alpha-Endosulfan	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dieldrin	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Methoxychlor	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11

NM = Not Monitired

Appendix G

Ice Island Plankton Samples
Identification of Dominant Species

J.S. Wilson
7 Jan 1988

ICE ISLAND PLANKTON SAMPLES

SUMMARY SHEET

Dominant Species:

The calanoid copepod species Calanus hyperboreus, C. glacialis and Metridia longa, in that order of importance, are the dominant species in most of these samples in terms of their contribution to the biomass. They are also numerically dominant in the 460 µm mesh samples and probably so in the 253 µm mesh samples. In the 73 and 20 µm mesh samples, however, while they still probably dominate the biomass, they are vastly outnumbered by small (<1 mm) species. These small species consist principally of juvenile copepod stages (nauplii and copepodites) with a small proportion of adults. Three copepod species, Oncaea borealis, Oithona similis and Microcalanus sp. appear to be the dominant species in this size group, and many of the juveniles can be ascribed to them.

Aside from the copepods, various other species make important contributions to the plankton biomass. The chaetognaths Sagitta maxima and Eukrohnia hamata are often the largest organisms in the samples. While not abundant, their large size is an important contribution to the biomass. The same is true of the medusa Aeginopsis laurentii. The large appendicularian Oikopleura vanhoeffeni is important in two of the samples. In one sample a single jellyfish, a colonial siphonophore, Dimophyes arctica, makes up most of the biomass. In one sample, the dominant organism is a small chain-forming dinoflagellate, (Gonyaulax catenata)?, present in very high numbers.

ICE ISLAND PLANKTON SAMPLES

26 May 1986	460 µm Mesh, 1 m diam. Net
Species Composition Tow	Vertical Tow Depth: 305 - 0 m
Jar 86-113	Flowmeter 3687

Dominant Species:

- Calanus hyperboreus
  - Adult Females, Copepodite Stage IV
- Calanus glacialis
  - Adult Females, Copepodite Stage V
- Metridia longa
  - Adult Females

Calanus hyperboreus copepodite stage V's are less important in this sample than in others. Most of the biomass is the Calanus-Calanus-Metridia complex.

Large Species:

Amphipods (1 Gammarid, 1 Hyperiid)
Aeginopsis laurentii (Narcomedusa) (2 specimens ~15 mm dia)
Eukrohnia hamata (Chaetognath) (Many <20 mm)
Sagitta maxima (Chaetognath) (4 specimens ~30 m)

Species Noted: (Present, but not abundant)

Euchaeta glacialis	Copepoda
Heterorhabdus norvegicus	
Scaphocalanus magnus	
Conchoecia borealis	Ostracoda

ICE ISLAND PLANKTON SAMPLES

14 June 1987	460 µm Mesh, 1 m diam. Net
Species Composition Tow	Vertical Tow Depth: 300 - 0 m
Jar 87-58	Flowmeter: 3503 Revs: 1498

Dominant Species:

Calanus hyperboreus
    Adult Females, Copepodite Stages V, IV
Calanus glacialis
    Adult Females
Metridia longa
    Adult Females, Copepodite Stages V

This sample is dominated by Calanus hyperboreus with copepodite stage V being slightly more abundant than the adult females

Large Species:

- Hyperiid Amphipod (1 specimen ~12 mm)
- Aeginopsis laurentii (Narcomedusa) (2 specimens ~15 mm dia)
- Eukrohnia hamata (Chaetognath) (2 specimens ~30 mm)
- Unidentified juvenile Chaetognaths (30 specimens <20 mm)

Species Noted: (Present, but not abundant)

Chiridius obtusifrons	Copepoda
Euchaeta glacialis	
Gaidius tenuispinus	
Heterorhabdus norvegicus	
Scaphocalanus magnus	
Spinocalanus sp.	
Conchoecia borealis	Ostracoda

ICE ISLAND PLANKTON SAMPLES

30 Aug 1986
Species Composition Tow
Jar 1027

460 µm Mesh, 1 m diam. Net
Vertical Tow Depth: 200 - 0 m
Flowmeter: 3505

Dominant Species:

Calanus hyperboreus
  Adult Females, Copepodite Stages V, IV
Calanus glacialis
  Adult Females, Copepodite Stage V
Metridia longa
  Copepodite Stages V
Oikopleura vanhoeffeni (Appendicularian)

There are about 60 specimens of *Oikopleura*, ranging from 10-25 mm length, many toward the larger size. Together with the *Calanus spp*. and the ctenophore, they make up over 90% of the volume.

Large Species:

Beroe cucumis (Ctenophore) (1 specimen, 10x15 mm)

Species Noted: (Present, but not abundant)

Gaidius tenuispinus	Copepoda
Microcalanus sp.	
Oithona similis	
Conchoecia borealis	Ostracoda

ICE ISLAND PLANKTON SAMPLES

27 May 1986
Species Composition Tow
Jar 86-15

253 µm Mesh, 1 m diam. Net
Vertical Tow Depth: 305 - 0 m

Dominant Species:

Calanus hyperboreus
  Adult Females, Copepodite Stages V, IV, III
Calanus glacialis
  Adult Females, Copepodite Stage V
Metridia longa
  Adult Females, Copepodite Stages V, IV

Dimophyes arctica (Siphonophore)

This sample has approximately twice the biomass of any of the other samples and has a strong yellow colour, unlike any of the other samples. A large part of the volume (50-75%) is apparently from a single colonial siphonophore. There are numerous large nectophores (swimming bells), gastrozoids, gonophores and gonozoids, and lots of small fragments, but only a single central stem. Identification as Dimophyes arctica is tentative. Metridia longa in this sample is more abundant than Calanus glacialis.

