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Monitoring Program for Major Atlantic Coast Fisheries

V. Zitko

Biological Station
St. Andrews, N. B., E0G 2X0

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MONITORING PROGRAM FOR MAJOR ATLANTIC COAST FISHERIES

by

V. Zitko

Fisheries and Environmental Sciences
Department of Fisheries and Oceans
Biological Station
St. Andrews, New Brunswick EOG 2X0

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ABSTRACT

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Data on contaminants are reviewed and a monitoring program is proposed. A toxicological program needed for the assessment of the significance of the observed levels of contaminants is discussed.

Key words: Contaminants, monitoring, toxicology, sublethal effects, organochlorine compounds, PAH, phthalates, trace elements

RÉSUMÉ

Zitko, V. 1981. Monitoring program for major Atlantic coast fisheries. Can. MS Rep. Fish. Aquat. Sci. 1615, iii + 15 p.

L'auteur étudie des données sur les contaminants et propose un système de surveillance; il présente un programme toxicologique qui est nécessaire pour évaluer l'importance des concentrations observées.

INTRODUCTION

This paper is an assessment of the data on contaminants in Canadian Atlantic coast fish and shellfish and a proposal for a monitoring program.

The objective of the monitoring program is to provide data on the levels of contaminants and their seasonal and year-to-year trends in directly and indirectly commercially important species of marine fauna. These data must be supplemented by background information on the effects associated with the observed levels of contaminants, on marine fauna and, in cooperation with the Department of Health and Welfare, on the effects of these levels on the consumers of fish and fisheries products. Baseline data on physiological and biochemical parameters and their random and seasonal variability in healthy fauna are part of the background information.

CURRENT INFORMATION

The current information is quite limited and deals mostly with organochlorine compounds and mercury (Hg). Some data are available on polycyclic aromatic hydrocarbons (PAH), phthalic acid esters (PAE), arsenic (As), cadmium (Cd), and lead (Pb).

ORGANOCHLORINE COMPOUNDS

The earliest survey for DDT and metabolites (p,p'-DDT, p,p'-DDE, and p,p'-DDD) was carried out by Sprague et al. (1969). The analyses were performed before the recognition of polychlorinated biphenyls (PCB) as contaminants and, consequently, the data are of limited value. Some more or less tentative assessment may be based on the concentration of DDE, since DDE is subject to the least interference by PCB due to its relatively high concentration in most samples. Most samples were taken in the Miramichi, Richibucto, and Ellerslie areas, and a few samples originated in the vicinity of St. Andrews. Means given below were obtained from 4-5 samples.

The concentration of DDE in mussels, clams, scallops, oysters, and quahaugs was about 0.05, not detectable - 0.05, 0.02-0.03, 0.01-0.02, and 0.01 µg/g wet weight, respectively, with no differences between the four sampling areas. The level of DDE in the lobster from Richibucto was 0.03 and 0.3 µg/g wet weight in muscle and eggs, respectively.

Whole mackerel, smelt, and tomcod from the Miramichi were analyzed and the concentrations of DDE were 0.09, 0.01, and not detectable, respectively. Salmon, cod, hake, and flounder muscle and viscera were analyzed separately. The levels of DDE were highest in cod (Richibucto), 0.04 and 0.2, followed by salmon (Miramichi) and hake (Richibucto), both at about 0.03 and 0.1, and flounder (Richibucto), 0.01 and 0.01 µg/g in muscle and viscera, respectively.

The next survey was carried out by Zitko (1971). PCB were found in higher concentrations than organochlorine pesticides in all samples. Mussels (Miramichi Bay, October 1970) contained PCB and DDE at 0.14 and 0.02 µg/g wet weight, respectively. Muscle of groundfish (cod, hake, plaice, and ocean perch, summer 1970) from Nova Scotia banks contained PCB and DDE at about 0.02 µg/g or less. The levels of PCB and DDE in the muscle of herring (Bay of Fundy December 1970, Chedabucto Bay January 1971) were 0.3-0.5 and 0.06-0.24 µg/g, respectively. Mackerel muscle (Bay of Fundy, September 1970) contained PCB and DDE at 0.35 and 0.07 µg/g, respectively.

DDT and metabolites in cod liver from six areas (Grand Manan, Yarmouth, Halifax, Chedabucto Bay, Sydney Bight, Shippegan) were determined by Sims et al. (1975). A few samples of cod muscle were analyzed as well. Initially, PCB were not separated from organochlorine pesticides. Some samples were later re-analyzed, correcting for the interference by PCB, and the authors estimated that this interference amounted to an overestimate of 15-26% in terms of the total DDT (DDE + DDD + DDT) concentration. The total DDT concentration was from 6-9 µg/g liver wet weight in four areas. The lowest concentration (4 µg/g) and the highest concentration (14 µg/g) were found in fish from Sydney Bight and off Halifax, respectively. The concentration of DDE in cod muscle from Grand Manan and Sydney Bight was about 0.01 µg/g wet weight.

A survey of the levels of organochlorine compounds in 29 species of fish and shellfish collected in 1971-72 was carried out by Sims et al. (1977). The analyses were mostly of edible tissues and the samples were taken from commercial catches from the Gulf of St. Lawrence, the Northumberland Strait, the Bay of Fundy, coastal Nova Scotia and coastal Newfoundland. No appreciable differences between these areas and between years (1971 and 1972) were found, but the results were too limited for a thorough evaluation. A ranking of species according to the concentration of PCB indicates an increasing trend from bivalve molluscs through groundfish and crustaceans to pelagic species (Table 1).

Data on organochlorine compounds in cod landed in 1975 have been published (ICES 1977a). A part of the data (Table 2) is used to illustrate a decreasing trend of PCB levels in a roughly northeasterly direction.

The levels of organochlorine compounds in two populations of herring have been monitored from 1972-77 as a part of an OECD program. The data are included in the Appendix and will be discussed in more detail in connection with trend monitoring.

A similar monitoring program of cod is under way under the auspices of ICES. Data from 2 yr are available (1977, 1978) and analyses of samples from 1979 are under way (Uthe, pers. comm.). Samples of tunas, sharks, and lobsters are analyzed occasionally by gas chromatography-mass spectrometry.

POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

The data on PAH in marine fauna are limited, but it appears that the contamination of shellfish from coastal areas is considerable, whereas there is little contamination of finfish.

Shellfish from the vicinity of creosoted wharf structures are usually highly contaminated (Eaton and Zitko 1978). The concentration of PAH in lobsters may be very high (Dunn and Fee 1979). This contamination is presumably acquired in storage pounds although lobsters from areas such as the Miramichi estuary contain relatively high levels of PAH (Sirota and Uthe 1980).

Table 1. Distribution of commercial marine fauna according to PCB concentration in edible parts (from the data of Sims et al. 1977) in 1971-1972.

