A Compilation and Classification of Unpublished Scientific Information on Persistent, Bioaccumulative Toxic Substances in Mexico (Gray Literature Report)

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Purpose

This documentary survey, which follows-up on previous "gray literature" studies,[1,2] has as its primary purpose the accession, collection, and assessment of potentially valuable information on persistent, bioaccumulative, toxic substances (PBTS) from academic institutions throughout Mexico. This is information that may have been archived or is not otherwise readily available either in recognized scientific journals or on the World Wide Web but that could be considered as a valuable resource for scientific, academic and administrative experts.

This project was undertaken in order to help contribute to the *Programa Nacional de Monitoreo y Evaluación de México* (Proname) and to Mexico's development of its National Implementation Plan under the Stockholm Convention on Persistent Organic Pollutants. The exercise included identifying particular geographic areas as well as academic institutions involved in assessing contaminants of concern and their analysis of PBTS measurements in biota.

The information for this project was gathered from the states of Yucatán, Quintana Roo, Campeche, Chiapas, Aguascalientes, Querétaro, San Luis Potosí, Guanajuato, Sinaloa, Nayarit, Jalisco, Colima, Baja Norte, Sonora and Baja California Sur by graduate students being supervised by academic experts from universities in the states or regions of interest and individually contracted by the Commission for Environmental Cooperation of North America through its Sound Management of Chemicals (SMOC) initiative.

For the purposes of this report, "gray literature" was defined as scientifically derived information on PBTS in Mexico, found in academic theses, dissertations and reports[3] not otherwise published in the scientific literature and not readily accessible on web sites or by other common searching methods.

Background

Mexico has expressed significant interest in improving its environmental monitoring and assessment capacity. One of the ways of initiating this is through the auspices of the CEC's Sound Management of Chemicals Monitoring and Assessment project. For Mexico, a sustainable program providing comprehensive, long-term environmental monitoring and assessment data would enable decision makers to:

- understand whether and how contaminants may be affecting the environment and health of Mexicans and to develop appropriate risk reduction policy initiatives;
- determine long-term trends from human and environmental exposure to contaminants and to understand the effectiveness of implemented policies;
- determine the degree to which the country is meeting its obligations under the international conventions it has ratified, such as those of Stockholm, Basel, Rotterdam, and the WSSD Earth Summit in Johannesburg; and
- assess the potential trade and economic implications of PBTS reduction strategies.

[1]Hansen, A.M., van Afferden, M., Villada Canela, M., Sánchez Castañeda, L.F. 2006. Scoping Study for the Evaluation of the National Program of Monitoring and Environmental Assessment in Mexico.
[2] González Farias, F.A., Castro Díaz, J. 2007. Recopilación de Información sobre Sustancias Toxicas Prioritarias en México.
[3] Throughout this report the term "documentation" will be used to refer to academic theses, dissertations and reports as described in the definition of "gray literature," above.

Successful adoption of a sustainable environmental monitoring and assessment infrastructure would provide valuable information to make sound environmental decisions, thereby helping Mexico to meet its domestic, regional and international obligations. The development of such a long-term sustainable monitoring and assessment initiative (Proname) is being led by Mexico with the assistance of the Sound Management of Chemicals Working Group of experts from the three North American Free Trade Agreement (NAFTA) countries and is supported by the CEC Secretariat.

Currently, Mexico has capacity to monitor a limited number of toxics in a number of media. Routine, sustained monitoring programs of PBTS are not apparent, or are only sporadic and chemical specific at best. Consequently there are neither formal inventories nor in-depth assessments about levels and risks of exposure to these toxicants.

There exists, in some of Mexico's major urban areas, automated networks for atmospheric monitoring that provide information on various atmospheric pollutants (CO, SO_2, NO_X, O_3 and PM_{10}). These data are collected by the *Instituto Nacional de Ecología* (National Institute of Ecology—INE) and made available in biannual publications. Currently, INE, with its National Air Quality Information System, allows the public to access air quality raw data for 22 localities with air quality monitoring systems, in real time and data of two particulate matter networks, located in Torreon and in the Tula-Tepeji region. However, none of these monitoring programs incorporates routine measurements of PBTS and thus were not included in this report.

There have been some ongoing non-PBTS programs, such as the monitoring carried out by the Mexican National Water Commission (Conagua) since the 1970s, where surface and groundwater quality is being routinely monitored in Mexican hydrological basins. Conagua has implemented a nationwide surveillance/monitoring program, the *Red Nacional de Monitoreo* (RNM). The main objective of this program is to measure physical, chemical and bacteriological parameters, to define regulations and help develop treatment systems for wastewater discharges and sources for water supply.

As a partner in NAFTA and the North American Agreement on Environmental Cooperation (NAAEC), and also as part of its international commitments, it is important for Mexico to be able to answer the following questions:

- What are the concentrations of PBTS in different matrices (fresh water and marine ecosystems, sediments and soil and, air, biota, human tissue, etc.)?
- What is their geographical distribution?
- Where and how do they accumulate?
- What is their persistence in different matrices?
- Are these matrices unique to Mexico or common to the North American region?
- Are there acute and/or chronic effects seen in biota and humans?
- What are the risks of exposure to the environment and/or human health?
- Are there seriously impacted sub-populations of Mexicans?
- Is there a potential for PBTS from within Mexico to adversely affect its neighbors?
- Is there evidence that PBTS from neighboring countries are adversely impacting Mexican interests?
- Are there potential remediation options that can be presented to the government?

Through investigations financed by different institutions[4] of the Mexican government, universities and centers for research and technological development, it was concluded that activities to measure and assess some limited PBTS in environmental matrices had been carried out. On closer examination, this information was not to be systematized and was deemed not to be amenable for use in an integrated format. The quality of the information from the perspective of sound scientific investigation and reporting of results was also an important consideration.

This project thus considered systematizing existing, but not readily accessible data from the "gray literature" in order to provide an important preliminary information source for Mexico. This could help Mexico's environmental monitoring and assessment capacities and supplement the data required for compliance with its National Implementation Plan (NIP) under the Stockholm Convention on Persistent Organic Pollutants (POPs).

Previous "Gray Literature" Studies

Previous gray literature studies aimed at providing information for the preparation of national monitoring and assessment programs for PBTS [persistent, bioaccumulative, toxic substance(s)] in Mexico and at obtaining more specific information on environmental monitoring related to PBTS in Mexico; these studies were utilized as a basis for this documentary survey. In these previous studies, specific objectives were to:

- develop a list of PBTS of priority concern to Mexico, including the Stockholm POPs;
- summarize available information on PBTS studies and monitoring in Mexico;
- elaborate of an inventory of existing research on PBTS;
- determine PBTS monitoring and assessment needs and activities and establish priorities[5]; and
- assess and summarize in a detailed manner, the information on the nature of the monitoring and the results in the studies referenced in the gray literature study including[6]:
  - location of monitoring exercises;
  - chemical(s) monitored;
  - results: mean, min, max, median, range, spatial and/or temporal trends;
  - time period of monitoring; and
  - an assessment of the validity of the study and its findings.

Farias and Díaz provided an overview of the publications, from both the scientific and gray literature, prepared by Mexican institutions located in Mexico City (i.e., universities, research laboratories, government institutes, etc.), and summarized the information in tables, indicating the levels detected for each selected toxic pollutant.

[4] Mexico's National Oil Company (PEMEX), *Comisión Nacional del Agua* (Conagua), state governments, the *Consejo Nacional de Ciencia y Tecnología* (National Council of Science and Technology—Conacyt), private companies and some international agencies, including the Commission for Environmental Cooperation (CEC), World Bank (WB), among others.
[5] Hansen, A.M, van Afferden, M., Villada Canela, M., Sánchez Castañeda, L.F. 2006. Scoping Study for the Evaluation of the National Program of Monitoring and Environmental Assessment in Mexico.
[6] González Farias, F.A., Castro Díaz, J. 2007. Recopilación de Información sobre Sustancias Toxicas Prioritarias en México.

The selected toxic persistent pollutants were DDT, chlordane, lindane, hexachlorobenzene (HCB), PCBs, furans, dioxins, lead, and mercury. The key words used for the bibliographic review, both in English and Spanish, were: DDT, dichlorodiphenyltrichloroethane, diclorodifeniltricloroetano, chlordane, clordano, lindane, lindano, hexachlorobenzene, hexaclorobenceno, HCB, polychlorinated biphenyls, bifenilos policlorinados, PCBs, furans, furanos, dioxins, dioxinas, lead, plomo, Pb, mercury, mercurio, Hg, pollution, contaminación, Mexico, Mexico City, Ciudad de México and Zona Metropolitana.

The libraries and data banks consulted by Farias and Díaz were:

- SCIRUS (http://www.scirus.com) – more than 200 million web sites containing scientific data.
- CSA (http://http://www.csa.com) – access to more than 100 databases edited by Cambridge Scientific Abstracts.
- DIRECCION GENERAL DE BIBLIOTECAS, U.N.A.M. (http://www.dgbiblio.unam.mx/bases.html) – access to more than 150 databases, with more than 50 million references.
- TESIUNAM (http://www.dgbiblio.unam.mx/tesiunam.html) – this is a specific databank on theses from the National Autonomous University of Mexico and incorporated Mexican universities. This databank has more than 320,000 references to bachelors, masters and doctoral theses.
- TESI@UNAM (http://www.dgbiblio.unam.mx/tesiunam.html) – this is a specific databank on theses from the National Autonomous University of Mexico and incorporated Mexican universities for the period 1998–2001. This databank has more than 40,000 references of bachelors, masters and doctoral theses.
- BIBLIOTECA CICESE (http://biblioteca.cicese.mx) – the references are mainly focused on oceanic and coastal research.
- BIBLIOTECA CIBNOR S.C. (http://www.cibnor.mx/servicios/biblioteca/ebiblio.php) – references mainly of oceanic and coastal research.
- BIBLIOTECA CICIMAR (www.cicimar.ipn.mx) – the references are mainly on oceanic and coastal research.
- INSTITUTO NACIONAL DE ECOLOGIA (http://www.ine.gob.mx) – references mainly on biodiversity and ecosystems management.
- SCHOLAR GOOGLE (http://scholar.google.com) – references mainly on general environmental issues.
- GOBIERNO DEL DISTRITO FEDERAL, SECRETARÍA DE MEDIO AMBIENTE (http://www.sma.df.gob.mx) – the references are mainly on soil, water and atmospheric pollution of Mexico City and surroundings.
- CENTRO NACIONAL DE INVESTIGACIÓN Y CAPACITACIÓN AMBIENTAL (http://www.ine.gob.mx/cenica/) – the references are mainly on soil, water and atmospheric pollution in Mexico.
- BIBLIOTECA INSTITUTO MEXICANO DE TECNOLOGÍA DEL AGUA (http://www.imta.mx/) – the references are mainly on water management, agriculture, water pollution and modeling.
- BIBLIOTECA UNIVERSIDAD AUTÓNOMA METROPOLITANA – Xochimilco (http://biblioteca.xoc.uam.mx/) – the references are in ecology, toxicology and pollution in all the country.

- BIBLIOTECA UNIVERSIDAD AUTÓNOMA DE MORELOS (http://antar.biblioteca.uaem.mx:8080/) – references in ecology, toxicology and pollution in Morelos state.

The first piece of work provided by Hansen and collaborators led to a recompilation of a number of case studies in Mexico. Hansen et al. identified information related to the type of PBTS and media sampled through searches on the World Wide Web from universities, research institutes and academic associations that carry out case studies on PBTS. Information on levels of contaminants was not provided in this first report.

