GLOBAL MONITORING PLAN

FOR PERSISTENT ORGANIC POLLUTANTS

UNDER THE STOCKHOLM CONVENTION ARTICLE 16 ON EFFECTIVENESS EVALUATION

FIRST REGIONAL MONITORING REPORT

WESTERN EUROPE AND OTHER GROUPS (WEOG) REGION

2008

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TABLE OF CONTENTS

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The WEOG regional organizational group (ROG) for the first evaluation was composed of the following six experts: Sara Broomhall (Australia); Ramon Guardans (Spain); Tom Harner (Canada); Britta Hedlund (Sweden); Tor Johannessen (Norway); and Paula Viana (Portugal).

Geographical and media responsibilities were divided among the ROG as follows: Sara Broomhall covered Australia and New Zealand and facilitated inter-regional cooperation with the Pacific Islands; Tom Harner covered North America; Ramon Guardans covered the Mediterranean Region and non-core media; Tor Johannessen arranged for receiving all available relevant air data from NILU-EMEP and for arranging the drafting of the air-related chapter; and, Britta Headlund coordinated soliciting of human data from national and international programmes. Tom Harner acted as coordinator for the group and rapporteur for teleconferences.

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PREFACE

Persistent organic pollutants (POPs) are a group of chemicals with toxic properties that are widely used in agricultural and industrial practices, as well as unintentionally released from many anthropogenic activities around the globe. POPs are characterized by *persistence* – the ability to resist degradation in various media (air, water, sediments, and organisms) for months, years, and even decades; *bio-accumulation* - the ability to accumulate in living tissues at levels higher than those in the surrounding environment; and *potential for long range transport* – the potential to travel great distances from the source of release through various media (air, water, and migratory species). Specific effects of POPs can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system. Some POPs are also considered to be endocrine disrupters, which, by altering the hormonal system, can damage the reproductive and immune systems of exposed individuals as well as their offspring. The ability of these toxic compounds to transport to isolated areas of the globe, such as the Arctic, and bioaccumulate in food webs has raised concerns for the health of humans and the environment, particularly for northern indigenous people that rely on traditional diets of marine mammals and fish. The transboundary movement of the compounds and the international scope of their manufacture, use and unintentional releases, and the long distances to impacted populations have led to the adoption of the Stockholm Convention on Persistent Organic Pollutants in May 2001 to "*protect human health and the environment from persistent organic pollutants by reducing or eliminating releases to the environment*". Substances presently being addressed under the Convention are aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, PCBs PCDDs/PCDFs and toxaphene. The Convention includes a procedure to add further substances to it.

The Convention calls for the reduction or elimination of releases of persistent organic pollutants, which should translate into reduced environment levels over time. Article 16 of the Stockholm Convention stipulates that the Conference of the Parties shall evaluate the effectiveness of the Convention four years after its date of entry into force. The effectiveness of the Convention shall be evaluated on the basis of available scientific, environmental, technical and economic information, including:

- Reports on monitoring of environmental levels
- National reports submitted pursuant to Article 15
- Non-compliance information provided pursuant to Article 17

An important component of effectiveness evaluation is the development of a global monitoring plan providing a harmonized organizational framework for the collection of comparable monitoring data or information on the presence of the persistent organic pollutants from all regions, in order to identify changes in levels over time, as well as to provide information on their regional and global environmental transport. The first report for the effectiveness evaluation will be presented at the fourth meeting of the Conference of the Parties in May 2009 and will serve as baseline for further evaluations.

The global monitoring plan is being implemented in all five United Nations Regions. This regional monitoring report presents (for the sampling window 2003 +/- 5 years) the findings and the baseline levels in the Western Europe and Other Groups (WEOG) Region.

ABBREVIATIONS AND ACRONYMS

ACP	Arctic Contamination Potential
ADI	Acceptable Daily Intake
ALRT	Atmospheric Long Range Transport
AMAP	Arctic Monitoring and Assessment Programme
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
APEs	Alkylphenol Ethoxylates
BCF	Bioconcentration Factor
BHC	Benzenehexachloride
BPH	Benzo(a)pyrene oxidation
CanMETOP	Canadian Model for Environmental Transport of Organochlorine Pesticides
CB	Chlorinated Biphenyls
CEE	Central and Eastern Europe
CEP	Caspian Environment Programme
CLRTAP	Convention on Long-range Transboundary Air Pollution
CRM	Certified Reference Material
CIS	Commonwealth of Independent States
CMC	Canadian Modelling Centre
COP	Conference of the Parties
CTD	Characteristic Travel Distance
CV	Coefficient of Variation
DDD /DDE	Metabolites of DDT
DDT	Dichlorodiphenyltrichloroethane
DLPCBs	Dioxin-like PCBs
EDCs	Endocrine Disrupting Chemicals
EMAN	Ecological Monitoring and Assessment Network
EMEP	Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe
EPER	European Pollutant Emission Register
ERL	Effects Range Low
ERM	Effects Range Median
EROD	7-ethoxyresorufin-O-deethylase
EUSES	European Union System for the Evaluation of Substances
FAO	Food and Agriculture Organisation of the United Nations
FERTIMEX	Fertilizantes Mexicianos, S.A.
GAPS	Global Atmospheric Passive Sampling (Network)
GAW	Global Atmospheric Watch
GEF	Global Environment Facility
GEMS	Global Environment Monitoring System
GerES	German Environmental Survey (for Children)
GLBTS	Great Lakes Bi-national Toxics Strategy
GMP	Global Monitoring Plan
HCB	Hexachlorobenzene

HELCOM	Helsinki Commission/The Baltic Marine Environment Protection Commission
HCHs	Hexachlorocyclohexanes
HIPS	High Impact Polystyrene
HPLC	High Performance Liquid Chromatography
HRGC	High Resolution Gas Chromatography (capillary column)
HRMS	High Resolution Mass Spectrometer
HTAP	Hemispheric transport of air pollutants (LRTAP task force)
HxBB	Hexabromobiphenyl
IADN	Integrated Atmospheric Deposition Network
IARC	International Agency for Research on Cancer
ICES	International Council for the Exploration of the Sea
IFCS	Intergovernmental Forum on Chemical Safety
IMO	International Maritime Organisation
INCATPA	Intercontinental Atmospheric Transport of Anthropogenic Pollutants
INSPQ	Centre de Toxicologie du Québec
INFOCAP	Information Exchange Network on Capacity Building for the Sound Management of Chemicals
IPPC	Integrated Pollution Prevention and Control
I-TEQ	International Toxicity Equivalence
K_{AW}	Air/Water Partition Coefficient
K_{OA}	Octanol/Air Partition Coefficient
K_{OW}	Octanol/Water Partition Coefficient
LC50	Median Lethal Concentration
LD50	Median Lethal Dose
LOAEL	Lowest Observable Adverse Effect Level
LOD	Limit of Detection
LOQ	Limit of Quantification
LRAT(P)	Long Range Atmospheric Transport (Potential)
LRT	Long Range Transport
LRTAP	Long-range Transboundary Air Pollution (Convention, see also CLRTAP)
LRTP	Long Range Transport Potential
MDL	Minimum Detectable Level
MEDPOL	Mediterranean Pollution Monitoring and Research Programme
MEA	Multi Lateral Environmental Agreements
MODIS	Moderate resolution imaging spectroradiometer
MONARPOP	Monitoring Network in the Alpine Region for Persistent and other Organic Pollutants.
MONET	Monitoring Network (passive air sampling)
MRL	Maximum Residue Limit
MSC-East	Meteorological Synthesizing Centre-East
NAFTA	North American Free Trade Agreement
NARAPs	North American Regional Action Plans
NCP	Northern Contaminants Program
ND	Not detected
NDAMN	National Dioxin Air Monitoring Network (US EPA)
NGOs	Non-Governmental Organisations

NHATS	National Human Adipose Tissue Survey
NILU	Norwegian Institute for Air Research
NIS	Newly Independent States
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observable Adverse Effect Level
NOEL	No Observable Effect Level
NWT	Northwest Territories
OCs	Organochlorines
OCPs	Organochlorine Pesticides
OECD	Organisation for Economic Co-operation and Development
OPs	Organophosphates
OSPAR	Commission for the Protection of the Marine Environment of the North-East Atlantic
PAHs	Polycyclic aromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
PCDDs	Polychlorinated dibenzo- p-dioxins
PCDFs	Polychlorinated dibenzofurans
PCP	Pentachlorophenol
PES	Potential emission sensitivity (map)
PFOS	Perfluorooctane sulfonate
PIC	Prior Informed Consent
POPs	Persistent Organic Pollutants (group of twelve as defined in the Stockholm Convention 2001)
PRTRs	Pollutant Release and Transfer Registers
PTS	Persistent Toxic Substances
PUF	Polyurethane Foam
PVC	Polyvinylchloride
QA/QC	Quality Assurance and Quality Control Regimes
REACH	Registration, Evaluation and Authorisation of Chemicals
RECETOX	Research Centre for Environmental Chemistry and Ecotoxicology
RENPAP	Regional Network on Pesticide Production in Asia and Pacific
ROGs	Regional Organization Groups for the Global Monitoring Plan
ROPME	Regional Organisation for the Protection of the Marine Environment
ROWA	Regional Organisation of West Asia
SAICM	Strategic Approach to International Chemicals Management
SCCPs	Short-chain chlorinated paraffins
SOP	Standard Operating Procedure
SPM	Suspended particulate matter
SPREP	South Pacific Regional Environment Programme
t	Tonnes
TBBPA	Tetrabromobisphenol A
TCDD	Tetrachlorodibenzo-*p*-dioxin
TEF	Toxicity Equivalence Factor
TEL	Tetraethyllead
TEQ	Toxicity Equivalents

TOMPS	Toxic Organic Micropollutants Survey
TPT	Triphenyltin
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation
WACAP	Western Airborne Contaminants Assessment Project
WFD	Water Framework Directive
WHO	World Heath Organisation
WMO	World Meteorological Organization
XAD	Styrene/divinylbenzene-co-polymer Resin
XVPCA	Xarxa de Vigilancia i Previsió de la Contaminació Atmosférica

GLOSSARY OF TERMS

Activity	Any programme or other activity or project that generates data or information on the levels of POPs in the environment or in humans that can contribute to the effectiveness evaluation under Article 16 of the Stockholm Convention Core matrices These are the matrices identified by the Conference of the Parties to the Stockholm Convention at its second meeting as core for the first evaluation: A = ambient air; M = (human) mother's milk and / or B = human blood
Congener	One of two or more substances related to each other by origin, structure, or function.
CTD	The characteristic travel distance– defined as the "half-distance" for a substance present in a mobile phase
I L-1	Instrumentation level 1 capable to analyze PCDD/PCDF and dioxin-like PCB at ultra-trace concentrations: must be a high-resolution mass spectrometer in combination with a capillary column
I L-2	Instrumentation level capable to analyze all POPs: (capillary column and a mass-selective detector)
I L-3	Instrumentation level capable to analyze all POPs without PCDD/PCDF and dioxin like PCB (capillary column and an electron capture detector)
I L-4	Instrumentation level not capable to do congener-specific PCB analysis (no capillary column, no electron capture detector or mass selective detector)
Inter-Comparisons	Participation in national and international intercalibration activities such as ring-tests, laboratory performance testing schemes, etc LOD Limit of detection. Definition: The lowest concentration at which a compound can be detected; it is defined as that corresponding to a signal three times the noise.
<LOD	Result below the of limit detection
LOQ	Limit of quantification. Definition: The lowest concentration that can quantitatively be determined is three times higher than LOD.
<LOQ	Result below limit of quantification. Compounds found at levels between LOD and LOQ can be reported as present, or possibly as being present at an estimated concentration, but in the latter case the result has to be clearly marked as being below LOQ.
MDL	Method detection limit. The MDL considers the whole method including sampling, sample treatment and instrumental analysis. It is determined by the background amounts on field blanks.
ND	Not detected

Phase I	Activities to support the Article 16 effectiveness evaluation that will be conducted by the Conference of the Parties at its fourth meeting, information collected between 2000 and 2007 (also termed as first evaluation).
P*ov*	Overall persistence of a chemical in the environment.
Primiparae Mothers	A woman who is pregnant for the first time.
TE	Transfer efficiency – an indicator of potential for a chemical to be transported in the atmosphere and deposited in a remote location.

EXECUTIVE SUMMARY

Decision SC-3/19 established a regional organization group (ROG), composed of six members for each of the five United Nations Regions to facilitate implementation of the global monitoring plan, and invited Parties to nominate members to those groups with expertise in monitoring and data evaluation The objectives of the regional organization groups were to define and implement the regional strategy for information gathering, and to prepare the regional monitoring reports as contributions to the first effectiveness evaluation report, to be presented to the Conference of the Parties at its fourth meeting in May 2009. The findings of the ROG for the WEOG region are provided below.

0.1 Contributing programs and collaborative programs

Information used to provide the basis of the WEOG region review was taken from existing international and national programmes and activities. Survey responses obtained by the Secretariat in 2006 and 2007 were reviewed and candidate programmes selected through their demonstrated compliance with the criteria contained in the "Implementation Plan for the First Evaluation Reports". The contributing programmes are therefore believed to be maintaining necessary arrangements to ensure that their monitoring information can be compared with results from the same programme both in the past and in the future for the purpose of determining temporal trends for effectiveness evaluation.

0.2 Key messages from the data

Adequacy of information: The information here reviewed on POPs in the core media of air, human milk and human blood provides a sufficient data base in the WEOG region for effectiveness evaluation of the Convention. Suggestions for improvement are given in the conclusions and recommendations section.

Levels in Air: Levels are generally decreasing in air or have done so and have now leveled off at low levels with some exceptions.

Levels in human media: Some organochlorine pesticides (OCPs) (e.g. aldrin, endrin) are present in such low concentrations in human milk and blood from the general population that trends will most likely not be detected. For those substances where sufficient information is available to suggest trends, a decline is indicated in most areas over the last 10-15 year period. In these cases levels are now low in relation to exposure guidelines used by health agencies.

For some populations of Arctic indigenous peoples, programmes have not (at the time of preparing this review) reported sufficient data to detect clear decreasing trends. Here some POPs, levels remain a concern relative to exposure guidelines used by health agencies. Reasons for this include high dietary exposure and the chemical and physical properties of POPs at low temperatures.

Regional and global environmental transport: Studies reviewed from existing programmes using the three approaches described in the implementation plan illustrate the regional and global environmental transport of POPs on sub-regional, regional, continental, and intercontinental scales and provide understanding to the data observed at air sampling sites. These demonstrate that a comprehensive evaluation of the Convention would not be possible in the absence of information on long-range transport (LRT) of POPs.

Climate change / variability: Some of the most important physical and chemical properties of POPs that determine how they move and are partitioned in the environment are temperature

dependant. Therefore POPs levels observed at a sampling site can be influenced by climate change and climate variability. Results indicate that this is being observed now in at least one Artctic monitoring site where recent warming may be facilitating re-emission of HCB, PCBs and DDT from surface environmental compartments.

Future evaluations: Several existing monitoring programmes in the WEOG region have measured in core and/or non-core media substances that are under consideration by the POPs Review Committee. Therefore if these substances are added to the Convention in the future, some time series may be readily available for further evaluations.

0.3 Description of data gaps and capacity building needs

Although the availability of information from existing programmes is not geographically homogeneous, much of the WEOG region is information rich. However two broad instances produce patchiness in the reported information. Possible strategies to address this situation are outlined in section 0.4 below.

0.4 Conclusions and recommendations

In addition to conclusions on the levels and trends of POPs in the WEOG region described in the "Key messages" section above, the following points are important in terms of the long term efficiency of effectiveness evaluation.

0.4.1 Media specific conclusions and recommendations

Air: For many of the OCPs listed as POPs under the Convention, concentrations in air have decreased over the past 10-15 years and are now leveling off. Current air concentrations are largely governed by environmental cycling between soil, water and the atmosphere and are dependent on climate change/variability (as noted above for HCB, PCBs and DDT). Some OCPs (e.g., Heptachlor, Mirex, Endrin and Dieldrin) are present at such low concentrations that trends cannot be detected. Air concentrations of industrial chemicals (e.g. PCBs) and unintentionally produced combustion by-products (e.g. PCDD/Fs) have also shown declining trends and current air burdens are associated with both cycling of previously deposited chemical and continued emissions from point sources (e.g. electrical equipment and industrial activity).

Human media: The review demonstrated that levels of the Stockholm Convention POPs in human media are heavily influenced by social, cultural, and ethnic factors that determine patterns of dietary exposure and by age. Therefore sampling strategies for new activities that focus on being able to examine data from the same age group of people of the same sex and in the same area will offer the best prospects for being able to detect changes in levels of POPs over time periods appropriate for the effectiveness evaluation of the Convention.

0.4.2 Generic conclusions and recommendations

Periodicity of effectiveness reviews: It is concluded that six years is an optimal time period for the repetitive review of environmental data in the context of effectiveness evaluation of the Convention. This suggestion is made on the basis of the trends reported in the WEOG region by contributing programmes that have established long time series of information on POPs in a variety of environmental media. The identification of trends requires a series of data points. An interval of at least six years will enable a substantial body of information to accumulate from contributing programmes and will also enhance statistical interpretation. A lesser period would

not be cost effective in terms of the effort involved. A longer period would leave the COP uninformed of important information on environmental levels.

Comparability of data: Each of the existing programmes that contributed information for the WEOG review has their own procedures for maintaining intra-program comparability of information. However since the use of different analytical laboratories is a major source of variance, it was concluded that it is unrealistic to expect comparability between all programmes. Therefore it is recommended that future efforts are focused to promote internal comparability within programmes over time for both the present and the future. While this conclusion generally means that there will be very limited direct comparability between regions, significant exceptions are evident, such as the WHO coordinated human milk programme which uses a single laboratory. The extensive use of such measures as utilization of common analytical laboratories and data centres has demonstrated the possibility of achieving adequate comparability between well established programmes in the WEOG region. An example is the collaborative practices of AMAP, EMEP (UNECE/CLRTAP-EMEP), OSPAR, and HELCOM.

Spatial and qualitative resolution: In some geographical areas of the region there is a general absence of continuing established environmental monitoring of POPs in the core media although in these cases there is usually a good understanding from past discrete surveys of what these levels are. Similarly in some areas there is a lack of information on certain substances, (e.g., dioxins and furans). It is therefore recommended that in the future when little information is available from existing activities in a sub-region because candidate activities are not part of an on-going monitoring programme, information can be reported from such activities providing they meet the other implementation plan data quality criteria.

Spatial enhancement: A more informative strategy to improve the ability of the COP to observe changes in POPs levels over time in areas presently lacking established monitoring programmes would be the setting up of new monitoring arrangements. If such steps are taken, it is recommended that careful attention is paid to ensuring the best possible comparability of data within such programmes. Passive samplers have been demonstrated to be a cost-effective approach for resolving regional data gaps for air.

Mediterranean rim: The review found a lower amount of information over many parts of the Mediterranean rim. It is therefore recommended that steps be explored for enhancing long term cooperation in POPs monitoring in this area to improve the information base for future effectiveness evaluations of the Convention.

Australia and New Zealand: Currently there are no systematic, repetitive, national-scale monitoring programmes in Australia and New Zealand for the measurement of POPs in the core media. However, levels of dioxins and furans, along with some of the other Convention POPs have been measured in the core media in Australia and New Zealand on a targeted basis. If repeated, such measurements could potentially contribute towards establishing a baseline for later trend analysis. Australia is exploring options, including the feasibility of a repetitive programme.

The objective of regional and global environmental transport studies of POPs in effectiveness evaluation: The COP has not clarified its expectations with respect to this requirement from Article 16 of the Convention. The present review has shown that the levels of POPs measured at an air sampling site cannot be understood without considering the key processes that have

transported POPs to that site. Therefore it is recommended that an appropriate objective for future evaluations could be for "the presentation of information on regional and global environmental transport to enable the COP to understand the levels of POPs observed at the reported air sampling sites".

Possible next steps for the evaluation of global environmental transport of POPs in future effectiveness evaluations: The present study has confirmed that the three methods to address this issue listed in the implementation plan are complementary to each other. However the topic spans all regions. Therefore it is recommended that the COP consider ways to provide itself with a plan or process to develop a coordinated cross regional approach to meet the environmental transport objective. This could be done independently through the formation of a time limited expert task group or in conjunction with the coordination group.

Climate change and climate variability: The review concluded that the effects of climate on the transport and partitioning of POPs has the potential to significantly complicate interpretation of measurements of POPs in environmental media for future evaluations. It is therefore recommended that the COP consider how to encourage studies on climate influences on levels of POPs in environmental media. This may best be undertaken in cooperation with the existing monitoring programmes and in conjunction with the proposed expert work on regional and global transport.

Non-core media: A number of existing monitoring programmes are producing information in a variety of media that could be of value for future effectiveness evaluation. However, a species which is a good environmental indicator of POPs levels (and with a rich existing body of monitoring information) in one region may be absent in another region. For future evaluations, it is recommended that the COP consider a two track media strategy. One track, termed "global core media" would be common to all regions and would comprise the present core media. The other track would be termed "specific regional / sub-regional media". It would contain non-core media and be specific to a region or sub-region. If such a strategy is adopted, all regions could be encouraged to report trends on POPs in the best available data sets from existing programmes in their regions / sub-regions. This flexibility would recognize that regions are unique. Guidance would be necessary on types of other media suitable for temporal trends analysis.

Finally, the ROG wishes to re-emphasize that the information reviewed to provide a baseline and to inform the COP of current trends in the WEOG region is mainly available from only a relatively small number of existing international programs. An important element of their long-term viability is the continued efficacy of the contributing national programs on which they often depend. The ability to compare POPs levels over time within these national and international programs therefore makes their long-term viability of utmost importance for future trends analysis to evaluate the effectiveness of the Convention.

1 INTRODUCTION

At its third meeting in May 2007, the Conference of the Parties, by decision SC-3/19 on effectiveness evaluation, adopted the amended global monitoring plan for persistent organic pollutants (UNEP/POPS/COP.3/22/Rev.1, annex II) and adopted the amended implementation plan for the global monitoring plan (UNEP/POPS/COP.3/23/Rev.1). It also adopted the Guidance on the Global Monitoring Plan for Persistent organic Pollutants[1], which has been prepared by the technical working group mandated by the Conference of the Parties in its decision SC-2/13. This guidance document provides the overall technical guidance for the implementation of the global monitoring plan in all United Nations Regions.

These decisions outlined a program to begin the evaluation of the effectiveness of the Convention through the use of regional monitoring reports that use existing national and international programs, in combination with strategic capacity building in regions where major data gaps have been identified, to provide information on the concentrations of the priority POPs.

Decision SC-3/19 established a regional organization group, composed of six members for each of the five United Nations Regions to facilitate implementation of the global monitoring plan, and invited Parties to nominate members to those groups with expertise in monitoring and data evaluation The main objectives of the regional organization groups were to define and implement the regional strategy for information gathering, including capacity building and establishment of strategic partnerships in order to fill the identified data gaps, and to prepare the regional monitoring report as contribution to the first effectiveness evaluation report, to be presented to the Conference of the Parties at its fourth meeting in May 2009.

The regional monitoring report that summarises the results of monitoring programs within their region to record baseline concentration in the environment and human milk or blood, against which temporal trends can be established, is major output to be produced by the regional organization group. The role of the report is also to facilitate communication on contaminant issues between regions and assist in addressing gaps in the global program. The regional reports comprise an element of the reporting to the Conference of the Parties and they provide an important link between the field sampling programs and the evaluation of the effectiveness of the Stockholm Convention.

The persistent organic pollutants listed in Annexes A, B, and C of the Stockholm Convention share a number of physical and chemical properties that result in concerns for human health and environment. Of particular importance is the toxicity of the compounds, and their ability to accumulate in the fat of humans and wildlife, as well as in soils and the sediments of lakes from where they may be re-emitted again. Their accumulation in fat makes them resistant to clearance from the human body, except in the formation of milk, and are subsequently passed on to a nursing child. Among their physical properties is their ability to transport over long distances through air, followed by condensation out of the air in the cold temperatures of the high latitudes and altitudes.

[1] United National Environmental Program (UNEP). 2007. Guidance on the global monitoring plan for persistent organic pollutants. Preliminary version, February 2007. Amended in May 2007.

Determining the effectiveness of controls on POPs mandated by the Convention requires detailed information on the background environmental concentrations of priority POPs from programs that are statistically robust and can detect changes in contaminants over time. Hence the global monitoring plan must be able to provide a harmonised organizational framework to collect comparable information between the regions to help determine changes over time, but also spatial trends of transport of chemical compounds.

A number of environmental media have been used to monitor environmental trends through time and the Parties have recognised the role that many of these could play in a global monitoring program. National programs reporting the concentration of priority chemicals in mussels, fish tissue, bird eggs and sediments have all been used to establish trends through time, but these programs are often regional in nature and may not be widely applicable across the globe. Each of these media has specific advantages and disadvantages for trend detection and difficulties in terms of sample collection, storage and analysis. For a number of reasons, the Conference of the Parties has chosen three core matrices - air, human milk and / or human blood- for global monitoring in that they provide information on the sources and transport of priority POPs and the levels of exposure in the human population. Data from regional programs using other media can be used to complement data from the core matrices in helping to establish trends using a weight of evidence approach. The first monitoring report, using data collected over the period 1998-2008, provides a critical baseline upon which concentrations in the core matrices will be studied over the long-term. Several monitoring programs in the WEOG region provide systematic measurements prior to 1998 that in some cases enable baseline trends to also be established.

2 DESCRIPTION OF THE REGION

2.1 Background

The Western European and Others Group (WEOG) is composed of twenty eight nations in Western Europe, North America, and Australasia.

A comprehensive summary of the characteristics of the region can be found in the reports of the 2002. UNEP/GEF: Regionally Based Assessment of Persistent Toxic Substances (PTS). This study used a different division of regions as was adopted by the conference of the Parties to the Stockholm Convention (COP) for the purposes of effectiveness evaluation. Therefore, the WEOG countries can be found in six different volumes of the PTS study. These are volumes on: the Arctic; North America; Europe; the Mediterranean; South East Asia and South Pacific; and, the Antarctic. These reports are recommended for providing a synthesis of geographical, physical, and biological characterization of these areas, as it relates to the sources and fates of POPs released to the environment. They provided the basis for the following brief political, geographical, and social and economic overview.

2.2 Political

Specific membership is as follows: Australasia- Australia; and, New Zealand.
North America - Canada; and, United States. Western Europe - Andorra; Austria; Belgium; Denmark; Finland; France; Germany; Greece; Iceland; Italy; Liechtenstein; Luxembourg; Malta; Monaco; Netherlands; Norway; Portugal; Republic of Ireland; San Marino; Spain; Sweden; Switzerland; Turkey; and, United Kingdom.

2.3 Geographical

The region is not a coherent geographical unit. Its membership is divided into three continents, and two hemispheres. However, Canada and the United States collectively occupy similar latitudinal zones as those occupied by Western Europe while Australia and New Zealand occupy generally the similar corresponding latitudes in the southern hemisphere.

The climate in Australia is mainly arid or semi arid. It is temperate in the south and tropical in the north. New Zealand is temperate with some regional contrasts.

In North America, climatic variation is large extending from the Arctic in the north to a sub-tropical climate in the south. Within this pattern there is much variation. For example, within the Arctic, there is considerable moderating maritime influence on the coastal strip of Alaska but intense cold in the central and high eastern Canadian sectors.

Western Europe includes four climatic zones – A sector of the circumpolar Arctic in the north, alpine climate in the main mountain ranges such as the Alps and Pyrenees, a temperate zone in the central area and the Mediterranean zone to the south. The latter is generally characterised by mild wet winters and hot dry summers with more than 90% of annual precipitation falling in winter. Superimposed on this pattern is the moderating and wet influence of the Atlantic to the west, with drier and more extreme temperature ranges to the east.

2.4 Social and economic considerations

Australasia: Australia and New Zealand are developed countries with mixed economies and substantial agricultural sectors. Available information suggests that environmental levels and human exposure to POPs in both countries has always been low in relation to most regions elsewhere. Comprehensive regulations are well established concerning the environmental release of POPs.

North America: The USA and Canada are developed, industrialised countries. Of particular interest in terms of historical and potential source characterization is the Great Lakes Basin. It covers an area of approximately 774,000 square kilometres including much of Ontario, and the eight Great Lakes States: Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin. The Great Lakes basin is home to a total of about 33 million people, more than one-tenth of the population of the United States and one-quarter of the population of Canada. It is also a focus of both the U.S. and Canadian industrial capacity, while agriculture in Ontario and Quebec accounts for the largest single use of Canadian land in the basin, contributing about 40 percent of the value of agricultural output in the Canadian economy. Nearly 7 percent of the American agricultural production is located in the basin. The emissions and environmental fate of POPs in the Great Lakes and St Lawrence basins have been extensively studied and have provided much of the information for North America in the present report.

Comprehensive regulations are well established concerning the environmental release of POPs.

Western Europe: In Western Europe the chemical industry, metal production and processing and agriculture are all significant parts of the economy. There is a range from highly industrialised economies to other countries with greater reliance on agriculture and / or a more developing economic structure.

Generally in Western Europe there is considerable information relating to industrial point source emissions to the atmosphere. Sources to air of well studied compounds such as PCBs, and PCDDs/Fs are generally well characterised and inventories have been calculated and updated regularly via EMEP. A number of European countries such as the UK, and Germany also have a long industrial history, involving combustion activity in the form of wood and coal burning. The smelting of metals, cement kilns, and the production of iron and steel also have a long history in Europe, activities known to produce significant PCDDs/Fs emissions.

Most of the Western Europe region is today part of the European Union and, comprehensive regulations concerning the environmental release of POPs are well established with progressive development of harmonized regulation.

The Arctic: North America and Western Europe collectively include a large segment of the Arctic. This area is of particular interest in terms of the fate of POPs in the environment because it is lightly populated and with a generally low intensity of industrialization. However historical uses of POPs have occurred in the Arctic and waste disposal is continuing. The eight Arctic countries that are members of the Arctic Council contribute monitoring information on POPs to the Arctic Monitoring and Assessment Programme (AMAP) which produces extensive periodic assessment reports.

