A synthesis report on mercury in fish tissue from Mexico

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List of acronyms, abbreviations and units

^{16}N	16 Molar
^{6}N	6 Molar
bw	body weight
DL	detection limit
FDA	Food and Drug Administration
g	gram
HCl	oxygen chloride
Hg	mercury
HNO_3	Nitric acid
IUPAC	International Union of Pure and Applied Chemistry
mg	milligram
mL	millilitre
ng	nanogram
NRC	National Research Council
PBTS	persistent bioaccumulative toxic substances
pg	picogram
POPs	persistent organic pollutants
ppm	parts per million
QA/QC	quality assurance/quality control
RSD	relative standard deviation
SD	standard deviation
Sn(II)	stannous salt
TDI	tolerable daily intake
THg	total mercury
UQAM	*Université du Québec à Montréal*
µg	microgram

Purpose

This report summarizes existing data on mercury in fish tissue from Mexico. This report was commissioned by the CEC to gather information to complement similar data on mercury concentrations in fish from the United States and Canada, in support of the CEC's objective to use a regional approach to monitoring persistent and bio-accumulating toxics. This information will inform the possible development of strategies to address risks posed by consuming mercury-contaminated fish.

Several data sets were used: the Veracruz market study (UQAM and University of Ottawa data), the CEC Gray literature report[1], the Lake Zapotlán study (University of Toronto data)[2] and the Raptor study (Canadian Wildlife Service data). Since this was not a purposely designed study, these datasets originate from various sources and different laboratories. This limits the comparability of the results, an issue that is addressed in the "limitations" section of this report. The report also provides context regarding the levels of mercury found in fish tissue with reference to fish consumption advisories from Canada and the US, as well as other health advisory reference levels.

The information for this report was gathered from reviews of existing data from the states of Veracruz (Veracruz market study); Yucatán, Quintana Roo, Campeche, Chiapas, Aguascalientes, Querétaro, San Luis Potosí, Guanajuato, Sinaloa, Nayarit, Colima, Baja Norte, Sonora and Baja California Sur (Gray literature report); and Jalisco (Gray Literature report and Lake Zapotlán study). The Raptor study included samples collected in Jalisco, Veracruz, Oaxaca, Nayarit and Tabasco. There were no data on mercury in fish tissue for some of the states that underwent reviews.

Background

Veracruz Market Study

Approach

Samples of market fish, with species identification, were provided to the CEC, allowing for rapid determination of mercury levels in fish from an industrial area of Mexico.

Sample collection

Samples were collected from a local market providing residents with fresh fish as a protein source. After identification, muscle tissue samples were preserved in ethanol.

Sample preparation before analyses

The samples were heated at 45°C overnight in a drying oven to remove ethanol and freeze-dried for 24 hours. The skin and the scales were removed from the flesh.

[1] See CEC 2009.
[2] Branfireun 2008. A MSc thesis prepared by the student entrusted with the analyses is Malczyk 2009.

Total mercury analyses in fish

A portion of dried flesh, about 100 mg, was used for the analyses. Tissues were digested in a mixture of ^{16}N HNO_3: ^{6}N HCl (10 mL: 1 mL) acid and heated at 120°C for 4 hours. Samples were digested in a Pyrex® uncovered tube. The top part of the tube was cooled with a ventilating system to promote the condensation of vapours and to avoid the loss of mercury by evaporation. The solution was brought to a final volume of 30 mL with NANOpure® water and then analyzed by cold vapour atomic fluorescence, which measures the liberated mercury following its reduction by Sn(II). A digestion series included digestion blanks and a certified standard.

Calibration was determined by injecting known quantities of Hg (II) (400-1000 pg Hg). The detection limit for a 100 mg sample was 0.001 μg Hg/g. The accuracy of the method was verified using the TORT-2 certified standard (lobster hepatopancreas reference material from NRC). Results for two aliquots averaged 0,287 ±0,002 μg Hg/g, which falls well within the certified value range of 0,272 ±0,060 μg Hg/g.

The Gray Literature Report

Objectives

The Gray Literature work consisted of:

- Compilation of available information on PBTS studies and monitoring outside Mexico City found in the "gray literature". Information was sought through a search of university and institute libraries in the various Mexican states.
- Elaboration of an inventory on existing reports and summary results on qualification and quantification of PBTS,
- Systematization of the information on PBTS.

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

In a concise manner and using a standard matrix, a summary of information on the nature of the monitoring studies and the results of the studies referenced in the "gray literature" search included, whenever possible:

- location and geographical coverage of described monitoring exercises
- chemical(s) monitored (with a focus on the 12 POPs under the Stockholm Convention[3])

[3] Aldrin, Chlordane, DDT, Dieldrin, Dioxins, Endrin, Furans, Heptachlor, Hexachlorobenzene (HCB), Mirex, Polychlorinated Biphenyls (PCBs), Toxaphene; as well as Lindane.

- toxic metals[4]
- media/matrices sampled
- results and, if available, mean, minimum, maximum, median, range, mean of detected samples, spatial and/or temporal trends
- number of samples
- number of samples over detection limits
- time period of monitoring
- a QA/QC assessment[5] 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.
- references.

Approach

Compilation of available information was provided by knowledgeable Mexican academics and graduate students who were likely to have a close professional and geographical relationship to the sampling and data development for the studies anticipated to be archived in the specific region. The list of visited institutions is provided in annex 1.

Limitations of the Gray Literature report

This report does not pretend to have thoroughly assessed all available information on PBTS in these regions. Difficulties in accessing information were encountered, both in university libraries and in governmental institutions that were visited. University libraries do not necessarily have a computerized search engines and some governmental institutions were reluctant to provide information without prior clearance from their senior management or headquarters. For this reason, one of the significant limitations of the report is that data collection may not represent all 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 included in the matrix could not provide data on every listed criterion described under “Specific Objectives” above. The standard matrix was adapted to represent the regional information availability and 5 regional matrices were developed as

[4] Cadmium, Lead, Mercury.

[5] 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-.

a result. More information is provided in the report *A Compilation and Classification of Unpublished Scientific Information on Persistent, Bioaccumulative Toxic Substances in Mexico (Gray Literature Report)*[6].

For the current report, mercury fish tissue data was retrieved from the 5 regional matrix of the Gray Literature report and compiled in a separate database (see annex 2). The only data kept for the summary table were those explicitly related to muscle measurements, which represent the relevant end point when dealing with human fish consumption. Mercury fish tissue data was available in few studies from Sinaloa, Baja Norte, Colima and Sonora.

Assessing Mercury Exposure Risk in the Lake Zapotlán Watershed, Mexico[7]

Objectives

This project was undertaken in three phases, supported by the CEC. The overarching project objective was to assess the potential for an elevated risk of methylmercury exposure for wildlife and human populations in Lake Zapotlán and the surrounding wetlands.

Phase 1, 2 and 3 project pursued several specific objectives (for more information refer to the Assessing Mercury Exposure Risk in the Lake Zapotlán Watershed, Mexico report). Specific objective related to the purpose of the current report is listed below.

Specific objective

To undertake a fish sampling program in cooperation with local fishers in October (end of wet season, high water for phase 1) in February (mid-dry season, low water for phase 2) and in June-July (beginning of wet season for phase 3). Small samples of flesh were taken from the commercial catch on a routine basis, and analysed for mercury content.

Approach[8]

Sample Acquisition

The fish were acquired via various methods. Live fish were acquired directly from the local fishers as they landed their catch. Ancillary data (weight, length) were collected at time of capture. The fish were killed and chilled until returned to the facility for processing. For larger fish, one or two grams of tissue were cut from the filet of the fish, with skin removed. The tissue sample was double-bagged, labelled and frozen at -15°C or

[6] http://www.cec.org/Page.asp?PageID=1180&ContentID=&SiteNodeID=512&BL_ExpandID=155

[7] Assessing Mercury Exposure Risk in the Lake Zapotlán Watershed, Mexico, report

[8] The methodological aspects were provided by Brian A. Branfireun and described in the Assessing Mercury Exposure Riskin the Lake Zapotlán Watershed, Mexico report

colder. Smaller fish or minnows were frozen intact.

