Web-Based Environmental Mercury Mapping, Modeling and Analysis (EMMMA)

Paul Hearn Stephen Wente John Aguinaldo David Donato

Susan Price Seth Tanner Ovidio Rivero-Bartolomei

Vision: Support Scientists in Initial Phases of the Research Process

- Data collection and visualization
- Hypothesis formulation
- Scientific collaboration
- Preliminary data analysis

Produces:

- Better research designs
- More cost-effective research process

Project Objectives

1. Compile fish tissue and other mercury data
2. Describe spatial and temporal trends in national fish-Hg data set, using model to factor out the confounding effects of dissimilar samples.
3. Serve raw and interpreted fish-Hg data over the web with maps, other ancillary data, and analytical tools.

Principal Databases

- States/EPA/USGS Fish tissue – 45,605 records
- EPA National Emissions Inventory – Data for 24,000 sites
- National Atmospheric Deposition Program – Data for 83 Sites
- USGS Stream sediments and soils – 97,000 records
- USGS Coal – 28,000 records
- USGS Mines/ Ore Deposits – 190,000 records

EMMMA.USGS.GOV

USGS In partnership with ...

EMMMA: Environmental Mercury Mapping, Modeling, & Analysis

Visualizing the Distribution of Mercury in our Environment

Overview | Data Download | Fish Model | Data Mapper | Other Sites

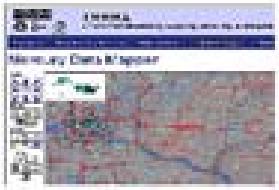
Overview - What We Do

EMMMA supports mercury research and decision-making by providing tools for Mapping, Modeling, and Analysis of mercury data.

As with many environmental contaminants, mercury can harm the health of humans and wildlife at concentrations that cannot be detected by our senses. Scientists must use chemical analyses to detect and measure the occurrence and distribution of mercury in the water, soil, air, and biological tissues of our environment. Because of the expense of these analyses, obtaining enough information to protect the health of humans and the environment is a constant challenge. The EMMMA web site helps scientists to get the most information possible from every mercury analysis by providing tools to map and to visualize:

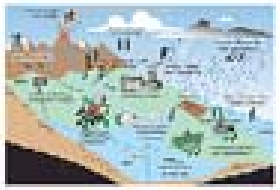
- How mercury concentrations change from place to place -- where concentration is high or low.
- How mercury concentrations change over time -- when concentration increases or decreases.
- How mercury is distributed in the environment -- why do concentrations in biological tissues vary and what is their relation to concentrations in water, soil, and air.

Some of the specific tools and services provided by this web site include:



Online mapping tools, USGS maps, images and other thematic data from *The National Map* to display and analyze mercury

An online model for mercury in fish-tissue, which standardizes the concentrations of mercury in fish to enable comparisons



Easy access to key environmental mercury datasets, including atmospheric mercury emissions. National

USGS NIEHS

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EMMMA: Environmental Mercury Mapping, Modeling, & Analysis

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Overview | Data Download | Fish Model | Data Mapper | Other Sites

Mercury Datasets

Fish Tissue

A database of ~35,000 fish tissue mercury records was compiled by USGS from various sources, including the following:

- National Pesticide Monitoring Program (NPMP)
- National Contaminant Biomonitoring Program (NCBP)
- Biomonitoring of Environmental Status and Trends (BEST) datasets of the USFWS and USGS. http://www.cerc.cr.usgs.gov/data/data.htm
- Environmental Monitoring and Analysis Program (EMAP): http://www.epa.gov/emap/
- Regional EMAP (REMAP) of USEPA http://www.epa.gov/emap/remap/index.html
- State agency data as compiled in USEPA's National Listing of Fish and Wildlife Advisory (NLFWA) database http://map1.epa.gov/

Selected records were required to have: a non-zero mercury concentration, valid species identifier; be identified as sampled as whole fish, skin-on fillet skin-off fillet, carcass, edible, eggs, liver, viscera (samples identified as 'fillet' only were rejected); and have a length measurement that is appropriate for that species.

Please contact Steve Wente (spwente@usgs.gov) with corrections and appropriate additions to this dataset.

Fish_Hg_Raw.zip (4,403KB)

EMMMA - Microsoft Internet Explorer

File Edit View Favorites Tools Help

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Address http://niehs2.er.usgs.gov/dev2/mapping.html Go Links

USGS The National Map

EMMMA

Environmental Mercury Mapping, Modeling, & Analysis

NIEHS

Overview | Download Hg Datasets | Fish-Hg Model | Hg Data Mapping | Links to Other Hg Sites

Mercury Data Mapper

Move

Zoom

Select

Misc

Zoom In

Map Created with ArcIMS - Copyright (C) 1992-2002 ESRI Inc.

0 1082 mi

Display Legend

Mercury and Other Thematic Data

- All Layers
  - Hg Point Emissions Data
  - Fish Tissue Hg Data
  - Soils & Stream Sediment Data
  - Mine Locations
  - Coal Data

USGS Base Map Layers

- Structures
- Geographic Names
- Transportation
- Boundaries
- Hydrography
- Orthoimagery
- Land Cover
- Elevation

Internet

USGS NIEHS

Links to Hg Deposition Network

Home AIRMoN MDN Search
Data Maps QA Sponsors Overview Contacts

National Atmospheric Deposition Program

NADP/NTN Monitoring Location TN11

Station	Great Smoky Mountains National Park-Elkmont (TN11)
Location	Sevier County, Tennessee
Dates of Operation	8/12/1980 - Present
Latitude	35.6645
Longitude	-83.5903
Elevation	640 meters
USGS 1:24000 Map Name	GATLINBURG, 1956
Operating Agency	National Park Service
Sponsoring Agency	National Park Service - Air Resources Division

More Site Photographs
2001 Site Survey (5) Large Small
1999 Site Survey (5) Large Small
Miscellaneous (2) Small

NADP/NTN Wet Deposition Data Available

Trend Plots
Annual Data Summaries
Annual Data
- data by calendar and water years
- wet deposition totals
- precipitation-weighted

Other NADP Data for

NADP/MDN 1/30/2002 - Present

External links related

Clean Air Status and Trends Network (CASTNet)
CASTNet Site GRS420 data

Great Smoky Mountains National Park

Site	Date On	Date Off	Subppt	Pptrec	HgConc	HgDep	QR	Sample Type	Notes
			mm	mm	ng/L	ng/m²			
TN11	01/30/2002	02/05/2002	5.4	--	6.6	35.4	B	W	dmz
TN11	02/05/2002	02/12/2002	13.0	--	4.9	63.7	B	W	dmz
TN11	02/12/2002	02/19/2002	0.0	--	--	0.0	B	D	mz
TN11	02/19/2002	02/26/2002	7.5	--	9.8	73.6	B	W	h
TN11	02/26/2002	03/05/2002	7.8	--	9.5	73.9	B	W	dmz
TN11	03/05/2002	03/12/2002	7.0	--	11.0	76.5	B	W	dm
TN11	03/12/2002	03/19/2002	116.8	116.8	9.3	1086.6	B	W	d
TN11	03/19/2002	03/26/2002	14.5	14.5	7.9	114.4	B	W	d
TN11	03/26/2002	04/02/2002	65.3	65.3	12.6	823.0	B	W	d
TN11	04/02/2002	04/09/2002	0.0	0.0	--	0.0	B	D	d
TN11	04/09/2002	04/16/2002	5.2	5.2	9.8	51.0	B	W	d
TN11	04/16/2002	04/23/2002	16.9	16.9	18.6	313.3	B	W	d
TN11	04/23/2002	04/30/2002	21.2	21.2	14.2	301.8	B	W	d
TN11	04/30/2002	05/07/2002	78.9	--	11.4	900.8	B	W	dm
TN11	05/07/2002	05/14/2002	39.2	39.2	7.6	299.2	B	W	d
TN11	05/14/2002	05/21/2002	22.1	--	2.3	51.4	B	W	dm
TN11	05/21/2002	05/28/2002	65.3	65.3	13.4	873.3	B	W	d

lay Legend

Other Thematic Data

itoring Sites
missions Data
Hg Data
eam Sediment Data
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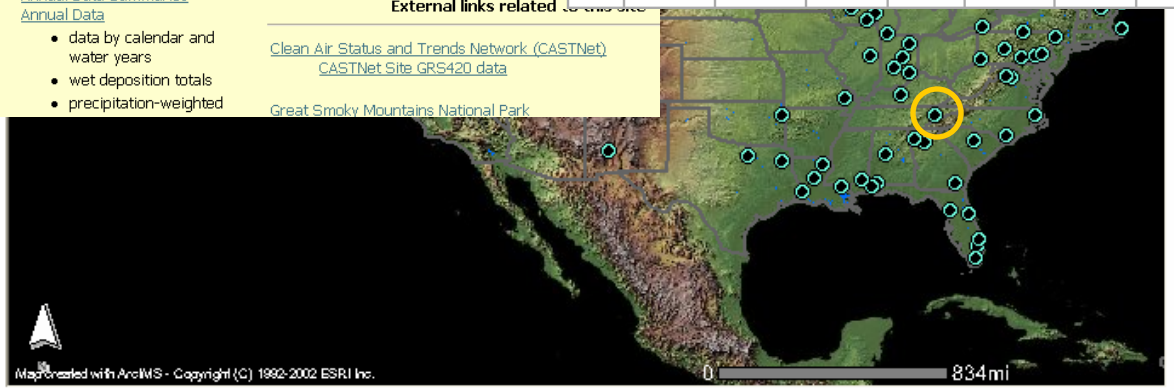

