Interpretations for Mercury Bioavailability in Soils

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Mercury 101

- Mercury is a naturally occurring element
  - Found in air, water and soil
- Mercury is found in many geologic formations, including coal

Source: http://www.epa.gov/mercury/about.htm

Mercury 101

- Natural sources to the atmosphere
  - Degassing through volcanoes
  - Diffusion from ore bodies
- Anthropogenic sources to the atmosphere
  - Incineration of coal

    "[Coal] fired power plants are the largest source of inorganic Mercury release in the US and account for 33% of all man-made inorganic mercury released into the environment worldwide" (Princeton, 2004).
  - Alkali and metal processing
  - Medical and other waste
  - Mining of gold and mercury

http://www.usgs.gov/themes/factsheet/146-00/

Mercury 101

- Methylmercury [CH_3Hg]
  - The most toxic form
    - Absorbed more readily and excreted more slowly than other forms of mercury
  - The only form of Hg that accumulates appreciably in fish
  - Produced in
    - Certain types of wetlands
    - Low-pH lakes

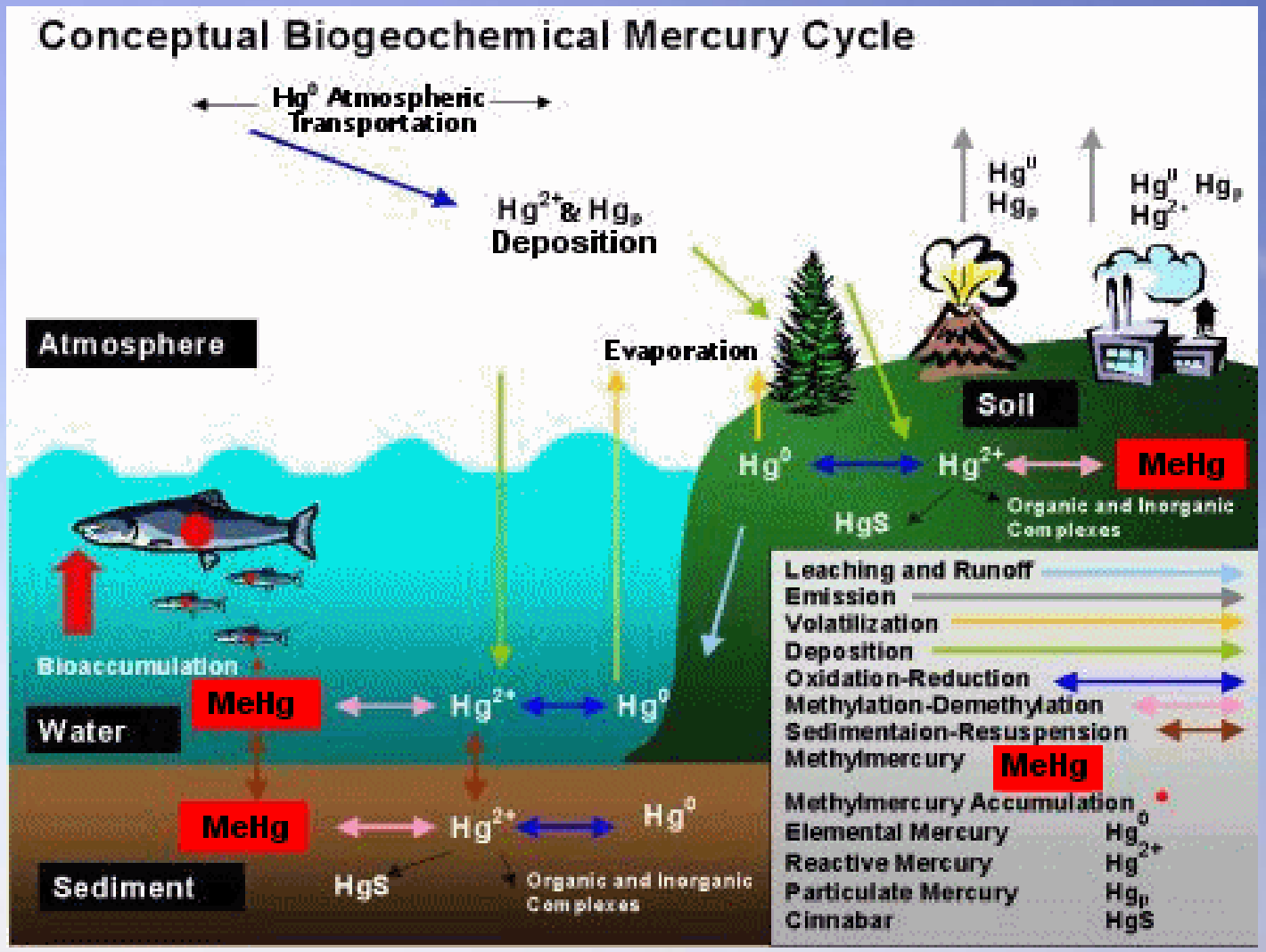
http://www.usgs.gov/themes/factsheet/146-00/