Total Mercury Analysis

The Milestone DMA-80 Direct Mercury Analyzer was used to analyze THg in fish tissue. Fish tissue standard reference materials were used (see report for more details).

General Quality Assurance

a) *Standardization*: Standardization was performed at least once at the beginning of a daily sample run.

For all analyses, a standard curve was used to calculate sample concentrations measured from an instrument response. The curve was generated by measuring instrument responses for a series of standard solutions of the analyte. Sample concentrations were then calculated by interpolating between the standard points. A set of at least three standards that bracket the expected sample concentrations was used for standardization. Instrument responses used to generate the standard curve must be linear according to criteria established for the specific method or a second series of standard solutions are analyzed prior to analysis of any samples.

b) *Precision – Duplicates*: The precision of an analytical procedure was determined by performing replicate analysis of a sample and had to meet the criteria established for the specific method. The indices of precision used are relative percent difference (RPD) and relative standard deviation (RSD):

RPD (%) = ((|X1-X2|)/mean) x 100

RSD (%) = (standard deviation/mean) x 100,

where X1 and X2 are the measured values for the first and second replicates, respectively. The Detection Limit (DL) is the concentration that is three standard deviations of multiple blank analyses (IUPAC definition for a 99% confidence level). Below this concentration, the analyte is considered to be undetectable. The region from three to five times the standard deviation of the blanks is the region of detection but not quantification. A concentration greater than five times the standard deviation of the blanks is the region of quantification. The RPD and RSD are applicable only in the region of quantification. If the RPD or RSD exceeded 10 percent for total mercury, the sample was reanalyzed.

c) *Accuracy – Spikes*: Sample accuracy was determined by adding a known amount of the analyte (spike) to the sample and measuring the change in concentration. The percent recovery was used as the index for measuring accuracy and was calculated as follows:

Percent Recovery = ((C2-C1)/C2) x 100,

where C2 is the spiked sample concentration and C1 is the sample concentration. Percent recoveries must meet criteria established for the specific method or a

second spiked sample must be analyzed. If the second spike did not meet criteria then all sample data for that run are suspect and were reanalyzed, or a flag was assigned to draw attention to that data.

d) *Blanks Method* was analyzed to verify that the analytical system was free of contamination and sample carryover. The mean of the instrument responses from the blanks was used as the zero value in the calibration curve and in the calculation of the DL. The DL/volume of sample in litres, as calculated from the first three blanks, must be less than the expected sample concentration.

Raptor Study: Mercury in muscle tissue from various species of Mexican fish[9]

Objectives

The objectives of this study were to determine mercury content in muscle samples of thirteen species of fish from 17 regions in Mexico.

Approach[10]

Sample Preparation: The muscle tissues taken from the fish were previously homogenized; 12 samples were composites of 4-5 individuals. With chemically cleaned spatulas,[11] 1 – 1.5 gram aliquots were taken. All of the samples were stored in acid-washed polypropylene vials, and were freeze-dried[12] for at least 72 hours, and then re-weighed to obtain their moisture content (as percentage). They were stored in a dessicator at room temperature.

Laboratory Quality Assurance: The balances[13] were checked daily for accuracy using an in-house set of weights,[14] between certified yearly calibrations. Those results with an average daily error based on at least four different weights and below |0.30g| were accepted. All of the pipettes used during the organic Hg extraction and sample reading were tested daily on the Mettler AE166. The pipettes were calibrated whenever they failed to satisfy the criteria for a pass, that is having less than 2% inaccuracy and with less than 2% RSD between at least four readings

Total Mercury

Analytical Method: Total mercury was determined on the solid, freeze-dried samples using the AMA-254 (mercury analyser), equipped with the ASS-254 Autosampler for

[9] Hg in Mexican Fish Hg analysis on muscle tissue from various species of Mexican fish Report – METRES-06-04

[10] The methodological aspects were provided by Tony Scheuhammer and described in the Hg in Mexican Fish Hg analysis on muscle tissue from various species of Mexican fish Report – METRES-06-04 report.

[11] This was performed according to the standard operating procedures for chemical cleaning of glassware and labware, SOP-TP-PROC-01D, July 6, 2005.

[12] Labconco Freezone 6

[13] Mettler AE166 and Sartorious AC210P

[14] Ohaus Sto-A-Weigh

Solid Samples (Altec, Czech Republic). Those samples that read between the two calibration ranges[15], that is, between 35ng and 45ng, were repeated at different weights to correct for any inaccuracy.

Total Mercury Accuracy: Several solid certified Standard Reference Materials (SRMs) are measured each day to validate the calibration curves.

Total Mercury Precision: Precision was measured by duplicate analyses variability - within day variability and between day variability, and this was quantified by calculating the % RSD[16].

Total Mercury Detection Limit: The theoretical method detection limit (TMDL) was determined by reading at least 5 – 9 blanks and determining the standard deviation calculated at 99% confidence limits, so that the DL = 3SD. The practical detection limit (PMDL) is 5 times the TMDL, and is used as the cutoff for samples. For total Hg, the PMDL ranged from 0.07 – 0.27 ng. Those samples below this limit are repeated at higher sample weights if possible. If a sample is still below the TMDL, it is reported as <TMDL, along with the uncertainty (± 2SD) of the sample.

Results

A matrix summarizing the information per region is provided in annex 2. Information on mean total mercury content in fish (standard deviation and maximum values, when provided in the reports), study from which the information was retrieved, species common and scientific name, trophic niche (herbivorous, detrivorous, carnivorous and mixed) and number of samples are included.

A table summarizing the mean total mercury content for each fish species (standard deviation and maximum values, when provided in the reports), including the number of samples is also provided in annex 2

The data summarized in Table 1 integrate information from the scientific reports (Lake Zapotlán, Raptor study), the Gray literature and Veracruz market reports.

Overall, fish mercury content is low, below the fish consumption advisories from Canada and the United States.

In the United States, the FDA has an action level for methylmercury in commercial marine and freshwater fish that is 1.0 parts per million (ppm), while in Canada the limit for the total mercury content for most commercial fish is 0.5 ppm, with a 1.0 ppm guideline applied to certain predatory species. All fish species subject to the 1.0 ppm guideline are also included in consumption advisory. The FDA action level for methylmercury in fish is 1.0 μg/g wet weight, which is used to regulate the sale of commercially caught fish for human consumption (U.S. Food and Drug Administration, 1994). The USEPA recently established a maximum methylmercury concentration of

[15] Range 1: 0 – 40 ng, Range 2: 40 – 600 ng
[16] RSD = SD/mean * 100%

0.30 μg/g wet weight as the fish tissue residue criterion for protecting human health (U.S. Environmental Protection Agency, 2001).

Table 1: Summary of information on number of species and fish mercury content

	Scientific reports[17]	Gray literature	Veracruz market	Total or weighted mean
Number of species	11	33	10	54
Number of carnivorous species	5	26	8	39
Mean Hg level and standard deviation of means for all species (µg/g wet)	0.094 (0.07)	0.220 (0.16)	0.258 (0.52)	0.196 (0.263)
Median Hg level for all species (µg/g wet)	0.092	0.190	0.093	0.137
Min-Max of means for all species (µg/g wet)	0.008-0.238	0-0.764	0.018-1.879	0-1.879
No. species over 0.25 µg Hg/g wet)	0	10	2	12
No. species over 0.5 µg Hg/g wet)	0	2	1	3

Three fish species (see figure 1) presented Hg levels higher than the Canadian commercial fish guideline of 0.5 ppm (Yellowtail amberjack in Sonora, based on 2 samples; Pacific crevalle jack in Sinaloa, based on 2 samples; Pacific porgy in Veracruz, based on 1 sample).