Large Species:

Clione limacina (Mollusca) (1 specimen ~20 mm)
Eukrohnia hamata (Chaetognath) (1 specimen~30 mm)
Sagitta maxima (chaetognath) (2 specimens ~30 mm)

Species Noted: (Present, but not abundant)

Euchaeta glacialis	Copepoda
Heterorhabdus norvegicus	
Scaphocalanus magnus	
Conchoecia borealis	Ostracoda

ICE ISLAND PLANKTON SAMPLES

28 May 1986	253 µm Mesh, 1 m diam. Net
Species Composition Tow	Vertical Tow Depth: 303 - 0 m
Jar '86-120	Flowmeter: 3687 Revs: 1693
	Time: 1042-1052

Dominant Species:

Calanus hyperboreus
    Adult Females, Copepodite Stages V, IV, III
Calanus glacialis
    Adult Females,Copepodite Stages V, IV, III
Metridia longa
    Adult Females & Males, Copepodite Stages V, IV

The above three species contribute most of the biomass and are also numerically dominant. There is a much greater presence of juvenile stages than in any of the 460 µm samples.

Large Species:

Sagitta maxima (Chaetognath) (1 specimen ~45 mm)
Eukrohnia hamata (Chaetognath) (Several ~30 mm)

Species Noted: (Present, but not abundant)

Euchaeta glacialis	Copepoda
Gaidius tenuispinus	
Haloptilus acutifrons	
Microcalanus sp.	
Oithona similis	
Pseudocalanus sp.	
Scolecithricella minor	
Conchoecia borealis	Ostracoda

ICE ISLAND PLANKTON SAMPLES

14 June 1987	253 µm Mesh, 1 m diam. Net
Species Composition Tow	Vertical Tow Depth: 295 - 0 m
Jar 87-53	

Dominant Species:

Calanus hyperboreus
  Adult Females, Copepodite Stages V, IV
Calanus glacialis
  Adult Females, Copepodite Stage V
Metridia longa
  Adult Females, Copepodite Stages V

Large Species:

Hyperiid Amphipods (3 specimens 10-15 mm)
Aeginopsis laurentii (Narcomedusa) (~15 mm dia)
Eukrohnia hamata (Chaetognath) (~30 mm)

Species Noted: (Present, but not abundant)

Euchaeta glacialis	Copepoda
Gaidius tenuispinus	
Haloptilus acutifrons	
Heterorhabdus norvegicus	
Microcalanus sp.	
Oithona similis	
Pseudocalanus sp.	
Scaphocalanus magnus	
Scolecithricella minor	
Conchoecia borealis	Ostracoda

ICE ISLAND PLANKTON SAMPLES

29 Aug 1986	253 μm Mesh, 1 m diam. Net
Species Composition Tow	Vertical Tow Depth: 180 - 0 m
Jar 1013	Flowmeter: 3503 Revs: 623

Dominant Species:

Calanus hyperboreus
Adult Females, Copepodite Stages V, IV
Calanus glacialis
Adult Females, Copepodite Stage V

C. hyperboreus stongly dominates this sample, with adult females and copepodite stage V's making up the commonest species and stage and the bulk of the biomass. Metridia longa is present, but much less common than in other samples.

Large Species:

No large chaetognaths or medusae are present.

Species Noted: (Present, but not abundant)

Oikopleura vanhoeffeni	Appendicularia
Euchaeta glacialis	Copepoda
Microcalanus sp.	
Oithona similis	
Pseudocalanus sp.	
Scaphocalanus magna	
Scolecithricella minor	
Conchoecia borealis	Ostracoda

ICE ISLAND PLANKTON SAMPLES

28 May 1986	73 µm Mesh, 1 m diam. Net
Species Composition Tow	Vertical Tow Depth: 285-0 m
Jar 86-121	Flowmeter: 3687

Dominant Species:

Large copepods dominate the biomass, while small species are numerically dominant. In Calanus hyperboreus, adult females and copepodite stage IV are more numerous than copepodite stage V's. In the small species, large diatoms are numerically dominant.

Large Species:

Aeginopsis laurentii (1 Narcomedusae ~15 mm dia)
Calanus hyperboreus
    Adult Females, Copepodite Stage IV
Calanus glacialis
    Adult Females
Metridia longa
    Adult Females, Copepodite Stage V
Sagitta maxima (3 Chaetognaths >30 mm)
Eukrohnia hamata (1 Chaetognath ~25 mm)

Small Species (Most <1 mm)

Coscinodiscus sp.?
    Large (<300 µm) centric diatoms
Copepod nauplii and copepodites
    (Various unidentified species and stages)
Oncaea borealis
    Adults and mostly copepodites
Oithona similis
    Adults and mostlycopepodites
Microcalanus sp.
    Adult females and copepodites

Species Noted: (Present, but not abundant)

Chiridius obtusifrons	Copepoda
Heterorhabdus norvegicus	
Scaphocalanus magnus	
Spinocalanus sp.	
Conchoecia borealis	Ostracoda
Tomopteris sp.	Polychaeta

ICE ISLAND PLANKTON SAMPLES

14 June 1987
Species Composition Tow
Jar 87-50

73 µm Mesh, 1 m diam. Net
Vertical Tow Depth: 295-0 m
Flowmeter: ***

Dominant Species:

In this sample the small species (<1mm) far outnumber the large species. This did not appear to be the case with the larger meshed samples. The large species still dominate the biomass, but quite obviously do not dominate the numbers. No obvious phytoplankton. Note: Small white chips particularly abundant in this sample.