USGS Base Map Layers

- Structures
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- Hydrography
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- Land Cover
- Elevation
- USGS Topo Maps
- Population

Pan

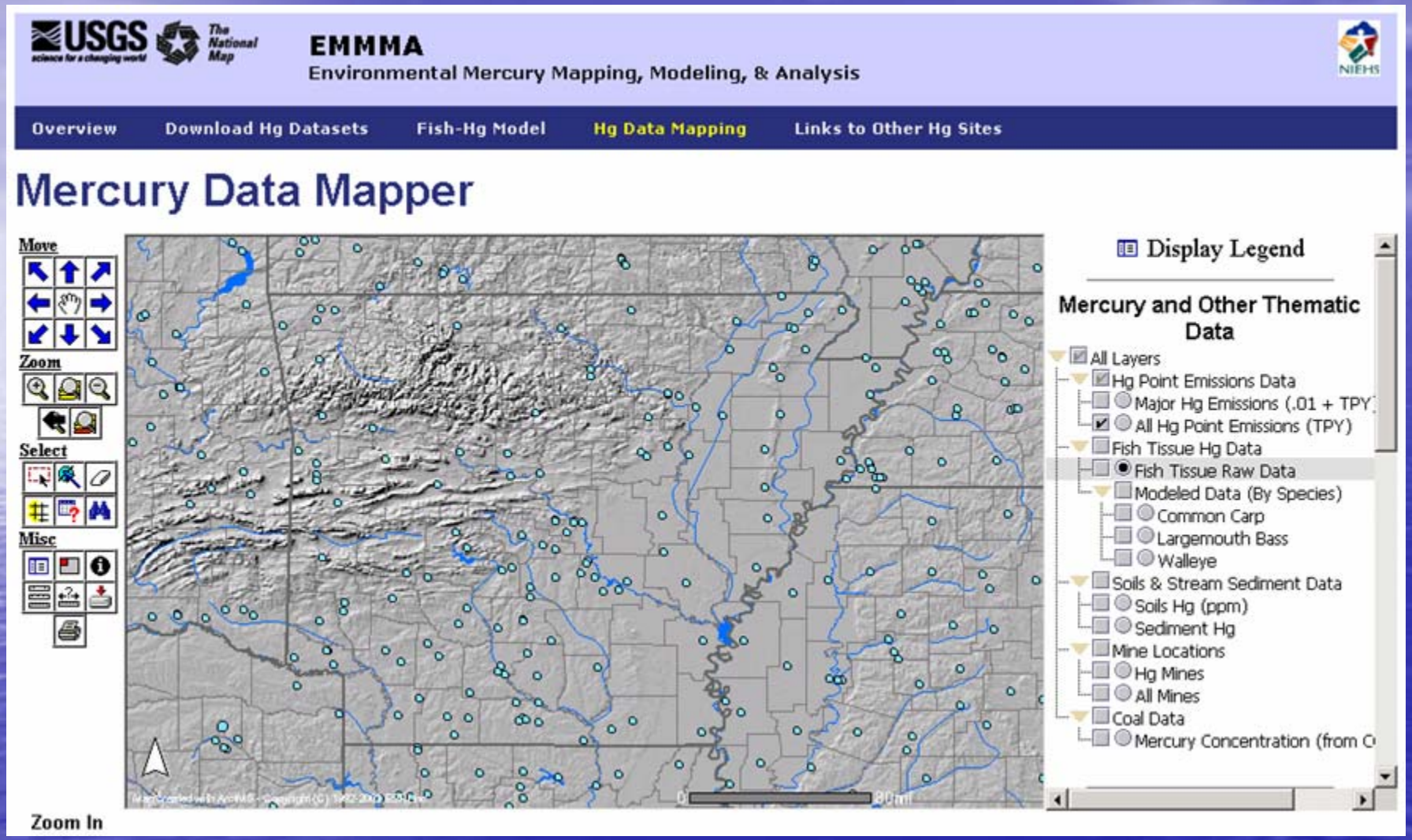
U.S. Department of the Interior | U.S. Geological Survey | Eastern Region Geography
| Maintainer: Eastern Region Geography