The Antarctic: The Antarctic is not defined by national boundaries. Because a number of WEOG region countries are parties to the Antarctic Treaty and are maintaining research activities in the area, the Antarctic has been given brief attention in this report (see section 4). The Antarctic is completely surrounded by ocean and is largely snow and ice covered. It is therefore remote from any significant primary source of the POPs listed in the Convention.

2.5 Considerations in relation to sampling strategies

The WEOG ROG report is based entirely upon existing programmes. Although it is difficult to provide a good categorization, the following illustrates the range of objectives observed from the programmes contributing to the WEOG report:

- Studies aimed to investigate levels and / or processes in areas close to historical local sources of POPs (e.g. HELCOM and studies in the Great Lakes region of North America such as IADN).
- Studies aimed to investigate levels and / or processes in areas distant from local sources of POPs where long-range transport and other processes are believed to be important in determining environmental levels and / or human exposure (e.g. AMAP; MONARPOP; and NCP)
- Studies aimed at understanding regional and / or global transport (e.g., EMEP and GAPS)
- Studies aimed at providing a wide survey of levels (e.g., WHO coordinated human milk surveys; New Zealand POPs study)

It is important to be aware of the historical objectives of the different programmes that have been the source of information used by the ROG. This information is contained in the programme summaries that are provided in Annexes 1 and 2 of this report.

3 ORGANIZATION OF REGIONAL IMPLEMENTATION

The WEOG regional Organizational Group (ROG) for the first evaluation was composed of six experts from each of the following countries: Australia; Spain; Canada; Sweden; Norway; and, Portugal.

3.1 Organization of activities

The ROG met exclusively by tele-conference calls supplemented by internet communication. A record of each meeting was kept which documented key decisions and work responsibilities until the next meeting when progress would be reviewed. Eight such tele-conferences were held before the draft report was sent to the WEOG focal points for their review. The chair rotated with each meeting. Early decisions were taken upon general responsibilities for coordination and drafting of the regional report (see acknowledgements section). A critical path was developed of work to be performed in sequence leading up to the finalization of the report and which included the elements detailed below. In general, this plan was followed throughout the data gathering and drafting process.

3.2 Strategy to locate and collect information from existing programmes

At its first and second meetings, the ROG reviewed information on existing programmes based upon survey responses obtained by the Secretariat, and selected candidate programmes to provide the basis for the first evaluation report. The basis of the selection was the application of the criteria contained in the "Implementation Plan for the First Evaluation Reports".

Candidate contributing programmes were contacted and invited to provide "programme summaries" according to a template developed by the ROG. The response from programmes was generally very cooperative (see annexes 1 and 2). In a few cases, the programme summaries were provided by ROG members, or by arrangements established by ROG members. This usually occurred when a single organization is host to the data bases for several programmes as is the case of the Norwegian Institute of Air Research (NILU) with the air information of both EMEP and AMAP.

3.3 Identified data gaps and strategies to fill them, including strategies and activities to generate monitoring data

The ROG reviewed the extent of information available from the programme summaries and the time available between its first conference call (27 November 2007) and the summer 2008 review by Convention focal points of the regional reports. The ROG concluded that information from existing programmes in the WEOG region provides an adequate overview of the status of POPs in the core media for the first evaluation and therefore decided not to attempt to initiate any new monitoring activities.

Although the availability of information from existing programmes is not geographically homogeneous, much of the WEOG region is information rich. However it was identified that there were two broad instances which led to patchiness in the reported information. In some geographical areas such as Australasia, there is a general absence of continuing established environmental monitoring of POPs although in these cases there is usually a good understanding of what these levels are, through the past conduct of surveys which may not necessarily be

continued. Therefore to improve the geographic resolution of information being made available to the COP, the ROG decided on the strategy to include such data if it otherwise was consistent with the criteria specified in the implementation plan for the first evaluation.

Another data issue noted by the ROG was that in some areas there was a lack of information on certain substances included in the annexes to the Convention, such as the dioxins and furans. The ROG therefore adopted a similar strategy as that described for geographical patchiness, and has included available information from sources which meet the criteria except for the confirmation of longevity of monitoring. In both instances, the ROG has termed such data sources as "snapshot" information.

3.4 Capacity strengthening needs

The ROG did not identify any capacity strengthening needs but it did observe that a lower amount of information is available for the Mediterranean rim than is the case elsewhere in Europe. This suggests a need for enhancing long term cooperation in POPs monitoring in the Mediterranean region to improve the information base for future effectiveness evaluations of the Convention.

3.5 Arrangements to elaborate the regional monitoring report

The ROG drafted its own report, with the assistance of three other individuals, Hayley Hung, Roland Kallenborn, and David Stone. The drafting responsibilities were as follows: Executive Summary, and Chapters 1-4 (David Stone); Chapter 5 – 5.1 Air (Roland Kallenborn and Hayley Hung); 5.2 Human tissue (Britta Hedlund); 5.3 Other Media (Ramon Guardans); 5.4 Long range transport (Tom Harner); and, Chapter 6 (David Stone). It was decided to add programme summaries as Annex 1 (Air) and Annex 2 (Human Tissues) to the report.

In order to increase the value of the drafting workshop organized by the Secretariat in Geneva, 19-23 May 2008, the ROG prepared draft chapters for the air, human media; and non-core media elements before the meeting. This experience revealed practical issues to be addressed at the meeting. Several drafts of each chapter were circulated for comment by the ROG and some of the key contributing programmes both before and after the drafting workshop. When the ROG was essentially satisfied with the individual sections, the latter were compiled into a single document by two members of the team 23-25 June 2008, at which time minor editing was conducted to ensure report consistency. Following a final review by the ROG, the report was distributed to WEOG focal points for the Convention on the 7 July 2008. Before being submitted to the Secretariat, the draft was revised to take account of comments received from the focal points.

4 METHODS FOR SAMPLING, ANALYSIS AND DATA HANDLING

4.1 Background

When initiating its activities to obtain monitoring information, the ROG took careful note of two concepts outlined in Article 16 of the Convention. First, it is stated that Parties shall make arrangements to obtain comparable monitoring data. The operational procedure to achieve comparability is the application of the criteria for programme selection outlined in the Implementation Plan for the first evaluation and the measures listed in the "Guidance Document". Second, Article 16 further states that the arrangements to gather data should be implemented using existing programmes and mechanisms to the extent possible.

As noted in section 3 of this report, the ROG decided that for the first effectiveness evaluation, it would base its review of POPs levels in the region using information derived entirely from existing programmes and activities. The ROG has not initiated any sampling, analytical, or data handling activities and therefore has nothing to report on such matters. However, the practices to conduct these elements were carefully considered when the ROG reviewed information on existing programmes based upon survey responses obtained by the Secretariat, and selected candidate programmes to provide the basis for the first evaluation report. The selection was performed by application of the above noted criteria which resulted in the identification of more than 16 established international and national programmes to be the main "comparable" information sources for the first evaluation. At least one member of the ROG (according to the expertise of that individual) then carefully examined the sampling, analytical, data quality, and data storage arrangements of each of the programmes. This enabled the ROG to satisfy itself that such arrangements are being maintained and will enable comparable data from the identified programmes to be used by the COP now and in the future to look for changes in POPs levels over time within those programmes.

4.2 Key Message regarding "comparable data" from existing programmes and activities

Although the ROG believed that it is practical and realistic to expect intra-programme (internal) comparability, it noted that each of the established programmes has its own procedures for conducting its work, usually including constraints on the use of different analytical laboratories within each programme. It is important to note that very few programmes share the same analytical laboratory with other programmes. Since the use of different analytical laboratories is a major source of variance, the ROG concluded that it would be very difficult to achieve levels of comparability between programmes necessary for effectiveness evaluation. Therefore in preparing this report, the ROG focused on using information from programmes where measures and procedures are expected to provide intra-programme comparability over time for present and future effectiveness evaluations. While this conclusion generally means that there will be very limited direct comparability between programmes and regions, significant exceptions are evident, such as when a programme operating in several regions has maintained a centralized analytical facility servicing all regions, such as with the WHO coordinated human milk programme. The extensive use of such measures as utlization of common analytical laboratories and data centres has demonstrated the possibility of achieving adequate comparability between well established programmes in the WEOG region. An example is the collaborative practices of AMAP, EMEP, OSPAR, and HELCOM.

4.3 Availability of information to allow data to be independently evaluated

At its first and second meetings, the ROG considered how best to provide the COP with all of the information requested in a concise fashion but in an easily accessible form. It was decided to that these needs are addressed by providing the COP with four tiers of information. They are:

1) The short "Executive Summary" and "Chapter 6 Summary" elements of this report which inform the COP of the essential features of the levels of POPs in the region;
2) The concise synthesis of information derived from the contributing existing monitoring programmes (Chapter 5 of this report);
3) More detailed information on the nature of operation and data used from each of the contributing programmes. These are termed "programme summaries" and are provided in annexes 1 and 2 to the WEOG report. They were chiefly prepared by experts working in the existing contributing programmes; and,
4) Ensuring that full details on any aspect of an existing programme can be accessed, usually through direct contact with the management or secretariats of each contributing programme.

Therefore if an individual would like to obtain more information for example on the analytical methodologies, quality assurance and control, data handling, and data availability practices of a contributing programme, that individual has a choice of the degree of detail that can be accessed.

4.4 Description of national and international programmes and activities that have contributed information for the regional report

The following tables (4.1 and 4.2) briefly summarize the nature of each of the main sources of information on environmental levels of the core media (air and human milk / blood) used by the ROG for this report. More details can be found in the programme summaries provided in annexes 1 and 2 including in many cases maps to indicate geographical coverage, while a collective synthesis of the programme results is provided in chapter 5. The ROG found it difficult to develop a summary map of the geographic coverage due in part to the evolving nature of programs.

Table 4.1 Major ongoing programmes and activities related to air monitoring that have contributed to the WEOG report

Monitoring programme	**Abbreviation**	**Region of interest**	**No. of POP monitoring sites**	**Monitoring period**	**Monitored compounds (Stockholm conv. POPs)**
Arctic monitoring and Assessment Programme	AMAP	Arctic	12 [a]	1992 - present	PCBs, HCB chlordanes, DDTs*; Station Nuuk (Greenland; operated by Denmark) has not reported PCBs and HCB but have included dieldrin and heptachlor epoxide; 8 NCP-related stations report additional compounds (see

					below).
Northern Contaminants Program (Canada) (Part of AMAP)	NCP	Arctic	8 [a]	1992 - present	PCBs, DDTs, mirex, chlordanes, heptachlor, heptachlor epoxide, HCB, endrin, dieldrin
European Monitoring and Evaluation Programme	EMEP	Europe	7	1993 - present	PCBs, DDTs, chlordanes, HCB,
Global Atmospheric Passive Sampling network	GAPS	Global	24 (in WEOG region)	2004 - present	PCBs, chlordanes, DDTs, heptachlor, heptachlor epoxide, dieldrin
Integrated Atmospheric Deposition Network (USA)	IADN	Great lakes (USA)	5 (master stations)	1990 - present	PCBs, chlordanes, DDTs, heptachlor, heptachlor epoxide, aldrin, endrin, dieldrin.
Monitoring Network in the Alpine Region for Persistent and other Organic Pollutants	MONARPOP	European Alpine regions	40 (3 stations with active samplers and other with SPMD passive air samplers)	2005 - present	PCBs, DDTs, HCB heptachlor, dieldrin. aldrin, endrin, mirex, PCDD/Fs
U.S. EPA's National Dioxin Air Monitoring Network	NDAMN	USA	34	1998 - 2004	PCDD/Fs, co-planar PCBs
Xarxa de Vigilancia i Previsió de la Contaminació Atmosférica	XVPCA	Catalonia (Spain)	28	1994 - present	PCDD/Fs, co-planar PCBs (2003-present)
The UK Toxic Organic Micro Pollutants (TOMPs) programme	TOMPS	UK	6	1991 - 2006	PCDD/Fs, PCBs

[a] The Northern Contaminants Program (NCP) is the Canadian National Implementation Plan of Arctic Monitoring and Assessment Programme (AMAP). Data from 11 AMAP stations are presented in the current assessment, within which 8 stations are operated under NCP. Under NCP, 5 stations are within WEOG [including Barrow, Alaska, operated by the U.S. National Oceanic and Atmospheric Administration (NOAA) under NCP protocols]. The remaining 3 stations are situated in Russia.

Table 4.2 Programmes and activities related to human media (human milk and /or blood) that have contributed to the regional report.

Programme	**Media**	**Geographic coverage**	**Time period**	**POPs measured**
AMAP	Blood	Arctic region	1993 – present	DDT, PCB, toxaphene, mirex, chlordanes, dieldrin, heptachlor, HCB,
CDC/CCEHIP/ NCEH	Blood	United States	1999 -	All 12 Stockholm Convention POPs

			present	
Uppsala	Human Milk	Sweden	1996 - present	DDT, PCB, PCDD/PCDF, HCB, chlordanes,
Stockholm	Human milk	Sweden	1970 - present	DDT, PCB, HCB, chlordanes
WHO	Human Milk	All UNEP regions	1988 - present	PCDD/PCDF, PCB
GerES	Blood and urine	Germany	1985- present	HCB,DDE, and PCB
ESB	Blood	Germany	1984 - present	HCB, PCB 153
Australia "snap shot" surveys	Blood and mother's milk	Australia	Not repetitive	PCDD/PCDF, PCB,
New Zealand "snap shot" surveys	Human mother's milk	New Zealand	Not repetitive	PCDD/PCDF, PCB, HCB, dieldrin, heptachlor epoxide, pp-DDT / pp-DDE

It is important to note that the results from national programmes could either be reported individually (such as the German human media GerES and ESB activities), or "invisibly" through their pre-existing participation in an international programme (such as the Canadian Northern Contaminants Programme, which provides data from the Canadian Arctic to AMAP). When opportunities for the latter approach exist, they were used by the ROG, because it enabled full advantage to be taken of the "comparability" measures maintained by the international programme.

4.5 Antarctica

The ROG briefly reviewed published material on air concentrations from Antarctica (chapter 5.1) while also noting that no ongoing POPs measurements are being maintained on the continent. However, a POP atmospheric monitoring program has been established at the Norwegian Antarctic station "Troll" in 2006/07 based upon the sampling and analytical protocols established for the ongoing monitoring program at the "Zeppelin" atmospheric research station (Ny-Ålesund, Svalbard). The first year around dataset has been analyzed in 2008 and is currently prepared for quantification. Thus, continuous POP atmospheric monitoring data for Antarctica will be available for future evaluations.

Because human exposure of POPs is primarily derived from diet and all provisions at Antarctic field stations will be imported, human exposure studies would not have value in the context of effectiveness evaluation.

The ROG believes that in future evaluations the engagement of the Antarctic Treaty and the Scientific Committee of Antarctic Research (SCAR) would be very beneficial.

5 RESULTS

5.1 Ambient air

5.1.1 Background

In the WEOG region, national and international atmospheric monitoring programmes (Table 4.1) over the last 20 years have documented air concentrations, distribution and fate of POPs. For example, it has been shown that many of these compounds are transported in the atmosphere through several climate zones into the Polar Regions with significant implications for the health and well-being of people in the North. Decades after they were banned, selected POPs are still continuously detectable at atmospheric background stations, including those in the Polar Regions.

In total 9 established monitoring programmes have contributed to this assessment (Table 4.1). Six monitoring programmes (AMAP, IADN, NCP (part of AMAP), EMEP, GAPS, and MONARPOP) report data from stations across national borders and can be considered as regional/ international co-operation programmes. The other 3 monitoring programmes mainly focus on national POP monitoring (NDAMN, XVPCA and TOMPS). The monitoring areas of the 3 national programmes overlap those of the regional/international programmes, providing air monitoring data of greater spatial resolution. AMAP, EMEP, NCP and GAPS are only reporting air concentration data of PCBs, HCB and organochlorine pesticides. MONARPOP and IADN include data of PCDD/Fs. The UK-programme TOMPS, U.S. EPA's NDAMN and the Spanish (Catalonian) XVPCA are focusing mainly on PCDD/Fs and/ or dioxin-like PCBs. Snap-shot information on PCDD/F air concentrations are available from the Australian National Dioxins Program in 2002/2003/2004 and the NCP short term survey in winter of 2000/2001. In addition, atmospheric POP concentration data from New Zealand measured from March 1996 to May 1997 are included in this report.

5.1.2 Contributing atmospheric monitoring programmes

This section gives a brief description of the scope and focus of the key programmes that have provided the information on which this atmospheric review has been based. A comprehensive network of atmospheric monitoring stations is established in Western Europe and Canada within the framework of the EMEP and AMAP monitoring programmes.

Spatial coverage of air concentration measurements conducted under each individual programme with corresponding maps is given in the respective program summaries included in Annex 1. Please refer to Annex 1 for further details on each contributing programme.

AMAP/EMEP monitoring programme and Northern Contaminants Program (NCP)

AMAP and EMEP are the largest established international monitoring networks with overlapping geographical coverage which represents atmospheric monitoring activities for POPs in a large part of Europe, including the European Arctic. As part of AMAP, Canadian-operated NCP features the longest time series for atmospheric POPs at the North American Arctic station of Alert (Canada). These three programmes were established in the early 1990s with the goal of assessing contaminant impact on the European and circumpolar environment. With their long

records of atmospheric POP concentrations, temporal trends were derived and reported here. Due to their overlapping geographical coverage, results from these programmes are jointly assessed.

Global atmospheric passive sampling network for POPs

The GAPS programme was initiated in December 2004 as a two-year pilot study before evolving into a network consisting of more than 60 sites on seven continents. Its objectives are to i) demonstrate the feasibility of passive air samplers (PAS) for POPs; ii) determine spatial and temporal trends for POPs in air; and iii) contribute useful data for assessing regional and global long-range atmospheric transport of POPs. The ability of passive samplers to provide a cost effective means of gathering air data in all of the regions being examined in the effectiveness evaluation has now been well demonstrated through the work inter alia of GAPs; MONET; and MONARPOP. Results from 24 stations under this network in the WEOG region are reported here.

Integrated Atmospheric Deposition Network (IADN)

The Integrated Atmospheric Deposition Network (IADN) was established jointly by the United States and Canada for conducting air and precipitation monitoring in the Great Lakes Basin. The network consists of 5 Master Stations, located on each of the 5 Great Lakes, along with a number of satellite stations in urban, rural and remote locations. Measurement results from the 5 Master Stations obtained between 1990 and 2003 are included in the current assessment.

Xarxa de Vigilancia i Previsió de la Contaminació Atmosférica (XVPCA)

XVPCA is an air quality monitoring system established in 1983 under the Department of the Environment and Housing of the Government of Catalonia, Spain. The objective of the XVPCA monitoring network is to identify temporal and spatial trends in concentrations of atmospheric pollutants in particular PCDD/Fs, coplanar PCBs and PAHs. Measurements of PCDD/Fs in air have been carried out by the XVPCA since 1994 and starting from 2003 coplanar PCBs are also monitored.

U.S. EPA's National Dioxin Air Monitoring Network (NDAMN)

NDAMN is a national network with 34 geographically dispersed monitoring stations in the United States. It operated from June 1998 through December 2004 and collected ambient air measurements of PCDD/Fs and coplanar PCBs in 24 rural, 7 remote and 3 urban sites. The focus of the programme is on atmospheric concentrations of these compounds in rural and remote locations, therefore the results of the 3 urban sites are not included in this report.

UK Toxic Organic Micro Pollutants (TOMPs) programme

TOMPs (Toxic Organic Micro Pollutants) is a monitoring network which measures the atmospheric concentrations of PAHs, PCBs, and PCDD/Fs within the U.K. The monitoring sites include three urban (London, Manchester and Middlesbrough), two rural (High Muffles and Stoke Ferry) and one semirural (Hazelrigg) stations. Data are reported quarterly and all stations have accumulated 10 to 16 years of data from which temporal trends were developed.

Monitoring Network in the Alpine Region for Persistent and other Organic Pollutants (MONARPOP)

MONARPOP aims to provide spatial and altitudinal monitoring information of POPs and other organic pollutants to decision makers in the European Alpine regions. The network consists of 33 standard sites (located at 1400 m ± 150 m a.s.l.) and 7 altitude-profile sites regularly spaced at increasing heights. Three summit stations above the timberline are equipped with remotely controlled active direction-specific samplers which collect air approaching the stations from different directions separately. Air concentrations at these stations are assessed with a combination of active and semi-permeable membrane device (SPMD) passive sampling techniques. This network intends to help to assess the success of the Stockholm Convention on POPs. Only mean air concentrations measured at the three summit stations in 2006 of priority POPs under the Stockholm Convention, except chlordane and toxaphene, are reported here.

5.1.2.1 "Snap-shot" information

Northern Contaminants Program (NCP) and AMAP Satellite Stations

In addition to the established monitoring in Alert, NCP also conducts atmospheric measurements of POPs at 6 satellite Arctic stations in Canada (Tagish, Little Fox Lake and Kinngait) and in Russia (Amderma, Dunai and Valkarkai). The National Oceanic and Atmospheric Administration (NOAA) (U.S.) operated air measurements of POPs at Barrow, Alaska, in 2002/03, following the NCP sampling, analytical and quality assurance/quality control (QA/QC) protocols. Air concentrations of POPs have been reported by Bossi et al. (2008) for measurements conducted at Nuuk (Greenland) by the Danish Environmental Protection Agency in 2004-2005 under AMAP. Measurements at these stations were conducted for shorter time periods of 1-2 years (except for Valkarkai where measurements only occurred for 2 months in 2002) (see NCP programme summary and Bossi et al. (2008)). Although measurements were not continuous and therefore impossible to derive time trends, results from these stations are included in the current assessment. If atmospheric measurements were restarted at these locations, it will be possible to estimate changes in atmospheric concentrations of POPs over time.

The NCP PCDD/F Special Study (2000/2001)

PCDD/Fs were analyzed in 15 air samples collected from Alert during the winter of 2000/2001. The 15 samples analyzed were deliberately selected such that the sampling periods coincided with the occurrence of the Arctic Haze (December to April). Only particle-bound PCDD/Fs were analyzed in this study. Therefore, air concentrations reported here are only particle-phase concentrations. More detailed information can be found in the NCP programme summary.

PCDD/Fs and co-planar PCBs in Australia

As a first study on PCDD/F levels and coplanar PCBs in Australian air, a survey was performed on 10 sampling locations (Gras et al. 2004). The ten sampling sites were situated around major cities including Perth (WA), Darwin (NT), Brisbane (QLd), Mutdapilly (QLd), Sydney (NSW), Boorolite (Vic), Melbourne (Vic) and Adelaide (SA). In addition, the remote sampling site Cape Grim (Tasmania) was selected as background reference location. Weekly samples were collected in the period during September 2002 – August 2003 (Netley, Adelaide: January 2003 – January 2004). The concentrations of the 17 toxic dioxin and furan congeners, the total (tetra to octa-PCDD/F) homologue groups, the 12 dioxin-like PCB congeners and a suite of inorganic and light organic aerosol components were determined for a complete annual cycle. Congener

patterns show strong resemblances to congener concentration patterns found in a study of wood smoke emissions from Australian residential wood heaters (Gras et al., 2002) and to homologue patterns reported for emissions from Christchurch and Masterton, NZ, during winter by Buckland et al. (1999).

POPs in New Zealand

From March 1996 to May 1997, POPs were measured in air at the Baring Head meteorological station on the coast near Wellington, New Zealand. The air concentration data were derived from air sampled only during periods of southerly winds to reflect southern ocean maritime conditions. Air concentrations of all POPs (except toxaphene, mirex and endrin) are reported here.

POPs in Antarctica

For Antarctica only restricted campaign based information on POP levels in ambient Air is available. A first land-based air sampling campaign in 1994-1995 at the British Antarctic research station Signy Island (South Georgian islands) revealed similar levels of POPs (PCBs, chlordanes, DDTs and HCB) as found for remote sampling sites in the Arctic (PCB: 20 and 60 pg/m^3, HCB: 20-40 pg/m^3, chlordanes: 0.1 – 0.5 pg/m^3; Kallenborn et al. 1998). A comprehensive description of the POP contamination status was summarized in an earlier report (UNEP 2002). Similar as the Arctic regions, Antarctica cannot be considered as a source of POPs to adjacent regions. In the report, it is stated that the presence of by-products like PCDD/Fs as well as PAHs results from local activity associated especially with long-term operations in the regions (e.g., McMurdo research base). Thus, incineration and transport emissions are the key means of introducing these POPs to the local environment. Based upon the findings of three earlier major studies (UNEP 2002) atmospheric long-range transport is identified as major source for POP concentrations in Antarctic air.

5.1.3 Results

The following provides key observations on the levels of the 12 POPs currently listed in the Convention.

Hexachlorobenzene (HCB) - HCB is ubiquitously distributed in the atmosphere globally. Background air concentrations of HCB in the WEOG region were approximately 10 - 100 pg/m^3. Higher concentrations can be expected in source regions such as industrial centers and cities with levels of several hundred pg/m^3. Under AMAP and EMEP, a concentration gradient was observed between the central European source region and the remote Arctic (Aas & Breivik 2007). In general, HCB levels in the WEOG atmosphere show a downward trend during the past decade. However, since 2003 a slight increase in HCB in ambient air samples from the Arctic station of Zeppelin (Svalbard) was observed. This increasing concentration may be due to increased evaporation of previously deposited HCB from open surfaces along the western coast of Spitsbergen which has been ice-free in the winters of 2004 to 2008. This indicates the influence of the local climate regime on HCB air concentrations (see programme summary). HCB levels from Iceland (2 – 13 pg/m^3) were in general considerably lower than those reported for the other AMAP/EMEP stations indicating possible differences in source contribution (Aas & Breivik 2004, 2005, 2006, 2007). In the Antarctica, HCB levels (11 – 32 pg/m^3) measured in 2001/2002 have shown approximately the same concentrations as those reported in 1998.

Polychlorinated biphenyls (PCB) - Polychlorinated biphenyls (PCBs) are the most investigated POP group in all environmental compartments. PCBs are considered ubiquitously distribution in the atmosphere throughout the entire WEOG region with background concentrations in the range of 5 – 20 pg/m^3 (7 or 10 sum of AMAP PCBs). PCBs levels in the range of 60 – 100 pg/m^3 are measured close to potential source regions, in rural central European cities (AMAP/EMEP programme summary). At the majority of the monitoring stations, a continuous downward trend is reported for PCBs (AMAP 2004). However, similar to HCB, PCB levels increased in Zeppelin (Svalbard) during the past 4 years (AMAP/EMEP programme summary).

Under MONARPOP, atmospheric PCBs are found to be higher in the European Alps than at sites of northern latitudes but lower than urban locations in Europe. The PCB air concentrations decreased from the western site (Weissfluhjoch, Switzerland) to the most eastern site (Sonnblick, Austria).

In New Zealand, 25 PCBs were measured in air and the total concentrations were found to be in the range of 6.98 – 18.2 pg/m^3. Measurements in the Terra-Nova Bay region (Victoria Land, Antarctica) in 2003/2004 have shown an average PCB concentration of 1 pg/m^3.

Coplanar PCBs measured in the U.S. under NDAMN ranged from 0.5-1.0 fg TEQ/m^3 in rural areas versus 0.1-0.5 fg/TEQ m^3 in remote locations. Air concentrations were higher in the spring and summer relative to the fall and winter. Similarly, coplanar PCB concentrations were found to be higher in Catalonia, Spain, by the XVPCA programme in the summer (2.98-13.6 fg TEQ/m^3) than in the winter (1.63-4.16 fg TEQ/m^3). This implies higher revolatilization of PCBs from previously deposited sinks, e.g. soil, to air in the summer as a result of higher temperatures. Generally speaking, the mean air concentrations of coplanar PCBs reported for Catalonia, Spain, [6 (2-18) fg TEQ/m^3] were much higher than those observed in the U.S. and at summits of the European Alps (0.13 - 0.73 fg TEQ/m^3).

Chlordanes (trans-/ cis-chlordane and trans-/cis-nonachlor) - Chlordanes were monitored under IADN, GAPS, AMAP, EMEP and in New Zealand in 1996/97. Generally, low concentrations (0.2 – 3 pg/m^3) are observed at Arctic monitoring stations (AMAP/EMEP programme summary) and in New Zealand. Higher concentrations were found in near-source regions, e.g. the Great Lakes (4.98 – 23.1 pg/m^3) in North America. Decreasing trends were found at all stations with half-lives of 6 to 16 years. The concentrations of chlordanes are usually found in ultra-trace concentrations close to the instrumental limit of quantification.

Heptachlor - Heptachlor is usually found at very low concentrations in the atmosphere. Once released into the environment, heptachlor degrades quickly to heptachlor epoxide which is more frequently observed in the atmosphere. In this report, baseline data are presented for both heptachlor and heptachlor epoxide. Heptachlor was sporadically detected in air samples from Alert in the Canadian Arctic at low concentrations (<0.5 pg/m^3). Low concentrations were also observed in the European Alps (0.03 – 0.06 pg/m^3), in New Zealand (median of 0.37 pg/m^3) and in passive air samples collected under GAPS. Most levels reported are in the ultra-trace concentration range and close to the instrumental detection limit. No clear trend information can, thus, be established based upon the available data. Heptachlor epoxide was found at low concentrations at Alert (0.02 – 5 pg/m^3) and under the GAPS programme at various locations.

Polychlorinated--dibenzo-*p*-dioxins and furans (PCDD/Fs) - The TOMPs PCDD/F monitoring programme (1991 – 2006) is the longest running measuring programme within the WEOG region (6 sampling stations within the UK). Significant downward trends were found for the urban sites (London, Manchaster, Middlesborough) from 200 – 300 fg TEQ/m^3 in 1992-1993 to 10 – 100 fg TEQ/m^3 in 2004-2005, with an half-life of 6.3 years (range: 3.2 - 11.1 years) for ΣPCDD/F. In 2006, the average air concentrations ranged from 0.47 (High Muffles) to 26.8 (Hazelrigg) fg TEQ/m^3.

The US NDAMN data suggests that there has been little or no change in the amount of PCDD/Fs present in ambient air in the U.S from 1998 to 2002 and in areas of the country that are distant from known anthropogenic source activities. The uniform pattern of PCDD/F congeners present in ambient air in cities, rural areas, and remote areas reflect that urban areas are the primary sources of PCDD/Fs present in ambient air. Thus, cities can be viewed as regional sources. NDAMN data indicate that mean contemporary U.S. background concentrations of PCDD/Fs in rural and remote areas are within a range of 6 to 15 fg TEQ/m^3, and 0.1 to 3 fg TEQ/m^3, respectively. Atmospheric concentrations of PCDDs and PCDFs were found to be higher in the fall and winter as compared to spring and summer.