Mercury 101

- Exposure to Hg is mainly by eating contaminated fish or shellfish
- Risks to humans
  - Methylmercury, MeHg
    - Affects immune system, genetic and enzyme systems, and nervous system
    - Particularly damaging to developing embryos
      - Five to ten times more sensitive than adults
  - Elemental mercury, Hg(0)
    - Less toxic than MeHg
    - Causes tremors, gingivitis, and excitability
      - Requires long-term exposure to vapors

http://www.usgs.gov/themes/factsheet/146-00/

Mercury Cycle

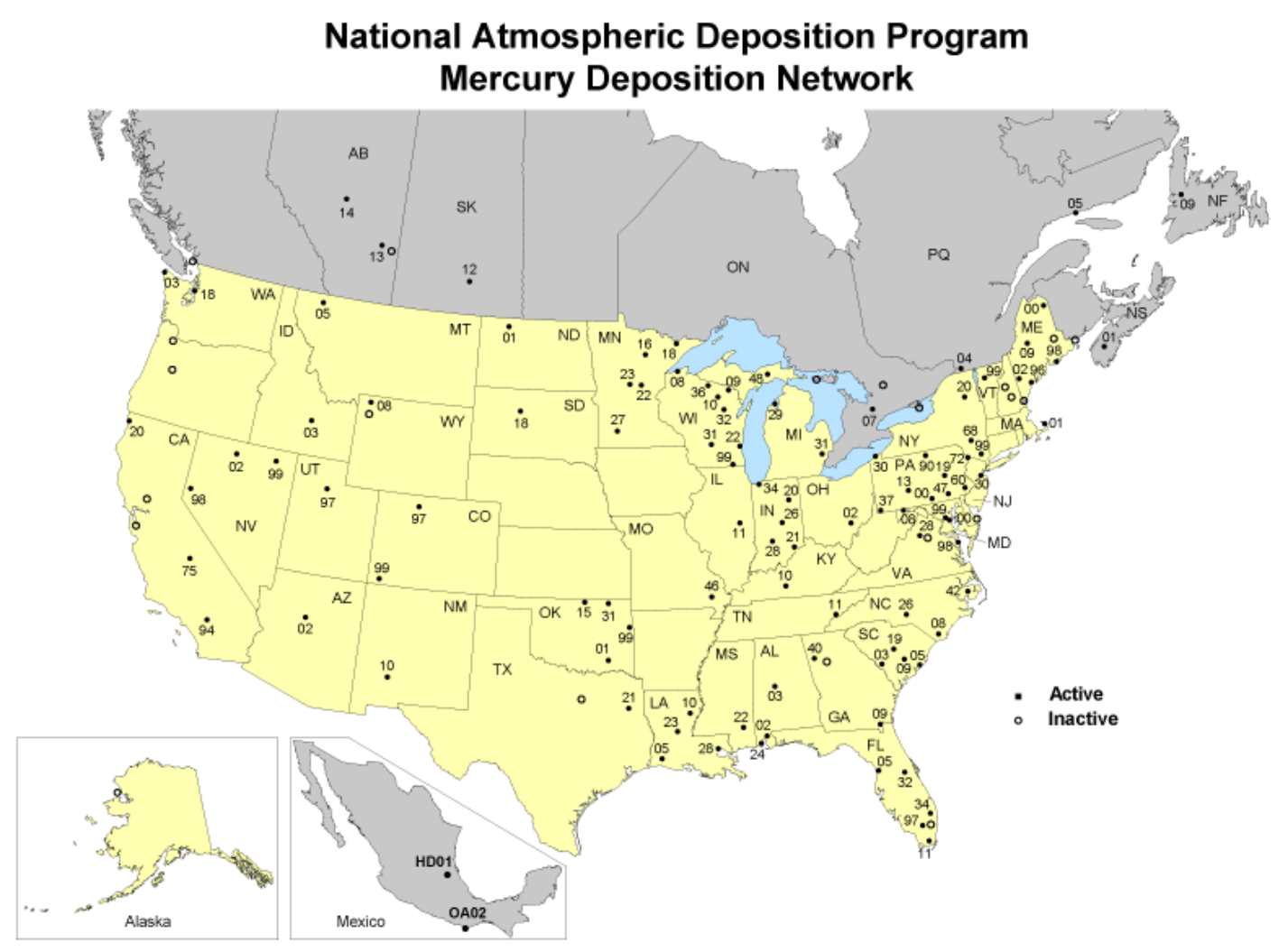


Source: http://toxipedia.org

Mercury Cycle

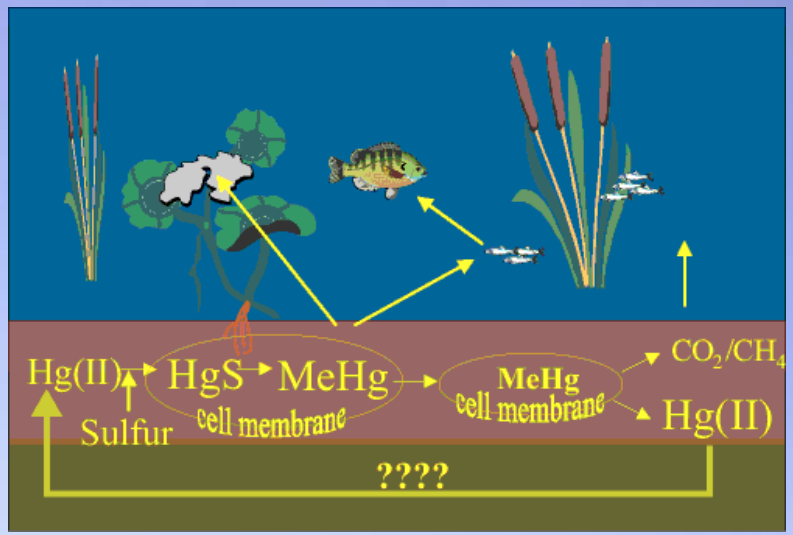
1. Degassing from rock, soils, and surface waters, or emissions from volcanoes and human activities
2. Movement in gaseous form through the atmosphere
3. Deposition on land and surface waters
4. Conversion to insoluble mercury sulfide
5. Precipitation or bioconversion into more volatile or soluble forms, such as MeHg
6. Reentry into the atmosphere or biomagnification up the food chain