Table 1: Available information on PBTS studies and monitoring in Mexico in 2006

Media	Number of case studies	Main PBTS	Main institutions
Air	81	Metals, PAH	*Universidad Nacional Autónoma de México* *Instituto Nacional de Salud Pública* *Centro de Investigación y de Estudios Avanzados* *Instituto Mexicano de Tecnología del Agua* *Universidad Autonoma Metropolitana*
Surface freshwater	141	Metals, pesticides	*Instituto Mexicano de Tecnología del Agua* *Universidad Nacional Autónoma de México* *Universidad Autónoma de Sinaloa* *Centro de Investigación en Alimentación y Desarrollo A.C.* *Universidad Autónoma de Baja California*
Drinking water / groundwater	33	Pesticides, metals	*Instituto Mexicano de Tecnología del Agua* *Universidad Nacional Autónoma de México* *Universidad Autónoma de Nuevo León* *Instituto Politécnico Nacional* *Universidad Autónoma de Aguascalientes*
Sediment	93	Metals, pesticides	*Instituto Mexicano de Tecnología del Agua* *Universidad Nacional Autónoma de México*

			Universidad Autónoma Metropolitana *Instituto Politécnico Nacional* *Universidad Autónoma de Baja California*
Waste and soil	138	Metals, pesticides, PAHs, dioxins and furans	*Universidad Nacional Autónoma de México* *Instituto Mexicano de Tecnología del Agua* *Colegio de Postgraduados* *Universidad Autónoma de Nuevo León* *Universidad Autónoma de Zacatecas*
Biota, fish and other wildlife	257	Metals, pesticides, PAHs, PCBs	*Universidad Nacional Autónoma de México* *Centro de Investigación y de Estudios Avanzados* *Instituto Politécnico Nacional* *Centro de Investigación en Alimentación y Desarrollo A.C.* *Universidad Autónoma de Sinaloa*
Food	58	Metals, pesticides, PCBs, dioxins and furans	*Universidad Nacional Autónoma de México*
Human health	255	Metals, pesticides	*Universidad Nacional Autónoma de México* *Instituto Nacional de Salud Pública* *Centro de Investigación y de Estudios Avanzados* *Universidad Autónoma de Yucatán* *Universidad Autónoma de San Luis Potosí*
Media not specified	43		
Total	**1099**		

Detailed tables providing information on number of case studies for each medium are found in **Annex 1**.

In their work focusing on Mexico City, Farias and Díaz provided more information on the levels of exposure; minimum and maximum values for each chemical reported. They reported that most of the research conducted in Mexico was related to metals (Pb and Hg) and pesticides (organochlorines, mainly DDT).

Lead is a public health issue, mainly due to the past use of leaded gasoline and its use in glazes on pottery intended for food contact. Mercury, given the historical and continuing mine tailings recovery activities in Zacatecas, was actively studied. Several studies on the presence of these metals in agricultural soil, well water, wastewater and crops from the Mezquital Valley, Hidalgo, where huge quantities of raw wastewater from Mexico City have been used for more than 100 years for crop irrigation, were undertaken.

Pesticides were studied both from a public health and environment perspective. Breast milk and adipose tissue were monitored for organochlorine pesticides (mainly DDT). DDT was also measured in water, soils, sediments and organisms from diverse ecosystems.

PCBs were not as extensively studied: only a few studies mainly focusing on human blood, atmosphere, water and marine organisms were found.

Only a few references were found for dioxins and furans, the focus of which was, for dioxins, on estimated emissions from the different possible sources and, for furans, on cytotoxicity.

The two sources from Hansen et al. and Farias and Díaz, referenced above, allowed further development of the actual documentary survey that assessed and categorized unpublished scientific information from atypical sources in particular regions of Mexico.

Current "Gray Literature" Survey

The work consisted of:

- Compilation of available information from PBTS studies and monitoring outside Mexico City found in the "gray literature." Information was sought through a library search of universities and institutes in the various Mexican states, as mentioned above.
- Compilation of an inventory of existing reports and summaries of data and identification of PBTS.
- Systematization of the information on PBTS.

Specific contractor requirements were to extract detailed information about selected monitoring data available in the "gray literature" and information not otherwise available through such standard literature as peer-reviewed professional journals.

Specific objectives

In a concise manner and using the standard matrix described in **Annex 2**, the contractors were to summarize information on the nature and results of the monitoring studies referenced in the "gray literature" search, including, whenever possible:

- location and geographical extent of described monitoring programs;
- chemical(s) monitored (with a focus on the 12 POPs of the Stockholm Convention[7];
- toxic metals[8];

[7] Aldrin, chlordane, DDT, dieldrin, dioxins, endrin, furans, heptachlor, hexachlorobenzene (HCB), mirex, polychlorinated biphenyls (PCBs), toxaphene, as well as lindane.

- media/matrices sampled;
- results and where given; mean, minimum, maximum, median, range, mean of detected samples, spatial and/or temporal trends;
- number of samples taken;
- number of samples over detection limits;
- time period of monitoring;
- a QA/QC assessment[9] of the validity of the study and its findings, determined by quantification of replicate analyses, blind sample validations, and similarly accepted laboratory and analytical data protocols which ensure quality and validity of information; and
- references.

Approach

Knowledgeable academics were selected to conduct the study who were likely to have a close professional and geographical relationship to the sampling and data anticipated for each specific region. The familiarity of the graduate students and their supervisors with the region and with the facilities where the information was held proved to be extremely effective and beneficial. The economic benefit to the students and significant financial savings to the CEC were also valuable considerations for using a diversely located and talented group of enthusiastic, emerging professionals.

Several conference calls were organized to optimize the scope of the work and to receive input for the development of the matrix. The states of Yucatán, Quintana Roo, Campeche and Chiapas were covered by Virginia Yolanda Garcia Ríos, supervised by Gerardo Gold-Bouchot (professor, Cinvestav, Unidad Mérida). The states of Aguascalientes, Querétaro, San Luis Potosí and Guanajuato were covered by Gabriela Domínguez Cortinas, supervised by Fernando Díaz Barriga Martínez (head, *Departamento de Toxicología Ambiental, Universidad Autónoma de San Luis Potosí*). Information for Sinaloa, Nayarit, Jalisco and Colima was provided by Ricardo Meraz Sánchez, supervised by Miguel Betancourt Lozano (researcher, *Laboratorio de Ecotoxicología*, *Centro de Investigación en Alimentación y Desarrollo* – Unidad Mazatlán). Information for Baja Norte was collected by Maricarmen Yolanda Necoechea Zamora and by José Luis Sánchez Osorio for Baja Sur, under the supervision of José Vinicio Macias Zanora (researcher, *Instituto de Investigaciones Ocean, Universidad Autónoma de Baja California*).

Limitations of the Report

This report does not pretend to have thoroughly assessed all available information on PBTS included in this documentary survey. Difficulties in accessing information were encountered,

[8] Cadmium, lead, mercury.

[9] Quality Assurance – a set of coordinated actions, such as plans, specifications, and policies, used to assure that a measurement program can be quantifiable and produce data of known quality.
Quality control – the routine use of procedures designed to achieve and maintain a specified level of quality for a measurement system.

both in university libraries and in governmental institutions that were visited. University libraries do not necessarily have computerized search engines and some governmental institutions were reluctant to provide information without prior clearance from their senior management or headquarters' offices. For this reason, one of the significant limitations of this report is that data collection may not represent the total available information.

Studies were included in the matrix primarily on a chemicals basis. As long as a study had monitored aldrin, chlordane, DDT, dieldrin, dioxins, endrin, furans, heptachlor, hexachlorobenzene (HCB), mirex, polychlorinated biphenyls (PCBs), toxaphene, lindane (HCH), cadmium, lead or mercury, it was included in the regional matrix. As a result, some studies, although included in the matrix, could not provide data on each and every listed criterion described under "Specific Objectives," above. The standard matrix was adapted to represent the regional information availability and five regional matrices were therefore developed.

Results

Several institutions were visited and library searches were undertaken in each of these. Study reports, to be included in the standard matrix, were found in a majority of the institutional libraries visited. In total, 146 documents were used to compile the five regional matrices; of these, 107 (73 percent) included data on metals and 39 (27 percent) on POPs. The following lists provide, for each sampling district (which might encompass several states) the institutions that were visited. The summary tables provide the number of documents, by region and institutions, from which data on POPs or metals were found and extracted. An inventory of existing reports and summary results on qualification and quantification of PBTS was compiled. Detailed data, including identification of chemical(s), media sampled, location, year of sample collection, number of samples and mean (or median) level of chemical, were tabulated in the regional matrix and also presented for each sampling district.

Yucatán, Quintana Roo, Campeche and Chiapas

Institutions Visited

In these states, the following institutions were visited:

- *Universidad Autónoma de Campeche. Facultad de Ciencias Químico-Biológicas.*
- *Instituto Tecnológico de Campeche*
- *Consejo Quintanarroense de Ciencia y Tecnología*
- Ecosur (*El Colegio de la Frontera Sur), Campeche*
- *Centro Epomex*
- *Universidad Autónoma del Carmen.*
- PEMEX
- *Ecosur, Unidad Chetumal*
- *Universidad Autónoma de Quintana Roo*
- *Consejo Nacional del Agua, Chetumal*
- *Instituto Tecnológico de Chetumal*

- Cinvestav *(Centro de Investigación y de Estudios Avanzados del I.P.N.*—Center for Research and Advanced Studies)*, Unidad Mérida*
- *Instituto Tecnológico de Mérida*
- *Universidad Autónoma de Yucatán, Facultad de Química*
- *Universidad Autónoma de Yucatán, Facultad de Ingeniería Química*
- *Facultad de Medicina Veterinaria y Zootecnia de la Universidad Autónoma de Yucatán*
- *Ecosur, Unidad Tapachul*
- *Universidad Autónoma de Chiapas, Escuela de Ciencias Químicas*

Available information

Documentation, including results on POPs or metals, was found in 10 of the 18 institutions visited. The following table presents the number of documents found in each institution.

Table 2: Available information on PBTS in Yucatán, Quintana Roo, Campeche and Chiapas

Institution	**Number of documents**	
	POPs	**Metals**
Cinvestav*, Unidad Mérida*	4	4
Instituto Tecnológico de Mérida		4
Facultad de Ingeniería Química de la Universidad Autónomas de Yucatán	1	
Facultad de Química de la Universidad Autónomas de Yucatán	2	6
Universidad de Quintana Roo		3
Instituto Tecnológico de Chetumal	1	
Consejo Quintanarroense de Ciencia y Tecnología	1	1
Universidad Autonomía de Campeche	2	1
Universidad Autonomía del Carmen		2
El Colegio de la Frontera Sur	2	1
Total	13	22

Thirty-five documents, from which data were extracted, were included in the regional matrix for Yucatán, Quintana Roo, Campeche and Chiapas. Reports found in Yucatán accounted for more than 50 percent of the overall information (21 of 35). A majority of these 35 reports (23 out of 35) were produced in the 2000–2007 time period. Metals data were more frequently reported than POPs data.