Large Species:

- Aeginopsis laurentii (1 Narcomedusae ~15 mm dia)
- Amphipods (3 Hyperiids ~10 mm)
- Calanus hyperboreus
  - Adult Females
- Calanus glacialis
  - Adult Females
- Metridia longa
  - Adult Females, Copepodite Stage V
- Sagitta sp. (Several Chaetognaths ~12 mm)

Small Species (Most <1 mm)

- Copepod nauplii and copepodites
  - (Various unidentified species and stages)
- Oncaea borealis
  - Adults and mostly copepodites
- Oithona similis
  - Adults and mostly copepodites
- Microcalanus sp.
  - Adult females and copepodites

Species Noted: (Present, but not abundant)

Fritillaria sp.	Appendicularia
Oikopleura vanhoeffeni	
Euchaeta glacialis	Copepoda
Haloptilus acutifrons	
Heterorhabdus norvegicus	
Spinocalanus sp.	
Conchoecia borealis	Ostracoda
Tomopteris sp.	Polychaeta

ICE ISLAND PLANKTON SAMPLES

29 Aug 1986	73 µm Mesh, 1 m diam. Net
Species Composition Tow	Vertical Tow Depth: *****
Jar 1032	Flowmeter: 3503 Revs: 1000
	Time: 3 min 53 sec

Dominant Species:

Large species appear to dominate the biomass, while small species are numerically dominant. In the large species, Calanus glacialis and Metridia longa are present and common, but much less so than Calanus hyperboreus. Oikopleura and C. hyperboreus make up most of the biomass. Special Note: This sample contains numerous small white chips.

Large Species:

Calanus hyperboreus
    Adult Females, Copepodite Stage V
Calanus glacialis
    Adult Females, Copepodite Stage V
Metridia longa
    Adult Females, Copepodite Stage V
Oikopleura vanhoeffeni (Appendicularia)
    (78 specimens >20 mm, more of smaller size)

Small Species (Most <1 mm)

Copepod nauplii and copepodites
    (Various unidentified species and stages)
Oncaea borealis
    Adults and copepodites
Oithona similis
    Adults and copepodites
Microcalanus sp.
    Adult females

Species Noted: (Present, but not abundant)

Fritillaria sp.	Appendicularia
Euchaeta glacialis	Copepoda

ICE ISLAND PLANKTON SAMPLES

29 May 1986	20 µm Mesh, 3/4 m diam. Net
Species Composition Tow	Vertical Tow Depth: 280-0 m
Jar 86-118	Flowmeter: 3687

Dominant Species:

In this sample, the small species (<1mm) greatly outnumber the large species (>1mm). While the large species are sparse in comparison with the larger mesh samples, because of their size differential they still contribute a large proportion of the biomass. No phytoplankton obvious, only a few dinoflagellates (Gonyaulax?, Peridinium?), in contrast with the other 20 µm sample. Most of the small settled material appears to be detritus, rather than copepod nauplii.

Large Species:

- Calanus hyperboreus
  - Adult Females, Copepodite stage IV & III. CV's sparse.
- Calanus glacialis
  - Adult Females
- Metridia longa
  - Adult Females, Copepodite Stage V
- Sagitta maxima (3 Chaetognaths >20 mm)

Small Species (Most <1 mm)

- Copepod nauplii and copepodites
  - (Various unidentified species and stages)
- Oncaea borealis
  - Adults and mostly copepodites
- Oithona similis
  - Adults and mostly copepodites
- Microcalanus sp.
  - Adult females and copepodites

ICE ISLAND PLANKTON SAMPLES

28 Aug 1986
Species Composition Tow
Jar 1026

20 µm Mesh, 3/4 m diam. Net
Vertical Tow Depth: 180-0 m

Dominant Species:

There are very few (<100) large species in this sample, mostly Calanus hyperboreus. They are obviously numerically dominated by the smaller species. In this sample the most abundant small species is a dinoflagellate, tentatively identified as Gonyaulax catenata. This species is present by the million, individual cells (~55 µm) forming small 4-5 celled chains (~200 µm). These phytoplankton chains totally dominate the sample, making it difficult to see anything else but the largest organisms. Small zooplankters are present, resembling those in the 73µm samples, but with a higher percentage of nauplii and copepodites.

Large Species:

Calanus hyperboreus
    Adult Females, Copepodite stages V & IV
Calanus glacialis
    Adult Females
Metridia longa
    Adult Females, Copepodite Stage V
Scaphocalanus magnus