Among all programmes that reported PCDD/Fs in air included in the current report, the highest concentrations of PCDD/Fs were observed in Catalonia, Spain. Data from the XVPCA monitoring network indicate clear spatial differences between the mean background [33 (range: 4-250) fg TEQ/m^3] and industrial [88 (range: 3-1000) fg TEQ/m^3] locations in Catalonia, Spain (1994-2007). A decrease in maximum and average values for PCDD/Fs (TEQ) in the period 1994-2002 was observed (Abad et al., 2004). Similar to the US-EPA NDAMN programme, PCDD/F levels were found to be higher in winter (8.25-72.7 fg TEQ/m^3) than in the summer (3.04-10.4 fg TEQ/m^3). This difference can be due to an increase of sources in winter, lower dispersion than in the summer and lower concentrations of OH radicals in winter. The levels found in the Catalonian network were considerably higher compared to those observed under US-EPA NDAMN but closer to that measured by TOMPS.

In the European Alps, higher air concentrations of PCDD/Fs were observed at Zugspitze in the northern periphery of the Alps in Germany compared to the other 2 centrally located MONARPOP summit stations. This is consistent with the significantly higher concentrations detected in soils and needles from the Northern fringes of the Alps compared to the central sites.

Snap-shot data on PCDD/F levels are available from Australia, New Zealand and Arctic Canada (NCP). A strong, seasonal cycle in PCDD/F concentrations, both as mass concentrations and TEQ, with a winter concentration maximum in all of the major population centres studied, from Perth, through Adelaide, Melbourne, Sydney and as far north as Brisbane in Australia was found. Despite the winter enhancement in PCDD/F, overall annual mean concentrations in the major cities in Australia are still very low by world standards. Extremely low PCDD/PCDF concentrations were observed in clean marine air and also in rural locations removed from the major urban centres. Similarly the air concentrations measured in New Zealand were low (1.21 – 7.48 fg TEQ/m^3). This indicates a very clean regional background, with the major sources being local and associated with the urban population.

The air concentrations of PCDD/Fs at the Canadian Arctic station of Alert (2000 – 2001) are much lower than at the southern Swedish station of Rörvik (monitoring site moved in 2001 to the nearby location Råö) and Arctic station of Zeppelin (Svalbard). Although both Alert and Zeppelin are located in the high Arctic, the latter is a destination for cruise ships in spring and summer and is closer to Eurasian sources than Alert (Hung et al. 2002, Schlabach et al. 1996, Tysklind et al 1993).

DDT derivatives - DDT derivatives including the major transformation products of *p,p'*-DDT and/ or *o,p'*-DDT are reported in atmospheric samples from the WEOG region. Background concentrations were found in the Arctic in the range of 0.1 – 11 pg/m^3 (sum 6 major isomers). In general, decreasing trends were found for the majority of the stations confirming the concentration reduction of DDT compounds in WEOG air. However, similar as reported for HCB and PCB, DDT air concentrations seem to increase in Zeppelin (Svalbard) during the past 3 years. Air concentrations of DDTs measured in the Alps (2-7 pg/m^3) were higher than at Arctic stations (generally between 0.5 and 4 pg/m^3). In New Zealand, the air concentrations of DDTs were approximately 4 pg/m^3. Recent reports confirm that DDT derivatives and HCB have not been declining in Antarctica. This finding was attributed to the increase in contribution from secondary sources and remobilization of POPs through increased ice melting processes on the Antarctic continent.

Mirex - Mirex was occasionally observed at Alert in the Canadian High Arctic but the concentrations are extremely low and close to detection limits. Therefore, no clear trend can be established based on the available data. However, mirex was fequently detected at the three MONARPOP summit stations in the European Alps indicating long range transport across the Alps since Mirex has never been used in central Europe. Annual average concentrations were in the range of 0.06 – 0.09 pg/m^3 in 2006 in the European Alps.

Aldrin - Aldrin was occasionally observed at Alert but the concentrations are extremely low. IADN reported low air concentrations ranging from 0.07 – 0.97 pg/m^3 (1990 – 2003) in the Great Lakes region. It is known that aldrin degrades readily to dieldrin.

Dieldrin - Despite generally low air concentrations observed, dieldrin was reported sporadically at Alert (Canada). It was also observed at low levels (0.10 - 3.7 pg/m^3) at Barrow, Alaska, and was found in the Great Lakes region (11.9 - 30.1 pg/m^3) and European Alps (1.52 - 2.51 pg/m^3).

Endrin - Endrin was observed sporadically at Alert (Canada) at ultra-trace concentrations (0.041 – 5.0 pg/m^3). The presence of endrin in the atmosphere above the European Alps is confirmed by MONARPOP in levels between 0.03 and 0.05 pg/m^3. Endrin was found in the atmosphere of the Great Lakes region at low levels (1.04 - 5.29 pg/m^3).

Toxaphene - Toxaphene was only reported in the Great Lakes region by the IADN programme at the Master Station of Point Petre (Lake Ontario). Total airborne toxaphene was found to be 1.5 – 10 pg/m^3 in 1992 and 0.9 – 10.1 (Oct 95 – Sep 97) (Shoeib et al., 1999).

5.1.3.1 Summary of air concentrations

Atmospheric concentrations of the priority POPs measured in the WEOG region as reported by the programme summaries (otherwise referenced) are summarized below in Table 5.1.1 to 5.1.8. High air concentrations reported as maxima in the tables indicate the highest values observed during the corresponding time period and are not 'outliers' or results of sampling/analytical artifacts. These high values reflect occasional atmospheric transport episodes from source regions to remote/background sites. It is, thus, expected and reasonable that these elevated values be reported as concentration ranges are given here.

Table 5.1.1a Range of atmospheric PCB concentrations in the WEOG region
aa = annual average concentration

PCBs (pg/m^3)							
Year/ Location	**Arctic Canada [a]**	**Norway [a]**	**Sweden [b]**	**Iceland [a] (aa)**	**Finland [b] (aa)**	**Svalbard [a]**	**Alaska, U.S. [a]**
1993	0.18 – 26						
1994	0.86 – 47						
1995	1.9 – 22						
1996	0.17 – 18						
1997	0.17 – 9.1						
1998	2.7 - 9.1		7.8 - 14	7.4	6.2	<LOD – 132	
1999	0.17 - 137		0 – 12	6.3	7.5	<LOD – 99	
2000	0.19 – 11		13	10	6.4	<LOD – 58	
2001	0.70 – 19		6.9 - 8.9	13	5.4	2.8 – 37	
2002	0.14 - 17		5.8 - 16	6.0	6.2	2.8 - 15	8.6 – 47 [h]
2003	2.4 - 8.2		12	6.0	5.1	<LOD - 16	
2004	0.74 – 5.0	1.6 – 13	6.7 - 9.9	6.6	5.5	3.2 – 28	
2005	2.0 - 38	2.2 – 42	4.6 - 8.9	5.5	5.1	3.6 – 14	
2006		1.9 – 23				3.2 - 30	

PCBs (pg/m^3)					
Year/ Location	**U.K. [c]**	**Great Lakes, Canada/U.S. [d]**	**GAPS (24 WEOG sites) [e]**	**New Zealand [f]**	**European Alps [g]**
1993/1994		60 - 230 [h]			
1994/1995					
1996/1997				7.0 – 18	
1998					
1999					
2000					
2001					
2002					
2003					
2004					
2005	19 - 698		204 (<LOD-4052)		12 - 44

2006					

[a] ΣAMAP 10 PCBs. Svalbard data are collected from the Norwegian-operated Zeppelin Station.
[b] ΣAMAP 7 PCBs
[c] Total TOMPS PCBs
[d] Total IADN Suite PCBs (1990-2003)
[e] 24 sites located over the WEOG region. Value shown as mean (range). LOD = limit of detection
[f] Sum of 25 PCB congeners including half limit of detection values for non-detected congeners.
[g] Sum of 6 PCBs of MONARPOP. Measurements at 3 summit sites in the European Alps
[h] Highlighted area indicates time period over which range was derived.

Table 5.1.1b Range of atmospheric coplanar PCB concentrations in the WEOG region

Coplanar PCBs, fg TEQ/m^3				
Year/Location	**US**	**Catalonia, Spain**	**Australia**	**European Alps [a]**
1998	0.12 - 0.80 [b]			
1999				
2000	0.06 - 0.91			
2001	0.06 - 0.74			
2002	0.13 - 0.92		0.02 – 6.4 [b]	
2003		2 – 18 [b]		
2004				
2005				
2006				0.13 - 0.73
2007				

[a] 3 summit sites in the European Alps
[b] Highlighted area indicates time period over which range was derived.

Table 5.1.2 Range of atmospheric ΣPCDD/F concentrations in the WEOG region [a]

ΣPCDD/Fs, fg TEQ/m^3						
Year /Location	**U.K. Urban**	**U.K. Rural**	**U.S. Rural**	**U.S. Remote**	**Great Lakes, Canada [b]**	**Catalonia, Spain**
1991		1 - 50				
1992	200 - 300					
1993						
1994						11 - 954
1995						
1996					6.1 - 590 (median: 30)	
1997						18 - 405
1998			7.2 - 14	0.1 - 2.9		
1999						5 - 357
2000			7.4 – 15	0.36 - 1.6		
2001			6.4 – 14	0.44 - 0.96		10 - 223
2002			7.4 – 14	0.50 - 1.6		
2003						
2004	10 - 100					
2005						
2006	0.13 – 30 [c]	0.09 - 59 [c]				

continued -Table 5.1.2 Range of atmospheric ΣPCDD/F concentrations in the WEOG region [a]

SPCDD/Fs, fg TEQ/m^3				
Year /Location	**Australia**	**New Zealand**	**Arctic Canada**	**European Alps [d]**
1991				
1992				
1993				
1994				
1995				
1996		1.2 – 7.5		
1997				
1998				
1999				
2000			<LOD - 1.6	
2001				
2002	0.11 – 122			
2003				
2004				
2005				
2006				1.8 - 6.9

[a] Highlighted area of the same colour indicates time period over which range was derived. LOD. = limit of detection

[b] Dann, T. and Krieger, K. (2000) Results from 7 monitoring stations in the Great Lakes region in Canada.

[c] Derived from data reported on website: http://www.lec.lancs.ac.uk/ccm/

[d] 3 summit sites in the European Alps

Table 5.1.3 Range of atmospheric HCB concentrations in the WEOG region

HCB, pg/m^3				
Year/Location	**Norway**	**Iceland**	**Svalbard[a]**	**Arctic Canada**
1993/1994			41 - 312	0.06 - 901
1994/1995			76 - 541	16 - 288
1995		3.1 – 16	41 - 211	1.4 - 132
1996	72 – 132	4.3 – 11	61 - 201	0.33 - 243
1997		2.3 – 25	48 - 763	6.1 - 96.1
1998	83 – 117	2.1 – 65	51 - 162	28 - 136
1999	49 - 138	3.3. – 17	62 - 101	3.9 - 114
2000	44 - 76	3.6 – 11	2.8 – 73	20 – 100
2001	29 – 91	3.8 – 16	36 – 76	7.3 - 126
2002	33 - 114	1.7 – 6.7	32 - 267	0.06 - 118
2003	39 – 90	2.9 – 5.8	14 – 74	15 – 78
2004	44 – 134	1.1 – 5.6	54 – 80	0.06 - 70
2005	33 – 114	1.2 – 4.0	48 – 79	0.06 - 120
2006	34 – 93		48– 150	

HCB, pg/m^3				
Year/Location	**Alaska, U.S.**	**Great Lakes, Canada/U.S.[d]**	**New Zealand**	**European Alps[b]**
1993/1994		29 – 77[c]		
1994/1995				
1995				
1996			26[c]	
1997				
1998				
1999				
2000				
2001				
2002	13 – 125[c]			
2003				
2004				
2005				
2006				64 - 89

[a] Svalbard data were collected from the Norwegian-operated Zeppelin Station.
[b] 3 summit sites in the European Alps
[c] Highlighted area indicates time period over which range was derived.
[d] Range derived from gas phase concentrations measured at 5 IADN Master Stations (1990- 2003)

Table 5.1.4 Range of atmospheric DDT concentrations in the WEOG region

DDTs, pg/m^3						
Year/ Location	**Sweden [a]**	**Iceland [b]**	**Finland [a]**	**Svalbard [c]**	**Arctic Canada [c]**	**Alaska, U.S. [c]**
1993/1994					0.12 - 26	
1994/1995					0.25 - 6.8	
1995		<LOD – **6.9**			0.26 - 6.2	
1996		<LOD – **117**	**1 – 3.7**		0.15 – 11	
1997			0.9 – 5.0	0.2 – 2.8	0.31 - 2.8	
1998		0.5 – 19	0.9 – 2.6	<LOD – 4.2	0.45 - 5.3	
1999		<LOD - 0.55	1.7 – 8.1	<LOD – 3.3	0.24 - 2.0	
2000		0.39 – 0.89	0.5 – 3.2	<LOD – 1.2	0.31 - 5.5	
2001		0.33 – 1.9	-	<LOD – 2.9	0.18 - 2.8	
2002	1.3 – 12	0.43 – 1.0	0.1 – 1.2	<LOD – 2.2	0.15 - 2.4	0.48 - 4.4 [h]
2003	1.6 – 11	0.76 – 2.5	0.4 – 1.5	<LOD – 1.6	0.59 - 2.2	
2004	1.2 – 6.0	0.5 – 0.94	0.4 – 1.3	0.1 – 1.6	0.63 – 4.1	
2005		0.4 – 0.76	0.5 – 1.8	0.1 – 2.8	0.61 – 2.3	
2006				0.1 – 9.8		

DDTs, pg/m^3					
Year/ Location	**Greenland [d]**	**New Zealand [e]**	**GAPS [f]**	**European Alps [g]**	**Great Lakes, Canada/ U.S. [h]**
1993/1994					5.1 - 42 [i]
1994/1995					
1995					
1996		4.8 [i]			
1997					
1998					
1999					
2000					
2001					
2002					
2003					
2004	0.97 [i]				
2005			< LOD - 464		
2006				1.92 – 7.0	

[a] Sum of p,p'-DDT, p,p'-DDE, p,p'-DDD

[b] Sum of p,p'-DDT, p,p'-DDE, p,p'-DDD, o,p'-DDT, o,p'-DDE

[c] Sum of p,p'-DDT, p,p'-DDE, p,p'-DDD, o,p'-DDT, o,p'-DDE, o,p'-DDD. Svalbard data were collected from the Norwegian-operated Zeppelin Station. LOD = limit of detection

[d] Sum of reported means of p,p'- and o,p'-DDE. p,p'- and o,p'-DDTs were not detected in any samples. Greenland data were collected from the Danish-operated Nuuk Station.

[e] Sum of reported means of p,p'-DDE, o,p'-DDT and p,p'-DDT.

[f] Only p,p'-DDE was detectable at 24 sites located in the WEOG region. p,p'-DDT was detected in 1 sample only, therefore, not reported here. LOD=limit of detection.

[g] 3 summit sites in the European Alps

[h] Range derived from sum of minimum and maximum (1990 -2003) of each DDT isomer in both gas and particle phases measured at 5 IADN Master Stations. Note that not all isomers were detectable in both phases at all sites.

[i] Highlighted area indicates time period over which range was derived.

Table 5.1.5 Range of atmospheric chlordane concentrations in the WEOG region

Chlordanes, pg/m^3								
Year/ Location	**Svalbard** [a]	**Storhofdi** [b]	**Arctic Canada** [a]	**Alaska, U.S.** [a]	**Greenland** [c]	**New Zealand** [c]	**GAPS** [d]	**Great Lakes, Canada/ U.S.** [e]
1993/1994			0.33 - 13					5.0 - 23 [f]
1994/1995			0.26 – 31					
1995		<LOD – 9.6	0.46 – 31					
1996	<LOD	0.2 – 2.3	0.07 - 8.1			1.4 [f]		
1997	<LOD – 5.3	<LOD– 1.4	0.25 – 4.0					
1998	<LOD – 3	<LOD – 1.2	0.60 - 3.8					
1999	<LOD – 2.9	0.6 – 2.7	0.14 - 3.2					
2000	<LOD– 2.2	1.4 – 3.0	0.20 - 2.2					
2001	<LOD – 3.7	1.4 – 2.6	0.33 - 2.4					
2002	<LOD – 3.2	0.6 – 2.1	0.097 - 2.8	0.29 - 2.6 [f]				
2003	<LOD – 3.9	0.8 – 1.6	0.28 - 2.9					
2004	1 – 2.8	0.6 – 1.6	0.21 -15		0.86 [f]			
2005	1.0 – 2.3	0.2 – 1.0	0.65 – 2.9				<LOD – 105	
2006	<LOD - 4						<LOD - 14	

[a] Sum of t- and c-chlordane, t- and c-nonachlor. Svalbard data were collected from the Norwegian-operated Zeppelin Station.
[b] Sum of t-chlordane and c-nonachlor
[c] Sum of means of t- and c-chlordanes. Greenland data were collected from the Danish-operated Nuuk Station.
[d] Sum of t- and c-chlordane and t-nonachlor at 24 sites located over the WEOG region. LOD = limit of detection
[e] Range derived from sum of minimum and maximum (1990-2003) of each of t- and c-chlordane in both gas and particle phases measured at 5 IADN Master Stations. Note that not all isomers were detectable in both phases at all sites
[f] Highlighted area indicates time period over which range was derived.

Table 5.1.6 Range of atmospheric heptachlor and heptachlor epoxide concentrations in the WEOG region

	Heptachlor (pg/m^3)				Heptachlor Epoxide (pg/m^3)		
Year/ Location	**Arctic Canada**	**New Zealand [a]**	**European Alps [b]**	**GAPS [c]**	**Arctic Canada**	**Greenland [c]**	**GAPS [d]**
1993/1994	0.008 - 0.47				0.02 - 4.8		
1994/1995	0.02 - 0.28				0.02 - 4.8		
1995	0.023 -0.28				0.02 - 2.5		
1996	0.015 - 0.28	0.37 [e]			0.016 - 2.1		
1997	0.024 - 0.24				0.03 - 1.4		
1998	0.013 - 0.17				0.18 - 1.4		
1999	0.016 - 0.053				0.02 - 6.4		
2000	0.016 -0.23				0.06 – 13		
2001	0.007 - 0.055				0.12 - 1.2		
2002	0.06 -0.28				0.02 -1.2		
2003	0.069 - 0.13				0.02 – 3.0		
2004	0.08 - 16				0.05 – 1.4	0.33-2.74 [e]	
2005	0.06 – 0.13			<LOD – 21	0.40 – 1.9		<LOD - 587
2006			0.03 - 0.06	<LOD - 9.2			n.d. - 30

[a] Median measured.
[b] 3 summit sites in the European Alps
[c] Greenland data were collected from the Danish-operated Nuuk Station.
[d] 24 sites located over the WEOG region; LOD=limit of detection
[e] Highlighted area indicates time period over which range was derived.

Table 5.1.7 Range of atmospheric dieldrin concentrations in the WEOG region

Dieldrin, pg/m^3							
Year/ Location	**Arctic Canada**	**Alaska, U.S.**	**GAPS [a]**	**Great Lakes, Canada/U.S. [b]**	**Greenland [c]**	**New Zealand [d]**	**European Alps [e]**
1993/1994	0.02 – 21			11.9 - 30 [f]			
1994/1995	0.03 - 4.2						
1995	0.22 - 2.8						
1996	0.08 - 3.9						
1997	0.33 - 3.3					4.7 [f]	
1998	0.29 -2.8						
1999	0.07 - 3.1						
2000	0.15 - 1.8						
2001	0.08 - 1.5						
2002	0.03 - 2.3	0.10 - 3.7					
2003	0.03 - 3.4						
2004	0.1 – 1.6				N.D. – 4.30 [f]		
2005	0.28 – 1.6		<LOD – 282				
2006			<LOD - 39				1.5 - 2.5

[a] 24 sites located over the WEOG region. LOD=limit of detection
[b] Range derived from sum of minimum and maximum (1990 -2003) of both gas and particle phases measured at 5 IADN Master Stations. Note that dieldrin may not be detectable in both phases at all sites.
[c] Greenland data were collected from the Danish-operated Nuuk Station. N.D. = not detected (=method detection limits)

[d] Mean reported.
[e] 3 summit sites in the European Alps
[f] Highlighted area indicates time period over which range was derived.

Table 5.1.8 Range of atmospheric toxaphene, endrin and aldrin concentrations in the WEOG region

Year/ Location	Toxaphene (pg/m^3)	Mirex (pg/m^3)	Endrin (pg/m^3)			Aldrin (pg/m^3)
	Great Lakes, Canada/ U.S.[a]	European Alps [b]	Arctic Canada	European Alps [b]	Great Lakes, Canada/U.S. [c]	Great Lakes, Canada/U.S.[c]
1993/1994			0.05 - 0.99		1.0 - 5.3 [d]	0.07 - 0.97 [d]
1994/1995			0.11 - 0.99			
1995	0.9 – 10 [d]		0.12 - 0.62			
1996			0.10 - 3.5			
1997			0.08 - 1.3			
1998			0.073 - 5.0			
1999			0.096 - 1.1			
2000			0.097 -1.4			
2001			0.044 - 0.24			
2002			0.041 – 0.42			
2003			0.046 - 0.57			
2004			0.051 – 0.28			
2005			0.046 - 0.30			
2006		0.06 – 0.09		0.03 - 0.05		

[a] Shoeib et al. (1999). Measurements at Point Petre, Lake Ontario.
[b] 3 summit sites in the European Alps
[c] Range derived from sum of minimum and maximum (1990 -2003) of both gas and particle phases measured at 5 IADN Master Stations. Note that aldrin and endrin may not be detectable in both phases at all sites.
[d] Highlighted area indicates time period over which range was derived.

5.1.3.2 Temporal trends

Several of the monitoring networks in the WEOG region possess long temporal records (>10 years) of atmospheric concentrations of POPs. These programmes include AMAP, EMEP, NCP, IADN, TOMPs and XVPCA. Long-term temporal trends were estimated using statistical techniques for most programmes. Details about trend development can be found in the individual programme summaries. Table 5.1.9 shows a summary of halflives estimated from air concentration data of POPs measured in the WEOG region by assuming a first order rate of decline. A decline in air concentrations over time can be quantified by an apparent first order halflife, $t_{1/2}$ (y), which is estimated by dividing ln 2 with the negative value of the linear regression slope of the trend line between the natural log of air concentrations, C (pg/m^3), or partial pressure, P (atm), and time. Note that many compounds presented in this survey do not necessarily decline linearly or consistently in the first order manner throughout the monitoring periods. Halflives presented here are only used to compare the relative rates of decline between the stations. Readers are advised to use the absolute values of these halflives with caution. It can be seen that generally declining trends were observed for most priority compounds. Note that the air concentrations of PCBs, HCB and DDTs have been increasing after 2002 at the Zeppelin station in Svalbard, possibly as a result of a change in local climate regime as mentioned above. Also the increase in DDT air concentrations in the North may be affected by

the re-introduction of DDT as an insecticide in tropical regions in recent years. For the XCPCA programme, trends and halflives were not derived but the programme summary reported decreasing atmospheric concentrations of PCDD/Fs from 1994 to 2002.

NDAMN, which measures PCDD/Fs and coplanar PCBs in U. S. ambient air, has also accumulated a long dataset of air concentrations. However, no significant temporal or spatial variation in concentrations of PCDD/Fs and coplanar PCBs was observed under this programme during the reporting period of 1998-2002.

Monitoring programmes such as GAPs and MONARPOP have only started recently (after 2004). Therefore, only 1-2 years of data are available at this time and derivations of long-term temporal and spatial trends are not possible. However, both programmes intend to continue sampling. Results of these networks will provide highly valuable temporal and spatial information in the future when more years of air concentration data are accumulated.

Recent short-term monitoring studies conducted in the Antarctica confirmed that the levels of POPs [including PCB (measured in 2003/2004), HCH and HCB (measured in 2001/2002)] are considerably lower than reported 10 years ago by Kallenborn et al. 1998 (Gambaro et al. 2005, Dickhut et al 2005).

Snap-shot datasets such as those from the Australian National Dioxins Program, POP measurements in New Zealand, the satellite stations of NCP and the NOAA Barrow station may become useful in determining changes over time if these stations were restarted at a later date.

Table 5.1.9 Summary of half-lives[a] derived from air concentrations of POPs measured in the WEOG region

Compound	Reporting period	Programme/location	Mean Halflife (range) (y)
PCDD/Fs	1991-2006	TOMPS/ U.K. urban	6.3 (3.2-11.1)
	1996-2002	Great Lakes (Point Petre), Canada	ΣPCDF: 4.3 ΣPCDD: 9.1 [b]
PCBs	1991-2007	TOMPS/ U.K.	(1.5 – 20) [c]
	1990-2003	Great Lakes, Canada/U.S.	15.2 (7.1-26) [d]
	1998-2006	Zeppelin, Svalbard	5.4 [e]
	1995-2005	Storhofdi, Iceland	36 [e]
	1996-2005	Pallas, Finland	12.1 [f]
	1993-2001 [g]	Alert, Canada	6.47 [e]
HCB	1993-2006	Zeppelin, Svalbard	17.7
	1995-2005	Storhofdi, Iceland	6.19
	1993-2001 [g]	Alert, Canada	N. S.
	1990-2003	Great Lakes, Canada/U.S.	21.4 (12-32) [h]
Σchlordane	1993-2006	Zeppelin, Svalbard	15.9 [i]
	1995-2005	Storhofdi, Iceland	5.4 [j]
	1993-2001 [g]	Alert, Canada	5.77 [i]
	1990-2003	Great Lakes, Canada/U.S.	(6.1 – 16) [k]
ΣDDT	1994-2006	Zeppelin, Svalbard	7.15 [l]
	1995-2005	Storhofdi, Iceland	4.22 [l]
	1996-2005	Pallas, Finland	11.3 [m]

	1993-2001 [g]	Alert, Canada	14.1 [l]
	1990-2003	Great Lakes, Canada/U.S.	(5 – 19) [n]
Endrin	1990-2003	Great Lakes, Canada/U.S.	4.85 (4-5.7) [h]
Aldrin	1990-2003	Great Lakes, Canada/U.S.	5.7 (2.4-11) [h]
Dieldrin	1990-2003	Great Lakes, Canada/U.S.	(3.9 - 8.9) [o]

[a] Halflives ($t_{1/2}$, y) were derived as: $t_{1/2}$ = ln 2/ [linear slope of trend line between ln (C, pg/m^3) or ln (P, atm) and time (t, y)]
[b] Hung et al., 2003.
[c] Halflife derived using sum of TOMPs total PCBs.
[d] Halflife derived using sum of IADN suite PCBs.
[e] Halflife derived using sum of AMAP 10 PCBs.
[f] Halflife derived using sum of AMAP 7 PCBs.
[g] Laboratory change for samples taken at Alert in 2002 resulted in disruption in long-term trends. An extensive interlaboratory comparison study has been conducted between the two laboratories before and after the change. The long-term temporal trend will be maintained using the results of the interlaboratory comparison as more data are being collected under NCP.
[h] Halflife derived using gas phase concentrations only.
[i] Halflife derived using sum of t- and c-chlordane, t- and c-nonachlor.
[j] Halflife derived using sum of t-chlordane and c-nonachlor.
[k] Range estimated from halflives separately determined for gas and particle phases of t- and c-chlordane.
[l] Halflife derived using sum of 6 isomers.
[m] Halflife derived using sum of p,p'-DDT, p,p'-DDE and p,p'-DDD.
[n] Range estimated from halflives separately determined for gas and particle phases of individual DDT isomers.
[o] Range estimated from halflives separately determined for gas and particle phases of diedrin.

5.1.3.3 Altitudinal perspectives

From spruce needle and soil samples collected under MONARPOP, a clear barrier effect of the Alps for long range transport of POPs was observed. Concentrations were higher in the peripheral parts of the Alps than in the more shielded central parts. Although there was not enough air sampling stations within this network to confirm this conclusion, atmospheric transport of POPs over the Alps was clearly observable. For instance, mirex which was never used in central Europe was frequently detectable in air at the summit stations. The results presented indicates the importance of long range transport as a source of POPs in the Alps (particularly for some pesticides) and shows an additional contribution of nearby sources for locally emitted POPs such as PCDD/Fs.

5.1.4 Conclusions and Recommendations

Most of the POPs under the Stockholm Convention have shown declining trends over time. Current air concentrations are largely governed by re-volatilization from environmental surfaces, e.g. soil and water. Some organochlorine pesticides (OCPs) (e.g., heptachlor, mirex, aldrin, endrin and dieldrin) are now present at such low concentrations that trends cannot be detected. Air concentrations of industrial chemicals (e.g. PCBs and PCDD/Fs) have also shown declining trends and current atmospheric levels are associated with both cycling of previously deposited chemicals and continued emissions from point sources (e.g. PCBs: leakage from electrical equipment, evaporation from old construction material etc.; PCDD/Fs: vehicle emissions, combustion for space heating, incineration etc.).

WEOG is rich in atmospheric concentration information despite inhomogeneity in geographical distribution and chemical-specific information. Special emphasis should be placed on establishing continuous POP monitoring networks in the Mediterranean region and in Australasia where air concentration time series are lacking. Past discrete surveys have provided a perspective of atmospheric POP levels in areas where established monitoring programmes are

lacking. For future evaluations, information not part of any monitoring programme that meets the other implementation plan data quality criteria should be reported.

Establishing new monitoring operations in areas where continuous monitoring programs are absent would be the preferred approach to enhancing the spatial coverage in observing changes in atmospheric POP concentrations with respect to time. Data comparability in new programmes must be ensured. Passive air samplers are an option for dealing with data gaps in many areas. These devices have been used widely across the WEOG region and have been shown to be cost-effective. They can also be used as a reconnaissance tool for site selection and/or for obtaining spatially resolved information on POPs.

This evaluation has relied on information provided by a relatively small number of existing national and international atmospheric monitoring programmes which have accumulated almost 20 years of data. Atmospheric monitoring since the early 1990s under AMAP and EMEP, focusing on the Arctic and sub-Arctic regions, provides extensive datasets enabling temporal trend assessment in northern WEOG. In North America, the only non-Arctic established atmospheric monitoring program which offers the most comprehensive set of time series for POPs is the North American Great Lakes monitoring program of IADN. The ability to compare POP levels over time within these programmes makes their long term viability of utmost importance for future temporal trend analysis for assessing the effectiveness of the Convention.

