

## DIELDRIN

- Dieldrin, the second most commonly used agricultural pesticide in the U.S. in the 1960s (after DDT) and banned in the U.S. in 1987, is an acutely toxic carcinogenic and endocrine-disrupting compound. It also decreases the effectiveness of the immune system, reduces reproductive success, and causes neurological problems.
- Dieldrin is classified as a persistent, bioaccumulative, and toxic (PBT) compound by the EPA. More information about the toxic effects of dieldrin can be found at <http://www.atsdr.cdc.gov/tfacts1.html> or <http://www.epa.gov/pbt/pubs/aldrin.htm>.
- In Oldman Lake at Glacier, dieldrin concentrations in 1 of 10 fish exceeded the USEPA human consumption cancer screening value for recreational fishermen.
- Also at Oldman Lake, the average concentration of dieldrin in fish exceeded the USEPA human consumption cancer screening value for subsistence fish consumption.
- Lake sediment cores taken in this study provide a history of contaminant deposition over time. Sediments at Glacier's Oldman Lake (and Snyder Lake) showed negligible dieldrin levels over time.
- Concentrations of dieldrin in fish at some parks (notably ROMO, SEKI and GLAC) were significantly elevated compared with concentrations in fish from similar Canadian studies.
- The USEPA cancer screening threshold for dieldrin is based on a 1:100,000 cancer risk for adults eating 2.3 meals of fish per month (recreational) or 19 meals of fish per month (subsistence) that are over the threshold<sup>1</sup>.
- To compare the risk level of dieldrin concentrations in fish with other parts of the country; 39% of fish at all sites (urban, agricultural, mixed use, and undeveloped) and 5.3% of fish at undeveloped<sup>2</sup> sites sampled across the U.S. from 1992-2001 by the USGS as part of the National Water Quality Assessment Program<sup>3</sup>, exceeded the dieldrin human health fish consumption threshold<sup>4</sup>.

---

<sup>1</sup> Contaminant health thresholds do not accurately assess all contaminant risk (other contaminants weren't measured (e.g., dioxins, furans) and likely change the risk profile). Additionally, these thresholds do not individualize risk (everyone has different risks and body burdens), and they do not characterize fish eating benefits, which likely outweigh contaminant risks for some people.

<sup>2</sup> NAWQA's definition of "undeveloped" sites allows up to 5% urban land use and up to 25% agricultural land use within the watershed--so these sites are not necessarily pristine.

<sup>3</sup> Percentages presented may be overestimations for two reasons: NAWQA (and WACAP) calculates contaminants in whole fish rather than edible fish tissue, while EPA determines human health thresholds based on contaminants only in edible fish tissue. Additionally, most NAWQA fish taxa sampled are not necessarily species that are typically consumed by people, but those with a high likelihood of containing contaminants (e.g., bottom-feeders).

<sup>4</sup> The distinction between recreational and subsistence fish consumption is not made due to high detection limits.

## DDT

- DDT, an insecticide banned in the U.S. in 1972, is a known endocrine-disrupting compound. It is a probable human carcinogen, damages the liver, temporarily damages the nervous system, reduces reproductive success, can cause liver cancer, and damages the reproductive system.
- Sum DDTs (including p,p'-DDE) are classified as persistent, bioaccumulative, and toxic (PBT) compounds by the EPA. More information about the toxic effects of DDT (including DDE and another byproduct, DDD) can be found at <http://www.atsdr.cdc.gov/tfacts35.html> or <http://www.epa.gov/pbt/pubs/ddt.htm>.
- At Oldman Lake at Glacier, the average concentration of DDT in fish exceeded the USEPA human cancer risk for subsistence fish consumption (i.e., adults eating 19 meals of these fish per month).
- Average DDT levels in fish exceeded the piscivorous bird (kingfisher) health threshold at Oldman Lake in Glacier.
- Lake sediment cores taken in this study provide a history of contaminant deposition over time. At Oldman Lake in Glacier, DDT in sediment cores has maintained fairly constant, yet relatively minimal, presence since registration, albeit with a small decrease since the 1950s. At Snyder Lake in Glacier, DDT levels were fairly high in the 1950s and have decreased substantially since then.
- The USEPA cancer risk threshold for DDT is based on p,p'-DDE, the form of DDT most frequently detected in the fish, and a 1:100,000 cancer risk for adults eating 2.3 meals of fish per month (recreational) or 19 meals of fish per month (subsistence) that are over the threshold<sup>5</sup>.
- To compare the risk level of DDT (i.e., p,p'-DDE) concentrations in fish with other parts of the country; 14% of fish at all sites (urban, agricultural, mixed use, and undeveloped) and 4.8% of fish at undeveloped<sup>6</sup> sites sampled across the U.S. from 1992-2001 by the USGS as part of the National Water Quality Assessment Program<sup>7</sup>, exceeded the DDT (i.e., p,p'-DDE) human health recreational fish consumption threshold. Sixty-one percent of fish at all sites and 34% of fish at undeveloped sites exceeded the DDT (i.e., p,p'-DDE) human health subsistence fish consumption threshold.