Substances that were monitored included [the reader will note that the following listings preserve the Spanish chemical names found on the reports; it is felt that these are not so different from the English names that comprehension will be impaired]:

Yucatán

POPs: HCHs (α-HCH, β-HCH, γ-HCH, δ-HCH), drines[10] (aldrín, dieldrín and endrín), DDTs (o´p´-DDT, p´p´-DDT, o´p´-DDE, p´p´-DDE, o´p´-DDD, p´p´-DDD), clordanos [chlordane] (α-clordano, β-clordano, heptacloro, heptacloro epoxido [heptachlorepoxide], *cis*-nonaclor, *trans*-nonaclor), plaguicidas totales [total pesticides] (HCHs, drines, DDTs, clordanos, TCBs, pentaclorobenceno, HCB, endosulfan II and mirex), PCBs (PCB 8, PCB 18, PCB 28, PCB 29, PCB 44, PCB 52, PCB 66, PCB 87, PCB 101, PCB 105, PCB 110, PCB 118, PCB 128, PCB 138, PCB 153, PCB 170, PCB 180, PCB 187, PCB 195, PCB 201, PCB 206, PCB 209), lindano, ∑heptacloro (heptacloro, heptacloro E),[11] endosulfán S, ∑PCB (Ar. 1254, Ar. 1260), ∑HCB (HCB, α-HCB, β-HCB, δ-HCB)[12]
Metals: cadmio [cadmium], plomo [lead], mercurio [mercury]

Campeche

POPs: α-HCB, β-HCB, δ-HCB, heptacloro, aldrín, heptaclor epóxido, o´p´-DDE, p´p´-DDE, dieldrín, o´p´-DDT, p´p´-DDT, endrín, heptaclor epóxido, mirex, ∑DDT (4,4-DDD, 4,4-DDE and 4,4-DDT)
Metals: cadmio, plomo, mercurio

Chiapas

POPs: α-HCB, β-HCB, δ-HCB, heptacloro, aldrín, heptacloro epóxido, endosulfán I and II, 4,4'-DDE, dieldrín, endrín, 4,4'-DDD, 4,4'-DDT, endrín aldehído [endrin aldehyde], sulfato de endosulfán,
Metals: cadmio, plomo

Quintana Roo

POPs: drines (∑aldrín, dieldrín, endrín and endrín aldehído), HCHs (∑α-HCB, β-HCB, γ-HCH, δ-HCB), heptacloro (∑heptacloro and heptacloro epóxido), DDTs (∑p,p'-DDD, p, p'-DDE and p,p'-DDT), endosulfanes (∑endosulfán I, II and endosulfán sulfato), plaguicidas totales (∑drines, HCHs, heptacloro, DDT and endosulfanes),
Metals: cadmio, plomo, mercurio

Environmental monitoring dominated in these studies, with water, sediments, several algae, fish, oysters and mussel species as the most frequently reported sampled media.

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[10] "Drines" is used here as a collective term encompassing aldrin, dieldrin and endrin.
[11] "∑" indicates summary reporting for the chemical family specified.
[12] There is sometimes confusion in the nomenclature for hexachlorobenzene (C_6Cl_6). The abbreviation "HCB" may sometimes be mistakenly used to refer to hexachlorocyclohexane ($C_6H_6Cl_6$) and its isomers (HCHs: α-HCH, β-HCH, γ-HCH, δ-HCH), of which the pesticide lindane is the gamma isomer, γ-HCH. This confusion arose because HCH was thought in the analytical methodology to be HCB. Subsequently, the nomenclature was not corrected until long after HCH was identified as a pesticide.

Medians or means of chemicals measured in the different media of the thirty-five documents included in the regional matrix were summarized to allow a rough assessment of the range of mean exposures measured in Yucatán, Campeche, Chiapas and Quintano Roo. The following tables present this information.

Summary tables of ranges of exposure in several media in Yucatán

Table 3: Median/Mean or mean ranges of contaminants in sediments and water in Yucatán

Contaminants	**Sediments ng/g (means/mean ranges)**	**Water µg/L (means/mean ranges)**
HCHs (α-HCH, β-HCH, γ-HCH, δ-HCH)	0.09-1.46	
Drines (aldrín, dieldrín and endrín)	0-0.16	
DDT (o´p´-DDT, p´p´-DDT, o´p´-DDE, p´p´-DDE, o´p´-DDD, p´p´-DDD)	0.15-1.49	
Chlordanes (α-chlordane, β-chlordane, heptachlor, heptachlorepoxide, *cis*-nonachlor, *trans*-nonachlor)	0.11-0.87	
Total pesticides (HCHs, drines, DDTs, chlordanos, TCBs, pentachlorobenceno, HCB, endosulfan II and mirex)	2.47-8.24	
PCBs	0.97-3.38	
∑HCB (HCB, α-HCB, β-HCB, δ-HCB)	0.08-0.39	
lindane	0.44-3.81	
∑Heptachlor (heptachlor, heptachlor E)	0.04-270.93	
Aldrin	0.25-1.23	
Endrin	0.34-75.33	
Dieldrin	0.33	
Endosulfan S	0.43	
Cadmium	ND-1.57 (ppm) 0.3-0.45 (µg/g)	0.09-1.97
Lead	ND-3 (ppm) 1.02-23.92 (µg/g)	0.15-50.5
Mercury	444.46	1.28

PCBs = (PCB 8, PCB 18, PCB 28, PCB 29, PCB 44, PCB 52, PCB 66, PCB 87, PCB 101, PCB 105, PCB 110, PCB 118, PCB 128, PCB 138, PCB 153, PCB 170, PCB 180, PCB 187, PCB 195, PCB 201, PCB 206, PCB 209)

Table 4: Median/Mean or mean ranges of contaminants in bivalves, shrimp and crab and in Yucatán

Contaminants	Bivalves ng/g (unless otherwise stated) (means/mean ranges)	Shrimp spp. ng/g (means/mean ranges)	Crab µg/g (means/mean ranges)
∑HCB (HCB, α-HCB, β-HCB, δ-HCB)	31.4	0.5-1-1.18	
Lindane	21.97	0.8-11.98	
∑Heptachlor	3.59		
Endrin	15.47	ND-0.44	
Dielrin		ND-0.28	
Endosulfan S		ND-0.94	
Total DDTs	0-61.21	0.25-4.5	
PCBs (Ar1254, 1260)	29.09	0.74-18.54	
Cadmium	1-10.2 (ppm) 0.69-0.853		
Lead	0.46-1.2 (ppm) 0.108-0.392		2.23-2.27
Mercury	0.59-88 (µg/g)		
HCHs	0.02-45.81		
Chlordanes	0-15.59		
Drines	0-6.07		
Mirex	ND-6.67		
Total pesticides	5.72-66.57		
PCBs	3.44-46.51		

ND = Not Detected

Table 5: Median / Mean or mean ranges of contaminants for fish, turtle yolk and snails in Yucatán

Contaminants	Various fish species ng/g (means/mean ranges)	Turtle yolk ng/g (means/mean ranges)	Snails sp µg/g (means/mean ranges)
∑HCB (HCB, α-HCB, β-HCB, δ-HCB)	5.985-6.65		
Total DDTs	28.685-69.9		
PCBs (Ar1254, 1260)			
Cadmium			
Lead	0.69-0.9 (µg/g)		14.9-114 (dw) 3.63-24.6 (ww)
Mercury	3.96 (µg/g)		
HCHs	9.885-95.28		
Chlordanes	26.23-47.27		
Drines	0.45-16.159		
Mirex	0-1.96		
Total pesticides	143.645-462.29		
PCBs	56.67-107.42	1.43-8.46	

dw = dry weight

ww = wet weight

Table 6: Median / Mean or mean ranges of contaminants in brachydonts (mice and rats) in Yucatán

Contaminants	**Brachydonts (ng/g) (means/mean ranges)**
∑HCB (HCB, α-HCB, β-HCB, δ-HCB)	ND-1.68
lindane	ND-8.44
∑Heptachlor	ND-3.05
Aldrin	0.98-3.48
Endrin	5.32-299.88
Dieldrin	ND-0.29
Endosulfan S	ND-8.23
Total DDTs	1.44-22.34
PCBs (Ar1254, 1260)	7.56-192.97

Summary tables of ranges of exposure in several media in Campeche

Table 7: Range of values of contaminants for water and sediments in Campeche

Contaminants	**Water ppb (ranges)**	**Sediments ppb (ranges)**
α-HCB	ND-0.071	ND-43.299
β-HCB	ND-0.183	ND-34.322
δ-HCB	ND-0.014	ND-3.864
Heptachlor	ND-0.088	ND-51.066
Aldrin	ND-0.121	ND-11.384
Heptachlorepoxide	ND-0.155	ND-5.919
o´p´-DDE	ND-0.263	ND
p´p´-DDE	ND-0.585	ND-30.144
Dieldrin	ND	ND-12.787
o´p´-DDD	ND-0.142	ND-2.8
Endrin	ND-0.006	ND-8.379
p´p´-DDD	ND-0.126	ND-25.892
o´p´-DDT	ND-0.191	ND-3.2
p´p´-DDT	ND-0.408	ND-57.14
α-HCH		ND-3
β-HCH		ND-1.1
δ-HCH		ND-1.6
Mirex		ND-12.6
∑Chlordanes		1.736-1.974

∑Drines		1.456-1.581
∑DDTs		3.46-3.77
∑Endosulfans		1.779-1.956
Lead (total)	4.8-10.18 (µg/L)	
Lead (dissolved)	4.4387-9.87 (µg/L)	
Metal contaminants		**(µg/g)**
Cadmium		83.4-98.9
Lead		185-307
Mercury		0.07-0.13

ND = not detected

Table 8: Range of values of contaminants for fish and shrimp in Campeche

Contaminants	**Fish spp. ppb (ranges)**	**Shrimp ppb (ranges)**
α-HCB	ND-112.976	
β-HCB	ND-703.674	
δ-HCB	ND-22474	
Heptachlor	ND-213.516	ND-0.0027
Aldrin	ND	ND-0.0014
Heptachlorepoxide	ND-78.959	ND-0.0014
o´p´-DDE	ND-1982.594	ND-0.0013
p´p´-DDE	ND	ND-0.00092
Dieldrin	ND	ND-0.008
o´p´-0DDD	ND-69.829	ND-0.0012
Endrin	ND	
p´p´-DDD	ND-86.132	ND-0.0016
o´p´-0DDT	ND	ND-0.0005
p´p´-0DDT	ND	ND-0.0002
α-HCH		0.003-0.0038
γ-HCH		ND-0.0015
δ-HCH		ND
Mirex		ND-0.02

ND = Not detected

Table 9: Mean ranges of metal contaminants in hard clams (*Mercenaria mercenaria*—quahogs) in Campeche

Metal Contaminants	**Hard Clams (µg/g) (mean ranges)**
Cadmium	0.14-0.53 (dry weight)
Lead	0.9-2.02
Mercury	0.1

Summary tables of ranges of exposure in several media in Chiapas

Table 10: Range of values of contaminants in water, sediments and shrimp in Chiapas

Contaminants	Water ng/L (ranges)	Sediments ng/g (dw) (ranges)	Shrimp ng/g (dw) (ranges)
α-HCH	ND	ND	ND-12.812
γ-HCH	ND-3.5	ND-0.385	ND-3.038
β-HCH	ND-0.02	ND-0.864	ND-0.271
Heptachlor	ND	ND-0.259	ND-5.608
δ-HCH	ND-2	ND-0.504	ND-25.363
Aldrin	ND	ND-1.097	ND-0.199
Heptachlorepoxide	ND	ND-1.193	ND
Endosulfan I	ND-6.4	ND-0.873	ND
4,4´-DDE	ND	0.02-0.977	ND-1.427
Dieldrin	ND-4.4	ND-0.403	ND-1.896
Endrin	ND-17.9	0.27-0.669	ND-0.08
4,4´-DDD	ND-296.3	ND-0.589	ND-5.907
Endosulfan II	ND	ND-2.472	ND-1.888
4,4´-DDT	ND-2.9	ND-12.82	ND
Endrin aldehyde	ND-10.9	ND-0.311	ND-10.579
Endosulfan sulfate	1.4-8.9	ND-0.206	ND-1.711
Cadmium	0.25-0.79 (µg/L)		
Lead	2.5-18(µg/L)		

ND = Not detected, dw = dry weight

Summary tables of ranges of exposure in media in Quintana Roo

Table 11: Mean/Median ranges of contaminants in water and sediments in Quintana Roo

Contaminants	Water ng/L (mean ranges)	Sediments (mean ranges)
Cadmium	0.01-0.04 (µg/mL) / 4.89-13.83 (mg/L)	0.25-5.16 (µg/g) dry weight / 2.83-6.87 (mg/L)
Lead	0.03-0.29 (µg/L) / 3.15-11.9 (mg/L)	0.25-12.31 (µg/L) dry weight / 0.15-17.21 (mg/L)
Mercury	0.002-11.9 (mg/L)	0.917-4.6 (mg/L)
∑Drines	4.18-6.47	2.4-3.03 (ng/g) dry weight
∑HCHs	3.83-8.55	1.69-1.71 (ng/g)

		dry weight
Heptachlor	0.59-1.27	0.54-0.8 (ng/g) dry weight
∑DDTs	6.97-19.49	ND-0.58 (ng/g) dry weight
Endosulfanes	3.68	2.23-2.48 (ng/g) dry weight
Total pesticides	21.54-33.48 (ng/L)	7.47-7.99 (ng/g) dry weight

Table 12: Mean ranges of contaminants in algae and mussels in Quintana Roo

Contaminants	**Algae spp. µg/g dw (mean ranges)**	**Mussels spp. ng/g dw (mean ranges)**
Cadmium	0.17-6.33	
Lead	0.02-75.39	
Mercury	9.99-136.39	
∑Drines		ND-15.62 Range of values
∑HCHs		6.3-14.75
Heptachlor		ND-10.45
∑DDTs		ND-266.19 Range of values
Endosulfanes		ND-4.66
Total pesticides		26.81-146.11

Most studies lacked appropriate information to allow an assessment of the validity of methodology that was used and its findings. Replicate analyses, utilization of internal and external standards were considered ways of assuring quality and validity of information whenever these were reported.