PCB, µg/g edible parts wet weight	Species
<0.01	oysters
0.01-0.02	clams, scallops, grey sole, haddock
0.02-0.03	mussels, queen and rock crab, pollock
0.03-0.04	red crab, plaice, yellowtail
0.04-0.05	shrimp, cod
0.05-0.06	capelin
0.06-0.07	catfish, redfish
0.07-0.08	-
0.08-0.09	-
0.09-0.1	lobster
0.1 -1	halibut, dogfish, striped bass, salmon, smelt, alewives, herring, mackerel, swordfish
>1	bluefin tuna

Table 2. PCB in cod liver in 1975 (ICES 1977a).

NAFO/ICES area (see Fig. 1)	Approximate area	PCB concentration (µg/g wet weight)
4X	Browns Bank (south of Nova Scotia)	1.45
4W	LaHave Bank (southeast of Nova Scotia)	2.05
4T	Western part of the Gulf of St. Lawrence	2.9-4.1
4Vn	Northeast of Cape Breton Island	1.9
1E	West of southern Greenland	0.45
1B	Davis Strait (north of 1E)	0.43

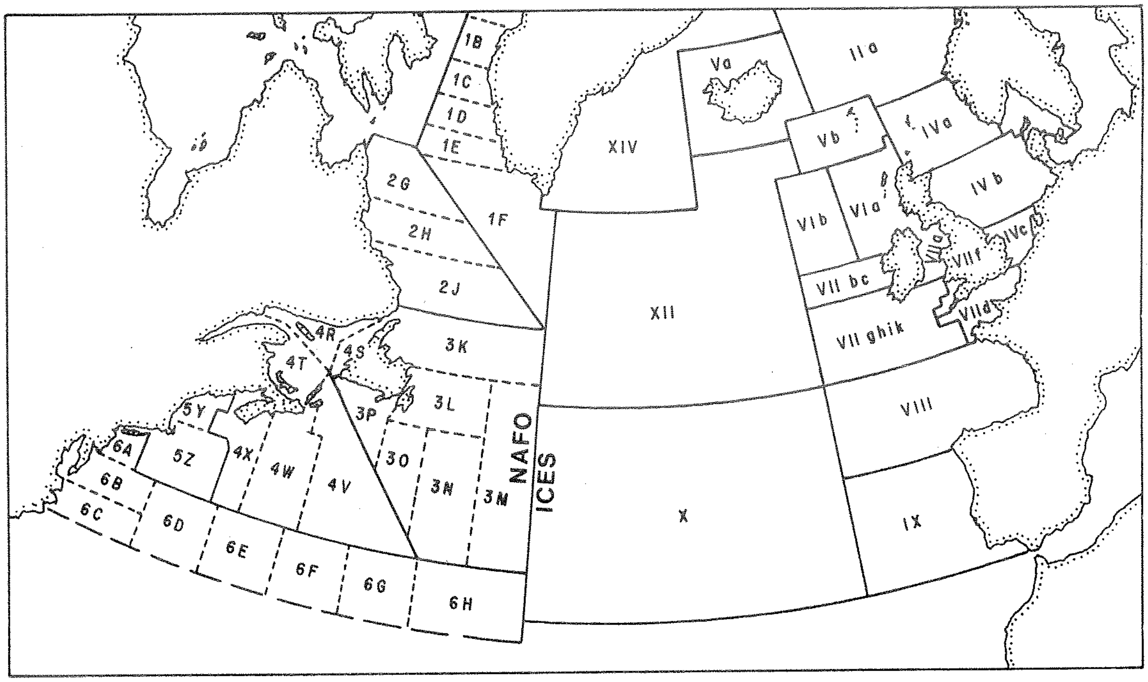

Fig. 1. NAFO/ICES areas.

PHTHALIC AND ESTERS (PAE)

Very little information is available on the presence of PAE in marine fauna. The usually detectable PAE are dibutyl- and di-(2-ethylhexyl)-phthalate. The former is present in the µg/kg range, the latter of up to 10 mg/kg wet weight. Unexpectedly high levels of di-n-hexylphthalate were found in herring and mackerel fillets from the Gulf of St. Lawrence (Musial and Uthe 1980).

MERCURY (Hg)

The levels of Hg in marine fish are generally low (Zitko et al. 1971). The exceptions are some large fishes with long life spans, such as swordfish and some tunas (Beckett and Freeman 1974), sharks, dogfish, large halibut, and larger offshore lobsters (Freeman et al. 1974).

ARSENIC (As)

High levels of As (over 100 µg As/g wet weight) were found in fish from certain areas (Uthe et al. 1979). As is present mainly in the form of an organo-As compound, possibly as arsenobetaine, phosphatidyl trimethyl arsoniumlactate, etc.

CADMIUM (Cd)

Relatively high concentrations of Cd are present in lobster (3-17 µg/g in hepatopancreas, (Freeman and Uthe 1974)). The highest Cd levels were found in lobsters off northern and eastern P.E.I.

LEAD (Pb)

The levels of Pb in fish appear generally low (≤0.5 µg/g wet weight), but a surprisingly high proportion (up to 90%) of Pb was found recently to be in the form of tetraalkyl-Pb (Uthe et al. 1979).

OTHER HEAVY METALS

The data on other heavy metals in Canadian marine fauna are quite limited. Concentrations of copper and zinc, as well as concentrations of trace elements discussed above, have been published (Ray et al. 1979). Literature data from other areas of the world indicate that levels of heavy metals in this category are generally low in fish (ICES 1977b). Bivalves may contain appreciable concentrations of copper, zinc, and other heavy metals (Kidder 1977).

INPUTS OF CONTAMINANTS INTO THE MARINE ENVIRONMENT

Long-range fallout, water transport, and local sources contribute contaminants to the marine environment. Little information is available on the amount of the long-range fallout. PAH are transported to Canadian coastal waters by long-range fallout from at least as far as the Boston area. The transport occurs in a northeasterly direction, and small, airborne particles from Boston appear to be reaching Nova Scotia. Larger particles reach the sediments in Boston Harbor and are transported seaward by resuspension and currents. The concentration of PAH in sediments decreases exponentially with the distance from Boston, with a 50% decrease over about 10 km (Hites et al. 1978). Similar data are not available for PCB but it is likely that the long-range fallout of PCB follows the same pattern. Trace elements are also transported by this mechanism. The annual deposition, monitored at St. Andrews, was 372, 67, 28, 47, 1 and 6 g/ha for Zn, Cu, Pb, Fe, Hg, and Cd, respectively (Zitko and Carson 1971).

Another long-range transport route may be in the general direction along the St. Lawrence River. Ware and Addison (1973) found a positive correlation between the concentration of PCB in No. 20 net plankton 16 km north of P.E.I. and the cumulative rainfall at Summerside.