[17] Scientific reports include the Lake Zapotlan study and the Raptor study

Figure 1: Mapping of available total mercury results in fish across Mexico

Based on a STELLA-based one-compartment model (Canuel et al., 2006) that offers a convenient way to test the relationships of various data sets on human MeHg exposure presented by the NRC (2000), simulation runs were made to evaluate the expected hair Hg levels for different consumption profiles:

- Consumption of 150g of fish containing 29.4 µg (**0.196** ppm) of Hg every 3 days for a 60kg bodyweight person would translate into hair Hg level of **2.4** ppm Hg.
- Daily consumption of 150 grams of fish containing 29.4 µg (**0.196** ppm) of Hg for a 60kg bodyweight person would translate into hair Hg level of **7** ppm Hg.

Health Canada considers a hair level of <6 ppm for adults to be within the normal acceptable range (Health Canada, 2004). Health Canada's provisional TDI of 0.2 ug MeHg per kg bw per day for children and women of child-bearing age (Health Canada, 2007) can be converted to a hair level of 2 ppm.

The Tolerable Daily Intake (TDI) is defined as the maximum amount of a chemical that can be ingested on a daily basis over a lifetime without increased risk of adverse health effects.

In the United States, a reference dose of 0.1 μg MeHg per kg bw per day is proposed. The reference dose (RfD) is an amount of methylmercury, which when ingested daily over a lifetime is anticipated to be without adverse health effects to humans, including sensitive subpopulations. At the RfD or below, exposures are expected to be safe. The risk following exposures above the RfD is uncertain, but risk increases as exposures to methylmercury increase.

RfDs are reviewed by Agency scientists for accuracy, appropriate use of risk assessment methodology, appropriate use of data and other scientific issues.

Hair mercury concentrations of 1 ppm or less are associated with dietary intakes of mercury of an estimated 0.1 μg/kgbw/day.

Limitations

Several sources were used to compile the data on mercury in fish tissue from Mexico. Data comparability can be defined as the characteristics that allow information from many sources to be of definable or equivalent quality so that it can be used to address program objectives not necessarily related to those for which the data were collected. Achieving data comparability and communicating the characteristics of the data that permit assessment of comparability (utility) by a secondary user are key issues to address. The issues involved in achieving data comparability to maximize data utilization are consistent with operating in a well-defined quality system. Methods and procedures need to be fully described, validated, and performed by competent practitioners, and performance needs to be evaluated against a reference. These requirements are equally applicable to field and laboratory data and physical, chemical, and biological measures.

Convenience samples, such as those used in this report, do not usually integrate in their design, methods and sampling frame the required information to address data comparability and, to a lesser extent, generalization of results to North America.

To ensure comparability, studies should provide information on:

- objectives
- data source
- detection level
- precision
- analytical methods and laboratory quality assurance procedures
- potential bias
- sample/handling methods
- sample size
- fish species

- fish length
- fish tissue analyzed

The Lake Zapotlán study, the Raptor study and, to a lesser extent, the Veracruz Market study, provided extensive information on the objectives, data source, detection level, precision, potential bias, sample/handling methods, analytical methods and laboratory quality assurance procedures.

In the Gray Literature report, Quality Control and Quality Assurance (QA/QC) information from sample collection to chemical analysis through data reporting was very scarce, indicating a critical shortcoming in these matrices. Lack of information on these critical aspects compromises an optimal usage of such information.

Overall, sample size in most studies was very small, except for the Lake Zapotlán study and two studies identified through the Gray literature report. Therefore, cautious interpretation of the fish THg content is required.

Another important aspect is related to the lack of information, for most studies, on fish length and in many cases on the kind of fish tissue analyzed. Fish mercury content is related to age and fish length; there can be a four-fold difference in mercury content between a one-year old and a six-year old fish. Without any specification on fish length, it is very difficult to compare data (Tremblay et al, 1998). For these reasons, fish length is an important aspect to consider; this information was only provided in Lake Zapotlán study.

Edible fish length (basically, the length of the part of the fish that is usually eaten, i.e. the body excluding the head and the tail) and species are also an important aspect to document when considering fish consumption advisories. Without knowledge of fish species usually consumed, it remains difficult to conclude if the data set assembled in this report provides a source of valuable starting point information, from the community health perspective.

Conclusions

This report provides a first overview on mercury in fish tissue from Mexico, using several data sets. A first glance on data comparability, defined as the characteristics that allow information from many sources to be of definable or equivalent quality so that it can be used to address program objectives not necessarily related to those for which the data were collected, was sought. It is further emphasized by this report that validated information which has been subjected to rigorous QA/QC protocols is imperative if decision makers are to base their policy directions on scientifically derived information. Therefore, it must be concluded that data from the Gray literature review did not provide enough background information to allow a proper comparison and integration of data to perform a meta-analysis, where the objective is to combine the results of several studies that address a set of related research hypotheses.

Fish consumption advisories from Canada and the US, as well as other health advisory

reference levels are also provided in this report. Available data on levels of mercury in fish tissue from Mexico were analyzed in regard to giving preliminary advice with reference to fish consumption and health advisories from these countries. Species of fish that are commonly consumed were only included in the Veracruz fish market and Lake Zapotlán study. Without knowledge of fish species usually consumed regionally in Mexico (fish consumption patterns), it is difficult to conclude from the data summarized in this report on the potentiality for an elevated risk of methylmercury exposure for Mexican fish consumers.

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Annex 1: Listing of visited Mexican Universities

Public Institutions

Universities

Instituto Politécnico Nacional (IPN)
Benemérita Universidad Autónoma de Puebla
Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), Morelia, Michorrracán
Universidad de Colima (UCOL), Colima, Colima
Universidad de Guanajuato
Universidad de Quintana Roo
Universidad de Sonora (Unison), Hermosillo, Sonora
Universidad de Guadalajara, Guadalajara, Jalisco
Universidad Juárez del Estado de Durango
Universidad Juárez Autónoma de Tabasco, Villahermosa
Universidad Pedagógica Nacional
Universidad Popular Autónoma del Estado de Puebla
Universidad Popular de la Chontalpa
Universidad Tecnológica de la Mixteco (UTM), Huajuapan, Oaxaca
Universidad Veracruzana
Centro de Enseñanza Técnica Industrial (CETI), Guadalajara, Jalisco,
Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Ensenada, Baja California
Centro de Investigaciones Biológicas del Noroeste (CIBNOR), La Paz, Baja California Sur
Universidad Autónoma del Estado de México, Toluca, Estado de México
Universidad del Mar
Autonomous Universities
Universidad Autónoma Chapingo
Universidad Autónoma de Aguascalientes (UAA), Aguascalientes, Aguascalientes
Universidad Autónoma de Baja California
Universidad Autónoma de Baja California Sur
Universidad Autónoma de Campeche
Universidad Autónoma del Carmen
Universidad Autónoma de la Ciudad de México
Universidad Autónoma de Chiapas
Universidad Autónoma de Chihuahua
Universidad Autónoma Agraria Antonio Narro (UAAAN)
Universidad Autónoma Benito Juárez de Oaxaca, Oaxaca, Oaxaca
Universidad Autónoma de Coahuila
Universidad Autónoma de Ciudad Juárez
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 (UAQ), Querétaro, 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 Yucatán
Universidad Autónoma de Zacatecas
Universidad Autónoma del Estado de Hidalgo
Universidad Autónoma del Estado de México (UAEM)
Universidad Autónoma del Estado de Morelos
Universidad Autónoma Metropolitana
Universidad Autonoma de Veracruz,
Universidad Juárez Autónoma de Tabasco
Universidad Nacional Autónoma de México (UNAM), México, D.F.