Map: -85.96 , 17.57 -- Image: 526 , 442 -- ScaleFactor: 0.12335893807718472

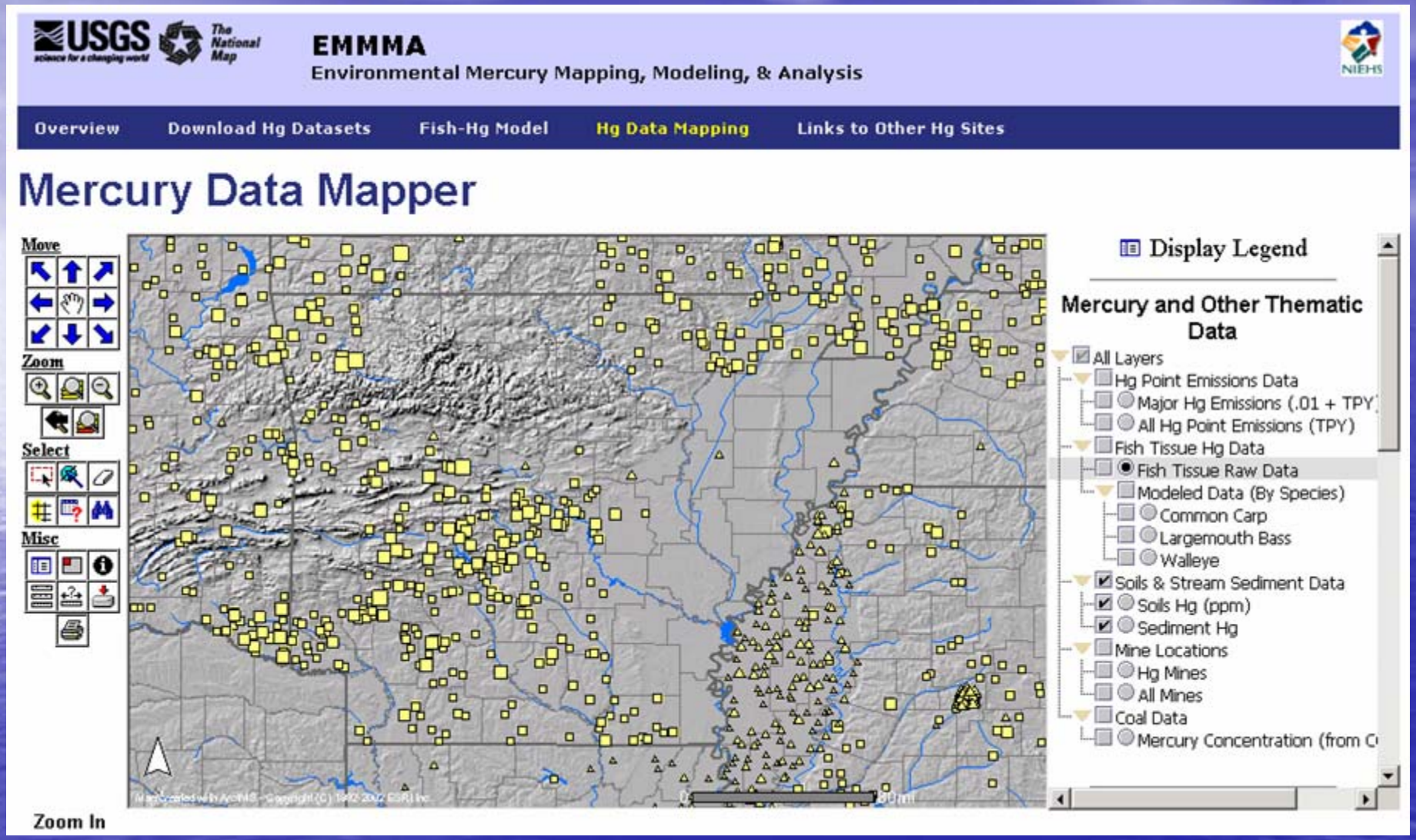
Internet

USGS NIEHS

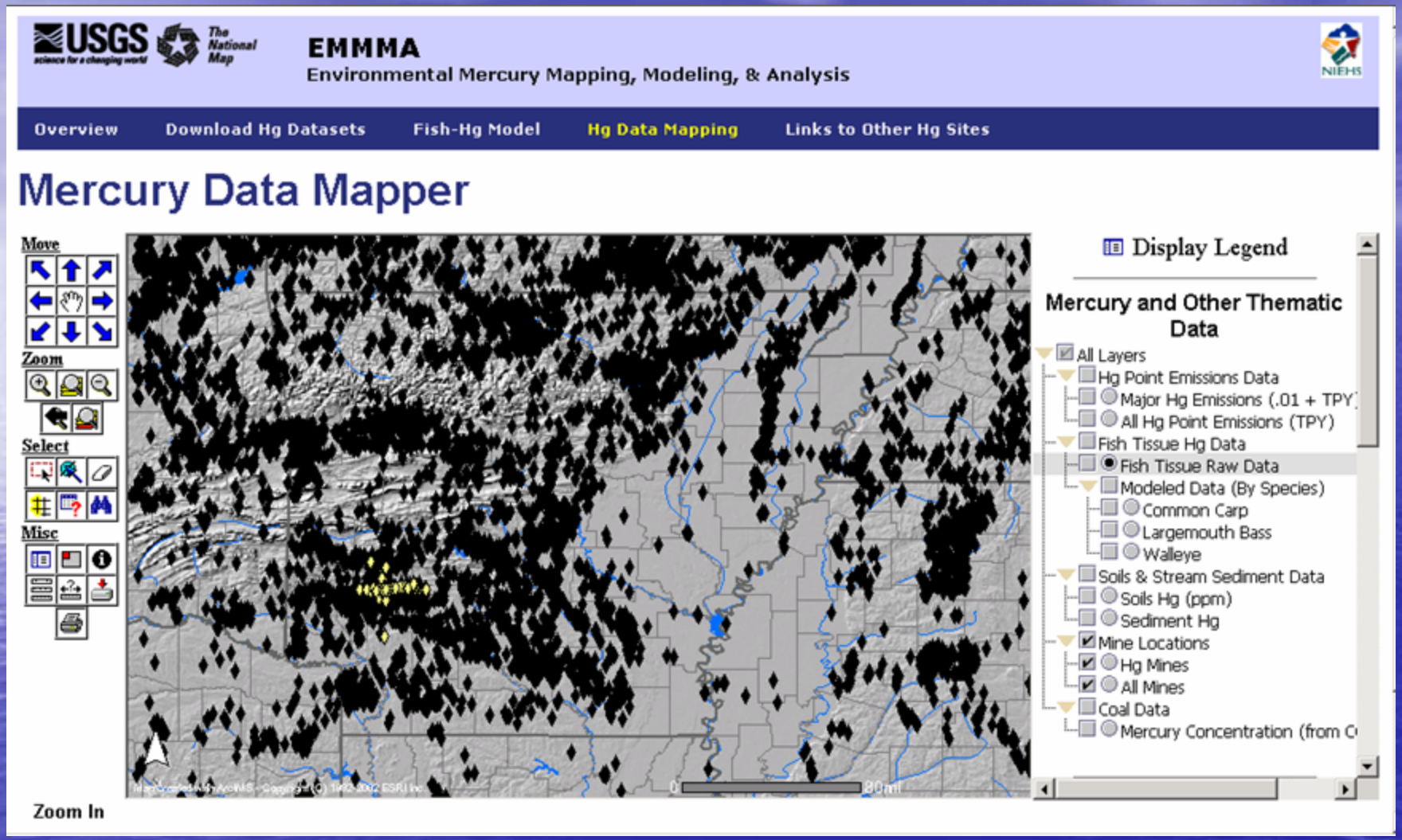
Hg Emission Sites (EPA/NEI)



Stream Sediment and Soil Hg Data



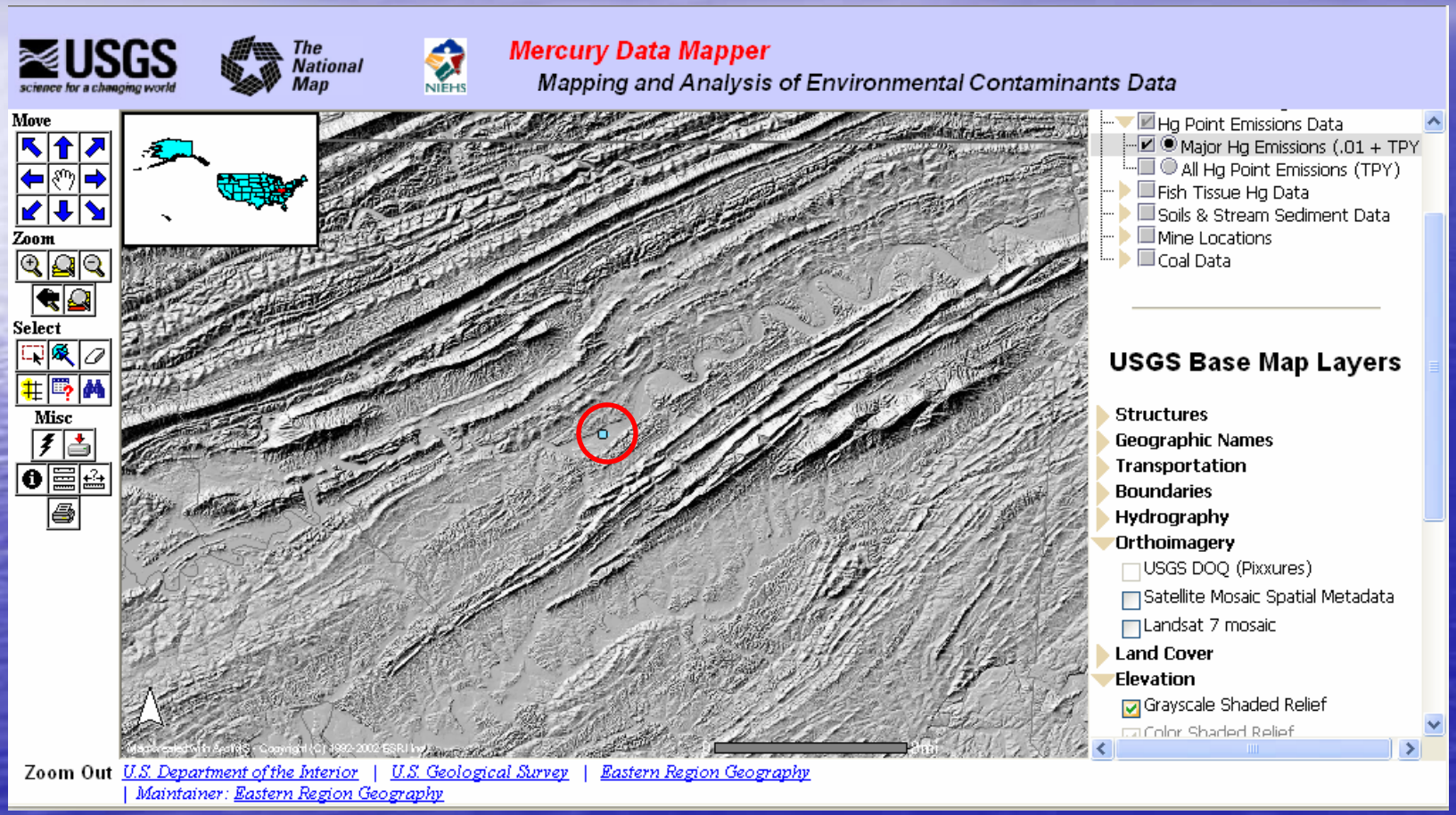
Hg and Other Mine Locations



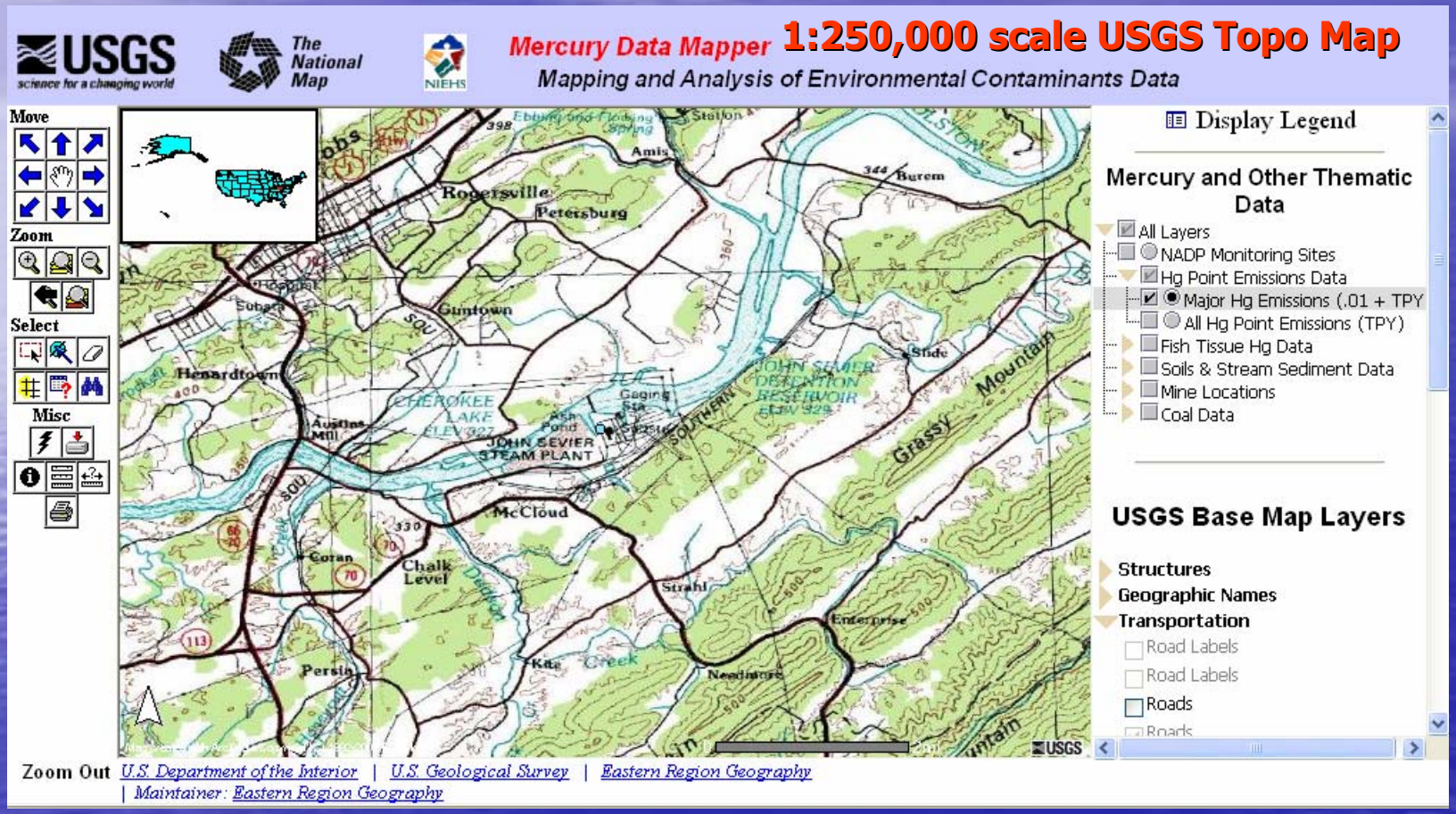
STANDARDIZ	LOCATION_A	LOCALITY_N	STATE	LOCATION_Z	HAP_CATEGO	URBAN_33_H	EMISSIONS1	EMISSION_T	SOURCE_TYP	MACT_CODE	NAICS_CODE	SIC_COD
JOHN SEVIER FOSSIL PLANT	611 Old Highway 70	Rogersville	TN	37857-190	Mercury Compounds	true	0	01	major	1808-1	2211	4911