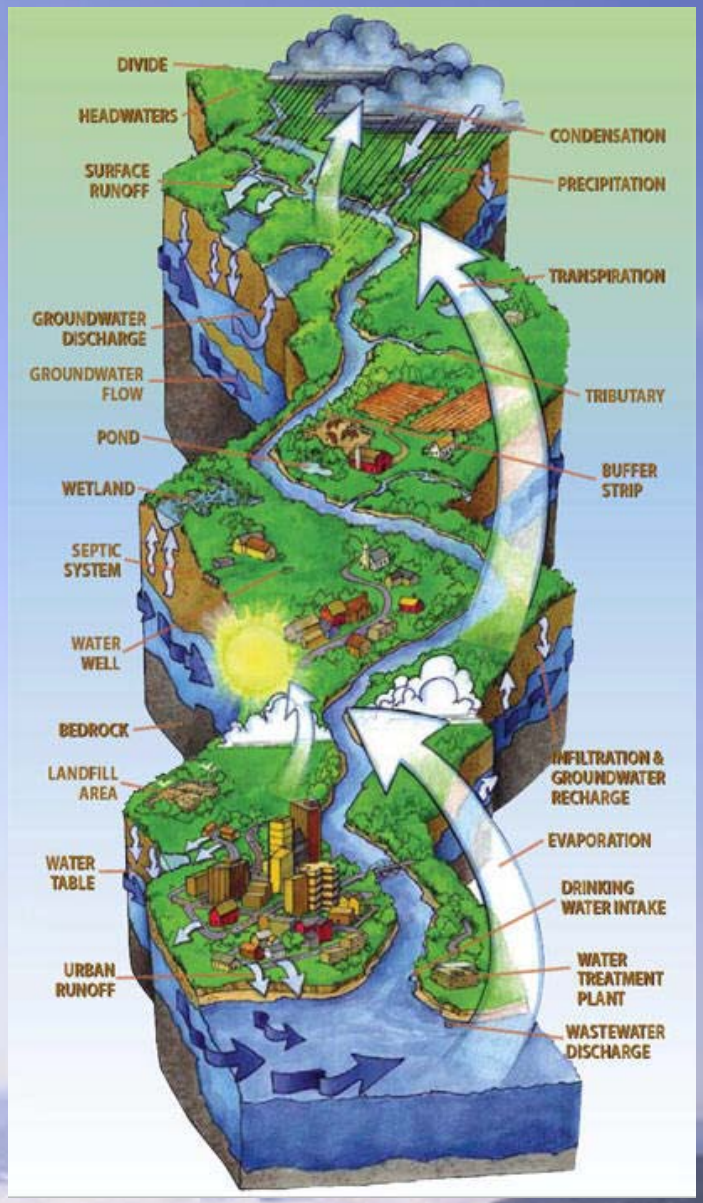
Monitoring Mercury in the US



Source: