

8.0 References⁵⁴, Internet Resources, and Glossary

8.1 References

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World Health Organization. 2002. Safety Evaluation of Certain Food Additives and Contaminants, Polychlorinated Dibenzodioxins, Polychlorinated Dibenzofurans, and Coplanar Polychlorinated Biphenyls, Who Food Additives Series: 48.

(<http://www.inchem.org/documents/jecfa/jecmono/v48je20.htm>)

Yamamoto, M.N. and A.W. Tagawa, 2000. Hawai'i's native and exotic freshwater animals. Mutual Publishing, Honolulu, Hawaii. 200 p.

Yardley, R.B. Jr., Lazorchak, J.M. and S. G. Paulsen. 1998. Elemental Fish Tissue Contamination in Northeastern U.S. Lakes: Evaluation of an Approach to Regional Assessment, Environmental Toxicology and Chemistry: Vol. 17, No. 9, pp. 1875–1884.

8.2 Internet Resources

New England State Fish Consumption Advisories:

<http://www.epa.gov/region1/eco/mercury/newengland-fish.htm>

Listing and mapping of fish consumption advisories in Canada and the U.S.:

<http://134.67.99.49/scripts/esrimap.dll?name=Listing&Cmd=Map>

MassDEP - Mercury Resources

<http://mass.gov/dep/toxics/stypes/hgres.htm>

Mercury in New England:

<http://www.epa.gov/region1/eco/mercury/>

Indigenous Environmental Network - How Persistent Organic Pollutants Threaten the Natural Environment and the Future of Indigenous Peoples:

http://www.ienearth.org/pops_threat-p1.html

Green Lane - Government of Canada - Persistent Organic Pollutants (POPs):

[http://www.ec.gc.ca/cleanair-airpur/Persistent_Organic_Pollutants_\(POPS\)-WS8F6FD286-1_En.htm](http://www.ec.gc.ca/cleanair-airpur/Persistent_Organic_Pollutants_(POPS)-WS8F6FD286-1_En.htm)

World Health Organization - Polychlorinated Biphenyls: Human Health Aspects

<http://www.inchem.org/documents/cicads/cicads/cicad55.htm>

Health Canada - It's Your Health - Food safety and PCBs found in fish:

http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2004/2004_pcb-bpc_e.html

Information from the National Institute of Environmental Health Sciences:

Mercury: <http://ehp.niehs.nih.gov/topic/mercury.html>

Dioxin: <http://ehp.niehs.nih.gov/topic/dioxin.html>

PCBs: <http://www.ehponline.org/topic/pcbs.html>

Pesticides: <http://ehp.niehs.nih.gov/topic/pesticides.html>

Persistent Organic Pollutants: <http://ehp.niehs.nih.gov/topic/pop.html>

United Nations Environment Program (UNEP) Toxicological and Chemical Information on Persistent Organic Pollutants (POPs): <http://www.chem.unep.ch/pops/>

Health Canada - It's Your Health - Dioxins and Furans:

http://www.hc-sc.gc.ca/iyh-vsv/environ/dioxin_e.html

Dioxins and Furans: What are They?:

http://www.ecoinfo.ec.gc.ca/env_ind/region/dioxinfuran/defndioxin_e.cfm#WHO

Greenfacts. 2004. Scientific Facts on Dioxins:

<http://www.greenfacts.org/dioxins/index.htm>

Interagency Working Group on Dioxin - Questions and Answers on Dioxins:

<http://www.cfsan.fda.gov/~lrd/dioxinqa.html>

Toxic Equivalences (TEQs): <http://c3.org/sitedata/test3/def.html>

USEPA - Anglers and Aquatic Resource Protection: <http://www.epa.gov/owow/fish/>

USEPA - Connecticut River Information Page: <http://www.epa.gov/ne/eco/ctriver/>

USEPA - Dioxin and Related Compounds:

http://cfpub.epa.gov/ncea/cfm/dioxin.cfm?ActTyellow_perche=default

USEPA - Draft Dioxin Reassessment:

http://cfpub.epa.gov/ncea/cfm/dioxreass.cfm?ActTyellow_perche=default

USEPA - Health Effects of Mercury:

<http://www.epa.gov/mercury/effects.htm>

USEPA - Persistent Bioaccumulative and Toxic Pollutants:

<http://www.epa.gov/opptintr/pbt/aboutpbt.htm>

USEPA - Persistent Organic Pollutants (POPs):

<http://www.epa.gov/oppfead1/international/pops.htm>

USEPA - EPA History - DDT:

<http://www.epa.gov/history/topics/ddt/index.htm>

8.3 Glossary

Amphipods - "Small shrimp-like crustaceans such as sand fleas and related forms. Many live on the bottom (i.e., are benthic) and feed on algae and detritus."
(<http://www.abag.ca.gov/bayarea/sfep/reports/soe/soegloss.htm>)

Analysis of Variance (ANOVA) - "is a test of the statistical significance of the differences among the mean scores of two or more groups on one or more variables."
(www.etr.org/recapp/research/researchglossary.htm)

Atmospheric deposition - "Airborne pollutants which are deposited back on land and water either in wet form (ie, in precipitation) or dry form (ie, as particles), often having undergone chemical transformation and often having been transported great distances in the atmosphere."
(library.marist.edu/diglib/EnvSci/archives/hudsmgmt/ny-njharborestuaryprogram/glossary.html)

Benthic - "Animals dwelling on the bottom of a water body. These organisms inhabit the sediment on lake, river, or ocean bottoms, as well as the sediment in marshes, tidal flats, and other wetlands."
(mapping.orr.noaa.gov/website/portal/portland/definitions.html)

Benthopelagic - Organism that "lives in the water column but is associated with the sea floor." (gmbis.marinebiodiversity.ca/BayOfFundy/glossA-D.html)

Bioaccumulation - "The accumulation by organisms of contaminants through ingestion or contact with skin or respiratory tissue. The net accumulation of a substance by an organism as a result of uptake from all environmental sources. As an organism ages, it can accumulate more of these substances, either from its food or directly from the environment. Bioaccumulation of a toxic substance has the potential to cause harm to organisms, particularly to those at the top of the food chain."
(www.great-lakes.net/humanhealth/about/words_b.html)

Biodiversity - "Number and variety of living organisms; includes genetic diversity, species diversity, and ecological diversity"
(<http://biology.usgs.gov/s+t/noframe/z999.htm>)

Biomagnification - "A cumulative increase in the concentration of a persistent substance in successively higher trophic levels of the food chain. The process by which the concentration of a substance increases in different organisms at higher levels in the food chain. For example, if an organism is eaten by another organism, these substances move up the food chain and become more concentrated at each step. See also bioaccumulation and accumulation."
(www.great-lakes.net/humanhealth/about/words_b.html)

Carcinogenic Screening Value - In the current study this is a human health screening value that predicts the likelihood of 1 in 100,000 of acquiring cancer with a lifetime exposure at the observed level (USEPA 2000a)

Chlorinated (Organochlorine) Pesticides - "Organochlorine Insecticides were commonly used in the past, but many have been removed from the market due to their health and environmental effects and their persistence (e.g. DDT and chlordane)"

(<http://www.epa.gov/pesticides/about/types.htm>). "Organochlorine pesticides are man-made organic chemicals. DDT was the first that was used on a large scale in the U.S. The Second National Report on Human Exposure to Environmental Chemicals measures metabolites, or chemicals created by the body's defenses acting on a parent compound, of DDT, such as DDE. Many organochlorine pesticides are extremely persistent in the environment and in people's bodies. Although most are no longer used in the U.S., many are manufactured here for use elsewhere, especially in developing countries. Scorecard provides information for organochlorine pesticides as a class as well as for several of the individual chemicals."
(www.scorecard.org/about/txt/organochlorine_pesticides.html)

Chironomids - "Small two winged flies called midges that lack piercing mouthparts; of the Family Chironomidae." (collections.ic.gc.ca/compendium/glossary.html)

Circuli - "Concentric, continuous lines on fish scales and various bones."
(www.fishbase.org/Glossary/Glossary.cfm?TermEnglish=circuli)

Cladocerans - "Any of an order (Cladocera) of minute, freshwater brachiopod crustaceans, including the water fleas." (biology.usgs.gov/s+t/SNT/noframe/zy198.htm)