Furthermore, climate change and variations will have significant implications on how POPs will be transported and partitioned among environmental media. From the current dataset, it has been demonstrated that changes in local climate regime, such as that at Zeppelin (Svalbard), may already be affecting temporal trends. To enable the comparison of POP levels over time and provide information on climate change influence on global and regional POP transport, sustaining the established operation of atmospheric measurement programmes is most important. Collaboration between established atmospheric monitoring programmes and regional/global transport studies will provide the knowledge basis to interpret POP measurements under the influence of climate change for future effectiveness evaluations.

5.2 Human tissues (milk and / or blood)

5.2.1 Background

Two international ongoing monitoring programmes dealing with contaminant levels in human matrices were identified within the WEOG region. These are the WHO milk survey and the AMAP Human Health Monitoring Programme (mainly blood). They have provided the core for this evaluation. In addition, some other national monitoring programmes in the WEOG region have been considered since these provide valuable additional information (e.g., the German specimen bank).

5.2.2 Levels and trends of POPs reported by international programmes

WHO Milk survey

Since the mid-1980s, the WHO Regional Office for Europe has coordinated a comprehensive

programme on possible health risks of polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) (Environmental Health Series, 1989; Environmental Health in Europe, 1996; Van Leeuwen and Malisch, 2002). In some countries milk samples to the WHO survey are delivered as a part of ongoing national monitoring programmes. One such programme (with samples collected in the Uppsala area in Sweden) has been discussed here as an example.

The WHO programme has concentrated particularly on the possible health risk to infants, due to exposure POP levels in breast- milk, and is aimed to assist measures to prevent and control environmental exposure to PCDDs, PCDFs and PCBs. It can be assumed that the levels of PCDDs, PCDFs and PCBs in breast milk are representative for those in plasma, serum lipid and adipose tissue. Therefore levels of these contaminants in human milk will reflect body burden 1462 and can thus be used as an indicator for the overall exposure of the sampled population (Environmental Health Series, 1989; Environmental Health in Europe, 1996; Van Leeuwen and Malisch, 2002). Participation by WEOG countries in the WHO surveys has varied with some countries participating in all of the surveys while some have not participated in any. Nonetheless, the geographical and temporal coverage for WEOG is the best of any of the UNEP regions used for the Stockholm Convention evaluation. As additional WEOG countries continue to enrol in the WHO fourth round survey, coverage is expected to improve in the future.

Dioxins and PCBs

Four WHO-coordinated human milk surveys have taken place since 1987. A summary of the results are presented in Tables 5.2.1 - 5.2.3. The current (2007) levels of dioxin-like PCBs were in the range of 5 to 11 WHO-TEQ (pg/g lipid). The current (2007) levels of PCDDs/PCDFs were in the range of 4 to 10 WHO-TEQ (pg/g lipid). The levels of marker PCBs were in the range of 40 to 80 ng/g lipid, also for 2007 (WHO, 2008). The number of participating countries has varied over the years. For PCDDs and PCDFs, some countries have participated in 3 or more of the surveys and data for participating countries suggest a continuing decline in levels of these POPs (see Figure 5.2.1). For dioxin- like PCBs, levels reported from a few countries have remained flat while declining in others (see Figure 5.2.2). Note, however, that because of the differences in protocols and in the toxic equivalence factors used to calculate these levels, no general statement on trends can be made. For the marker PCBs a decline in levels is indicated for all countries reporting (see Figure 5.2.3).

For PCDDs and PCDFs, data from the past two decades suggest that the levels of these POPs have fallen steadily in human milk from their earlier higher levels. For dioxin- like PCBs, the picture is less clear for some countries, but in general, declining levels are observed. Levels for the other POPs are low with levels for aldrin, endrin and mirex below the limit of determination. Most organochlorine pesticides have been banned for many years, which is reflected in the ratio of parent compound to degradation product, e.g., DDT to DDE. Declining trends in these POPs indicate a continuing decline of exposure of the general population as a result of emission reduction and other control measures that have been taken in the past.

Preliminary analyses of the results also reveal varying profiles of the individual congeners of PCBs suggesting different sources of contamination. Further analysis of the pattern of the various congeners and the demographic data collected in the different countries will provide a

clarification of these differences.

Table 5.2.1 Levels of PCDDs and PCDFs in Human Milk in the WEOG region

PCDDs/PCDFs (pg/g lipid)				
	1987/88 Data as Nordic-TEQ[1] Range	1992/93 Data as I-TEQ[2] Range	2001/2002 Data as WHO-TEQ[3] Range	2007 Data as WHO-TEQ Mean
Australia			5.5 – 5.79	
Austria	17.1 – 18.6	10.7 – 10.9		
Belgium	33.7 – 40.2	20.8 – 27.1	16.92	10.30
Canada	15.6 – 23.0	10.8 – 18.1		
Denmark	17.8	15.2		
Finland	15.5 – 18.0	12.0 – 21.5	9.35 – 9.52	6
Germany	27.6 – 36.8	16.5	12.53	
Ireland			6.19 – 8.54	
Italy			9.40 – 14.83	
Luxemburg			14.97	10.80
Netherlands	37.4 – 39.6	22.4	17.09 – 21.29	
New Zealand	5.8		6.08 – 7.00	
Norway	15.0 – 19.4	9.3 – 12.5	7.16 – 7.43	5.5
Spain		19.4 – 25.5	10.41 – 18.32	
Sweden	20.2 – 22.8		9.58	6.0
United Kingdom	16.6 – 37.0	15.2 – 17.9		
USA	16.7		7.17	

1) Environmental Health Series No 34 (1989)
2) Environmental Health in Europe No 3 (1996)
3) Van Leeuwen, R. and Malisch, R. (2002)

Table 5.2.2 Levels of Dioxin-like PCBs in Human Milk in the WEOG region

Dioxin-like PCBs (pg/g lipid)			
	1992/93 (I–TEQ pg/g lipid) Range	2001/2002 (WHO-TEQ pg/g lipid) Range	2007 (WHO-TEQ pg/g lipid) Mean
Australia		2.48 – 3.69	
Austria	11.7 – 19		
Belgium	4.7 – 7.8	12.6	7.02
Canada	3.0 – 6.8		
Denmark	4.5		
Finland		5.66 – 6.03	3.8
Germany	11.7	13.67	
Ireland		2.72 – 5.19	
Italy		11.02 – 19.33	
Luxemburg		13.67	10.3
Netherlands	11.0	10.90 – 13.08	
New Zealand		3.50 – 4.71	

Norway	9.5 – 19.5	6.56 – 9.61	5.6
Spain	8.2 – 10.6	9.96 – 16.97	
Sweden		9.71	6.8
United Kingdom	4.0 – 4.3		
USA		4.61	

Table 5.2.3 Levels of marker PCBs in Human Milk in the WEOG region

Marker PCBs (ng/g lipid)				
	1987/88 Range	1992/93 Range	2001/2002 Range	2007 Mean
Australia			25 – 35	
Austria		303 – 381		
Belgium	525 – 734	260 – 306	191	80.5
Canada		58 – 137		
Denmark	530 – 1320	209		
Finland	150 – 203	133 – 189	84 - 98	41.3
Germany	762	375	220	
Ireland			41 - 64	
Italy			195 - 323	
Luxemburg			217	115
Netherlands	392 – 419	253	178 - 210	
New Zealand			30 - 41	
Norway	255 – 947	273 – 302	106 - 132	65.7
Spain		452 – 461	278 - 469	
Sweden	600 - 1900		146	84.5
United Kingdom		129 – 131		
USA	202 – 220		5 4	

The sum of PCB 28, 52, 101, 138, 153 and 180 were used as marker PCB.

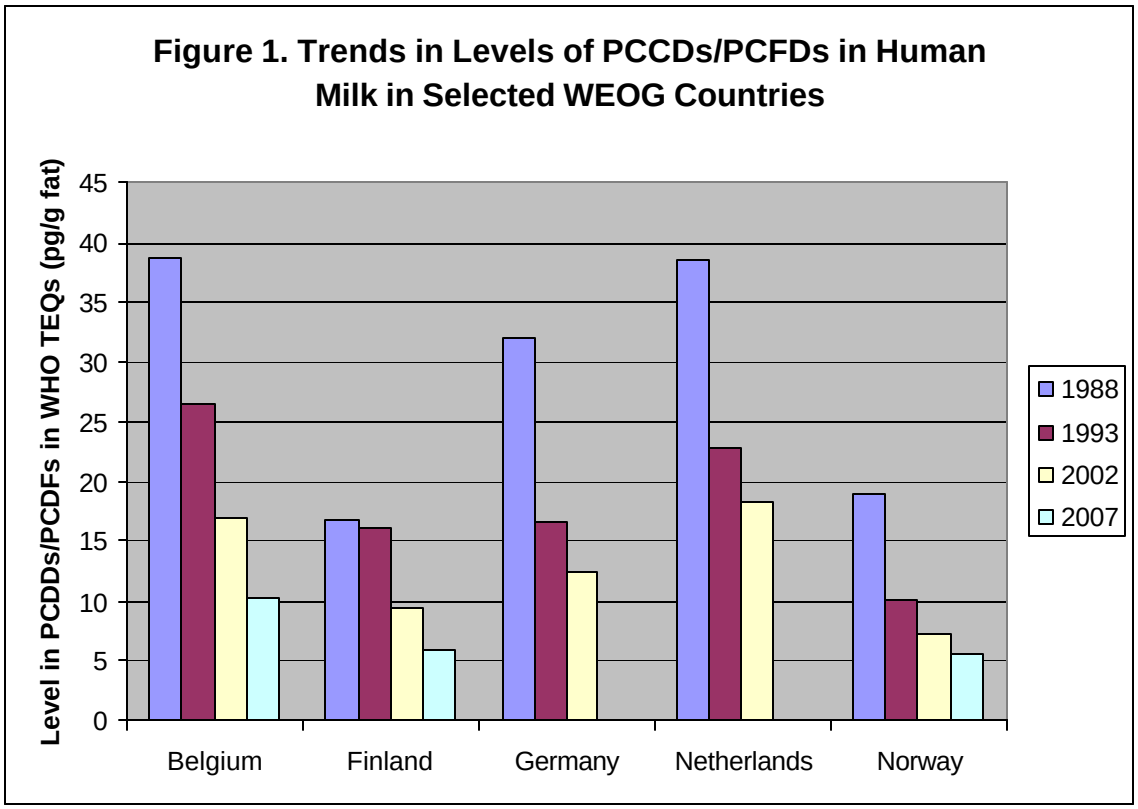


Figure 5.2.1 Changes in levels of PCDD/PCDFs in Human Milk in selected WEOG countries

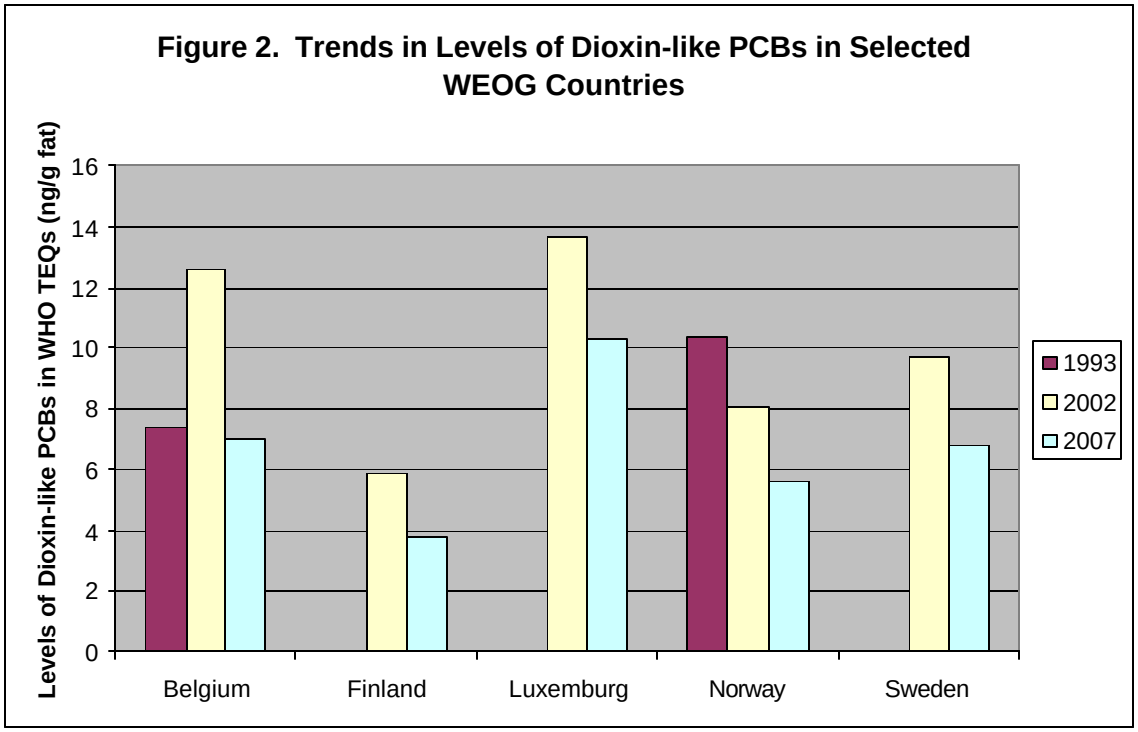


Figure 5.2.2 Changes in levels of dioxin-like PCBs in Human Milk in selected WEOG countries

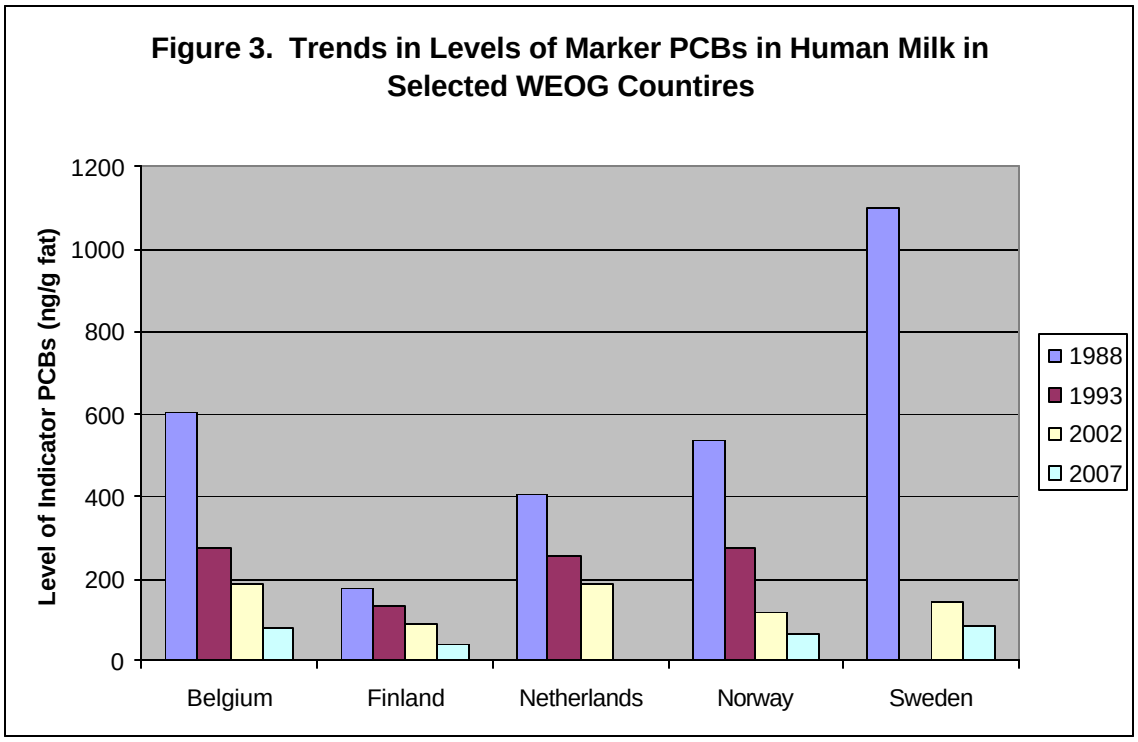


Figure 5.2.3 Changes in levels of marker PCBs in Human Milk in selected WEOG countries.

Other Stockholm Convention POPs

With the revision of the WHO protocol to include objectives related to the Stockholm Convention, the analysis of pooled human milk samples was expanded to include all of the other POPs presently included in the Stockholm Convention. Consequently, data on such POPs from pooled samples are available, but so far only from Belgium, Finland, Norway and Sweden. The data presented below are from 2007. Further data collected with the WHO protocol will become available as WEOG countries participate in the 4th WHO survey that is ongoing at this time (WHO, 2008).

Aldrin: Aldrin was not detected in any sample. Having been banned for many years, any aldrin present would have degraded into dieldrin, which is discussed below.

Chlordane Complex: Chlordane was not detected in any sample. However, the degradation products oxychlordane and trans- nonachlor were detected in the range of 2.2 to 7.8 ng/g lipid. Note that while cis- nonachlor was not included in these analyses, levels of cis- nonachlor are usually about 20% of the levels of trans-nonachlor and therefore would not contribute significantly to the total chlordane complex.

Dieldrin: Levels of dieldrin ranged from 1.5 to 6.7 ng/g lipid. Note that this would include any aldrin that has oxidized to dieldrin. Banned for many years in most countries, low levels would be expected today in WEOG countries.

DDT Complex: The database on DDT in human milk is perhaps the most extensive available. However, DDT has been banned in all WEOG countries for many years. The levels for the total

DDT complex currently reported in the WHO survey range from 33.1 ng/g lipid to 156.3 ng/g lipid. This is mainly comprised of p,p'-DDE indicating that these residues are the result of use of DDT in the distant past. Levels of DDT in human milk have fallen significantly (Smith, 1999). In many countries, further declines in levels of DDT in human milk are expected to be slight. In Finland the current level is 33.1 ng/g lipid and is not likely to decline significantly in the future.

Endrin: The levels of endrin in the four reporting countries was below the limit of determination

Heptachlor: Levels of the heptachlor complex reported in the WHO survey ranged from 5.3 to 0.8 ng/g lipid. As with DDT, the bulk of the residue was in the degradation product heptachlor epoxide- cis and not the parent molecule. This is evidence that there is no current use of heptachlor in the reporting countries.

Hexachlorobenzene: Levels of hexachlorobenzene reported in the WHO survey ranged from 2.7 to 16.9 ng/g lipid. The levels reported in various WEOG countries in the 1990s were in the range of 10 - 20 ng/g lipid, with the exception of Australia, which reported significantly higher levels of this chemical. Dramatic decreases in levels have been observed for most WEOG countries over the past several decades.

Mirex: Mirex was not detected in the current WHO survey down to the limit of determination. A few other studies in Canada and the USA suggest very low levels.

Toxaphene: The levels of toxaphene (Parlar) ranged from 1.9 to 3.7 ng/g lipid in the current WHO survey. Available historical data are limited, but levels reported in Northern Canada in 1997 suggest that levels can be quite high (about 70 ng/g lipid) in areas far from remote from its use.

AMAP Human Health Monitoring Programme

AMAP has collected information of human levels of several persistent organic pollutants in the circumpolar Arctic since the early 1990's. The Arctic provides both global and local sources of contaminants. The human data on levels and trends of contaminants listed in the Stockholm convention are available from three reports (AMAP 1998, 2003, 2004), supplemented by a number of recent scientific publications. (e.g. Polder et al., 2008; Anda et al., 2007; Hansen et al., 2008; Odland et al., 2005). AMAP anticipates future trend monitoring at approximately five year intervals. More specific trend data will be available through ongoing studies organized by AMAP during 2009.

The program has focused mainly on pregnant women and children. Baseline data on blood levels and, partly breast milk levels, are available for both temporal and spatial trends. Available information over the last 10 year period has been over too short a period to reveal any significant decline in levels of the 12 Convention POPs in human media (AMAP, 2004).

Intake of substances with dioxin- like effects is a matter of concern, especially in recent Greenlandic studies. In some Arctic marine communities in Canada and Greenland and also in the Faroe Islands, the dietary intake of PCBs exceeds exposure guidelines used by health authorities.

The AMAP studies demonstrate that the levels of some POPs in blood samples from those humans living in the Arctic regions who consume certain (mainly marine based) traditional/country foods (e.g., the Inuit of Greenland and Arctic Canada) are higher than with other population groups (Figures 5.2.4-5.2.5). For Greenland Inuit in particular, the levels of polychlorinated biphenyls (PCBs), DDE, hexachlorobenzene (HCB), total chlordanes in maternal blood samples are higher than those found in samples from other circumpolar countries. The pollutants have reached the Arctic region via long distance air transport. They are biomagnified and concentrated in biological species which are then used for food consumption.

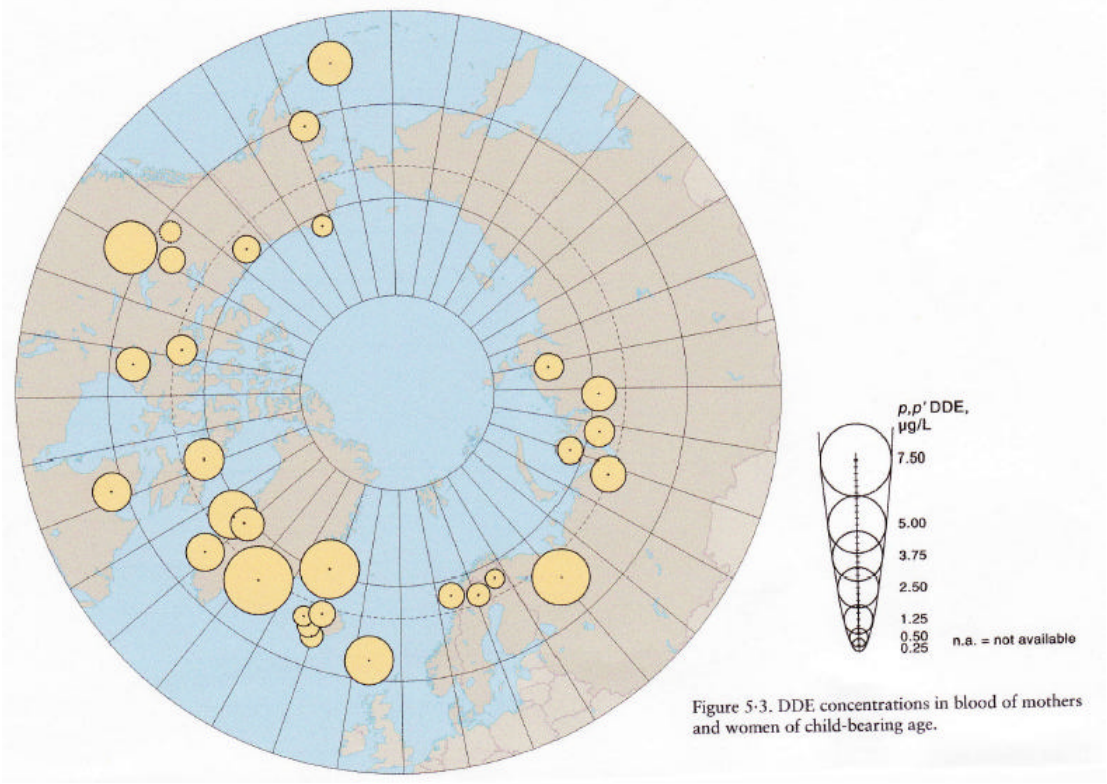


Figure 5·3. DDE concentrations in blood of mothers and women of child-bearing age.

Figure 5.2.4 DDE concentrations in blood of mothers and women of child-bearing age in the AMAP region. From AMAP monitoring and assessment report (2004).

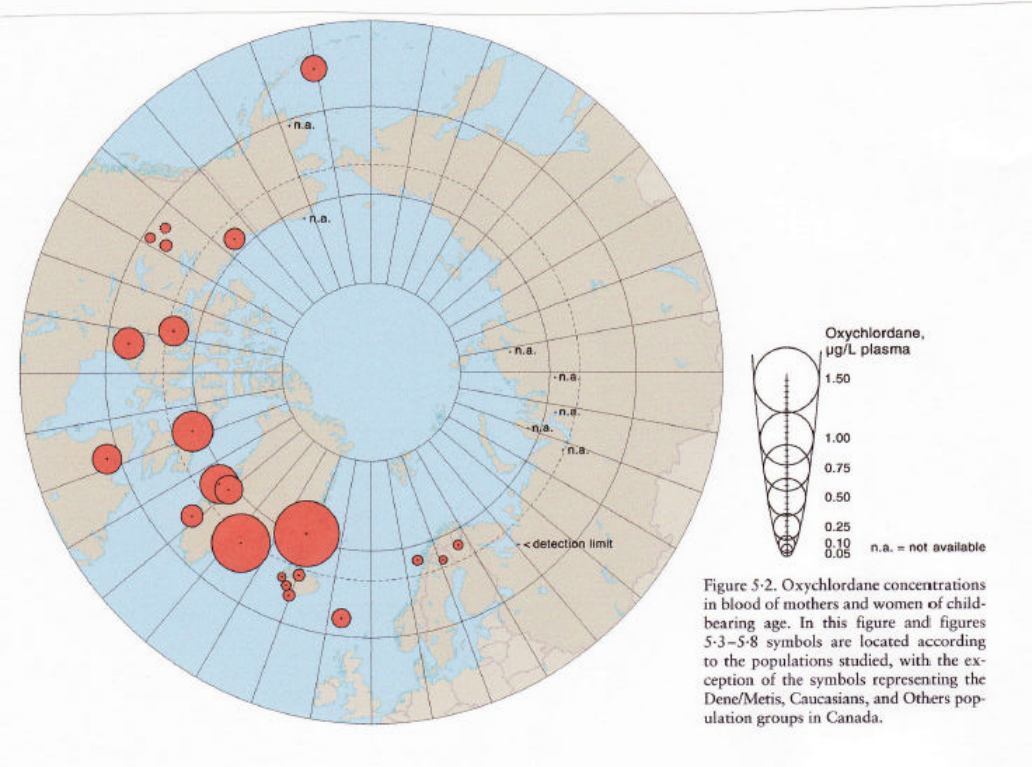


Figure 5·2. Oxychlordane concentrations in blood of mothers and women of child-bearing age. In this figure and figures 5·3–5·8 symbols are located according to the populations studied, with the exception of the symbols representing the Dene/Metis, Caucasians, and Others population groups in Canada.

Figure 5.2.5 Oxychlordane concentrations in blood of mothers and women of child-bearing age in the AMAP region. From AMAP monitoring and assessment report (2004).

5.2.3 Levels and trends of POPs reported by national programmes

A number of large national programmes contributed their information for this evaluation through their participation in international programmes (e.g., the Canadian NCP in AMAP). The national programmes described below contributed directly.

National Health and Examination Survey (NHANES), United States

In the United States, there are two main studies examining human serum concentrations of the 12 UNEP POPs: the continuous, general population (aged 12 years and older) National Health and Examination Survey (NHANES) since 1999 and the Alaska MOMs study (Maternal organics monitoring study - pregnant Native women and cord blood) (1999- 2004) (NHANES, 2008). In NHANES, the 12 UNEP POPs are measured with the exception of toxaphene (toxaphene will be added with the analysis of 2005-2006 NHANES serum samples). The most recent data from NHANES are from serum samples collected in 2003- 2004. The Alaska MOMs programme measures the UNEP POPs with the exceptions of polychlorinated dibenzo-*p*-dioxins and furans. The following is a summary of findings from the NHANES programme.

Hexachlorobenzene: Hexachlorobenzene was detected in almost all samples. The geometric mean was 15.2 ng/g lipid.

DDT and its environmental degradate/metabolite DDE: p,p'-DDT was detected in 74% of people, aged 12 years and older. o,p'-DDT was detected in only 5% of the people.
DDE was detected in almost all of the participants. The geometric mean for DDE was 104.6 ng/g

lipid.

Chlordane (as evaluated by measuring serum oxychlordane and *trans*-nonachlor): Oxychlordane, a persistent metabolite of chlordane, was detected in 83% of the participants with a geometric mean of 9.4 ng/g lipid . *Trans*- nonachlor, a persistent byproduct in technical chlordane, was detected in 93% of the participants with a geometric mean of 14.6 ng/g lipid.

Heptachlor (as evaluated by measuring its persistent metabolite heptachlor epoxide): Heptachlor epoxide was detected in 60% of the participants. The range of the geometric mean was between 10.2 to 15.8 ng/g lipid.

Mirex: Mirex was detected in 41% of the participants. Levels varied with different populations.

Aldrin and Dieldrin: Aldrin is rapidly metabolized to dieldrin. Therefore measurement of dieldrin does not differentiate exposure to aldrin to that of dieldrin. Aldrin was detected in only 0.2% of the participants. Dieldrin was detected in 87% . The 95th percentile was 18.9 ng/g lipid.

Endrin: Endrin was detected in very few of the participants.

Polychlorinated biphenyls: 35 individual congeners were measured and reported separately and by total PCBs. The geometric mean of total PCB for all age, sex, and race/ethnicity in the U.S. population for 2003-2004 is 134.4 ng/g lipid.

Polychlorinated dibenzo-p-dioxins and furans: The results provided a complex picture as is described in the annexed programme summary for NHANES. The most important message is that for the TEQ one cannot give a "universal" geometric mean, because the concentration is so very much age dependent. For example, for the non-Hispanic of African origin, the total dioxin TEQ was around 7 pg/g lipid for the 12-19 year olds but was about 30 pg/g lipid for the 60+ age group.

Data from Uppsala, Sweden
Temporal trends of levels of PCBs, HCB, *trans*-nonachlor, oxychlordane, DDT-compounds and dioxins are available from primparae mothers from the Uppsala area in Sweden (Glynn et al., 2007). A large number of individual samples are measured within this programme which makes trend analyses possible.

Multiple linear regression showed that the levels of all analysed POPs decreased significantly during the time period (1996-2006). The adjusted mean decrease in POP concentrations varied between 3 and 10% per year. Earlier, it has been shown that a simple regression model, with sampling year as the only explanatory variable, in most cases explained only a small fraction of the variation in POP levels. In the multiple regressions, the R^2-values increased considerably, showing that it is important to include other factors that are associated with POP levels in the analysis of temporal trends (Table 5.2.4). Observed levels are listed in the tables at the end of this chapter.