http://nadp.sws.uiuc.edu/

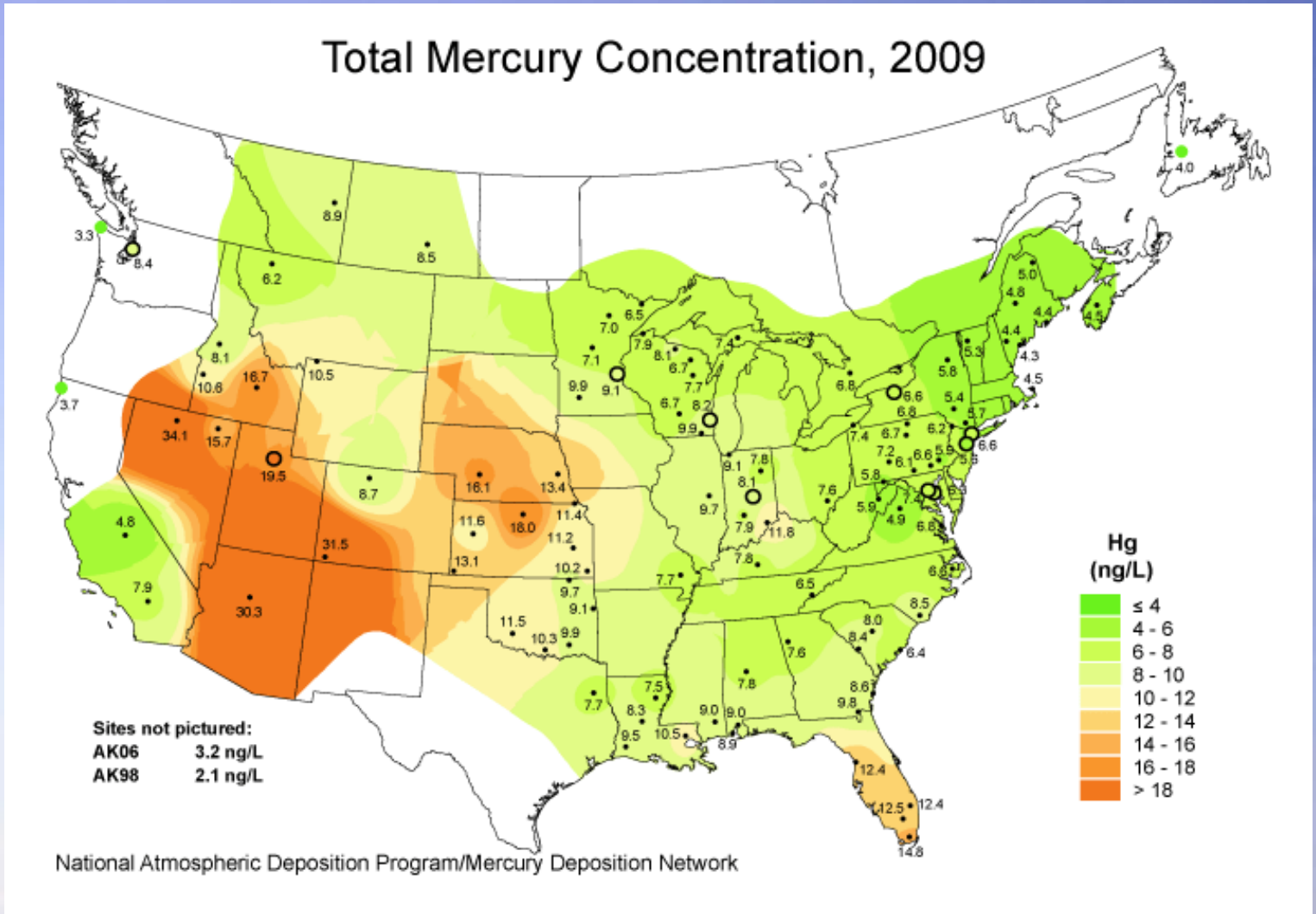
Watershed Management and Mercury