LATITUDE_M	LONGITUDE_	SOURCE_MAP	HORIZONTAL	HORIZONT_1	HORIZONT_2	REFERENCE_	COORDINATE	LOCATION_D	DATA_SOURC	YEAR	EMISS_	#SHAPE#	#ID#
-82.9641724	36.3766708		021			108	078	SITE-AVG	M1	1999	0.13	[point]	208

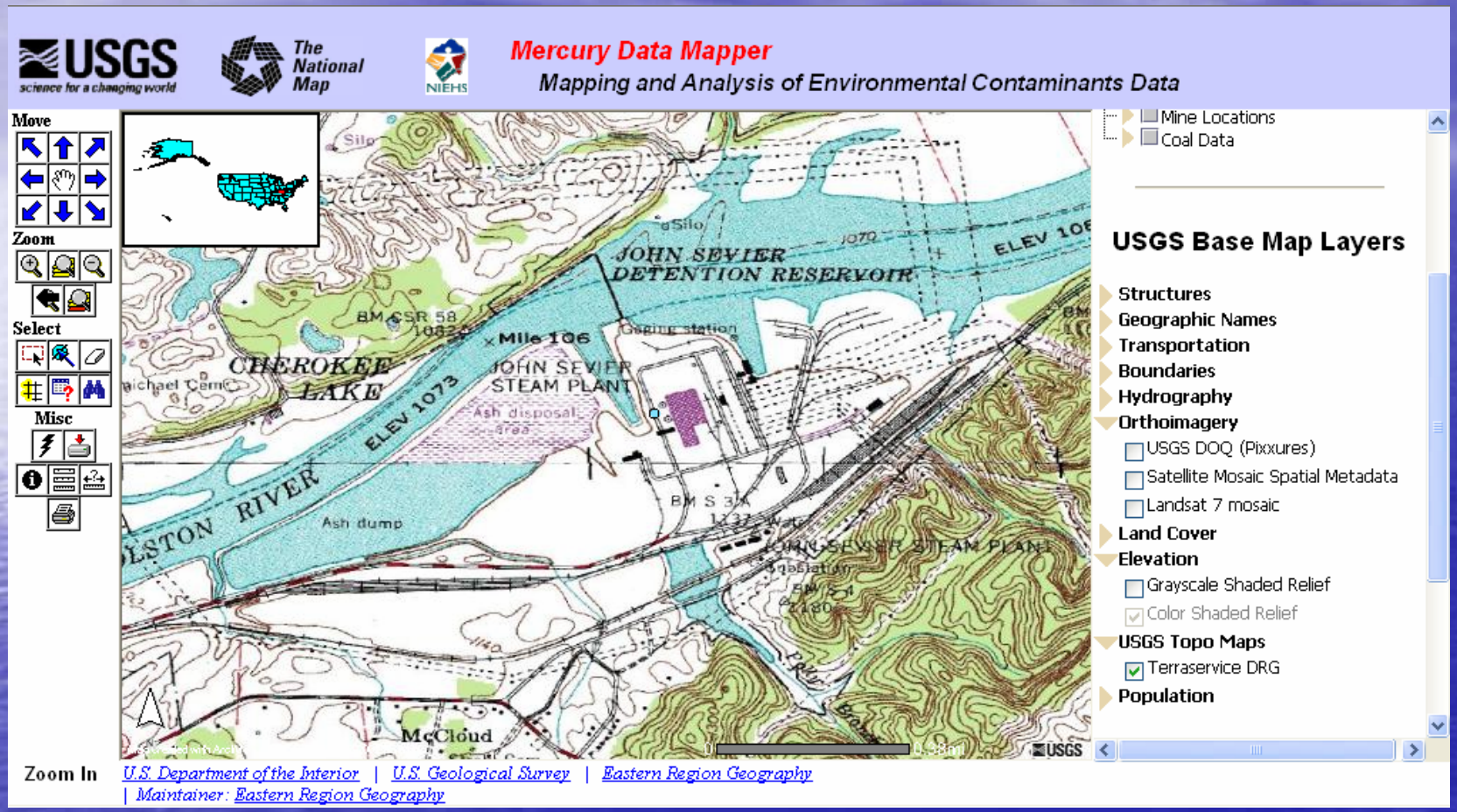
Data Visualization with Maps & Imagery



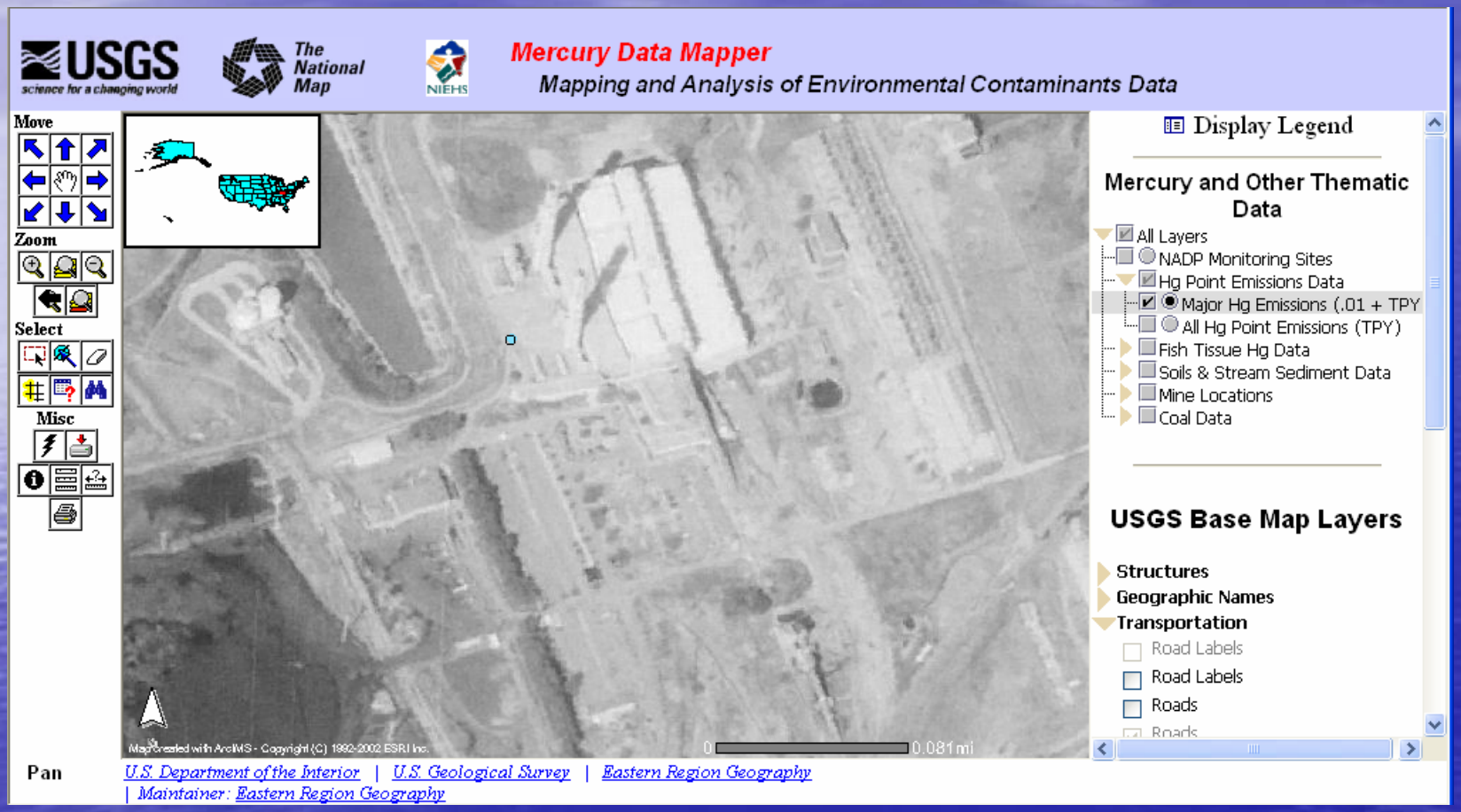
The National Map Adds Valuable Context Information to Contaminants Data