Local (Maritimes) sources of contaminants include not only various industrial and technological activities, domestic sewage, solid waste, agriculture, forest spraying, but also fishing activities (wharves, boat and gear maintenance, etc.), and forest fires. It can be assumed that the fallout decreases exponentially with the distance from the source in the direction of the prevailing offshore winds (from the west and southwest). In addition, practically all major estuaries are to some extent industrialized and contribute to the pollutant loading by runoff.

Estimates of the inputs of contaminants into the marine environment are not readily available. The amount of DDT deposited in rainfall into the Gulf of St. Lawrence was about 5000 kg in 1968 (Pearce et al. 1978).

In addition to the physical long-range transport of contaminants into the area, fish migrating along the eastern seaboard may be contaminated enroute. This is not likely a significant pathway of contamination in respect to the marine ecosystem, but it may explain the presence of some of the "more exotic" organochlorine compounds in some species (Zitko 1980).

YEARLY TRENDS OF THE LEVELS OF CONTAMINANTS

Some evaluation of the annual trends of contaminant levels can be made only for organochlorine compounds. On a superficial inspection of the OECD data on herring (Table 3 and Appendix), it appears that the levels of organochlorine compounds have been declining or remained more or less constant.

The data still have to be subjected to a more detailed statistical analysis. The levels of organochlorine compounds must be considered in conjunction with weight of the fish and the content of lipid. The latter varies considerably in the Blue Cove population and this variation makes the assessment of the temporal trend of organochlorine compounds extremely difficult.

Statistically significant differences may be obtained between years, but it is not clear how these may be reflected in respect to a trend line extending over a number of years.

In the ICES cod study, statistically significant increased levels in 1978 compared to 1977 were observed for Hg (liver and muscle), Cd (liver), Se (liver), PCB (liver and muscle), Zn (liver), and Pb (liver). The levels of As (liver and muscle), α-HCH (liver), and DDT (liver) have decreased, and the levels of Pb (liver), Cu (liver and muscle), Zn (muscle), and HCB (liver) have not changed (Uthe, pers. comm.). As mentioned, longer time periods are needed and biological factors have to be taken into account to assess the significance of these changes.

FISH POPULATIONS AFFECTED BY CONTAMINANTS

Information on the effects of the observed levels of contaminants on fish populations is difficult to obtain and extremely limited. Laboratory toxicity studies seldom deal with adult fish and rarely relate tissue levels of toxicants to effects. Even if these data are obtained, they usually refer to 50% mortality, and the extrapolation to lower mortality rates remains largely conjectural. The same is true for the assessment of the effect of an additional 5-10% mortality, superimposed on a large "natural" mortality and fishing mortality, on a fish population.

The situation is similar or worse in relating the effects of contaminants to the reproductive success.

Improvements in the assessment of the effects of realistic levels of contaminants on individual fish and fish populations are urgently needed. At the "individual" level, the development of biochemical criteria of health such as steroid metabolism and adenylate energy charge, and of histology appear promising (for further details see Uthe et al. 1978).

A close cooperation between toxicologists and fisheries scientists is needed for obtaining baseline physiological data and for extrapolating from "individual" to "population" effects.

There are indications from laboratory experiments that cod are affected by levels of PCB found in the more contaminated areas of the North Atlantic and, possibly, in some inshore stocks (Freeman et al. 1978). Inshore Nova Scotia cod (Terrence Bay, Halifax County) were fed PCB-(Aroclor 1254) contaminated herring for up to $5\frac{1}{2}$ mo. Altered steroid metabolism, tissue abnormalities in the testes, and fatty degeneration of livers were observed in all PCB dose regimes. The threshold of the effects is difficult to estimate since the control fish contained an average PCB level of 5.1 μg/g liver wet weight and the livers indicated "some degree of degeneration." Effects ascribed to PCB in food were observed starting from the lowest feeding level, resulting in a PCB concentration of 10 μg/g liver wet weight. For comparison, PCB levels of 1.8, 8.5, 5.6, and 19.6 μg/g wet weight were reported in cod livers from North Sea ICES areas IVa, IVb 1974-75, IVb 1975, and IVc 1975, respectively.

There is some evidence that bluefin tuna may be affected by high levels of organochlorine compounds (Zitko 1980).

There is no information on possible effects of other contaminants and mixtures of contaminants at the levels currently found in the marine environment. It is likely that contaminants that are not exclusively of anthropogenic origin, such as Hg, As,

Table 3. Lipid and organochlorine compounds in herring (geometric means). For additional details see Appendix.

Year	Weight, g	Lipid, %	Organochlorine compounds µg/g wet wt. PCB	DDT	DDE	DDD
			Blue Cove (4T)			
1972	188	1.98	0.256	0.019	0.062	0.052
1973	224	3.24	0.360	0.028	0.066	0.039
1974	253	5.77	0.679	0.059	0.198	0.058
1975	296	2.51	0.286	0.026	0.054	0.037
			Trinity (4X)			
1972	195	9.98	0.404	0.038	0.083	0.047
1973	166	8.35	0.192	0.029	0.040	0.021
1974	209	8.11	0.301	0.037	0.087	0.032
1975	229	7.63	0.295	0.040	0.033	0.044
1977	199	8.09	0.197	0.013	0.022	0.024

Cd, and Pb are not present in concentrations causing observable effects, except for localized areas of considerable anthropogenic input. This may be true also for PAH, although there are indications that highly elevated levels of PAH are in some areas associated with tumors. Some organochlorine pesticides are far more acutely toxic than PCB to fish and invertebrates and their concentration in marine fauna may be toxicologically more important than the concentration of PCB.

HUMAN HEALTH ASPECTS OF CONTAMINANTS

This general area is under the jurisdiction of National Health and Welfare and this section summarizes only the current tolerance levels of contaminants (Table 4) to indicate fisheries that may be potentially subject to regulation. Most of the data in Table 4, particularly those for trace elements, are "in a state of flux."

Only in swordfish, some tunas, and larger lobsters is Hg close to or exceeds the tolerance level in some instances.

The PCB tolerance is not likely to be exceeded, except in some bluefin tunas. Little PCB data are available for swordfish. The tolerance for DDT is well above the current levels. The other pesticides in Table 4 are covered by a "blanket" tolerance. If there are indications of a problem, whether real or imaginary, such a tolerance may change on a rather short notice. Tolerances in the part per trillion range are under consideration for polychlorinated dibenzodioxins and, possibly, dibenzofurans. Chlordane and toxaphene are likely to receive increasing attention.

The levels of As in many species of fish, PAE in herring and mackerel, and the levels of Cd and PAH in shellfish may be exceeded if a tolerance is established by Health and Welfare. In such a case, the role of Fisheries and Oceans is to cooperate with Health and Welfare in the development of a realistic tolerance level, taking into account the form and bioavailability of a particular contaminant

Table 4. Tolerance levels 1980 (concentration in µg/g wet weight, edible parts)

Contaminant	Tolerance or guideline
Hg	0.5 (1.0 for swordfish)
Pb	5-10 depending on product
Cd	Not established
As	5
PCB	2
DDT	5
Dieldrin	0.1
Chlordane	0.1
Toxaphene	0.1
PAH	Not established
Phthalates	Not established

as well as the proportion of a given fishery product in the total diet.