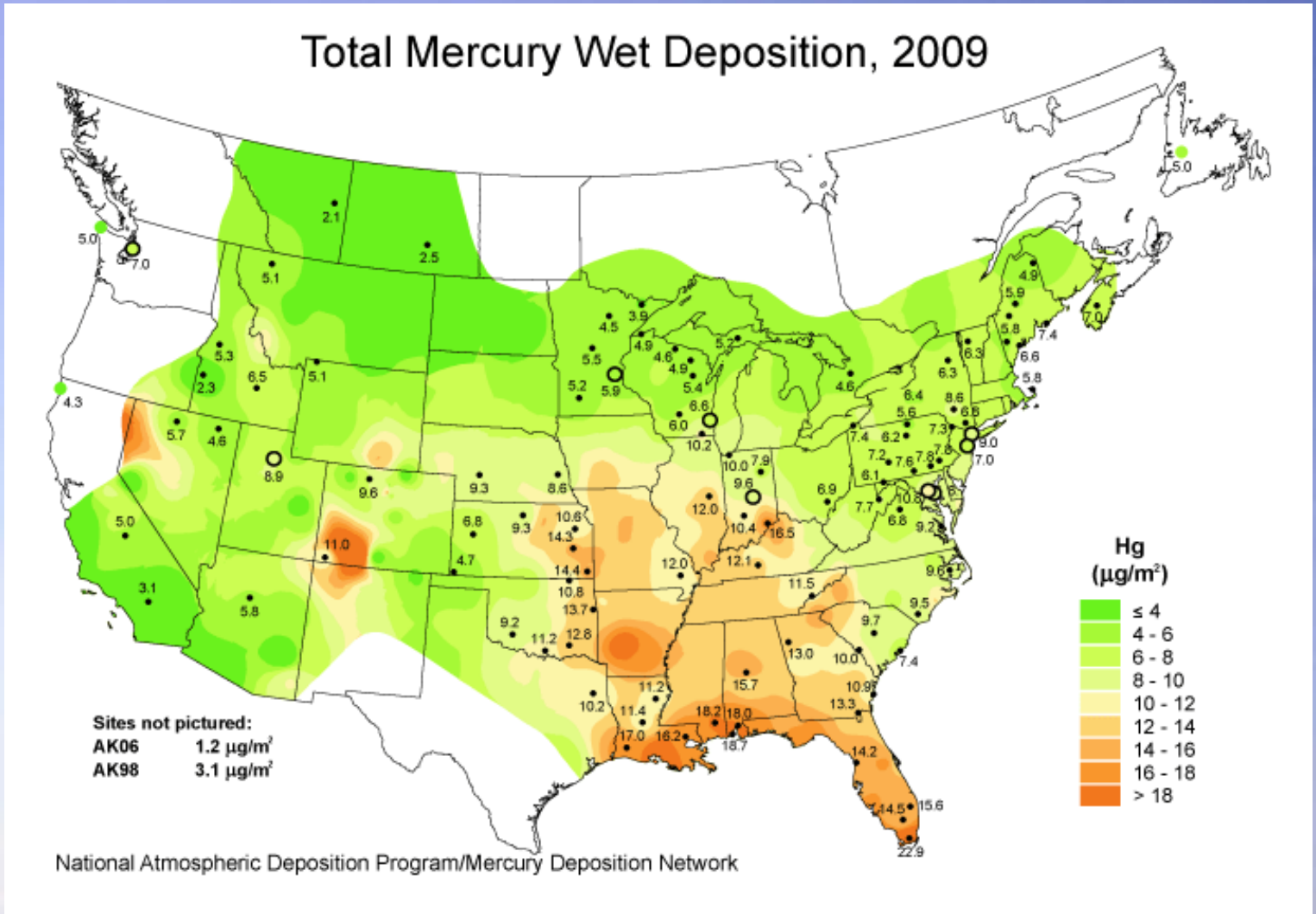
Source: http://connecticutwatertrails.com/