A link to the detailed regional matrix for Yucatán, Quintana Roo, Campeche and Chiapas is presented in **Annex 3**.

Aguascalientes, Querétaro, San Luis Potosí, Guanajuato

Institutions visited

In these states the following institutions were visited:

- Public universities
- *Instituto Tecnológico y de Estudios Superiores de Monterrey* (ITESM), campus Guanajuato, Querétaro, Aguascalientes and San Luis Potosí
- *Instituto Nacional de Ecología* (INE)
- *Instituto Nacional de Estadística, Geografía e Informática* (INEGI)
- *Secretaría Nacional de Medio Ambiente y Recursos Naturales* (Semarnat)
- *Instituto Mexicano de Tecnología del Agua* (Aguascalientes)
- *Fomento a la Investigación Científica y Tecnológica de Fondos Mixtos*—Conacyt (Aguascalientes)

Available information

Documentation that included data on POPs or metals was found in six of the visited institutions. The following table presents the number of documents found in each institution.

Table 13: Available information on PBTS in Aguascalientes, Querétaro, San Luis Potosí and Guanajuato

Institution	**Number of documents**	
	POPs	**Metals**
Instituto Mexicana de Tecnología del Agua	1	1
Conacyt, *Gobierno del Estado de Aguascalientes*	1	
Semarnat		4
Universidad Autonomía de Querétaro	1	
Instituto tecnológico y de Estudios Superiores de Monterrey	1	
Universidad Autonomía de San Luis Potosí	2	
Total	6	5

Eleven documents, from which data was extracted, were included in the regional matrix for Aguascalientes, Querétaro, San Luis Potosí and Guanajuato. Reports from Aguascalientes accounted for almost 50% of the overall information (5/11). All of these reports were produced from 2000–2007. POPs data were more frequently reported than data for metals.

Substances monitored included:

Aguascalientes
Solvents: Benceno, Tolueno, Etil-benceno, Xileno
POPs: Aldrin, β-HCH, α-HCH, Lindano, Heptacloro, Endosulfán, Dieldrín, Endrín, DDD, DDT
Metals: Cadmio, Plomo, Mercurio

Querétaro
Metals: Cadmio, Plomo, Mercurio

San Luis Potosí
POPs: DDD, DDE, DDT, DDE-$MeSO_2$ (analyzed in San Luis Potosí, from samples collected in Chiapas, Oaxaca, Potosína, Quintana Roo and San Luis Potosí), dioxinas.
Metals: Cadmio, Plomo, Mercurio

Guanajuato
POPs: HCB, PCB, DDT, Metoxicloro, Aldrin, α- and β-HCH, Aldrin, Dieldrín, Endrin, Heptacloro, Heptacloro Epóxido, Metil Paratión,
Metals: Plomo, Mercurio

Institutions in Aguascalientes, Querétaro and Guanajuato were mainly involved in environmental monitoring of water, sediments, soil, plankton and benthos. The University of San Luis Potosí's monitoring or assessment projects were mainly oriented towards human biomonitoring, with plasma and breast milk as sampled media. No information was provided to assess the validity of methodology that was used and its findings. Only one study reported replicate analyses.

Medians or means of chemicals measured in the different media of the eleven documents included in the regional matrix were summarized to allow an assessment of the range of mean exposures measured in Aguascalientes, Querétaro, San Luis Potosí and Guanajuato. The following tables present this information.

Summary tables of ranges of exposure in several media in Aguascalientes

Table 14: Means / Mean ranges of contaminants in water and sediments in Aguascalientes

Contaminants	Water (mg/L) (means/mean ranges)	Sediments (mg/kg) (means/mean ranges)
Lead	0.005-0.008	16-110
Cadmium	<0.001-0.005	1.05-17.25
Mercury		0.85-4.308
Benzene	<0.00007	
Toluene	<0.00007	
Ethyl-benzene	<0.00007	
Xylene	<0.00021	
Aldrin	<0.000007- <0.0001	0.000166-0.001
β-HCB	<0.000007- <0.0001	<0.001 (mg/L)
α-HCB	<0.000007- <0.0001	<0.001 (mg/L)

Lindane	<0.000007- <0.0001	<0.001 (mg/L)
Heptachlor	<0.000007- <0.0001	<0.001 (mg/L)
Endosulfans	<0.000007- <0.0001	<0.001 (mg/L)
Dieldrin	<0.000007- <0.0001	<0.001 (mg/L)
Endrin	<0.0001-<0.000135	<0.00015-<0.00025
Aniline		0.85-4.308
DDD	<0.000007- <0.0001	<0.001 (mg/L)
DDT	<0.000007- <0.0001	<0.001 (mg/L)
HCBs	<0.00017- <0.0012	<.00073-0.20 (mg/L)

Summary tables of ranges of exposure in several media in San Luis Potosí

Table 15: Mean ranges of contaminants in sediments and plankton/benthos in San Luis Potosí

Contaminants	**Sediments ppb (mean ranges)**	**plankton/benthos ppb (mean ranges)**
Mercury	320-524.9	103.37-1008.97

Table 16: Mean ranges of contaminants in breast milk, women's blood and cord blood in San Luis Potosí

Contaminants	**Breast milk (ng/g lipids) (mean ranges)**	**Women's blood (ng/g lipids) (mean ranges)**	**Cord blood (ng/g lipids) (mean ranges)**
DDT	28-126	130-319	125-255
DDE	54-503	287-844	285-675
DDD	0.09-19	3.8-10	3.6-10
DDT total	99-745	539-1339	517-1072
DDE-$MeSO_4$	0.1-7	1.7-101	1.6-82
Dioxins	8.3-21.5 (pg/g)		

Table 17: Means / Mean ranges of contaminants in women's blood Chiapas, Quintana Roo and Oaxaca analyzed in San Luis Potosí

Contaminants	Chiapas (ng/g lipids) (means/mean ranges)	Quintana Roo (ng/g lipids) (means/mean ranges)	Oaxaca (ng/g lipids) (means/mean ranges)
DDT	425-1323	748	335
DDE	1059-3738	1271	1362
DDD	144-236	162	145
DDT total	1596-5273	2259	1861
DDE-$MeSO_4$	64-66	20	43

Table 18: Means / Mean ranges of contaminants in breast milk of Chiapas and Quintana Roo women analyzed in San Luis Potosí

Contaminants	Chiapas (ng/g lipids) (means/mean ranges)	Quintana Roo (ng/g lipids) (means/mean ranges)
DDT	17-134	911
DDE	268-764	3100
DDD	0.19-0.9	1.2
DDT total	300-926	4287
DDE-$MeSO_4$	0.4-1.2	2.8

Summary tables of ranges of exposure in several media in Guanajuato

Table 19: Means of contaminants in soil and water in Guanajuato

Contaminants	Soil mg/kg (means)	Water mg/L (means)
DDT	13984	2.20
Aldrin	25.2	6.19
α-HCB	57.81	1.71
β-HCB	167	7.29
Dieldrin	903	7.06
Endrin	998	2.93
Heptachlor	123	0.51
Heptachlorepoxide	5.92	0.11
HCB	201.1	4.02
Methyl parathion	1107	

A link to the detailed regional matrix for Aguascalientes, Querétaro, San Luis Potosí and Guanajuato is presented in **Annex 3**.

Sinaloa, Nayarit, Jalisco, Colima

Institutions visited

In these states the following institutions were visited:

- *Universidad de Occidente,* Sinaloa (El Fuerte, Los Mochis, Guasave, Guamúchil, Culiacán and Mazatlán)
- *Instituto Tecnológico de Los Mochis*
- *Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional* (CIIDIR)
- *Centro de Investigación en Alimentación y Desarrollo* (CIAD)-Unidad Culiacán. *Universidad Autónoma de Sinaloa* (UAS)-Culiacán, Sinaloa
- *Centro de Investigación en alimentación y Desarrollo* (CIAD)-Unidad Mazatlán
- *Instituto de Ciencias del Mar y Limnología*-UNAM, Unidad académica Mazatlán
- *Universidad Autónoma de Nayarit* (UAN)-Tepic, Nayarit
- *Instituto Tecnológico de Tepic*
- *Centro de Innovación Aplicada en Tecnologías Competitivas, A.C.* (CIATEC), Guadalajara, Jalisco
- *Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco, A.C.* (CIATEJ), Guadalajara, Jalisco
- *Universidad Autónoma de Guadalajara* (UAG), Guadalajara, Jalisco.
- *Universidad de Guadalajara* (UDG), Guadalajara, Jalisco
- *Universidad de Colima-Facultad de Ciencias Marinas*

Available information

Documents including data on POPs or metals were found in 10 of the 13 institutions visited. The following table presents the number of documents found in each institution.

Table 20: Available information on PBTS in Sinaloa, Nayarit, Jalisco and Colima

Institution	**Number of documents**	
	POPs	**Metals**
Universidad de Occidente, Los Mochis		1
Centro Interdisciplinario de Investigación para el Desarrollo Integral regional, Unidad Sinaloa		2
Facultad de Ciencias del Mar	5	20
Centro de Investigación en Alimentación y Desarrollo, A.C., Unidad Mazatlán	1	1

Instituto de Ciencias del Mar y Limnología de la Universidad Nacional Autónoma de México	4	14
Instituto Tecnológico del Mar, Unidad Mazatlán		11
Universidad Autónoma de Nayarit	6	4
Centro Universitario de Ciencias Biológicas y Agropecuarias	2	3
Universidad de Colima	1	4
Total	19	60

Seventy-nine documents from which data was extracted were included in the regional matrix for Sinaloa, Nayarit, Jalisco and Colima. Overall, data on metals were more frequently reported (60/79) than on POPs.

Reports found in Sinaloa accounted for more than 60% of the regional information (52/79), 70% of these reports were produced during the 2000–2007 time period and 20% during the 1990–1999 time period. The remaining 10% resulted from work done from 1980 to 1989. Institutions in Sinaloa were mainly involved in environmental monitoring with water, sediments, birds, fish, shrimp, algae and zooplankton reported as the most frequently sampled media.

In the State of Nayarit, 10 documents were found in the visited institutions. Half of these reports were produced during the 2000–2007 and the other half from 1990–1999. Institutions in Nayarit were mainly involved in POPs environmental monitoring with fish, birds, shrimp, oysters, cattle, algae, sediments and cow's milk being the more frequently reported sampled media.

Only eight documents in total were found in Jalisco and Colima. In Jalisco, three of the reports were produced from 2000–2007. Institutions were involved in environmental and human monitoring with vegetables, milk and breast milk as reported sampled media. In Colima, all four reports were produced from 2000–2007 and institutions were involved in metals environmental monitoring, with water, oysters and mammalian liver reported as the sampled media.