Research Center

Centro de Investigacion Cientifica y de Educacion Superior de Ensenada, (CICESE)

Private Institutions

Universities

Centro de Enseñanza Técnica y Superior (CETYS)
Centro Universitario México, División de Estudios Superiores
Instituto de Estudios Superiores de Tamaulipas (IEST), Tampico, Tamaulipas
Instituto Tecnológico Autónomo de México (ITAM), Ciudad 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 México
Universidad Autónoma de Guadalajara (UAG), Guadalajara, Jalisco
Universidad Anáhuac del Sur
Universidad Anáhuac del Norte
Universidad Casa Blanca
Universidad de las Americas, A.C., Ciudad México
Universidad de las Américas, Puebla, Puebla
Universidad del Valle de México
Universidad Iberoamericana Ciudad de México
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Universidad La Salle
Universidad Panamericana Sede Guadalajara,
Universidad Panamericana Sede México,
Universidad Regiomontana
Universidad de Montemorelos (UM)
Universidad de Monterrey (UDEM)
Universidad España (UNES)

Universidad TecMilenio (UTM)
Universidad Tecnológica de México (UNITEC)
Universidad Tecnológica de Sinaloa,
Universidad Valle del Bravo
Centro de Estudios Universitarios Xochicalco, CEUX,
Universidad del Noroeste,
Universidad del Nuevo Mundo
Universidad Latina de América,
Universidad Latina de México
Universidad Latinoamericana
Universidad Motolinía
Universidad Regiomontana
Universidad Cristóbal Colon

Other

Alliant International University (AIU), (Mexico City)
Universidad Autónoma Indígena de México, Mochicahui, Sinaloa
Universidad Online
Centro de Estudios avanzados de las Américas (CEAAM), Distrito Federal, México