Table 5.2.4 Percent change in concentrations of some of the measured POPs per year in

mother's milk from primiparae women living in Uppsala, Sweden, 1996-2006. Adjusted for age, pre-pregnancy BMI, weight gain during pregnancy and weight loss after delivery. TEQ concentrations are based on 2005 WHO TEFs.

Compound	**Change/year (%)**		**R^2**[a]	**"half- time"**[b]	**P**
	Mean	**SE**	**(%)**	**(years)**	
PCB 28	-4.0	1.4	8	17	0.004
PCB 105	-4.3	1.2	26	16	<0.001
PCB 118	-8.6	0.6	56	8	<0.001
PCB 138	-6.9	0.5	55	10	<0.001
PCB 153	-8.0	0.5	68	8	<0.001
PCB 156	-5.8	0.5	62	12	<0.001
PCB 167	-5.4	0.9	42	12	<0.001
PCB 180	-7.3	0.5	76	9	<0.001
mono-*ortho* TEQ [c]	-7.4	0.5	60	9	<0.001
PCB 126	-7.7	0.7	49	9	<0.001
PCB 169	-3.4	0.7	54	20	<0.001
non-*ortho* TEQ [d]	-7.3	0.6	52	9	<0.001
PCDD TEQ	-6.9	0.5	66	10	<0.001
PCDF TEQ	-5.7	0.6	52	12	<0.001
PCDD/DF TEQ	-6.4	0.5	66	10	<0.001
Total TEQ	-7.0	0.5	64	10	<0.001
HCB	-8.2	0.4	52	8	<0.001
oxychlordane	-6.9	0.5	58	10	<0.001
trans-nonachlor	-6.3	0.6	53	11	<0.001
p,p'-DDT	-9.4	0.8	32	7	<0.001
p,p'-DDE	-8.5	0.8	41	8	<0.001

a coefficient of determination for the regression model
b the estimated time it takes for the concentrations to be halved
c including CB 105, 118, 156 and 167 TEQs
d including CB 77, 126 and 169 TEQs

Data from Stockholm, Sweden

Probably the longest trend information available for POPs in mother's milk is the one initiated in Stockholm in 1967. The investigations have included measurements of DDTs, PCBs, PCDD/PCDFs, dieldrin, chlordane and HCB in breast milk from women living in the Stockholm region. During the course of 20-30 years the levels of organochlorine compounds in human milk have decreased to a various extent. A decrease to half of the original concentration was attained in the range of 4-17 yr periods (Norén and Meyrinoté, 2000; Athanasiadou, 2008). Levels for PCBs increased until the middle 1970s followed by decreasing levels, presumably in response to regulatory actions initiated during those years. (Figure 5.2.6).

Another consistent decline observed in the Stockholm data is in the levels for p, p-DDT and p, p-DDE (Figure 5.2.7). The level of p, p- DDT in 1997 was only 1% of the level in 1967 and the halt life was calculated to be 4 yrs. The levels of dieldrin also declined with a half life of 6 yr. The concentration of dieldrin in 1985 was 13% of that in 1967. The concentrations of oxychlordane and trans- nonachlor also decreased. The concentrations of HCB in breast milk varied during the 1970s but a decline in the average levels is seen from 1974. The average concentration of HCB in 1997 was 5% of that in 1974 and the rate of decline to half of the concentration was calculated to be 6 yrs. The level of total PCBs in 1997 was about 30% of that in 1972. A decline in the levels of PCDDs and PCDFs is seen from 1972.

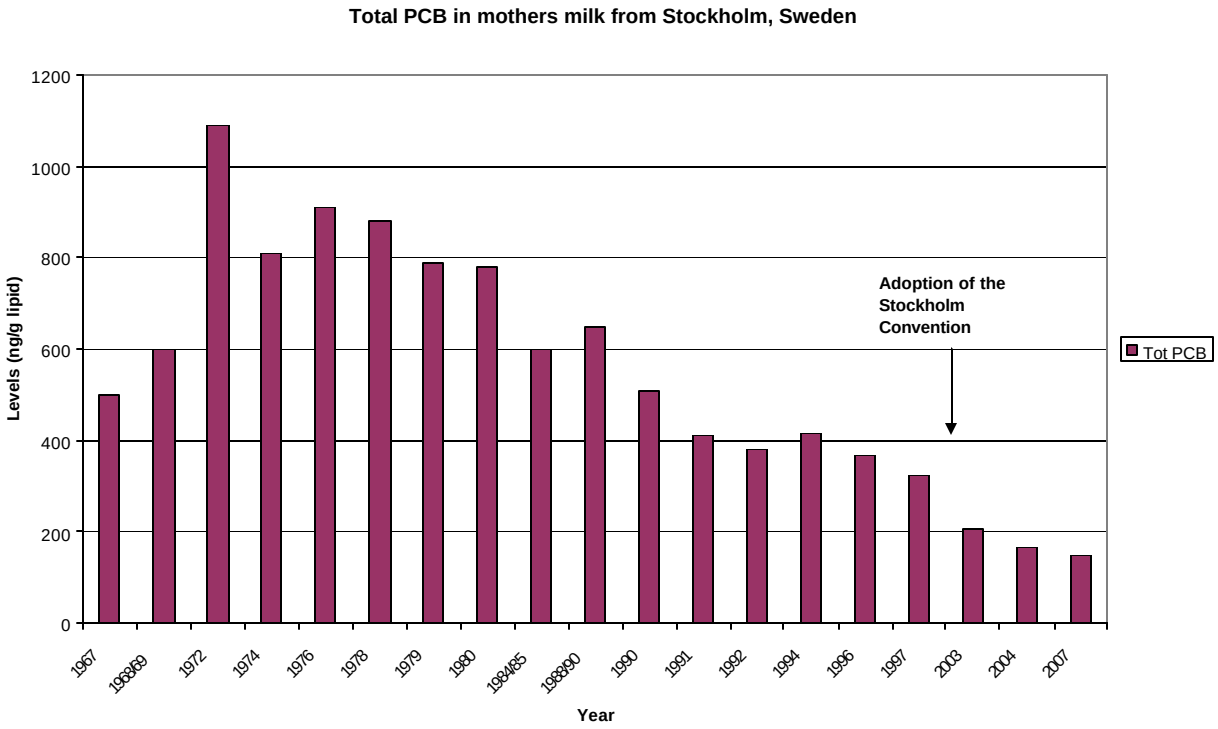


Figure 5.2.6 Levels of sumPCB (sum of 6 congeners) in mothers' milk from Stockholm, Sweden.

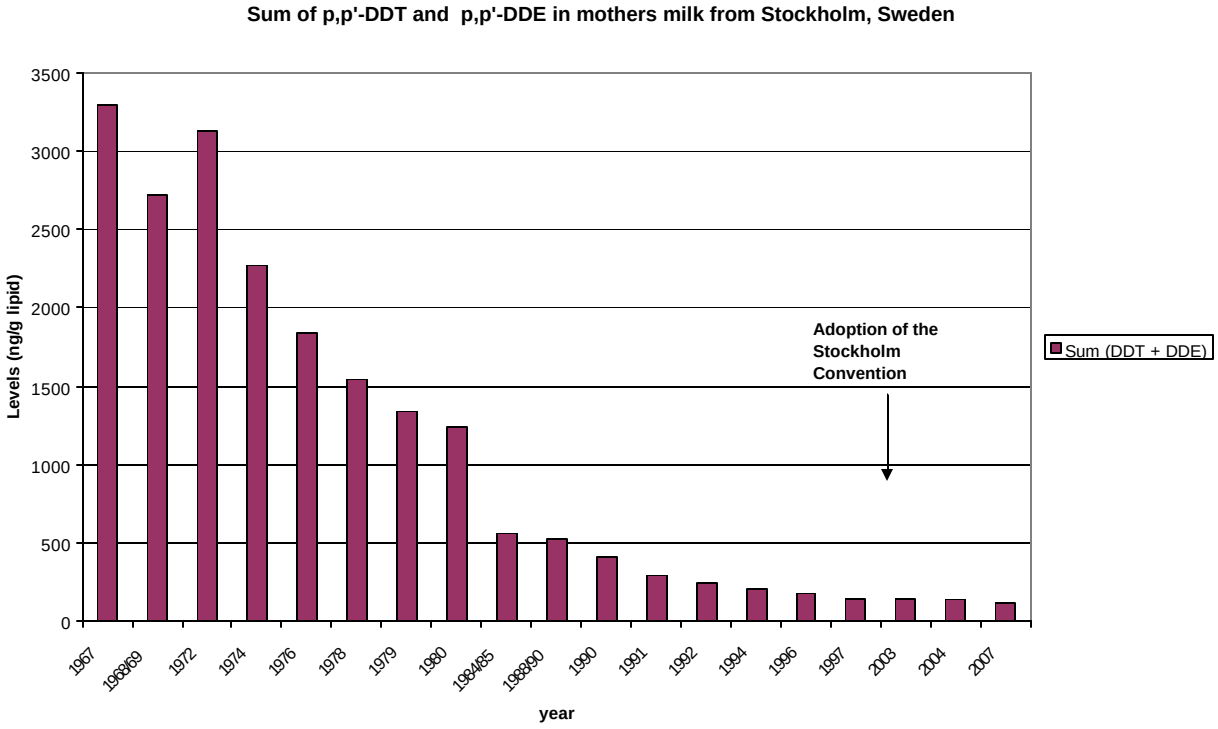


Figure 5.2.7 Levels of sum DDT (sum of p,p'-DDE and p,p'-DDT) in mothers milk from Stockholm, Sweden

German Environmental Survey for Children

The German Environmental Survey (GerES) is a representative population study to determine the exposure of Germany's general population to environmental contaminants. The study has been conducted by the German Federal Environment Agency since the mid-1980s (Becker et al., 2008). Blood specimens from GerES III and GerES IV were analyzed for polychlorinated biphenyls (PCB), dichlorodiphenyldichloroethylene (DDE), hexachlorobenzene (HCB) and a number of other substances not a part of this evaluation. The number of samples taken has varied. For example, in GerES II a cross sectional sample of 4822 adults aged 18 to 69 years with 120 sampling locations representative of the German population with regard to community size, age and gender were taken. In GerES IV, 1 790 children aged 3 to 14 years and living in 150 different sampling locations were examined.

Table 5.2.5 Levels of pollutants in whole blood of children (7-14 years) in the German Environmental Survey IV 2003/2006 (Becker et al., 2008).

Substance	***Group***	***Mean estim. Level*** *µg/l*
PCB (138, 153, 180)	Whole group	0.38
PCB (138, 153, 180)	Boys	0.39
PCB (138, 153, 180)	Girls	0.36
DDE	Whole group	0.30
DDE	Boys	0.31

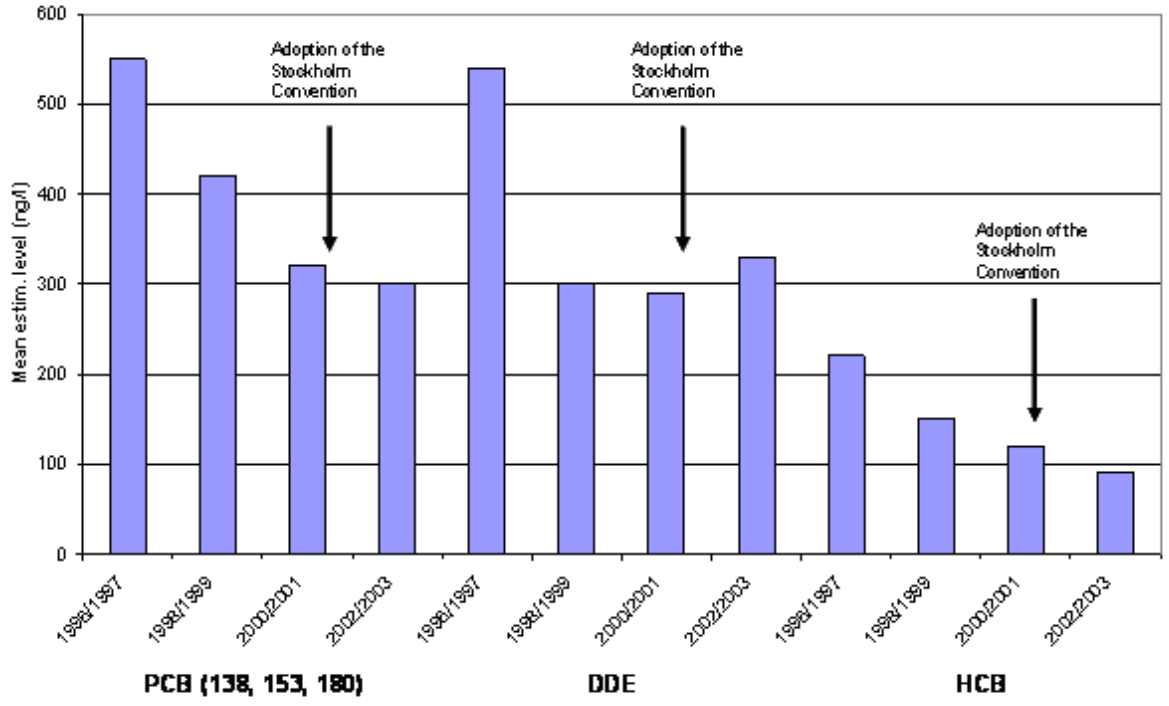
DDE	Girls	0.30
HCB	Whole group	0.11
HCB	Boys	0.11
HCB	Girls	0.11

For the population not exposed at the workplace, the essential exposure pathway is through food consumption, particularly that of foods rich in fat of animal origin. Other social factors, length of breast feeding and gender will also determine the levels observed.

Even if trends have not yet been reported from the German Environmental Survey, comparisons can be made with other German results. The data can be compared for example with the monitoring of organic pollutants in blood of children from Baden-Württemberg (Link et al., 2005) and data from North Rhine-Westphalia (Wilhelm et al., 2007). The observed levels of persistent organic pollutants are dependent on a number of factors such as gender, age, place of living and length of breast feeding (Link et al., 2005, Wilhelm et al., 2007). The available data do however indicate decreasing trends when comparisons are made within the same group at the same location.

The German Environmental Survey provides a basis for further trend monitoring in the future.

Figure 5.2.8 Concentration of POPs in the blood samples from children from Baden-Württemberg (Link et.al., 2005).

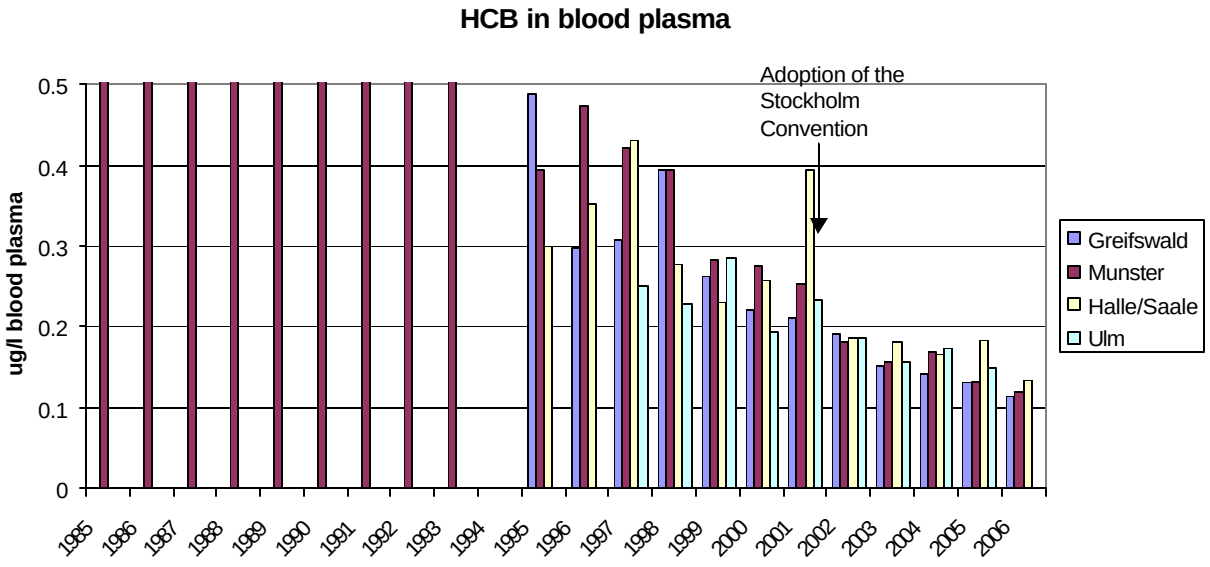


The German Environmental Specimen Bank (ESB)

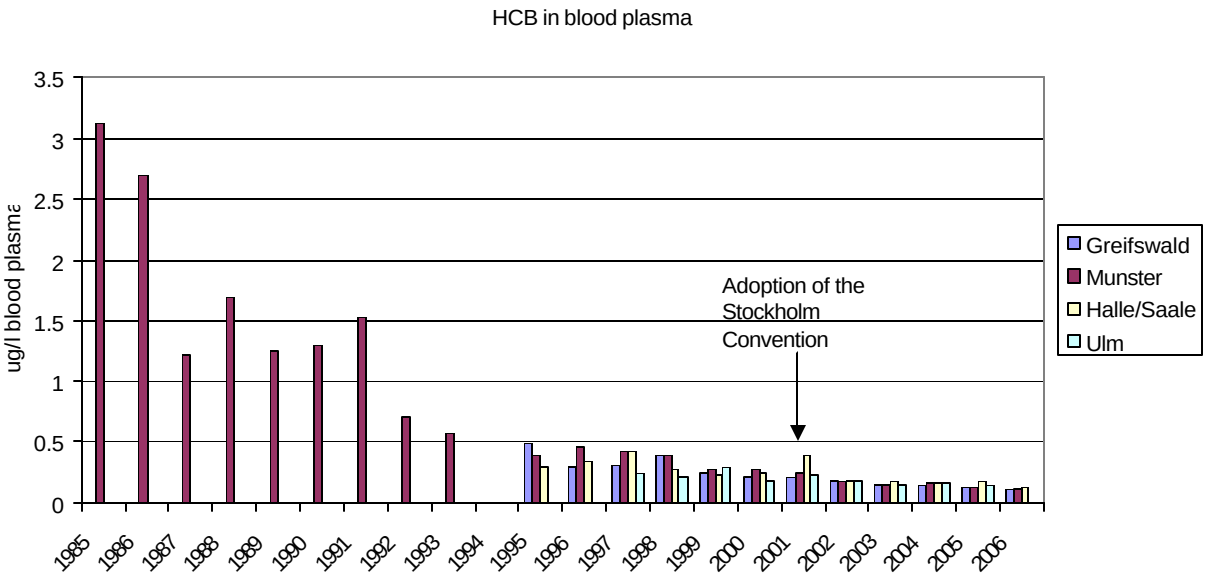
The German Environmental Specimen Bank (ESB) was established in 1985 as a permanent institution for the systematic collection, processing, characterisation and storage of environmental samples from marine, freshwater and terrestrial ecosystems as well as for human samples in Germany. Blood and other human specimens have been collected since 1981 from a group of about 100 persons in defined peripheral conditions (without known occupational / non dietary exposure) each year. The human media sampled (blood, urine, and hair) are taken from living persons at selected sites. The aim of the sampling is to collect samples which represent the general German population.

It was decided to use voluntary students from the Universities of Münster, Halle, Greifswald, and Ulm as donors. With individuals and groups moving home frequently in a mobile society, it is assumed that almost the entire country is represented (Gies et al., 2007; Umweltbundesamt, 2008). Since samples are stored in a specimen bank this makes retrospective studies possible.

PCB 153 and HCB have been analyzed in pooled samples on a yearly basis. The data indicate a continuous decreasing trend with 4-5% change each year (Figures 5.2.10 and 5.2.11).



Figures 5.2.9 PCB153 concentrations in pooled blood samples from the ESB programme



Figures 5.2.10 HCB concentrations in pooled blood samples from the ESB programme

Observations from Australia and New Zealand
Results are available from Australia and New Zealand but not as parts of ongoing monitoring programmes. In 2002/2003 levels of PCDD/F and PCBs were measured as a part of the Australian National Dioxins Programme (Harden et.al., 2004a,b). Measurements were also carried out in 1998/99 in New Zealand (Bates et al., 2001). These data are included to give the full picture of the situation in the WEOG region.

Levels in human milk – Australia
The results of this study provide a measure of the levels of dioxin-like compounds, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs), in pooled human milk samples collected throughout Australia in 2002-2003. The study focused on donor cohorts with different potential exposure to dioxins and dioxin-like compounds in Australia (i.e. urban/industrial/rural exposure).

Breast milk samples were collected from primiparae mothers selected according to suitable criteria to allow direct comparison with previous World Health Organization (WHO) studies. In total, 157 samples were collected from 12 regions of Australia during 2002 and 2003, for 17 pooled samples.

PCDD/PCDFs and PCBs were detected in all pooled samples. For samples collected during 2002-03, the mean and median levels, expressed as TEQ (middle bound), were 9.0 and 8.9 pg TEQ/g lipid, respectively. No systematic differences were observed in the levels of dioxin- like chemicals in breast milk samples collected from different regions of Australia during 2002-03. In addition to these samples, a further 24 samples collected in 1993 were analysed as three pools of eight samples. For these samples, the mean and median levels, expressed as TEQ (upper bound), were 16 and 16.4 pg TEQ/g lipid, respectively.

Overall, the levels of dioxin- like chemicals in the breast milk of Australian women were

relatively low in this study when compared to international data reported by WHO.

Levels in blood – Australia
The results of this study provide a measure of the levels of dioxin-like compounds, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs), in pooled blood serum collected throughout Australia in late 2002-2003.

Dioxin- like compounds were detected in all samples. The mean and median levels expressed as upper bound TEQ values for all pooled samples were 10.9 and 8.3 pg TEQ/g lipid, respectively. A direct relationship of increasing dioxin- like compound levels with increasing age was observed and found to hold from approximately 25 years of age until at least the eighth decade.

For males, and females the mean levels were 10.4 and 11.5 pg TEQ/g lipid, respectively. No systematic differences were observed in the levels of dioxin- like compounds in samples collected from males and females. Overall the levels in the Australian population were low by international standards and comparable with, although lower than, those observed in the New Zealand population in the late 1990s (Buckland et al, 2001).

Levels in human milk – New Zealand
A total of 53 milk samples were collected from October 1998 to May 1999 (Bates et al., 2001). The distribution of PCDD/Fs and PCBs was similar across study areas with a tendency for higher concentrations to be found in the milk of women who were older, heavier, and of non-European ethnicity. Mean PCDD/F concentration was 6.3 pg WHO-TEQ/g lipid for all samples combined. The mean sum of 14 PCBs was 4.2 pg WHO-TEQ/g lipid for all samples combined. Also HCB, dieldrin, heptachlor epoxide, pp-DDT and the metabolite pp-DDE were detected in all the samples. The mean concentrations of these substances for all samples combined were 10.6, 15.4, 4.7, 25.6 and 626 ng/g lipid, respectively. Higher concentrations of the DDT metabolite, pp-DDE,
were found in the milk of women from the South Island compared with the North Island, but the difference was less than in the 1988 study because levels in the South Island had since decreased more than in the North Island.

The data of this study were compared to data from a similar study undertaken a decade earlier (Bates et al., 1990; 1994). This comparison found that levels of each class of POP contaminant, namely PCDD/Fs, PCBs and pesticides, in the milk of New Zealand women had declined by about 70 percent over the ten year period 1988 to 1998. This can be taken as evidence that the exposure of the New Zealand population generally to these substances has substantially declined, and that measures to reduce these contaminants in the New Zealand environment have been effective.

5.2.4 Comprehensive summary of base-line levels for POPs in the WEOG region, 1998-2008

The previous section has described changes in environmental levels and in human media that have been reported by the existing monitoring programmes used as the basis for this report.

The ROG took note that the COP has requested that the first evaluation establish a baseline for future evaluations and that the sampling window for the first evaluation and baseline as described in the Implementation Plan is 2003 +/- 5 years. Therefore in order to highlight the available information that can be used as the baseline for the noted sampling window, a set of tables have been prepared (tables 5.2.6 -5.2.16). These tables have been compiled mainly from the
existing programmes already described. In subregions and for substances and matrices which have been under-represented by these programmes, the ROG has also included information from other supplementary activities when they are available. In these cases, the ROG members have reviewed the sampling, analytical and data quality practices of these supplementary activities and is satisfied that the only reason for their being excluded through the original application of the implementation plan criteria is the absence of firm plans for the continued operation of the activity in future years.

The ROG has not prepared any additional description of the significance of these data, beyond that already described in the previous section.

Table 5.2.6 Aldrin – Human media baseline summary for 1998-2008.

Year	**Location**	**Observed level**	**Reference**
Mother's milk			
2001	Spain	2.2 – 3.3 ng/ml	Campoy et al., 2001 *)
2002/2003	Australia	<0.01 – 0.7 ng/g lipid	Mueller et al., 2008 *)
2007	Belgium	<0.5 ng/g lipid	WHO, 2008
2007	Finland	<0.5 ng/g lipid	WHO, 2008
2007	Norway	<0.5 ng/g lipid	WHO, 2008
2007	Sweden	<0.5 ng/g lipid	WHO, 2008

*) supplementary activity

Table 5.2.7 Chlordane – Human media baseline summary for 1998-2008.

Year	**Substance**	**Location**	**Observed level**	**Reference**
Mother´s milk				
2006	Oxychlordane	Uppsala, Sweden	2.3 ng/g lipid	Glynn et al., 2007
2007	Oxychlordane	Belgium	8.0 ng/g lipid	WHO, 2008
2007	Oxychlordane	Finland	1.0 ng/g lipid	WHO, 2008
2007	Oxychlordane	Norway	3.7 ng/g lipid	WHO, 2008
2007	Oxychlordane	Sweden	2.3 ng/g lipid	WHO, 2008
2007	Chlordane complex	Belgium	7.8 ng/g lipid	WHO, 2008
2007	Chlordane complex	Finland	3.8 ng/g lipid	WHO, 2008
2007	Chlordane complex	Norway	3.6 ng/g lipid	WHO, 2008
2007	Chlordane complex	Sweden	2.2 ng/g lipid	WHO, 2008
2007	Trans-nonachlor	Belgium	1.7 ng/g lipid	WHO, 2008

2007	Trans-nonachlor	Finland	2.8 ng/g lip id	WHO, 2008
2007	Trans-nonachlor	Norway	5.7 ng/g lipid	WHO, 2008
2007	Trans-nonachlor	Sweden	3.0 ng/g lipid	WHO, 2008
Maternal blood				
1994/1999	Oxychlordane	Canada	40 - 50 ng/l	AMAP, 2003
1996/1999	Oxychlordane	Northern Scandinavia	10 – 110 ng/l	AMAP, 2003
2000/2001	Oxychlordane	Faroe Islands	30 – 1400 ng/l	AMAP, 2003
1994/2000	Oxychlordane	Canada Inuit pop.	150-580 ng/l	AMAP, 2003
1994/2000	Trans-nonachlor	Canada Inuit pop.	280-640 ng/l	AMAP, 2003
1994/1999	Trans-nonachlor	Canada	60 ng/l	AMAP, 2003
1996/1999	Trans-nonachlor	Northern Scandinavia	30-320 ng/l	AMAP, 2003
2000/2001	Trans-nonachlor	Faroe Islands	20 – 4200 ng/l	AMAP, 2003
Blood plasma				
1997/2000	Oxychlordane	Greenland women	260 - 1500 ng/l	AMAP, 2003
1997/2000	Oxychlordane	Greenland women	260 – 1500 ng/l	AMAP, 2003
1999	Oxychlordane	Iceland	<20 - 170 ng/l	AMAP, 2003
1999	Trans-nonachlor	Iceland	50 - 370 ng/l	AMAP, 2003
Blood serum				
2001	Oxychlordane	United States (Alaska)	<20 - 4200 ng/l	AMAP, 2003
2004-2005	Oxychlordane	United States	9.4 ng/g lipid	NHANES, 2008
2001	Trans-nonachlor	United States (Alaska)	<4 – 12400 ng/l	AMAP, 2003
2004- 2005	Trans-nonachlor	United States	14.6 ng/g lipid	NHANES, 2008

Table 5.2.8 DDT/DDE – Human media baseline summary for 1998-2008.

Year	**POP**	**Location**	**Observed level**	**Reference**
Mother's milk				
2006	Sum DDT	Uppsala, Sweden	67 ng/g lipid	Glynn et al., 2007
2007	Sum DDT	Belgium	156 ng/g lipid	WHO, 2008
2007	Sum DDT	Finland	33 ng/g lipid	WHO, 2008
2007	Sum DDT	Norway	70 ng/g lipid	WHO, 2008
2007	Sum DDT	Sweden	82 ng/g lipid	WHO, 2008
2001	p,p-DDT	North Rhine-Westphalia, Germany	124 ng/g lipid	Wilhelm, 2007 *)
2007	p,p-DDT	Stockholm, Sweden	2 ng/g lipid	Athanasiadou, 2008
Maternal blood				
1994/ 1999	p,p-DDT	Canada	30 – 50 ng/l	AMAP, 2003
1994/ 2000	p,p-DDT	Canada Inuit pop.	70 – 140 ng/l	AMAP, 2003
1994/ 1999	p,p-DDE	Canada	700 – 4000 ng/l	AMAP, 2003
2000/ 2001	p,p-DDT	Faroe Islands	100 – 1500 ng/l	AMAP, 2003
2000/ 2001	p,p-DDE	Faroe Islands	350 - 39400 ng/l	AMAP, 2003
1996/ 1999	p,p-DDT	Northern Scandinavia	20 - 40 ng/l	AMAP, 2003
1996/ 1999	p,p-DDE	Northern Scandinavia	190 - 5080 ng/l	AMAP, 2003
Blood plasma				
1997/ 2000	p,p-DDT	Greenland women	40 – 310 ng/l	AMAP, 2003
1999	p,p-DDT	Iceland	<10 – 220 ng/l	AMAP, 2003
1999	p,p-DDE	Iceland	260 - 2400 ng/l	AMAP, 2003
2004-2005	p,p-DDE	United States	105 ng/g lipid	NHANES, 2008
Blood serum				

2001	p,p-DDT	Alaska	<10 - 580 ng/l	AMAP, 2003
2001	p,p-DDE	Alaska	<45 - 158000 ng/l	AMAP, 2003
Whole blood				
1998	p,p-DDE	Germany, general population	2620 ng/l	Becker et al., 1998
2002/ 2003	p,p-DDE	Germany, children	330 ng/l	Link et al., 2005 *)
2003/ 2006	p,p-DDE	Germany, children	300 ng/l	Becker et al., 2008

*) supplementary activity

Table 5.2.9 Dieldrin – Human media baseline summary for 1998-2008.