Substances that were monitored included:

Sinaloa
POPs: Fosdrín (aka phosdrin or mevinphos), metil-paratión, disiston, metil paratión, monocrotofos, metoxicloro, dimetoato (aka dimethoate), folimat, bayleton, clorpirifos, daconil, diazinón, etion, DDVP (aka dichlorvos), coumaphos, gution, fosdrin (aka phosdrin or mevinphos), α-HCH, β-HCH, DDT, DDD, DDE, HCB, lindano, heptacloro, clordano, heptacloro epóxido, epóxido, aldrin, teladrín, dieldrín, endrín, endrín cetona y endrín aldehido, endosulfan I, sulfato de endosulfan.

Metals: Cadmio, Plomo and Mercurio.

Nayarit
POPs: α-, β- and γ-HCH, endosulfan I and II, DDD, DDE, DDT, HCB, heptacloro, heptacloro epóxido, aldrín, dieldrín and endrín, endrín aldehído, endosulfán sulfato, metoxicloro;
Metals: Cadmio, Mercurio, Plomo.

Jalisco

POPs: DDT, Lindano, Heptacloro, Dieldrín, Aldrín and Endrín;
Metals: Cadmio y Plomo.

Colima

Metals data were found on only cadmium, lead and mercury.

Medians or means of chemicals measured in the different media of the seventy-nine documents included in the regional matrix were summarized to allow a rough assessment of the range of mean exposures measured in Sinaloa, Nayarit, Jalisco and Colima. The following tables present this information.

Summary tables of ranges of exposure in several media in Sinaloa

Table 21: Ranges of values of contaminants in water, sediments and zooplankton in Sinaloa

Contaminants	Water ng/mL (ranges)	Sediments ng/g (ranges)	Zooplankton (µg/g) (ranges)
Fosdrin	0.0049-0.0739	6.5186-14.0298	
Methyl parathion	0.0041-0.3985	3.1394-60.7887	
Disiston	0.0072-0.0026	1.4001-22.4171	
Monocrotophos	0.2355-0.9376		
Malathion		1.8162-10.0634	
Dichlorvos		1.7678-12.7607	
Cigon		0.8839-9.7763	
Ethion		3.6478	
Aldrin	0.0112-0.55 (µg/L) / 0.08-1.36 (ppb)	0.01-0.02 (µg/g)	
p,p DDD		0.94-2.44 (ppb) / 15.27	
p,p DDE		0.01-2.6 (ppb)	
p,p DDT	0.5-2.3 (ppb)	0.87-3.27 (ppb)	
Metoxiloro	1.4 (ppb)		
Lindane	0.0052-0.87 (µg/L) / 0.2-0.9 (ppb)	0.009-0.022 (µg/g)	
Endrin	0.26-1.5 (ppb)	0.025 (µg/g)	
Endosulfane	.8-1.3 (ppb) / .48-.68 (µg/L)		
Heptachlor	0.08-4.28 (ppb) / 0.01-0.02 (µg/L)	0.01-0.026 (µg/g)	
Dieldrin	0.36 (ppb)	0.01 (µg/g)	
Epoxide	0.23-.67 (ppb)		
α-HCB	0.03-1.24 (ppb) / 4.14 (µg/L)	0.08 (µg/g)	
β-HCB	.79-7.33 (ppb)	0.08-0.12 (µg/g)	

Eldrin	1.17		
Bayceton	.039 (µg/L)	0.0012-0.003 (µg/g)	
Dimetoato	.0043-.549 (µg/L)	0.0009-0.032 (µg/g)	
Folimat	.0357-.1904 (µg/L)		
Chlorpiriphos		0.0006 (µg/g)	
Methyl malathion		0.0014-0.007 (µg/g)	
Cadmium	0.17-0.97 (µg/L)		3.8
Lead	1.88-7.88 (µg/L)		
Heptachlorepoxide		0.01-0.02 (µg/g)	
Endosulfan sulfate	7.15-8.76 (µg/L)	0.82-1.02 (µg/g)	

Table 22: Means / mean ranges of contaminants in sediments, water, macro algae and aquatic plants in Sinaloa

Contaminants	**Sediments ng/g (ranges/mean values)**	**Water µg/L (ranges/mean values)**	**Macro algae / aquatic plant ng/g (ranges/mean values)**
Mercury	340-2250		58-134
Cadmium	0.01-4.71 / 0.09-.6 (mg/kg)	0.19-1.97	
Lead	0.01-103.09 / 0.42-1 (ppm)/ 12-37.1 (mg/kg)	0.81-7.2	
α-HCB	0.09-21.32	0.16	
Lindane	139.28-2462.55 / 10.36 (µg/g)		
β-HCB	998.33-3101.41	0.0295	
Aldrin	2.36 / 2.41 (µg/kg)		
Teladrin		0.0261	
p,p DDD	10.57-26.47	0.1439-1325	
p,p DDE	3.4-63.55	0.0347-0.37	
p,p DDT	0.09-44.7	0.0194-0.3828	
Endosulfan I	4.45-76.65 / 0.02 (µg/g)		
Endosulfan II	9.62-42.39		
Metoxychlor	1.05-1.7		
Heptachlor	2.6-312.93 / 3.99 (µg/kg)		
Endrin	0.09-108.04 / 2.88 (µg/kg)	0.0694-0.15	
Dieldrin	0.35-14.46 / 0.1 (µg/kg)	0.0267	
Endrin aldehyde	0.09-18.76		
DDTs (total)	5.88 (µg/kg)		

Heptachlorepoxide	65.16 / 2.97 (µg/kg)		
Chlordane	α: 6.55 /γ: 12.29	2.6	
Endosulfan sulfate	5.09		
HCBs total	2 (µg/kg)		
Diazinon	5.93		
Disyston	1.03		
Methyl parathion	1.12		
Ethion	1.09		
Chlorpyriphos	1.01		
Malathion	0.81		
DDVP	0.18		
Coumaphos	5.74		
Guthion	0.06		
Phosdrin	0.44		
Dimetoato	0.06		
Endrin cetone (ketone)	2.5		

Table 23: Means and mean ranges of contaminants in tissues from ducks and fish in Sinaloa

Contaminants	**Several duck species tissues ng/g/µg/g (ranges/mean values)**	**Several fish species tissues ng/g/µg/g (ranges/mean values)**
Mercury	5-3575 / 0.07-5.08	0.11-722 / 0.05-4.12
Lead	/ 0.02-56.48	/ 0.25-7.88
Cadmium	/ 0.01-4.76	/ 0.02-8.9
HCBs		0.48
Endosulfan		5.77
Aldrines		65.81
DDTs		99.52
HCHs		30.06
Heptachlor		7.67

Table 24: Mean ranges / values and range of values of contaminants in lobster and shrimp tissues in Sinaloa

Contaminants	**Lobster spp. tissues µg/g/mg/kg (ranges/mean values)**	**Shrimp spp. tissues µg/g/ppm (ranges/mean values)**
Mercury		0.06-0.72
Lead	/ 0.63-7.69	/ 0.08-180
Cadmium	0.1 / 3.48	/ 0.0012-10.85
Heptachlor		/ 0.0010-.021
Dieldrin		0.003-0.03
Epoxide		0.001-0.17
DDD		0.034-0.051

DDT		0.006
α-HCB		0.002-0.154
β-HCH		0.004-0.005
Lindane		0.001-0.005

Table 25: Mean ranges / values and range of values of contaminants in tissues from bivalves and crustaceans in Sinaloa

Contaminants	**Bivalve spp. tissues µg/g/ppm (ranges/mean values)**	**Crustacean spp. tissues µg/g/ppm (ranges/mean values)**
Mercury		0.63 (ng/g)
Lead	0.32-8.71 / 5.5-7.52	0.29-65.9 / 0.21-0.24
Cadmium	0.56-13.76 / 0.52-3.47	0.88-25.8 / 0.16-0.20
DDE	0.0018-0.0064	
Endosulfan	/0.05	
Heptachlorepoxide	0.001-0.01	
Endrin	0.033	
Lindane	0.002-0.0045	
Daconil	0.002-0.012	
Chlorpyriphos	0.035	

Table 26: Means of contaminants in breast milk in Sinaloa

Contaminants	**Breast milk mg/L (mean values)**
(α + β) HCH	0.0047
Lindane	0.0013
Aldrin + Dieldrin	0.003
Heptachlor + heptachlorepoxide	0.0021
DDT	0.0017
DDE	0.0138

Table 27: Mean ranges of contaminants in hair of baby sea lions in Sinaloa

Contaminants	**Baby sea lion hair mg/kg (mean ranges)**
Cadmium	0.0907-0.3039
Lead	3.6126-36.065

Summary tables of ranges of exposure in several media in Nayarit

Table 28: Means / mean ranges of contaminants in sediments, suspended particulate matter and water in Nayarit

Contaminants	Sediments ng/g (ranges/mean values)	Suspended particulate matter ng/g (ranges/mean values)	Water mg/L (ranges/mean values)
α-HCH	0.28-6.29	67.6875	
β-HCH	1.48-5.01	85.0625	
γ-HCH (lindane)	1.12-2.85	26.6875	
Endosulfan I	0.07-45.83	22.9375	
Dieldrin	0.06-2.14	4.125	
Endrin	1.09-42.85	41.9375	
Endosulfan II	0.19-1.33		
δ-HCH	0.27-8.41	3.6875	
Heptachlor	1.4-8.23	9.75	
Aldrin	0.11-7.19	3.75	
Heptachlorepoxide	1.03-2.06		
p,p DDE	0.74-1.89	231.6875	
p,p DDD	0.5-1.83		
Endosulfan sulfate	1.13-1.92	7	
p,p DDT	1.94-26.53		
Endrin aldehyde	0.76-230	14.125	
Lead	22.94-38.81 (ppm)		0.0015-0.0304
HCBs	2.47-117.76		

Table 29: Means / mean ranges of contaminants in cow milk, shrimp and oysters in Nayarit

Contaminants	Cow milk µg/g (ranges/mean values)	Shrimp spp. ng/g (ranges/mean values)	Oysters spp. ng/g (ranges/mean values)
α-HCH	0.011-0.022	0.04-0.25	
β-HCH	0.063-0.092	2.7-10.63	
γ-HCH	0.006-0.023	15.37	
Endosulfan I	0.018-0.09	0.11-4.02	0.11-5.56 (µg/g)
Dieldrin	0.013-0.031	0.04-2.72	
Endrin	0.145-0.224	0.02-21.55	165.96
Endosulfan II	0.045	2.74	
δ-HCH		3.56-3.84	
Aldrin		0.23-10.46	1.78-11.46
Heptachlorepoxide		0.92-4.72	

p,p DDE		0.34-3.27	0.82
p,p DDD		0.1	3.12
Endosulfan sulfate		0.41	
p,p DDT		3.48-31.27	3.48-12.15
Endrin aldehyde		0.14-.61	
Cadmium			0.7-3.4 µg/g
Lead			1.9-2.9 µg/g
HCBs		8.47-19.81	7.51-9.5

Table 30: Values / ranges of values of contaminants for fish, mollusks and ducks in Nayarit

Contaminants	**Fish spp. tissues ng/g**	**Mollusks ng/g**	**Duck spp. tissues ng/g**
Aldrin	0.21		34.69
Endosulfan I	0.4		1.22-31.23
Dieldrin	0.22		
Endrin	21.04	2.37	20
Endosulfan sulfate	0.29		
α-HCH	0.14		
δ-HCH		0.15-0.31	
DDE		0.14	
Endosulfan II		1.43	
Mercury	0.07-1.02		
HCBs			10.76-37.24
Heptachlor			1.52-48.51
DDT			18.71

Summary tables of ranges of exposure in several media in Jalisco

Table 31: Means / mean ranges or median ranges of contaminants in water, sediments and air in Jalisco

Contaminants	**Water mg/L (range)**	**Sediments mg/kg (mean)**	**Air µg/m³ (mean)**
Lead	0.066-0.104	8.4	1.65

Table 32: Means / mean ranges or median ranges of contaminants in vegetables, mammal tissues and cow milk in Jalisco

Contaminants	**Vegetables mg/kg (range)**	**Mammals tissues mg/kg / ppm (ranges/mean**	**Cow milk mg/kg (ranges/mean**

		values)	values)
Cadmium	0.001-0.25	0.013-2.498	0.003-0.004
Lead		0.009-0.405 / 12.04	
(α + β)-HCH			0.0002-0.005
γ-HCH (Lindane)			0.0004-0.0005
Aldrin + dieldrin			0.0009-0.001
Heptachlor + heptachlorepoxide			0.002-0.003
Endrin			0.0001-0.006
DDT + metabolites			0.009

Summary tables of ranges of exposure in several media in Colima

Table 33: Means / mean ranges of contaminants in water and sediments in Colima

Contaminants	**Water ppm/µg/L (ranges/mean values)**	**Sediments ppm (mean)**
Cadmium	0.0187-0.0385 / 0.2675	
Lead	0.075-2.9167 / 0.2963	7.94
Mercury	0.0004-0.0013	

Table 34: Means / mean ranges of contaminants in spotted red snapper and oysters in Colima

Contaminants	**Spotted red snapper ppm (range)**	**Oyster spp. ppm (range)**
Cadmium	0.0301-0.3376	0.4869-3.2184
Lead	0.5666-0.9241	0.2286-0.5031
Mercury	0.0128-0.406	0.0163-0.0708

Most studies lacked appropriate information to assess the validity of the methodology used and its findings. Replicate analyses were, whenever reported, ways of assuring quality and validity of information.