Copepods - "are a group of small crustaceans found in the sea and nearly every freshwater habitat. Many species are planktonic, but more are benthic, and some continental species may live in limno-terrestrial habitats and other wet terrestrial places, such as swamps, under leaf fall in wet forests, bogs, springs, ephemeral ponds and puddles, damp moss, or water-filled recesses (phytothelmata) of plants such as bromeliads and pitcher plants. Many live underground in marine and freshwater caves, sinkholes, or stream beds. Some copepods are parasitic and attach themselves to fish, sharks, marine mammals, and many kinds of invertebrates such as molluscs, tunicates, or corals....Copepods are very important food organisms for small fish, whales, and other crustaceans such as krill in the ocean and in fresh water. They are typically 1-2 mm long. They feed directly on phytoplankton, catching cells singly. Some scientists say they form the largest animal biomass on earth. They compete for this title with Antarctic krill (*Euphausia superba*)." (<http://en.wikipedia.org/wiki/Copepods>)

Coplanar (Dioxin-like) PCBs - Coplanar PCBs (PCB 77, PCB 81, PCB 105, PCB 114, PCB 118, PCB 123, PCB 126, PCB 156, PCB 157, PCB 167, PCB 169, PCB 189) are believed to have dioxin-like activity and their toxicity is determined using the consensus WHO TEFs (Table 23). Coplanar refers to the chemical structure of these PCBs, which is flat or in a plane.

Correlation - Non-parametric and parametric correlation is used in the current study.

“A statistical relationship between two variables such that high scores on one factor tend to go with high scores on the other factor (positive correlation) or that high scores on one factor go with low scores on the other factor (negative correlation).”

(psy.st-andrews.ac.uk/resources/glossary.shtml). The conventional dictum is that correlation does not imply causation. Such causation is considered a logical fallacy. “However, correlations are not presumed to be acausal, though the causes may not be known.” ([en.wikipedia.org/wiki/Correlation#Correlation does not imply causation](http://en.wikipedia.org/wiki/Correlation#Correlation_does_not_imply_causation))

Cumulative Distribution Functions (CDFs) - “A CDF indicates, across the full range of values, the proportion of samples at or below a given value. CDFs are a useful descriptive tool in determining whether most of the values are very low, with a few high values or whether values cover a broader range” (USEPA 2001e:11).

Demersal - Fish that frequent bottom habitats.

Dioxin - “...commonly used to refer to a family of toxic chemicals that all share a similar chemical structure and a common mechanism of toxic action. This family includes seven of the polychlorinated dibenzo dioxins (PCDDs), ten of the polychlorinated dibenzo furans (PCDFs) and twelve of the polychlorinated biphenyls (PCBs)[Table x]. PCDDs and PCDFs are not commercial chemical products but are trace level unintentional by products of most forms of combustion and several industrial chemical processes. PCBs were produced commercially in large quantities until production was stopped in 1977. Dioxin levels in the environment have been declining since the early seventies and have been the subject of a number of federal and state regulations and clean-up actions; however, current exposures levels still remain a concern. “Because dioxins are widely distributed throughout the environment in low concentrations, are persistent and bioaccumulated, most people have detectable levels of dioxins in their tissues. These levels, in the low parts per trillion, have accumulated over a lifetime and will persist for years, even if no additional exposure were to occur. This background exposure is likely to result in an increased risk of cancer and is uncomfortably close to levels that can cause subtle adverse non-cancer effects in animals and humans.”(<http://www.epa.gov/toxteam/pcb/defs.htm>)

Ecological Risk Assessment - Ecological risk assessment is a “...process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors” (USEPA 1998). In the current study an ecological risk screening was conducted in which observed levels of contaminants were compared to screening values (SVs) obtained from EPA and other scientific references, as noted.

Epibenthic - “Living on the bottom surface of lakes or the ocean.” (museum.gov.ns.ca/mnh/nature/nhns2/glossary.htm). “Occurring on, but not penetrating, the substrate and submerged objects (= Aufwuchs).” (gmbis.marinebiodiversity.ca/BayOfFundy/glossE-H.html)

Ecosystem - “The interacting synergism of all living organisms in a particular environment; every plant, insect, aquatic animal, bird, or land species that forms a complex web of interdependency. An action taken at any level in the food chain, use of a pesticide for example, has a potential domino effect on every other occupant of that system.” (www.nsc.org/ehc/glossary.htm)

Fish Advisories - “Fish are a lean, low-calorie source of protein. However, some fish may contain chemicals that could pose health risks. When contaminant levels are unsafe, consumption advisories may recommend that people limit or avoid eating certain species of fish caught in certain places” www.epa.gov/ost/fish/