---

<sup>5</sup> Contaminant health thresholds do not accurately assess all contaminant risk (other contaminants weren't measured (e.g., dioxins, furans) and likely change the risk profile). Additionally, these thresholds do not individualize risk (everyone has different risks and body burdens), and they do not characterize fish eating benefits, which likely outweigh contaminant risks for some people.

<sup>6</sup> NAWQA's definition of "undeveloped" sites allows up to 5% urban land use and up to 25% agricultural land use within the watershed--so these sites are not necessarily pristine.

<sup>7</sup> Percentages presented may be overestimations for two reasons: NAWQA (and WACAP) calculates contaminants in whole fish rather than edible fish tissue, while EPA determines human health thresholds based on contaminants only in edible fish tissue. Additionally, most NAWQA fish taxa sampled are not necessarily species that are typically consumed by people, but those with a high likelihood of containing contaminants (e.g., bottom-feeders).

## CHLORDANE

- Chlordane, a pesticide banned for use in the U.S. in 1988, likely causes cancer and may cause liver cancer, can cause behavioral disorders in children if they were exposed before birth or while nursing, and harms the endocrine system, nervous system, digestive system, and liver.
- Chlordane is a persistent, bioaccumulative, and toxic (PBT) pollutant targeted by EPA. See <http://www.atsdr.cdc.gov/tfacts31.html> or <http://www.epa.gov/pbt/pubs/chlordane.htm> for more information.
- No chlordane levels in fish exceeded human health thresholds for recreational or subsistence fishing. However, at Oldman Lake in Glacier, the chlordane concentration in one out of eight individual fish exceeded the kingfisher health threshold.
- Compared to fish collected from several alpine lakes in Canada, WACAP fish were significantly lower in chlordanes (and HCHs) (only ~ ¼ of the concentration), likely reflecting differences in SOC exposure.

## INTERSEX

- Intersexuality can be used as an indicator of endocrine-disrupting contaminants such as dieldrin and DDT. The presence of an egg yolk precursor protein (vitellogenin-- Vtg) in the blood of male fish, normally found in mature female fish and used in egg production, is also another biomarker indicative of a chemical effect.
- “Intersex” (male and female reproductive structures in the same fish) has been found in one of 20 male fish (5%) at Glacier National Park.
- One of 20 male fish (5%) in Glacier exhibited intersex (Oldman Lake). Seven percent of male fish in Rocky Mountain NP also exhibited this condition.
- The intersex fish at Oldman Lake in Glacier had elevated Vtg levels, and had the highest levels of chlordanes, the dioxin-like PCB 118, and was the only fish in the study with detectable levels of o,p’-DDT (a byproduct of DDT), also a confirmed xenoestrogen (mimic female fish hormones). This finding implies that contaminants are associated with the reproductive health of that individual.
- These results are considered preliminary, because the small sample size in this screening study does not indicate the extent of the fish intersex condition in all surface waters across the two parks where the condition was documented, or in other parks in the western U.S. In addition, the screening-level design of the study means that “cause and effect” linkages between fish health and contaminants were not thoroughly explored. Further studies are planned to help us understand more about the extent of this condition in fish in western parks along with factors that may contribute to its development.
- **These are the first known examples of fish from “pristine” areas (such as western National Parks), to exhibit these signs of potential reproductive dysfunction** (intersex condition, feminizing chemicals in male fish). This study is also the first time that researchers have looked for intersex conditions in fish in western national parks, so there is much more to learn about how widespread it may be or what causes the condition.

## MERCURY

- While mercury is a naturally occurring element, human activities have greatly increased the amount of mercury currently cycling in the atmosphere, soils, lakes, and streams due to fossil fuel combustion (coal-burning), steel and lime production, smelting, petroleum refining, and mercury cell chlor-alkali production.
- Toxic effects of (methyl-) mercury include reduced reproductive success, impaired growth and development, behavioral abnormalities, reduced immune response and decreased survival. The forms of mercury are classified as a persistent, bioaccumulative, and toxic (PBT) by the EPA. More information about the toxic effects of mercury can be found at <http://www.atsdr.cdc.gov/cabs/mercury/> or <http://www.epa.gov/mercury/about.htm>.
- Mercury levels in fish at Glacier were not above the health threshold for human consumption
- Average concentration of mercury in fish exceeded the piscivorous bird (kingfisher) health threshold at Glacier.
- In general, mercury concentrations in snow were highest in the Rocky Mountain parks (Glacier and Rocky Mountain).
- Concentrations of industrial contaminants (PAHs and mercury) were highest in parks where local/regional point sources produce these contaminants.
- The contaminant health threshold for mercury is applied to the general population of adults eating 2.3 meals of fish per month.
- The human threshold is 300 ng/g wet weight (USEPA, 2001), and is based on methyl-Hg in the fillet for a general population of adults with 70 kg body weight and 0.0175 kg fish intake per day. 95-100% of Hg in fish is methyl-Hg (Bloom, 1992), and 300 ng/g in the fillet is equivalent to 185 ng/g ww whole body methyl-Hg (Peterson et al., 2007). Contaminant health thresholds in piscivorous animals (wildlife) are based on 100% fish in the diet for whole body total Hg, as determined by Lazorchak et al., (2003).
- Previous studies show that mercury in fish is strongly influenced by watershed and food web characteristics, and that the interplay among these variables is complex and varies in unpredictable ways.