A link to the detailed regional matrix for Sinaloa, Nayarit, Jalisco and Colima is presented in **Annex 3**.

Baja Norte, Sonora

Institutions visited

The most important university in Sonora was closed in December for major renovations. The student was unable to access any information from this institution.

In the State of Baja California del Norte, the following institutions were visited:

- Centro de Investigación Científica y de Educación Superior de Ensenada
- Universidad Autónoma de Baja California, Unidad Tijuana
- Universidad Autónoma de Baja California, Unidad Ensenada

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Available information

Documents including data on metals were found in all institutions visited. There were none on POPs. The following table presents the number of documents found in each institution.

Table 35: Available information on PBTS in Baja Norte and Sonora

Institution	**Number of documents**	
	POPs	**Metals**
Centro de Investigación Científica y de Educación Superior de Ensenada		4
Universidad Autonomía de Baja California Unidad Tijuana		3
Universidad Autonomía de Baja California Unidad Ensenada		4
Total	0	11

In this state, 11 documents from which data were extracted are included in the regional matrix for Baja Norte. Reports found in Baja Norte accounted for all of the overall information included in the matrix. A majority of these reports (7/11) were produced in the 2000–2007 time period. Institutions in Baja Norte were only involved in environmental monitoring of metals with sediments, mussels, oysters and human biological fluids reported as the media sampled.

Metals measured in Baja Norte
Cadmio, Plata, Cromo, Cobre, Zinc, Plomo, Aluminio, Magnesio, Mercurio, Níquel.

Medians or means of chemicals measured in the different media of the eleven documents included in the regional matrix were summarized to allow a rough assessment of the range of mean exposures measured in Baja Norte. The following tables present this information.

Table 36: Means / mean ranges of contaminants in sediments, mussels and oysters in Baja Norte

Contaminants	**Sediments mg/kg / µg/g / µg/g dry weight (mean values / ranges)**	**Mussels µg/g dry weight (range)**	**Oysters ng/g**
Cadmium	1.23 / / 0.25-0.547	5-7.27	
Lead	4.5 / 26-28 / 24.3-39.1	0.5-1.1	
Chrome	5 / 66-73 / 64.4-115	1.1-1.7	
Nickel	3.3 / / 29.1-55.2		
Mercury	/ 0.032-0.036 /		
Arsenic	9-17 / 9-17 /		
Silver	/ / 0.096	0.04-0.13	
Copper	/ / 18.3-24.5	5.2-8.5	
Manganese	/ / 230-506	3.73-32.7	
Zinc	/ / 121-203	102-148	
Aluminum		39.01-932	

Table 37: Means / mean ranges of contaminants in human urine and blood in Baja Norte

Contaminants	**Urine mg/L (range)**	**Blood mg/L / µg/dl (range)**
Mercury	4.19-36.48	13.084
Lead		3.97-4.89

Most studies utilized replicate analyses and internal standards as ways of assuring quality and validity of information.

A link to the detailed regional matrix for Baja Norte and Sonora is presented in **Annex 3**.

Baja Sur

Institutions visited

In this state the following institutions were visited:

- Centro de Investigaciones Biológicas del Noroeste, La Paz
- Centro Interdisciplinario de Ciencias del Mar, I.P.N., La Paz
- Universidad Autónoma de Baja California Sur, La Paz
- Instituto Tecnológico de la Paz
- Centro Universitario Tijuana, Campus la Paz
- Centro de Estudios del Mar
- Universidad Internacional de la Paz
- Centro de Estudios Científicos y Superiores de Ensenada

Available information

Documents including data on POPs or metals were found in three of the nine institutions visited. The following table presents the number of documents found in each institution.

Table 38: Available information on PBTS in Baja Sur

Institution	**Number of documents**	
	POPs	**Metals**
Universidad Autónoma de Baja California Sur		2
Centro Interdisciplinario de Ciencias del Mar		3
Centro de Investigaciones Biológicas del Noreste	1	4
Total	1	9

In this states, 10 documents from which data were extracted were included in the regional matrix for Baja Sur. A majority of these reports (8/10) were produced in the 2000–2007 time period. Research projects in these institutions were mostly oriented toward metal sampling (9/10) of macro algae, turtles, soil, sediments and water.

Substances that were monitored in Baja Sur included:
POPs: PCBs (8, 28, 37, 44, 49, 52, 60, 66, 70, 74, 77, 81, 82, 87, 99, 101, 105, 114, 118, 126, 128, 138, 153, 156, 158, 166, 169, 170, 179, 180, 183, 187 y 189), ∑DDT (o,p-DDT, o,p-DDE,

o,p-DDD, p,p-DDT, p,p-DDE y p,p-DDD), ∑Clordano (alfa y beta Clordano, *cis* y *trans* Nanoclor y Oxiclordano), Heptaclor (los datos solo representan Heptaclor ya que no se detectó Hepoxico de heptaclor), Aldrin, Dieldrin y Endrin, Hexaclorobenceno, Lindano, Endosulfan I, Endosulfan II
Metals: Arsenico, Cromo, Mercurio, Cadmio, Plomo

Medians or means of chemicals measured in the different media of the ten documents included in the regional matrix were summarized to allow a rough assessment of the range of mean exposures measured in Baja Norte. The following tables present this information.

Summary tables of ranges of exposure in several media in Baja Sur

Table 39: Mean ranges of contaminants in water, sediments and vegetation in Baja Sur

Contaminants	Water mg/L	Sediments µg/g	Vegetation mg/kg
Arsenic	ND-3.14	0.07-58.65	0.9-10.57
Chromium		22-222	
Mercury		0.02-0.17	
Cadmium		0.25-31.39	

Table 40: Mean ranges of contaminants in tissues from turtles, clams and in microalgae in Baja Sur

Contaminants	Turtles' tissues ng/g	Clam tissues µg/g	Microalgae mg/kg
Lead	ND-13.98 (ppm) / 0.04-0.65 (mg/kg)	ND-0.38	0.58-1.95
Cadmium	0.15-216.88 (ppm) / 6.07 (mg/kg)	ND-5.43	0.57-2.18
∑DDTs	1.88-45.81		
∑Chlordanes	23.15-92.51		
Heptachlor	ND-2.57		
HCB	ND-23.35		
Lindane	ND-1.11		
Endosulfan I	ND-2.98		

Most studies lacked appropriate information to allow an assessment of the validity of the methodology used and its findings. Replicate analyses, utilization of internal standards and added spikes were, whenever reported, ways of assuring quality and validity of information.

A link to the detailed regional matrix for Baja Sur is presented in **Annex 3**.

Conclusions

The information gathered provided highlights on Mexico's regional capacities and indicated the strong position of Sinaloa and Yucatán in generating validated environmental PBTS data. The research projects used to develop the regional matrixes were, in the main, conducted recently (2000–2007) and principally oriented toward metals monitoring and assessment. Several institutions in different states conducted research projects involving the analysis of POPs in environmental matrices.

Quality control and quality assurance (QA/QC) information was very scarce—a critical shortcoming in these matrixes. To assure specific data quality, QA/QC activities should be implemented for all the steps of the measurement activities, from sample collection to chemical analysis through data reporting. All QA/QC activities should be documented and reported to allow a proper assessment of the validity of the provided information. Despite these limitations, this documentary survey, systematizing existing but not readily accessible data from the "gray literature" should provide a source of valuable information that will allow Mexico to further develop its environmental monitoring and assessment capacities. Detailed information on the levels of contaminants measured in several media is provided in the tables in the results section of the report. The authors emphasize that validated information that has been subjected to rigorous QA/QC protocols is imperative if decision makers are to base their policy decisions on scientifically derived information.

Annex 1 — Detailed Tables Providing Information on the Number of Case Studies for Each Medium

Identified case studies on PBTS in air in Mexico[13]

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Universidad Nacional Autónoma de México	**Not specified (8), PAHs (1), Metals (4)**	**13**
Instituto Nacional de Salud Pública	**Not specified (4), Metals (3)**	**7**
Centro de Investigación y de Estudios Avanzados	**Not specified (5)**	**5**
Instituto Mexicano de Tecnología del Agua	**Metals (5)**	**5**
Instituto Mexicano del Petróleo	**Metals (2), PAHs (1)**	**3**
Federación Mexicana de Ingeniería Sanitaria y Ciencias Ambientales	**Metals (2)**	**2**
Instituto Nacional de Investigaciones Nucleares	**Not specified (2)**	**2**
Universidad Autónoma de Querétaro	**Dioxins/Furans (2)**	**2**
Universidad Autónoma de San Luis Potosí	**Metals (1), Not specified (1)**	**2**
Universidad Autónoma Metropolitana	**Metals (1), PAHs (1)**	**2**
Instituto Nacional de Ecología	**PBDD/PBDF**	**1**
Comisión para la Cooperación Ambiental	**Metals**	**1**
Gamatek, S.A. de C.V.	**Dioxins/Furans**	**1**
Instituto Nacional de Cancerologia	**Not specified**	**1**
Instituto Nacional de Ciencias Medicas y Nutrición Salvador Zubirán	**Metals**	**1**
Instituto Nacional de enfermedades Respiratorias	**Not specified**	**1**
Instituto Tecnológico y de Estudios Superiores de Monterrey	**Not specified**	**1**
University of California	**PCBs**	**1**
Universidad Autónoma de Baja California	**Not specified**	**1**
Universidad Autónoma de Nuevo León	**Metals**	**1**

[13] Information provided by: Hansen, A.M, van Afferden, M., Villada Canela, M., Sánchez Castañeda, L.F. 2006. Scoping study for the evaluation of the national program of monitoring and environmental assessment in Mexico.