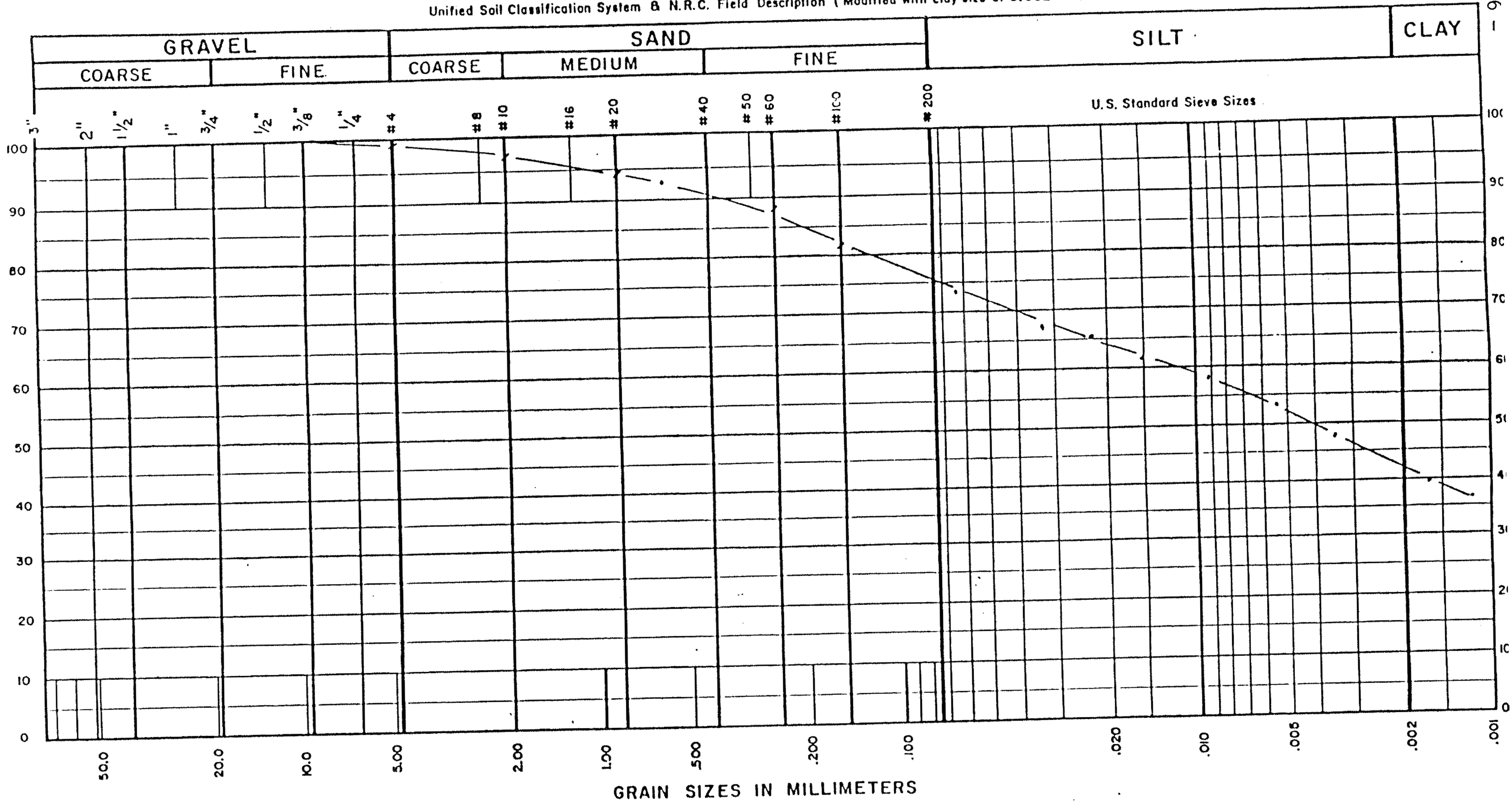
Small Species (Most <1 mm)

Coscinodiscus sp. Centric diatom
Copepod nauplii and copepodites
    (Various unidentified species and stages)
Oncaea borealis
    Adults and mostly copepodites
Oithona similis
    Adults and mostly copepodites
Microcalanus sp.
    Adult females and copepodites

Appendix H

Grain Size Data

Unified Soil Classification System & N.R.C. Field Description (Modified with clay size at 0.002 mm)



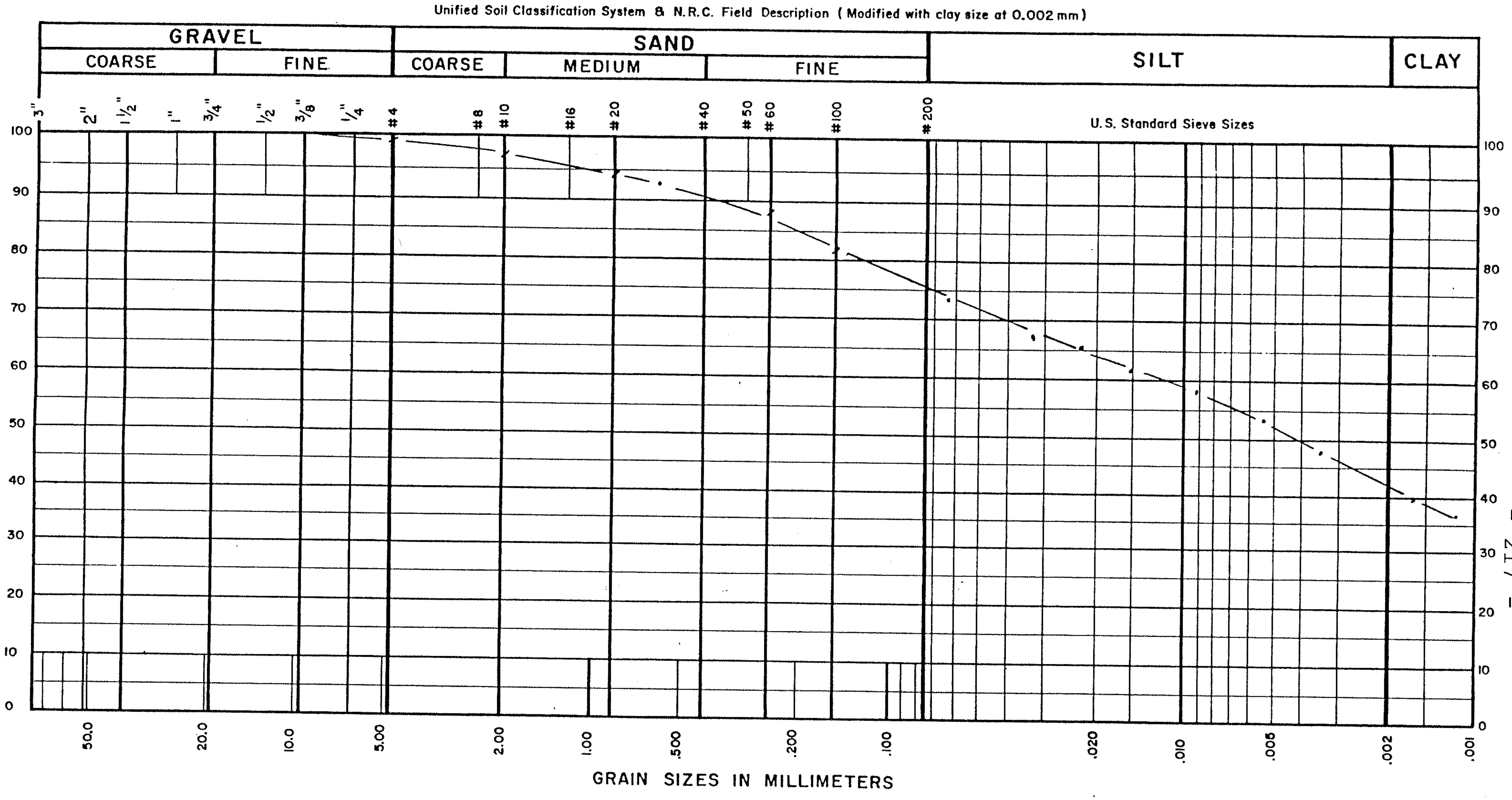
Nat. Water Content			%
Liquid Limit			
Plastic Limit			
Plastic Index			