Dibenzofuran - “Dibenzofurans can also refer to a family of organic compounds which have atom or group substitutions made for the hydrogens on any of the numbered carbon atoms in the dibenzofuran structure. For example, 2,3,7,8-tetrachlorodibenzofuran (TCDF) has chlorine atoms substituted for each of the hydrogens on the number 2, 3, 7, and 8 carbons (see structure below). Dibenzofurans are very toxic chemicals with properties and chemical structures similar to dioxins.” (<http://en.wikipedia.org/wiki/Dibenzofuran>)

DDT Homolog - In this study total DDT homologs (chemical forms of the parent DDT compound resulting from biological and chemical ‘weathering’) are the sum of the six homologs (o,p'-DDT, p,p'-DDT, p,p'-DDE, o,p'-DDE, o,p'-DDD, and p,p'-DDD).

Homologous Series - In chemistry, a homologous series is a series of organic compounds with a similar general formula, possessing similar chemical properties due to the presence of the same functional group, and shows a gradation in physical properties as a result of increase in molecular size and mass (http://en.wikipedia.org/wiki/Homologous_series)

Human health risk screening - Human health risk assessment, for example, to mercury includes hazard identification and dose-response assessments and assessment of exposure covered in Volumes 4 and 5 of EPA’s Mercury Study Report to Congress (USEPA 1997b; 1997c). In the current study the human health risk screening compared observed levels of contaminants to screening values (SVs) found in EPA’s (2000a; 2000b) Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories - Third Edition.

Lowest-Observed-Adverse-Effect Level (LOAEL) - The lowest exposure level at which there are biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group (Glossary of IRIS Terms - <http://www.epa.gov/iris/gloss8.htm>)

Methylation - "In biochemistry, methylation refers to the replacement of a hydrogen atom (H) with a methyl group (CH₃), regardless of the substrate. In general chemistry, the term deals with delivery of a methyl group in a variety of ways, not necessarily replacing hydrogen. In biological systems, methylation is catalyzed by enzymes; such methylation can be involved in modification of heavy metals, regulation of gene expression, regulation of protein function, and RNA metabolism. Methylation of heavy metals can also occur outside of biological systems."
(<http://en.wikipedia.org/wiki/Methylation>)

Morphometric - "Relative to measurements of the shape of an individual; body proportions; the size relationship of various morphological characteristics of an animal."
(www.fishbase.org/Glossary/Glossary.cfm?TermEnglish=morphometric)

Mysids - "Group of small, shrimp-like crustaceans characterised by possessing a ventral brood pouch." (www.reefed.edu.au/glossary/m.html)

Nekton - "Free-swimming organisms in aquatic ecosystems; unlike plankton, they are able to navigate at will (such as fishes, amphibians, and large swimming insects)."
(biology.usgs.gov/s+t/SNT/noframe/zy198.htm)

No-Observed-Adverse-Effect Level (NOAEL) - The highest exposure level at which there are no biologically significant increases in the frequency or severity of adverse effect between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse or precursors of adverse effects (Glossary of IRIS Terms - <http://www.epa.gov/iris/gloss8.htm>)

Non-carcinogenic Screening Value - In the current study a human health screening level with a non-cancer health risk (USEPA 2000a).

Non-Parametric Statistics - "Used when data is ordinal or nominal in scale, so that operations like addition and subtraction cannot be meaningfully applied. These tests are less sensitive than parametric tests to trends in the data (eg differences between conditions) but can be used with a wider range of measures."
(psy.st-andrews.ac.uk/resources/glossary.shtml)

Ostracods - "Ostracoda is a class of the Crustacea, sometimes known as the seed shrimp because of their appearance. Some 50,000 extinct and extant species have been identified, grouped into several orders. Ostracods are small crustaceans, typically around one mm in size, but varying between 0,2 to 30 mm, laterally compressed and protected by a bivalve-like, chitinous or calcareous valve or "shell". The hinge of the two valves is in the upper, dorsal region of the body. Ecologically ostracods can be part of the zooplankton, or (most commonly) they are part of the benthos, living on or inside the upper layer of the sea floor. Many ostracods are also found in fresh water and some are known from humid continental forest soils." (<http://en.wikipedia.org/wiki/Ostracod>)