A similar situation may arise with dieldrin, chlordane, and toxaphene.

GENERAL ASPECTS OF A MONITORING PROGRAM

The results of a large number of monitoring programs for organochlorine compounds have been reviewed (Phillips 1978) and several OECD monitoring programs have been evaluated (OECD 1978). A number of recommendations are given in these two publications. Assuming that the analytical part of the program is under control (interlaboratory reproducibility and intercalibration), OECD recommends that as the first step the aim of the project be defined and financing be secured. The project should be planned by a group consisting of chemists, biologists, and mathematicians, and the actual project should be preceded by a "baseline" study. The purpose of the baseline study is to ensure that the monitored contaminants are present in measurable concentrations in the samples of fauna. The initial study may also give some idea about the natural variability and, consequently, the needed numbers of individuals per sample (see also Gordon et al. 1980). Biological data on the sampled population, such as migration patterns and diet, should be considered. In the actual sampling, size (weight, length and, if possible, age), sex and state of sexual maturation, organ sizes, incidence of tumors and other abnormalities should be recorded. Phillips (1978) recommends sampling a range of ages (sizes) on several occasions during the years, since the levels of contaminants may not have simultaneous timing of maximum or minimum.

It appears to the writer that long-term monitoring should be conducted on organs or tissues containing highest levels of contaminants. High levels of contaminants are likely to minimize analytical errors and laboratory contamination problems, and may simplify statistical treatment of the results (for example, truncated distributions due to detection limits). Liver or its equivalent seems to be the organ of choice.

Data on other organs and tissues, including edible parts, should be obtained to have a rough idea about the distribution of contaminants and when required by specific research objectives. Routine monitoring of edible parts should be the responsibility of Fish Inspection.

The following terminology is used in the subsequent discussion:

Individual sample (IS) means a sample of tissues or organs from a number of specimens, analyzed individually.

Pooled sample (PS) means a sample of tissues or organs from a number of specimens, pooled, homogenized, and analyzed as one sample. Pooling may be carried out on an "equal weight" basis (equal weights from each individual specimen), or an "equivalent weight" basis (equal percentage of body weight from each individual specimen).

Pooled size-stratified sample (PSS) means several samples of tissues or organs from a number of specimens pooled within several size-classes (length or weight, whichever is more convenient or conventional). Within each class, pooling is carried out as for PS. The range of a size-class depends on the species sampled.

The purpose of pooling is to alleviate the load on the chemical laboratory and to decrease the cost of the program. Statistical simulation studies should be carried out to determine the effect of pooling on the estimates of means and standard deviations of the population, under various assumptions about the distribution of the concentrations of contaminants (for example, normal or log normal distribution, concentration size dependent, etc.).

Length-stratified sampling has been adopted by ICES to determine the impact of biological and other variables on pollutant levels in a population and should be the basis of the proposed expanded sampling study as well. Since little is known about the levels of contaminants in many of the Canadian Atlantic fish populations, the initial studies should have the form of a "baseline" or "preliminary survey" study. Based on the availability of biological expertise and samples, I recommend that the Halifax component of Fisheries Environmental Research be responsible for monitoring groundfish and invertebrates and the St. Andrews component for monitoring pelagic species as well as for the analyses of selected samples of all species by gas chromatography/mass spectrometry (GCMS).

Without a major disruption of research responsibilities and additional funding, the Halifax component could analyze about 100 samples per year for organic compounds. The St. Andrews component could analyze approximately 30 samples per year by routine techniques and 10 samples per year by GCMS. The capacity for trace metals is about 200 and 50 samples, respectively.

The above are maximum estimates, achievable only with up-to-date equipment without downtime. In addition, the samples would have to be biologically characterized and delivered to the laboratory by staff of other Resource Branch Divisions.

The interval between repeated analyses of individual specimens from the same study should be about 4-5 yr, unless the preliminary data cause some concern.

The specific proposal below was developed on the basis of fish and shellfish distributions described by Hare (1977).

SPECIFIC PROPOSAL FOR 1981-82

Cod, herring, lobster, and bluefin tuna should receive attention first because of their commercial importance and indications of elevated levels of some contaminants in several stocks.

COD

In addition to the Gulf of St. Lawrence stock (4T), analyzed within the ICES program (60 fish, IS), PSS should be taken from the Georges Bank stock (5Ze), and from the Nova Scotia coastal stock. These samples would establish whether there is a detectable gradient of contamination in the northeasterly and away from the coast directions. Additional PSS could be taken from the Banquereau Bank-Sable Island Bank area.

Cod enter the commercial catches at the age of about 3-4 yr. It may be interesting to extend the sampling to younger fish by special arrangements during research cruises.

The sampled organs are liver and muscle. Four pooled liver samples will be analyzed by GCMS. The number of analyses (Table 5) are rough estimates. The actual numbers of size-classes should be determined in cooperation with the Marine Fish Division.

HERRING

A considerable amount of data is available on two herring stocks (4T, 4X) analyzed last in 1975 and 1980, respectively. It is recommended to analyze three PSS (Table 5).

Table 5. Summary of monitoring in 1981-82.

Species	Area	Type of sample	Organ/tissue	Contaminant	No. of analyses
Cod	4T	IS	liver, muscle	OC[a]	60
		PS	"	PAE	1-2
	5Ze	PSS	"	OC, PAE	5-10
	Nova Scotia Coastal	PSS	"	OC, PAE	5-10
	Banquereau Bank	PSS	"	OC, PAE	5-10
	Sable Island Bank	PSS	"	OC, PAE	5-10
Herring	4T	PSS	muscle	OC, PAE	5
	5Y	PSS	"	OC, PAE	5
	4X	PSS	"	"	5
Lobsters	5Ze	IS	hepatopancreas	Cd, PAH	50
		IS	tail meat	Cd	25
		PSS	hepatopancreas	OC	4
	5Y	IS	"	Cd, PAH	75
		IS	tail meat	Cd	25
		PSS	hepatopancreas	OC	4
	4X	PSS	"	Cd, PAH	12
		PSS	tail meat	Cd	4
		PSS	hepatopancreas	OC	4
	4T	IS	"	Cd, PAH	100
		PSS	"	OC	4
Bluefin tuna	St. Margaret's Bay	IS	liver, muscle	OC	10
Swordfish		IS	liver, muscle	OC	10

[a]OC = organochlorine compounds: PCB and pesticides

LOBSTER

Offshore lobsters from Georges Bank, inshore lobsters from the Gulf of Maine, southern Nova Scotia, and the Gulf of St. Lawrence should be analyzed (Table 5). Of the contaminants, the main emphasis is on Cd and PAH. Organochlorine compounds will be measured in pooled samples.