Annex 2: Summary matrix

Table 1: Results of the summary matrix per region

Region	Study	Species	Scientific name	Trophic niche	number samples	Hg mean (ww)(ppm)	sd	Max	Other names	Water	Hyperlink
Jalisco	**Lake Zatoplan**	Tilapia	*Oreochromis sp.*	Mixed	88	**0,004**	na	0,014	Red tilapia	F,B	http://www.aquaculture.co.il/Services/56strain.html
Jalisco	**Lake Zatoplan**	Carp	*Cyprinus carpio*	Detritivorous	46	**0,008**	na	0,029	Common carp	F,B	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1450&genusname=Cyprinus&speciesname=carpio%
Jalisco	**Raptor study**	Mackerel	*Scomberomorus sierra*	Carnivorous	4	**0,178**	0,092	0,045	Pacific sierra, spanish mackerel	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=126&genusname=Scomberomorus&speciesname=
Jalisco	**Raptor study**	Mullet	*Mugil sp.*	Mixed (algae, juveniles, plankton)	6	**0,018**	0,008	0,033	White mullet	F,B,M	http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema
Jalisco	**Raptor study**	Mojarra	*Geridae sp.*	Mixed (insects, clams,detritus)	5	**0,035**	0,010	0,302	Pacific flagfin, Eucinostomus currani	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13728&genusname=Eucinostomus&speciesname=
Veracruz	**Raptor study**	Mullet le brancha	*Mugil curema*	Detritivorous	10	**0,095**	0,078	0,186	White mullet	F.B.M	http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema
Veracruz	**Raptor study**	Snook chuchumite	*Centropomus parallelus*	Carnivorous	10	**0,182**	0,091	0,371	Fat snook	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1014&genusname=Centropomus&speciesname=pa
Veracruz	**Raptor study**	Guabino	*Gobiomorus dormitor*	Carnivorous	7	**0,104**	0,010	0,117	Bigmouth sleeper	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3831&genusname=Gobiomorus&speciesname=dor
Veracruz	**Raptor study**	Catfish	*Arius felis*	Carnivorous (crabs, fish, shrimps)	5	**0,132**	0,071	0,239	Hardhead catfish, sea catfish	M	http://www.tpwd.state.tx.us/huntwild/wild/species/hardhead/
Veracruz	**Raptor study**	Tilapia jonuta	*Cichlasoma uropthalmus*	Carnivorous (small fish, invertebrates)	10	**0,100**	0,058	0,158	Mexican Mojarra	F,B	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=4798&genusname=Cichlasoma&speciesname=urop
Veracruz	**Raptor study**	Tilapia topuda	*Oreochromis niloticus*	Herbivorous	3	**0,012**	0,006	0,019	Nile Tilapia	F,B	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=2&genusname=Oreochromis&speciesname=niloticu
Oaxaca	**Raptor study**	Chulin	*Rhamdia sp.*	Carnivocous (fish, insects,crustaceans	3	**0,130**	0,011	0,142	Guatemalan chulin, catfish Rhamdia guatemalensis	F	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=23351&genusname=Rhamdia&speciesname=quele
Oaxaca	**Raptor study**	Tilapia topuda	*Oreochromis niloticus*	Herbivorous	4	**0,018**	0,006	0,022	Nile Tilapia	F,B	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=2&genusname=Oreochromis&speciesname=niloticu
Nayarit	**Raptor study**	Mullet	*Mugil sp.*	Mixed (algae, juveniles, plankton)	12	**0,029**	0,014	0,057	White mullet	F,B,M	http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema
Nayarit	**Raptor study**	Tang	*Paracanthurus hepatus*	Herbivorous	4	**0,092**	0,055	0,169	Blue tang, palette surgeonfish	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=6017&genusname=Paracanthurus&speciesname=h
Nayarit	**Raptor study**	Catfish	*Arius sp.*	Carnivorous (crabs, fish, shrimps)	6	**0,165**	0,061	0,268	Hardhead catfish, sea catfish	M	http://www.tpwd.state.tx.us/huntwild/wild/species/hardhead/
Nayarit	**Raptor study**	Sardinas	*Centropomus sp.*	Carnivorous	6	**0,238**	0,129	0,460	Fat snook	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1014&genusname=Centropomus&speciesname=pa
Tabasco	**Raptor study**	Guabino	*Gobiomorus dormitor*	Carnivorous	5	**0,027**	0,050	0,033	Bigmouth sleeper	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3831&genusname=Gobiomorus&speciesname=dor
Tabasco	**Raptor study**	Catfish	*Arius felis*	Carnivorous (crabs, fish, shrimps)	3	**0,135**	0,125	0,278	Hardhead catfish, sea catfish	M	http://www.tpwd.state.tx.us/huntwild/wild/species/hardhead/
Tabasco	**Raptor study**	Chulin	*Rhamdia sp.*	Carnivocous (fish, insects,crustaceans	4	**0,104**	0,042	0,145	Guatemalan chulin, catfish Rhamdia guatemalensis	F	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=23351&genusname=Rhamdia&speciesname=quele
Tabasco	**Raptor study**	Tilapia jonuta	*Cichlasoma uropthalmus*	Carnivorous (small fish, invertebrates)	5	**0,037**	0,022	0,059	Mexican Mojarra	F,B	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=4798&genusname=Cichlasoma&speciesname=urop
Sinaloa (3)	**Grey Literature**	Cominate sea catfish	*Arius platypogon*	Carnivorous	2	**0,196**	nc	na	*Sciades platypogon*	B,M	http://www.fishbase.org.cn/Summary/SpeciesSummary.php?id=13479&lang=German
Sinaloa (3)	**Grey Literature**	Pacific crevalle jack	*Caranx caninus*	Carnivorous	2	**0,664**	nc	na		B.M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1901&genusname=Caranx&speciesname=caninus
Sinaloa (4)	**Grey Literature**	Bull shark	*Carcharhinus leucas*	Carnivorous	1	**0,173**	nc	na		F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=873&genusname=Carcharhinus&speciesname=leuc
Sinaloa (3)	**Grey Literature**	Ocean whitefish	*Caulolatilus princeps*	Carnivorous	4	**0,114**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3539&genusname=Caulolatilus&speciesname=prin
Sinaloa (3)	**Grey Literature**	Snook	*Centropomus sp.*	Carnivorous	11	**0,213**	nc	na	Fat snook	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1014&genusname=Centropomus&speciesname=pa
Sinaloa (4)	**Grey Literature**	Orangemouth weakfish	*Cynoscion xanthulus*	Carnivorous	8	**0,000**	nc	na	Orangemouth corvina	M	http://www.discoverlife.org/20/q?search=Cynoscion+xanthulus&b=FB3582
Sinaloa (3)	**Grey Literature**	Peruvian mojarra	*Diapterus peruvianus*	Carnivorous	5	**0,113**	nc	na	Short-snout mojarra	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=10430&genusname=Diapterus&speciesname=peru
Sinaloa (3)	**Grey Literature**	Pacific ladyfish	*Elops affinis*	Carnivorous	4	**0,194**	nc	na	Machete, Pacific machete	B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=2601&genusname=Elops&speciesname=affinis
Sinaloa (3)	**Grey Literature**	Graceful mojarra	*Eucinostomus gracilis*	Carnivorous	3	**0,136**	nc	na	Pacific flagfin mojarra; slender mojarra	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3565&genusname=Eucinostomus&speciesname=g
Sinaloa (4)	**Grey Literature**	Peruvian sea catfish	*Galeichthys peruvianus*	Carnivorous	1	**0,317**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13493&genusname=Galeichthys&speciesname=pe
Sinaloa (3)	**Grey Literature**	Yellow fin mojarra	*Gerres cinereus*	Carnivorous (invertebrates,crustaceans)	6	**0,157**	nc	na		F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1054&genusname=Gerres&speciesname=cinereus
Sinaloa (3)	**Grey Literature**	Yellostripe grunt	*Haemulopsis axilaris*	Carnivorous	3	**0,246**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13734&genusname=Haemulopsis&speciesname=a
Sinaloa (3)	**Grey Literature**	Greybar grunt	*Haemulon sexfasciatum*	Carnivorous	5	**0,298**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13718&genusname=Haemulon&speciesname=sexf
Sinaloa (3)(4)	**Grey Literature**	Colorado snapper	*Lutjanus colorado*	Carnivorous	20	**0,139**	nc	na		B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1426&genusname=Lutjanus&speciesname=colorad
Sinaloa (3)(4)	**Grey Literature**	Flathead mullet	*Mugil cephalus*	Mixed	19	**0,022**	nc	na	Striped mullet	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=785&genusname=Mugil&speciesname=cephalus
Sinaloa (3)(5)	**Grey Literature**	White mullet	*Mugil curema hembra*	Mixed (algae, juveniles, plankton)	134	**0,078**	nc	na	White mullet, *Mugil curema*	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema
Sinaloa (3)	**Grey Literature**	Roosterfish	*Nematistius pectoralis*	Carnivorous	2	**0,268**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3550&genusname=Nematistius&speciesname=pec
Sinaloa (3)	**Grey Literature**	Leatherjack	*Oligoplites saurus*	Carnivorous	2	**0,348**	nc	na	Yellowtail leatherjack	B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1001&genusname=Oligoplites&speciesname=saur
Sinaloa (3)	**Grey Literature**	Spechled flounder	*Paralichthys woolmani*	Carnivorous	3	**0,136**	nc	na	Halibut	B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13971&genusname=Paralichthys&speciesname=wo
Sinaloa (3)	**Grey Literature**	Sand grunt	*Pomadasys branickii*	Carnivorous	2	**0,234**	nc	na		B.M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13736&genusname=Pomadasys&speciesname=bra
Sinaloa (3)	**Grey Literature**	White grunt	*Pomadasys leuciscus*	Carnivorous	2	**0,190**	nc	na	*Haemulopsis leuciscus*, Raucous grunt	B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13720&genusname=Haemulopsis&speciesname=le
Sinaloa (3)	**Grey Literature**	Roncador	*Roncador stearasii*	Carnivorous	3	**0,278**	nc	na	Spotfin croaker	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3588&genusname=Roncador&speciesname=stearn
Sinaloa (3)	**Grey Literature**	Pacific sierra	*Scomberomorus sierra*	Carnivorous	1	**0,128**	nc	na	Spanish mackerel	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=136&genusname=Scomberomorus&speciesname=
Sinaloa (3)	**Grey Literature**	Bigeye scad	*Selar crumenophhalmus*	Planktivorous	3	**0,130**	nc	na	Pulse-eyed scad	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=387&genusname=Selar&speciesname=crumenoph
Sinaloa (3)	**Grey Literature**	Bullseye puffer	*Sphoeroides annulatus*	Carnivorous	15	**0,152**	nc	na		B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=4293&genusname=Sphoeroides&speciesname=ann
Sinaloa (4)	**Grey Literature**	Scalloped hammerhead	*Sphyrna lewini*	Carnivorous	1	**0,320**	nc	na		B.M	http://www.fishbase.org/summary/speciessummary.php?id=912
Sinaloa (3)	**Grey Literature**	Paloma pompano	*Trachinotus paitensis*	Mixed (gastropods, worms, crustaceans)	3	**0,284**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1972&genusname=Trachinotus&speciesname=pait
Golfo de California (6)	**Grey Literature**	Black brotula	*Cherublemma emmelas*	Carnovorous	24	**0,140**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13926&genusname=Cherublemma&speciesname=
Golfo de California (6)	**Grey Literature**	Roundel bayfish	*Zalieutes elater*	Mixed (crustaceans,bony fishes)	9	**0,100**	nc	na	Spotted batfish	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3096&genusname=Zalieutes&speciesname=elater
Colima (7)	**Grey Literature**	Spotted rose snapper	*Lutjanus guttatus*	Mixed (crustaceans,bony fishes)	48	**0,047**	nc	na		B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=152&genusname=Lutjanus&speciesname=guttatus
Sonora (8)	**Grey Literature**	Flathead mullet	*Mugil cephalus*	Mixed	6	**0,019**	nc	na		F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=785&genusname=Mugil&speciesname=cephalus
Sonora (8)	**Grey Literature**	Pacific thread herring	*Opisthonema libertate*	Mixed (zoo, phyto, larvae)	8	**0,209**	nc	na	Deepbody thread herring	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1484&genusname=Opisthonema&speciesname=lib
Sonora (8)	**Grey Literature**	Congo sea catfish	*Cathorops fuerthii*	Carnivorous	6	**0,460**	nc	na		F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=13491&genusname=Cathorops&speciesname=fuer
Sonora (8)	**Grey Literature**	Yellowtail amberjack	*Seriola lalandi*	Carnivorous	2	**0,764**	nc	na	Yellowtail	B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=382&genusname=Seriola&speciesname=lalandi
Veracruz	**Veracruz market**	Grunt	*Anisotremus davidsoni*	Mixed (crustaceans, mollusks, bryozoans	1	**0,064**	nc	na	Xantic sargo	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3568&genusname=Anisotremus&speciesname=dav
Veracruz	**Veracruz market**	Mexican barracuda	*Sphyraena ensis*	Carnivorous	1	**0,355**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=6405&genusname=Sphyraena&speciesname=ensis
Veracruz	**Veracruz market**	Mullet la brancha	*Mugil curema*	Detritivorous	1	**0,018**	nc	na	White mullet	F.B.M	http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema
Veracruz	**Veracruz market**	Yellow fin snook	*Centropomus robalito*	Mixed (crustaceans,bony fishes)	1	**0,112**	nc	na		B.M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=10978&genusname=Centropomus&speciesname=r
Veracruz	**Veracruz market**	Dwarf sand perch	*Diplectrum bivittatum*	Carnivorous	1	**0,168**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3318&genusname=Diplectrum&speciesname=bivitt
Veracruz	**Veracruz market**	Vermillion snapper	*Rhomboplites aurorubens*	Carnivorous	1	**0,039**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=213&genusname=Rhomboplites&speciesname=aur
Veracruz	**Veracruz market**	Pacific porgy	*Calamus brachysomus*	Carnivorous	1	**1,879**	nc	na		M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3573&genusname=Calamus&speciesname=brachy
Veracruz	**Veracruz market**	Tilapia	*Eucinostomus californiensis*	Carnivorous	1	**0,019**	nc	na	Graceful mojarra, Eucinostomus gracilis	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3565&genusname=Eucinostomus&speciesname=g
Veracruz	**Veracruz market**	Grunt	*Anisotremus davidsoni*	Mixed (crustaceans, mollusks, bryozoans	1	**0,073**	nc	na	Xantic sargo	F.B.M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=3568&genusname=Anisotremus&speciesname=dav
Veracruz	**Veracruz market**	Fat snook	*Centropomus parallelus*	Carnivorous	1	**0,175**	nc	na	Snook chuchumite	F,B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=1014&genusname=Centropomus&speciesname=pa
Veracruz	**Veracruz market**	Red snapper	*Lutjanus peru*	Carnovorous	1	**0,137**	nc	na	Pacific red snapper	M	http://www.fishbase.org/Summary/SpeciesSummary.php?ID=170&genusname=Lutjanus&speciesname=peru
Veracruz	**Veracruz market**	Trout	*Cynoscion arenarius ??*	Carnivorous	1	**0,057**	nc	na	White seatrout	B,M	http://www.fishbase.org/Summary/SpeciesSummary.php?id=1170