Otolith - "Calcareous concretions in the ear capsules of bony fishes used for perception of acceleration including gravity. Also called 'ear bones', 'ear stones' or statoliths. These bones frequently show daily, seasonal or annual checks, rings or layers which can be used to determine ages. The lapillus lies in the utricle, the sagitta in the sacculus, and the asteriscus in the lagena. See also otoconium and marginaria."
(www.fishbase.org/Glossary/Glossary.cfm?TermEnglish=otolith)

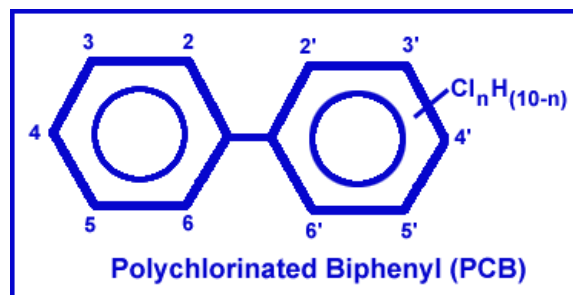
PBDE, (Polybrominated Diphenyl Ether) - "is a flame-retardant of the brominated flame-retardant group rated as a Persistent Organic Pollutant. It has been used in a wide array of household products, including fabrics, furniture, and electronics. There are three main types, referred to as penta, octa and deca for the number of bromine atoms in the molecule. Of the three, deca is most commonly used and is considered the "safest" of the three. After studies in Sweden found the chemicals accumulating in breast milk and other tissues, Sweden banned the chemicals. The European Union is in the process of banning PBDEs with a full ban to be in place by 2006. Surprisingly, an experiment done at Woods Hole Oceanographic Institution in Massachusetts in 2005 showed that the isotopic signature of PBDEs found in whale blubber contained carbon-14, the naturally occurring radioactive isotope of carbon. If the PBDEs in the whale had come from artificial (human-made) sources, they would have only contained carbon-12 and no carbon-14 due to the fact that virtually all PBDEs which are produced artificially use petroleum as the source of carbon, all carbon-14 would have long since completely decayed from that source. The experiment thus shows that there must be some as yet unidentified natural source of PBDEs." (<http://en.wikipedia.org/wiki/PBDE>)

Persistent Bioaccumulative and Toxic (PBTs) Pollutants - "PBT pollutants are chemicals that are toxic, persist in the environment and bioaccumulate in food chains and, thus, pose risks to human health and ecosystems. The biggest concerns about PBTs are that they transfer rather easily among air, water, and land, and span boundaries of programs, geography, and generations."
(<http://www.epa.gov/pbt/aboutpbt.htm>)

Persistent Organic Pollutants (POPs) - "Persistent organic pollutants (POPs) are a class of chemicals that persist in the environment, are capable of long-range transport, bioaccumulate in human and animal tissue, and have significant impacts on human health and the environment. They include such substances as dioxin, PCBs, DDT, brominated flame-retardants or tributyltin (TBT). POPs released to the environment can travel through air and water to regions far distant from their original source."
(en.wikipedia.org/wiki/Persistent_organic_pollutants)

Plankton - "Minute floating forms of microscopic plants and animals in water which cannot get about to any extent under their own power. They form the important beginnings of food chains for larger animals."
(www.stateofthesalmon.org/resource/glossary.asp)

Polychlorinated Biphenyl (PCB or PCBs) "is a category, or family, of chemical compounds formed by the addition of Chlorine (Cl_2) to Biphenyl ($\text{C}_{12}\text{H}_{10}$), which is a dual-ring structure comprising two 6-carbon Benzene rings linked by a single carbon-carbon bond. The nature of an "aromatic" (Benzene) ring allows a single attachment to each carbon. This means that there are 10 possible positions for chlorine substitution (replacing the hydrogens in the original Biphenyl). Species with a single chlorine substituent are called 'Monochlorobiphenyl' (or just 'Chlorobiphenyl'). Species with two chlorines are called 'Dichlorobiphenyl', and the those with three through ten chlorines, in order, are called: "Tri...", "Tetra...", "Penta...", "Hexa...", "Hepta...", "Octa...", "Nona...", and "Decachlorobiphenyl". The positions of the chlorine substituents on the rings are denoted by numbers assigned to each of the carbon atoms, with the carbons supporting the bond between the rings being designated 1 and 1'."