Clay	42.0		%
Silt	31.6		
Sand	25.5		
Gravel	0.9		

Classification

CLIENT SEAKEM OCEANOGRAPHIC
PROJECT
LOCATION
SAMPLE II-1
TEST DATE MAR 5/87 FILE Nº 17-375-0

THURBER CONSULTANTS LTD., Geotechnical Engineers



Nat. Water Content			%
Liquid Limit			
Plastic Limit			
Plastic Index			

Clay	42.0		%
Silt	31.6		
Sand	25.5		
Gravel	0.9		

Classification

CLIENT SEAKEM OCEANOGRAPHIC
PROJECT
LOCATION
SAMPLE II-1
TEST DATE MAR 5/87 FILE Nº 19-395-0

THURBER CONSULTANTS LTD., Geotechnical Engineers

GRAIN SIZE ANALYSIS

Project Senken Oceanographic

Test Hole II -1

Depth

Tested by AGL

Date Mar 5/87

Checked by BKE

Dry Wt. of Coarse Sample =

Screen	Wt. Ret.	% Ret.	% Pass.
2-1/2"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"	-		100.0
1/4"			
#4	0.77		99.1
#10			
Pass. #10			
TOTALS			

HYDROMETER TEST

Dry Wgt. of Sample = 82.25

Cs = 2.80

Tc = 6.2

k = .01307

a = .97

Time Interval	Clock Reading	hyd'mtr. Reading	Temp. o F.	Grain Size m.m.	% Passing
-	1000		20		
1/2		-			
1	1001	63.5		.0319	67.6
2	1002	61.5		.0232	65.2
5	1005	58.5		.0152	61.7
15	1015	55.5		.0091	58.1
45	1045	51.5		.0055	53.4
120	1200	47.0		.0035	48.1
570	1930	40.0		.0017	39.9
1320	800	37.0		.0012	36.3

Dry Wt. of 1/4'd Sample Passing No. = 82.25

Screen	Wt. Ret.	% Ret.	% Pass.
#10	2.22		97.3
#20	4.67		94.3
#~~40~~ 30	6.05		92.6
#60	9.84		88.0
#100	15.03		81.7
#~~200~~ 230	21.71		73.6
Pan.			
TOTALS			

SPECIFIC GRAVITY TEST

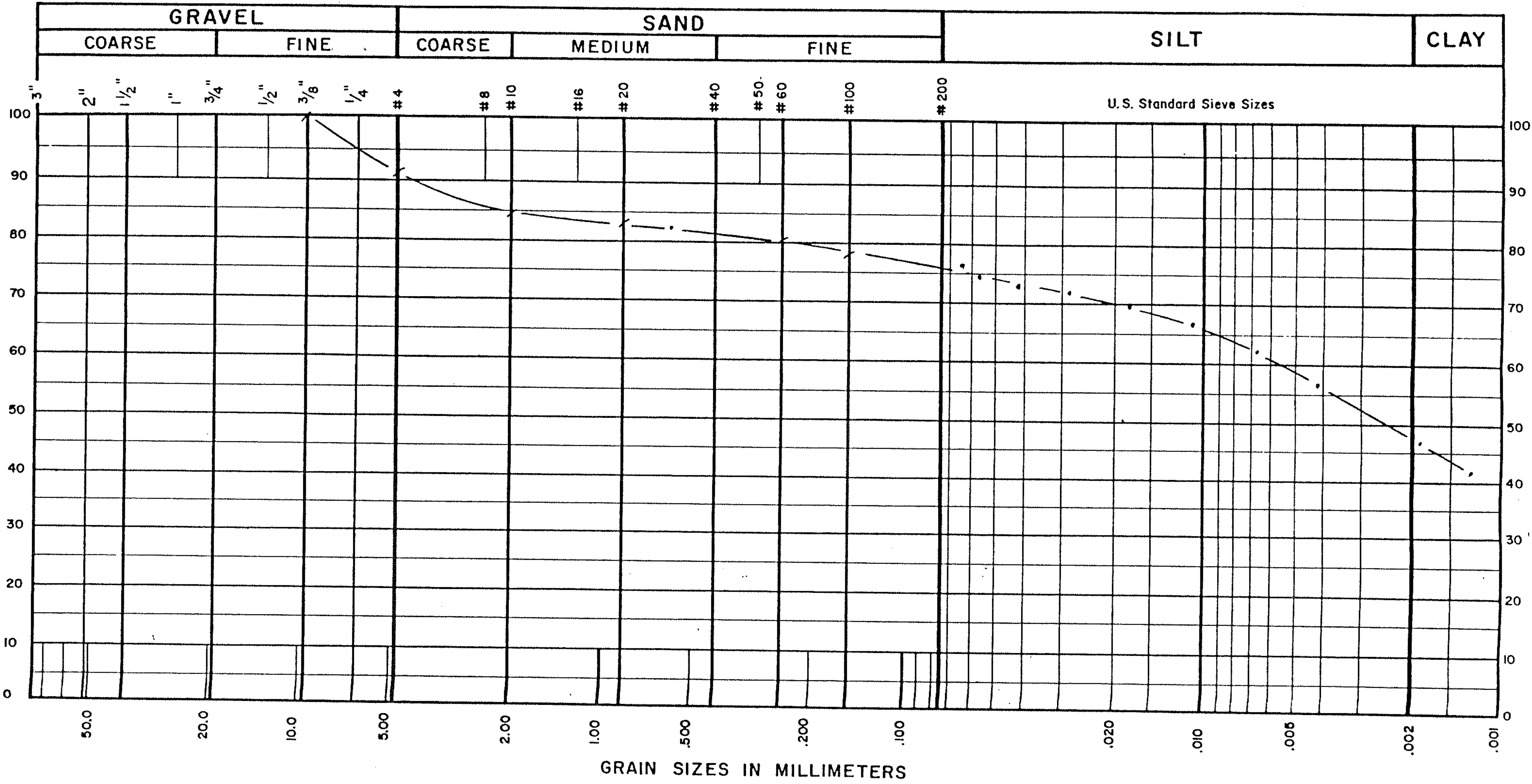
			191.23
(1) Wt. of Flask + Soil			
(2) Wt. of Flask		100	103.98
(3) Wt. of Soil = (1) - (2)			
(4) Wt. of Flask + Water			87.25
(5) (3) + (4)			5.00
(6) Wt. of Flask + Water + Soil			82.25
(7) Vol. of Soil = (5) - (6)			
(8) Temp. & Corr. (Tc)			
Specific Grav. = (3) x Tc/ (7)			