COLOR CODE:
Yellow highlight: Misuse of common or scientific name or misspelling or information deduced according to species scientific name indicated in the database.
Gray highlight: Data from gray literature

GENERAL CONSIDERATIONS:
- Hg data are reported as µg Hg/g fish wet weight; Hg values are averages per species.
- F: freshwater; B: brackish water; M: marine; nc: not compiled, na: not available.
- When a scientific name was unspecified at the species level (e.g., *Oreochromis* sp.) the most probable common name at the species level, given the geographical region, was chosen.

DATA SOURCE:
Reports:
(1) Lake Zapotlán study: Assessing Mercury Exposure Risk in the Lake Zapotlán Watershed, Mexico; B. Branfireun; U. Toronto (2008); Maximum values were estimated from the graphs provided in the report.
(2) Raptor study: Hg in Mexican fish - Hg analysis on muscle tissue from various species of Mexican fish - Report - METRES-06-04; T. Scheuhammer & J. Dorzinsky; Environment Canada (2006); Data originally reported in dry weight; transformed in wet weight considering a water content of 80%.

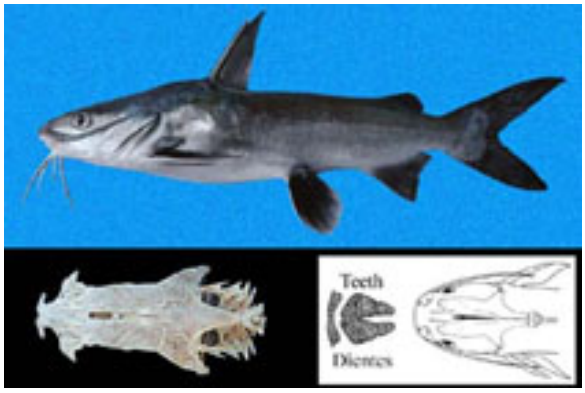
Gray Literature:Data measured on fish muscle were the only ones kept for the summary on the gray literature;
(3) Meza López Guadalupe. 2005. Distribución de mercurio en músculo, branquias e Hígado de diversas especies de peces de importancia comercial en el estado de Sinaloa. Tesis Profesional. Instituto Tecnológico del Mar, Unidad Mazatlán. Data considered to be originally reported in dry weight; transformed in wet weight considering a water content of 80%.
(4) Valenzuela Aguilar Elizabeth. 2003. Concentración de mercurio en 4 especies de peces y 2 especies de tiburones del sistema lagunar Altata.Ensenada del Pabellón, Sin. Tesis Profesional. Instituto Tecnológico del Mar, Unidad Mazatlán. Data considered to be originally reported in dry weight; transformed in wet weight considering a water content of 80%.
(5) Rodríguez Preciado Any. 2004. Análisis comparativo de la concentración de mercurio en el tejido muscular de la lisa Mugil curema, (Valenciennes,1836) delos esteros Urías y Teacapán, Sinaloa, México. Tesis Profesional. Escuela Nacional de Ingeniería Pesquera de la Universidad Autónoma de Nayarit. Data considered to be originally reported in dry weight; transformed in wet weight considering a water content of 80%.
(6) Monzalvo Santos Idalia Karina. 2003. Determinación de mercurio en dos especies de peces bentónicos (Cherublemma emmelas y Zalieutes elater) de la zona del talud del Golfo de California. Tesis Profesional. Escuela de Biología de la Universidad Autónoma de Sinaloa. Data considered to be originally reported in dry weight; transformed in wet weight considering a water content of 80%.
(7) Carrasco Orozco Ana Karina y López Pizano Dánae Zoara. 2005. Determinación de metales pesados (Pb, Hg, Cd y As) en agua de mar y huachinango (Lutjanus guttatus) en la costa del estado de Colima. Tesis Profesional. Facultad de Ciencias Químicas en la Universidad de Colima. Data considered to be originally reported in wet weight;no transformation applied.
(8) Esquer Herrera Hilda Velia Patricia. 2003. Concentración de mercurio en sedimentos superficial, flora y fauna representativos en la bahía de Guaymas, Sonora. Tesis Profesional. Instituto Tecnológico del Mar, Unidad Mazatlán. Data considered to be originally reported in wet weight;no transformation applied.
(9) Veracruz market fish study: Analysts: D.Lean (U. Ottawa); I. Rheault (UQAM) (2007); Data are averaged values for measurements made at University of Ottawa and UQAM