## PAHs

- Polycyclic Aromatic Hydrocarbons (PAHs) are primarily by-products of incomplete combustion. These combustion sources are numerous, including natural sources such as wildfires, industrial processes, transportation (vehicle exhaust, fuel spills), energy production (burning coal) and use, food preparation (grilling meats), smoking tobacco, and disposal activities such as open trash burning.
- Some PAHs (e.g., benzo(a)pyrene) are PBT chemicals and suspected to cause cancer and developmental, reproductive, and neurological effects. See <http://www.epa.gov/pbt/pubs/benzo.htm> for more information on benzo(a)pyrene.
- The frequency of PAH detection was too low (i.e., 4% average detection) to perform appropriate human and wildlife health risk estimations. While the WACAP method was capable of measuring PAHs at levels below the human health thresholds, PAHs were not detected. This suggests that PAHs in WACAP fish likely did NOT exceed human health thresholds, but with so many fish lacking measurements, it would be inappropriate to estimate the human health risk from PAHs.
- Total PAH concentrations in vegetation were lowest in the Arctic (<10 ng/g lipid) and highest in Glacier (up to 200,000 ng/g lipid). The number of PAH compounds detected generally increased with total PAH concentration from 2 in the arctic to 17 in GLAC.
- PAHs had the highest surficial sediment flux of all SOCs in the WACAP sites. PAHs in sediment profiles were significantly greater at Snyder Lake in Glacier compared with all other lake profiles.
- Concentrations of PAHs in vegetation, snow, and sediments at GLAC were 1 to 2 orders of magnitude greater than at any other site.
- PAH ratios can be used to identify potential sources, and the data strongly suggests that GLAC's Snyder Lake watershed is influenced by the Columbia Falls aluminum smelter.

## **PBDEs**

- Polybrominated diphenylethers, or PBDEs, are often used as flame retardants in furniture foam and camping equipment, plastics for TV cabinets, consumer electronics, wire insulation, back coatings for draperies and upholstery, and plastics for personal computers and small appliances. While important for safety, there is growing evidence that PBDEs persist in the environment and accumulate in living organisms, as well as toxicological testing that indicates these chemicals may cause liver toxicity, thyroid toxicity, and neurodevelopmental toxicity. See <http://www.atsdr.cdc.gov/tfacts68-pbde.html> for more information on the toxic effects of PBDEs.
- No PBDE levels in fish exceeded human health thresholds for recreational or subsistence fishing.
- Wildlife health thresholds have not been established for PBDEs, thus the lack of comparison for kingfisher, otter, and mink.
- PBDE fluxes were above the method detection limits in the surficial sediment only from ROMO. Within ROMO, Mills Lake, located on the east side of the Continental Divide, had PBDE focus-corrected flux an order of magnitude greater than Lone Pine Lake, which is located on the west side of the Continental Divide.
- PBDEs were measured only in sediment and fish samples. PBDE 47 and PBDE 99 were two of the ten most dominant SOCs detected in fish. PBDE concentrations in fish across the WACAP parks varied less than most other SOCs, both within and between lakes, and were highest in MORA fish, and lowest in fish in the Alaska national parks.
- Concentrations of PBDEs in WACAP fish were approximately 3 times higher than concentrations in fish from similar alpine environments in Europe.

## PCBs

- Polychlorinated biphenyls (PCBs) have been used widely as coolants and lubricants because they do not easily burn and are good insulators. While the manufacturing of PCBs in the U.S. stopped in 1977, present sources of PCBs may include organic wastes burned at municipal and industrial incinerators, hazardous waste sites, etc.
- PCBs are persistent, bioaccumulative, and toxic (PBT) pollutants that have been targeted by EPA, and they are the leading chemical risk from fish consumption. They are a probable human carcinogen, can damage the stomach, cause skin irritation, liver and kidney damage, and thyroid gland injuries. See <http://www.atsdr.cdc.gov/cabs/pcb/> or <http://www.epa.gov/pbt/pubs/pcbs.htm> for more information.
- Human health risks from eating PCBs in WACAP fish were not calculated because WACAP did not measure the same chemicals as the PCB human health thresholds.
- No PCB levels in fish exceeded piscivorous wildlife health thresholds.
- PCBs were detected throughout sediment profiles in Glacier.