BLUEFIN TUNA

Monitoring of bluefin tuna from St. Margaret's Bay for organochlorine compounds will continue at a level of about 10 samples.

SWORDFISH

About 10 samples of swordfish will be analyzed for organochlorine compounds to be able to determine priority of a future monitoring requirement.

TENTATIVE PROPOSAL FOR 1982-83

The monitoring activity in 1982-83 may depend to a large extent on the results obtained in 1981-82. Provided that the latter does not detect extremely high levels of contamination, needing follow-up studies, the main objective of 1982-83 should be to expand the monitored areas and to provide information on additional commercially important species (Table 6).

PLANS FOR 1983-84 AND LATER

The activity in 1983 and beyond will depend on the results of the first 2 yr of the program and on ICES monitoring requirements. It is likely that a few gaps will have to be filled.

In 1984 the monitoring program may be repeated starting with year 1 (Table 5), or used to look at seasonal variations of contaminants in selected stocks.

ANTICIPATED OUTCOME OF THE 1981-82 MONITORING

The 1981-82 monitoring will improve our knowledge of levels and geographical trends of organochlorine compounds in cod. This, in conjunction with the toxicological data on PCB, will provide a

Table 6. Summary of monitoring in 1982-83.

Species	Area	Type of sample	Organ/tissue	Contaminant	No. of samples
Cod	4T	IS	liver	OC	60
		PS	"	PAE	1-2
	4Vn	PSS	"	OC, PAE	5-10
Herring	4X	PSS	muscle	OC, PAE	25
	4W	PSS	"	OC, PAE	5
Haddock	5Ze	PSS	liver	OC, PAE	5
		"	muscle	OC, PAE	5
	4X	"	liver	"	5
			muscle	"	5
	4W	"	liver	"	5
			muscle	"	5
Redfish	4T	PSS	liver	"	5
		"	muscle	"	5
Pollock	5Ze	"	liver	"	5
			muscle	"	5
	4X	"	liver	"	5
			muscle	"	5
	4W	"	liver	"	5
			muscle	"	5
Flounder	4X	"	liver	"	10
			muscle	"	10
	4Vs	"	liver	"	10
			muscle	"	10
	4Vn	"	liver	"	10
			muscle	"	10
	4T	"	liver	"	10
			muscle	"	10
Mackerel	4X	"	muscle	"	5
	4Vn	"	"	"	5
	4T	"	"	"	5
Scallop	4X	"	muscle	Cd, Hg	5
			viscera	PAH, OC, Cd	5
	4T	"	muscle	Cd, Hg	5
			viscera	PAH, OC, Cd	5

better basis for the assessment of the effects of PCB on cod stocks.

The data on herring will contribute to the estimation of temporal trends of organochlorine compounds, although the information may be inconclusive.

Monitoring of lobsters will update the existing data on Cd and provide an initial data base for the assessment of the contamination by PAH.

Tunas may be affected by accumulating organochlorine compounds. If one can obtain samples of "healthy" as well as samples of "sickly" fish, a better assessment of the situation may be possible.

Monitoring of swordfish will provide an initial data base.

ASSOCIATED TOXICOLOGICAL RESEARCH

The significance of the observed levels of contaminants needs assessment based on laboratory toxicological studies. These studies include projects dealing with the occurrence and effects of contaminants on fish (A) and projects dealing with the effects of contaminants on fishery products as human food (B).

Examples of projects of type A include the recently completed projects on the effects of PCB on cod (Freeman et al. 1978) and a project on the effects of di-(2-ethylhexyl)-phthalate on cod, which is now under way.

In connection with such studies, considerable effort must go into the development of biochemical and other (histological, anatomical etc.) indicators of the status of the animal. Histopathology, steroid metabolism and adenylate energy charge criteria are currently being used or developed. The development of pharmacokinetic models should be considered.

The next contaminants included in the type A study should be toxaphene and chlordane, in view of the occurrence of their residues in marine fish, and of their generally very high toxicity to aquatic fauna.

Examples of type B projects are those on Cd and As (Uthe et al. 1979). It appears that As should still remain on the high priority list, and projects dealing with PAH, such as uptake and associated histopathology, excretion, and metabolism in cod, should be considered.

In addition to the long-term studies discussed above, short-term screening of type A studies have to be carried out on a large number of chemicals identified as potential contaminants for a preliminary risk assessment and determination of priorities for further research.

The main selection criterium of chemicals for short-term studies is the probability of exposure; that is, a chemical must be produced or used in quantities and a manner leading to considerable releases into the environment and, once released, the chemical or metabolite must be stable long enough to reach the marine environment. Additional criteria such as toxicity, uptake and accumulation or metabolism by aquatic fauna also come into consideration.

High priority chemicals in this group include some agricultural chemicals (insecticides, herbicides, fungicides), additives to plastics (plasticizers, flame retardants, antioxidants), surfactants, hydraulic fluids, and components of drilling muds.

A number of "model chemicals" have to be studied to develop a better understanding of factors determining the movement, effects, and fate of chemicals in the marine environment. Such data lead to the development of quantitative structure activity relationships and to the improvement of predicting in general, to avoid, with most contaminants, the need to deal with each on a case-by-case basis.

The toxicological research requires a considerable part of the analytical chemical capacity in methods development and in actual analyses.

Both monitoring and toxicological research require up-to-date instrumentation with little down time. Unfortunately, our instrumentation is ageing, with high breakdown rate, and some recent, superior analytical capability is not available. This is the result of a steady decline in capital funds over the last 4-5 yr.

The optimum split between monitoring and toxicological research is about 30:70.

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APPENDIX

Organochlorine compounds in herring 1972-77 (OECD Program)

TRINITY 1972

WGT	AGE	PCB	DDT	DDE	DDD	LPD
131.500	3.000	.080	.020	.020	.020	.063
145.000	3.000	.190	.010	.030	.010	.067
218.700	4.000	.200	.020	.040	.060	.069
177.200	3.000	.100	.010	.020	.020	.050
212.300	6.000	.630	.005	.150	.020	.164
216.500	7.000	.100	.020	.050	.020	.022
201.800	4.000	.120	.020	.030	.020	.078
213.200	4.000	.130	.030	.030	.030	.091
187.200	5.000	.150	.010	.040	.030	.035
233.400	4.000	2.220	.120	.320	.220	.255
176.100	4.000	.030	.010	.010	.010	.007
202.100	5.000	.560	.005	.110	.030	.115
224.500	4.000	1.580	.090	.400	.160	.224
229.400	4.000	1.290	.140	.290	.130	.196
163.200	4.000	.500	.080	.090	.055	.158
197.700	3.000	.610	.070	.110	.080	.201
175.000	4.000	.620	.110	.110	.070	.171
163.000	3.000	.440	.110	.090	.060	.154
202.000	5.000	1.070	.080	.200	.090	.158
181.400	4.000	.560	.060	.070	.050	.163
216.800	4.000	1.620	.190	.290	.170	.121
244.600	4.000	.880	.070	.160	.070	.182
210.100	4.000	1.040	.090	.180	.090	.129
185.700	4.000	1.020	.050	.160	.090	.137
210.900	4.000	.550	.065	.100	.035	.098