Year	Location	Observed level	Reference
Mother's milk			
2007	Belgium	6.7 ng/g lipid	WHO, 2008
2007	Finland	1.5 ng/g lipid	WHO, 2008
2007	Norway	2.5 ng/g lipid	WHO, 2008
2007	Sweden	1.8 ng/g lipid	WHO, 2008
Blood plasma			
2004/2005	United States	19 ng/g lipid	NHANES, 2008

Table 5.2.10 Dioxins & Furans – Human media baseline summary for 1998-2008.

Year	Substance	Location	Observed level as WHO-TEQ	Reference
Mother´s milk				
2001/2002	PCDD/F TEQ	Australia	5.50-5.79 pg/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	PCDD/F TEQ	Finland	9.35-9.52 pg/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	PCDD/F TEQ	Ireland	6.19-8.54 pg/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	PCDD/F TEQ	Italy	9.40-14.83 pg/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	PCDD/F TEQ	Netherlands	17.09-21.29 pg/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	PCDD/F TEQ	New Zealand	6.08-7.00 pg/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	PCDD/F TEQ	Norway	7.16-7.43 pg/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	PCDD/F TEQ	Spain	10.41-18.32 pg/g lipid	Van Leeuwen and Malisch, 2002
2003	I-TEQ	North Rhine- Westphalia, Germany	9.5 pg/g lipid	Wilhelm, 2007 *)
2006	PCDD/F TEQ	Uppsala, Sweden	4.6 pg/g lipid	Glynn et al., 2007
2007	PCDD/F TEQ	Belgium	10.3 pg/g lipid	WHO, 2008
2007	PCDD/F TEQ	Finland	6 pg/g lipid	WHO, 2008
2007	PCDD/F TEQ	Luxemburg	10.8 pg/g lipid	WHO, 2008
2007	PCDD/F TEQ	Norway	5.5 pg/g lipid	WHO, 2008
2007	PCDD/F TEQ	Sweden	6.0 pg/g lipid	WHO, 2008

Table 5.2.11 Endrin – Human media baseline summary for 1998-2008.

Year	Location	Observed level	Reference
Mother´s milk			
2007	Belgium	<0.5 ng/g lipid	WHO, 2008
2007	Finland	<0.5 ng/g lipid	WHO, 2008
2007	Norway	<0.5 ng/g lipid	WHO, 2008
2007	Sweden	<0.5 ng/g lipid	WHO, 2008

Table 5.2.12 Heptachlor – Human media baseline summary for 1998-2008.

Year	Location	Observed level	Reference
Mother's milk			
2002/2003	Australia	<1 - <20 ng/g lipid	Mueller et al 2008*)
2007	Belgium	5.3 ng/g lipid	WHO, 2008
2007	Finland	0.5 ng/g lipid	WHO, 2008
2007	Norway	0.6 ng/g lipid	WHO, 2008
2007	Sweden	0.8 ng/g lipid	WHO, 2008
Blood plasma			
2004/2005	United States	14-16 ng/g lipid	NHANES, 2008

*) Supplementary activity

Table 5.2.13 Hexachlorobenzene (HCB) – Human media baseline summary for 1998-2008.

Year	Location	Observed level	Reference
Mother's milk			
2001	North Rhine-Westphalia, Germany	30 ng/g lipid	Wilhelm, 2007*)
2006	Uppsala, Sweden	7.6 ng/g lipid	Glynn et al., 2007
2007	Stockholm, Sweden	6.3 ng/g lipid	Athanasiadou, 2008
2007	Belgium	15 ng/g lipid	WHO, 2008
2007	Finland	2.7 ng/g lipid	WHO, 2008
2007	Norway	16.9 ng/g lipid	WHO, 2008
2007	Sweden	7.1 ng/g lipid	WHO, 2008
Maternal blood			
1994/ 1999	Canada	110 – 180 ng/l	AMAP, 2003
1994/ 2000	Canada Inuit pop.	310 – 560 ng/l	AMAP, 2003
1996/ 1999	Northern Scandinavia	120 - 310 ng/l	AMAP, 2003
2000/ 2001	Faroe Islands	50 – 1900 ng/l	AMAP, 2003
Blood plasma			
1999	Iceland	180 - 760 ng/l	AMAP, 2003
2004-2005	United States	15 ng/g lipid	NHANES, 2008
2005	Ulm, Germany	150 ng/l lipid	UBA, 2008
2006	Greifswald, Germany	114 ng/l lipid	UBA, 2008
2006	Munster, Germany	120 ng/l lipid	UBA, 2008
2006	Halle/Saale, Germany	134 ng/l lipid	UBA, 2008
Whole blood			

1998	Germany, general population	790 ng/l	Becker et al., 1998
2002/ 2003	Germany, children	90 ng/l	Link et al., 2005 *)
2003/ 2006	Germany, children	110 ng/l	Becker et al., 2008

*) Supplementary activity

Table 5.2.14 Mirex – Human media baseline summary for 1998-2008.

Year	Location	Observed level	Reference
Mother's milk			
2002/2003	Australia	0.12 – 0.53 ng/g lipid	Mueller et al, 2008 *)
2007	Belgium	<0.5 ng/g lipid	WHO, 2008
2007	Finland	<0.5 ng/g lipid	WHO, 2008
2007	Norway	<0.5 ng/g lipid	WHO, 2008
2007	Sweden	<0.5 ng/g lipid	WHO, 2008
Maternal blood			
1994/ 1999	Canada	20 ng/l	AMAP, 2003
1994/ 1999	Canada Inuit pop.	30 – 70 ng/l	AMAP, 2003
1996/ 1999	Northern Scandinavia	10 ng/l	AMAP, 2003
Blood plasma			
2004-2005	United States	11-38 ng/g lipid	NHANES, 2008
Blood serum			
2001	Alaska	<1 – 800 ng/l	AMAP, 2003

*) Supplementary activity

Table 5.2.15 PCBs – Human media baseline summary for 1998-2008.

Year	Substance	Location	Observed level	Reference
Mother's milk				
2001/2002	Sum PCB_6	Australia	25-35 ng/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	Sum PCB_6	Norway	106-132 ng/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	Sum PCB_6	Ireland	41-64 ng/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	Sum PCB_6	Italy	195-323 ng/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	Sum PCB_6	Finland	48-98 ng/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	Sum PCB_6	New Zealand	30-41 ng/g lipid	Van Leeuwen and Malisch, 2002
2001/2002	Sum PCB_6	Spain	278-469 ng/g lipid	Van Leeuwen and Malisch, 2002
2006	Sum PCB_7	Uppsala, Sweden	77 ng/g lipid	Glynn et al., 2002
2007	Sum PCB_7	Stockholm, Sweden	148 ng/g lipid	Athanasiadou, 2008
2007	Sum PCB_6	Belgium	80.5 ng/g lipid	WHO, 2008
2007	Sum PCB_6	Finland	41.3 ng/g lipid	WHO, 2008
2007	Sum PCB_6	Luxemburg	115 ng/g lipid	WHO, 2008
2007	Sum PCB_6	Norway	65.7 ng/g lipid	WHO, 2008
2007	Sum PCB_6	Sweden	84.5 ng/g lipid	WHO, 2008
2003	PCB 138	North Rhine-Westphalia,	38 ng/g lipid	Wilhelm, 2007 *)

		Germany		
2003	PCB 153	North Rhine-Westphalia, Germany	65 ng/g lipid	Wilhelm, 2007 *)
2006	PCB 153	Uppsala, Sweden	31 ng/g lipid	Glynn et al., 2002
2003	PCB 180	North Rhine-Westphalia, Germany	36 ng/g lipid	Wilhelm, 2007 *)
Maternal blood				
1994/ 1999	Sum PCB_{14}	Canada	520 ng/l	AMAP, 2003
1994/ 2000	Sum PCB_{14}	Canada inuit pop.	820 – 2700 ng/l	AMAP, 2003
1995/ 1999	Sum PCB_{14}	Northern Scandinavia	800 - 6200 ng/l	AMAP, 2003
2000/ 2001	Sum PCB_{14}	Faroe Islands	<10 – 14500 ng/l	AMAP, 2003
Blood plasma				
1999	Sum PCB_{14}	Iceland	760 - 3900 ng/l	AMAP, 2003
2004/2005	Sum PCB	United States	0.82 ng/g lipid	NHANES, 2008
2005	PCB 153	Ulm, Germany	363 ng/l lipid	UBA, 2008
2006	PCB 153	Greifswald, Germany	252 ng/l lipid	UBA, 2008
2006	PCB 153	Münster, Germany	352 ng/l lipid	UBA, 2008
2006	PCB 153	Halle/Saale, Germany	272 ng/l lipid	UBA, 2008
Blood serum				
2001	Sum PCB_{36}	Alaska	4800 ng/l	AMAP, 2003
Whole blood				
1998	Sum PCB_{3}	Germany, general population	2070 ng/l	Becker et al., 1998
2002/ 2003	Sum PCB_{3}	Germany, children	300 ng/l	Link et al., 2005 *)
2003/ 2006	Sum PCB_{3}	Germany, children	380 ng/l	Becker et al., 2008

*) supplementary activity

Table 5.2.16 Toxaphene – Human media baseline summary for 1998-2008.

Year	Substance	Location	Observed level	Reference
Mother's milk				
2002	Sum toxaphene	Germany	7-24 ng/g lipid	Skopp et al., 2002 *)
2007	Sum toxaphene	Belgium	2.3 ng/g lipid	WHO, 2008
2007	Sum toxaphene	Finland	1.9 ng/g lipid	WHO, 2008
2007	Sum toxaphene	Norway	3.7 ng/g lipid	WHO, 2008
2007	Sum toxaphene	Sweden	2.4 ng/g lipid	WHO, 2008
Maternal blood				
1994/ 1999	Sum toxaphene	Canada	50 - 70 ng/l	AMAP, 2003
1994/ 2000	Sum toxaphene	Canada inuit pop	430 - 740 ng/l	AMAP, 2003
1999	Parlar 26	Northern Norway	<58 - 180 ng/l	AMAP, 2003
1999	Parlar 50	Northern Norway	<50 - 620 ng/l	AMAP, 2003
2000/ 2001	Parlar 50	Faroe Islands	30 - 1600 ng/l	AMAP, 2003
Blood plasma				
1999	Parlar 26	Iceland	<58 – 90 ng/l	AMAP, 2003
1999	Parlar 50	Iceland	<50 - 200 ng/l	AMAP, 2003

*) Supplementary activity

5.2.5 Discussion of results

5.2.5.1 Levels

There is considerable variation in the amount of information available in the WEOG region. The most established existing programmes are in northern Europe, while some programmes are available in North America. In Australasia, a number of surveys of levels have been carried out, but these are not components of ongoing monitoring programmes.

In general, the most extensively monitored substances are polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Less data tends to be available for other substances currently listed in the Stockholm Convention. This may be due to the fact that many of them have been banned for a long time within the WEOG region and levels, at least in the general population, are low. Under these circumstances, existing programmes not constrained by legal requirements may in the past have discontinued monitoring certain POPs or may do so in the future (e.g., aldrin, endrin, and mirex).

5.2.5.2 Trends

In cases where sufficient information is available to suggest trends, an ongoing decline is indicated in the level of the Stockholm Convention POPs in the human population of the WEOG region. This is demonstrated by the decreasing trends in mother's milk as well as in blood. There are however geographic areas of high dietary exposure such as in the Arctic.

The highest Arctic exposures to several POPs are faced by Inuit populations in Greenland and Canada. The exposures are linked mainly to consumption of marine mammal species as part of the traditional diets. The exposure represents the result of biomagnification of POPs in long lived food species over many years where the POPs have been derived from long-range transport. Intake of substances with dioxin- like effects is a matter of concern, especially in recent Greenlandic studies. Dietary intake of PCBs exceeds national guidelines in a number of Arctic coastal communities especially in Canada and Greenland.

5.2.5.3 Considerations

The levels of pollutants observed in human matrices are mainly dependent on diet and age. The chief exposure route is via food, generally making up more than 90% of the total intake. Detailed statistical evaluations showed that the levels of POPs in human milk tend to increase with the age of the mother, and to decrease with the length of breast-feeding and the number of breast- fed children. For the general population, food items are usually of widespread origin resulting in there being no distinct difference between exposure in urban and rural areas. Exposure pathways are possible resulting from for example, diet choice, and food production and processing practices that could lead to high concentrations in some population groups. The combination of local sources, different groups investigated, long range transport and other factors makes it however difficult to compare contaminant levels observed between areas. The issue of age is well illustrated in the NHANES study showing that for the TEQ, as for most of the UNEP POPs, one cannot give a "universal" geometric mean, because the concentration is very much age dependent. This study also demonstrated the influence of ethnic patterns of dietary exposure. Therefore when seeking to detect changes in levels over time, the only really valid comparison is at one area and in the same group of people.

5.2.6 Recommendations for the future

The present report has relied very heavily on the information provided by a small number of national and international monitoring programmes. The ability to compare POPs levels over time within these programmes makes them of utmost importance for future trend analysis. It is recommended that these programmes be encouraged to continue their work of this nature.

To provide better basis for further evaluations it is recommended that steps be taken to improve the ability of the COP to observe changes in POPs levels over time in areas lacking established monitoring programmes such as in southern Europe and Australasia.

If new human media programmes are established to address the needs of effectiveness evaluation of the Convention, it is recommended that careful attention is paid to ensuring the best possible comparability of data within such programmes.

5.3 Other media (non-core media)

5.3.1 Background

In 2007, COP3 decided that the first Evaluation of Effectiveness should focus on data relating to the core media (air and human milk and /or human blood) but data relevant to other media may also be covered if already available. In the WEOG region a number of programmes (e.g., AMAP, HELCOM, OSPAR, MAP_MEDPOL,MONARPOP) have monitored POPs in the biotic and abiotic environment over several decades operating with consistent methods and rigorous quality procedures in line with the GMP guidance document and the implementation plan for the first evaluation. These programmes provide some of the best available data collections to attempt an evaluation of levels and trends of POPs in non-core environmental media. The ROG examined their potential in the context of effectiveness evaluation, and concluded that the large volume of material would make it impractical to attempt a review of the same nature as that undertaken for the core media. It was therefore decided to provide the COP with a brief overview of the POPs monitoring activities of some of the most established programmes in order to that such information is available in any future discussions on adding to the core media. At the same time, the opportunity was taken to very briefly indicate the general nature of the time trends described by a small number of the programmes and to make some suggestions for the future.

5.3.2 Programmes and Documents

Some of the main monitoring programmes believed to fullfill all the conditions and requirements concerning the timeframe, longevity and QA/QC identified by the COP (UNEP/POPS/COP.3/23/Rev.1,) are briefly described, maps of their geographical coverage can be found in the programme summaries. Then some of the documents produced on the basis of these programmes and other scientific literature are summarised A simplified list of sample matrices and a summary of the available data on levels and trends reported by the programmes is presented in Table 5.3.1. The summary is illustrative and not comprehensive. Other well established programmes exist, such as MONARPOP in the alpine region and Mussel Watch

programmes in America (Kimbrough et al 2008) and Europe (Tripp et al. 1992, CIESM 2002, Andral et al 2004).

Table 5.3.1 Brief summary of available measurements of POPs in other media in some long term international monitoring programmes examined by the WEOG ROG.

AMAP		Aldrin	Chlord.	DDT	Dield.	End.	Hepta.	HCB	Mirex	PCB	PCDD	PCDF	Toxaph.
Air	deposition	X	X	X	X	X	X	X	X	X	X	X	X
	snow&ice	X	X	X	X	X	X	X	X	X	X	X	X
Marine	water	X	X	X	X	X	X	X	X	X	X	X	X
	sediments	X	X	X	X	X	X	X	X	X	X	X	X
	plants	X	X	X	X	X	X	X	X	X	X	X	X
	invertebrates	X	X	X	X	X	X	X	X	X	X	X	X
	vertebrates	X	X	X	X	X	X	X	X	X	X	X	X
Terrestrial	plants	X	X	X	X	X	X	X	X	X	X	X	X
	vertebrates	X	X	X	X	X	X	X	X	X	X	X	X
Food		X	X	X	X	X	X	X	X	X	X	X	X
HELCOM													
Marine	water			X				X		X	X	X	
	sediments			X				X		X	X	X	
	invertebrates			X				X		X	X	X	
	vertebrates			X				X		X	X	X	
Terrestrial	vertebrates			X				X		X	X	X	
OSPAR													
Air	deposition			X	X			X		X			
Marine	sediments			X	X			X		X			
	invertebrates			X	X			X		X	X	X	
	vertebrates			X	X			X		X	X	X	
MAP-MEDPOL													
Marine	sediments			X				X		X			
	invertebrates			X				X		X			
	vertebrates			X				X		X	X	X	

5.3.2.1 AMAP

In 1991, the eight circum-polar countries launched a major multi-year program, the Arctic Monitoring and Assessment Programme (AMAP), to evaluate and document the occurrence and consequences of persistent toxic substances (PTSs) and other pollutants in the Arctic. AMAP depends largely on contributions from existing national programmes, such as the NCP in Canada. In 1998, AMAP published its first comprehensive report, the "AMAP Assessment Report: Arctic Pollution Issues" (AMAP 1998). Key subsequent publications include AMAP 2003, Macdonald et al. 2003; and AMAP 2004a. A further report (AMAP2004 b) is specifically concerned with the segment of the Arctic that is included in the CEE region and is not considered here.

Considerably more data on temporal trends than was available in 1998, including a 25 to 30-year perspective for polar bears, seabirds, and ringed seals in the Canadian Arctic, as well as for fish in the Swedish Arctic was published in the 2002 assessment (AMAP 2004a).

Studies covering a 10 to 15-year period are available for polar bear at Svalbard, peregrine falcons in Alaska, Atlantic cod in Iceland, glaucous gulls in Svalbard, burbot, lake trout and beluga whales in Canada and walrus in northwestern Greenland.

A statistical comparison of temporal trends of HCB, and PCBs among seabirds, ringed seal, and polar bear in the Canadian Arctic showed significant differences in rates of decline among species. This reflects different biological half-lives of the contaminants in each species as well as migratory behavior in the case of Arctic seabirds.

AMAP has also reported (Macdonald et al 2003) evidence that the routes and mechanisms by which POPs are delivered to and are pertitioned in the Arctic are strongly influenced by climate variability and global climate change. These pathways are complex, interactive systems involving a number of factors, such as temperature, precipitation, winds, ocean currents, and snow and ice cover. Pathways within food webs and the effects on biota may also be modified by changes to climate. Studies using global change scenarios have indicated the potential for substantial changes in atmospheric and oceanographic pathways that carry contaminants to, within, and from the Arctic. These studies indicate that climate-related variability in recent decades may be responsible at least in part for some of the trends observed in contaminant levels.

All reports are available from www.amap.no

5.3.2.2 HELCOM [1] and some national programmes in the Baltic Sea

A substantial data base of POPs levels in marine species is available from HELCOM. HELCOM reports (HELCOM 2003; 2004a,b; and, 2005) show that concentrations of polychlorinated biphenyls in herring have decreased significantly, probably due to reduced emissions following stricter regulations and bans in the HELCOM countries. Some fish from the Baltic Sea exceed the new EU limits on concentrations of dioxin in food and livestock feed. Concentrations of dioxins in herring and salmon vary regionally (HELCOM 2004b). The most contaminated fish are found in the Gulf of Bothnia, including herring in the Bothnian Sea, and salmon in the Bothnian Bay.

The upward concentration of dioxins in the Baltic marine food chains is evident in fish-eating birds and their eggs. Concentrations of dioxins in guillemot eggs have now decreased to one third of their 1970-levels. These concentrations decreased rapidly until the mid 1980s, but have subsequently remained at roughly the same level.

Some national monitoring data is also available for the Baltic. For example, (Bignert et al 2007) have reported a Swedish study that provides levels and time trends (1980-2005) for sum PCB, sum DDT, DDE, HCB in: Herring (*Clupea harengus*); Cod (*Gadus morhua*); Dab (Limanda limanda); Flounder (*Platichtys flesus*); Blue mussel (*Mytilus edulis*); Guillemot (*Uria aalge*); Perch (*Perca fluviatilis*); viviparous eelpout or Blenny (*Zoarces viviparus*). Results include a

[1] Helsinki Commission. Baltic Marine Environment Protection Commission (www.helcom.fi)

decreasing trend for HCB in herring, cod and guillemot from the Baltic and also in herring and cod at the Swedish west coast. However, some relatively high concentrations have been detected in the last years, suggesting that the decrease is leveling out. TCDD-equivalents have not decreased in herring at Harufjärden, Karlskrona and Fladen during the investigated time period 1990-2005. There is a significant decrease of these substances in guillemot eggs from St Karlsö between 1970 and the middle of the 1980s after which the decrease leveled out (HELCOM 2004b).

Other studies include the long-term monitoring of bioaccumulating contaminants (including DDTs, PCBs, and dioxins) in biota from Swedish terrestrial environments (Swedish National Monitoring Programe 2008) based on the analysis of a variety of matrices collected in pristine areas throughout the Swedish mainland, outside known hot spots and urban areas. Tissues (muscle, liver, kidney) of reindeer (*Rangifer tarandus*) have been collected annually at three sites in the northwestern sub-arctic region in 1980-2007 as indicators in monitoring of airborne and deposited contaminants. The same tissues have also been annually collected from the male calves of moose (*Alces alces*) in a forest area in central Sweden in the same period. Collected matrices are stored in the Environmental Specimen Bank at the Swedish Museum of Natural History, Stockholm. Reindeer data shows that Hexachlorobenzene tended to decrease in an earlier study 1983-1995 (Odsjö et al 1998) but not in the prolonged study from 1987-2006. PCBs (CB-138, CB-153 and CB-180) decreased significantly during the period with 3.4-4.5% per year, while no corresponding change was revealed for CB-118.

The retrospective study of organochlorine levels in moose revealed that hexachlorobenzene decreased during the period with on average 6.7% annually. PCBs (CB-118, CB-138, CB-153 and CB-180) decreased significantly during the period with 3.1- 4.8% in average per year.

5.3.2.3 OSPAR[1]

OSPAR has published several reports containing data on trends in POPs levels in the environment and organisms from the North Atlantic and its adjacent eastern seas. (OSPAR 2005a, 2005b, 2006, 2007a 2007b). In addition, through the Comprehensive Atmospheric Monitoring Programme (CAMP), (OSPAR 2005) OSPAR has been been monitoring airborne inputs of contaminants including some POPs to the marine environment since 1987.

Information on temporal trends over the period 1999-2005 in biota and sediment are available (OSPAR 2005b and OSPAR 2007b). This includes PCB congeners 118 and 153; dieldrin, p,p'-DDE; and Hexachlorobenzene (HCB) in the following organisms: Atlantic cod (*Gadus morhua*); Dab (*Limanda limanda*); Flounder (*Platichthys flesus*); Herring (*Clupea harengus*); Megrim (*Lepidorhombus whiffiagonis*); Plaice (*Pleuronectes platessa*); Whiting (*Merluccius productus*); Blue mussel (*Mytilus edulis*); Common shrimp (*Crangon crangon*); Common

[1] The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain. OSPAR Regions
Region I: Arctic waters , Region II: Greater North Sea
Region III: Celtic Seas, Region IV: Bay of Biscay and Iberian Coast, Region V: Wider Atlantic

whelk (*Buccinum undatum*); Dogwhelk (*Nucella lapillus*); Mediterranean mussel (*Mytilus galloprovincialis*) Pacific oyster (*Crassostrea gigas*); Common periwinkle (*Littorina littorea*); Netted dogwhelk (*Nassarius reticulata*); Red whelk (*Neptunea antiqua*); and, Sand gaper (*Mya arenaria*).

The summary of time trend analysis in (OSPAR 2005b) covering biotic samples during 1999-2003 indicates that:

- For PCB153 There were 186 datasets of 5 years or more for which trends could be assessed. There were 2 significant upward linear trends and 45 significant downward linear trends. There was a significant non-linear component in 12 time series.
- For the sum of 7 PCBs there were 180 datasets of 5 years or more for which trends could be assessed. There were 2 significant upward linear trends and 49 significant downward linear trends. There was a significant non-linear component in 12 time series.
- For both PCB 153 and for the sum of 7 PCBs, the 10-year detectable trend varied between 3 and about 67% with a median of 13% for time series = 5 years.

There is evidence (OSPAR 2007b) that PCB concentrations in biological samples are generally decreasing over the assessed time period (1999-2005). But compared to the last assessment (1999-2003) (OSPAR 2005b), for many of the long time series concentrations are not decreasing further and vary at a relatively constant concentration level.

5.3.2.4 MAP-MEDPOL[1]

There is a dispersed wealth of data on POPs levels in the Mediterranean, compiled by the Mediterranean Action Plan (MAP) of the Barcelona Convention. The Monitoring plan under MAP (MEDPOL) does not, at this stage, consider POPs in its workplan. The available information on POPs in the Mediterranean was summarized in UNEP 2002d.

Other relevant publications include:
Abusamra et al 2005 , EEA 2006 , UNEP-MAP 1992 , 1995, 2001, and 2004. Gómez-Gutiérrez et al 2007 provides a survey of time trends for PCB, DDT and HCB in marine sediments in the Eastern and Western Mediterranean that indicates the main sources to be land based with the largest concentrations found on the continental shelf. In agreement with observations in other regions for PCBs, DDTs and HCB, general decreases occured in the 1980's with smaller reductions if at all in the last decade.

5.3.2.5 UNEP 2002 PTS regional reports

The UNEP 2002 Regionally Based Assessments of Persistent Toxic Substances gave a comprehensive regionally based overview of POPs levels in the environment (UNEP 2002a-f). The regional structure differed from the one used by the Convention. Six of the PTS study regions are relevant for the WEOG region (Arctic, North America, Europe, Mediterranean, South East Asia and South Pacific, and Antarctica) . These reports are a valuable compilation of available information but they are not the primary reports of ongoing monitoring activities.

[1] http://www.unepmap.org

The UNEP 2002b report on North America includes in pp 56-85 a detailed survey of available data in a wide variety of media on levels and trends for DDT, Dieldrin, PCDD/F, HCB, Mirex, PCB and Toxaphene in the region

All reports are available from UNEP Chemicals (http://www.chem.unep.ch)

5.3.2.6 UN-ECE/LRTAP

Much of the WEOG region (i.e. Western Europe and North America) is included in the area covered by the UN-ECE Convention on Long-range Transboundary Air Pollution (LRTAP). The International Cooperative Programme on Assessment and Monitoring of Acidification on Rivers and Lakes (ICP Waters) under the Working group on Effects of the LRTAP Convention has published (Fjeld et al 2005) an overview of recently observed levels of selected POPs in freshwater fish and sediments from North America, Europe and the circumpolar Arctic. It shows that there is a general lack of coordinated monitoring or regional surveys that focus on POPs in the freshwater environment. The very few sites with trend data show decreasing levels of the POPs listed in the Stockholm Convention.

The 1998 Protocol on POPs under the LRTAP Convention was reviewed in 2005 on the basis of a technical report derived from EMEP data and a scientific literature review (UNECE 2005). The information in this document provides a comprehensive summary of the best then available knowledge on levels and trends in the Northern Hemisphere area of WEOG. in many media. The following provides a brief overview of the most significant observations in the context of the Stockholm Convention effectiveness evaluation.

The body of information on PCBs and DDTs is relatively extensive and permits the assessment of some spatial and temporal trends that can be attributed to changes in deposition resulting from LRAT. Results suggest that levels of both substances have generally decreased over the past 15-30 years as indicated in natural deposition archives (e.g. sediment cores) and levels in biota. The 10-15 year temporal data from atmospheric and biological monitoring suggest that environmental levels are still decreasing though at a much slower rate, particularly in remote environments such as the Arctic. Despite these trends a number of species continue to display sum of PCB levels, and to a lesser extent sum DDT levels, that exceed various thresholds for toxic effects. In general, levels of sum DDT exposure among the general human population are well below dietary intake guidelines. Highly exposed groups, such as Inuit from Greenland and Canada, who regularly exceed guidelines for PCB intake, also have levels of sum DDT exposure that approach and occasionally exceed WHO guidelines.

The amount of information on environmental levels of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) is not as extensive as it is for most other POPs. Models of current atmospheric levels and deposition suggest decreasing trends in industrial regions of the LRTAP Convention area that are in the order of 50% since the late 1980s. Similar trends have been observed in breast milk in some European countries. Monitoring results from remote areas such as the Arctic generally show no discernible trends for PCDDs and PCDFs in abiotic media or biota. These data also suggest that some of the more highly exposed species of marine mammals and fish eating birds may exceed some toxicity thresholds.

Information on environmental levels and trends of hexachlorobenzene (HCB), chlordanes, toxaphene and to a lesser extent dieldrin and heptachlor epoxide show some spatial and temporal trends that can be attributed to LRT. Data suggest that environmental levels of HCB, heptachlor epoxide, chlordanes and toxaphene have generally decreased over the past 30 years. However, the evidence for decreasing trends in dieldrin, is not as clear. Similar findings are also expressed in Arctic atmospheric monitoring data collected over the past 10-15 years.

Once released into the environment aldrin is readily degraded to dieldrin and is therefore rarely measured. Endrin and mirex are occasionally measured in environmental media; however, the existing data are insufficient for assessing temporal trends. A comparison of some recent results with those of 20-30 years ago suggests environmental levels have decreased.

5.3.3 Conclusions and recommendations

The WEOG review of available monitoring information on POPs in non-core environmental media concluded that:

1) A number of existing monitoring programmes are producing information in a large variety of media that could be of value for future effectiveness evaluations. Such programmes are most available for the Arctic, North America and the north of Europe. The Mediterranean, Australia and New Zealand have valuable data but the information is dispersed and / or does not result from systematic long term monitoring.