1:24,000 scale USGS Topo Map

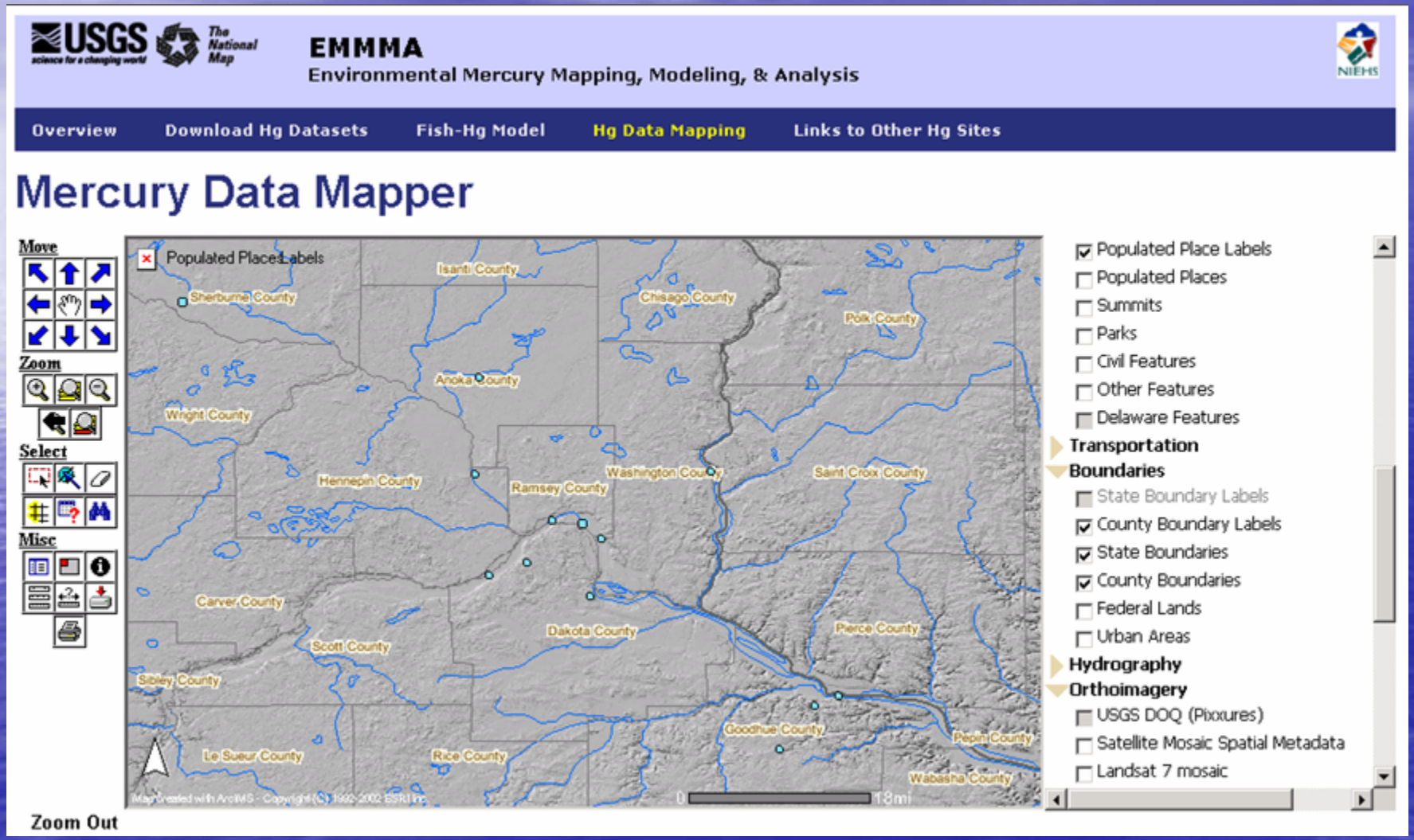


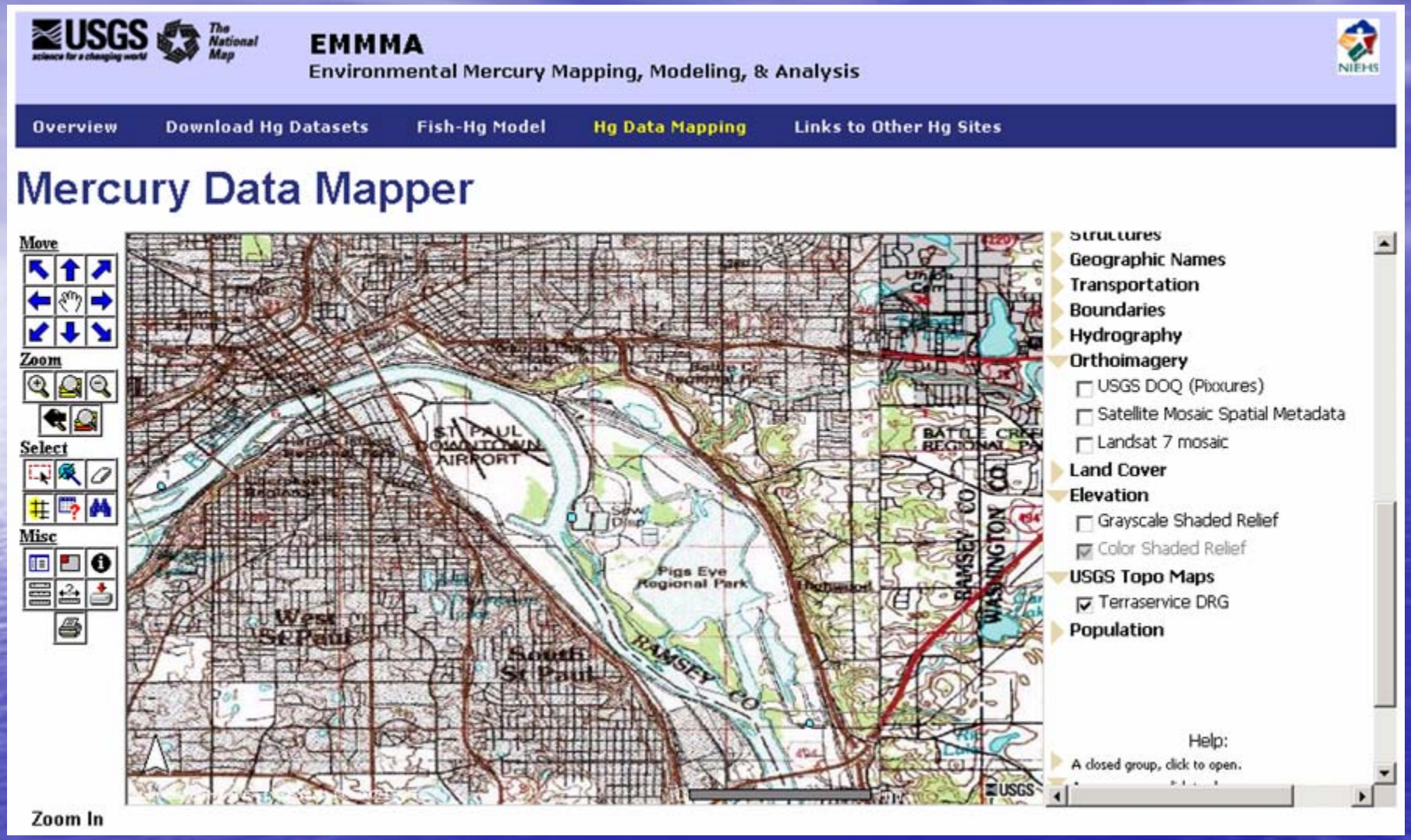
USGS Aerial Photo (1 meter resolution)



STANDARDIZ	LOCATION_A	LOCALITY_N	STATE	LOCATION_Z	HAP_CATEGO	URBAN_33_H	EMISSIONS1	EMISSION_T	SOURCE_TYP	MACT_CODE	NAICS_CODE	SIC_CODE
MCES METROPOLITAN WWTP - ST PAUL	2400 Childs Rd	ST. PAUL	MN	55106	Mercury Compounds	true	0	01	major	none	221320	4952

SIC_CODE	LATITUDE_M	LONGITUDE_	SOURCE_MAP	HORIZONTAL	HORIZONT_1	HORIZONT_2	REFERENCE_	COORDINATE	LOCATION_D	DATA_SOURC	YEAR	EMISS_	#SHAPE#	#ID
4952	-93.0488815	44.9236183	24000	003	50	001	108	080	SITE-AVG	S1	1999	0.175	[point]	149