Classification

Remarks:

FILE No. 19-395-0

Unified Soil Classification System & N.R.C. Field Description (Modified with clay size at 0.002 mm)



Nat. Water Content			%
Liquid Limit			
Plastic Limit			
Plastic Index			

Clay	47.5		%
Silt	28.8		
Sand	14.7		
Gravel	9.0		

Classification

CLIENT SEAKEM OCEANOGRAPHIC
PROJECT
LOCATION
SAMPLE II-2
TEST DATE MAR 5/87 FILE Nº 19-395-0

THURBER CONSULTANTS LTD., Geotechnical Engineers

THURBER CONSULTANTS LTD.

GRAIN SIZE ANALYSIS

Project SEAKEM OCEANOGRAPHIC

Test Hole II - 2

Depth

Tested by ACW

Date MAR 5/87

Checked by BME

Dry Wt. of Coarse Sample =

Screen	Wt.Ret.	% Ret.	% Pass.
2-1/2"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"	–		100.0
1/4"			
#4	3.97		91.0
#10			
Pass. #10			
TOTALS			

HYDROMETER TEST

Gs = 2.80

Tc = 6.2

K = .01307

a = .97

Dry Wgt. of Sample = 44.14

Time Interval	Clock Reading	hyd'mtr. Reading	Temp. o F.	Grain Size m.m.	% Passing
–	1006		20		
½		40.0		.0578	74.3
1	1007	39.5		.0410	73.2
2	1008	39.0		.0291	72.1
5	1011	38.0		.0186	69.9
15	1021	36.5		.0109	66.6
40	1046	34.5		.0068	62.2
115	1201	32.0		.0041	56.7
565	1931	27.5		.0019	46.8
1315	801	25.0		.0013	41.3

Dry Wt. of 1/4'd Sample Passing No. = 44.14

Screen	Wt. Ret.	% Ret.	% Pass.
#10	6.82		84.5
#20	7.50		83.0
#~~40~~30	7.81		82.3
#60	8.71		80.3
#100	9.66		78.1
#~~200~~230	10.48		71.3
Pan.			
TOTALS			