2) Many biological species prominent in the existing monitoring programmes have a geographical range that does not extend to all parts of the northern hemispheric portion of WEOG and very few are common with the southern hemispheric portion of WEOG. A species which is a very good environmental indicator of POPs levels (and with a rich existing body of monitoring information) in one sub-region may be absent in another region.

3) The effects of climate change/variability on the transport and partitioning of POPs has the potential to significantly complicate the interpretation of measurements of POPs in environmental media.

4) Several existing monitoring programmes (e.g.,AMAP, HELCOM, OSPAR) in the WEOG region have measured in core and non-core media substances that are under consideration by the POPs Review Committee. Therefore if these substances are added to the Convention, some time series may be readily available for further evaluation.

Based upon the above conclusions, the ROG recommends that:

1) For future evaluations, the COP considers a two track strategy for media. In one track would be the present core media of air and human milk / blood. These could be called the global core media. In the other track would be media that would be specific to a region or sub-region. These could be called specific regional / sub-regional media.

2) If such a strategy is adopted, the WEOG ROG recommends that all regions should be encouraged to report trends on POPs in the best available data sets that are available from existing programmes in their regions / sub-regions for future evaluations. This flexibility would recognize that regions are unique and that a medium that works well for one region might not be appropriate or available for other regions.

3) Some guidance would be necessary (perhaps through a revision of the GMP guidance document) on what type of other media are most suitable for temporal trends analysis for the purpose of effectiveness evaluation.

4) Steps are explored for enhancing long term cooperation in POPs monitoring in the Mediterranean region (core and non-core media) for the purpose of increasing the body of information available for future effectiveness evaluations of the Convention.

5) Steps be considered for undertaking studies to build an understanding of how climate change/variability may influence levels of POPs in various environmental media.

5.4 Long Range Transport (Regional and Global Environmental Transport)

5.4.1 Background

Article 16 of the Stockholm Convention on Persistent Organic Pollutants on effectiveness evaluation states that in order to facilitate such evaluation, the Conference of the Parties shall, at its first meeting, initiate the establishment of arrangements to provide itself with comparable monitoring data on the presence of chemicals listed in Annexes A, B and C as well as their regional and global environmental transport.

The ROGs noted that the Conference of the Parties has not clarified its expectations concerning long-range transport (LRT). However, the amended implementation plan for the global monitoring plan was adopted at COP 3. This describes four types of information treatment that could be used in the context of effectiveness evaluation. At the same time, the COP endorsed the amended global monitoring plan which included the same approaches and further developed the connection between long range transport of POPs and potential influences on observed temporal trends. The ROGs considered that these four approaches are complementary to one another and are not duplicative. It was therefore decided to explore each of these approaches in the WEOG report in order to enable the COP to review the characteristics and products of each methodology and possibly to further clarify its future needs. The role of climate variability on LRT of POPs is also explored.

5.4.2 Options for assessing LRT

Several approaches have been considered for evaluating LRT in order to gain a better understanding of POPs concentrations and trends. These have already been described in documents UNEP/POPS/COP.3/23/Rev.1 – implementation plan for the global monitoring plan and UNEP/POPS/COP.3/INF/14/Rev.1 – guidance on the global monitoring plan for persistent organic pollutants, and are further elaborated below. The focus so far has been on LRT in the atmosphere although water transport is also considered. Biotransport, through migratory species, has so far not been pursued as information on this pathway offers little prospect for effectiveness evaluation. Following this summary of the various approaches to assess LRT is a brief discussion of climate variability and the potential influences on LRT and observed POPs trends.

5.4.2.1 LRT potential of POPs

This approach is already well described in the revised UNEP guidance document where examples are given, showing the characteristic travel distances (CTD) for various POPs in air and water. The CTD (expressed in units of km) reflects a chemical's ability to migrate away

from its source. Larger values reflect greater LRT potential. Of the 12 POPs listed in Annex A, B and C, of the Stockholm Convention, most are preferentially mobile in air and thus referred to as "flyers". It is also possible that for some chemicals i.e. the "swimmers", oceanic transport may be important. The relative values of the CTD depend on the physical chemical properties of the compounds being evaluated. This assessment has already been completed for POPs listed under the Convention (UNEP/POPS/COP.3/INF/14/Rev.1; Beyer et al., 2000).

With this information, and knowledge regarding a chemical's preferential transport pathway – air versus water – it is then possible to use a generic description of air and water currents to evaluate potential transport pathways on regional and global scales. This represents a highly simplified evaluation of transport mechanisms as it ignores the complexities of meteorology and water flow, but it provides a standard "yardstick" for interpreting monitoring data for identified POPs and candidate POP substances. Although most of the identified POPs listed in Annex A, B and C of the Convention are predominantly transported in air, water transport may become a more relevant concern as new POPs are added to the Convention in the future.

Building on the CTD methods for assessing LRT potential in air or water, the Organization for Economic Cooperation and Development (OECD) promulgates an approach that considers both the LRT potential of a chemical and its overall persistence (P*ov*) in the environment (Klasmeier et al., 2008). The reasoning behind the OECD approach is that POP chemicals generally combine high potential for long-range transport with high persistence. Their assessment method considers the behavior of the chemical in the whole environment by 1) evaluating P*ov* that accounts for degradation half-lives in air, water and soil and environmental partitioning, and 2) by considering two metrics of LRT that reflect different types of possible hazards. P*ov* and LRT values are model-specific however an evaluation of several models showed that when applied in the same context, they provide comparable values for these indicators (Fenner et al., 2005). Therefore, the OECD sponsored the production of a standard software package for evaluating P*ov* and LRT, The OECD P*ov* and LRTP Screening Tool, (The Tool), which represents the current state-of-the art in POPs modeling, and is distributed free of charge from the OECD (http://tinyurl.com/66q47j).

The benefit of the OECD approach is that chemical hazard can be rapidly assessed by visually comparing chemicals in terms of how long they might linger in the environment (P*ov*) and their potential for LRT. This information is useful in the context of trends analysis as chemicals with higher P*ov* values are likely to exhibit slower declining trends in the environment. The Tool calculates two metrics of LRT. Maximum CTD in air or water provides a measure of the typical distance the chemical might be transported in the atmosphere or oceans, and Transfer Efficiency (TE) indicates potential for transport through the atmosphere and deposition in a remote location. Figure 5.4.1 shows the placement of the Stockholm POPs on charts of these two LRTP metrics (CTD and TE) versus LRTP and P*ov* versus these two LRTP metrics (Klasmeier et al., 2008), and is an example of output from the OECD Tool software.

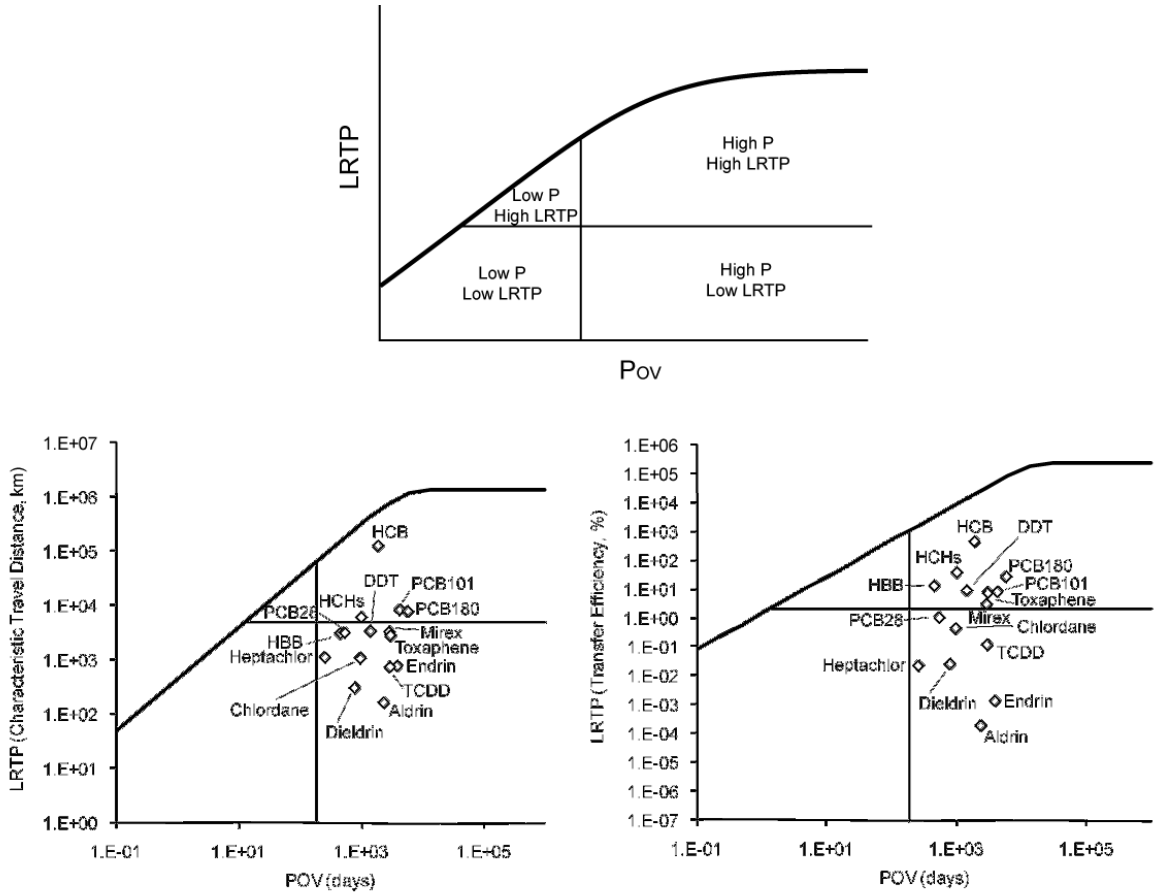


Figure 5.4.1 Comparison of POPs listed under the Stockholm Convention according to their maximum overall persistence (P*ov*) and long-range transport potential LRTP measured as characteristic transport distance (CTD, left-hand plot) and transfer efficiency (TE, right-hand plot).

The curved solid line on the plots in Figure 1 represents the maximum LRT for a given P*ov*. POPs that appear in the top right region (high P*ov*, high LRT) are highest priority as they exhibit both POP-like LRT and P*ov*. These chemicals will travel far from sources and decline slowly in the reservoirs where they tend to accumulate – often polar regions. HCB is a prime example of a POP with this type of behaviour (Figure 5.4.1). Chemicals in the bottom left (low P*ov*, low LRT) are low priority as they are not efficiently transported and degrade relatively quickly. The remaining two regions (low P*ov*, high LRT and high P, low LRT) have intermediate priority. Chemicals in the top left (low P*ov*, high LRT) are expected to be transported more efficiently, however, due to their lower P*ov*, their levels in the environment should decline relatively quickly following reduction in emissions. Chemicals in the bottom right sector (high P*ov*, low LRT) are less prone to migrate from sources but will demonstrate slower declines in environmental compartments following a reduction in emissions. Several of the UNEP POPs fall into this category (Fig. 5.4.1).

Water transport may also be important for some POPs – the 'swimmers' (Li and Macdonald, 2005). In these instances, information on riverine inputs and especially ocean currents could identify potential transport of chemicals from one region to another. The predominant LRT pathway – air vs water – will influence the spatial and temporal trends and the delivery of chemical to marine biota. Figure 5.4.2 shows circulation map for the world's oceans identifying the map flow pathways.

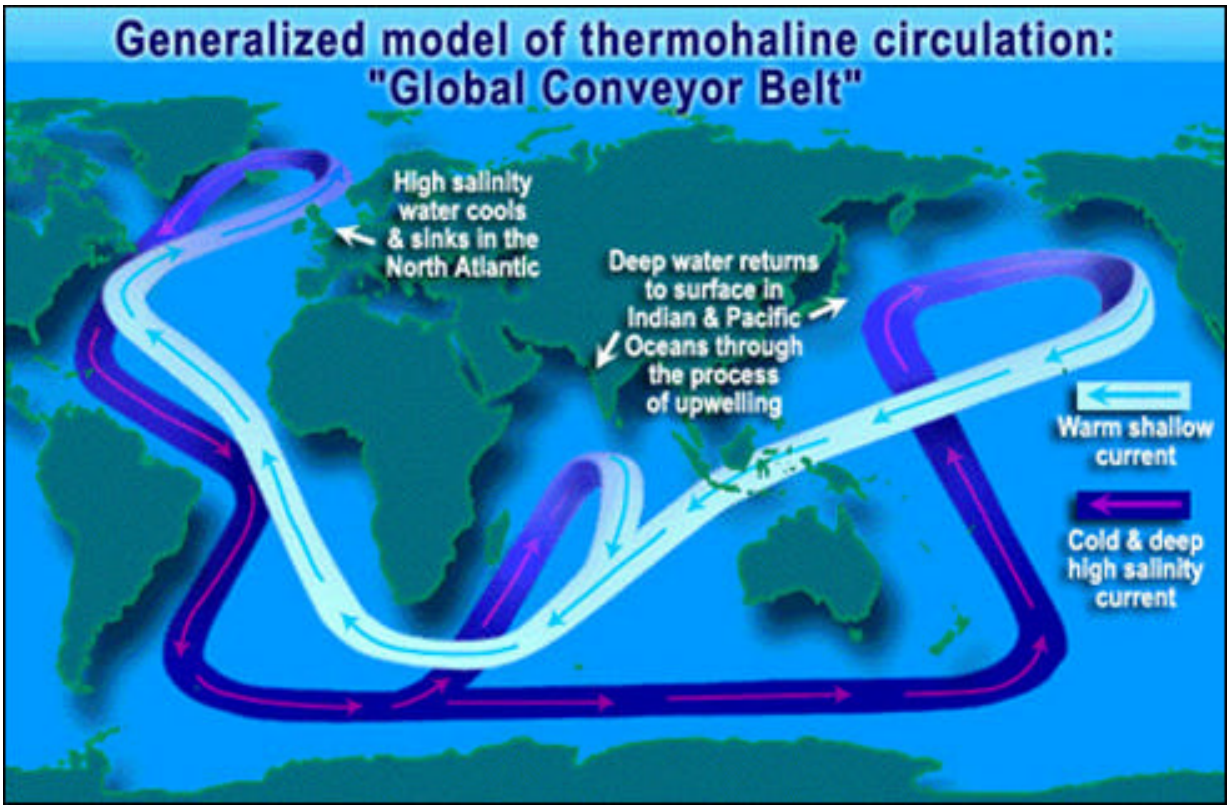


Figure 5.4.2 Simplified ocean water circulation map.

Related to the topic of water transport is the issue of water-air exchange. Jantunen et al. (2008) have shown that for some classes of banned pesticides, the world's oceans may act as a long term reservoir and dampen the expected declines in air concentrations. This phenomenon is particularly relevant in cold polar regions where chemicals are subjected to a condensation effect. Other studies have shown the importance of dynamic air-water coupling and cycling of POPs over the open ocean (Jaward et al., 2004). Ship-based measurements from research and/or commercial transects of the world's oceans have contributed some of the best spatial information on POPs and insight to their global-scale transport.

Information on the LRT transport and persistence of Stockholm POPs is readily available and so the approach(es) described above can be easily employed to assess the likeliness of a POP traveling by air or water from known source regions to a background air sampling site. Although this technique can provide a general sense of a chemicals spatial and temporal range it cannot be applied quantitatively to assess time trends.

5.4.2.2 Air parcel back trajectory analysis

This approach was described and promoted in the revised guidance document and implementation plan. The purpose of this technique is to provide information on the history of an air mass that has traveled to a location where it has been sampled. This yields additional information for better understanding observed trends from one sample to the next and/or for comparisons over longer time scales. This is particularly useful for sampling sites that are potentially impacted by advection from regional sources of POPs. Air back trajectories are calculated based on wind fields that are usually taken from meteorological analyses provided by numerical weather prediction centers. On-line services for generating back trajectories are provided free of charge by several meteorological agencies (e.g NOAA's Hysplit model (http://www.arl.noaa.gov/ready/hysplit4.html), the Canadian Modeling Centre Trajectory Model (http://iweb2.cmc.ec.gc.ca/~afsuair/traj/) and the Flextra model available through the Norwegian Institute for Air Research (NILU) (http://www.nilu.no/trajectories/).

Various analysis techniques can be applied to summarize trajectory information in order to explore the source region. For instance, cluster and sector analysis (Moody et al.,1998) can be used to discriminate source pathways to a site. In the simplest form, air trajectories for a given integration period can be grouped to identify the 'airshed' represented by the defined sampling period. The resulting 'spaghetti plots' can be presented graphically on a map. For instance, potential source contribution functions (Hsu et al., 2003a,b) and variations of this approach referred to as probability density maps, airshed maps (Gouin et al., 2005) are now widely used. These techniques integrate back trajectory information onto a map showing the percentage of time (for a given integration period) that air masses pass over various regions (e.g. Fig. 5.4.3).

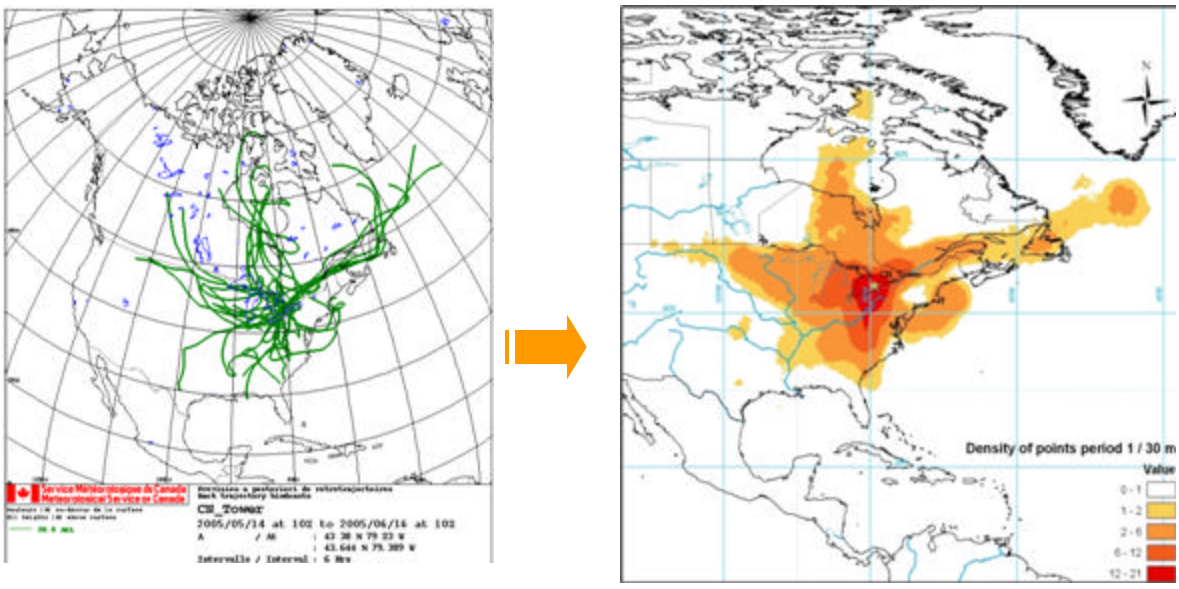


Figure 5.4.3 A 'spaghetti' plot (3-day back trajectories) for an integrated passive air sample collected in Toronto, Canada over a one-month period (calculated using the CMC model) and the resulting airshed density map.

If the back trajectory technique is to be widely adopted it will be important that guidelines be established for performing these calculations and for how the results should be interpreted. For instance, standardized approaches such as using 3-day back trajectories for regional transport and six-day or longer-trajectories for global transport (recognizing that calculation errors increase with trajectory length) (Stohl et al., 1998). Limitations of this technique should also be considered. For instance the back trajectory technique does not consider chemical reactivity in the air parcel and hence does not distinguish chemicals.

Easy and free access to web-based trajectory services has contributed to the popularity of back trajectory analysis for investigating source-receptor relationships and for explaining episodic events in monitoring data. In this Lagrangian approach, air mass movements are accurately described, however, the presence of chemical and its fate within the air parcels is currently not considered.

5.4.2.3 Transport Models

This the final and most complex approach (in terms of input data and resource requirements) considered in the implementation plan and Revised Guidance document. This modeling approach is chemical specific and requires information on physical chemical properties. As with back trajectory analysis, air mass movements are based on real meteorology, however, the key difference between with this technique is that chemicals are allowed to react and partition between media during their time spent in air.

Conventionally, regional and global models are initialized using information on emission estimates. For the OC pesticides, soil residues represent a key emission source. Emission factors applied to soil residues/inventories are often used to generate air concentrations that are then used to drive model calculations (e.g. Li and Ren, 2007). In the case of industrial chemicals such as PCBs, industrial regions are key emission sources to the atmosphere (Breivik et al. 2007). Because this emissions-based approach relies heavily on estimations, derived air concentrations are also estimates. Uncertainties in the approach and the performance of specific models are assessed by validation against real measurements.

An alternate approach has become possible in recent years with the proliferation in the use passive air samplers, that are capable of providing globally-resolved air concentrations (e.g. GAPS) at a reasonable cost. The measured air concentrations are used directly, to initialize the model. However, this technique often suffers from lack of data resolution, and thus requires some interpolation. This is another source of uncertainty.

The best strategy may be an integrated one, that combines the best available measurements and emissions information. Although sufficient data is available for some of the substances covered by the Convention, the best available information is presently for γ-HCH, currently under consideration by the POPs review committee. Therefore, the ROG decided to use this material in order to best illustrate the potential of this methodology for effectiveness evaluation.

Figure 5.4.4 shows the superimposed snapshot of γ-HCH air concentration at 3000m height from the Canadian Model for Environmental Transport of Organochlorine Pesticides (CanMETOP, Ma et al., 2003) – a regional/global scale three-dimensional atmospheric transport model coupled

with soil-air wand water-air exchange models. Input for this simulation is based on 2005 measurements under the GAPS Network – a global passive air sampling program (Pozo et al., 2006; http://www.msc-smc.ec.gc.ca/gaps/) and an updated global lindane emission inventory (Li and Ren, 2007). For regions where measurement data is lacking, air concentrations are generated from soil residues by the approach described above. Although this approach is illustrated for γ-HCH, it can also be applied to the UNEP POPs if air and emissions information are available.

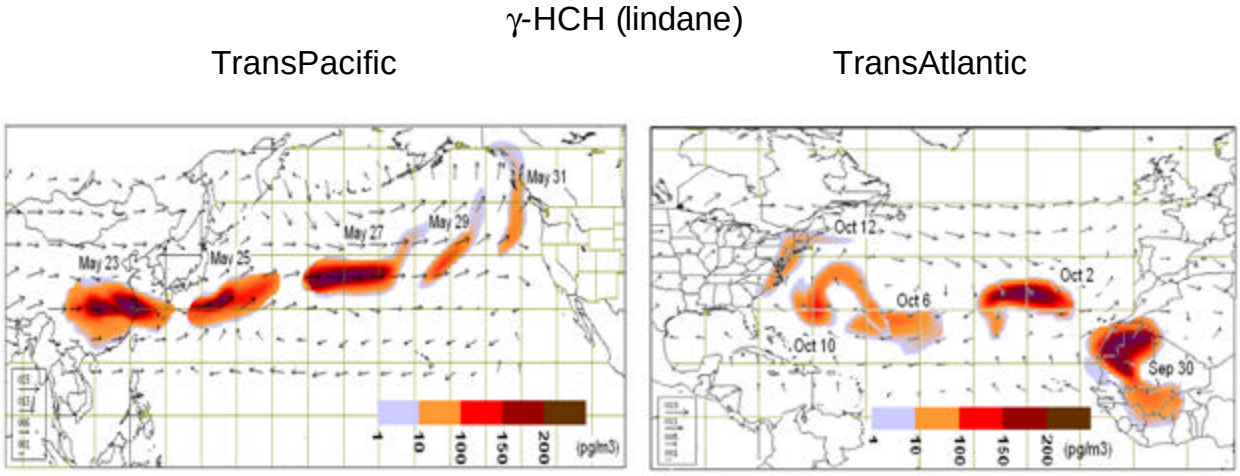


Figure 5.4.4 Output from the CanMETOP model illustrating intercontinental transport of γ-HCH to North America.

The figure is a compilation of snap-shots showing the importance of trans-regional inputs. In this case, demonstrating how γ-HCH (the main component of lindane) concentrations in North America are influenced and sustained by inputs from trans-Pacific and trans-Atlantic flow. Temporal trends for γ-HCH in North America over the next several years will likely be controlled by this 'sandwich effect' and not reflect regulation of the chemical within North America. Not captured in this still image is the large variability/intermittent nature of these intercontinental flows. These transport episodes occur in pulses and do not always pass over the same regions. This further complicates matters and enforces the need to consider air mass movements on a site-by-site basis and period-by-period basis when considering air concentration trend data.

Another example of how transport models can elucidate monitoring data is given by Eckhardt et al. (2007) using the Lagrangian particle dispersion model FLEXPART (http://zardoz.nilu.no/~andreas/flextra+flexpart.html) which incorporates relevant meteorological processes having influence on the dispersion of the substances (e.g. turbulence, convection, scavenging). In this case, two separate events of anomalously high PCBs measured at the air monitoring station at Zeppelin Mountain on Svalbard were attributed to long-range transport of biomass burning emissions in Eastern Europe (Figure 5.4.5) and North America.

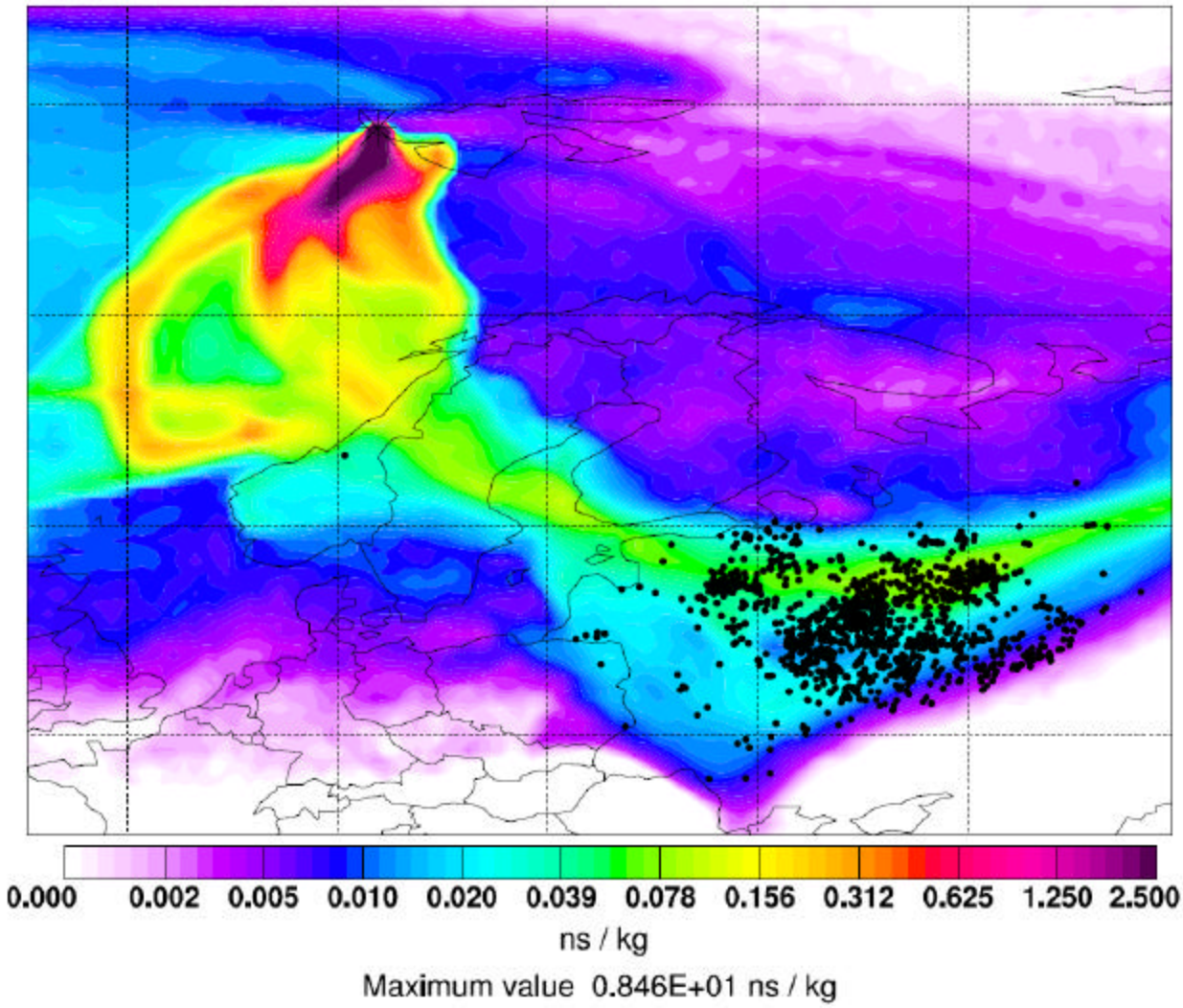


Figure 5.4.5 Column-integrated potential emission sensitivity (PES) map for air arriving at Zeppelin Mountain, Svalbard between 1 May and 3 May 2006 (top panel) Black dots show MODIS fire detections during these transport episodes. Eckhardt et al. (2007).

Advances continue to be made in the development and application of global models and expertise in this area continues to spread. For instance, the LRTAP Convention (http://www.unece.org/env/lrtap/) Task Force on Hemispheric Transport of Air Pollution (HTAP; http://www.htap.org/) has recently expanded their mandate to include POPs models and the first POPs assessment report that will be available in 2010. The hemispheric and global modelling of POPs is supported by the Meteorological Synthesizing Centre-East (MSC-E; Moscow, Russia; http://ww.msceast.org/) and their cooperation with other international organizations and national scientific programmes.

The field of transport modeling for POPs will continue to progress with improved input and validation data. This includes globally-resolved air concentrations of POPs, improved emission estimates for POPs and research and monitoring programmes directed at investigating

intercontinental POPs transport. Examples of the latter include WACAP, the Western Airborne Contaminants Assessment Project (http://www.nature.nps.gov/air/studies/air_toxics/wacap.cfm), investigating the risk to ecosystems in western national parks from the long-range transport of airborne contaminants. Under the International Polar Year effort, the project INCATPA, Intercontinental Atmospheric Transport of Anthropogenic Pollutants to the Arctic (http://www.msc-smc.ec.gc.ca/arqp/incatpa/incatp0_e.cfm) is investigating long-range transport of POPs to the Canadian Arctic. Many of these international efforts benefit from the support and infrastructure provided by existing meteorological stations operated under national and international programmes; for instance, those sites contributing to the Global Atmospheric Watch (GAW) through the World Meteorological Organization (WMO).