USGS
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ST PAUL DOWNTOWN AIRPORT
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West St Paul
South St Paul
RAMSEY CO
WASHINGTON CO
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Hydrography
Orthoimagery
USGS DOQ (Pixxures)
Satellite Mosaic Spatial Metadata
Landsat 7 mosaic
Land Cover
Elevation
Grayscale Shaded Relief
Color Shaded Relief
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Terraservice DRG
Population
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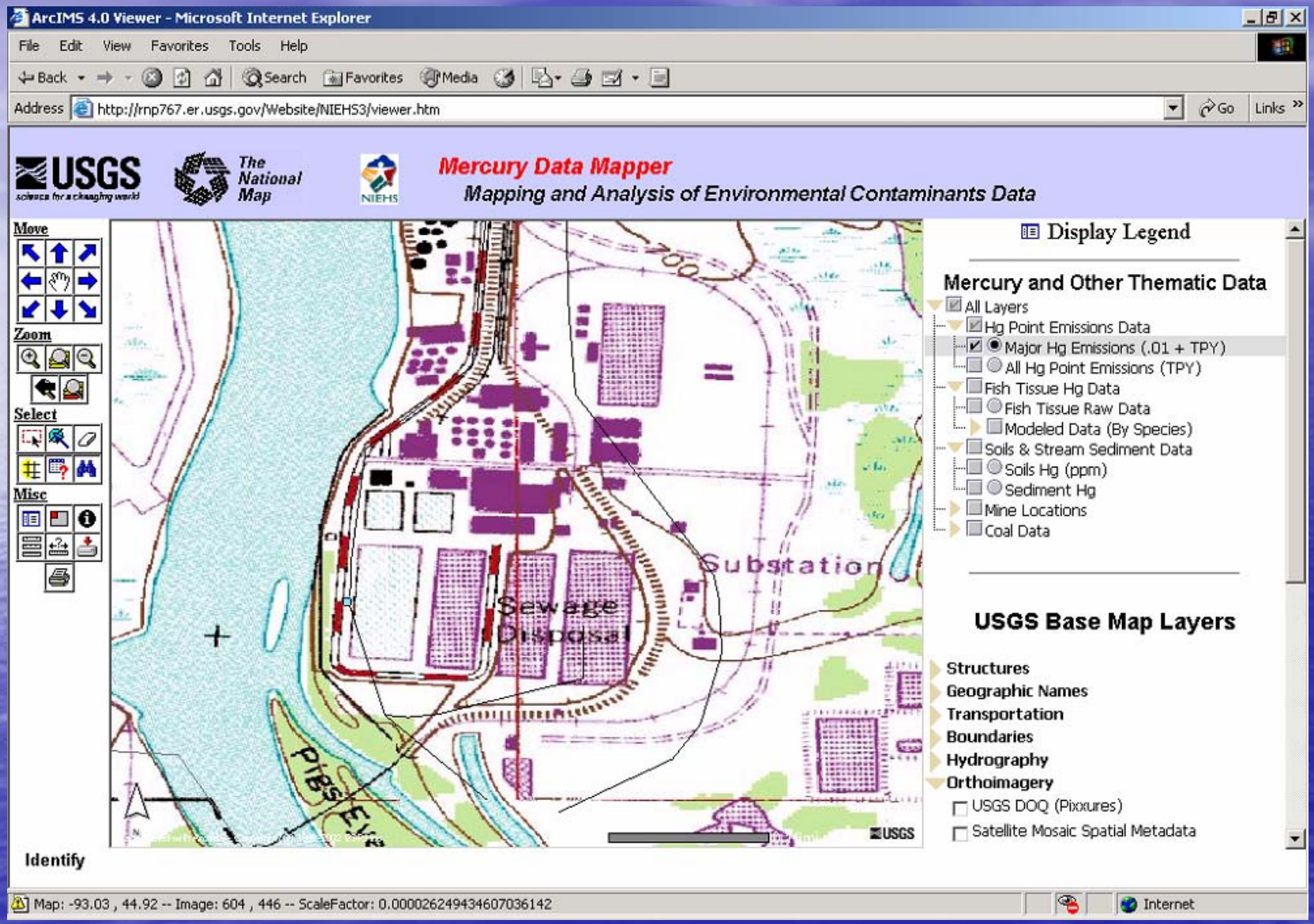
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Address http://rnp767.er.usgs.gov/Website/NIEHS3/viewer.htm
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All Hg Point Emissions (TPY)
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Fish Tissue Raw Data
Modeled Data (By Species)
Soils & Stream Sediment Data
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Satellite Mosaic Spatial Metadata
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The National Map

NIEHS

Mercury Data Mapper

Mapping and Analysis of Environmental Contaminants Data

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Mercury and Other Thematic Data

- All Layers
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    - Major Hg Emissions (.01 + TPY)
    - All Hg Point Emissions (TPY)
  - Fish Tissue Hg Data
    - Fish Tissue Raw Data
    - Modeled Data (By Species)
  - Soils & Stream Sediment Data
    - Soils Hg (ppm)
    - Sediment Hg
  - Mine Locations
  - Coal Data

USGS Base Map Layers

- Structures
- Geographic Names
- Transportation
- Boundaries
- Hydrography
- Orthoimagery
  - USGS DOQ (Pixxures)
  - Satellite Mosaic Spatial Metadata

Map created with ArcIMS - Copyright (C) 1992-2002 ESRI Inc.

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Mercury Data Mapper

Mapping and Analysis of Environmental Contaminants Data

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Las Aguilas Creek

Griswold Creek

Pimental Creek

Vallecitos Creek

Larious Creek

Ranchette Creek

Display Legend

Mercury and Other Thematic Data

- All Layers
  - Hg Point Emissions Data
    - Major Hg Emissions (.01 + TPY)
    - All Hg Point Emissions (TPY)
  - Fish Tissue Hg Data
    - Fish Tissue Raw Data
    - Modeled Data (By Species)
      - Common Carp
      - Largemouth Bass
      - Walleye
  - Soils & Stream Sediment Data
    - Soils Hg (ppm)
    - Sediment Hg
  - Mine Locations
    - Hg Mines
    - All Mines
  - Coal Data

USGS Base Map Layers

- Structures
- Geographic Names
- Transportation
- Boundaries

Map: -120.39 , 36.46 -- Image: 627 , 468 -- ScaleFactor: 0.0009339224429294594

Internet

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The National Map

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Mercury Data Mapper

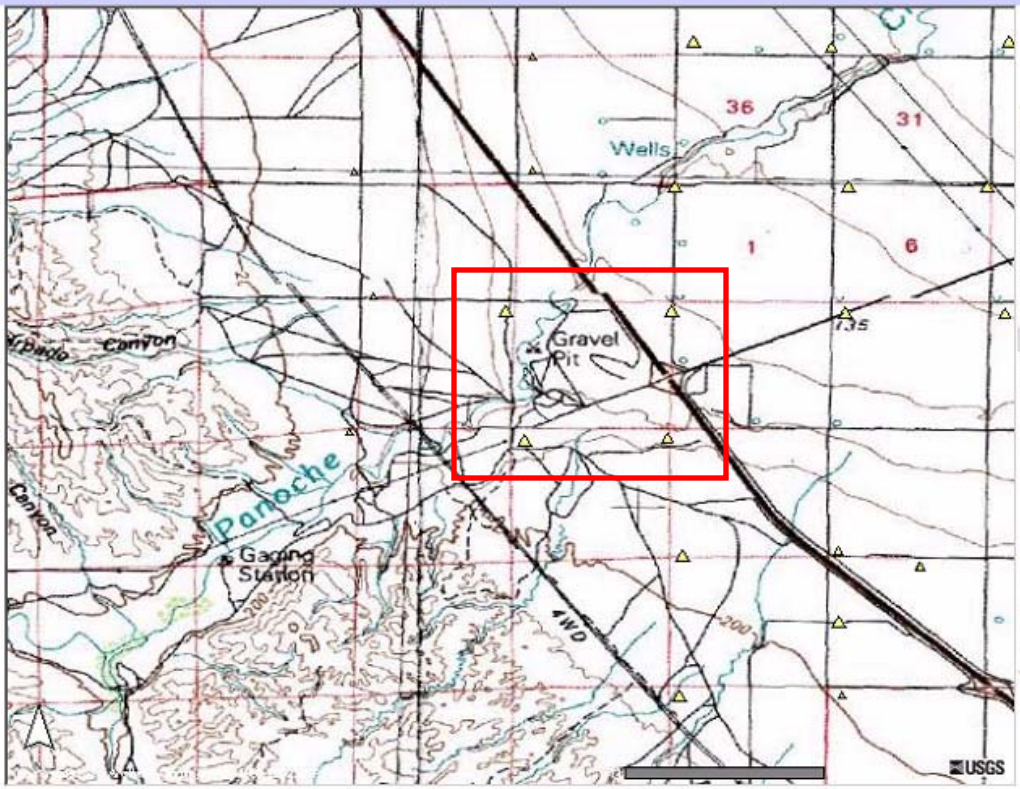
Mapping and Analysis of Environmental Contaminants Data