Identified case studies on PBTS in surface water

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Instituto Mexicano de Tecnología del Agua	**Not specified (36), Pesticides (3), Metals (2)**	**41**
Universidad Nacional Autónoma de México	**Metals (12), Pesticides (3)**	**15**
Universidad Autónoma de Sinaloa	**Metals (2), Pesticides (9), Not specified (1)**	**12**
Centro de Investigación en Alimentación y Desarrollo A.C.	**Metals (5) Pesticides (1), Not specified (1)**	**7**
Universidad Autónoma de Baja California	**Metals (5), Pesticides (1)**	**6**
Centro d Investigación y Estudios Avanzados	**Not specified (3), Pesticides (1), Metals (1)**	**5**
Universidad Autónoma de San Luis Potosí	**Nor specified (2), Metals (2), Pesticides (1)**	**5**
Universidad Autónoma Metropolitana	**Metals (3), Pesticides (1), PAH (1)**	**5**
Universidad de Guadalajara	**Not specified**	**4**
Instituto Politécnico Nacional	**Metals (1), Pesticides (1), Not specified (1)**	**3**
Universidad Autónoma de Aguascalientes	**Not specified**	**3**
Universidad Autónoma de Tamaulipas	**Not specified**	**3**
Universidad Autónoma de Zacatecas	**Metals (2), Not specified (1)**	**3**
El Colegio de la Frontera Sur	**Not specified (1), Pesticides (1)**	**2**
Instituto Nacional de Investigaciones Nucleares	**Not specified**	**2**
Instituto Nacional de Salud Pública	**Metals**	**2**
Universidad Autónoma de Querétaro	**Not specified (1), Pesticides (1)**	**2**
Universidad Autónoma de Yucatán	**Metals (1), Pesticides (1)**	**2**
Benemérita Universidad Autónoma de Puebla	**Not specified**	**1**
Cámara Nacional de la Industria de la Transformación	**Metals**	**1**
Centro de Investigación Biomédica de Oriente	**Not specified**	**1**
Centro de Investigación y Asesoría Tecnológica en Cuero y Calzado	**Metals**	**1**
Centro de Investigaciones Biológicas del Noroeste S.C.	**Not specified**	**1**
Federación Mexicana de Ingeniería Sanitaria y Ciencias Ambientales	**Metals**	**1**
Harvard School of Public Health	**Metals**	**1**
Instituto Tecnológico de Tijuana	**Metals**	**1**
University of California	**PCBs**	**1**
Texas A&M University	**Metals**	**1**
Universidad del Mar	**Not specified**	**1**
Universidad Autónoma de Campeche	**PCBs**	**1**
Universidad Autónoma de Coahuila	**Not specified**	**1**
Universidad Autónoma de Nayarit	**Not specified**	**1**
Universidad Autónoma del Estado de Morelos	**Not specified**	**1**

Universidad del Mar	**Not specified**	**1**

Identified case studies on PBTS in groundwater

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Instituto Mexicano de Tecnología del Agua	**Not specified (9), Pesticides (3)**	**12**
Universidad Nacional Autónoma de México	**Metals (1), Not specified (4)**	**5**
Universidad Autónoma de Nuevo León	**Not specified**	**3**
Instituto Politécnico Nacional	**Metals (1), Not specified (1)**	**2**
Universidad Autónoma de Aguascalientes	**Not specified**	**2**
Centro de Investigación en Alimentación y Desarrollo A.C.	**Metals**	**1**
Centro de Investigación y de Estudios Avanzados	**Not specified**	**1**
Universidad Autónoma de Coahuila	**Not specified**	**1**
Universidad Autónoma de Querétaro	**Pesticidas**	**1**
Universidad Autónoma de Tamaulipas	**Pesticidas**	**1**
Universidad Autónoma de Yucatán	**Pesticidas**	**1**

Identified case studies on PBTS in wastewater

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Instituto Mexicano de Tecnología del Agua	**Not specified**	**10**
Universidad Nacional Autónoma de México	**Metals (9) PCBs (1)**	**10**
Universidad Autónoma de Nuevo León	**Metals (4) Not specified (1)**	**5**
Universidad Autónoma de Ciudad Juárez	**Metals (1) Not specified (2)**	**3**
Instituto Nacional de Salud Pública	**Not specified**	**2**
Universidad Autónoma del Estado de Morelos	**Not specified**	**2**
Centro de Investigación en Alimentación y Desarrollo A.C.	**Not specified**	**1**
Centro de Investigación y de Estudios Avanzados	**Not specified**	**1**
Colegio de Postgraduados	**Metals**	**1**
Texas A&M University	**Not specified**	**1**
Instituto Nacional de Investigaciones Nucleares	**Not specified**	**1**
Tecnológico de Estudios Superiores de Ecatepec	**Metals**	**1**
Universidad Autónoma de Aguascalientes	**Not specified**	**1**
Universidad Autónoma de Baja California	**Pesticides**	**1**

Universidad Autónoma de Querétaro	**Metals**	**1**
Universidad Autónoma de Zacatecas	**Metals**	**1**
Universidad Autónoma Metropolitana - Xochimilco	**Not specified**	**1**

Identified case studies on PBTS in sediments

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Instituto Mexicano de Tecnología del Agua	**Not specified (15), Pesticides (4), Metals (4)**	**26**
Universidad Nacional Autónoma de México	**Metals (14), Pesticides (1)**	**15**
Universidad Autónoma Metropolitana	**Metals (5), Pesticides (1), PAHs (1)**	**7**
Instituto Politécnico Nacional	**Metals (1), Pesticides (3), PAHs (1)**	**5**
Centro de Investigación y de Estudios Avanzados	**Not specified (3), Metals (1)**	**4**
Centro de Investigación en Alimentación y Desarrollo A.C.	**Metals**	**3**
Universidad Autónoma de Baja California	**Not specified**	**3**
Universidad Autónoma de Yucatán	**Metals (1), PAHs (2)**	**3**
Centro de Investigación Biomédica de Oriente	**Not specified (1), Metals (1)**	**2**
El Colegio de la Frontera Sur	**Pesticides (1), PAHs (1)**	**2**
Universidad Autónoma de Baja California	**Metals (1), Pesticides (1)**	**2**
Universidad Autónoma de Zacatecas	**Metals (1), Not specified (1)**	**2**
Centro de Investigaciones Biológicas del Noroeste S.C.	**Metals**	**1**
Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Sinaloa, Universidad Autónoma de Sinaloa, Universidad Nacional Autónoma de México, Centro de Investigación en Alimentación y Desarrollo	**Metals**	**1**
Federación Mexicana de Ingeniería Sanitaria y Ciencias Ambientales	**Metals**	**1**
Instituto Nacional de Ecología	**Metal**	**1**
Instituto Nacional de Investigaciones Nucleares	**Metals**	**1**
Instituto Tecnológico y de Estudios Superiores de Monterrey	**Not specified**	**1**
Southern California Coastal Water Research Project	**Metals**	**1**
Texas A&M University	**Metals**	**1**
Universidad Autónoma Metropolitana y Universidad Nacional Autónoma de México	**Pesticides**	**1**
Universidad Autónoma de Campeche	**PCBs**	**1**

Universidad Autónoma de San Luis Potosí	**Metals**	**1**
Universidad Autónoma de Tamaulipas	**Not specified**	**1**
Universidad Autónoma del Estado de Morelos	**Not specified**	**1**
Universidad de Guadalajara	**Not specified**	**1**
University of Texas	**Metals**	**1**

Identified case studies on PBTS in soil

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Universidad Nacional Autónoma de México	**Metals (17) Dioxins/Furans (1) PAHs (2) Pesticides (1) Not specified (3)**	**24**
Instituto Mexicano de Tecnología del Agua	**Pesticides (3) Not specified (4)**	**7**
Colegio de Postgraduados	**Metals**	**6**
Universidad Autónoma de Nuevo León	**Metals**	**4**
Universidad Autónoma de Zacatecas	**Metals (3) Not specified (1)**	**4**
Instituto Politécnico Nacional	**Metals (1) PAHs (2)**	**3**
Universidad Autónoma de Querétaro	**Metals (1) Pesticides (1) Not specified (1)**	**3**
Universidad Autónoma de San Luis Potosí	**Metals**	**3**
Universidad Autónoma del Estado de Morelos	**Not specified (2) Pesticides (1)**	**3**
Instituto Mexicano del Petróleo	**PAHs**	**2**
Instituto Nacional de Ecología	**Metals**	**2**
Universidad Autónoma de Ciudad Juárez	**Metals (1) Not specified (1)**	**2**
Centro de Investigación y de Estudios Avanzados	**Metals**	**1**
Comisión Nacional del Agua, Instituto de Ingeniería, Universidad Nacional Autónoma de México	**Metals**	**1**
Universidad Autónoma Agraria Antonio Narro	**Metals**	**1**
Universidad Autónoma de Chapingo	**Metals**	**1**
Universidad Autónoma Metropolitana	**PAHs**	**1**
Universidad de Guadalajara	**Not specified**	**1**
Universidad del Mar	**Not specified**	**1**

Identified case studies on PBTS in solid waste

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Instituto Mexicano de Tecnología del Agua	**Not specified**	**1**
Instituto Nacional de Salud Pública	**Not specified**	**1**

Universidad Autónoma de Yucatán	**Metals**	**1**

Identified case studies on PBTS in biota, fish and other wildlife

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Universidad Nacional Autónoma de México	**Not specified (3) Metals (100) PCBs (1) Pesticides (11)**	**115**
Centro de Investigación y de Estudios Avanzados	**Not specified (8) Metals (4) Pesticides (2) PAHs (6)**	**20**
Instituto Politécnico Nacional	**Metals (10) PAHs (2) Pesticides (3)**	**15**
Centro de Investigación en Alimentación y Desarrollo A.C.	**Not specified (4) Metals (5) Pesticides (2)**	**11**
Universidad Autónoma de Sinaloa	**Not specified (1) Metals (5) Pesticidas (4)**	**10**
Universidad Autónoma de Baja California	**Metals (3) PAHs (2) Pesticides (4)**	**9**
Centro de Investigaciones Biológicas del Noroeste S.C.	**Not specified (3) Metals (2) Pesticides (2)**	**7**
Universidad Autónoma Metropolitana	**Metals (5) PAHs (2)**	**7**
Universidad Autónoma de Nuevo León	**PAHs (1) Metals (4)**	**5**
El Colegio de la Frontera Sur	**Not specified (1) Pesticides (3)**	**4**
Universidad Autónoma de San Luis Potosí	**Not specified (1) Pesticides (1) Metals (1)**	**3**
Universidad Autónoma de Yucatán	**Metals (1) PAHs (1) Pesticides (1)**	**3**
Benemérita Universidad Autónoma de Puebla	**Metals**	**2**
Centro de Investigaciones Agrícolas del Noreste	**Pesticides**	**2**
Instituto Mexicano de Tecnología del Agua	**Not specified**	**2**
Instituto Nacional de Cardiología Ignacio Chávez	**Metals**	**2**
Instituto Nacional de Ciencias Medicas y Nutrición Salvador Zubirán	**Not specified**	**2**
Universidad Autónoma del Estado de Morelos	**Not specified (1) PAHs (1)**	**2**
Universidad de Guadalajara	**Not specified (1) Pesticides (1)**	**2**
National Institute of Water & Atmospheric Research, Centro de Investigación y Estudios Avanzados	**PAHs**	**1**
Centro de Investigación Biomédica de Oriente y Centro de Investigación y Estudios Avanzados	**Metals**	**1**
Centro de Investigación y Estudios Avanzados, Colegio de Postgraduados, Instituto Mexicano del Petróleo	**PAHs**	**1**
Centro de Investigación en Alimentación y Desarrollo	**Metals**	**1**
Trent University, Peterborough, ON, Canada	**Not specified**	**1**
Harvard School of Public Health	**Metals**	**1**