Table 2: Results of the summary matrix per species

Species	Scientific name	n	Hg(wet)(ppm)	SD	max
Catfish	*Arius felis*	8	**0,133**	0,086	0,278
Catfish	*Arius sp.*	6	**0,131**	0,098	0,268
Snook "chuchumite"	*Centropomus paralellus*	10	**0,182**	0,091	0,371
Sardinas	*Centrpomus sp.*	6	**0,238**	0,129	0,460
Tilapia "jonuta"	*Cichlasoma uropthalmus*	15	**0,079**	0,057	0,155
Carp	*Cyprinus carpa*	45	**0,008**		0,029
Mojarra	*Family Geridae*	5	**0,035**	0,010	0,045
Guabino	*Gobiomorus dormitor*	12	**0,072**	0,040	0,117
Mullet la brancha	*Mugil curema*	10	**0,095**	0,078	0,186
Mullet	*Mugil sp.*	17	**0,026**	0,013	0,057
Tilapia "topuda"	*Oreochromis niloticus*	7	**0,015**	0,006	0,024
Tilapia	*Oreochromis sp.*	88	**0,004**		0,015
Chulín	*Rhamdia sp.*	7	**0,116**	0,033	0,145
Mackerel	*Scomberomerus sierra*	4	**0,178**	0,092	0,302
Tang		4	**0,092**	0,055	0,169
Cominate sea catfish	*Anus platypogon*	2	**0,196**		
Pacific crevalle jack	*Caranx caninus*	2	**0,664**		
Bull shark	*Carcharhinus leucas*	1	**0,173**		
Congo sea catfish	*Cathorops fuerthii*	6	**0,460**		
Ocean whitefish	*Caulolatilus princeps*	4	**0,114**		
Snook	*Centropomus sp.*	11	**0,213**		
Black brotula	*Cherublemma emmelas*	24	**0,140**		
Orangemouth weakfish	*Cynoscion xanthulus*	8	**0,000**		
Peruvian mojarra	*Diapterus peruvianus*	5	**0,113**		
Pacific ladyfish	*Elops affinis*	4	**0,194**		
Graceful mojarra	*Eucinostomus gracilis*	3	**0,136**		
Peruvian sea catfish	*Galeichthys peruvianus*	1	**0,317**		
Yellow fin mojarra	*Gerres cinereus*	6	**0,157**		
Greybar grunt	*Haemolupsis axillaris*	3	**0,246**		
Yellostripe grunt	*Heamulon sexfaciatum*	5	**0,298**		
Colorado snapper	*Lutjanus colorado*	20	**0,139**		
Spotted rose snapper	*Lutjanus guttatus*	48	**0,047**		
Flathead mullet	*Mugil cephalus*	25	**0,021**		
White mullet	*Mugil curema hembra*	134	**0,078**		
Roosterfish	*Nematistius pectoralis*	2	**0,268**		
Leatherjack	*Oligoplites saurus*	2	**0,348**		
Pacific thread herring	*Opisthonema libertate*	8	**0,209**		
Spechled flounder	*Paralichthys woolmani*	3	**0,136**		
Sand grunt	*Pomadasys branickii*	2	**0,234**		
White grunt	*Pomadasys leuciscus*	2	**0,190**		
Roncador	*Roncador stearasii*	3	**0,278**		
Pacific sierra	*Scomberomorus sierra*	1	**0,128**		
Bigeye scad	*Selar crumenophhalmus*	3	**0,130**		
Yellowtail amberjack	*Seriola lalandi*	2	**0,764**		
Bullseye puffer	*Sphoeroides annulatus*	15	**0,152**		
Scalloped hammerhead	*Sphyrma lewini*	1	**0,320**		
Paloma pompano	*Trachionotus paitensi*	3	**0,284**		
Roundel bayfish	*Zalieutes elater*	9	**0,100**		

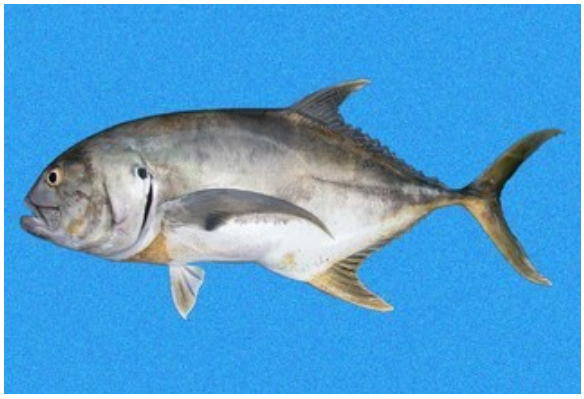
near or over 0,5 ppm Hg (wet)

Annex 3: Illustrations of fish species



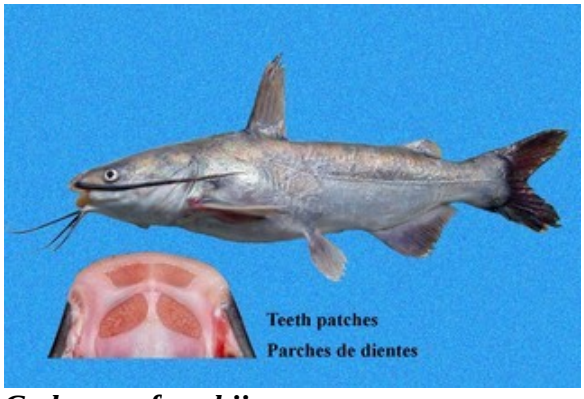
Arius platypogon
Cominate Sea Catfish (0.196 ppm Hg)

Arius felis
Hardhead Catfish, Sea Catfish (0.132 ppm Hg)



Caranx caninus
Pacific Crevalle Jack (0.664 ppm Hg)

Carcharhinus leucas
Bull Shark (0.173 ppm Hg)



Cathorops fuerthii
Congo Sea Catfish (0.460 ppm Hg)

Caulolatilus princeps
Ocean Whitefish (0.114 ppm Hg)

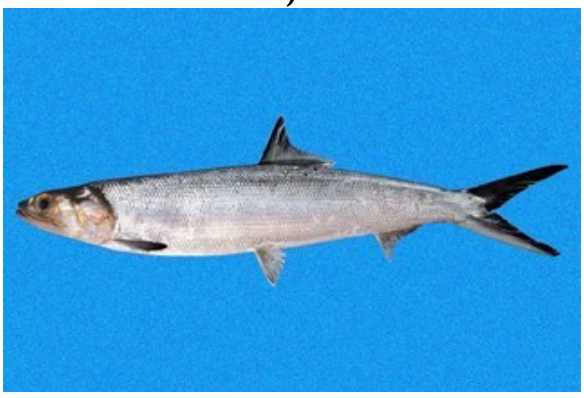
Centropomus paralellus
Fat Snook (0.182 ppm Hg)

Cherublemma emmelas
Black Brotula (0.140 ppm Hg

Cichlasoma uropthalmus
Mexican Mojarra (0.100 ppm Hg)

Cynoscion xanthulus
Orangemouth Weakfish (0.0 ppm Hg)

Diapterus peruvianus
Peruvian Mojarra (0.132 ppm Hg)



Elops affinis
Pacific Ladyfish (0.194 ppm Hg)

Eucinostomus gracilis
Graceful Mojarra (0.136 ppm Hg)

Galeichthys peruvianus
Peruvian Sea Catfish (0.317 ppm Hg)

Gerres cinereus
Yellow Fin Mojarra (0.132 ppm Hg)

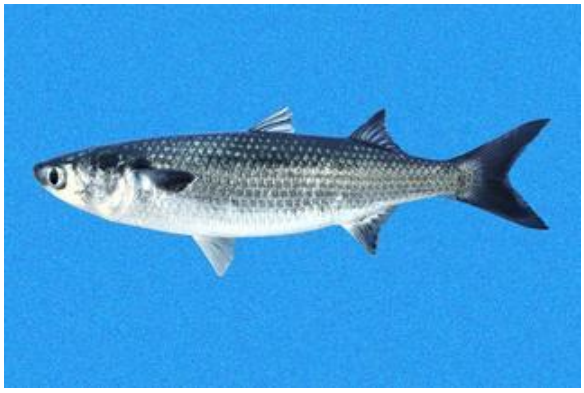
Gobiomorus dormitor
Guabino, Bigmouth Sleeper
(0.027 ppm Hg)

Haemulopsis axilaris
Yellostripe Grunt (0.246 ppm Hg)

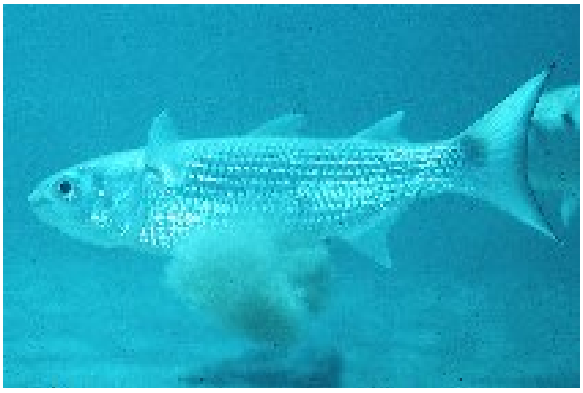
Haemulon sexfasciatum
Graybar Grunt (0.298 ppm Hg)

Lutjanus colorado
Colorado Snapper (0.139 ppm Hg)