	ARITHMETIC MEAN	&STD.	GEOM.MEAN	& STD.
WGT	196.8120	27.8584 (14%)	194.7772	.0653
AGE	4.1200	.9274 (23%)	4.0315	.0904
PCB	.6516	.5710 (88%)	.4036	.4883
DDT	.0594	.0492 (83%)	.0375	.4761
DDE	.1240	.1059 (85%)	.0831	.4278
DDD	.0656	.0546 (83%)	.0471	.3731
LPD	.1243	.0651 (52%)	.0998	3548

BLUE COVE 1972

WGT	AGE	PCB	DDT	DDE	DDD	LPD
202.800	4.000	.510	.050	.180	.200	.017
191.300	4.000	.210	.030	.040	.060	.022
183.200	4.000	.100	.020	.040	.050	.015
180.200	4.000	.440	.050	.100	.080	.048
171.700	4.000	.140	.005	.040	.025	.003
182.100	4.000	.220	.020	.060	.040	.026
191.000	4.000	.170	.020	.040	.040	.008
177.100	4.000	.110	.010	.030	.010	.004
196.900	4.000	.280	.040	.060	.060	.052
190.000	4.000	.155	.005	.045	.030	.010
178.900	4.000	.240	.020	.060	.050	.033
198.400	4.000	.510	.020	.060	.030	.015
178.700	4.000	.550	.020	.140	.060	.047
192.500	4.000	.700	.040	.190	.150	.035
189.100	4.000	.110	.010	.025	.030	.009
192.500	4.000	.400	.020	.090	.080	.016
200.300	4.000	.260	.050	.060	.090	.043
145.400	3.000	.410	.005	.070	.100	.129
164.500	4.000	.100	.010	.030	.020	.004
196.700	4.000	.120	.015	.030	.025	.015
210.900	4.000	.560	.040	.160	.100	.057
215.100	4.000	.420	.040	.110	.130	.049
185.200	4.000	.450	.040	.150	.100	.049
208.300	4.000	.105	.010	.025	.020	.006

	ARITHMETIC MEAN	&STD.	GEOM.MEAN	& STD.
WGT	188.5250	15.2021 (8%)	187.9112	.0363
AGE	3.9583	.2041 (5%)	3.9523	.0255
PCB	.3067	.1793 (58%)	.2562	.2735
DDT	.0246	.0153 (62%)	.0195	.3245
DDE	.0765	.0517 (68%)	.0624	.2798
DDD	.0658	.0467 (71%)	.0517	.3196
LPD	.0297	.0277 (93%)	.0198	.4223

TRINITY 1973

WGT	AGE	LNG	LPD	PCB	DDT	DDE	DDD
171.600	3.000	26.200	.104	.390	.025	.064	.027
149.700	3.000	26.100	.093	.190	.032	.040	.024
167.900	3.000	26.600	.050	.210	.019	.048	.024
154.000	3.000	25.900	.103	.200	.029	.041	.024
206.200	3.000	27.200	.192	.240	.035	.052	.037
185.100	3.000	27.300	.127	.230	.027	.037	.031
168.000	3.000	26.300	.082	.270	.033	.038	.025
164.500	3.000	26.700	.077	.260	.017	.043	.015
164.300	3.000	26.100	.056	.170	.017	.024	.019
141.200	3.000	24.900	.078	.275	.038	.046	.025
180.300	3.000	27.200	.098	.200	.047	.067	.027
180.300	3.000	26.700	.129	.200	.031	.067	.024
183.600	3.000	27.100	.072	.170	.023	.037	.014
176.900	3.000	27.100	.101	.330	.032	.058	.022
192.500	3.000	27.900	.072	.180	.040	.028	.026
137.600	3.000	25.100	.108	.160	.040	.032	.022
145.000	3.000	25.200	.069	.150	.020	.033	.019
167.900	3.000	27.000	.055	.130	.019	.030	.013
183.000	3.000	27.500	.057	.120	.020	.025	.011
170.500	3.000	26.300	.106	.185	.041	.046	.023
139.500	3.000	25.200	.068	.120	.038	.038	.021
159.600	3.000	25.500	.087	.190	.049	.044	.031
169.100	3.000	25.800	.070	.170	.023	.040	.015
141.800	3.000	25.300	.090	.230	.038	.045	.024
167.600	3.000	26.200	.053	.085	.022	.017	.013

	ARITHM. MEAN	STD.		GEOM. MEAN	STD.
WGT	166.7120	17.6582	(11%)	165.8086	.0464
AGE	3.0000	.0000	(0%)	3.0000	NOT CALCD.
LNG	26.3760	.8017	(3%)	26.3644	.0132
LPD	.0879	.0311	(35%)	.0835	.1392
PCB	.2026	.0671	(33%)	.1924	.1439
DDT	.0302	.0095	(32%)	.0287	.1411
DDE	.0417	.0129	(31%)	.0397	.1424
DDD	.0223	.0062	(28%)	.0214	.1304

BLUE COVE 1973

WGT	AGE	LNG	LPD	PCB	DDT	DDE	DDD
219.000	6.000	29.900	.009	.330	.030	.070	.042
218.200	6.000	29.800	.055	.360	.031	.070	.031
250.900	6.000	31.200	.049	.600	.041	.170	.052
242.500	6.000	29.800	.061	.480	.039	.081	.049
216.300	5.000	30.300	.059	.695	.040	.125	.061
235.100	5.000	30.500	.044	.580	.051	.102	.071
205.000	5.000	28.600	.030	.400	.020	.071	.048
217.100	5.000	29.600	.066	.460	.021	.085	.050
253.100	5.000	30.000	.063	.390	.019	.074	.050
259.600	6.000	30.300	.039	.390	.045	.065	.051
220.500	6.000	29.600	.005	.210	.011	.041	.021
239.100	5.000	30.100	.024	.380	.019	.072	.029
194.400	6.000	29.500	.048	.510	.021	.101	.053
263.800	6.000	29.800	.043	.250	.018	.040	.027
219.100	5.000	29.800	.032	.360	.030	.075	.035
224.600	6.000	30.200	.018	.180	.020	.031	.021
233.700	5.000	30.200	.081	.590	.050	.111	.072
210.500	5.000	28.500	.040	.300	.031	.060	.042
159.900	5.000	28.300	.011	.100	.012	.021	.010
203.600	6.000	29.400	.016	.205	.155	.030	.025
242.200	6.000	29.200	.019	.280	.020	.053	.042
260.300	5.000	29.000	.040	.360	.030	.057	.038
225.400	5.000	29.300	.049	.490	.042	.093	.040
190.600	5.000	28.800	.023	.430	.022	.070	.041
229.400	5.000	30.300	.044	.425	.021	.058	.041