(<http://www.epa.gov/toxteam/pcb/defs.htm>)

PCB Congener - Any single, unique, well-defined chemical compound in the PCB category is called a "Congener". The name of a congener specifies the total number of chlorine substituents and the position of each chlorine. For example: 4,4'-Dichlorobiphenyl is a congener comprising the Biphenyl structure with two chlorine substituents, one on each of the two carbons at the "4" (also called "para") positions of the two rings. There are 209 PCB congeners.
(<http://www.epa.gov/toxteam/pcb/defs.htm>)

Piscivorous (fish-eating) - Wildlife that relies on fish as a substantial portion of its diet.

Recreational (Sport) Fisher - "Sport fishers include all noncommercial fishers who are not subsistence fishers. (They have also been referred to as recreational fishers.)"
EPA (2000b). EPA currently recommends default fish consumption rates of 17.5 g/d for recreational fishers.

Screening Values (SVs)/Screening Levels (SLs) - These terms are used synonymously in the current study to refer to human health and eco-risk criteria against which observed contaminant levels are compared. Exceedance of these SVs/SLs suggests a level of possible concern which should be assessed further to determine the magnitude of the potential risk.

Parametric Statistics - "Parametric inferential statistical methods are mathematical procedures for statistical hypothesis testing which assume that the distributions of the variables being assessed belong to known parametrized families of probability distributions. Analysis of variance assumes that the underlying distributions are normally distributed and that the variances of the distributions being compared are similar. The Pearson product-moment correlation coefficient assumes normality."
(en.wikipedia.org/wiki/Parametric_statistics)

Subsistence Fisher - "...subsistence fishers are defined as fishers who rely on noncommercially caught fish and shellfish as a major source of protein in their diets...Native American subsistence fishers are a unique subsistence fisher population that needs to be considered separately" (USEPA 2000b:1-6). EPA (2000b) currently recommends default fish consumption rates of 142.4 g/d for subsistence fishers.

Toxic Equivalent Factors (TEFs) - Apply to selected dioxins and furans (Table 23). "Toxic Equivalence Factors (TEF) (WHO 1998) standardize the toxicity of the dioxins and furans, to derive a toxic equivalence as 2,3,7,8-T4CDD. The TEF for the dioxins and furans without chlorine atoms at the 2, 3, 7, and 8 positions is zero." (http://www.ecoinfo.ec.gc.ca/env_ind/region/dioxinfuran/defndioxin_e.cfm#WHO).

Toxic Equivalence (Equivalents) (TEQs) - "The toxic equivalence, or TEQ, of a combination of dioxins and furans is calculated by applying the TEF to each concentration of the congener in a sample and summing. Congener concentrations that are below the detection limit are assigned a value of 0 (zero) when calculating TEQ according to the Environment Canada procedure⁵⁵." (http://www.ecoinfo.ec.gc.ca/env_ind/region/dioxinfuran/defndioxin_e.cfm#WHO)

Trophic Level - "A number indicating the position of a species within an ecosystem. By definition, plants have a TL = 1, herbivores TL = 2, and so on, up to a TL = 5 in killer whales and polar bears. Note that trophic levels do not need to be whole numbers; intermediate values occur among fishes and other animals with a mixed diet composition. The phrase "fishing down marine food webs" refers to the increased tendency for marine landings to consist of animals with lower trophic levels." (research.amnh.org/biodiversity/symposia/archives/seascapes/glossary.html)

Zoobenthos - "In marine geology and biology, benthos are the organisms and habitats of the sea floor; in freshwater biology they are the organisms and habitats of the bottoms of lakes, rivers, and creeks. Animals belonging to the benthos are sometimes referred to as zoobenthos." (en.wikipedia.org/wiki/Zoobenthos)

Zooplankton - "The animal component of plankton; animals suspended or drifting in the water column including larvae of many fish and benthic invertebrates." (www.fishonline.org/information/glossary/)

⁵⁵ The current study decided to *not* follow the USEPA (2000b) recommendation to assign all non-detects values of half the detection limit. In the case of TEQs, in particular, we believed this could falsely inflate the apparent toxicity. Given our conservative screening assumptions we believed this approach provided both a close approximation of the actual toxicity and was protective of human health and the environment. The detection limits of all analyses are available in Appendices C and D.