Mercury Deposition Network



Source: http://nadp.sws.uiuc.edu/

Mercury Deposition Network



Source: http://nadp.sws.uiuc.edu/

Mercury in the Environment

- Forms of Hg in the atmosphere
  - Elemental Hg, Hg(0)
    - >95% of the Hg in the atmosphere
  - Reactive gaseous Hg (RGM), Hg(II)
    - More soluble
    - Dominant form in wet deposition
  - Particulate phase Hg, Hg(p)
    - Highly susceptible to wet and dry deposition

Mercury Deposition

- Wet deposition
  - Precipitation, throughfall
- Dry deposition
- Foliar uptake (from atmosphere), litterfall
  - Greater than precipitation or throughfall

Mercury in Soils

- Pool size
  - Mineral soils: ~10x vegetation, ~5x forest floor
  - Even greater with organic soils
- Forms of Hg
  - Hg^{2+} [Hg (II)]
  - Methylmercury, MeHg
    - Lower binding to SOM than Hg(0)
    - <5% of total Hg
- Transformations
  - Hg(II) reduction in wet soils
  - Methylation

Mercury Risk Interpretation

- Storage potential
  - Organic matter content (+)
    - Reduced S groups
  - *Clay content* (+)
  - *Charcoal* (+)

Mercury Risk Interpretation

- Volatilization potential
  - Soil water content (+)
  - pH (+)
  - Temperature (+)

Mercury Risk Interpretation

- Methylation potential
  - Soil water content (+)
  - Organic matter content (+)
  - Temperature (+)

Watershed Characteristics

- Landscape factors
  - Proximity to surface waters
  - Slope gradient, runoff potential
  - Variable source areas
- Vegetation type, cover

Interpretation Development

- Development of interpretive statement
  - Relate land use, limiting features, interactions
- Criteria
  - Interpretations
  - Rules, sub rules
  - Evaluations
  - Properties

Risk Potential

- Effect of soil properties on:
  - Potential for MeHg to enter into the food chain
  - Where on the landscape this is likely to occur
- Effect of management activities:
  - Delivery of Hg laden sediments
  - Areas where Hg could accumulate and exit a watershed
- Ultimately: Risk to fauna and human health via consumption

Users and Uses

- Air quality scientists
  - EPA, USGS, USFS, NPS, and those that work in industry who are the source…
- Forest managers
  - Soil disturbance (logging), prescribed burns, recreation development
- Managers of aquatic ecosystems
  - USFWS, state natural resource staff, TVA, other entities interested in the health of fisheries
- Public health agencies
  - Health warnings and alerts, food security