Instituto Nacional de Investigaciones Forestales y Agropecuarias	**Not specified**	**1**
Instituto Nacional de Investigaciones Nucleares	**Metals**	**1**
Instituto Nacional de Neurología y Neurocirugía	**Metals**	**1**
Instituto Tecnológico del Mar No. 2	**Metals**	**1**
Instituto Tecnológico y de Estudios Superiores de Monterrey	**Not specified**	**1**
Tecnológico de Estudios Superiores de Ecatepec	**Metals**	**1**
Texas A&M University	**Metals**	**1**
Universidad Autónoma Metropolitana y Universidad Nacional Autónoma de México	**Pesticides**	**1**
Universidad Autónoma Agraria Antonio Narro	**Metals**	**1**
Universidad Autónoma de Aguascalientes	**Metals**	**1**
Universidad Autónoma de Campeche	**Not specified**	**1**
Universidad Autónoma de Chapingo	**Metals**	**1**
Universidad Autónoma de Ciudad Juárez	**Metals**	**1**
Universidad Autónoma de Tamaulipas	**Not specified**	**1**
Universidad Autónoma de Zacatecas	**Metals**	**1**
Universidad Autónoma del Estado de Hidalgo	**Metals**	**1**
Universidad Autónoma Metropolitana y Universidad Nacional Autónoma de México	**PAHs**	**1**
Universidad Autónoma Metropolitana y Universidad Autónoma de Baja California Sur.	**Metals**	**1**
Universidad de Sonora	**Metals**	**1**
Universidad Michoacana de San Nicolás de Hidalgo	**Metals**	**1**
University of California	**Pesticides**	**1**
University of Illinois	**Metals**	**1**

Identified case studies on PBTS in food

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Universidad Nacional Autónoma de México	**Metals (29) PCBs (1) Pesticides (6)**	**36**
Centro de Investigación en Alimentación y Desarrollo, A.C.	**Metals (2) Pesticides (1) Not specified (1)**	**4**
Universidad Autonoma de Guadalajara	**Metals**	**2**
Universidad Autónoma de Nuevo León	**Dioxins/Furans**	**2**
Centro de Investigación y de Estudios Avanzados	**PCBs**	**1**
Instituto Politécnico Nacional	**Pesticides**	**1**
Centro de Investigación en Alimentación y Desarrollo, A.C.	**Metals**	**1**

Universidad Autónoma Metropolitana, Universidad Autónoma de Baja California Sur.	**Metals**	**1**
Universidad Autónoma de Campeche	**PCBs**	**1**
Universidad Autónoma de Chihuahua	**PAHs**	**1**
Universidad Autónoma de Tamaulipas	**Dioxins/Furans**	**1**
Universidad La Salle	**Metals**	**1**
Universidad Motolinia	**Metals**	**1**
Universidad Veracruzana	**Not specified**	**1**

Identified case studies on PBTS in human tissue

INSTITUTION	CONTAMINANTS CATEGORY	NUMBER OF REFERENCES
Universidad Nacional Autónoma de México	**Metals (91) Not specified (1) Pesticides (6)**	**98**
Instituto Nacional de Salud Pública	**Metals (24) Not specified (8) PAHs (2) Pesticides (3) Phtals (1)**	**38**
Centro de Investigación y de Estudios Avanzados	**Metals (8) Not specified (1) Pesticides (1)**	**10**
Universidad Autónoma de Yucatán	**Metals**	**9**
Universidad Autónoma de San Luis Potosí	**Dioxins/Furans (2) Metals (1) Pesticides (5)**	**8**
Universidad Autónoma de Zacatecas	**Metals**	**5**
Universidad Autónoma de Nuevo León	**Metals (3) PAHs (1)**	**4**
Universidad Autónoma de Querétaro	**Dioxins/Furans (1) Metals (1) Not specified (1) PBDD/PBDF**	**4**
Universidad de Sonora	**Metals**	**3**
Instituto Mexicano del Seguro Social	**Metals**	**2**
Instituto Nacional de Ecología	**Metals (1) Not specified (1)**	**2**
Instituto Politécnico Nacional	**Metals**	**2**
Universidad Autónoma de Ciudad Juárez	**Metals (1) Not specified (1)**	**2**
Universidad Autónoma de Guadalajara	**Metals**	**2**
Universidad Veracruzana	**Not specified (1) PAHs (1)**	**2**
Centro de Investigación Biomédica de Oriente del IMSS	**Not specified**	**1**
Centro de Investigación en Alimentación y Desarrollo A.C.	**Not specified**	**1**
Centro de Investigaciones Biológicas del Noroeste S.C.	**Metals**	**1**
El Colegio de la Frontera Sur	**Pesticides**	**1**
Instituto de Ginecología y Obstetricia en Mexico	**Pesticides**	**1**
Gobierno del Distrito Federal	**Metals**	**1**
Grupo Interdisciplinario de Tecnología Rural Apropiada	**Metals**	**1**
Instituto Mexicano de Tecnología del Agua	**Not specified**	**1**

Instituto Mexicano del Petróleo	**Not specified**	**1**
Instituto Nacional de Cardiología Ignacio Chavez	**Metals**	**1**
Instituto Nacional de enfermedades Respiratorias	**Not specified**	**1**
Instituto Nacional de Pediatría	**Not specified**	**1**
Instituto Nacional de Perinatología, Instituto Nacional de Salud Pública, University of Medicine and Science, California, USA	**Metals**	**1**
Instituto Tecnologico Autonomo de Mexico	**Metals**	**1**
Instituto Tecnologico de Estudios Superiores de Occidente	**Metal**	**1**
Instituto Tecnológico y de Estudios Superiores de Monterrey	**Not specified**	**1**
Instituto Universitario del Norte	**Metals**	**1**
Organización Panamericana de la Salud; Centro Nacional de Salud Ambiental; Centro de Vigilancia Epidemiológica	**Pesticides**	**1**
Universidad Autónoma Metropolitana y Universidad Autónoma de Baja California Sur.	**Metals**	**1**
Universidad Autónoma de Aguascalientes	**Not specified**	**1**
Universidad Autónoma de Campeche	**Pesticides**	**1**
Universidad Autónoma de Tamaulipas	**Pesticides**	**1**
Universidad Autónoma del Estado de México	**Metals**	**1**
Universidad Femenina de Mexico	**Metals**	**1**
Universidad Iberoamericana	**Metals**	**1**
Universidad La Salle	**Metals**	**1**

Annex 2 — Standard Matrix

Samples over DL (n=)	% reported below DL	Mean concentration (S.D.)	Mean of detected concentration (S.D.)	Range	replicates?	QA/QC statement	Reference

Annex 3 — Detailed Regional Matrices

The following hyperlinks will lead to files containing the data tables for each region:

Aguascalientes-Querétaro-Guanajuato-San Luis Potosí: www.cec.org/files/pdf/pollutants/smoc/Aguascalientes-Queretaro-Guanajuato-San Luis Potosi.xls <http://www.cec.org/files/pdf/pollutants/smoc/Aguascalientes-Queretaro-Guanajuato-San%20Luis%20Potosi.xls>

Baja California Norte: www.cec.org/files/pdf/pollutants/smoc/Baja California Norte.xls <http://www.cec.org/files/pdf/pollutants/smoc/Baja%20California%20Norte.xls>

Baja California Sur: www.cec.org/files/pdf/pollutants/smoc/Baja California Sur.xls <http://www.cec.org/files/pdf/pollutants/smoc/Baja%20California%20Sur.xls>

Sinaloa-Nayarit-Jalisco-Colima: www.cec.org/files/pdf/pollutants/smoc/Sinaloa-Nayarit-Jalisco-Colima.xls <http://www.cec.org/files/pdf/pollutants/smoc/Sinaloa-Nayarit-Jalisco-Colima.xls>

Yucatán-Campeche-Chiapas, Quintana Roo: www.cec.org/files/pdf/pollutants/smoc/Yucatan-Campeche-Chiapas-Quintana Roo.xls <http://www.cec.org/files/pdf/pollutants/smoc/Yucatan-Campeche-Chiapas-Quintana%20Roo.xls>

Annex 4 — Listing of Mexican Universities and Institutions of Higher Education

Public Institutions

Benemérita Universidad Autónoma de Puebla
Centro de Enseñanza Técnica Industrial (CETI), Guadalajara, Jalisco
Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Baja California
Centro de Investigaciones Biológicas del Noroeste (Cibnor), La Paz, Baja California Sur
Instituto Politécnico Nacional (IPN)
Universidad Autónoma Agraria Antonio Narro (UAAAN), Saltillo, Coahuila
Universidad Autónoma Benito Juárez de Oaxaca
Universidad Autónoma Chapingo, Estado de México
Universidad Autónoma de Aguascalientes
Universidad Autónoma de Baja California
Universidad Autónoma de Baja California Sur
Universidad Autónoma de Campeche
Universidad Autónoma de Chiapas
Universidad Autónoma de Chihuahua
Universidad Autónoma de Ciudad Juárez, Chihuahua
Universidad Autónoma de Coahuila
Universidad Autónoma de Colima
Universidad Autónoma de Durango
Universidad Autónoma de Guanajuato
Universidad Autónoma de Guerrero
Universidad Autónoma de Nayarit
Universidad Autónoma de Nuevo León
Universidad Autónoma de Querétaro
Universidad Autónoma de Quintana Roo
Universidad Autónoma de San Luis Potosí
Universidad Autónoma de Sinaloa
Universidad Autónoma de Tamaulipas
Universidad Autónoma de Tlaxcala
Universidad Autónoma de Veracruz
Universidad Autónoma de Yucatán
Universidad Autónoma de Zacatecas
Universidad Autónoma de la Ciudad de México
Universidad Autónoma del Carmen, Ciudad del Carmen, Campeche
Universidad Autónoma del Estado de Hidalgo
Universidad Autónoma del Estado de México
Universidad Autónoma del Estado de Morelos
Universidad Autónoma Metropolitana (UAM), Ciudad de México

Universidad de Colima (Ucol)
Universidad de Guadalajara, Jalisco
Universidad de Guanajuato
Universidad de Quintana Roo
Universidad de Sonora (Unison)
Universidad del Mar, Oaxaca
Universidad Juárez del Estado de Durango
Universidad Juárez Autónoma de Tabasco
Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), Morelia, Michoacán
Universidad Nacional Autónoma de México (UNAM)
Universidad Pedagógica Nacional
Universidad Popular Autónoma del Estado de Puebla
Universidad Popular de la Chontalpa, Tabasco
Universidad Tecnológica de la Mixteca (UTM), Huajuapan, Oaxaca
Universidad Veracruzana

Private Institutions

Alliant International University (AIU), campus Ciudad de México
Centro de Enseñanza Técnica y Superior (Cetys), Baja California
Centro de Estudios Avanzados de las Américas (Ceaam), universidad en línea
Centro de Estudios Universitarios Xochicalco (CEUX), Baja California
Centro Universitario México (CUM), División de Estudios Superiores, Ciudad de México
Instituto de Estudios Superiores de Tamaulipas (IEST), Tampico, Tamaulipas
Instituto Tecnológico Autónomo de México (ITAM), Ciudad de México
Instituto Tecnológico de Estudios Superiores de Occidente (ITESO), Guadalajara, Jalisco
Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM)
Seminario Teológico Juan Calvino, Ciudad de México
Universidad Anáhuac del Norte, Huixquilucan, Estado de México
Universidad Anáhuac del Sur, Ciudad de México
Universidad Autónoma de Guadalajara (UAG), Jalisco
Universidad Autónoma Indígena de México, Sinaloa
Universidad Casa Blanca, Culiacán, Sinaloa
Universidad Cristóbal Colón, Veracruz
Universidad España (UNES), Durango, Durango
Universidad de Montemorelos (UM), Nuevo León
Universidad de Monterrey (UDEM), Nuevo León
Universidad de las Américas, Ciudad de México
Universidad de las Américas, Puebla
Universidad del Noroeste, Sonora
Universidad del Nuevo Mundo, Estado de México
Universidad del Valle de México, Ciudad de México
Universidad Iberoamericana, Ciudad de México
Universidad Intercontinental, Ciudad de México
Universidad Latina de América, Morelia, Michoacán
Universidad Latina de México, Celaya, Guanajuato

Universidad Latinoamericana, Ciudad de México
Universidad Motolinía, Ciudad de México
Universidad La Salle
Universidad Panamericana, campus Guadalajara
Universidad Panamericana, campus México
Universidad Regiomontana, Monterrey, Nuevo León
Universidad TecMilenio (UTM)
Universidad Tecnológica de México (Unitec), Ciudad de México
Universidad Tecnológica de Sinaloa
Universidad Valle del Bravo, Tamaulipas