Transport models are the most sophisticated and realistic method for investigating LRT for POPs and can differentiate chemicals and describe real long-range transport behaviour, quantitatively. However, in many cases, the resolution of the required input data is not yet adequate and model output should therefore be used conservatively, in a qualitative way. Due to the expertise and resource demands for this approach, it is still not widely available, although this situation is improving quickly.

5.4.2.4 Synthesis

The approaches described above are considered complimentary, providing additional tools and information for interpreting and understanding trend information for a given site. The approaches are elaborated further in Table 5.4.1.

Table 5.4.1 Summary for approaches to investigate LRT of POPs.

LRT Technique	Resource Requirement	Added Value	Limitations
CTD (*Characteristic Travel Distance*)	Information already available.	- identify POPs suspectible to LRT by air or water. - can be used to explain occurrence of POPs at sites that are far from sources.	- little benefit to interpreting trends.
LRT vs P*ov*	Information already available.	- an indication of a chemical's persistence in the environment. - results can be linked to trends analysis.	- generalized approach that is not applicable to individual data sets.
Back Trajectories	- via internet: resources are now available on-line, free of charge and provide graphical results the same day; - production of airshed maps is more labour	- can be applied to data sets. - a tool for investigating period to period differences in air flow for a given site.	- limited to air - no prescribed guidlelines for how this technique should be used so there is potential for mis-use. - the technique does

	intensive although macros are now available in the research community for easily producing these maps from back trajectory data.	- useful for explaining trend data and/or anomalous data. - useful for source-receptor investigations.	not consider real interactions/reactions that the chemical may experience during its flight. It describes the transport of an air mass. - not quantitative in terms of air concentrations for individual chemicals.
Transport Models	- expert support / access to meteorological data. - desktop PC	- chemical specific. wealth of information and inclusion of multiple fate processes for the chemical that will affect its LRT. - can be used to describe how a given emission or air concentrations will be distributed/transported.	- high resource requirement and need for input data (e.g. chemical properties, process information, source information, air concentrations). - high potential for results to be misinterpreted.

5.4.3 Climate Influences on LRT and POPs Trends

As a result of their regulation in recent years/decades many of the UNEP POPs now cycle in the environment and are distributed through various geochemical processes. This includes air and water transport, and exchange between the atmosphere and surface media where they are retained (e.g. soil, vegetation, snow/ice, sediment, water bodies). Consequently, these pathways also govern air concentrations in the atmosphere. (Macdonald et al., 2005)

Several investigations in recent years have demonstrated the linkage between inter-annual fluctuations in POPs concentrations (Ma et al., 2004a, b, 2006; Macdonald et al., 2005). Climate indices (e.g. El Nino-southern oscillation or the North Atlantic oscillation) which vary over time scales of years to decades have been shown to influence air flow and water circulation patterns globally. This will in turn affect LRT and source-receptor relationships for POPs. Air concentrations of POPs at background sites will vary accordingly. These indices are also strongly correlated to surface temperatures in water and soil. This influences the surface-air exchange of POPs and consequently air concentrations will also be affected.

An excellent example of the effect of this short term climate variability on POPs trends is discussed in Ch. 5.1 of this report. Concentrations of HCB, low molecular weight PCBs and DDT at the long-term arctic monitoring site at Zeppelin Mountain have been increasing substantially for the past few years following more than a decade of declining concentrations. This increasing trend has been attributed to recent warming that has resulted in longer periods of ice-free conditions, facilitating re-emission of HCB from surface compartments.

Climate change associated with longer term global warming will have similar effects on the LRT and cycling of POPs in the environment.

5.4.4 Summary

This overview illustrates that the levels of POPs in the environment are heavily influenced by the air transport patterns surrounding a sampling site. However the complex factors influencing LRT can only be understood using a range of techniques such as those described. If these are employed in future evaluations, it will provide insight to the data and allow the COP to make an informed evaluation of the effectiveness of the Stockholm Convention on POPs.

5.4.5 Conclusions and recommendations

The COP has not clarified its expectations with respect to the requirement in Article 16 of the Convention for information on the regional and global environmental transport of POPs. The present review has shown that the levels of POPs measured at an air sampling site cannot be understood without considering the key processes that have transported POPs to that site. Therefore it is recommended to the COP that an appropriate policy objective for future evaluations could be for "the presentation of information on regional and global environmental transport to enable the COP to understand the levels of POPs observed at the reported air sampling sites".

The present study has confirmed that the three methods to address this issue listed in the implementation plan and guidance document are complementary to each other. However the topic spans all regions. Therefore it is recommended that the COP consider ways to provide itself with a plan or process on how to develop a coordinated cross regional approach to meet the environmental transport objective. This could be done independently through the formation of a limited time expert task group or in conjunction with the coordination group.

Passive air samplers are a proven, cost-effective tool for enhancing spatial resolution and for reducing uncertainty in model simulations of regional and global transport of POPs.

Most of the POPs currently listed in Annex A, B and C of the Convention is predominantly transported in air. However the properties of several of the substances presently being examined by the POPs Review Committee indicate that water transport may also become a relevant concern for future effectiveness evaluations. It is recommended that the need to accommodate water soluble substances is borne in mind while developing plans to examine regional and global environmental transport.

The review concluded that the effects of climate change and climate variability on the transport and partitioning of POPs has the potential to significantly complicate the interpretation of measurements of POPs in environmental media for future evaluations. It is therefore recommended that the COP consider how to encourage studies on climate influences on levels of POPs in various environmental media. This may be undertaken in cooperation with existing monitoring programmes and in conjunction with the proposed expert work on regional and global transport.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Findings and conclusions

This section provides a brief synopsis of the major findings and conclusions for the WEOG region on POPs monitoring information for the first effectiveness evaluation.

6.1.1 Concerning ongoing programmes and activities

Information used to provide the basis of the review was taken entirely from existing international and national programmes and activities. No new monitoring activities were initiated. Survey responses obtained by the Secretariat in 2006 and 2007 were reviewed and candidate programmes selected through their demonstrated compliance with the criteria contained in the "Implementation Plan for the First Evaluation Reports" and in the "Guidance Document". It was concluded that the selected contributing programmes are maintaining necessary arrangements to ensure that their monitoring information can be compared with other results from the same programme both in the past and in the future for the purpose of determining temporal trends. The programmes and activities that contributed to the evaluation review for the core media are shown in the Tables 6.1a and 6.1b below.

Tables 6.1a and 6.1b Major ongoing programmes contributing information for the evaluation review.

6.1a Programmes contributing air monitoring information					
Monitoring programme	**Abbreviation**	**Region of interest**	**No. of POP monitoring sites**	**Monitoring period**	**Monitored compounds (Stockholm conv. POPs)**
Arctic monitoring and Assessment Programme	AMAP	Arctic	12 [a]	1992 - present	PCBs, HCB chlordanes, DDTs*; Station Nuuk (Greenland; operated by Denmark) has not reported PCBs and HCB but have included dieldrin and heptachlor epoxide; 8 NCP-related stations report additional compounds (see below).*
Northern Contaminants Program (Canada) (Part of AMAP)	NCP	Arctic	8 [a]	1992 - present	PCBs, DDTs, mirex, chlordanes, heptachlor, heptachlor epoxide, HCB, endrin, dieldrin
European Monitoring and Evaluation Programme	EMEP	Europe	7	1993 - present	PCBs, DDTs, chlordanes, HCB,
Global Atmospheric Passive Sampling network	GAPS	Global	24 (in WEOG region)	2004 - present	PCBs, chlordanes, DDTs, heptachlor, heptachlor epoxide,

					dieldrin
Integrated Atmospheric Deposition Network (USA)	IADN	Great lakes (USA)	5 (master stations)	1990 - present	PCBs, chlordanes, DDTs, heptachlor, heptachlor epoxide, aldrin, endrin, dieldrin.
Monitoring Network in the Alpine Region for Persistent and other Organic Pollutants	MONARPOP	European Alpine regions	40 (3 stations with active samplers and other with SPMD passive air samplers)	2005 - present	PCBs, DDTs, HCB heptachlor, dieldrin. aldrin, endrin, mirex, PCDD/Fs
U.S. EPA's National Dioxin Air Monitoring Network	NDAMN	USA	34	1998 - 2004	PCDD/Fs, co-planar PCBs
Xarxa de Vigilancia i Previsió de la Contaminació Atmosférica	XVPCA	Catalonia (Spain)	28	1994 - present	PCDD/Fs, co-planar PCBs (2003-present)
The UK Toxic Organic Micro Pollutants (TOMPs) programme	TOMPS	UK	6	1991 - 2006	PCDD/Fs, PCBs

6.1b Programmes contributing human media monitoring information

Programme	Media	Geographic coverage	Time period	POPs measured
AMAP	Human blood	Arctic region	1993 – present	DDT, PCB, toxaphene, mirex, chlordanes, dieldrin, heptachlor, HCB,
CDC/CCEHIP/ NCEH	Blood	United States	1999 - present	All 12 Stockholm Convention POPs
Uppsala	Human Milk	Sweden	1996 - present	DDT, PCB, PCDD/PCDF, HCB, chlordanes,
Stockholm	Human milk	Sweden	1970 - present	DDT, PCB, HCB, chlordanes
WHO	Human Milk	All UNEP regions	1988 - present	PCDD/PCDF, PCB
GES	Human blood and urine	Germany	1985- present	HCB, DDE, PCB
ESB	Human Blood	Germany	1984 - present	HCB, PCB 153
Australia "snap shot" surveys	Human blood and mother's milk	Australia	Not repetitive	PCDD/PCDF, PCB,
New Zealand "snap shot" surveys	Human mother's milk	New Zealand	Not repetitive	PCDD/PCDF, PCB, HCB, dieldrin, heptachlor epoxide, pp-DDT / pp-DDE

6.1.2 Concerning baseline concentrations and evidence of temporal trends

Interpretation of air information: Air concentrations of POPs across a given region demonstrate large variability, sometimes of the orders of magnitude. This is dependent on the nature of the site and its proximity/influence to/from various sources. Therefore, air data should be presented and interpreted on a site-specific basis and identified by the site name and type rather than by the country in which the site exists.

Air baselines and trends: For many of the organochlorine pesticides (OCPs) listed as POPs under the Convention, concentrations in air have decreased over the past 10-15 years and are now leveling off. In the absence of new current primary sources, air concentrations are largely governed by environmental cycling between soil, water and the atmosphere and are strongly dependent on climate change/variability (as noted below for HCB, PCBs and DDT). Some organochlorine pesticides (e.g., Heptachlor, Mirex, Endrin and Dieldrin) are present at such low concentrations that trends cannot be detected. Air concentrations of industrial chemicals (e.g. PCBs and PCDD/Fs) have also shown declining trends, and current air burdens are associated with both cycling of previously deposited chemical and continued emissions from point sources (e.g. electrical equipment and industrial activity). Levels and time series are summarized in Table 6.2 below.

Table 6.2 Summary of half-lives derived from air concentrations of POPs measured in the WEOG region

Compound	Reporting period	Programme/location	Mean Halflife (range) (y)
PCDD/Fs	1991-2006	TOMPS/ U.K. urban	6.3 (3.2-11.1)
		Great Lakes (Point Petre),	ΣPCDF: 4.3
	1996-2002	Canada	ΣPCDD: 9.1 [a]
PCBs	1991-2007	TOMPS/ U.K.	(1.5 – 20) [b]
	1990-2003	Great Lakes, Canada/U.S.	15.2 (7.1-26) [c]
	1998-2006	Zeppelin, Svalbard	5.4 [d]
	1995-2005	Storhofdi, Iceland	36 [d]
	1996-2005	Pallas, Finland	12.1 [e]
	1993-2001 [f]	Alert, Canada	6.47 [d]
HCB	1993-2006	Zeppelin, Svalbard	17.7
	1995-2005	Storhofdi, Iceland	6.19
	1993-2001 [f]	Alert, Canada	N. S.
	1990-2003	Great Lakes, Canada/U.S.	21.4 (12-32) [g]
Σchlordane	1993-2006	Zeppelin, Svalbard	15.9 [h]
	1995-2005	Storhofdi, Iceland	5.4 [i]
	1993-2001 [f]	Alert, Canada	5.77 [h]
	1990-2003	Great Lakes, Canada/U.S.	(6.1 – 16) [j]
ΣDDT	1994-2006	Zeppelin, Svalbard	7.15 [k]
	1995-2005	Storhofdi, Iceland	4.22 [k]
	1996-2005	Pallas, Finland	11.3 [l]
	1993-2001 [f]	Alert, Canada	14.1 [k]
	1990-2003	Great Lakes, Canada/U.S.	(5 – 19) [m]
Endrin	1990-2003	Great Lakes, Canada/U.S.	4.85 (4-5.7) [g]
Aldrin	1990-2003	Great Lakes, Canada/U.S.	5.7 (2.4-11) [g]

Dieldrin	1990-2003	Great Lakes, Canada/U.S.	(3.9 - 8.9) [n]

[a] Hung et al., 2003.
[b] Halflife derived using sum of TOMPs total PCBs.
[c] Halflife derived using sum of IADN suite PCBs.
[d] Halflife derived using sum of AMAP 10 PCBs.
[e] Halflife derived using sum of AMAP 7 PCBs.
[f] Laboratory change for samples taken at Alert in 2002 resulted in disruption in long-term trends. An extensive interlaboratory comparison study has been conducted between the two laboratories before and after the change. The long-term temporal trend will be maintained using the results of the interlaboratory comparison as more data are being collected under NCP.
[g] Halflife derived using gas phase concentrations only.
[h] Halflife derived using sum of t- and c-chlordane, t- and c-nonachlor.
[i] Halflife derived using sum of t-chlordane and c-nonachlor.
[j] Range estimated from halflives separately determined for gas and particle phases of t- and c-chlordane.
[k] Halflife derived using sum of 6 isomers.
[l] Halflife derived using sum of p,p'-DDT, p,p'-DDE and p,p'-DDD.
[m] Range estimated from halflives separately determined for gas and particle phases of individual DDT isomers.
[n] Range estimated from halflives separately determined for gas and particle phases of diedrin.

Human media baselines and trends: Some organchlorine pesticides (e.g. aldrin, endrin) are present in such low concentrations in human milk and blood from the general population that trends will most likely be not detected. It was concluded that for those substances where sufficient information is available to suggest trends, an ongoing decline is indicated over the last 10-15 year period. In these cases levels are now low in relation to exposure guidelines used by health agencies. Table 6.3 below provides examples of the levels and trends observed from the ongoing existing programmes.

Table 6.3 Summary of levels and trends in human milk and maternal blood

Substance	Mother's milk		Maternal blood	
	Levels (ng/g lipid)	Changes in levels observed	Levels (ng/l)	Changes in levels observed
Aldrin	<0.1 - 1	n.i.		n.i.
Chlordane	1. - 10	Decreasing	10-4000	n.i.
DDT	1.-150	decreasing	30-5000	decreasing
Dieldrin	1.-7	decreasing		n.i.
dioxins - furans	5.-10	decreasing		n.i.
Endrin	<0.5	n.i.		n.i.
heptachlor	0.5-5	decreasing		n.i.
hexachlorbenzene	2.-30	decreasing	50-1900	decreasing
Mirex	<0.5	n.i.	10.-70	n.i.
PCB	40-150	decreasing	<10-14500	decreasing
Toxaphene	1.-24	n.i.	30 - 1600	n.i.

n.i. = no information

There are exceptions to the trend towards low levels in some geographic areas such as with some Arctic indigenous peoples where present programmes have not (at the time of preparing the present review) reported decreasing trends and where for some POPs, levels remain a concern

relative to the exposure guidelines used by health agencies. Reasons for this situation include high dietary exposure and the chemical and physical properties of POPs at low temperatures.

6.1.3 Concerning regional and global environmental transport

Studies reviewed from existing programmes using all three of the approaches described in the implementation plan have demonstrated the regional and global environmental transport of POPs on sub-regional, regional, continental, and intercontinental scales and provide understanding to the data observed at air sampling sites. It was concluded that a comprehensive evaluation of the Convention would not be possible in the absence of information on long-range transport (LRT) of POPs. In addition, the review enabled the strengths of the three approaches to be examined. They are as follows

Determination of the characteristic travel distances (CTD): The CTD (expressed in units of km) reflects a chemical's ability to migrate away from its source. Larger values indicate greater LRT potential. With this information, it is possible to use a generic description of air and water currents to evaluate potential transport pathways on regional and global scales. The relative values of the CTD depend on the physical chemical properties of the compounds being evaluated and this information for the present 12 Stockholm POPs is readily available. It was concluded that this approach can be easily employed to assess the likeliness of a POP traveling by air or water from known source regions to a background air sampling site. Although this technique can provide a general sense of a chemicals spatial and temporal range it cannot be applied quantitatively to assess time trends.

Air parcel back trajectory analysis: This approach which provides information on the history of an air mass that has traveled to a location where it has been sampled also yields information on trends from one sample to the next and/or for comparisons over longer time scales. This is particularly useful for sampling sites that are potentially impacted by advection from regional sources of POPs. Air back trajectories are calculated based on wind fields that are usually taken from meteorological analyses provided by numerical weather prediction centers. It was concluded that the availability of on-line services for generating back trajectories free of charge, together with the comparative simplicity of the approach contributes to its attractiveness for investigating source-receptor relationships and for explaining episodic events in monitoring data in the context of effectiveness evaluation.

Transport Models: This modelling approach is chemical specific and is the most complex method (in terms of input data and resource requirements) considered in the implementation plan and guidance document. Air mass movements are based on real meteorology and chemicals are allowed to react and partition between media during their time spent in air. It was concluded that transport models are the most sophisticated and realistic method for investigating LRT for POPs and can quantitatively describe real long-range transport behavior. They therefore hold promise for future effectiveness evaluations. However, in many cases, the resolution of the required input data is not yet adequate and present model outputs should therefore be used conservatively, in a qualitative way. Due to the expertise and resource demands for this approach, it is still not widely available, although this situation is improving quickly.

6.1.4 Concerning climate change and climate variability

Some of the most important physical and chemical properties of POPs that determine how they move and are partitioned in the environment are temperature dependant. Therefore POPs levels observed at a sampling site can be influenced by climate change and variability. It was concluded that this phenomenon is already documented in data from one Arctic monitoring site where recent warming may be facilitating re-emission of HCB, and PCBs from surface environmental compartments. The potential significance of this observation is addressed in the recommendations for the future section. At this site the data also suggest increasing DDT levels that may be due to climate related re-emission or perhaps to the recent reintroduction of DDT use in some countries.

6.1.5 Concerning information on non-core media

A brief survey concluded that a number of existing monitoring programmes are producing information in a large variety of non-core media that could be of value for future effectiveness evaluations. All of the programmes discussed in the document maintain procedures to ensure intra-programme comparability of their data. The scope of non-core data available in the WEOG region is illustrated in Table 6.4.

Several existing monitoring programmes (e.g., AMAP, HELCOM, and OSPAR) in the WEOG region have measured in core and non-core media substances that are under consideration by the POPs Review Committee. Therefore if these substances are added to the Convention in the future, some time series may be readily available for further evaluations. Possible actions concerning non-core media are presented in the "recommendations for the future" section.

Table 6.4 Brief summary of available measurements of POPs in other media in selected long term international monitoring programmes examined by the WEOG ROG.

AMAP		Aldrin	Chlord.	DDT	Dield.	End.	Hepta.	HCB	Mirex	PCB	PCDD	PCDF	Toxaph.
Air	deposition	X	X	X	X	X	X	X	X	X	X	X	X
	snow&ice	X	X	X	X	X	X	X	X	X	X	X	X
Marine	water	X	X	X	X	X	X	X	X	X	X	X	X
	sediments	X	X	X	X	X	X	X	X	X	X	X	X
	plants	X	X	X	X	X	X	X	X	X	X	X	X
	invertebrates	X	X	X	X	X	X	X	X	X	X	X	X
	vertebrates	X	X	X	X	X	X	X	X	X	X	X	X
Terrestrial	plants	X	X	X	X	X	X	X	X	X	X	X	X
	vertebrates	X	X	X	X	X	X	X	X	X	X	X	X
Food		X	X	X	X	X	X	X	X	X	X	X	X
HELCOM													
Marine	water			X				X		X	X	X	
	sediments			X				X		X	X	X	
	invertebrates			X				X		X	X	X	
	vertebrates			X				X		X	X	X	
Terrestrial	vertebrates			X				X		X	X	X	
OSPAR													
Air	deposition			X	X			X		X			
Marine	sediments			X	X			X		X			
	invertebrates			X	X			X		X	X	X	
	vertebrates			X	X			X		X	X	X	
MAP-MEDPOL													
Marine	sediments			X				X		X			
	invertebrates			X				X		X			
	vertebrates			X				X		X	X	X	

6.1.6 Concerning the adequacy of monitoring arrangements, gaps in data coverage and possible steps to enhance the information available for future effectiveness evaluations

It was concluded that the information here reviewed on POPs in the core media of air, human milk and human blood provides an adequate data base in the WEOG region for the first effectiveness evaluation of the Convention. All of this information is derived from existing national and international programmes.

It was also concluded that the reported and evaluated information is adequate as a baseline for future evaluations. Suggestions on how the resolution of information may be improved are given in the "recommendations for the future" section.

Although the availability of information from existing programmes is not geographically homogeneous, much of the WEOG region is information rich. It was concluded that there are two broad instances which produce patchiness in the reported information. In some geographical areas of the region there is a general absence of continuing established environmental monitoring of POPs in the core media although in these cases there is usually a good understanding from past discrete surveys of what these levels are. Similarly in some areas there is a lack of

information on certain substances, (e.g., dioxins and furans). Possible strategies to address this situation are given in the "recommendations for the future" section.

6.2 Recommendations for the future

To complement the conclusions presented above, the following recommendations are offered to the COP to enhance future effectiveness evaluations.

Human media: The levels of pollutants observed in human matrices are mainly dependent on donor diet and age. Detailed statistical evaluations showed that the levels of POPs in human milk tend to increase with the age of the mother, and to decrease with the length of breast-feeding and the number of breast-fed children. The issue of age dependency in blood serum studies is well illustrated in the NHANES programme showing that for the TEQ, as for most of the UNEP POPs, (unless a single age class is sampled) one cannot give a "universal" geometric mean. This study also demonstrated the influence of ethnic patterns of dietary exposure. Exposure pathways are possible resulting from for example, diet choice, and food production and processing practices that could lead to high concentrations in population groups. Therefore sampling strategies for new activities that focus upon being able to examine data from the same age-group of people of the same sex and in the same area will offer the best prospects for being able to detect POPs changes in levels over time periods appropriate for effectiveness evaluation of the Convention.

Periodicity of effectiveness reviews: It is concluded that six years is an optimal time period for the repetitive review of environmental data in the context of effectiveness evaluation of the Convention. This conclusion and recommendation is made on the basis of the trends reported in the WEOG region by contributing programmes that have established long time series of information on POPs in a variety of environmental media (including the present core media of air and human milk / human blood). The identification of trends requires a series of data points. An interval of at least six years will enable a substantial body of information to accumulate from contributing programmes and will also enhance statistical interpretation. A lesser period would not be cost effective in terms of the effort involved. A longer period would leave the COP uninformed of important information on environmental levels. However, two points are stressed. Firstly, because the WEOG review is based upon information from many existing programmes, this recommendation is not founded on any statistical evaluation of the presently available collective information. Instead it matches the reporting frequencies of most of the contributing programmes with the anticipated frequency of meetings of the COP. Secondly, the recommendation does not refer to sampling frequency.

Comparability of data: Each of the existing programmes that contributed information for the WEOG review has their own procedures for maintaining intra-program comparability of information. However in general, different programmes do not use the same analytical laboratories. Although there are procedures to evaluate variance between laboratories (such as blind interlaboratory comparisons), the use of different analytical laboratories remains a potential major source of variance between programmes. Because of the large number of existing programmes used as information sources for the WEOG report, it was concluded that it would be unrealistic to expect comparability between programmes now and in the future. Therefore it is recommended that future efforts are focused to promote internal comparability within

programmes over time. While this conclusion generally means that there will be very limited direct comparability between regions, significant exceptions are evident, such as the WHO coordinated human milk programme which uses a single laboratory. The extensive use of such measures as utilization of common analytical laboratories and data centres has demonstrated the possibility of achieving adequate comparability between well established programmes in the WEOG region. An example is the collaborative practices of AMAP, EMEP, OSPAR, and HELCOM".

Enhancement of spatial and qualitative resolution: It is recommended that when little information is available in a sub-region because existing candidate activities are not part of an on-going monitoring programme, information can be reported from such activities providing they meet the other implementation plan criteria. An alternative and more informative strategy to improve the ability of the COP to observe changes in POPs levels over time in areas presently lacking established monitoring programmes would be the setting up of new monitoring arrangements. If such steps are taken, it is recommended that careful attention is paid to ensuring the best possible comparability of data within such programmes. Passive air samplers have been demonstrated in many areas to be an option for dealing with air data gaps. These devices have been used widely across the WEOG and other regions and have been shown to be cost-effective. They can also be used as a reconnaissance tool for site selection and/or for obtaining spatially resolved information on POPs.

Mediterranean rim: The review found a lower amount of information over many parts of the Mediterranean rim. It is therefore recommended that steps be explored for enhancing long term cooperation in POPs monitoring in the Mediterranean region to improve the information base for future effectiveness evaluations of the Convention.

Australia and New Zealand: Currently there are no systematic, repetitive, national-scale monitoring programmes in Australia and New Zealand for the measurement of POPs in the core media. However, levels of dioxins and furans, along with some of the other Convention POPs have been measured in the core media in Australia and New Zealand on a targeted basis. If repeated, such measurements could potentially contribute towards establishing a baseline for later trend analysis. Australia is currently exploring options in this regard, including the feasibility of a repetitive programme.

Longevity of monitoring arrangements: This review has relied on information provided by a relatively small number of existing national and international monitoring programmes. The ability to compare POPs levels over time within these programmes makes their long term viability of utmost importance for future trend analysis to evaluate the effectiveness of the Convention. It is also important that such programmes do not alter their procedures in ways that compromises the data comparability that is necessary for the examination of temporal trends. The existing programmes should be commended for their outstanding work.

The objective of regional and global environmental transport studies of POPs in effectiveness evaluation: The COP has not clarified its expectations with respect to the requirement in Article 16 of the Convention for information on the regional and global environmental transport of POPs. The present review has shown that the levels of POPs measured at an air sampling site

cannot be understood without considering the key processes that have transported POPs to that site. Therefore it is recommended to the COP that an appropriate objective for future evaluations could be for "the presentation of information on regional and global environmental transport to enable the COP to understand the levels of POPs observed at the reported air sampling sites".

Possible next steps for the evaluation of global environmental transport of POPs in future effectiveness evaluations: The present study has confirmed that the three methods to address this issue listed in the implementation plan and guidance document are complementary to each other. However the topic spans all regions. Therefore it is recommended that the COP consider ways to provide itself with a plan or process on how to develop a coordinated cross regional approach to meet the environmental transport objective. This could be done independently through the formation of a limited time expert task group or in conjunction with the coordination group.

Global and regional transport and possible outcomes from the POPs Review Committee process: Most of the POPs currently listed in Annex A, B and C of the Convention are predominantly transported in air. However the properties of several of the substances presently being examined by the POPs Review Committee indicate that water transport may also become a relevant concern for future effectiveness evaluations. It is recommended that the need to accommodate water soluble substances is borne in mind while developing plans to examine regional and global environmental transport.

Climate change and climate variability: The review concluded that the effects of climate change and climate variability on the transport and partitioning of POPs has the potential to significantly complicate the interpretation of measurements of POPs in environmental media for future evaluations. It is therefore recommended that the COP consider how to encourage studies on climate influences on levels of POPs in various environmental media. This may be undertaken in cooperation with existing monitoring programmes and in conjunction with the proposed expert work on regional and global transport.

Non-core media: A number of existing monitoring programmes in the WEOG region are producing information in a large variety of media that could be of value for future effectiveness evaluation. However, a species which is a very good environmental indicator of POPs levels (and with a rich existing body of monitoring information) in one region may be absent in another region. For future evaluations, it is recommended that the COP consider a two track media strategy. One track, termed "global core media" would be common to all regions and would comprise the present core media of air and human milk / blood. The other track would be termed "specific regional / sub-regional media" and would be specific to a region or sub-region. If such a strategy is adopted, all regions could be encouraged to report trends on POPs in the best available data sets that are available from existing programmes in their regions / sub-regions. This flexibility would recognize that regions are unique and that a medium that works well for one region might not be appropriate for other regions. Guidance would be necessary on types of other media suitable for temporal trends analysis.

Finally, the ROG wishes to re-emphasize that the information reviewed to provide a baseline and to inform the COP of current trends in the WEOG region is available from only a relatively small

number of existing national and international programs. The ability to compare POPs levels over time within these programs makes their long-term viability of utmost importance for future trends analysis to evaluate the effectiveness of the Convention.

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EMEP	http://www.emep.int/
FLEXTRA	http://www.nilu.no/trajectories/
FLEXPART	http://zardoz.nilu.no/~andreas/flextra+flexpart.html
GAPS	http://www.msc-smc.ec.gc.ca/gaps/
HTAP	http://www.htap.org/
INCATPA	http://www.msc-smc.ec.gc.ca/arqp/incatpa/incatp0_e.cfm
LRTAP	http://www.unece.org/env/lrtap/
MAP-MEDPOL	http://www.unepmap.org
MONARPOP	http://www.monarpop.at/
MSC-E	http://ww.msceast.org/
NHANES	http://www.cdc.gov/nchs/nhanes.ht ml
NOAA (Hysplit Model)	http://www.arl.noaa.gov/ready/hysplit4.html
OECD (Tool software)	http://tinyurl.com/66q47j
WACAP	http://www.nature.nps.gov/air/studies/air_toxics/wacap.cfm
WHO	http://www.who.int/foodsafety/chem/pops/en/index.html