	ARITHM. MEAN	STD.		GEOM. MEAN	STD.
WGT	225.3560	24.2427	(11%)	224.0326	.0490
AGE	5.4400	.5066	(9%)	5.4177	.0401
LNG	29.7120	.6701	(2%)	29.7049	.0098
LPD	.0387	.0197	(51%)	.0324	.2958
PCB	.3902	.1436	(37%)	.3604	.1895
DDT	.0335	.0278	(83%)	.0281	.2375
DDE	.0731	.0325	(44%)	.0662	.2040
DDD	.0417	.0149	(36%)	.0386	.1877

TRINITY 1974

WGT	AGE	LNG	LPD	PCB	DDT	DDE	DDD
212.000	4.000	29.300	.086	.390	.043	.084	.039
260.000	5.000	31.900	.097	.450	.054	.150	.045
191.000	4.000	28.500	.084	.260	.049	.086	.040
217.000	4.000	29.000	.133	.290	.044	.084	.042
188.000	4.000	28.600	.053	.160	.025	.059	.020
189.000	4.000	28.700	.112	.240	.045	.097	.050
257.000	5.000	31.400	.154	.390	.050	.170	.052
190.000	4.000	29.100	.095	.290	.043	.130	.037
248.000	5.000	30.500	.091	.260	.042	.096	.035
166.000	4.000	28.400	.021	.180	.015	.053	.019
221.000	4.000	30.300	.147	.420	.073	.120	.051
208.000	4.000	29.600	.079	.330	.048	.083	.028
196.000	4.000	28.500	.107	.380	.032	.100	.035
208.000	4.000	29.800	.064	.250	.036	.075	.034
195.000	4.000	29.400	.069	.390	.025	.071	.023
161.000	4.000	27.300	.048	.280	.019	.054	.022
223.000	4.000	29.500	.105	.360	.031	.082	.038
220.000	4.000	30.500	.104	.450	.041	.082	.044
223.000	4.000	29.600	.044	.250	.029	.058	.022
202.000	4.000	28.300	.094	.455	.049	.110	.039
230.000	4.000	28.700	.164	.430	.031	.110	.022
216.000	4.000	29.100	.051	.240	.029	.072	.015
234.000	4.000	30.400	.076	.230	.047	.083	.036
212.000	4.000	29.000	.112	.350	.055	.110	.036
196.000	4.000	28.300	.041	.155	.025	.065	.027

	ARITHM.MEAN & STD.		GEOM. MEAN & STD.	
WGT	210.5200	24.5684 (12%)	209.1365	.0512
AGE	4.1200	.3317 (8%)	4.1086	.0321
LNG	29.3480	1.0455 (4%)	29.3305	.0153
LPD	.0892	.0364 (41%)	.0811	.2056
PCB	.3152	.0931 (30%)	.3010	.1388
DDT	.0392	.0132 (34%)	.0369	.1586
DDE	.0913	.0292 (32%)	.0873	.1320
DDD	.0340	.0106 (31%)	.0323	.1478

BLUE COVE 1974

WGT	AGE	LNG	LPD	PCB	DDT	DDE	DDD
309.000	6.000	33.000	.070	1.150	.047	.350	.100
242.000	6.000	30.500	.033	.800	.034	.210	.064
292.000	6.000	32.200	.065	.980	.039	.250	.070
330.000	7.000	33.800	.069	.920	.040	.260	.065
282.000	6.000	31.700	.073	.890	.076	.275	.079
281.000	6.000	31.900	.039	.840	.034	.230	.071
284.000	6.000	31.700	.042	.780	.035	.240	.064
388.000	9.000	35.200	.069	1.040	.058	.430	.084
310.000	7.000	31.900	.066	.910	.044	.190	.068
283.000	6.000	32.400	.058	.855	.105	.280	.086
155.000	3.000	26.200	.121	.650	.092	.150	.054
239.000	6.000	31.200	.052	.710	.090	.250	.057
288.000	6.000	32.200	.062	.750	.100	.250	.065
145.000	3.000	27.000	.052	.320	.043	.069	.033
187.000	3.000	27.700	.082	.430	.051	.115	.041
309.000	6.000	32.100	.086	.750	.090	.250	.066
294.000	6.000	32.100	.047	.610	.084	.220	.067
193.000	4.000	28.200	.103	.520	.064	.110	.046
174.000	3.000	26.700	.122	.620	.071	.150	.043
192.000	3.000	27.900	.137	.500	.064	.104	.045
278.000	6.000	32.400	.006	.520	.046	.200	.037
316.000	6.000	32.700	.065	.600	.079	.230	.061
293.000	6.000	31.300	.057	.730	.068	.290	.058
259.000	6.000	31.400	.023	.480	.050	.140	.034
187.000	4.000	28.400	.055	.405	.056	.115	.047

	ARITHM.MEAN & STD.		GEOM. MEAN & STD.	
WGT	260.4000	61.3419 (24%)	252.7386	.1118
AGE	5.4400	1.5297 (28%)	5.2031	.1383
LNG	30.8720	2.3887 (8%)	30.7804	.0345
LPD	.0662	.0304 (46%)	.0577	.2702
PCB	.7108	.2115 (30%)	.6786	.1389
DDT	.0624	.0220 (35%)	.0587	.1551
DDE	.2143	.0830 (39%)	.1977	.1865
DDD	.0603	.0169 (28%)	.0579	.1270

TRINITY 1975

WGT	AGE	LNG	LPD	PCB	DDT	DDE	DDD
201.000	5.000	29.100	.056	.284	.041	.030	.051
225.000	5.000	29.900	.044	.362	.034	.037	.045
247.000	5.000	31.000	.100	.413	.075	.063	.086
281.000	5.000	30.600	.177	.408	.074	.047	.082
286.000	5.000	32.700	.079	.262	.061	.034	.061
200.000	3.000	28.200	.109	.272	.054	.026	.052
224.000	5.000	30.400	.089	.526	.062	.064	.072
232.000	5.000	30.000	.094	.299	.061	.036	.058
207.000	5.000	29.000	.055	.295	.032	.034	.036
248.000	4.000	30.300	.098	.510	.055	.056	.059
263.000	5.000	30.000	.107	.309	.047	.045	.057
223.000	5.000	29.500	.089	.344	.049	.056	.057
251.000	5.000	30.500	.079	.384	.048	.037	.055
218.000	4.000	29.300	.099	.344	.048	.039	.055
201.000	4.000	29.100	.099	.267	.045	.028	.050
224.000	5.000	29.100	.125	.313	.054	.032	.058
270.000	5.000	31.800	.024	.183	.014	.011	.017
216.000	5.000	29.500	.042	.182	.020	.031	.020
237.000	5.000	30.400	.069	.249	.034	.025	.037
202.000	5.000	28.800	.067	.222	.026	.023	.026
216.000	5.000	28.900	.132	.369	.056	.059	.061
244.000	5.000	30.000	.075	.241	.038	.025	.034
261.000	5.000	30.300	.169	.493	.041	.043	.057
173.000	4.000	27.400	.036	.087	.016	.008	.017
227.000	5.000	30.000	.026	.225	.015	.026	.017