SPECIFIC GRAVITY TEST

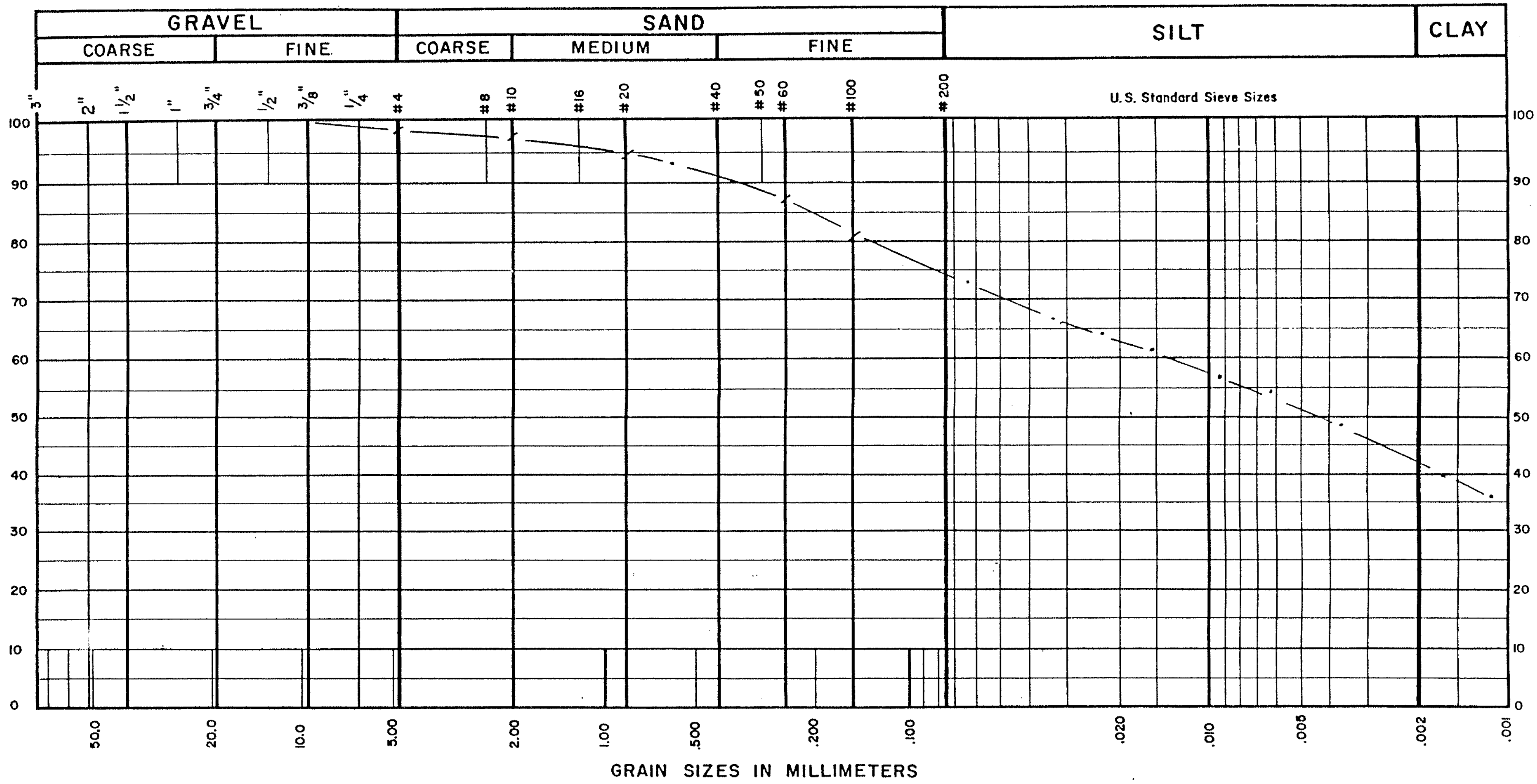
			237.58
(1) Wt. of Flask + Soil			
(2) Wt. of Flask		41	188.44
(3) Wt. of Soil = (1) - (2)			
(4) Wt. of Flask + Water			49.14
(5) (3) + (4)			5.00
(6) Wt. of Flask + Water + Soil			44.14
(7) Vol. of Soil = (5) - (6)			
(8) Temp. & Corr. (Tc)			
Specific Grav. = (3) x Tc / (7)			

Classification

Remarks:

FILE No. 19-395-0

Unified Soil Classification System & N.R.C. Field Description (Modified with clay size at 0.002 mm)



Nat. Water Content			%
Liquid Limit			
Plastic Limit			
Plastic Index			

Clay	42.0		%
Silt	30.9		
Sand	26.0		
Gravel	1.1		

Classification

CLIENT SEAKEM OCEANOGRAPHIC
PROJECT
LOCATION
SAMPLE II - 3
TEST DATE MAR 5/87 FILE No 19-395-0

THURBER CONSULTANTS LTD., Geotechnical Engineers

THURBER CONSULTANTS LTD.

GRAIN SIZE ANALYSIS

Project SEARCH OCEANOGRAPHIC

Test Hole II-3

Depth

Tested by AGW

Date MAR 5/87

Checked by BRE

Dry Wt. of Coarse Sample =

Screen	Wt. Ret.	% Ret.	% Pass.
2-1/2"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"	–		100.0
1/4"			
#4	0.87		98.9
#10			
Pass. #10			
TOTALS			

HYDROMETER TEST

Gs = 2.80

Tc = 6.2

Dry Wgt. of Sample = 79.76

K = .01307 a = .97

Time Interval	Clock Reading	hyd'mtr. Reading	Temp. o F.	Grain Size m.m.	% Passing
–	1012		20		
1/2		–			
1	1013	61.0		.0330	66.6
2	1014	59.0		.0239	64.2
5	1017	56.5		.0156	61.2
15	1027	53.0		.0093	56.9
35	1047	51.0		.0062	54.5
110	1202	46.0		.0037	48.4
560	1932	39.0		.0017	39.9
1310	802	35.5		.0012	35.6

Dry Wt. of 1/4'd Sample Passing No. = 79.76

Screen	Wt. Ret.	% Ret.	% Pass.
#10	1.92		97.6
#20	4.34		94.6
#~~40~~30	5.46		93.2
#60	10.17		87.2
#100	15.58		80.5
#~~200~~230	21.60		72.9
Pan.			
TOTALS			