Move

Zoom

Select

Misc



Zoom In

Display Legend

Mercury and Other Thematic Data

- All Layers
  - Hg Point Emissions Data
    - Major Hg Emissions (.01 + TPY)
    - All Hg Point Emissions (TPY)
  - Fish Tissue Hg Data
  - Soils & Stream Sediment Data
    - Soils Hg (ppm)
    - Sediment Hg
  - Mine Locations
    - Hg Mines
    - All Mines
  - Coal Data

USGS Base Map Layers

- Structures
- Geographic Names
- Transportation
- Boundaries
- Hydrography
  - Water Bodies
  - Streams
  - Streams

javascript:void(null); Internet

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Select Data

Download Data

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Move

Zoom

Select

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Zoom In

Query/Selection Results - Microsoft Internet Explorer

ND	SUBMITTER	AS	AS_METH	HG	HG_METH	CD	CD_METH	PB	PB_METH	SE	SE_METH	SUB_DATE	
	TIDBALL,	7.3	HyAA	0.06	CVAA	-2	IPC40	14	ICP-AES	0.7	HyAA	Fri, 26 Jul 1985 00:00:00	R
	TIDBALL,	9.2	HyAA	0.13	CVAA	-2	IPC40	14	ICP-AES	1.3	HyAA	Wed, 17 Jul 1985 00:00:00	R
	TIDBALL,	6.2	HyAA	0.14	CVAA	-2	IPC40	16	ICP-AES	0.9	HyAA	Wed, 17 Jul 1985 00:00:00	R
	TIDBALL,	7.1	HyAA	0.26	CVAA	-2	IPC40	21	ICP-AES	0.9	HyAA	Wed, 17 Jul 1985 00:00:00	R

File Download

Some files can harm your computer. If the file information below looks suspicious, or you do not fully trust the source, do not open or save this file.

File name: ...niehs2_rnp767355625442.zip

File type: WinZip File

From: rnp767.er.usgs.gov

Would you like to open the file or save it to your computer?

Open | Save | Cancel | More Info

☑ Always ask before opening this type of file

Sediment Hg

Mine Locations

Hg Mines

All Mines

Coal Data

USGS Base Map Layers

Structures

Geographic Names

Transportation

Boundaries

Hydrography

Water Bodies

Streams

Streams

Map: -120.62 , 36.63 -- Image: 359 , 390 -- ScaleFactor: 0.00007757443036676501

Internet

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Address http://niehs2.er.usgs.gov/dev2/fishHgAbout.html

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Environmental Mercury Mapping, Modeling, & Analysis

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Overview of Fish-Hg Model | Model Details

Overview of the National Descriptive Mod

Environmental scientists and fisheries managers face
mercury (Hg) is dispersed in the environment and to
the consumption of fish. However, important spatial
obscured by natural variations between different fish
enough samples of each fish species to achieve accur
expensive.

A statistical model has been developed which promis
overcome these challenges. The model improves ana
to distinguish trends by factoring out the effects of va
between different species, sizes, and sample types of
Modeled data can be normalized to a large number
species, length, and sample cuts. In this way, data fr
sample can be used to estimate mercury concentratio
fish with very different characteristics, dramatically lo
sampling costs without decreasing accuracy.

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2) Model on Species Commonality Between Sites

Done

A Statistical Model and National Data Set for Partitioning Fish Tissue Mercury Concentration Variation between Spatiotemporal and Sample Characteristic Effects

By Stephen P. Wente

In final review –

Publication date - early September 04

ABSTRACT

Many Federal, State, local and tribal agencies monitor mercury in fish-tissue samples to identify sites with elevated fish tissue mercury (fish-mercury) concentrations, track changes in fish-mercury concentrations over time and produce fish consumption advisories. Interpretation of such monitoring data is often impeded by difficulties in reliably separating the effects of sample characteristics (species, tissues sampled, and length of fish) from the effects of spatial and temporal trends on fish-mercury concentrations. Without such a reliable separation, variation in fish-mercury concentrations due to differences in the characteristics of samples collected over time or across space can be misattributed to temporal or spatial trends; and/or actual trends in fish-mercury concentration can be misattributed to differences in sample characteristics. This report describes a statistical model and national data set (31,813 observations) that produces a relatively reliable separation of spatiotemporal and sample characteristic effects in fish-mercury concentrations. Therefore, this model should be suitable for measuring spatial and temporal trends in fish-mercury concentrations and developing fish consumption advisories. The observed fish-mercury concentration data and model predictions can be accessed, displayed geospatially, and downloaded via the World Wide Web (http://emmma.usgs.gov). This report and the associated website may assist in the interpretation of large amounts of data from widespread fish-mercury monitoring efforts.

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Address http://niehs2.er.usgs.gov/dev2/mapping.html Go Links

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Overview | Download Hg Datasets | Fish-Hg Model | Hg Data Mapper | Links to Other Hg Sites

Mercury Data Mapper

Move

Zoom

Select

Misc

Zoom In

> 1.5 mg/Kg
1.2 – 1.5 mg/Kg
0.9 – 1.2 mg/Kg
0.6 – 0.9 mg/Kg
0.3 – 0.6 mg/Kg
< 0.3 mg/Kg
Mines
Fish-Hg

Raw Data

Scale Information:

Out In

(Scale ~ 1:7,139,701)

Display Legend

Mercury and Other Thematic Data

- All Layers
- NADP Monitoring Sites
- Hg Point Emissions Data
- Fish Tissue Hg Data
  - Fish Tissue Raw Data
  - Modeled Data (By Species)
    - Walleye (20 in. skin-on fillet)
    - Largemouth Bass (skin-off fil
    - Largemouth Bass (14 in. skir
    - Largemouth Bass (14 in. wh
    - Yellow Perch (10 in. skin-off
    - Yellow Perch (10 in. skin-on
    - Yellow Perch (10 in. whole f
    - Channel Catfish (18 in. skin-c
    - Common Carp (20 in. skin-or
    - Common Carp (20 in. whole
    - Largescale Sucker
    - White Sucker

Internet

USGS NIEHS

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Address http://niehs2.er.usgs.gov/dev2/mapping.html Go Links

USGS

The National Map

NIEHS

EMMMA

Environmental Mercury Mapping, Modeling, & Analysis

Overview | Download Hg Datasets | Fish-Hg Model | Hg Data Mapper | Links to Other Hg Sites

Mercury Data Mapper

Move

Zoom

Select

Misc

Zoom In

> 1.5 mg/Kg
1.2 – 1.5 mg/Kg
0.9 – 1.2 mg/Kg
0.6 – 0.9 mg/Kg
0.3 – 0.6 mg/Kg
< 0.3 mg/Kg
Mines
Fish-Hg

Data Normalized to 14 inch Largemouth Bass

Scale Information:

Out In

(Scale ~ 1:6,537,194)

Display Legend

Mercury and Other Thematic Data

All Layers
NADP Monitoring Sites
Hg Point Emissions Data
Fish Tissue Hg Data
Fish Tissue Raw Data
Modeled Data (By Species)
Walleye (20 in. skin-on fillet)
Largemouth Bass (skin-off fil
Largemouth Bass (14 in. skir
Largemouth Bass (14 in. wh
Yellow Perch (10 in. skin-off
Yellow Perch (10 in. skin-on
Yellow Perch (10 in. whole f
Channel Catfish (18 in. skin-c
Common Carp (20 in. skin-or
Common Carp (20 in. whole
Largescale Sucker
White Sucker

Internet

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0.3 – 0.6 mg/Kg
< 0.3 mg/Kg
Mines
Fish-Hg

Scale Information:

Out In

(Scale ~ 1:1,292,987)

Display Legend

Mercury and Other Thematic Data

- All Layers
- NADP Monitoring Sites
- Hg Point Emissions Data
- Fish Tissue Hg Data
  - Fish Tissue Raw Data
  - Modeled Data (By Species)
- Soils & Stream Sediment Data
  - Soils Hg (ppm)
  - Sediment Hg
- Mine Locations
  - Hg Mines
  - All Mines
- Coal Data

Map: -121.81 , 38.54 -- Image: 620 , 153 -- ScaleFactor: 0.0030199250164546767

Internet

Start | EMMMA - Microsoft In... | > Abstract for MN Water... | Palm Desktop | EMMMA - Microsoft Inter... | ProgramCouncil_2-17-20... | Document1 - Microsoft ... | Overview of ULRMC Fift... | Wente Abstract for MN ... | Microsoft PowerPoint - [...

7:55 AM

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Mines
Fish-Hg

Scale Information:

Out In

(Scale ~ 1:1,292,987)

Display Legend

Mercury and Other Thematic Data

- All Layers
- NADP Monitoring Sites
- Hg Point Emissions Data
- Fish Tissue Hg Data
  - Fish Tissue Raw Data
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    - Walleye (20 in. skin-on fillet)
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    - White Sucker

Internet

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Address http://niehs2.er.usgs.gov/dev2/fishHgModel.html Go Links

Demonstration of the National Descriptive Model for Mercury in Fish Tissue

IMPORTANT:
This is a partially functioning prototype of the Fish-Hg Model.
Mapping is functional, however, the **graphing functionality is simulated**. Various functioning simulation scenarios have been hard-coded.
All simulated functionality is indicated in red below. Choose only these options when using this page.