	ARITHM.MEAN & STD.			GEOM. MEAN & STD.	
WGT	231.0800	27.7609	(12%)	229.4823	.0523
AGE	4.7600	.5228	(11%)	4.7271	.0547
LNG	29.8320	1.0994	(4%)	29.8128	.0159
LPD	.0856	.0392	(46%)	.0763	.2250
PCB	.3137	.1053	(34%)	.2947	.1668
DDT	.0440	.0172	(39%)	.0400	.2087
DDE	.0365	.0148	(40%)	.0332	.2128
DDD	.0488	.0192	(39%)	.0443	.2106

BLUE COVE 1975

WGT	AGE	LNG	LPD	PCB	DDT	DDE	DDD
288.000	7.000	32.900	.049	.762	.078	.090	.113
270.000	6.000	32.100	.024	.380	.038	.050	.049
242.000	6.000	32.900	.020	.332	.027	.047	.042
271.000	7.000	32.600	.010	.139	.016	.021	.022
257.000	6.000	32.800	.009	.231	.020	.031	.025
288.000	7.000	35.000	.025	.253	.027	.032	.030
294.000	6.000	32.000	.079	.530	.073	.107	.089
315.000	6.000	33.900	.015	.292	.019	.034	.030
280.000	7.000	33.100	.038	.680	.058	.113	.098
326.000	6.000	33.600	.065	.215	.063	.049	.051
346.000	7.000	34.600	.026	.328	.027	.048	.058
374.000	6.000	33.800	.018	.350	.023	.075	.044
310.000	7.000	33.900	.022	.366	.020	.158	.055
354.000	6.000	34.100	.024	.298	.030	.072	.051
270.000	6.000	32.200	.031	.313	.024	.092	.051
254.000	6.000	31.700	.009	.064	.010	.018	.009
302.000	6.000	33.600	.018	.148	.017	.033	.025
306.000	6.000	33.600	.009	.171	.019	.045	.036
305.000	6.000	33.400	.054	.353	.035	.055	.039
348.000	7.000	33.300	.074	.377	.056	.118	.074
270.000	6.000	32.000	.018	.181	.016	.039	.022
281.000	6.000	32.400	.019	.180	.032	.035	.042
266.000	6.000	32.900	.021	.249	.001	.034	.001
292.000	6.000	32.200	.033	.424	.046	.074	.063
343.000	7.000	34.600	.063	.500	.047	.097	.070

	ARITHM.MEAN & STD.			GEOM. MEAN & STD.	
WGT	298.0800	34.6468	(12%)	296.2032	.0496
AGE	6.3200	.4761	(8%)	6.3034	.0319
LNG	33.1680	.9037	(3%)	33.1564	.0118
LPD	.0309	.0209	(68%)	.0251	.2868
PCB	.3246	.1635	(50%)	.2860	.2338
DDT	.0329	.0199	(60%)	.0259	.3740
DDE	.0627	.0357	(57%)	.0539	.2457
DDD	.0476	.0267	(56%)	.0372	.4055

TRINITY 1977

WGT	AGE	LNG	LPD	PCB	DDT	DDE	DDD	HCB	DIL	
191.0000	4.0000	28.6000	.1359	.2670	.0149	.0054	.0175	.0021	.0119
188.0000	4.0000	28.4000	.0349	.3130	.0085	.0065	.0155	.0017	.0054
228.0000	5.0000	30.3000	.0646	.2260	.0211	.0094	.0204	.0018	.0073
259.0000	4.0000	30.8000	.1633	.2630	.0186	.0339	.0240	.0091	.0106
262.0000	4.0000	30.0000	.1634	.4740	.0212	.0488	.0285	.0105	.0111
164.0000	4.0000	26.3000	.0592	.1030	.0025	.0123	.0730	.0049	.0995
210.0000	4.0000	29.9000	.0616	.1520	.0035	.0217	.0838	.0060	.1440
221.0000	4.0000	30.1000	.1233	.2380	.0054	.0333	.1570	.0074	.1770
250.0000	4.0000	29.9000	.1284	.2110	.0054	.0318	.1580	.0081	.1960
179.0000	4.0000	28.2000	.1161	.1760	.0203	.0257	.0213	.0085	.0109
184.0000	4.0000	27.8000	.0356	.0980	.0092	.0171	.0094	.0058	.0044
187.0000	4.0000	28.0000	.0577	.3150	.0205	.0370	.0255	.0070	.0084
241.0000	4.0000	30.4000	.1135	.2120	.0148	.0285	.0155	.0059	.0095
178.0000	4.0000	26.9000	.0884	.1850	.0176	.0220	.0193	.0047	.0076
191.0000	4.0000	28.3000	.0688	.2310	.0193	.0334	.0266	.0057	.0079
191.0000	4.0000	28.7000	.0824	.1700	.0216	.0288	.0194	.0082	.0079
172.0000	4.0000	27.4000	.0391	.1110	.0127	.0166	.0118	.0059	.0048
224.0000	4.0000	29.4000	.1103	.2440	.0255	.0359	.0259	.0113	.0112
231.0000	5.0000	29.6000	.0694	.1840	.0192	.0336	.0185	.0090	.0079
165.0000	3.0000	26.9000	.0687	.1920	.0188	.0234	.0185	.0054	.0072
160.0000	4.0000	26.9000	.0703	.1400	.0123	.0173	.0118	.0077	.0064
175.0000	4.0000	27.4000	.1389	.1980	.0171	.0296	.0176	.0067	.0100
195.0000	4.0000	29.6000	.0609	.1780	.0192	.0281	.0194	.0065	.0071
192.0000	4.0000	27.5000	.1154	.2330	.0276	.0293	.0256	.0116	.0112
192.0000	4.0000	27.6000	.0521	.1400	.0113	.0177	.0113	.0067	.0054

	ARITHM.MEAN & STD.		GEOM.MEAN & STD.	
WGT	201.2400	30.0699 (15%)	199.1840	.0629
AGE	4.0400	.3512 (9%)	4.0255	.0378
LNG	28.5960	1.3158 (5%)	28.5671	.0200
LPD	.0891	.0388 (44%)	.0809	.1990
PCB	.2102	.0799 (38%)	.1973	.1570
DDT	.0155	.0068 (44%)	.0134	.2718
DDE	.0251	.0105 (42%)	.0223	.2375
DDD	.0348	.0407 (117%)	.0243	.3232
HCB	.0067	.0026 (39%)	.0061	.2227
DIL	.0316	.0566 (179%)	.0127	.4928