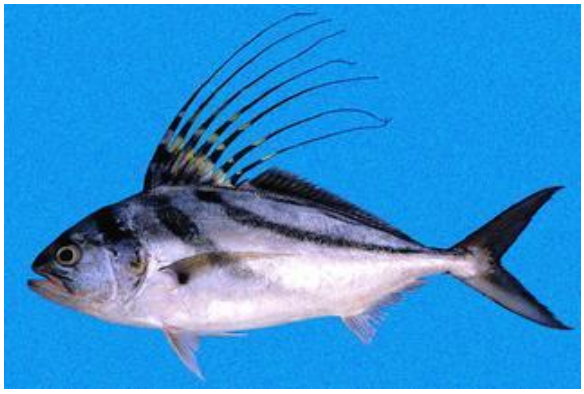
Lutjanus guttatus
Spotted Rose Snapper (0.047 ppm Hg)



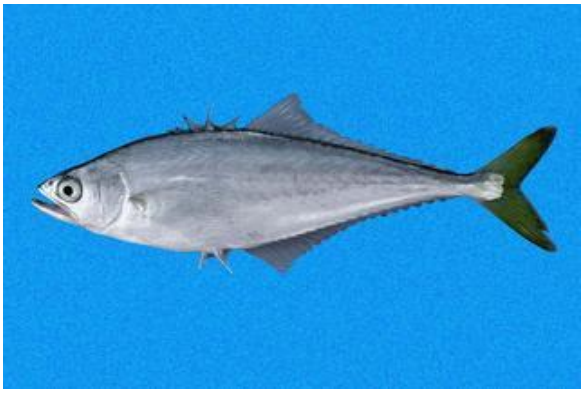
Mugil cephalus
Flathead Mullet (0.022 ppm Hg)



Mugil curema hembra
White Mullet (0.078 ppm Hg)



Nematistius pectoralis
Roosterfish (0.268 ppm Hg)



Oligoplites saurus
Leatherjack (0.348 ppm Hg)

Opisthonema libertate
Pacific Thread Herring (0.209 ppm Hg)

Paracanthurus hepatus
Blue Tang, Palette Surgeonfish (0.092 ppmHg)

Paralichthys woolmani
Spechled Flounder (0.136 ppm Hg)

Pomadasys branickii
Sand Grunt (0.234 ppm Hg)

Pomadasys leuciscus
White Grunt (0.190 ppm Hg)

Rhamdia sp.
Chulin (0.130 ppm Hg)

Roncador stearasii
Roncador (0.173 ppm Hg)

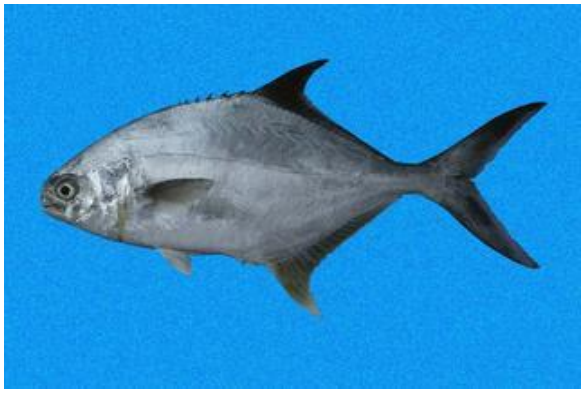
Scomberomorus sierra
Pacific Sierra (0.128 ppm Hg)

Selar crumenophhalmus
Bigeye Scad (0.130 ppm Hg)

Seriola lalandi
Yellowtail Amberjack (0.764 ppm Hg)

Sphoeroides annulatus
Bullseye Puffer (0.152 ppm Hg)

Sphyrna lewini
Scalloped Hammerhead (0.320 ppm Hg)

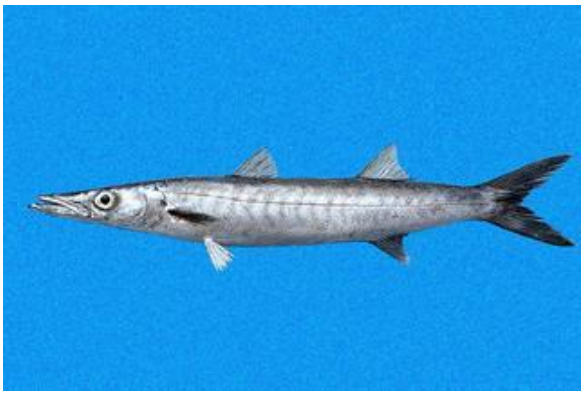


Trachinotus paitensis
Paloma Pompano (0.284 ppm Hg)

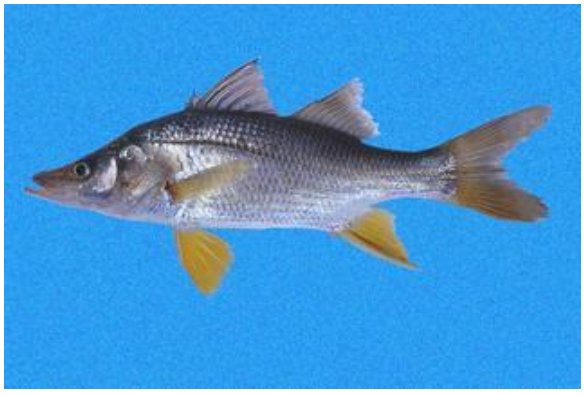
Zalieutes elater
Roundel bayfish (0.100 ppm Hg)

VERACRUZ MARKET

Anisotremus davidsoni
Grunt, Xantic Sargo (0.069 ppm Hg)

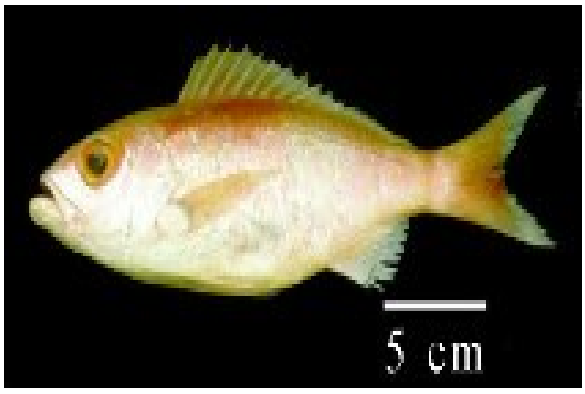


Sphyraena ensis
Mexican barracuda (0.355 ppm Hg)

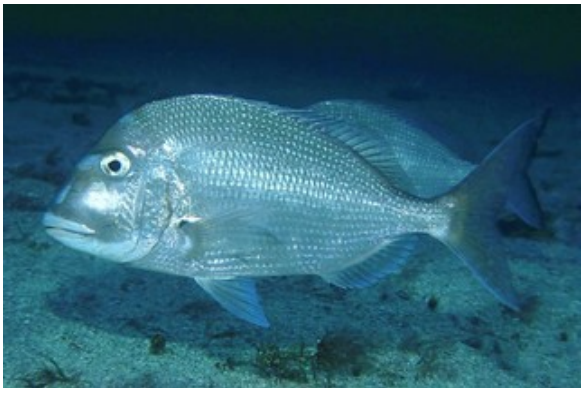


Centropomus robalito
Yello Fin Snook (0.112 ppm Hg)

Diplectrum bivittatum
Dwarf Sand Perch (0.168 ppm Hg)



Rhomboplites aurorubens
Vermillion snapper (0.039 ppm Hg)



Calamus brachysomus
Pacific Porgy (1.879 ppm Hg)

Eucinostomus californiensis
Tilapia, graceful mojarra (0.019 ppm Hg)

Lutjanus peru
Red snapper (0.137 ppm Hg)

Pictures were retrieved from http://www.fishbase.org/ and http://www.discoverlife.org/