SPECIFIC GRAVITY TEST

266.40

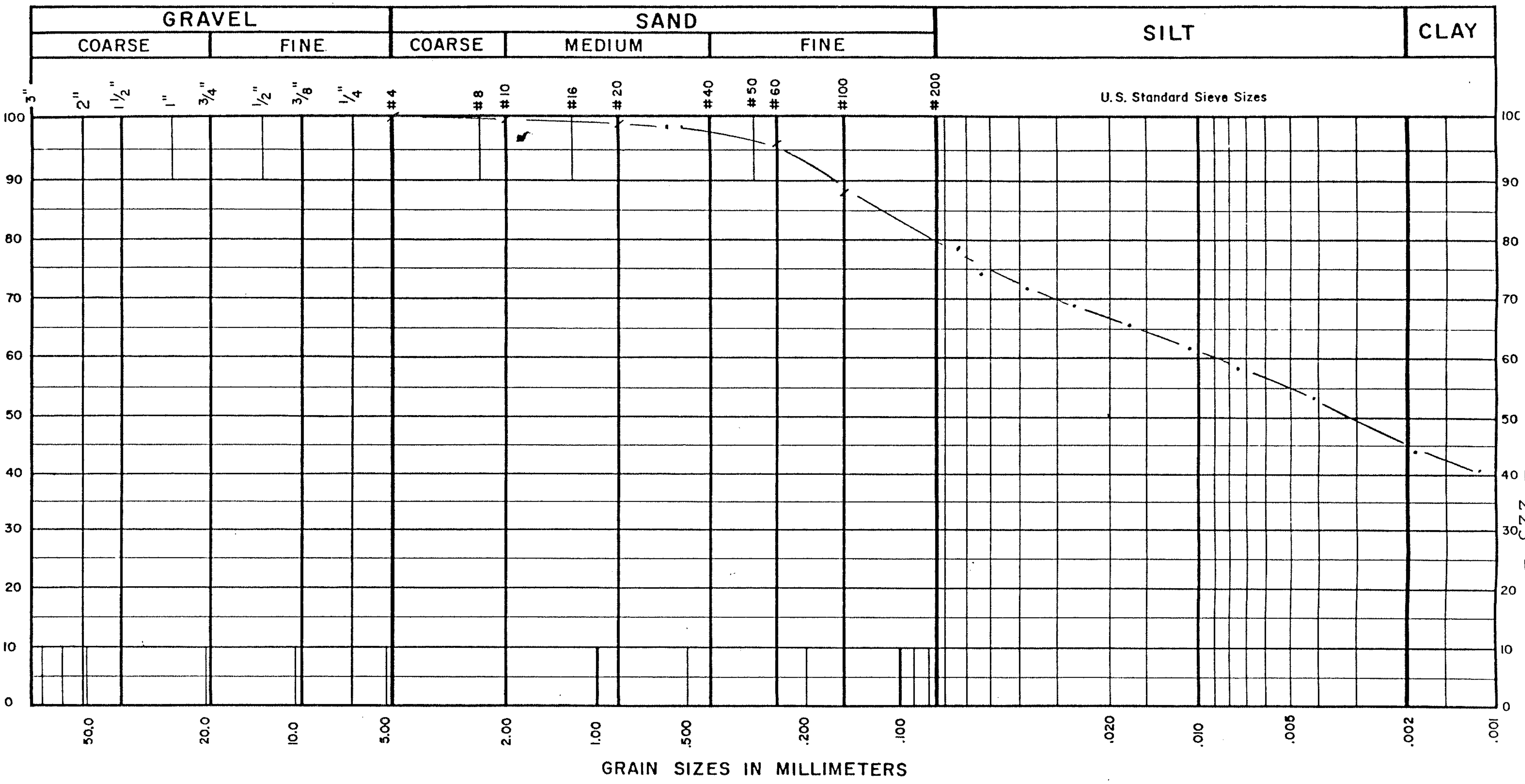
(1) Wt. of Flask + Soil (2) Wt. of Flask		9	181.64
(3) Wt. of Soil = (1) - (2)			
(4) Wt. of Flask + Water			84.76
(5) (3) + (4)			5.00
(6) Wt. of Flask + Water + Soil			79.76
(7) Vol. of Soil = (5) - (6)			
(8) Temp. & Corr. (Tc)			
Specific Grav. = (3) x Tc / (7)			

Classification

Remarks:

FILE No. 19-395-0

Unified Soil Classification System & N.R.C. Field Description (Modified with clay size at 0.002 mm)



Nat. Water Content			%
Liquid Limit			
Plastic Limit			
Plastic Index			

Clay	45.0		%
Silt	33.4		
Sand	21.6		
Gravel	—		

Classification

CLIENT SEAKEM OCEANOGRAPHIC
PROJECT
LOCATION
SAMPLE II-4
TEST DATE MAR 5/87 FILE Nº 19-395:0

THURBER CONSULTANTS LTD., Geotechnical Engineers

THURBER CONSULTANTS LTD.

GRAIN SIZE ANALYSIS

Project SEAKEM OCEANOGRAPHIC

Test Hole II-4

Depth

Tested by ACW

Date MAR 5/81

Checked by BAE

Dry Wt. of Coarse Sample =

Screen	Wt. Ret.	% Ret.	% Pass.
2-1/2"			
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
1/4"			
#4			
#10			
Pass. #10			
TOTALS			

HYDROMETER TEST

G = 2.75

Dry Wgt. of Sample = 54.56

Tc = 6.2 k = .01307 a = .97

Time Interval	Clock Reading	hyd'mtr. Reading	Temp. o F.	Grain Size m.m.	% Passing
-	1018		20		
1/2		48.0		.0538	74.3
1	1019	46.5		.0386	71.6
2	1020	45.0		.0277	69.0
5	1023	43.0		.0178	65.4
15	1033	41.0		.0105	61.9
30	1048	39.0		.0075	58.3
105	1203	36.0		.0041	53.0
555	1933	31.0		.0019	44.1
1305	803	29.0		.0012	40.5

Dry Wt. of 1/4'd Sample Passing No. = 54.56

Screen	Wt. Ret.	% Ret.	% Pass.
#10	0.30		99.5
#20	0.56		99.0
#~~40~~30	0.73		98.7
#60	2.23		95.9
#100	6.57		88.0
#~~200~~230	11.79		78.4
Pan.			
TOTALS			

SPECIFIC GRAVITY TEST

142.46

(1) Wt. of Flask + Soil			
(2) Wt. of Flask		56	82.90
(3) Wt. of Soil = (1) - (2)			
(4) Wt. of Flask + Water			59.56
(5) (3) + (4)			5.00
(6) Wt. of Flask + Water + Soil			54.56
(7) Vol. of Soil = (5) - (6)			
(8) Temp. & Corr. (Tc)			
Specific Grav. = (3) x Tc/ (7)			

Classification

Remarks:

FILE No. 17-395-0