Load previously saved settings?

— Load this setting Delete this setting

Data Setup

1 Data Source: Modeled

2 Data View: Temporal Trend Graph

3 Output: Concentration

Sample Output

Click on Thumbnail to Auto-Load Selection

javascript:void(0) Internet

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The National Map

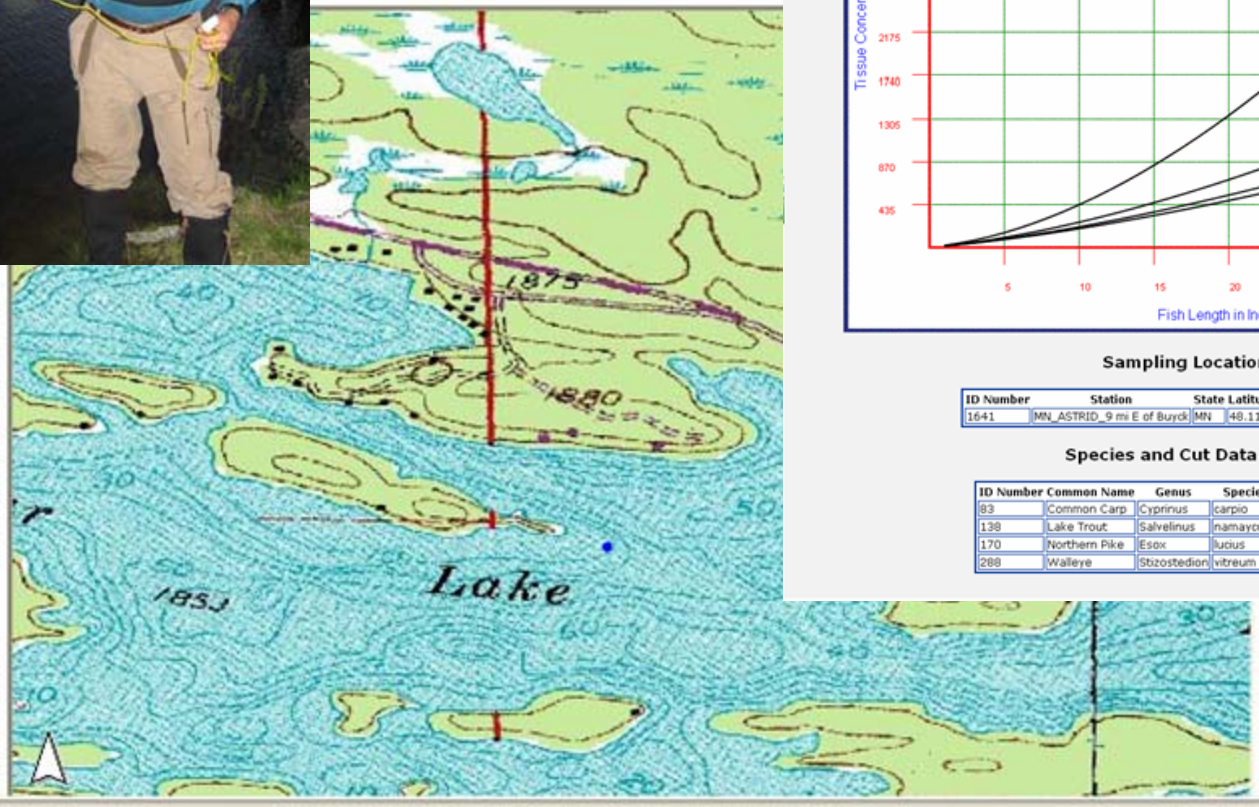
NIEHS

Mercury Mapping, Modeling,

Fish Model | Data Mapper | Other

Select

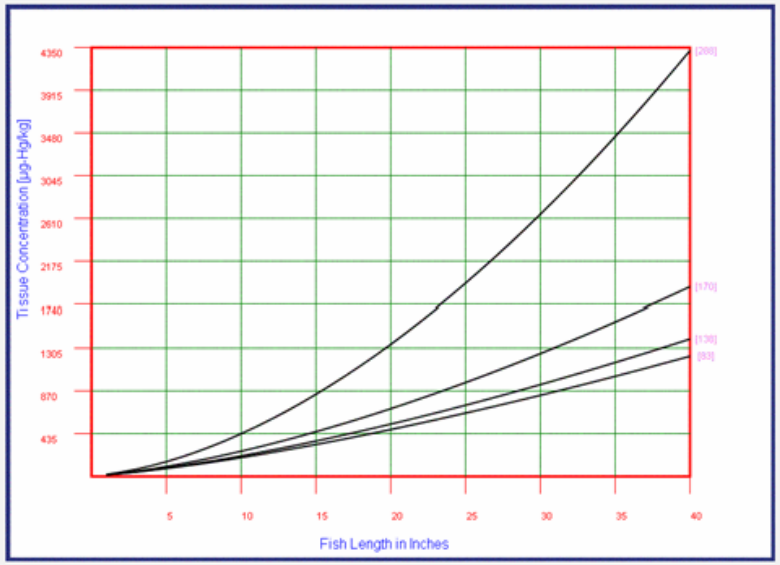
Misc



Interactive Descriptive-Model Concentration Graph (Type 1a)

Not Restricted to Species/Cuts Actually Observed at the Selected Location

This is the Type 1a graph of predicted fish-tissue mercury concentrations based on your selections. Please click the "refresh" buttor on your browser to insure the correct graph is displayed.



Sampling Location and Date

ID Number	Station	State	Latitude	Longitude	Year	Estimate Parameter
1641	MN_ASTRID_9 mi E of Buyck	MN	48.1111	-92.3311	1994	1.89817123565113

Species and Cut Data for This Graph

ID Number	Common Name	Genus	Species	Sample Type	Estimate Parameter
83	Common Carp	Cyprinus	carpio	Fillet skin off	1.403860385
138	Lake Trout	Salvelinus	namaycush	Fillet skin off	1.439828915
170	Northern Pike	Esox	lucius	Fillet skin off	1.524381426
288	Walleye	Stizostedion	vitreum	Fillet skin off	1.743177413

USGS Base Map Layers

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Mercury Data Mapper

Move

Zoom

Select

Misc

USGS

Map Created with ArcIMS - Copyright (C) 1992-2002 ESRI Inc.

0 0.96mi

Fish Tissue Raw Data

Modeled Data (By Species)

Soils & Stream Sediment Data

Mine Locations

Coal Data

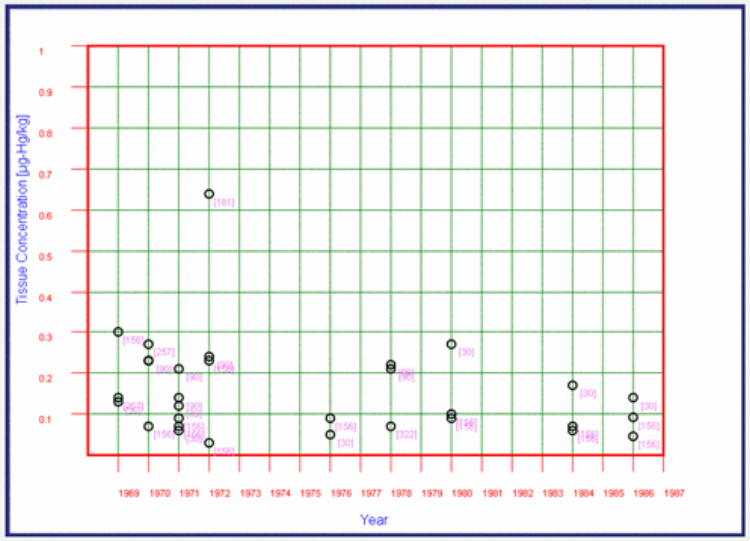
USGS Base Map Layers

Map: -119.32 , 45.9 -- Image: 475 , 386 -- ScaleFactor: 0.00015167142873717508

Internet

Chart of Observed Fish-Tissue Mercury Concentrations

This is the chart of predicted fish-tissue mercury concentrations based on your selections.



Sampling Location and Date

ID Number	Station	State	Latitude	Longitude	Estimate Parameter
4084	NCBP44	WA	46.35323611	-119.9887083	1.60333871430956

Species and Cut Data for This Graph

ID Number	Common Name	Genus	Species	Sample Type	Estimate Parameter
30	Black Crappie	Pomoxis	nigromaculatus	Whole	1.617594281
90	Common Carp	Cyprinus	carpio	Whole	1.278997999
156	Largescale Sucker	Catostomus	marcocheilus	Whole	1.248342199
181	Northern Squawfish	Ptychocheilus	oregonensis	Whole	1.681854917
257	Smallmouth Bass	Micropterus	dolomieui	Whole	1.650414721
322	White Crappie	Pomoxis	annularis	Whole	1.535672455

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Future Directions & Applications

- Refine website to allow user input of data, dynamic recalibration of model
- Improve national data coverage; create fish-Hg exposure surface
- Identify high fish-Hg events, link to causes
- Extend site/models to marine fish, lipophilic PBTs, etc.
- Explore spatial & temporal correlation of Hg surfaces with disease

Volunteers needed
to Beta-test EMMMA website

EMMMA@usgs.gov

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